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Recommended Food for Wellbeing of Heart: World Heart Day Exclusive

Richa Kumari, Kumari Asmita and Sudhanand Prasad Lal

Introduction

World Heart Day is celebrated every year on 29th September. World Heart Day was first time celebrated in 2000 and was proposed by Antoni Bayés de Luna who was the President of the World Heart Foundation in that time. Globally, cardiovascular diseases (CVD) constitute the leading cause of death. Heart Day is a component of a global initiative to raise awareness regarding prevention of heart disease and stroke. The purpose of the day is to raise awareness of cardiovascular disease, which is responsible for roughly half of all non-communicable diseases globally. The World Health Organization (WHO) estimates that 17.9 million people die from cardiovascular illnesses each year, or 31% of all fatalities worldwide. Heart attacks and strokes are to blame for about 85% of these fatalities.

History

World Heart Day was created by the World Heart Federation and World Health Organization in 1999. On September 24, 2000, WHF & the WHO held the first celebration of the day. World Heart Day is an international movement where people, families, communities, and governments take part in actions to take control of their own and others' heart health.

World Heart Day 2022: Theme

Every year, the World Heart Federation organize the global event and declares the theme. The day is celebrated every year on a particular theme. Below is the list of past 10 year world heart day theme.

Sl. No.	Year	World Heart Day Themes
1.	2012	One world- one home- one world
2.	2013	Take the road to healthy heart
3.	2014	Make heart choices not hard ones
4.	2015	Creating heart-healthy environ-ments
5.	2016	Power your Life
6.	2017	Share the power'
7.	2018	My Heart, Your Heart
8.	2019	Creating a global community of 'Heart Heroes'
9.	2020	Use Heart to make better choices
10.	2021	Use Heart To Connect
11.	2022	Use Heart for Every Heart

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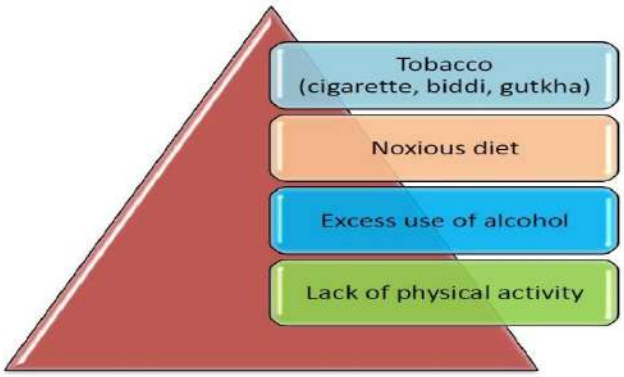
Causes of Cardiovascular disease



Heart's Healthy Foods

Approx 1/3rd of global deaths cause due to heart disease. Diets play a very important role in keep our heart healthy. By consuming different healthy foods in our diet we have to improve our health condition.

These are 11 foods that one should include in their diet to improve wellbeing of heart.

1. Whole grains

Grains are considering main staple food in maximum family around the world. Whole grains contains high amount of iron, magnesium, manganese, phosphorus, B vitamins and dietary fiber etc. including whole grains in our daily diet reduce the chances of risks of heart disease, type 2 diabetes, cancer etc.. Fiber present in whole grains helps to reduce cholesterol level and also help to prevent the development of small blood clots that can produce heart attacks or strokes. Whole grains are protective in nature. An extra 1 or 2 servings per day include these foods in daily diet increases or decreases risk of heart disease by approximately 10% to 20%. Oatmeal and fiberous cereals are a heart-fit technique to start our day. Oats are very rich source of soluble fibers that is essential for keeping well being of heart it also be full of beta glucan that fights against increasing the level of fats or lipids in the body.

2. Green leafy vegaetables

Green leafy vegetables are loaded with full of vitamins, minerals, and antioxidants and also immense source of vitamin K that helps against arteries problems and prevent blood clotting. Green leafy vegetables are rich in dietary nitrates, which prevent against increasing blood pressure, arterial stiffness, and advance the utility of cells line in the blood vessels. According to different studies, consuming more green leafy vegetables is associated to decrease the risk of heart sickness.

3. Fatty Fish and Fish Oil

Fatty fish and fish oil both are loaded with omega-3 fatty acids that are necessary for a strong heart which reduce the risk factors responsible for developing heart disease like blood pressure, triglycerides and cholesterol level and cardiovascular

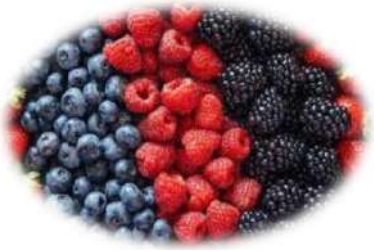
disease, depression, and mortality. e.g.- salmon, sardines, tuna etc. Fish oil supplements play a major role in to decrease blood triglycerides and blood pressure also look up arterial function, e.g. krill oil or algal oil etc.. These help to keep our arteries clear. There are also different vegetarian sources that contain omega 3 fatty acids examples are chia seeds, hemp seeds, flaxseeds, etc.

4. Nuts

Nuts are containing a good amount of vitamin E e.g. Almonds, Walnuts etc., which help to control bad (LDL) cholesterol in the blood, help to reduce risks of cardiovascular diseases. Walnuts are supply immense amount of fibers and different micronutrients e.g. Magnesium, copper etc. and also facilitate to reduce cholesterol level, blood pressure and risk of heart disease. Almonds are full of vitamins, minerals, fibers & monounsaturated fats that are very essential for fitness of heart. According to a study on 48 people with suffering from high cholesterol revealed that consumption of 43 grams of almonds on a daily basis for 6 weeks help to reduce stomach fat and bad cholesterol levels.

5. Berries

Berries are good sources of different antioxidants that advance healthy function of cell and defend against inflammation and anthocyanins (antioxidants), which save from harm against the oxidative stress and inflammation that responsible for developing heart disease, reducing cholesterol levels. It is contains fibers, flavonoids, different plant compounds that are related with lower chances of developing heart disease, like Strawberries, blueberries, blackberries, and raspberries etc. Berries may help to improve blood sugar and insulin levels in the body, improving the utility of arteries. Several antioxidants in berries, including anthocyanins, ellagic acid, and resveratrol, may reduce risk of cancer Spritzler, F. (2019). Several studies show that eating plenty of berries can cut several risk factors of heart disease. For example, one study involving 33 adults suffering from obesity revealed that consuming strawberries at two and a half servings for 4 weeks drastically enhanced insulin resistance and Low Density Lipoprotein (bad) cholesterol level. One another study showed that consumption of blueberries daily enhanced the cells that help to control pressure and clotting of blood.



6. Avocados

Avocados are an outstanding source of monounsaturated fats that are very beneficial for proper functioning of heart, and have been associated to reduced cholesterol level and also reduce possibility of heart disease, blood pressure, and metabolic syndrome. They're loaded with many nutrients eg. magnesium, B_6, vitamin C, vitamin E,

and folate that are essential for the health of the immune system and a very rich source of antioxidant and anti-inflammatory compounds (Kubala, J., 2022). It May help to promote a well body weight Avocados are too loaded with potassium, a nutrient that's vital for wellbeing of heart. One avocado stores 975 mg potassium.

7. Beans

Beans are having full of resistant starch that have potential to make use of a healthy impact on the gut and certain members of its resident microbiota, Several studies have stated that consumption of beans in diet can help to decrease possible factors of heart disease, triglycerides, blood pressure and inflammation. A review of 26 studies stated that a diet high in beans and legumes drastically decrease the levels of bad (LDL) cholesterol.

8. Tomatoes

Tomatoes are contains natural pigment lycopene which have great antioxidant properties. These antioxidants help to reduce the effect of dangerous free radicals, prevent oxidative damage and irritation. Low levels of lycopene in blood are increased the risk of heart attack and stroke. Adding tomato & tomato products in our diet increase High Density Lipoprotein (HDL) cholesterol in body.

9. Seeds

Seeds are full of fibers, omega-3 fatty acids, e.g. chia seeds, flaxseeds, and hemp seeds etc. Pumpkin seeds are packed with magnesium that be capable of protect our heart by maintaining the heart beat balanced and reducing blood pressure, as well maintaining other heart functions. Eating chia seeds in diet help to minimize blood triglyceride levels and boosted beneficial HDL (good) cholesterol level. Hemp seeds are containing high amount of arginine (amino acid) which help to reduce blood levels of certain inflammatory markers. flaxseed are high in fiber(both soluble and insoluble), phytochemicals, and lots of great antioxidants called lignans (NDTV 2018) and omega-3 fatty acids to facilitate proper management of blood pressure and cholesterol levels, minimizing chances of cardiovascular disease and cancer.

10. Oranges

Orange is a sweet and juicy fruit, that containing pectin (cholesterol-fighting fiber) and potassium, which protect against increasing blood pressure level. A medium orange has contains a propos 62 calories and 3 g of fiber.

11. Amla and Gooseberry

The Amla is loaded with vitamin C that is one of the most excellent nutrients to eat for keeping our

heart strong and healthy.

Conclusion

Approx 1/3rd of global deaths cause due to heart disease. Diets play a very important role in keep our heart healthy. By consuming different healthy foods in our diet we have to improve our health condition. So, if one incorporates 11 recommended foods in their diet then it may improve wellbeing of heart.

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Types of Maize and Its Production Technology

Meghna Sarma and Gayatri Kumari

Maize (*Zea mays* L.) belong to the family Poaceae, also known as corn, is the world's third most important cereal crop after wheat and rice. It is believed to be originated in Central America *i.e.* Mexico. Currently in India it is cultivated over 9.4 million ha with the production of 24.26 million tonnes and average productivity of about 2.57 tonnes/ha, contributing 9 % in food basket of the country. Maize is grown primarily for grain and secondarily for fodder and raw materials for industrial processes. World area under maize is about 140 Mha with a production of around 420 Mt (Shalini *et al.,* 2016). The antiquity of maize in India is not clearly established. It is, generally, believed that the Portuguese introduced it to India from Europe during the early part of sixteenth century. There is no evidence for its existence on the Indian plains in pre-Columbian times. Watt (1892) indicated that the vernacular names for maize did not throw any light on the history of maize in India. The most commonly occurring name 'Makkai' which would mean from 'Mecca' suggests introduction from outside India.Other than grain, maize is also cultivated for various purposes like quality protein maize and other special purposes known as 'Specialty Corn'. The various specialty corn types are quality protein maize (QPM), baby corn, sweet corn, pop corn, waxy corn, high oil corn etc. In India, QPM, baby corn and sweet corn are being popularized and cultivated by the large number of farmers. The brief summary of different type of specialty maize is as follows

1. Quality Protein Maize: As more than 85 % of the maize is used directly for food and feed, the quality has a great role for food and nutritional security in the country. In this respect, discovery of Opaque-2 (O_2) and floury-2 (F_2) mutant had opened tremendous possibilities for improvement of protein quality of maize which later led to the development of "Quality Protein Maize (QPM). QPM which is nutritionally superior over the normal maize is the new dynamics to signify its importance not only for food and nutritional security but also for quality feed for poultry, piggery and animal sectors as well. Quality Protein Maize has specific features of having balanced amount of amino acids with high content of lysine and tryptophan and low content of leucine & isoleucine. The balanced proportion of all these essential amino acid in Quality Protein Maize enhances the biological value of protein. The biological value of protein in QPM is just double than that of normal maize protein which is very close to the milk protein as the biological value of milk and QPM proteins are 90 and 80 %, respectively.

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Whereas it is less than 50 % in normal maize protein. There are 9 QPM hybrids of different grain colours have been developed and relased in India for their cultivation in different agro-climatic conditions across the country. The production technology of QPM is same as of normal grain maize except isolation as to maintain the purity of QPM, it should be grown in isolation with normal maize.

2. Baby corn: Baby corn is a young finger like unfertilized cobs with 1-3cm emerged silk preferably harvested within 1-2 days of silk emergence (50 to 60 DAS) depending upon the growing season. The harvest can be made 8-10 times over a period of 3-4 weeks. It can be eaten raw as salad and in preparation of different recipes such as chutney, pakora, mix vegetables, pickles, candy, murabba, kheer, halwa, raita, Chinese preparations, etc. The desirable size of baby corn is 6 to 11 cm length and 1.0 to 1.5 cm diameter with regular row/ ovule arrangement. The most preferred colour by the consumers / exporters is generally creamish to very light yellow. Baby corn is nutritive and its nutritional quality is at par or even superior to some of the seasonal vegetables. Besides proteins, vitamins and iron, it is one of the richest sources of phosphorus. It is a good source of fibrous protein and easy to digest. It is almost free from residual effects of pesticides. It can be cultivated round the year therefore, three to four crops of baby corn can be taken in a year. Cost of cultivation of baby corn in India is lowest in the world therefore; India can become one of the major baby corn producing country. It has great potential both for internal consumption and export. In general, the cultivation practices of baby corn are similar to grain crop except (i) higher plant population (ii) higher dose of nitrogen application because of higher plant population (iii) preference for early maturing single cross hybrid and (iv)harvesting within 1-3 days of silk emergence

3. Sweet corn: Sweet corn is one of the most popular vegetables in the USA, Europe and other developed countries of the world. It is a very delicious and rich source of energy, vitamin C and A. It is eaten as raw, boiled or steamed green cobs/ grain. It is also used in preparation of soup, salad and other recipes. It is becoming very popular in urban areas of country therefore, its cultivation is remunerative for peri-urban farmers. Besides green cobs the green fodder is also available to the farmers for their cattle. Generally sweet corn is early in maturity. It is harvested in 70-75 days during kharif season. Green cobs are harvested after 18-20 days of pollination during kharif but the duration may varies season to season. At the harvest time the moisture is generally 70 % in the grain and sugar content varies from 11 to more than 20 %.

Color: Sweet corn is generally dull yellow and white but dull yellow color is preferred.

Precaution: Its picking should be done in the morning or evening time. Green cobs should be immediately transported to the cold storage in refrigerated trucks to avoid the conversion of sugar to starch. It loses flavor if kept in high temperature after picking. Sweet corn with high sugar content should not be planted when temperature is below 16^{o}C.

4. Pop Corn: Popcorn is one of the common snack items in many parts of the world, particularly in cities and is liked because of its light, porous and crunchy texture. The popcorn flour can also be used for preparing many traditional dishes. It is consumed fresh, as it has to be protected against moisture absorption from the air. It is hard endosperm flint maize. Kernels of pop corn are very small and oval/round in shape. When heated at about 170^{0}C, the grains swell and burst, turning inside out. Quality of pop corn depends on popping volume and minimum number of non pop corn.

5. Waxy corn: It is originated in China but largely used in USA. Grain gives wax-like appearance and having 100 % amylopectin starch. While in normal maize, the starch is nearly 30 percent amylose and the remaining 70 % is amylopectin. Waxy corn is mainly used for food and industrial purposes.

6. High oil corn: Most of the normal maize lines have 3- 4 % oil content. In general, lines with more than 6 % oil are considered high oil lines. 95 % of the total oil is in the germ. When the oil percent increases the starch decreases. The wet milling industries are still in advantage with high oil content corn. In USA the high oil corn is cultivated on contractual basis and remunerative price is paid to the farmers. In India its cultivation is not economical because it is not sold on premium basis. Generally in normal maize crop, 15-20 % population of high oil hybrids is used as pollen parent and there is detasseling of the normal corn plant. Due to xenia effect there is an increase of oil in normal maize and its cultivation is done in isolation. The corn oil has low content of saturated fatty acid and is considered to be one of the best quality cooking oil. In India more than 60000 tonnes of corn oil is made available for various uses.

7. Fodder maize: Maize fodder can be used at any crop growth stage. Its quality is adversely affected after anthesis. To maintain the fodder quality the detasseling is advised to the farmers for better digestibility and palatability. By grazing this fodder to the milch cattle, their milk is increased. The tall, leafy and longer duration cultivars are most preferred for maize fodder cultivation. The cultivation of maize for fodder can be done round the year. Very high seed rate is used. Generally the farmers grow composite varieties or advance generation of hybrid seed which is economical to the farmers.

Table 1: Different types of maize varieties

S. No.	Maize types	Varieties
1.	Quality Protein Maize	Shakti-1, HQPM-7, Vivek QPM 9, HQPM-5, HQPM-1, Shaktiman 4, Shaktiman-3, Shaktiman-2, Shaktiman-1, FQH-38 and Anand QPM-1.
2.	Baby corn	H:HM-4, C: VL Baby Corn 1
3.	Sweet corn	Sweet corn H: HSC1 for J&K and HP C:Madhuri, Win orange, Priya
4.	Pop corn	C: Jawahar, Amber, Pearl &VL pop corn
5.	Fodder	C: African tall, J 1006 & Pratap chari-6

*H=hybrid and **C=composite

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Phytoremediation: Curing Soil Problems

Dr. Ashok S. Dambale

Introduction

Heavy metal accumulation in soil has been rapidly increased due to various natural processes and anthropogenic (industrial) activities. As heavy metals are non-biodegradable, they persist in the environment, have potential to enter the food chain through crop plants, and eventually may accumulate in the human body through biomagnification. Owing to their toxic nature, heavy metal contamination has posed a serious threat to human health and the ecosystem. Therefore, remediation of land contamination is of paramount importance. Phytoremediation is an eco-friendly approach that could be a successful mitigation measure to revegetate heavy metal-polluted soil in a cost-effective way.

Phytoremediation is defined as "the use of green plants and the associated microorganisms, along with proper soil amendments and agronomic techniques to remove or render toxic environmental contaminants to harmless substances" (UNEP, 2012). The term is an amalgam of the Greek phyto (plant) and Latin remedium (restoring balance). Phytoremediation is proposed as a cost-effective plant-based approach of environmental remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to detoxify various compounds. A range of processes mediated by plants are present in treating environmental problems. The mechanisms of phytoremediation include phytoextraction, phytovoltatlization, phytodegradation, phytostimulation and phytostabilization.

Phytoextraction

Phytoextraction (or phytoaccumulation or phyto mining) exploits the ability of plants or algae to remove contaminants from soil or water into harvestable plant biomass. The roots take up substances from the soil or water and concentrate in their aboveground biomass. Organisms that can uptake high amounts of contaminants are called hyperaccumulators. In recent times, phytoextraction is the most important phytoremediation technique for reclamation of heavy metals and metalloids from the polluted soil (Sarwar *et al.*, 2017). Unlike phytostabilization, by which plants only temporarily contain heavy metals, and these heavy metals still remain belowground, phytoextraction is a permanent solution for the removal of heavy metals from polluted soil. Therefore, it is more suitable for commercial application. The process of phytoextraction of heavy metals includes a few steps: (i) mobilization of heavy metals in rhizosphere, (ii) uptake of heavy metals by plant roots, (iii) transloca-

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tion of heavy metal ions from roots to aerial parts of plant, (iv) sequestration and compartmentation of heavy metal ions in plant tissues (Ali *et al*., 2013).

Phytovoltatlization

Phytovolatilization involves the use of plants that uptake metals from soil, biologically convert them in a volatile form, and then release them into the atmosphere by volatilization. Some metal contaminants, such as, Hg, and Se, exist naturally in the gaseous form in the environment.

Phytovolatilization involves the uptake of contaminants by plant roots and its conversion to a gaseous state, and release into the atmosphere. This process is driven by the evapotranspiration of plants. Plants that have high evapotranspiration rate are sought after in phytovolatilization. Organic contaminants, especially volatile organic compounds (VOCs) are passively volatilized by plants. For example, hybrid poplar trees have been used to volatilize trichloroethylene (TCE) by converting it to chlorinated acetates and CO_2. Metals such as Se can be volatilized by plants through conversion into dimethylselenide [Se $(CH_3)_2$]. Genetic engineering has been used to allow plants to volatilize specific contaminants. For example, the ability of the tuliptree (*Liriodendron tulipifera*) to volatilize methyl-Hg from the soil into the atmosphere (as Hg^0) was improved by inserting genes of modified *E. coli* that encode the enzyme mercuric ion reductase (merA).

Phytodegradation

Phytodegradation which is also known as phyto-transformation is the breakdown of contaminants taken up by plants through metabolic processes within the plant, or the breakdown of contaminants surrounding the plant through the effect of enzymes produced by the plants. Plants are able to produce enzymes that catalyze and accelerate degradation. Hence, organic pollutants are broken down into simpler molecular forms and are incorporated into plant tissues to aid plant growth.

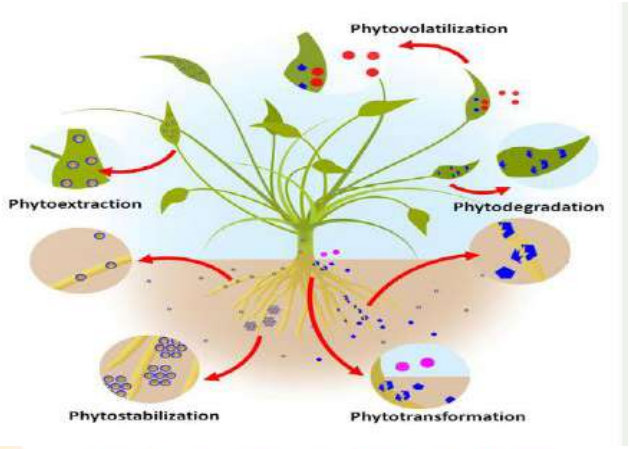

Fig 1: Schematic representation of phytoremediation approaches

Phytostabilization

Phytostabilization involves the use of plants to eliminate the bioavailability of toxic metals in soil. Contaminants in soil are immobilized by certain hyper accumulating plants through absorption and accumulation by roots, adsorption onto roots or precipitation within the root zone, and physical stabilization of soil.

Green vegetation is very helpful in controlling soil erosion as plant roots effectively bind the soil. Furthermore, the roots of vegetation facilitate holding a considerable amount of rain water that returns to the atmosphere through transpiration. The roots reduce the amount of heavy metals enteri-

ng the water table and other water bodies. Tore-establish vegetation at sites where flora have disappeared or been destroyed due to the presence of high metal concentrations, metal-tolerant plant species can be planted, thereby reducing the effective migration of contaminants through soil leaching, groundwater contamination, wind, and transport-ation of the exposed surface soil. Some plants developed metal tolerance during evolution while others may have this ability inherently.

Conclusion and Future Prospective

Phytoremediation techniques are suitable tools for the effective heavy metal remediation of soil, water, and sediments. Special care should be taken while selecting a suitable approach depending on the health attributes of the contamination site, target contaminant, and efficacy of the plant selected. Various bio monitoring tools are available for assessing the effectiveness of heavy metal phytoremediation processes. In the future, additional studies are required to understand the mechanism of action of the plants. Despite few disadvantages of phytoremediation technologies, it is an efficient method for environmental cleaning. With the advancement in the field of genetic recombination technology, genetically engineered plants can be instrumental in the phytoremediation approaches for making environment clean. Future studies should be focused on the combined use of more than one phytoremediation approach for the successful remediation of the polluted area under field conditions.

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Prescriptive Model of Twenty-One-Point Programme on Retention of Rural Youth in Agriculture

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Abstract

Agriculture is one of the major sources of the Indian economy where more than 60 per cent of the population depends on it for survival. The increase in population size directly affects economic growth in the agriculture field. Over the past decade, many researchers have addressed this problem and provide solutions for the retention of rural youth in agriculture and methodologies for effective implementation of projects for rural youth. Most studies have only focused on the effective implementation of schemes, projects and programmes of youth development but till date challenged to retain rural youth in agriculture. This present study used an exploratory research design with a sample of 300 rural youth of Nagpur and Yavatmal district of Maharashtra state. Hence this paper is based on the field experience and major findings of research outcomes. The prime challenge for the stakeholders is "How to retain rural youth in agriculture". The prescriptive model is multidisciplinary, focusing on all the possible ways and means for retaining the rural youth in agriculture and providing them handhold support to stay in agriculture. The twenty-one-point programme on RRYA - 2021 consists of 21 indicators and 77 sub-indicators items considered for computation of retention index. The proposed model is designed with the objective of retention of rural youth in agriculture.

Introduction

The global population is predicted to be around 8.0 billion by 2025 and 9.0 billion by 2050. Youth would represent around 26 per cent (FAO, 2014) global population. It's well-known that the Asia-Pacific region is incredibly young, because, it's home to over 60 per cent of the world's youth. The Asia-Pacific region supports 70 per cent of the world's agricultural population with one-fifth of the world's landmass. Youth are a very important asset of our country which are full of energy and enthusiasm. They are the future communities of states and nations. Youth are the foremost powerful division of the population of a country. They are the backbone of the country. Agriculture remains the key sector, providing livelihood and employment opportunities to over 60 per cent of India's population living in rural areas. Overall, within the developing world, youth and agriculture are the twin pillars of progress and prosperity, especially for

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achieving sustainable development goals (Paroda *et al.,* 2014). This noticeably seems to reflect a bright future since around half of this population (nearly 200 million) lives in rural areas, which may well be motivated and attracted professionally to agriculture and allied fields. Contrary to the present situation only around five per cent of the agricultural youth is currently getting engaged in agriculture (TAAS, 2018).

Census, 2011 revealed that we have 95.8 million cultivators for whom agriculture farming is their core profession and which comes about 8 per cent of the population (Down from 103 million in 2001 and from 110 million in 1991). If we include all marginal cultivators (22.8 million) which continue to be but 10 per cent of the total population. India is losing about 2,000 farmers every single day and since 1991, the general number of farmers has dropped by 15 million (Sainath, 2013). Sixty-five (65%) per cent of people of India live in rural areas and 35 per cent in urban areas. The percentage residing in urban areas has doubled in 2020 from 17% in 1950 and is expected that half of the Indian population will be in urban areas by 2050. The share of rural youth in the total population has been increasing continuously from the level of 30.6 per cent in the year 1971 to 34.8 per cent in the year 2011. And after this, it is expected to decline and their share will come down to 31.8 per cent by 2031 (CSO, 2017).

The existing situation of rural youth engaged in the agricultural sector, becoming a threat against the improvement of agricultural sector performance in the future, is the rural young generation's low interest in and motivation to work in the agricultural sector. The data shows that, the maximum number of operational land holders (33.7%), belonged to the age group of 41-50 years, followed by 33.2 per cent in the age group of 51-60 years out of 100 million farmers in India. While this generation is reaching the age of retirement, the next one does not want to farm (Mahapatra, 2020).

The investment in youth in agriculture remains minimal, as there are just some youth-focused programs and thus, few clear samples of impact. Nevertheless, the Indian Council of Agriculture Research (ICAR) and departments of Agriculture in many nations are recognizing the farmers including the young and innovative ones for the innovative and diversified farming ventures preoccupied with them. Many young farmers are taking over high-risk high returns agri-ventures like protected agriculture, precision farming, organic agriculture, floriculture, medicinal and aromatic plant cultivation, food processing, value addition, agro-tourism, etc. which are mostly avoided by the aging farmers. These new agri-ventures should be actively supported by the government agencies and financial institutions with skill training, financing and marketing support.

Youth participation in agriculture can solve the crisis of unemployment and migration. Questions required to be answered are whether the agriculture sector has enough prospects to provide decent liveli-

hoods to youth, how youth are motivated to take up farming and farm-related businesses, and most importantly, whether leveraging youth for agriculture is an instrument for modernization and future growth of Indian agriculture. (Sukanya Som, *et. al.*, 2018).

Retaining rural youth in agriculture is critical for Indian farming. Most of the innovations (both technical and institutional) required a talented agriculture workforce. Young farmers and producers often have a greater capacity to adopt innovation and entrepreneurship than older farmers. The genuine solution is to take a position of "the rural youth of today, the farmers of tomorrow". Based on study findings of 21 retention indicators to formulate the "Perspective model of the twenty-one-point programme on retention of rural youth in agriculture" are expected to contribute significantly towards the worldwide and national efforts of skyrocketing production and ensuring food security through increasing rural youth retention in agriculture.

Results and discussion

Retention Index

In this study, retention of rural youth in agriculture has been operationalised as empowering and keeping rural youth in rural areas to take up agriculture as a profession for sustainable livelihood in society. The existences of selected indicators are important to the retention of rural youth in agriculture.

The twenty-one major indicators are included in the retention index. Each major indicator has been analysed with sub-indicators. Each major and sub-indicator were already subjected to standardization procedure.

From the obtained scores, indicator-wise index scores were calculated. The results are presented in Table 3.

Table 3: Indicator wise Retention Index Score

Sl. No.	Retention Indicators	Mean Index Score
1	Skill development	76.00
2	Family income	75.80
3	Affiliation	75.60
4	Intrinsic motivation	75.40
5	Autonomy (Self-sufficiency)	75.20
6	Access to market	75.00
7	Quality education	74.40
8	Access to technology	74.40
9	Employment policy	74.40
10	Perception	74.20
11	Access to agricultural input	73.40
12	Aspiration	73.40
13	Health care services	73.00
14	Exposure to agribusiness management	72.60
15	Reward and recognition.	72.60
16	Social support	72.40
17	Access to farm mechanization	71.80
18	Access to finance services	70.40
19	Government schemes	70.20
20	Access to digital technology	69.60
21	Agricultural policy	69.00

It could be inferred from Table 3 that, the indicator wise index scores for the twenty-one components were skills development (76.00), family income (75.80), affiliation (75.60), intrinsic motivation (75.40), autonomy (75.20), access to market (75.00), quality education (74.40), access to technology (74.40), employment policy (74.40), perception (74.20), access to agricultural input (73.40), aspiration (73.40), health care services (73.0

0), exposure to agribusiness management (72.60), reward and recognition (72.60), social support (72.40), access to farm mechanization (71.80), access to financial services (70.40), government schemes (70.20), access to digital technology (69.60) and agricultural policy (69.00), respectively.

Finally, the composite retention index worked out was (73.00). The indicator-wise discussions of the retention Index are presented above.

Prescriptive process model on retention of rural youth in agriculture (Fig.1) based on the field experience and major findings of research outcome.

Fig. 1: Prescriptive model of the 21-point programme on retention of rural youth in agriculture

The prime challenge for the stakeholders is "How to retain rural youth in agriculture". Keeping in view the outcome of the study, an attempt was made to retain rural youth in agriculture. The prescriptive model is multidisciplinary, focusing on all the possible ways and means for retaining the rural youth in agriculture and providing them handhold support to stay in agriculture

The twenty-one-point programme on Retention of Rural Youth in Agriculture - 2021 consists of 21 indicators and 77 sub-indicators items considered for computation of retention index. The details of each of the 21 indicator points included in the model are as above.

1. Skill development

Skill development is the most significant factor for the well-being of the rural youth in agriculture. The majority of the rural youth in agriculture were found to be poor in their skills essential to meet the challenging demands of the dynamic agriculture activity. Campaign-oriented extension activities must be taken up in the form of specialized multidisciplinary training programs with the latest cutting-edge technology demonstration which will enrich their skill components.

2. Family income

Family income is a major determinant of the economic status of rural youth. Every rural youth's standard of living is decided to a great extent by his regular and reliable family income from agriculture and allied occupation. Lower-income can create difficulties in managing the economic and social affairs of the family. Steps required to be taken for engaging family members properly in planned agriculture management and made the availability of need base modern technology in agriculture so they can achieve strong economic stability in their family.

3. Affiliation

It was found to be a more perceived attachment to agriculture. The only agriculture

business is an important activity for livelihood and employability in a rural area. The strong in-group team spirit of farm families of these rural youth would have prompted their affiliation towards agriculture. It needs a plan for encouraging their forthcoming generations to engage in agriculture.

4. Intrinsic motivation

The rationale behind it is their enthusiastic outlook towards agriculture as a profession because they feel self-satisfaction as they can provide food for people and other living beings. The rural youth need to be made aware about a scope/ prospectus for skill variability, task identity, task significance, substantial freedom to innovate suitable technology in agriculture with a high level of recognition from stakeholders in the field of agriculture.

5. Autonomy

Most of the rural youth aspired to attain more independence in their profession. They must be encouraged by providing essential opportunities in the agriculture sector so that he takes his own decisions to decide and manage resources in near future on their own.

6. Access to market

Favourable marketing policies are needed to develop and encourage rural youth in their agriculture activities. Hence there is required to be strict control and regulatory system to supervise the cost of inputs as well as the minimum support prices for the produce. As well as rural-urban roads, cold storage, warehousing, market yards, input supply agencies and other essential facilities are essential.

The rural youth engaged in agriculture need to be created awareness on all the sources of export farm products and e-marketing opportunities in agriculture products.

7. Quality education

A possible remedy for this is to introduce agriculture education like science, commerce and arts as one of the subjects in the school level itself and exposing the school children and youth at higher education level about the farming practices and agricultural entrepreneurship which will help them to realize the importance of farming and the necessity of taking it as the profession in future. When some of them finally take agriculture as an occupation and due to awareness regarding agriculture knowledge and skill they can be engaged in a farming better way and also create a valuable asset to the family and encouraging their forthcoming generations to engage in agriculture.

8. Access to technology

The justification behind it is their enthusiastic outlook. The digital platform should be provided to the rural youth engaged in agriculture and allied sectors not only to enhance productivity and efficiency. The current digital sector is improving day by day and developing with sophisticated features like convenient access to different improved agriculture technologies at the fingertips. Different web portals on Artificial intelligence (AI), Expert system (ES), Decision Support Systems (DSS), market information and agri-business firms, different mobile apps on technologies related to production,

access to finance, trading, markets, and consumption are flourishing enormously. Consequently, the liability of government to set up necessary information center's in rural areas.

9. Employment policy

The rural youth accepted that agriculture is a better option at the present situation and can take up agriculture with value addition for different farm produce and establish their own enterprise which can generate employment in rural areas because of wider/diversified opportunities available in agriculture. At present paradigm shift from primary production activities to secondary activities especially value addition, post-harvest handling through processing of farm produce is vital to improve agri- entrepreneurship and also prevent wastage of farm produce. This helps to development of entrepreneurial culture among rural youth. They must be encouraged by providing crucial venture capital required to set up the enterprises with sophisticated infrastructure in rural areas. It helps to retaining of rural youth in agriculture.

10. Perception

The rural youth believed that agriculture is a primary occupation that would be the best profession for them because a career in agriculture is noble and blessed as they are working with the soil. The farmer's lifestyle is a very busy and hectic one and multi-tasking. A lot of tasks and works must be completed every day to achieve their ultimate goal.

11. Access to agricultural input

High-input farming may generate high yields in the short term. Quality of output depends on the quality of inputs, present farm inputs are of very poor quality in some of the cases and misleading advertisements are causing huge losses in the agriculture sector. Strict vigilance towards the quality of all types of inputs is necessary. It is also important to educate the rural youth about the quality parameters of different inputs and evaluations. Input subsidy is one of the significant factors to reduce the financial burden. But technology is improving day by day and the expenditure on production is also rising. At this moment there is a need for subsidies that will support the rural youth in farming to use all such innovative technologies for getting high returns.

Therefore, rural youth suggested the agricultural credit to be made available at a reduced rate of interest in time and needs to be sanctioned to purchase the inputs at the subsidized rates for them.

12. Aspiration

Rural youth have the aspirations of attaining a stable economic, social status, material and property possession. Additionally, the researcher was able to observe an intricate relationship between the educational status and the aspirations of rural youth. On contrary, it was interesting to note that the educational attainment of the rural youth did not discourage aspiring for a better economic and social status.

13. Health care services

The present studies explored access to health care for rural youth. Rural youth experience poorer access to health care services in rural areas as compa-

red to urban areas. They need more improvement in services available in villages for increasing retention of rural youth in the villages.

14. Exposure to agribusiness management

The reason behind it would be that the rural youth who are currently involved in agriculture, it is energetic will help them to expand their talents in several aspects of management of agriculture, horticulture, livestock production, marketing, finance and employment skills in rural areas. The agriculture department's integrated different training approaches regarding business management theories and practical skills so that they may respond to the needs of a modern agricultural sector.

15. Reward and recognition

The rationale behind it would be the reward and recognition are the expectations of the rural youth in receiving appreciation and high opinion from family and social system while practicing modern agricultural technologies in his/her profession. Such an approach needs to give strategic importance at local, taluka, district, state, regional and country levels to ensure rural youth's inclusive growth in agriculture.

16. Social support

The majority of the rural youth felt proud being a young farmer and felt happy about their increase's social status in society if they are retaining in agriculture. Rural youth needs high level of social support due to which they experience less stress when they are in stressful situations and are able to cope with stress more successfully. It helps to motivate rural youth to retain in agriculture.

17. Access to farm mechanization

During the ground visits, the researcher was able to observe the subdued opinion possessed by the rural youth towards farm mechanization in agriculture. There is a need to promote bank-linked sufficient credit facilities with subsidies for farm mechanization and entrepreneurship involving trained rural youth from the same village. Farm mechanization centers with custom hiring options should be promoted.

18. Access to finance services

Responses obtained from rural youth revealed that finance, banking, crop insurance and credit facility were the primary preferred crucial requirement of rural youth in starting profitable and sustainable agriculture. If credit institutions have given the right support, these youth enterprises can succeed and they will retain in agriculture.

19. Government schemes

Rural youth were found to be interested in contribution and involvement in the planning process of different schemes/projects/ policies/programs for self and rural development. Most of the younger generation suggested that government should make available a single-window information system that should be developed for rural youth.

20. Access to digital technology

The justification behind it is their enthusiastic outlook. The digital platform should be provided to the rural youth engaged in agriculture and allied sectors not only to enhance productivity and efficien-

cy. These rural youth should be taught what great amount of information these devices can provide and are easily available on hold and how their correct utilization can make them own boss. It is of prime importance to maintain proper connectivity of data speed in a rural area.

21. Agricultural policy

From the field-level survey, observed that the government is on track for achieving the target of doubling farmers' income by 2024. On the same side will also provide a unique opportunity for rural youth to start Agri-tech start-ups with a commercially viable solution. The government of India has and is announcing multifarious policies. These policies are based on the principle of social inclusion, gender equality, sustainable development and felt need of the rural youth living in a rural area. The implementation of those policies at the ground level is most important.

Conclusion

The recommendations of this prescriptive model suggest the necessity or need for a concentrated effort of extension agency on skill development, increasing in family income, institutional affiliation, training on motivational aspects, make them self-sufficient, easy access to market information, facilitated quality education in rural areas, easy access to technology, with better employment policy, increases perception towards agriculture, supply of quality inputs, increase aspiration, better health care facility, training on agribusiness management, innovative rural youth facilitated with reward and recognition at various levels, gives more social support, avail facility of custom hiring centre for farm machinery, better access to financial services, proper implementation of government schemes, availability of high speed ICT connectivity and involving rural youth in agriculture policymaking to prepare reliable new image of agriculture that can help to the retention of rural youth in agriculture.

In this study, for measurement of retention of rural youth in agriculture retention index was developed and standardized, on the basis of results of retention index proposed a model on “Twenty-one-point programme on retention of rural youth in agriculture” this model consists of 21 indicators viz., skill development, family income, affiliation, intrinsic motivation, autonomy, access to market, quality education, access to digital technology, employment policy, perception, access to agricultural input, aspiration, health care services, exposure to agribusiness management, reward and recognition, social support, access to farm mechanization, access to financial services, government schemes, access to digital technology and agricultural policy. These indicators are very important in the development of a project or programme. Therefore, it is implied that policymakers, development agencies and extension functionaries should consider these indicators while preparing and planning programs or projects for the development of rural youth.

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Climate Change: Necessitates Evolving out of Smart Agro-techniques

Namita Das Saha, Mayank Tiwari, Partha Saha and D. Damodar Reddy

"Climate change will almost surely make life even harder for the world's poorest and most vulnerable populations..... Technology options, in particular, must become more available."

By ICTSD-IPC Platform on Climate Change, Agriculture and Trade

Introduction

Climate change is exacerbating the already daunting challenges facing by the agricultural sector, and this is particularly more intense in developing countries and poor countries. Innovations in agriculture have always been important and will be even more vital in the context of future climate change scenario. The present climate change demands smarter innovations to deal with the obvious losses in agriculture. In the coming decades, the development and effective diffusion of new agricultural practices and smart technologies will largely shape how and how well farmers will be mitigating and adapting in farming practices in parallel to unavoidable climate change forces. This adaptation and mitigation potential is more pronounced in the developed countries than in developing countries where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh.

Innovative and climate smart agricultural technologies will play a central role in enabling producers to meet several core challenges. As agriculture is inseparably linked to climate and feedback runs in both directions, most agricultural technologies have direct or indirect climate linkages. Most new and smarter technologies which are derived time to time as induced by climate change forces; in particular target changes in the use of farm inputs, often in ways that alleviate the negative impacts on production. While most agricultural technologies therefore have climate implications, there are a handful of current and emerging technologies with particular relevance to developing country agriculture and climate change. Some of these technologies have straightforward connections to climate change, but for others these connections are more nuanced. It is a fool's errand to attempt to fully catalogue in any comprehensive way agricultural technologies with potential for climate change mitigation and adaptation over the next many

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decades. If history is any guide, the most important such technologies have yet to be developed or even conceived. Yet the several examples of such smart agro-techniques are already on the platter to quote but implementation at small scale farmer's level is another challenge.

Broad themes for developing climate smart agro-techniques

Climate smart agro-techniques can be further classified at different angles. While addressing to the climate change issues, the derived techniques must have root link to any of the following broad themes (Figure. 1). There are already a handful of proven smart agro-techniques available which further is referred and explained below (Table. 1).

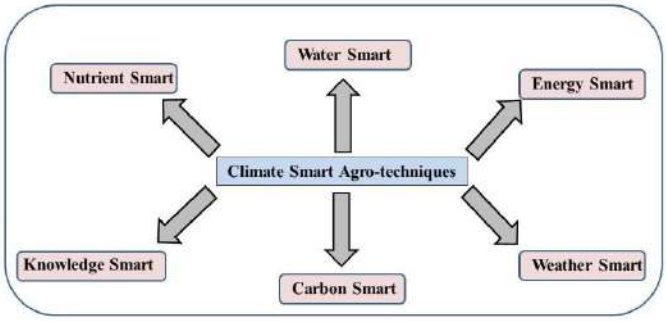

Fig. 1: Broad themes to target for developing climate smart agro-techniques (Modified and drawn from Rathore *et al*., 2021)

Developing improved crop varieties against emerging pest and diseases

Climate change will also lead to new pest and disease pressures. The nuances of temperature changes, e.g., higher low temperatures and fewer freezes - could shorten dormant periods, speed pest and disease growth and change the dynamics of these populations and their resistance. Crops, varieties and traits that are resistant to pests and diseases will improve producers' ability to adapt to climate change. To the extent that these varieties reduce the need for pesticides, they also reduce carbon emissions by decreasing pesticide demand as well as the number of in-field applications. Conventional and biotechnological tools based variety development is such an option.

For the development of traits and varieties that help to mitigate and adapt to climate change, agricultural biotechnology stands out as an especially promising set of tools. While it remains controversial in some policy arenas and public fora, agricultural biotechnology has produced dramatic improvements in yield and reductions in production costs and input use intensity.

Recently the development of cultivars with improved NUE is of utmost essential as after decades of green revolution application of N fertilizer is increased tremendously to meet grain yield demands. Simultaneously, its negative impact may be witnessed in the form of the increased cost of cultivation and hazardous effect on the ecosystem. The transcription factors, allosteric control, and post-transcriptional modification all play a vital role in the expression of a complex trait like NUE.

Omics techniques for enhancing Nutrient Use Efficiency (NUE)

By virtue of the necessity of precise identification of genes involved in Nutrient uptake, mobilization, and recycling at various plant growth stages from seedling to maturity, taking the benefits of many omics data sets that include transcriptomics,

Table 1: A handful proven smart agro-techniques that have been developed as necessitated by different aspects including climate change forces

S. No.	Smart Agro-techniques	Possible adaptation and mitigation aspects against climate change
1.	**Water Smart agro-techniques**	
	Drip Irrigation (DI)	Reduces loss of water as water is applied directly near the root zones
	Drip Fertigation (DF)	The application of nutrients to crops through a drip system is called drip fertigation. It is the most advanced method in nutrient as well as in water management. Farmers are practicing drip fertigation, particularly for winter wheat, across the globe owing to significant improvement in WUE and NUE. Drip fertigation matches the water and N supply with crop demand which eventually enhances water productivity and NUE.
	Laser Land Levelling (LL)	Uniform levelling of the soil reduces the water losses from the soil surfaces and additionally enhances nutrient use efficiency
	Furrow Irrigated Bed Planting (FIBP)	This technique allows more effective control over the irrigation, less loss of water and enhances nutrient use efficiency
	Cover crops methods (CCM)	Evaporation loss is reduced, improves many soil physic-chemical properties
	Rain water harvesting (RH)	Use of natural harvested water for on-site application preferably in rainfed or dry areas.
	Application of Hydrogels (HG)	Moisture released by hydrogel close to root area helps reduce stress and increase growth and plant performance. Hydrogels can reduce fertilizer leaching and reduce application of pesticides. Hydrogel works as water reservoirs round the root mass zones of the plant. Also improves soil aggregations and other physic-chemical properties.
2.	**Energy Smart agro-techniques**	
	Zero Tillage/ Minimum Tillage (ZT/MT)	Reduces energy consumption in agricultural operations. In long run, it improves many soil physic-chemical properties, helps in improving soil organic matter as the practice allows for retention of previous crops residues in soil.
3.	**Nutrient Smart agro-techniques**	
	Application of Leaf Colour Chart (LCC)	It relies on the principle of need based application of nitrogen based on greenness of the leaves as quantified by LCC. Mostly applied in Rice for top dressing applications of N and also equally suitable for Maize and Wheat crops.
	Application of SPAD meter/Chlorophyll meter	Soil Plant Analysis Development (SPAD) is also called a chlorophyll meter that measures the chlorophyll concentration of leaves and helps in judicious application of N. Thus reduces N-fertiliser application.
	Nano-Clay based superabsorbent polymer based coated fertiliser for slow release of nutrients (NCPC)	Fertilizer loaded nanoclay superabsorbent polymer composite (NCPC) can release the nutrients slowly and makes the nutrients available at different critical growth phases of crop and thus improves yield, reduce amount of fertiliser application, reduce cost of cultivation, reduce greenhouse gas emission.
	Application of Biofertilizers (BF)	Bio-fertilizers are formulations of beneficial microorganisms which directly or indirectly enhance microbial activity and thereby increase movement and solubilization of nutrients in the soil.
	Application of Diazotrophs (DZ)	Diazotrophs have the capacity to reduce N_2 to ammonia, and flora and fauna rely on biologically fixed nitrogen for growth and development
	Application of Phosphorus solubilising microbes/ Bacteria (PSB)	Phosphate solubilizing bacteria (PSB) releases enzymes that solubilise unavailable form of phosphorus and make it available to crops, reduces fertilise application rate, improve the plant growth by producing phytohormones, liberating nutrients, and stimulating induced systemic resistance
	Application of Vesicular Arbuscular Mycorrhizae (VAM)	Mycorrhiza has the potential to go deeper in the soil and provide the available form of nutrients to the plant roots thereby increasing the uptake.
	Application of Potassium solubilising bacteria (KSB)	The application of KSB can be a promising technique to solubilise the K reserves from soil and make it available to the plants, resulting in promotion of plant growth and minimizing the application of K-fertilizers.

	Application of Zeolites	Zeolites have a minute void diameter (0.3-0.8 nm) that helps in the fixation of NH_4^+ ion and slow release of N which ultimately minimizes the N losses that occur through volatilization and denitrification. The main use of zeolites is for N capture, storage, and slow-release, as they adsorb molecules at relatively low pressure and are considered as a nano-enhanced green application.
	Sulphur coated Urea (SCU)	Sulphur Coated Urea (SCU) fertilizer is a slow-release fertilizer that is made by coating urea with sulphur and wax that increases nitrogen efficiency, improves plant growth and reduces water pollution, compared with water soluble fast-release urea.
	Neem coated Urea (NCU)	Neem oil basically acts as a 'nitrification inhibitor' when coated on urea. By slowing down urea hydrolysis and nitrification, it allows a more gradual release of nitrogen, which can be used by the plant. "Neem-coating increases nitrogen use efficiency.
	Incorporation of legumes in the cropping systems (ICL)	Incorporation of short duration legume crops in the cropping rotations or along with the crop in the rows in between. It helps in improvement of soil N content, improves soil health.
	Green Manuring (GM)	Growing of Green Manuring crops and turnover into the soil before the next crop enhances the soil N content and improves soil quality.
	Site Specific Integrated Nutrient Management (SSINM)	Required and optimum supply /application of nutrients with the right type of product, right time, right amount and right place.
4.	**Carbon Smart Agro-techniques**	
	Agro-Forestry (AGF)	Promote Carbon sequestration in soil and improves soil health, less emission of Green House Gases (GHGs) from soil.
	Concentrate feeding for Livestocks (CF)	Requires fewer amounts of feeds and reduces the nutrient losses.
	Application of 'Microbial Decomposer' for in-situ decomposition of rice straws	Application of microbial decomposer as for example 'Pusa Decomposer' for in-situ decomposition of rice straws which reduces GHG emission, reduces air pollution, reduced burning and thus does not allow soil biological and other properties to get disturbed, soil organic matter gets improved.
	Blue-Green Algae (BGA)	Application of Blue green Algae allows for sequestration of huge atmospheric Carbon di oxide, fix atmospheric nitrogen thus reduces application of chemical fertiliser.
	Azolla	Co-cultivation of Azolla in rice allows sequestering C, fixing atmospheric Nitrogen.
	Application of Biochars	Biochar is a charcoal-like material produced from partial pyrolysis of organic material produced from agriculture, increasing the nutrient availability and organic carbon in the soil ultimately soil fertility and NUE. Biochar is attributed with a high surface area, pores, and different functional groups which imparts nutrient holding capacity in soil.
5.	**Weather Smart Agro-techniques**	
	Weather based Crop Agro-advisory (CA)	Weather based agro-advisory services provides farmers useful information which help in avoiding many losses and income gain.
	Crop Insurance (CI)	It is crop specific insurance to compensate economic loss of farmers due to weather vagaries.
6.	**Knowledge Smart Agro-techniques**	
	Contingent crop planning (CC)	Climatic risk management plan to cope with major climatic events related contingencies like drought, flood, heat/cold stresses during the crop
	Improved crop varieties (ICV)*	Crop varieties that are tolerant to abiotic stresses like drought, flood, extreme cold/hot spells.
	Crop Diversification (CD)	It has a tremendous role in optimum utilization of resources and enhancement of resource use efficiency.
	Seed and fodder bank (SFB)	Developing seed and fodder bank can manage climatic risks.
	Crop modelling	Crop models can improve NUE, Decision Support System for Agrotechnology Transfer (DSSAT) and many such applications which help to simulate crop performance in the climate change scenarios.

proteomics, and metabolomics which could further be accessed in an interactive manner by using bioinformatics, computational, and mathematical techniques, improved traits can be identified for further development of improved varieties with higher NUE which will help in reducing fertiliser application and thus will reduce indirectly the consumption of fossil fuels.

Drone technology based agricultural operations

Agricultural drones can analyse soil and fields for effective field planning. They can be used to mount sensors that measure soil moisture, terrain, soil conditions, soil erosion, soil nutrient concentration, and soil fertility. Drones are being used in the agriculture sector in Rajasthan, and an action plan has been developed for their multi-purpose use in spraying farm chemicals and water-soluble fertilizers on crops. The Agriculture Department of the state government is investigating the technical parameters and safety features of drones. It reduces labour cost, reduces time consumption. Additionally requires lesser amount of resources to apply in the crops as compared to conventional practices. Drones are a powerful tool for farmers and agronomists to assess the health of their crops. With the use of drones, they can get an overview of their fields and collect data much faster and more efficiently than traditional methods. Drones will allow farmers to see how healthy their plants are, where they might need water or nutrients, and if there is any pest activity before it gets out of control. By reducing the use of chemicals through data-driven targeted treatment and reducing the need of fossil fuel as drones are powered by intelligent batteries, drones can help reduce pollution, help the environment and help in the fight against climate change.

Effective diffusion of smart agro-techniques and policy principles

In the coming decades, the development and effective diffusion of new agricultural practices and technologies will largely shape how and how well farmers mitigate and adapt to climate change. This adaptation and mitigation potential is more pronounced in developed countries than in developing countries; where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. Thus, any agro-technique that is developed is at first to be assessed at local with small scale farmers with the specific climate change problem which is to be addressed and this will help in better adoption of the techniques.

"Innovations that are guided by small holder farmers, adapted to local circumstances & sustainable for the economy and environment will be necessary to ensure food security in the future"

-Bill Gates

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Reverse Breeding: An Innovative Technology of Plant Breeding

Ankur Kumar Singh, Akanksha Singh and Alok Kumar Singh

Abstract

Reverse breeding (RB) is a novel plant breeding technique (NPBT) that is designed to produce the parental lines for any heterozygous plant. Reverse Breeding generates a perfectly complementing pair of the homozygous parental lines through bio-engineered meiosis. The method is based on reducing genetic recombination in the selected heterozygote by eliminating meiotic crossing over. Also, the male or female spores that are obtained from such plants contain combinations of non-recombinant parental chromosomes which can be cultured *in vitro* to generate homozygous doubled haploid plants (DHs). From these DHs, complementary parents can be selected and used to reconstitute the heterozygote. Since the identification of unknown heterozygous genotypes is impossible, reverse breeding could fundamentally change future plant breeding.

Introduction

Humankind has been through different periods of agricultural improvement aimed at enhancing our food supply system and the performance of food crops. For many years Plant Breeding has been a trial-and-error exercise. Now it is more science than art. Hybrid vigor is the most important achievement of Plant Breeding. Several Plant Breeding techniques have been developed that help to feed the world through high-yielding varieties. There are some new techniques have been developed within these decades (after 2000) are Novel Plant Breeding Techniques (NPBT). Reverse breeding is one of the best examples of a novel plant breeding technique. Since it is difficult to predict which parental lines will give the best progeny. Reverse breeding puts this long-relevant problem by starting with superior hybrid selection followed by recovery of parental lines. This is an excellent tool in the plant breeder's arsenal, as it allows for a much more efficient and targeted hybrid plant production. Reverse breeding meets the challenge of fixation of complex heterozygous genomes by constructing complementing homozygous lines. This is accomplished by the knockdown of meiotic crossovers and the subsequent fixation of non-recombinant chromosomes in homozygous doubled haploid lines (DHs). The approach not only allows

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the fixation of uncharacterized germplasm but allows the rapid generation of chromosome substitutions that will facilitate breeding on an individual chromosome level.

Objectives that could be achieved through reverse breeding

- ✓ To produce breeding lines for the undefined hybrid.
- ✓ To enhance the performance of the hybrid lines by the genetic improvement of parental lines.
- ✓ To maintain the stability of already produced hybrid.
- ✓ To maintain a highly heterozygous nature of the plant from a homozygous parental line.

Mechanism of Reverse breeding

Reverse breeding comprises two essential steps:

- ✓ The suppression of crossover recombination in a selected plant is followed by the regeneration of DHs from spores containing non-recombinant chromosomes. The DH lines can then be used to recapitulate the elite heterozygote on a commercial scale.
- ✓ Reverse breeding relies on achiasmatic meiosis: Achiasmatic chromosomes (chromosomes that did not form crossovers) remain as univalent. Chiasmata that in bivalents promote segregation of homologues to opposite poles (regular disjunction), are absent in univalent and the homologues may segregate to the same pole instead (non-disjunction). This leads to unbalanced chromosome numbers (aneuploidy) in the spores. Consequently, achiasmatic plants are highly sterile.

Doubled haploids

Doubled haploid plants resulting from achiasmatic meiosis can be obtained from unfertilized ovules (gynogenesis) or from microspores and anther cultures (androgenesis). The efficiency of DH formation from haploid spores is species-dependent. Development of RB is limited to those crops where DH technology is common practice. For the great majority of crop species, this technology is well established and professional breeding companies routinely use such techniques in their breeding programs. There are, however, some notorious exceptions such as soybean, cotton, lettuce, and tomato where doubled haploid plants are rarely formed or not available at all. Genotyping of DHs by molecular markers is routine practice in contemporary plant breeding and is also indispensable for RB. In the complete absence of meiotic recombination, one polymorphic molecular marker per chromosome would suffice to genotype every DH since the entire chromosome would behave as a single linkage block.

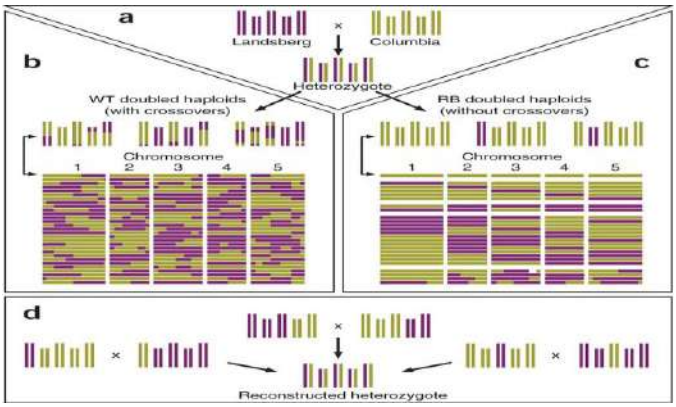

Fig 1: Reverse-breeding strategy and genotypes of wild-type (WT) and reverse-breeding (RB) doubled-haploid offspring

Reverse breeding applications

- ✓ **Reconstruction of heterozygous germplasm:** For crops where an extensive collection of breeding lines is still lacking, RB can accelerate the development of varieties. In these crops, superior heterozygous plants can be propagated without prior knowledge of their genetic constitution.
- ✓ **Breeding on the single chromosome level:** Many interesting characteristics in crops are based on polygenic gene interactions, very often located on different chromosomes. These quantitative traits are therefore not easy to breed on. RB is applied to an F_1 hybrid of known parents. These homozygous chromosome substitution lines provide novel tools for the study of gene interactions. When crossed with one of the original parents, hybrids can be formed in which one of the chromosomes is homozygous whereas it is also possible to produce hybrids in which just one chromosome is heterozygous.
- ✓ **Reverse breeding and marker-assisted breeding:** Especially in combination with (high throughput) genotyping, reverse breeding becomes a versatile tool. Evidently, high throughput genotyping speeds up the process of identification of complementing parents in populations of DHs in the early stages. Also, use in the study of gene interactions of the various heterozygous inbred families (HIFs) that can be produced by crossing and backcrossing the products of RB. The screenings of populations that segregate for traits on a single chromosome allow the quick identification of QTLs when genotyping is combined with for example transcriptome or metabolome profiling. Such HIFs further aid the generation of chromosome-specific linkage maps and the fine mapping of genes and alleles. RB can as such provide highly valuable insights into the nature of heterotic effects.
- ✓ **Backcrossing in CMS background:** In several vegetable crops such as cabbages and carrots, breeders make use of cytoplasmic male sterility (CMS). In these systems, the presence of male sterility presents a special challenge to RB. In these cases, gynogenesis rather than androgenesis can be used to obtain DH plants. This is perfectly compatible with RB in the sense that the chromosomes from the maintainer line can be recovered directly in the cytoplasm of the sterile line in one step. Gynogenesis has been described in several crops such as Brassica, maize, sugar beet, cucumber, melon, rice, onion, sunflower, and barley. In cases where the efficiency of gynogenesis is too low, it is possible to cross the male sterile (A) lines with maintainer lines (B) that carry one copy of a restorer gene. The AB combination will be fertile and RB can be performed. It should therefore be possible to use a restorer gene and a gene for crossover suppression in the same vector (both transgenes) and perform RB in a

double suppressed (CMS and cross-over) background.

Difference between End Products of Conventional and Reverse Breed Crops

- ✓ Reverse-breed crops produce end products that are identical to parental lines obtained through traditional breeding.
- ✓ There will be no change in the DNA sequence if RNAi silencing is limited to meiotic crossing. The products are completely risk-free to use.
- ✓ There is no bioethical issue with reverse-breed crops because they are not genetically engineered.

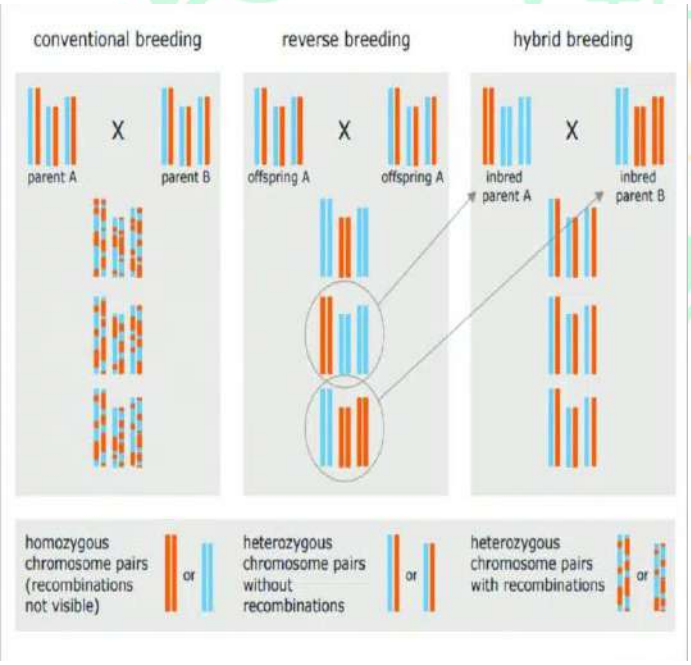

Fig 2: Schematic overview of the final outcomes of different breeding approaches

Limitations of Reverse Breeding

- ✓ This strategy is only applicable to crops where double haploid technology is widely used. Some exceptions exist, such as soybean, cotton, lettuce, and tomato, where DHs is rarely formed.
- ✓ It can only be grown in crops with a haploid chromosomal number of 12 or less, or in crops where spores can be regenerated into DHs. The number of non-recombinant double haploids required to find the complementary pair that reconstitutes the original heterozygous plant in plants with a higher number of chromosomes would be extraordinarily high and almost impossible to find in plants with a higher number of chromosomes.
- ✓ There is no room for further selections due to the total homozygosity of the obtained plants, which limits the genetic variety desired in plant breeding.

Conclusion

- ✓ Reverse Breeding is a novel breeding approach that accelerates the breeding process and increases the available genetic combinations.
- ✓ Facilitates selection of superior plant hybrids.
- ✓ Large number of plants are generated, screened, and regenerated without prior knowledge of their genetic constitution.
- ✓ Though reverse breeding is a process in the breeding process that develops homozygous parental lines from complex genotypes, it has a significant impact on crop breeding.

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Pluralistic Role of Information and Communication Technology (ICT) in Extension in India

Vishal Yadav, Preeti Yadav and Ashutosh Kumar Yadav

ICT (Information and Communications Technology) ICT is one of the pillars of "e-agriculture" and acted as a fulcrum for extension activity. ICT is often used as an extended synonym for information technology (IT) but is usually a more general term that stresses the role of unified communications and the integration of tele-communications (telephone lines and wireless signals), intelligent building management systems and audio-visual systems in modern information technology. ICT in simple terms can be defined as the basket of technologies, which assist or support in storage, processing of Data/Information, or in dissemination/communication of Data/Information or both. Information and Communication Technology (ICT) is an umbrella term that includes computer hardware and software, digital broadcast and telecommunications technologies as well as digital information repositories online or offline (Selwyn, 2009) and includes contemporary social networking aspects, read/write interfaces on the web besides file sharing systems online. It represents a broad and continually evolving range of elements that further includes the television (TV), radio, mobile phones and the policies and laws that govern the widespread use of these media and devices. The term is often used here in its plural sense (ICTs) to mean a range of technologies instead of a single technology.

ICTs in the Context of Extension

From the perspective of agricultural knowledge and information systems (AKIs), ICTs can be seen as useful in improving linkages between the research and the extension sub systems. The experience of rural telecenters in the developing world shows that ICT can help in enabling rural development workers to gather, store, retrieve, adapt, localise and disseminate a broad range of information needed by rural families (Davison *et al.*, 2005). The ICTs in extension can lead to the emergence of knowledge workers that will result in the realization of a bottomup, demand driven paradigm for technology generation, assessment, refinement and transfer.

The Need of ICT in Agriculture

Extension agent to farmer ratio in India is

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estimated at 1:2,000. Public agricultural extension services were criticized for being technically weak, providing insufficient coverage of and contacts with farmers. Less than one-third of the technologies generated by Agricultural Universities and ICAR institutes in India were transferred to the farmer‘s field due to the lack of an appropriate extension model (Katyal, 2001). Direct contact by agricultural experts with all the needed farmer clients cannot be established practically with the available technical manpower and budget in India. Hence the research challenge is to identify an effective means to provide quality and timely technical advice to all the needed farmers using the available experts and their time efficiently. Developments in ICTs offer ample opportunities to accomplish this challenge. Given the complex nature of agriculture and the challenges being faced, the use of multidisciplinary expertise is more appropriate to address agricultural information needs to empower farming community. Project rationale is that technology transfer efforts in agriculture sector must harness the huge potentials of ICT to provide better linkage between agricultural experts and farmers for timely and appropriate technical advice to enhance agricultural productivity and improve living standards of farmers in the region.

Role of ICT in Agriculture

- ✓ ICT has a tremendous potential to improve the reach, credibility and impact of Agricultural Extension, ifused appropriately.
- ✓ ICT expands the role of agricultural extension from transfer of technology to Agricultural Informationsharing and Building Agricultural Knowledge Networks.
- ✓ The type of ICT application needed is decided once we understand the context of agricultural extension *i.e.* to provide total information and advisory support to farmers on all aspects of farming, marketing andmanagement.

The areas in which ICT can be deployed are

- ✓ On-line services for information on each crop.
- ✓ On line interaction facility to interact with nearest KVK, SAU, ICAR research station, agriculture and allied departments etc. for advice on current schemes, projects, varieties etc.
- ✓ Information on all sources of Agricultural credit and crop insurance and their terms and conditions.
- ✓ Information sharing mechanisms among the farmers, extension workers and Scientists of every district,block and mandal.
- ✓ Question - Answer service (on the lines of kisan call centre) for each district in the country.
- ✓ On-line information on market prices of all commodities at mandal, block, district, state and majornational market level.
- ✓ On-line monitoring and information sharing on all Agricultural development projects in the country.
- ✓ On-line sharing of District Agriculture development plans (example- strategic research and tension plans(SREP‘s) of different ATMA

districts.

- ✓ On line information on Market prices of all commodities at mandal, block, district, state and majornational market level.
- ✓ Market intelligence on major crops.
- ✓ On-line weather forecasting and its impact on major crops, on weekly basis, including early warning system and on line service on land records.
- ✓ E-commerce for direct linkages between local producers, traders, retailers and farmers.
- ✓ Information on availability and rates of agricultural inputs-seeds, fertilizers, pesticides, machinery etc.
- ✓ Information on all Government and Non-Government Organizations working directly or indirectly forthe agricultural sector.

Problems of ICT in India

There are several success stories to the credit of this information revolution initiative in rural areas, but it still lacks the 100% efficacy in implementation and its prime objective of bettering rural lives. Following are themajor problem of ICT in agriculture in India:

- ✓ Many times the information provides through the various media is not locations specifics, therefore,farmers feel trouble to accept it.
- ✓ Majority of our farmers are illiterate therefore they are unaware about the latest information andcommunication systems.
- ✓ Many times messages are complex and untimely therefore farmers could not accept it.
- ✓ Poor updating of information & communication technologies.
- ✓ Slack broadband or wireless connections in internet.
- ✓ Low level of intrusion of telephone lines in rural areas leading to low modem availability.
- ✓ Radio and television though have a deep approach in rural areas, but the service providers have a limitedand wanting coverage of issues.
- ✓ The economic Purchasing Power Parity (PPP) of rural people is low as compared to urban people.
- ✓ Low motivational parameters among the rural people to acquire the new and advanced information.
- ✓ Inadequate and improper training to the extension machinery especially the staff which aids thefunctioning of ICTs.

Conclusions

Agriculture Knowledge & information systems have to be implemented on priority for rural empowerment and improved livelihoods as Economic growth and industrial growth of India are dependent on productivity in agriculture and allied sectors. Ministry of Agriculture is implementing various schemes for mainstreaming ICT in Agriculture to improve the Agricultural Productivity with emphasis on improving the service delivery at the grass-root level. Though this ICT enabled Extension has made giant strides in the rural development sector but there still lacks the perfect

efficiency in delivering what it is meant to deliver or cater to the rural masses. So, there is still great scope to push its mileage to the uppermost limit.

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Fish Farming Integrated with Cattle Farming

Jadhav Amit and Zod Priyanka

Introduction

Integrated fish farming is the farming of fishes with livestock and Agriculture i.e., rising of fishes with agriculture and animals. Integrated fish farming is also called Agro-Pisci culture. It is beneficial for farmers to reduce feed and fertilizers cost used in fish farming and enhances profit as well as social economic status of fish farmers. Fish farming integrated with cattle means fishes are raised on the output of cattle farming in point of manures. Integrated farming is the use of waste from one system as an input for another system. India having was same land resources and having 302.3 million of cattle's and buffaloes and ranks first in milk production so waste that is cow dung and buffalo dung used as input for fish farming.

Principle

The waste generated from cattle rearing is reclaimed, recycled, reused i.e., animal waste as fish feed manure for crops that is fish. Dung droppings contain 1.85 percent nitrogen 1.46 percent phosphorus and contributed calcium into pond. Cattle graze on pond banks and grazy areas in the vicinity and manure is either collected directly from cattle shed into fish pond. Cow dung is efficient in promoting production of zooplanktons and phytoplankton. Cow dung increases the nutrient status in a fish pond and acts as feed for fishes or enhancing the food availability fishes. One cow excretes 400 kg of dung and 300-liter urine annum^{-1}.

Significance of cattle used in fish cattle farming

- ✓ Cattles provide organic manure to fish ponds.
- ✓ Cattle dung is nutritionally rich.
- ✓ Cattle dung is very fine due to repeated digestion in the cattle.
- ✓ Cattle dung can suspend longer in fish pond.
- ✓ The suspend ability of dung not only enables fish to get more feed, but also reduces oxygen consumption caused by manures, this also avoids the formation of harmful gases.
- ✓ The BOD of cattle dung is relatively less than other livestock manures, because the cattle forage decomposes already by microbes in the cattle stomach itself. This causes no risk for the fish ponds using cattle manure.

Present Status in India

India, is organic-based and derives inputs from agriculture and animal husbandry. The integrated fish farming is accepted as a sustainable form of aquaculture. The Cattle population in 2017-18 was 192.5 million whereas buffalo population was 109.9 million. The total bovine population was 392.3 million. Cattle accounts for 35.94%of total livestock and percentage of buffalo was 20.45% of

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total livestock population. India stands first in the milk production with 187.7 mt of milk production in 2018-19. The per capita availability is 394 g day^{-1}. The Fish cum cattle farming is practiced in north eastern states of India, the major activity observed in Assam and Tripura states. The Apatanis, a form integrated culture practiced in north eastern states.

Farming Methods

fish cum cattle farming having two methods that is semi-integration means raising livestock on land and transporting the manure to fish pond and another method is complete or vertical integration that is raising livestock directly above the fish pond and animal manure drop directly into fish pond. The complete method is less used due to control of ammonia level in fish pond is hardy. Semi integration is more popularly used because of manure is given as per requirement a fish pond to avoid forming of algal bloom.

Manures and Animal Waste Management

Following methods of manure management

i) Composting

ii) Biogas

iii) Applying for other Species- Fish

The animal waste includes fecal matter urinary waste discarded products of animals such as mastitis milk, clipped hair, feed residues etc.

Application of cow dung

The application of cow dung enhanced the group performance of fishes significantly. Cow dung especially efficient in enhancing production of zooplanktons and phytoplankton. Sun dried cow dung contains 0.10 g nitrogen which also given as manure. The quantity of cow dung required is 10 ton ha^{-1} if Mahua oil cake used then quantity is 5 ton ha^{-1}. The 20% quantity of manure given initially prior 15 days of stocking and remaining 80% is applied in 11 equal installments. In Tripura cow dung applied 15 ton ha^{-1} in culture ponds. Application of 3000 kg ha^{-1} cow dung shows increased growth. Cow dung in the form of biogas slurry is even better @ 80- 120 kg of fresh slurry ha^{-1} of pond each day.

The optimum stocking density is 6000-8500 fingerling ha^{-1} without any feed supplement. Pond should be stocked with 100-150 mm long fingerlings of desired species. Stocking rate depends primarily upon the volume of water and on the oxygen balance of the pond. Quality of available natural fish food in pond and capacity of farmer to provide supplementary feed are also matters for consideration. In composite fish culture rearing of six species of carps is considered to be ideal combination but 3-4 species combination can also be taken up. Stocking pond also should have a desired level of plankton population of about 13 - 50 ml $metric^{-1}$ cube.

- ✓ Nursery Pond 1.5-2.5 million ha^{-1}
- ✓ Rearing pond 0.25-0.30 million ha^{-1}
- ✓ Grow-out Pond 6000-8500 fingerling ha^{-1}

Fish species can be cultured

Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*), Tilapia (*Oreochromis mossambica*), Magur

(*Clarias batrachus*), Java puthi (*Puntius javanicus*) Kurhi (*Labeo gonius*), Freshwater prawn, etc.

Production

Fish productivity was recorded highest in fish cum cattle farming. Culture of Chinese carp in pond manure with 15 ton ha^{-1} $year^{-1}$ cow dung produced 5 tons ha^{-1} $year^{-1}$. 5-8 cattle are sufficient to fertilize a hectare water area to get over 4000 kg fish without feed or any other application. According to Samra *et al,* fish production from integrated cattle farming is 5-7.5 ton ha^{-1} $year^{-1}$. One cow 3000 liter of urine and 400 kg of dung $year^{-1}$. The milk production from one cow per annum approximately 3000 liter. Energy efficiency in cattle cum fish farming is 0.66 experiment taken at Calicut in 2006-2007 integrated fish farming evaluated the net return from livestock is 14.3%. Conversion ratios of animal manure to fish that is kg of fresh manure to kg^{-1} increase in fish weight in cattle is 35%. The survival rate is recorded in cattle farming is 80-95%.

Importance of Cattle-Fish Integration

- ✓ Minimizing wastes leading to improved environment quality of the area.
- ✓ Reducing need for fertilizer but with increased fertility.
- ✓ Improves soil nutrients and increased its fertility.
- ✓ Increases fish production leading to improved nutrition and income of rural population.
- ✓ Reduces dependence upon outside inputs leading to increase stability.
- ✓ Increasing employment opportunities.
- ✓ Catties are raised for milk and manure on pond banks and their washing are drained directly into the pond. Under this system cost of fish culture is reduced by 50%.

Conclusion

The integration of aquaculture, fisheries, agriculture and other productive or ecosystem management activities has an integral role to play in the future of the aquaculture industry. Effort is required to standardize the fish size, stocking rate, feeding, species combination and feeding, type of animal, number of animal and their size; age and diet, quality of seasonal factors will also have to be considered. As the success of integrated system depends on low production cost and high returns, the management techniques for animals will have to be improved. Feeding technology for reducing feed cost, faster growth and higher yield of animals should be adopted. Liquid manure of effluent from bio-gas digester can be matched with this production technology.

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Value Addition in Flowers: A Money Spinner

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Abstract

Floriculture is presently considered as the most lucrative agro-enterprise in terms of profit making. As the flowers are the utmost perishable horticultural farm produce, there remains some hindrance in proper marketing following standard postharvest management practices by the common farmers. Hence, value addition by the agro-industries is another important component for proper utilization of fresh ornamentals in either garden-fresh or processed form. Flower crops are perishable in nature; it needs a proper postharvest practice and value addition to enhance the value. Nowadays, different kinds of value-added products are formulated and marketed by the agro-enterprises which include essential oils, flavors, fragrance, pharmaceutical and nutraceutical compounds, insecticides, pigments, natural dye, gulkand, rose water, etc. It also includes fresh flower products from cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage and secondly loose flower products like garland, floral strings, pomanders, wreaths, floral jewelry. Dry flower value added products includes dried flower arrangements, products of press dried flowers and pot pourries etc. Traditional flower crops in country like India have its own spiritual importance which makes floriculture sector flourishing.

Introduction

Flowers provide the opportunity to convert them directly from fresh flowers into financially rewarding value added products which including garland, bouquet, flower arrangements, or after drying the flowers into different dried flower products also including pot pourri, wreath, painted gourds, greeting cards, or after processing like as rose water, gulkand, gulroban, perfumes, essential oils, insect repellants, cosmetics, and so on.Besides, a number of pigments like xanthophylls, carotenoids, luteins, anthocyanins, etc. which have neutraceutical properties and pharmaceutical compounds can also be prepared from the flowers. It is a good source of income generation by self-employment. The value-added products can be classified into three categories namely 1. Fresh Flower Products, 2. Dried Flower Products and 3. Processed Flower Products (De, 2020).

Objectives of value addition in ornamental flower crops: We need to add values to ornamental flower crops for the following reasons;

- ✓ To stabilise farm income by increasing farmer profitability.

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- ✓ To increase the sale of floricultural products by improving their quality.
- ✓ To increase profits by eliminating middle men.
- ✓ Use of unsold (unmarketable) flowers to avoid post-harvest losses.
- ✓ To deal with the volatility of raw commodity prices.
- ✓ Adapt to evolving consumer tastes by supplying quality, safe, and branded items.
- ✓ To provide employment and empower women.
- ✓ Produce more acceptable quality items for both the domestic and foreign markets.

Classification of value added products: The value-added products can be classified into three categories namely,

1. **Fresh flower value added products:** It includes two types of flower arrangements:
   - ✓ Cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage etc.
   - ✓ Loose flower arrangements like garland, floral strings, pomanders, wreaths, floral jewelry etc.
2. **Dried flower value added products:** Dried flower value added commodities include dried flower arrangements, floral jewellery, floral presents, press dried flower products such as petal embedded papers, candles, pot pourriesetc.
3. **Processed flower value added products:** Essential oils, absolutes, concrete, petal jam (rose, rhododendron), jelly, fully prepared beverages, wine floral tea, rose hip juice, poultry feed, insect repellant, floral dyes, petal embedded handmade paper, cosmetics such as calendula cream, rose water, rose cream, and so on are examples of processed flower products.

Value added products made from flowers

According to Jain, 2016 there are various types of value added products which can be prepared either by practice or by obtaining training of making these products. Some of the fresh flower value added products are given below:

1. **Flower bouquets:** A flower bouquet is a creatively arranged gathering of flowers. Flower bouquets can be arranged for decoration in homes, public places, or they can be sold. Handled bouquets are divided into numerous common shapes and styles, including as nosegay, crescent, and cascade bouquets. Flower bouquets are frequently presented as gifts on important occasions such as anniversaries.
2. **Rangoli:** Generally, the Rangoli (Drawing patterns at the entrance) is made up of colours but keeping in view the eco-friendly nature, the loose flowers are used to make rangoli.
3. **Garlands:** Garlands are utilised for a variety of auspicious occasions, religious functions, and festivals. These are made by tying the flowers together with a needle in a string or thread using one or more types of flowers. Garlands can sometimes include foliage as well as flowers. Roses, chrysanthemums, marigolds, jasmine, tuberose, orchids, and other flowers are commonly used to make garlands.
4. **Floral jewelry:** On the mehndi celebration of

marriage, the floral jewellery theme has become quite popular among brides, particularly in metropolitian cities. Floral jewellery will match the outfit and be light in weight, making it easy to use and eliminating the possibility of jewellery theft. Floral jewellery also includes adornments such as garland, floral bangles, crowns, earings, gajra and veni.

Flower Bouquets | Rangoli | Garland | Floral jewelry

5. **Wreath:** It is a band of flowers or foliage interwined into a ring, usually placed on a grave as a memorial or worn on the head as a crown or a mark of honour.
6. **Buttonhole/butonniere:** These are typically worn by males in the lapel of their coats, but they can also be worn by ladies. It is a little floral arrangement made using a single small flower, such as a rose or orchid, and filler, such as thuja leaf.
7. **Corsage:** A flower or tiny arrangement of flowers worn as an adornment by a person. Corsages are typically worn by women on special occasions and can be pinned to the chest or linked to the wrist. It is often larger and more artistic than a butonniere.

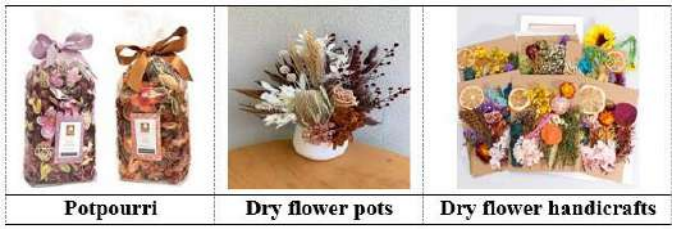
Wreath | Buttonhole/butonniere | Corsage

Commercial dried flower value added products

Dry flowers are in high demand in both Indian and international markets. It is exported from India to countries such as the United States, Japan, and Europe. Because of the variety of plants available, India stands first in dry flower export. Dry flowers include dried shoots, seeds, barks, and other plant parts as well as flower parts. Export of dried flowers and plants from India isabout Rs 100 crore per year. The industry exports 500 varieties of flowers to 20 countries. According to Swarnapriya and Jayaseka, 2022 there are many types of value added product made from dry flowers for different different purposes.

1. **Potpourri:** It is a polythene bag filled with perfumed loose dry flowers. Typically found in almyrahs, drawers, and bathrooms. This approach employs almost 300 different plant species. Potpourri is widely made in India with bachelor's button, Cock’s comb, jasmine, rose petals, Bougainvillea flowers, neem leaves, and nuts from the fruits.
2. **Dry flower pots:** We use dried stems and shoots. Despite having less market demand, it offers a good price and is mostly favoured by the upper income level. Dried cotton skins, pine flowers, dry chillies, dry bottle gourd, grass, tree jasmine, everlasting flower, asparagus leaves, fern leaves, tree barks and twigs are some of the most regularly utilised materials.
3. **Dry flower handicrafts:** The latest development in dry flower market. Framed dry flower pictures,

greeting cards, covers, bouquets, candle stands, glass bowls are made using different colored dry flower materials.



Potpourri | Dry flower pots | Dry flower handicrafts

Processed flower value added products

That type products made from flowers after processing. Generally, they are divided into two one is Edible products and another one is Non edible products.

Edible value added products

1. **Gulkand:** Rose petals are also preserved for direct consumption by preparing gulkand, which is made by smashing equal parts petals and white sugar. It is used as both a tonic and a laxative. Rose petals or flower buds can be used to flavour regular tea or combined with other herbs to make herbal teas. Rose-flavored fondant covered in chocolate, often topped with a crystallised rose petal, is a traditional English delicacy readily available in the UK from a variety of manufacturers.
2. **Herbal tea:** Rose petal or flower buds are sometimes used to flavor ordinary tea, or combined with other herbs to make herbal teas.
3. **Rose cream:** Rose flavoured fondant covered in chocolate, often topped with a crystallized rose petal are a traditional English confectionary widely available from numerous producers in the UK.
4. **Rose syrup:** Rose syrup, most frequently produced from rose petals extract, is widely used in France. This French rose syrup is used to make rose scones and marshmallows in the United States. Rose blooms are used in food, mainly as flavouring or to provide fragrance. Candied rose petals are another small application.
5. **Jasmine tea:** Green tea with jasmine flowers. Jasmine tea is consumed in china, where it is called jasmine-flower tea. Flowers are also used to make jasmine tea, which often has a base of green tea or white tea, but sometimes an oolong base is used.

Gulkand | Herbal tea | Rose cream | Rose syrup | Jasmine tea

Non edible value added product

According to Kombo and Sahare, 2021 flowers are used for making perfume, Rose water as non edible products and also for pharmaceutical use some time edible but most of the time as a non edible value added products.

1. **Perfume:** Rose perfume is produced by using atter of roses or rose oil, which is a combination of volatile essential oils obtained from steam distillation of the crushed petals of roses. A related product is rose water which is utilized for cooking, as cosmetics, medication and in religious occasions.
2. **Rose water:** It is a significant product in which 100 kg of rose petals are boiled in a still until 1000

L of water is distilled. Rose water is utilised in the preparation of sweets and religious activities. It can also be sprayed directly on the skin for natural moisturizers and to help reduce excess oil on face cosmetics, among other things. Rose water can also be found in ice cream and other desserts.

3. **Pharmaceutical uses:** Rose extract is used in mouthwash to lessen the discomfort and size of ulcers. Roses, which are anti-infective and anti-inflammatory, are also used to treat conjunctivitis, dry eyes, and other eye issues. Rose oil is also recognised for its anti-cancer, anti-depressant, relaxing, antioxidant, antibacterial, and antimicrobial properties. Rose essential oil has great benefit to the patient suffering from Alzheimer and dementia as it helps in memory enhancement. The red rose consist anthocyanin pigments which are used as an anti-bacterial agent (Kumar, 2017 and Saati *et al*., 2018).

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Impact of Elevated Carbon oxide Level on Seed Production and Quality

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Earth is the only planet in the solar system known to harbour life and radiation coming from the sun act as a source of energy. Human activities such as industry, transport, energy generation and deforestation all produce these greenhouse gases. The total concentration of these gases has risen greatly since the start of the Industrial Revolution in Europe and the average global temperature has also risen over that time period. The impacts of climate change are many and varied, as all lifeon earth and many of the planet's physical processes are heavily influenced by temperature. A warming planet means that sea levels will rise as water takes up more space as it heats up. Higher temperatures also melt ice locked away in glaciers and Polar Regions (Arunanondchai *et al.*, 2018).

This contributes to rising seas but also (in the case of glaciers) increases the risks of flooding in the short term, and decreased river flow in the longer term. Climate change may also affect watersupplies in other ways, such as altering the South Asian monsoon (Noya *et al.*, 2018).

In agriculture seed is the most basic and vital input in agriculture to reap the benefit of agriculture quality seed production is important. But Climate change poses several challenges to the continued production of high-quality seed and impacts the seed industries because the seed industry is the cornerstone of global food security; food security depends on seed security. The global seed market is currently around US$ 66.9 billion. Domestically, the largest seed market is in the USA, followed by China, France, India, Brazil and Canada. Forty countries have domestic seed markets of US$ 100 million or greater, but others rely heavily on imports to supply their seed needs. The international seed market has tripled over the last three decades driven mainly by the evolution of multinational seed companies, the increased availability of F_1 hybrids, the protection of intellectual property, the increasing use of counter-season production, and the development of genetically engineered crops (FAO, 2017).

The seed has to pass through the reproductive system and climate change effect on sexual reproductive phase in plants for better seed production and quality. With this let's observe how climate change has an impact on seed production and quality and options for adaptation.

Flowering time

Elevated CO_2 can advance, delay, or impose no change on flowering time depending on genotypes and growing conditions.

MicroRNAs change significantly in expression

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with the atmospheric CO_2 concentration. Using the RNA-sequencing method, (May *et al.,* 2013) strongly correlated expression changes between miR156/157 and miR172, and their target transcription factors under elevated CO_2 concentration and demonstrate that both CO_2 and temperature alter microRNA expression to affect Arabidopsis growth and development, and miR156/157- and miR172-regulated transcriptional network might underlie the onset of early flowering induced by increasing CO_2 miR156 and miR157 decreased, and miR172 increased in expression significantly under elevated CO_2. The downregulations of miR156/157 expressions correlated with upregulations of several squamosa promoter binding protein-like (SPLs) gene transcripts; these SPLs include SPL10 in all three biological replicates, SPL13A and SPL13B in replicate 2 and 3, and SPL9 and SPL2 inreplicate 1 and 3. SPL13A and SPL13B are identical in the open-reading frame but differ in the untranslated regions of their mRNAs. Similar expression correlations were also identified formiR172 and its target transcription factors; nearly all miR172 targets were downregulated,including SMZ in replicate 1 and 2, TOE1 in replicate 2 and 3, TOE2 in replicate 2 and SNZ inreplicate 3, correlating with increased levels of miR17. mRNA-seq and RNA-seq results indicated that this early-flowering phenotype was likely to be mediated by the miR156/miR157-SPLs-miR172-AP2-like transcription factor pathway. It is well-established that the sequential action of the components in this pathway controls the vegetative juvenile-to-adult phase transition and flowering time during normal development.

Pollen

Exposure to elevated CO_2 either increase or not change pollen production. But reduce pollen viability and pollen germination. This decrease in pollen viability may have resulted from a nutrient limitation that developed as CO_2 became abundant. Both nitrogen and phosphorous can become limiting under elevated CO_2 a reduction in their availability can reduce pollen quality (Osborne *et al.,* 1997).

Pollinators

Seed production from 87 of the world's leading food and forage crops depends on insect pollination. In plant species where elevated CO_2 increases floral display increased flower numbersand longevity, attractiveness to pollinators may be increased, and the increased nectar resources should benefit the populations of bees (and other insects) feeding on the flowers.

However, CO_2 enhancement can affect bees directly; within honey bee (*Apis mellifera* L.) hives, the highest flight traffics out of the hive is during the period of lowest CO_2 concentration.

Seed quality

Viability and Germination

Seed germination in response to elevated CO_2 is also highly variable, with responses varying among species. The reported change in carbon/nitrogen ratio may reduce seed protein content, reducing seed viability by limiting the seed's

ability to supply the amino acids required for protein synthesis during embryo growth. Mean proportion of germinated seeds and mean germination time in Control and 2 X [CO_2] conditions for greenhouse-produced seeds. When the seeds were produced under control conditions, a high CO_2 concentration during germination of Arabidopsis thaliana seeds does not change the proportion of germinated seeds butdoes induce faster germination. In seeds that were produced under high CO_2, germination is slowerand total germination is lower. Elevated atmospheric CO_2 concentration seems to reduce seed quality in Arabidopsis thaliana. This could result from an influence on the maturation processes or by altering seed filling. They said elevated [CO_2] is known to increase the C/N ratio in vegetative tissues, As the protein content of seeds is very high, an increase in C/N could lead to a decrease ofthe protein content and reduce seed viability or change the quality of the teguments (Hampton *et al.,* 2013).

Seed yield

CO_2 enrichment is likely to increase yields of most crops by approximately 13 per cent but leaves yields of C4 crops unchanged. It will tend to reduce water consumption by all crops, but this effectwill be approximately cancelled out by the effect of the increased temperature on evaporation rates.In many places increased temperature will provide opportunities to manipulate agronomy to improve crop performance increase in CO] in the atmosphere can have a large impact on the rate of photosynthesis, particularly of C_3 plants. However, CO_2 also affects water use by plants becausehigh concentrations cause partial closure of the stomata. The magnitude of its effects on dry matter production depends upon the illumination conditions, water availability, N supply and the transportand storage of the photosynthesis. CO_2 affects the water economy of crop plants. Increased CO_2 increases the rate at which this gas diffuses into leaves through the stomata, relative to the rate at which water vapours diffuse out. Because the extra CO_2 increases the rate of dry matter production of C_3 plants, this change in relative diffusion rates also increases the water use efficiency WUE, the amount of dry matter produced per unit of water transpired. An increase in CO_2 also causes a decrease in the aperture of the stomata, which reduces the rate of water consumption. Yield increases are usually because of a greater number of seeds per unit area as a result of increased resource use efficiency for radiation, water, and nitrogen. Elevated CO_2, through decreasing stomatal conductance, increases water use efficiency. In water stress conditions, this may allow plants to retain more seeds, but yields will always be lower compared to those in non-resource stress environments Sometimes there is also an increase in seed mass, although the effects of elevated CO_2 on seed mass are highly variable .plants with C_4 of photosynthesis possessamechanism that increases the CO_2 con at the site of rubisco as the CO_2 can increase the oxygenating function of rubisco repressed the carboxylate function is almost unsaturated CO_2 induced decreasein stomatal conductance may

reduce transpiration thereby conserving soil water can be deployed for extra photosynthesis but the CAM plants are facultative and change according to the situation (Farrar *et al.*,2013)

Conclusion

Increase in carbon oxide content is alarming the world by hampering agriculture and its products. Industrialization and poisonous gases cause global warming, which ultimately disturbs the world's environment. Change in carbon oxide content has devastating effects on plant growth and yield. Abiotic stresses are the major type of stresses that plants suffer. To understand the plant responses under elevated carbon oxide conditions the most pressing current need is to explore the genetic basis underlying these mechanisms. Some bottleneck molecular and physiological challenges present in plants need to be resolved for better plant adaptation under increased carbon oxide conditions.

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Lac Culture: History, Meaning, Types and Uses

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Introduction

Lac Culture is a scientific method of controlling lac insects. Lac insects are used by humans to obtain a large quantity of high-quality lac. Animals have long been prized by humans for their many uses. Wild animals, as well as domestic animals, are beneficial to mankind in a variety of ways. Humans benefit from animals of various sizes and sorts in a variety of ways. The list of items we receive from both live and dead animals is possibly endless. The lac bug is a fascinating and tiny insect that provides us with a product that may be used in a variety of ways. This article can be used by students who want to learn more about Lac Culture.

What is Lac Culture?

Lac is a natural resinous secreted by insects called lac insects. Lac culture definition is the scientific management and rearing of lac insects for high-quality lac to be used for commercial purposes are called lac culture. Management involves the selection of host plants, inoculation of plants with lac insects, rearing of lac insects, pest management and harvesting and processing of lac.

History of Lac Culture

Indians have been using lac for ages. The epic Mahabharata mentions the detail of the famous *'Lakshagruha'*, a house built of lac, which was built to burn the Pandavas. So, one can assume that Indians know the inflammable nature of lac and its other uses too. Other than this, Indians have been using lac for making toys and ornaments. Evidence also suggests the use of Lac by ancient Romans and Greek people. The scientific study of lac was started by Father Tachard in 1709. The name *Laccifer lacca* was finalized after many changes.

Systematic Position of Lac Insect

The lac insect is classified as follows:

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Hemiptera

Superfamily: Coccoidea

Family: Kerriidae

Genus: *Laccifer*

Species: *lacca*

So, the binomial name of lac insects is *Laccifer lacca*.

Host Plants of Lac Insects

Lac insect is an ectoparasite and feeds on the plant sap sucked from the tender shoot of the plant.

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So, they can be reared on specific trees only, and these trees/plants are called host plants. The lac culturist must know the host plants and which plants suit the geographic conditions of the place. The lac management includes the rearing of healthy host plants in a stage that is suitable for the lac insects to suck the sap.

The host plants of lac insects are:

Vernacular Name	Scientific Name
Kusum	*Schleichera trijuga/oleosa*
Palas	*Butea frondosa or Butea monosperma*
Ber (plum)	*Zizyphus jujuba*
Babul	*Acacia arabica*
Khair (Rangeeni)	*Acacia catechu*
Arhar	*Cajanus indicus*

Lac Culture Life Cycle of Insects

A lac culturist must have knowledge of the life cycle of lac insects and must be able to identify the stage at which lac is produced maximum and to be harvested. The lac insects show very distinct morphological differences and sexual dimorphism. The life cycle of lac insect has 4 stages as:

1. Eggs
2. Larva
3. Pupa
4. Adult

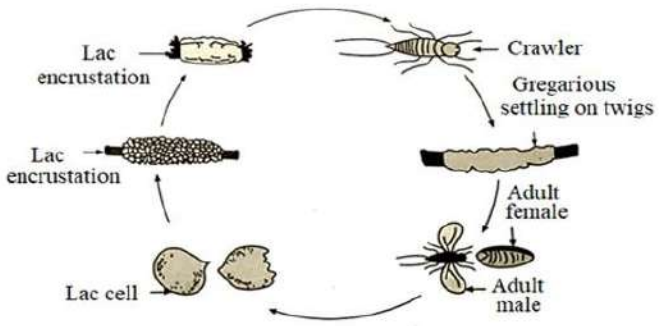

Fig: Life Cycle of Lac Insect

The phases of the lac culture life cycle of insects are as follows:

Fertilisation: the male adult walks over the female incrustations and inserts itself into the female cells, where it fertilizes the female.

Egg-laying: After fertilization, the female grows rapidly till it becomes capable of egg-laying. A single female lays an average of 200 to 500 eggs after fertilization and deposits inside the incubating chambers of the female cell.

Egg Hatching: After 6 weeks, the eggs are hatched into first instar larvae. The mass movement of these larvae in search of a suitable place to suck plant sap is called swarming.

Pupa: A larva is a sluggish and continuous feeder. It encases itself and the twig by secreting a resinous secretion from the body. The secretion hardens upon contact with air and is called a lac cell. Inside the lac cell, the larva undergoes three moultings. During moulting, male and females lose some body parts.

Adults: Male larvae develop into male adult insects and are without any mouthparts and thus do not feed. One adult male insect can fertilize several females, and soon after fertilization, it dies. The adult female is smaller in size than the male and is without legs and wings. The female larvae never move out of the cell once they settle down after swarming.

Lac Secretion and Composition

Lac is the only known commercial resin of animal origin. It is a resinous material secreted by the lac insects. Special glands called lac glands are pres-

ent in the skin of the larvae and the adults. Lac is a mixture of several substances, but resin is the main constituent. It is thought to be a polyester of a straight chain of complex fatty acids containing 14 to 18 carbon atoms. The approximate percentage of different constituent of lac I resin 68 to 90%, dye 2 to 10%, wax 5 to 6%, mineral matter 30 to 7%, albuminous matter 5 to 10% and water 2 to 3%. It also contains sugar, proteins, soluble salts, debris of lac insect and some woody material.

Culture Technique of Lac Insect

Culturing of lac begins when the farmer inoculates a plant with a female cell where eggs are ready to hatch. As soon as the eggs hatch and first instar larvae emerge, they infest the host plant by a process called swarming. After finding the spots for feeding, the larvae start secreting the resinous material around their body. This material appears shiny in the beginning and hardens when it comes in contact with air. The lac casing is thus around the body of the larva and the twig on which it is feeding. Many lac cells of nearby larvae fuse together, and a lac incrustation is formed. This is the lac that a lac culturist is interested in.

The culture technique of lac insect involves the following steps:

Inoculation: inoculation means the introduction of lac insects to the host plant. Inoculation can be natural (without any human intervention) or artificial.

Cultivation of host plants: since the larvae of lac insects suck the plant sap from the tender shoots of host plants, proper cultivation and pruning become important in lac culture.

Lac Crop: the life cycle of lac insects of 66 months and hence two crops in a year are regular. There can be four lac crops as lac insects behave differently on Kusum and non-Kusum host plants.

Harvesting and Extraction of Lac

The twigs with thick encrustations are cut and removed from the site. This is stick lac. Then the lac cells are scraped from the twig, and the lac is the granular lac. If the cutting and scraping are done before swarming, it is 'Ari lac', and if it is done after swarming, it is 'Phunki lac'. The scraped lac is washed thoroughly with water. Drying and bleaching of lac are done by exposing it to sunlight. Lac granules are melted in a pot over an open charcoal fire. The molten lac is then spread in the form of sheets. The sheets are dried, brokeninto pieces and sold in the market as flakes.

Types of Lac

Depending on the host plant, lac is of two types

1. **Kusumi Lac:** insects are reared on Kusum plants, and lac is harvested from these plants.
2. **Rangeeni Lac:** when the lac insects are reared on non-Kusum plants, the lac is known as Rangeeni lac.

Inoculation	Emergence of Male	Crop Reaped	Rise of Swarming larvae
Rangeeni (non-kusumi) Crop			
Kataki (June-july)	Aug	Oct.-Nov.	Oct.-Nov.
Baisakhi (Oct.-Nov.)	Feb.-March	April-May	June-July
Kusumi Crop			
Aghani (June-July)	September	Dec.-Jan.	Jan.-Feb.
Jethwi (January)	March-April	June-July	June-July

Lac Culture Uses

Lac is used for making toys, bracelets or bangles, for filling the ornament, sealing wax, gramophone records etc. It is also used in making the grinding stones, for manufacturing varnishes and paints, for silvering the back of a mirror, for encasing cable wires (due to insulating property of lac) etc. During the washing of scraped lac, a dye is left behind in the water which is then used for dying purposes. Some examples of by-products of lac are nail polish, lithographic ink, shoe polish etc.

Position of Lac Culture

- ✓ Globally lac is produced in many countries like India, Thailand, Myanmar, China, Indonesia, Vietnam and Laos.
- ✓ India and Thailand are the major producers, producing an average of 1700 tonnes annually, followed by China.
- ✓ Until 1950, India held the monopoly in lac production, accounting for almost 85% of the global production.
- ✓ In a later period, Thailand became one of the major competitors.
- ✓ Now India's contribution to global lac production is about 70%.
- ✓ Roughly 200 million rupees is the net export of lac from India
- ✓ 3-4 million people, including tribals, are engaged in lac culture in India
- ✓ In India, Bihar is the highest producer of lac.
- ✓ Other states like Madhya Pradesh, West Bengal, Maharashtra, Assam and Odisha also produce lac.
- ✓ Some pockets of lac cultivation also exist in Andhra Pradesh, Punjab, Rajasthan, Karnataka, Gujarat, and Mirzapur and Sonebhdra districts of Uttar Pradesh

Conclusion

A lesser-known but economically sustainable part of animal husbandry, lac culture makes a worth-attention topic of applied zoology. A small insect of the order Hemiptera, lac insect, is reared for the resinous material that it secretes during its life cycle. Larva and pupa are the main stages that produce lac. Lac is the only known commercial resin of animal origin.

Scientific management of lac insect, which includes rearing of insect and its host plants, pest management and cultivation and harvesting of lac is together known as lac culture. Economically, lack of culture is a stronger option of self-employment, and many villagers, including tribals, are in this business. India holds the first position in the world for commercial production of lac.

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Impact of Flood on Crop Farming and Its Management in Bihar

Tulika Kumari, Rashmi Sinha, Ritambhara Singh and R. K. Meena

Abstract

During monsoon season, the phenomenon of flood is very common in North Bihar. Total flood prone area of the State is 68.80 lakh hectares which is 73.06 per cent of its total geographical area and 17.2 per cent of the total flood prone area in the country. Out of 28 flood prone districts, 15 districts are worst affecting results in huge loss of property, lives and farmland etc. The total damage due to flood was Rs. 528.76 crore in the year of 2016. Crop farming is severely damaged by the flood and farmers got trapped into the vicious circle of poverty. The loss of cropped area was 0.41 mha which was Rs. 443.53 crore in value terms due to flood. The impact of flood can be minimised through adoption of various management practices like; crop insurance, farm diversification, flood tolerant varieties, adjustment in planting dates etc.

Background

Flood is recurring phenomenon in the country which causes huge loss of lives, properties, infrastructure and livelihood systems of the region. Bihar is one of the worst affected states due to flood in the country. The state is surrounded by Nepal in the north as well as its topography is marked by a number of perennial and non-perennial rivers. Many rivers have their origin in Nepal. The volume of these rivers increases up to 50 times during monsoon season, which is concentrated in 3 months, causing a flood crisis in Bihar. According to the flood management information systems cell, Class I floods are flash floods, class II river floods, class III drainage backups at river confluences, and class IV permanent waterlogged areas. Rainfall in Nepal is causing flash floods, which have a short lead time, about 8 hours, and the receding of flood is fast. The lead time of river flood is 24 hours and the receding of flood water takes 7 days or more. In case of drainage congestion at river confluence, the lead time is more than 24 hours lasting full monsoon season i.e., receding of flood water takes 3 months. Almost every year the state is facing flood, which severely hampers economy of the state. Total flood prone area of the State is 68.80 lakh hectares which is 73.06 per cent of its total geographical area and 17.2 per cent of the total flood prone area in the country (Kumar *et al.*, 2007). Flood situation is more severe in northern plains of Bihar. This is because almost all the major rivers enter from Nepal in this region. Bed slope of these rivers is very sharp in the Nepal and they usually enter the State on plain lands. 15 districts out of the 28 flood-prone districts are the worst affec-

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ed, which causes significant loss of property, life, farmland, etc. Over 350,000 acres of rice, 18,000 acres of maize, and 240,000 acres of other crops were negatively impacted by the Kosi floods in 2008, affecting nearly 500,000 farmers (GoB, 2010).

Impact of Flood

The impact of flood can be classified into two categories i.e., primary and secondary impact, based on direct and indirect effect. Primary impact is direct effect of flood such as loss of human life, livestock and properties. The secondary impact is indirect effect like disruption of electricity, water and health problems. In the state, agriculture is badly affected by flood. As we are aware that agriculture is the predominant sector of Bihar's economy with employment of 80 per cent of population in agricultural production (ibef, 2020). Majority of farmers in the state belong to marginal category and poverty is key characteristic of them. Agriculture in the state is crucially dependent on monsoon and flood is common phenomenon during the season in the state. Farmers are facing vagaries of flood every year which leaves them into misery. The total damage due to flood was Rs. 528.76 crore in the year of 2016. Crop farming is severely damaged by the flood and farmers got trapped into the vicious circle of poverty. The loss of cropped area was 0.41 mha which was Rs. 443.53 crore in value terms due to flood (GoI, 2018). The most affected districts in terms of crop loss are Sitamarhi, Katihar, Darbhanga, Madhubani, East Champaran, and Muzaffarpur. The estimated crop damage in these districts is Rs. 8526. 75, 8414.69, 8027.44, 7188.49, 5925.34 and 5344.32 lakhs, respectively as shown in Table 1 (Flood report, GoB, 2017).

Table 1: Impact of Flood on Agriculture

Sl. No.	Name of the Districts	Affected Agricultural Area (in lakh ha)	Crop Damage (in Rs. Lakh)
1	Purnea	0.34	4553.59
2	Supaul	0.16	2220.41
3	Madhubani	0.53	7188.49
4	Kishanganj	5.08	717.00
5	Araria	1.29	260.61
6	Katihar	0.62	8414.69
7	East Champaran	1.24	5925.34
8	Sitamarhi	0.42	8526.75
9	Darbhanga	10.89	8027.44
10	West Champaran	0.47	3967.00
11	Sheohar	0.11	1540.43
12	Muzaffarpur	0.98	5344.32
13	Gopalganj	0.22	2001.64
14	Saharsa	0.27	3708.5
15	Khagaria	0.21	2863.37
16	Saran	0.2	2712.52
17	Samastipur	0.01	464.74
18	Siwan	0.1	143.16
19	Nalanda	0.0024	6.89
	Total	**24**	**68587**

Source: Flood report, GoB, 2017

It is evident from the data that crop farming is not sufficient to support the livelihood of farmers due to flood.

Ways to Reduce the Impact of Flood

Flood in the state is recurring phenomenon, almost every year farmers face the vagaries of flood in terms of crop losses. The flood can not be eliminated but the impact of flood can be minimised through adoption of various management practices like; crop insurance, farm diversification, flood tolerant varieties, adjustment in planting dates etc. Crop insurance schemes are not properly distributed among millions of small scale farmers. Therefore,

proper institutional framework should be adopted in order to reach among the needy farmers. Farm diversification can be one way to reduce the impact of flood on farmers as it is production of two or more enterprise like crop, livestock, poultry at same farm. During off flood season, farmer can utilize his land at best to get the sufficient income to support his family. The income earned from diversification play key role when crop fails by flood. In flash flood, receding is very fast so flood tolerant varieties can survive under this condition. Also, the planting dates can be adjusted to avoid the flood situation.

Conclusion

In the state, flood is recurring phenomenon which is responsible for huge loss. It affects human lives badly by damaging electricity, water pipes, and agriculture. The total damage due to flood was Rs. 528.76 Crore in the year of 2016. Crop farming is severely damaged by the flood and farmers got trapped into the vicious circle of poverty. The most affected districts in terms of crop loss are Sitamarhi, Katihar, Darbhanga, Madhubani, East Champaran, and Muzaffarpur. This indicates the crop farming alone is not sufficient for maintaining farmers' livelihood. Under this situation, some management practices should be adopted to reduce the impact of flood as the flood can not be eliminated. The various management practices like; crop insurance, farm diversification, flood tolerant varieties, adjustment in planting dates etc. can minimize the loss occurred due to flood. Therefore, it is suggested to adopt these practices in flood prone areas.

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Nano-pesticides: Its Scope and Applicability in Pest Management

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Abstract

Pesticides have become one of the inevitable parts in Indian agriculture. The higher dosage of these chemicals on per hectare basis has led to many environmental and health hazards. The development of a new scientific area, nanotechnology has led to the development of nano pesticides. These chemicals contain the carrier molecule or the active ingredient in nano size. Several formulations viz., nanoemulsions, nanosuspensions, controlled release formulations, solid based nanopesticides have been developed by the research community. The smaller size of the chemicals helps in proper spreading on the pest surface and thus, a better action than conventional pesticides. Meanwhile, we should have a better understanding on the ill effects of these nano-pesticides after their application.

Introduction

The importance of pesticides has been increasing over the last few decades driven by the need to improve overall agricultural productivity, in order to safeguard adequate food availability and sufficiency for the growing global population. Every year in India pests and diseases eat away on an average 15-25% of food produce. In order to offset the growing demand for food grains either the area under the production should be increased or productivity of the existing land should be improved. As the arable land is limited, increasing productivity is the only option available. This can only be achieved through usage of high yielding varieties, fertilizers and pesticides. As the crop yield increases, the incidence of pest attack rises which leads to increased demand for pesticides. The conventional group of insecticides have several major disadvantages like high dosage per unit crop, drift hazards, operational hazards and residues in environment, plants and in marketable produce, they also affect non-target vegetation and non-target organisms. So, they need to be replaced by an alternative pest control strategy that can overcome the above lacunas.

Nano-pesticides are one of the alternatives to overcome the lacunas of conventional group of insecticides. Nano-pesticides are plant protection chemicals, in which either the active ingredient or the carrier molecule is developed through nano-technology. As it really indicates, the Greek origin word ‘nano’ means dwarf. The major aim in the development of nano-pesticides is to lessen the environmental hazards of a pesticide active ingredient through improving the efficacy of a chemical. The absolute small size of the particles is the benefit here. The size of a nanopaticle generally

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ranges 1-100 nanometer and a nanometer is one billionth of a meter. When the size gets this small, particles reach a very large surface area and thus more volume of pesticides get contact with the pests. The ability of nanoparticles to permeate is due to their extremely small size and shape. Like other pesticide formulations, nanopesticide formulations will also constitute the active ingredient, the carrier molecule and surfactants. The major benefits of these nanoparticles include the improved solubility active ingredients, better stability of formulation, slow release of active ingredient and improvement in mobility caused by smaller particle size and higher surface area. The mode of action against target pests is expected to be enhanced with nanoparticles, as opposed to bulk materials. Moreover, nano-formulations provide systemic properties, uniform leaf coverage and improved soil properties to support their constructive use in agriculture.

Formulations of Nano-Pesticides

The research in nanotechnology has led to the development of different nano-formulation which can be applied in crop protection *viz.*, nano-insecticides, nano-herbicides, nano-fungicides and nano-nematicide. Nano-pesticides are formulated according to their intended purpose as formulations improving solubility, slow release of active ingredients, prevent degradation etc. For achieving these purposes, modifications in the chemical nature carrier molecule have been modified and classified as organic polymer-based formulations, lipid-based formulations, nanosized metals and metal oxides, clay-based nanomaterials etc. Some foremost nano-formulations are mentioned in this article.

Nano-emulsions: Generally, an oil-in-water (O/W) emulsion is more common as a nano-emulsion where, active ingredient of the chemical is dispersed as nanosized droplets in water, with surfactant molecules confined at the pesticide-water interface. Nano-emulsions get further classified based on the quantity and type of surfactants, as thermos-dynamically stable and kinetically stable. If the pesticide is partially soluble in the aqueous phase and spontaneous formation of a stable emulsion happens when surfactant, pesticide, and water components are brought together, that is a thermodynamically stable nano-emulsion. The insolubility of the active ingredient make the pesticide and surfactant to initially form a two-phase system and thus, a continuous shearing make them to mix together and pesticides droplets in the nano-emulsion will remain dispersed for an extended period of time and so are considered to be kinetically stable. Eg: Oil in water nanoemulsion of neem oil has been developed for insect management using Tween 20 as the surfactant.

Nano-suspension: Nano-suspensions, also termed as nano-dispersions, are formulated by dispersing the pesticide as solid nanosized particles in aqueous media. In nano-dispersions, the surfactant molecules get confined at the particle surface where polar portions extending into the aqueous solution and the non-polar portions associating with the solid pesticide. Eg: Aqueous dispersions of nano-permethin, novaluron and β-cypermethrin have been

developed by researchers.

Polymer based nano-particles: Polymer-based pesticide nanocarriers are majorly deployed in the slow and controlled release of active ingredients to the target site. Moreover, they can serve to improve dispersion in aqueous media and also as a protective reservoir. Nano-encapsulation, nano-spheres, nano-gels, nano-fibers, etc are some of them falling in this category.

Nano-encapsulation: Nano-capsules or nano-encapsulation are heterogeneous reservoir type structure containing an inner central cavity which confines the hydrophobic or hydrophilic active ingredient, surrounded by a polymer coating or membrane. The active ingredient in neem-azadiractin formulation can be protected through this formulation. Eg: Controlled-release nano-formulation of the neonicotinoid insecticide i.e., acetamipirid and imidacloprid have been developed.

Nanospheres: These are homogeneous vesicular structures, in which the bioactive ingredient is uniformly dispersed throughout the polymer matrix. Eg: Polymer stabilized bifenthrin nanoparticles are developed as nanospheres.

Nanogels: These are also known also hydrogel nanopartciles. These are formulated by cross linking of polymeric particles having hydrophilic groups, thus absorb higher quantities of water. Chitosan nanogel is an example for this.

Nano-fibres: Nano-fibres are developed through electrospinning, thermal induced phase separation. Researchers have developed electospun nano-fibers loaded with the chemical, (Z)-9-dodecenyl acetate, an ingredient of pheromone which get embedded in the polymer matrix for the management of many lepidopteran insect pests.

Solid Nanoparticles as Nano-Pesticides

In addition to the above formulations, solid nanoparticles can also be used as nano-pesticides. The inert dusts, such as silica, alumina, and clays cause damage to the wax coating on the insect cuticle through both sorption and abrasion. This physical damage can cause to lose water and thus resulting in dehydration to the insect. Nano-silica particle can be suggested as an eligible candidate among solid nanoparticles due to its additional benefit to aid in increasing tolerance to abiotic and biotic stresses by the plant. However, high dosages have to be applied for a better result which can adversely affect the grain properties. Nanostructures alumina was also reported to have pesticide properties. Moreover, nano-clays developed from montmorillonite were also shown to have pesticidal function but low toxicity.

Among metals, silver, titanium oxide and copper are most preferred as nanoparticles. The bactericidal and viricidal activity of silver nanoparticles makes them favourable by nanotechnology researchers. The low toxicity, inherent charge, larger surface area and crystallographic structure increase its preference. The use of titanium dioxide to crops has proved effective antimicrobial and antifungal activity.

Nano-copper formulations can cause cell wall damage of bacterial cells and found effective against pomegranate bacterial blight at very low concentrations. Cell wall damage was observed in nano-copper treated bacterial cell.

From past one-decade, considerable research has been made in the field of nanotechnology. Yet, it is only recently we are beginning to recognize how nanoparticles can impact on our lives and lead to both positive and negative results. Research in nano-pesticide development is being taken up in a faster rate but, this subject matter has not reached the public awareness or regulatory authorities so far. By and large, innovation all the time results in both benefits and problems for human and environmental health. The current level of knowledge regarding environmental fate does not allow us to a fair assessment of the advantages and disadvantages that will result from the use of nano-pesticides.

However, the major advantages of use of nano-pesticides over conventional pesticides are:

- ✓ Nanotechnology offers a tool for developing novel formulations of eco-friendly pesticides as majority of nano-pesticide formulations are highly target specific.
- ✓ Generally, targeted delivery and controlled release of nano-pesticides can improve pesticide utilization and reduce residue and pollution. For example, Nano-microcapsule formulations have slow release and protection performance because they have been prepared using light-sensitive, thermo-sensitive, humidity-sensitive enzyme-sensitive and soil pH-sensitive high polymer materials to deliver pesticides.
- ✓ Nano-pesticide formulations improve adhesion of droplets on plant surface (reduces drift losses) which intern improves the dispersion and bio-activity of active ingredient (a.i.) of pesticide molecules. Therefore, Nano-pesticides will have high efficacy compared to the conventional pesticide formulations (i.e., D-Dust, G-Granule, P-Pellet, EC-Emulsifiable Concentrate, WP-Wettable Powder, WDG-Water Dispersible Granule, etc.) and due to their small size, improvable pesticide droplet ductility, wettability and target adsorption when sprayed in fields has made these nano-pesticides provide efficient and environmental friendly advantages.
- ✓ Nano-pesticides are extraordinary means for setting up an eco-friendly and sustainable agriculture system because it reduces the overall chemical usage, decreases the toxic residues and enhances the overall crop protection.

The Limitations in the usage of Nano-Pesticides

- ✓ The risk that nano-particles (nano-pesticides) may pose to human and environment health is not yet fully understood.
- ✓ Nano-pesticides may also create new kinds of contamination of soils and waterways since nano-pesticides are apparently much more persistent and have higher degrees of toxicity when compared to their traditional counterparts.

Therefore a better understanding of the fate and effect of nano-pesticides after their application is

required. It is a good thing that all necessary safety precautions are taken before deciding to go ahead and use new technologies on a large scale.

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Application of *Dashparni Ark* as a Pesticide in Natural Farming

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Introduction

Current agricultural practices are over dependent on the use of chemical insecticides. Overuse of these harmful chemical insecticides not only damages the health condition of the human being but also deteriorates soil health, which reduces the productivity of the soil. Natural farming can be an effective solution to decrease the dependence on insecticides in the agricultural crop production system. The natural farming system has freed the farmers from the debt trap and has instilled in them a renewed sense of confidence to make farming an economically viable venture (Bishnoi and Bhati, 2017). Natural farming basically goes back to use of only rich a natural resource on which ancient agriculture was fully depended (Ranjan and Sow, 2021). 'Natural farming' means farming with nature and without chemicals (Asokan, 2020). To control different pests in natural farming system *Dahparni Ark* is used. *Dahparni Ark* is a natural pesticide. The word '*Dahparni Ark*' comes from the word '*Dash'* which means 10 and *'Parni'* which means leaves. Thus, '*Dashparni Ark*' means pesticide which is prepared from leaves of 10 plants. This natural pesticide can be used in different types of crops with same efficacy. Natural farming methods promote non-chemical and homemade pest control methods (Panda *et al*., 2022). In general different insects and pests mainly attracted by the smell of crops and damage the crops by feeding on it. *Dashparni Ark* due to its pungent and bad smell repels insects and pests from damaging the crops. This pesticide can be made very easily at homes for application in the field.

Materials required for preparation of '*Dashparni Ark'*

For preparation of *Dashparni Ark*, leaves of 10 plants are essential. The preparation materials are easily available in any farm households who are involved in integrated farming system. The required materials for preparation of *Dashparni Ark* are as follows:

- ✓ 200 litres of water
- ✓ 2 Kg Karanja or Indian pongamia leaves (*Millettia pinnata*)
- ✓ 2 Kg Custard apple leaves (*Annona reticulata*)
- ✓ 2 Kg Mango leaves (*Mangifera indica*)
- ✓ 2 Kg of Jamun or black plum/ Malabar plum leaves (*Syzygium cumini*)
- ✓ 2 Kg Datura leaves (*Datura stramonium*)
- ✓ 2 Kg Tulsi or holy basil leaves (*Ocimum tenuiflorum*)
- ✓ 2 Kg Papaya leaves (*Carica papaya*)
- ✓ 2 Kg Marigold leaves (*Calendula officinalis*)

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- ✓ 2 Kg Bael or Bengal quince/wood apple leaves (*Aegle marmelos*)
- ✓ 2 Kg Karabi or Oleander/Nerium leaves (*Nerium oleander*)
- ✓ 2 Kg cow dung
- ✓ 500 gms green chilli
- ✓ 500 gms ginger
- ✓ 5 gms tobacco leaves
- ✓ 500 gms garlic
- ✓ 500 gms ground turmeric
- ✓ 10 litres cow urine

Process for preparation of '*Dashparni Ark*'

- ✓ Firstly, in a big drum or a tub, 200 litres of water should be taken. After that, 10 litres of cow urine may be added to the water. Then 2 kg fresh cow dung is mixed with the solution. It should be ensured that the cow dung should be free from foreign materials like small pieces of bricks, seeds of plants and other impurities.
- ✓ The leaves of Karanja or Indian pongamia, Custard apple, Mango, Jamun or black plum/ Malabar plum, Datura, Tulsi or holy basil, Papaya, Marigold, Bael and Karabi plants are mixed in the mixture of cow dung, cow urine and water. The mixture added with leaves of plants is kept aside for one day in a cool shady place.
- ✓ In the next day green chilli, ginger, tobacco leaves, garlic and ground turmeric are added in the mixture. After adding the ingredients, the mixture should be stirred well with the help of one stick.
- ✓ The mixture should be covered by one piece of cloth and kept aside in a cool, dry and shady place for 40 days. The mixture should be stirred with a stick every morning and evening during those 40 days.
- ✓ After 40 days the *Dashparni Ark* can be obtained
- ✓ Once the *Dashparni Ark* is prepared, it can be used within six months

Procedure for application of '*Dashparni Ark*'

For per acre of land 5 to 8 litres of *Dashparni Ark* is required. For spraying, *Dashparni Ark* should be mixed with 200 litres of water. The 25 litre sprayers generally used in field operations can be used for spraying *Dashparni Ark*. In case of using that size of sprayer, 600 to 700 millilitre of *Dashparni Ark* may be poured in the sprayer and the remaining place should be filled with water.

Conclusion

Insecticides are the essential requirements for any agricultural production system. Insect pests cause huge damages in terms of yield and economic losses. As a result of that, farmers have to use insecticide, but after certain period of time pests become resistant to those insecticides. As a result of that, farmers are compelled to use higher doses of insecticide with stronger chemical ingredients. These chemicals are damaging the overall ecological balance. To overcome these problems, natural farming has been adopted by many farmers. They are using *Dashparni Ark* as an effective alternative to chemical insecticides. The ingredients required for

preparation of *Dashparni Ark* are easily available and are very cost effective. Moreover efficient utilisation of livestock bi-product like cow dung and urine can also be ensured by the use of *Dashparni Ark* as a natural insecticide. In a nutshell, it can be said that use of *Dashparni Ark* as an important practice of natural farming can ensure cost effective and eco-friendly alternative to costly and harmful chemical pesticide. Application of *Dashparni Ark* will guarantee effective, efficient and sustainable agricultural farming system in the long run.

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Nano Urea Fertilizer for Sustainable Farming

Sushanta Sarkar

What is nano urea?

- ✓ Nano-urea is developed by the Indian Farmers and Fertiliser Cooperative (IFFCO), a multi-state cooperative society and promoted by the government of India.
- ✓ Nano urea is a nanotechnology based revolutionary agri-input and a result of the 21st century. Nano urea is a sustainable option for farmers towards smart agriculture and to combat against climate change. It has great importance to keep the climate (soil, air and water) safe for future generation while getting pollution free atmosphere for all.
- ✓ This nano urea liquid is required as a substitute for granular urea which is probably the most broadly utilized chemical fertilizer in farmland across the world.
- ✓ Nano urea liquid is a chemical nitrogen fertiliser (contain 4% N), white in colour, which artificially provides nitrogen to the plants.
- ✓ It is developed to replace the use of conventional urea and it can curtail the requirement of the same by at least 50%.
- ✓ Nano urea is bio available to plants because of its desirable small particle size (about 20-50 nm); more surface area (10,000 times over 1 mm urea prill) and number of particles (55,000 nitrogen particles over 1 mm urea prill) than conventional granular urea.
- ✓ A 500 ml bottle contains 40,000 mg/L of nitrogen which is equivalent to the impact of nitrogen nutrient provided by one bag of conventional granular urea.
- ✓ It is less expensive than granular urea.
- ✓ This new nano urea liquid will build the creation of yields with improved dietary quality.

Benefits of nano urea liquid

- ✓ Nano urea increases its availability to crop by more than 80% resulting higher nutrient use efficiency.
- ✓ Nano urea helps in minimizing the environmental footprint by reducing the loss of nutrients from agriculture fields in the form of leaching and gaseous emissions which used to cause environmental pollution (soil, water and air pollution) and climate change.
- ✓ Nano urea provides targeted amount of nitrogen to crops, as they are absorbed by the stomata and other pores found on the epidermis of leaves.
- ✓ It will reduce the unbalanced and indiscriminate use of conventional urea in agricultural sector.
- ✓ Increases crop productivity by 8%.
- ✓ Nano urea has higher surface-mass ratio that helps in releasing nitrogen to plants in a control-

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led manner.

- ✓ It has a huge positive impact on the quality of underground water and a very significant impact on sustainable development.
- ✓ Nano urea helps to boost a balanced nutrition program by reducing the excess application of urea in the soil and makes the crops stronger, healthier and protects them from the lodging effect.
- ✓ Nano urea enhances farmers' income by lowering input and storage costs.

How to use nano urea liquid

First, wear mask and hand gloves then take nano urea bottle to make a solution. According to the age and condition of the crop choose a concentration per liter of water. For 30-40 days old crop farmers can use 4ml nano urea per liter of water. Mix nano urea and water in a spray pump and spray this mixture on crop leaves. Nano urea liquid is recommended for application only as a foliar spray at critical growth stages of the crop.

Points keep in mind while use of nano urea

- ✓ Spray nano urea on crop leaves at morning or evening time.
- ✓ Do not spray when wind at high speed.
- ✓ Do not spray in a foggy atmosphere.

How does nano urea work?

When nano urea is sprayed on crop leaves, it easily enters through stomata and other pores found on the epidermis of leave; and assimilated by the plant cells. It can be easily distributed through the phloem from the source to sink inside the plant as per the need. Unutilized nitrogen is stored in the plant vacuole and later it is slowly released for proper growth and development of the plant.

How is the liquid nano urea better than the conventional granular urea?

- ✓ The efficiency of liquid nano urea can be as high as 85-90 per cent while conventional urea has an efficiency of about 25 per cent.
- ✓ Liquid nano urea is cheaper than conventional urea (Rs 240 for a half litre bottle of liquid nano urea without any subsidy while a farmer pays around Rs 300 for a 50 kg bag of heavily subsidised conventional urea). A bottle of the nano urea can effectively replace at least one bag of conventional granular urea.
- ✓ Nano urea has a shelf life of a year. So, farmers need not be worried about "caking" when it comes in contact with moisture.

The application of nano urea liquid fertilizer has a significant influence on crop productivity by lowering fertilizer price and minimizing emission concerns. Nano urea is more soluble and has the ability to boost penetration through the cuticles allowing for targeted distribution. Nano urea boosts crop production and nitrogen use efficiency.

Ways to Improve the Grade-Schooler's Communication Skills

Y. D. Haritha

Grade school kids are just learning how to interact with their classmates and make friends. At this age, your child may need your help with making conversation, and they may need your help to learn how to better communicate their thoughts and feelings.

1. Talk regularly with the child

Kids who have trouble communicating may not want to talk at all. Your job is to encourage your child to begin or join in conversation as much as possible. This will most definitely help your child begin to feel more comfortable opening up.

2. Describe the day

Encourage your child to tell you how the day went in as much detail as possible. Ask, "What were the best and worst parts of school?" This helps with recall and sequencing: two skills kids who struggle with communication may have trouble with. Recount the events of your day as well. Maybe say something like, "I was in the grocery store today. Guess what I saw in the fruit aisle?"As a bonus, this kind of sharing also promotes connection between you and your child.

3. Listen to and reflect what the child says

Model one of the most important conversation skills: Listening to and expanding upon what someone else says. After your child has told you something, repeat back part of what your child said, and then follow up with a question: "Wow, it sounds like that art project took a lot of patience. What other project do you think would be fun to make? And what different materials would you need?"

4. Have practice conversations with the child

Talk through the types of situations your child might be the most nervous about. These might include talking to other kids while waiting for the bus, for example, or sitting with them at lunch. Then practice what your child might say. Take turns pretending to be each person in the conversation so that your child can think through different scenarios, conversation topics, and responses.

5. Start fun conversations with the child

6.

6. Point out body language

Kids who struggle with communication may not always pick up on other kids' nonverbal cues. Some times these cues are called body language.

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For your grade school child, consider showing and explaining body language. You can say, "I'm crossing my arms because I'm feeling angry," or "When you roll your eyes at me, I feel disrespected."

7. Read with the child

It doesn't matter what he/she read with your child. What's most important is that you do it together. If you're concerned that your child chooses the same books every night, don't be. Your child is developing a better understanding of the character and plots and vocabulary used.

Take turns reading to one another, even if your child just fills a word in here and there. After finishing a book or TV show, discuss the setting, plot, characters, and any new words that might be in the story.

8. Teach the child how to play conversational "catch."

Try getting your child used to the back-and-forth nature of conversations:

Try getting your child used to the back-and-forth nature of conversations. Here's an example:

Player 1: Throws a ball while asking a question. "How's school?"

Player 2: Catches the ball and answers the question. But before throwing the ball back, Player 2 must ask another related question. ("Good! How's math club?")

The goal is for your child to get comfortable having conversations.

9. Ask the child's opinion

Communicating requires kids to reflect on their feelings. Ask your child to weigh in on daily decisions. The conversation can be as simple as which library you should go to or where you might spend your vacation. Ask your child's opinion about relevant topics. Things like, "Should the other team have won?" Thinking about recent news events? Using "I think" or "I feel" statements is good practice for having successful everyday conversations.

10. Encourage the child to keep a journal

Some kids find it easier to talk with other people once they've had a chance to think their thoughts through. Writing in a diary or journal about day-to-day activities and feelings may help. The process can make it easier for your child to form thoughts to share with others. This can ultimately make your child feel more prepared and confident when someone asks what's been going on.

Conclusion

Every interaction individual have with the child is a form of communication. It's not just about the words he/she say: The tone of the voice, the look in the eyes and the hugs and kisses he/she give all convey messages to the child. The way he/she communicate with the child not only teaches them how to communicate with others, it shapes their emotional development and how they build relationships later in life.

What is a Bad Mood? How to overcome from it?

Y. D. Haritha

Introduction

Bad mood means an angry or irritable state of mind. “the cold put him in a bad mood” in a bad mood. In an irritable, annoyed or angry state of mind to feel sad and depressed.

Beating a bad mood is not easy, but the only person that can get you out of the bad mood is yourself! Here are a dozen mood tips to drag self into a more positive frame of mind. Tips to beat a bad mood, you will be able to deal with your bad mindset in a number different ways so if one doesn’t work, another one will!

1. Talk about what has put person in a mood

If you are in a bad mood, then there’s obviously a reason for it. Pinpoint why you’re in a bad mood and, if you can, talk to a friend about it. Simply talking about your problem with someone will make you feel many times better. After all, what they say about ‘a problem shared is a problem halved’ rings very true. But if you can’t talk to a friend, try going outside and letting out a mighty scream or having a good cry. Remember that bottling it all up will only darken your mood.

2. Beat a bad mood with exercise

Exercise is a great way to get you out of a bad mood. If you can make yourself do some exercise, you will reap the benefits. Exercise releases endorphins, which are chemicals in your brain that make you feel good, so by doing some exercise you will automatically make yourself feel better. A game of squash could be a good option, as you’ll be able to take your bad mood out on the ball. On the other hand, if you take your sport too seriously and are a bad loser, then a non-competitive form of exercise may be the best way to go.

3. Eat Chocolate to make person feel better

It’s amazing how many people instantly reach for their favourite chocolate for comfort if they are feeling low. It’s probably not a bad thing to do, though, as chocolate is known to be responsible for positive mood-lifting effects due to the release of serotonin, the brain’s natural pick-me-up. If you find that chocolate does the trick for you, then a little of it can be no bad thing. However, if you’re the sort who ends up with pang of guilt, then it’s best that you give it a miss.

4. Think about less fortunate people

If you’re in a really bad mood, it may be because you think everything is going wrong for you. What you need to do in this case is to regain your sense of perspective on life. Take a stroll, maybe in your lunch time, and have a look at the people around you. Chances are you’ll probably pass by at least one person who would probably settle for your problems

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and a roof over their head. Or you might see someone disabled or elderly struggling to get into a shop. If you can, get a sense of perspective then things may not seem so bad after all!

5. Blasting Out Some 'Positive'

Music everybody has some favourite tunes to listen to, from rousing classical music compositions to bouncing pop tunes. Listening to one of your favourite tracks such as one that you associate with a happy time in your life will help draw you out of your bad mood. And why not go one step further by belting out your favourite tune at the top of your voice? You could even do this if you feel yourself being drawn into a bad mood while stuck in traffic as long as you don't mind being a source of amusement to other motorists.

6. Get more light

At certain times of the year particularly around winter, the lack of daylight hours can have a negative impact on your mood. Some people even get seasonal affective disorder (SAD), which is even worse. Whether or not you get SAD, it's always good to get more light into your life. You could try to get out more during daylight hours, as this is known to improve mood.

7. Take time out

Give yourself a chance to blank out all your negative thoughts by taking a few moments out and doing something different. For example, take half an hour out to have a soak in the tub it can work wonders and help soothe both the body and mind. And why not get some candles out and have a glass of wine at the same time? If you're in a bad mood, it's sometimes good not to be around other people until you have got it out of your system. If you stay around people, you may cause a reduction which will, in turn, add to your bad mood.

8. Avoid people who put individual in a bad mood

It might seem obvious, but there are people who just have an ability to put you in a bad mood. Okay, so some situations can't be avoided for example a work colleague or your boss. But there will be others in your social life who you can avoid. Some people can drain you and leave you in a bad mood. It's best to avoid these people when you can or at least keep your contact with them to a minimum.

9. Make contact with positive people

The flipside of avoiding negative people is making contact with positive ones. There are some people out there who have a very positive influence on us. They are the sort you probably never argue with, or the type of people that have you cracking up with their sense of humor. It may be that you've lost touch with them recently, so why not look them up and give yourself a boost. Don't be waiting for them to make the first move do it yourself. Surrounding yourself with positive people will have a positive effect on your mood.

10. Get a Pet

Studies have found that pets can actually help us feel better. For starters, animals do some pretty funny things at times, which will help to make you laugh. Even stroking a pet is known to lower heart

rate, making you calmer. And if you get yourself a dog that requires plenty of walks, this will mean you get some exercise and daylight which will further enhance your good mood.

11. Think happy thoughts

If you can take yourself back to a time when you were happy, then this will instantly fill you with happy thoughts. If you need a prompt, why not dig out some old photographs of great times that you've had? Being in a bad mood is avoidable if you rid yourself or intruding bad thoughts and replace them with good ones. It really comes down to choice choose to think of unhappy thoughts and you will be unhappy, and vice versa. People are only as happy as they allow themselves to be! Try To Avoid Worrying: Worry is one of the major causes of unhappiness. The simple answer is to stop worrying after all, worrying doesn't actually help in any way at all. If it's something that you can deal with at the time, then do it, and hopefully that will end the worry. If you can't deal with it at that moment in time, then think of potential solutions and be optimistic rather than worrying excessively about a problem.

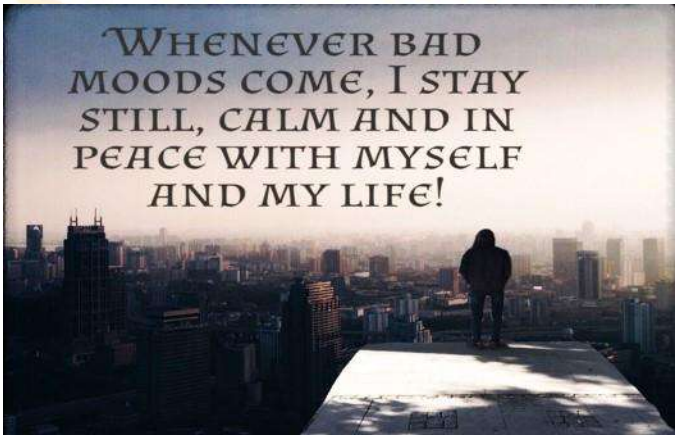
Conclusion

It is possible to overcome a bad mood or anger, but it takes a commitment to do it. "He/She can have control over the life or emotions. It just takes practice," says Annette Nunez, psychotherapist. "Every day may not be good, but there's something good in every day." ~Unknown

Everyone get in bad moods, no matter how positive it try to be. Maybe individual didn't get enough sleep last night. Or individual feel overworked and overwhelmed. Or perhaps something happened and individual keep dwelling on it, going over and over in his/her head how he/she froze up in a meeting or spoke too aggressively to someone he/she love.

Whatever the case may be, individual feel something he/she don't want to feel and he/she're not sure how to change it. Individual just know individual need to do something before acting on that feeling.

The reality is he/she don't have to act on everything person feel. Still, emotional responses happen so quickly that it becomes challenging to put space between feeling and doing.



Robotics for Smart Farming

Plabani Roy and Moumita Ash

Introduction

Advanced decision support systems, smart analysis, and planning are just a few of the ways that smart farming is evolving toward digitalized and data-driven operations. A new line of creative research for smart agriculture has been opened up by technologies like artificial intelligence (AI), cloud computing, and the Internet of Things (IoT) (Ahmed *et al.*, 2016). Agriculture has entered a new phase of robotics as a result of agricultural mechanization and automation technology. Robotic technologies offer a significant potential to further minimize the need for labor and improve the accuracy and efficiency of production inputs.

Agricultural robot

A robot used for agriculture is referred to as an agricultural robot. Robotics are primarily used in agriculture today during the harvesting process. Weed control, cloud seeding, seed planting, harvesting, environmental monitoring, and soil analysis are examples of new robotic or drone applications in agriculture (Dokin *et al.*, 2017).

Robots used in agriculture

- ✓ Fruit-picking robots,
- ✓ Driverless tractor / sprayers
- ✓ Sheep shearing robots
- ✓ Robots can be used for other horticultural tasks such as pruning, weeding, spraying and monitoring
- ✓ Livestock robotics (such as automatic milking, washing and castrating)
- ✓ Autonomous precision seeding
- ✓ Robotic automation process (RPA) (nursery planting)
- ✓ LiDAR-powered robots to collect data
- ✓ Drones
- ✓ Sorting and packing robots

Fig.: Fruit picking robots

Classification of agricultural robot systems (Jin *et al.*, 2021)

Aspect	Type
Type of industry	Crop farming, livestock and poultry farming, aquaculture
Function	Phenotyping, monitoring, mapping, health protection, etc.
Intelligent level	Remote control, man-robot collaboration, full autonomous
Working mode	Selective, non-selective
Mobility	Stationary, mobile
Space	Aerial, ground, aquiclude

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Applications

The world population is projected to grow to 9 billion by 2025. With a dramatic increase imminent, it's time for countries to start thinking about new ways to feed their populations. Fortunately, the agriculture sector is next in line to adopt technology for a major transition. The United States, Australia, Japan, and European countries are already turning to robotics to solve their manufacturing challenges. The future of robotics in agriculture is expected to increase dramatically over the next few years. Robots have many fields of application in agriculture. An example of the large-scale use of robots in agriculture is milk bots widely used on dairy farms in the UK as it is efficient and does not require relocation. Robots can complete complex tasks if they are repetitive and robots are allowed to sit in one place. In addition, robots that perform repetitive tasks (such as milking) perform their roles uniformly.

Fig.: Different agricultural robots used for sowing and spraying

Another field of application is horticulture. One of his horticultural applications is RV100 development by Harvest Automation Inc. The RV 100 is designed for transporting potted plants in greenhouses or outdoors. Benefits of using the RV100 for this task include high placement accuracy autonomous outdoor and indoor capabilities, and reduced production costs (Khatoon *et al.*). The fast-moving world of production has greatly increased the need for human labor in packaging. That's why many agricultural companies use sorting and packing robots to streamline operations at high speed without interruption. Coordination capabilities and line-following technology enable these robots to speed up the packaging process.

Benefits of agricultural robotics

- ✓ Robotics ease the non availability of laborer in peak time of season
- ✓ Along with committing fewer errors and working at higher speeds, top quality products can also be expected by robots
- ✓ Robots are designed to expedite the farming process with nominal human interferences, they happen to ensure the sustainability of the agricultural method
- ✓ Robots play a key role in protecting human workers from harm that can be caused by sniffing or picking up pesticides with their hands
- ✓ Robots consistently produce error-free results in less time than human workers

Fig.: Robots for food storage and packaging

Conclusion

The robot revolution is clearly happening before our very eyes. From self-driving cars to automated service bots, robots are playing an increasingly important role in our daily lives. Agriculture is the world's largest manufacturing sector and requires enormous skill. With population growth, climate change, political pressure to migrate, rural-to-urban population decline, and demographic aging putting pressure on the global food chain, now is the time to apply robots to agriculture. It's the right time. Robotics and autonomous systems are seen as an escape from intrusive reality. It also provides a backup solution for critical transformations in the food chain. Fortunately, governments, recognizing the food crisis situation, have also jumped on board and jumped on the agrorobotics bandwagon.

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RNAi- Mediated Pest Control

Durgesh K. Narwade, Ankush S. Gadge, Vishal B. Mhetre, Vanitha Khandibagur and Dhananjay V. Shirsath

Abstract

RNAi is a gene regulation and antiviral response mechanism in plants. Transgenic and non-transgenic plant-based RNAi approaches have shown remarkable effectiveness and potential to target specific pests and help to manage pests effectively, especially when no alternatives are available. By modifying and developing sequencing technologies, new opportunities will open that will develop novel approaches to plant disease control.

Introduction

Plant pests and pathogens are significant constraints to agricultural productivity, and insects are the major ones contributing 20-40% of crop damage. Climate change and the increasing demand for food by the growing population present enormous challenges for food security. Worldwide, farmers rely mainly on conventional synthetic pesticides to protect crops from these pests and pathogens. However, the excessive use of these traditional chemicals in the last decades has had severely detrimental environmental effects. It has also promoted the emergence of resistance in pest populations. Consequently, there is a pressing need for alternative, selective, environmentally friendly, and sustainable pest control and crop improvement solutions. In this context, RNA interference (RNAi)-based biocontrol has emerged as an excellent alternative to hazardous pesticides. Due to the possibility of designing the active molecule (double-stranded RNA, dsRNA) to be species-selective and its biodegradability in the environment, RNAi-based biocontrol is considered to have a low environmental impact. Bioclay-based formulation of RNAi developed by UQ QAAFI (University of Queensland, Australia Queensland Alliance for Agriculture and Food Innovation research team for sustainable crop protection) was found effective for whitefly control on cotton (Jain *et al*., 2022).

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What is mean by RNAi?

RNAi, termed RNA interference, is a natural regulatory and defense mechanism in most eukaryotic organisms, where transcript expression is reduced sequence-specific. It is naturally present in all eukaryotic cells as a regulatory or defense mechanism. RNAi inducers, in the form of transgenic plants or a crop spray, have the potential to silence specific genes effectively. RNAi has revolutionized the possibilities for creating custom "knock-downs" of gene activity. RNAi operates in plants and animals and uses double-stranded (dsRNA) as a trigger that targets homologous mRNAs for degradation or inhibiting its transcription or translation, whereby susceptible genes can be silenced. This RNA-mediated gene control technology has provided new platforms for developing eco-friendly molecular tools for crop improvement by suppressing the genes responsible for various stresses and improving novel traits in plants, including pest resistance.

Mechanism of RNA Interference (RNAi)

The proposed RNA silencing mechanism starts with the production of 20 to 26 nucleotide (nt) small RNA (sRNAs) through a series of critical components, such as Dicer-like protein (DCL), Argonaute (AGO) protein, and RNA-dependent RNA polymerase (RDRs). The DCL proteins generate siRNAs from a dsRNA precursor and then incorporate them into RNA Induced Silencing Complexes (RISCs). These sRNAs are divided into siRNAs or microRNAs (miRNAs) based on their origin and formation. AGO proteins perform a large part of RISCs, bind the sRNAs, and interact with homologous RNAs that affect DNA methylation, endonuclease activity, or translational repression of mRNAs. RDR enzymes are responsible for synthesizing dsRNAs using single-stranded RNAs (ssRNAs) as the templates, which are then further processed by Dicer-like (DCLs) proteins and start a new round of RNA silencing. In line with the diverse roles of RNAi, researchers found several DCLs, AGOs, and RDRs genes in different plant species and described their roles in plant defense mechanisms. Due to the presence of many pathogens and their threats to plants, researchers continuously study plant RNAi mechanisms as a defensive mechanism against pathogens. RNAi Pathway Components Dicer-Like Proteins (DCLs). DCLs are the RNase III family of endoribonucleases that contain DExD-box Helicase-C, Piwi-Argonaute-Zwille (PAZ) domain, the Domain of unknown function 283 (DUF283), RNase III, and dsRNA-binding domains (dsRBDs). These proteins perform the initiation stage of the RNAi mechanism, in which dsRNAs are cleaved into small RNAs 21-24 nt in length. Argonaute (AGO) Proteins are highly specialized sRNA-binding modules and are considered essential components of RISCs in silencing pathways. AGO proteins perform the effector phase of silencing, and the small RNAs produced in the initiation stage are loaded into AGO proteins to guide sequence-specific regulation of gene expression. RNA-induced silencing complex

(RISC) is a large multiprotein complex comprising siRNA, Dicer, Argonaute. It functions at the transcriptional or translational level. The RISC-loading complex (RLC) is the essential structure required to load dsRNA fragments into RISC to target mRNA.

Application of RNAi Technology in Crop Protection

RNA silencing has proven to be novel and a potential reverse genetics tool for functional genomics to decipher the function of genes through genome-wide screening in different eukaryotic organisms, including plants (McGinnis 2010), *C. elegans and Drosophila*. It is also a powerful strategy for silencing genes to improve several agronomically important crop plants infested by insect pests, which cause a significant loss of crop yield. Conventional methods, like using insecticides for insect control, are met with certain limitations. Recently, RNAi has been successfully applied to control insect pests in crops. After choosing the appropriate target genes, the most suitable delivery system is selected for the efficient application of RNAi in pest control. The most used methods for the application of RNAi in the field studied are:

1. Host-induced gene silencing (HIGS)

This involves the identification of a vital gene of the target pest and its silencing through host plant-mediated RNAi or host-induced gene silencing (HIGS**).** This entails creating transgenic crops expressing the dsRNA specific for the pest. SmartStax Pro is the first commercial RNAi product targeting insect pests. It is a transgenic corn crop developed by Monsanto (currently Bayer crop science) against Western corn rootworm (WCR). It employs a pyramid strategy utilizing two different Bt proteins and dsRNA targeting *snf7* gene expressed in the plant (Head *et al*., 2017). Bt protein inserts itself into gut epithelium and causes gut paralysis and, thereby, death. Downregulation of *snf7*, a gene that plays an essential role in protein trafficking, will also bring insect mortality. This combined strategy leads to the swift death of the pest and less resistance development against the PIP. Bt gene also ensures protection from lepidopteran pests like fall armyworms resulting in a healthy crop both above and below ground. The United States Environment Protection Agency approved this product in 2017. In 2016, Canada, and a year later, in 2017, released in the USA.

2. Spray-induced gene silencing (SIGS)

This technique involves the application of dsRNA topically as a spray. This is an emerging area under focus due to the restrictions in the transgenic approach. It is found to be more effective for insects that are more sensitive to dietary uptake of dsRNA. This method is also known as the topical or exogenous application of dsRNA. In this method, we externally applied the dsRNA as a spray solution. Functional foliar application of dsRNAs targeting the plant viruses Pepper mild mottle virus (PMMoV), Alfalfa mosaic virus (AMV), and Tobacco etch virus (TEV) was first reported by Tenllado and co-workers in 2001. In a statement to

prove prescient, the authors noted that topical application of in vitro-expressed dsRNA protection against plant viruses could be commercially viable provided dsRNA production became inexpensive and an adequate means of delivery was developed. The same authors attempted to reduce the costs of the dsRNA by applying a crude extract of *E. coli* HT115 expressing the same dsRNA fragments used previously and achieved similar positive results with viral co-inoculation. Nevertheless, the window of resistance was limited to five to seven days.

However, there are lots of problems associated with this topical application of naked dsRNA, such as the instability of naked dsRNA in the environment, degradation of dsRNA in the environment *via* the action of ribonuclease enzymes or by UV radiation, and can get easily washed off after spray, protection last for only 5-7 days after spray. Given the low persistence of dsRNA in the environment, SIGS most likely need unique formulations to increase stability and RNAi efficiency. The stability of an arthropod-targeting dsRNA should also be sufficient for ingestion, necessitating persistence in non-neutral pH gut conditions before delivery to relevant tissues. Using nanocarriers as components of the delivery system is an option to surmount these hurdles. Nanomaterials have dimensions of less than 100 nm resulting in high surface area-to-volume ratios and can be engineered with both protective and slow-release properties for their payloads (Ghormade *et al.*, 2011). Here, at present, a groundbreaking discovery for world food security.

Conclusion

The environmental (particularly spray) application of dsRNA and their formulations for RNAi-based pest control has a huge potential to replace harmful traditional chemical pesticides with species-specific, sustainable, and environment-friendly products. However, being novel active compounds, current regulatory structures are challenged to provide a standardized legal framework for these dsRNA-based products. Further, more emphasis is on the need for a well-defined risk assessment procedure. This analysis should comprise not only the dsRNA as an active ingredient but also take into account the effect of formulations. If conception and development are conducted in a precautionary and rigorous way, RNAi- based products have the ability to revolutionize pest and pathogen management in a safe and effective manner.

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Dispersal or Dissemination or Spread of Weed Seeds

Sapna Bhagat and Ashu Sharma

Introduction

Weed dissemination is a silent, unseen, unidirectional and/or multidirectional travelling of the weed seeds from one place to another and, therefore, weeds are described as the silent traveler. For dissemination of seeds, weeds require, a) a successful dispersing agent e.g. wind, water, animals, human etc., and b) an effective adaption to the new environment. Once a seed has successfully dispersed to an area, it starts colonization with its seeds produced and spreads as a front gradually. Many species of plants have seeds with anatomical structures that make them very buoyant, so they can be dispersed over great distances by the winds. In the absence of proper means of their dispersal, weeds could not have moved from one country to another.

Common weed dispersal agents are Wind, Water, Animals, Human, Machinery, etc.

1. **Wind:** Dissemination of weed seeds through wind may constitute the major mechanism of spread/distribution of terrestrial weeds. The prime requirement for dispersal by wind is that the seeds should be small and very light and/or should be equipped with specialized structures, which facilitate floating in air. Many seeds are well adapted to wind travel. Cottony coverings and parachute-like structures allow seeds to float with the wind. Examples of wind-dispersed seeds include common milkweed (*Asclepias syriaca)*, common dandelion, Canada thistle, and perennial sowthistle (*Sonchus arvensis).* Weed seeds and fruits that disseminate through wind possess special organs to keep them afloat. Such organs are

   i. **Pappus:** It is a parachute like modification of persistent calyx into hairs. Eg. Asteraceae family weeds - *Tridax procumbens*

   ii. **Comose:** Some weed seeds are covered with hairs, partially or fully Eg. *Calotropis* sp.

   iii. **Feathery, persistent styles:** Styles are persistent and feathery Eg. *Anemone* sp.

   iv. **Baloon:** Modified papery calyx that encloses the fruits loosely along with entrapped air. Eg. *Physalis minima*

   v. **Wings:** One or more appendages that act as wings. Eg. *Acer macrophyllum*

2. **Water:** Weed seed are transported by surface run-off, irrigation and drainage water and stream, rivers and canals. Water is the main dispersing agent for Aquatic weeds. Irrigation and drainage water is also highly responsible for dissemination of weed seed from one crop field to another. Weeds growing in the bunds and channels shed their seeds, which move through water to the crop field, Moreover; the irrigation water carries soil, which also contains

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weed seeds. Surface run-off from rainwater is also, in a greater way, responsible for weed dissemination.

3. Animals: Several weed species produce seeds with barbs, hooks, spines, and rasps that cling to the fur of animals or to clothing and then can be dispersed long distances. Farm animals carry weed seeds and fruits on their skin, hair and hooves. This is aided by special appendages such as Hooks (*Xanthium strumarium*), Stiff hairs (*Cenchrus* spp), Sharp spines (*Tribulus terrestris*) and Scarious bracts (*Achyranthus aspera*). Even ants carry a huge number of weed seeds. Donkeys eat *Prosophis julifera* pods. Weed seed often is ingested and passed through the digestive tracts of animals. Animal droppings provide an ideal nutrient and moisture environment for weed germination. While only a small percentage of the seed remains viable after exposure to an animal's digestive enzymes. The ingested weed seeds are passed in viable form with animal excreta (0.2% in chicks, 9.6% in calves, 8.7% in horses and 6.4% in sheep), which is dropped wherever the animal moves. This mechanism of weed dispersal in called endozoochory. Eg., *Lantana* seeds by birds. *Loranthus* seeds stick on beaks of birds. Viable weed seeds are present in the dung of farm animals, which forms part of the FYM. Besides, addition of mature weeds to compost pit as farm waste also act as source.

4. Dispersal by Man: Man disperses numerous weed seeds and fruits with raw agricultural produce. Weeds mature at the same time and height along with crop, due to their similar size and shape as that of crop seed man unknowingly harvest the weeds also, and aids in dispersal of weed seeds. Such weeds are called “Satellite weeds” Eg. *Avena fatua*, *Phalaris minor*.

5. Dispersal by Agricultural implements: Weed seeds often are dispersed by tillage and harvesting equipment. Seeds move from field to field on the soil that sticks to tractor tires, and vegetative structures often travel on tillage and cultivation equipment and latter dropping them in other fields to start new infestation. Disc-type cultivation equipment is less likely to drag vegetative plant parts than are shovels or sweeps.

6. Intercontinental movement of weeds: Introduction of weeds from one continent to another through crop seed, feed stock, packing material and nursery stock. Eg. *Parthenium hysterophorus*

7. Crop mimicry dispersal: Weed seed adaptations to look like crop seed: plant body or seed same size, shape, and morphology as crop. Eg: barnyard grass biotype looking like rice escapes hand weeding and is dispersed with rice, nightshade fruit ("berries") same size, shape as dry beans, harvested and dispersed with beans.

8. As admixtures with crop seed, animal feed, hay and straw: Weeds probably are spread more commonly during the seeding of a new crop or in animal feed and bedding than by any other method. Seed labels often indicate a tiny percentage of weed seed, but consider this example. If a legume seed contains 0.001 percent dodder (a parasitic annual; *Cuscuta campestris)* seed by weight, there will be

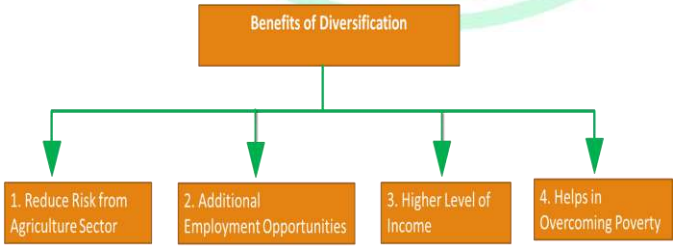
eight dodder seeds per 2 kg of legume seed. If the legume seed is sown in a field despite an extremely low dodder seed percentage by weight, the small size of the seed, combined with rapid early-season growth, could result in an infested legume field within a single season.

Development of the Power and Energy Sector through Agriculture

Ankur Kumar Singh, Akanksha Singh and Suraj Kumar

Introduction

Energy has a crucial part in both economic and social development, yet there aren't many rural energy development strategies that concentrate on agriculture. Due to its historical involvement in managing essential resources, especially land and biomass, the agriculture sector is crucial to the shift to renewable energy. A multi-level approach must be developed to understand these emerging transition processes, envisioning changes toward renewable electricity production as instances of multi-regime interaction between national-level agricultural and power and energy regimes. This aspect of agriculture provides significant prospects for rural development and a way to slow global warming by switching to bioenergy instead of fossil fuels. We must look for land and businesses to operate diverse renewable energy production methods across the nation.



Growth is accelerating in the livestock, horticulture, fishery, and poultry industries. The usage of contemporary inputs and farm mechanisation is trending upward on the input side. These changes have a big impact on how much energy is used in agriculture. The management of perishable goods is further affected by modern inputs and mechanisation, which calls for greater commercial energy. The patterns of energy use in Indian agriculture are so likely to have undergone a considerable alteration. The demand for additional energy is increasing as a result of this as well as the growing need for commercial energy in non-agricultural sectors. Oil prices are once more on the rise globally, and nations are exploring alternative energy sources and energy-saving technologies.

Energy Resources

The energy gap in these areas could be reduced by using alternative energy sources such as biomass, solar energy, and modest hydropower. To do this, some restrictions that were found in this review must be overcome. The first step to improving success in utilizing alternative energy sources in rural areas would be to identify the energy demands of rural communities, their potential to develop and use various types of existing alternative energy sources, and the anticipated obstacles they face. Alternative energy development, management, monitoring, and assessment in rural regions would

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require education, enlightenment, and the dissemination of knowledge.

Solar Power

Solar energy has been widely used for residential, agricultural, and agro-industrial purposes virtually since the dawn of humanity. Interest in the scientific exploitation of renewable sources of energy has increased due to the growing prospect of a severe scarcity of commercial sources of energy combined with substantial environmental pollution issues. The sun is an endless source of clean, renewable energy. As a result, the use of solar energy technology in a variety of thermal applications as well as decentralised power generation and distribution systems is projected to be significant in the foreseeable future. There are roughly 1.8 x lOll MW of solar energy that the earth intercepts. Because of this, it ranks as one of the most promising unconventional energy sources. In the majority of our country, solar energy is widely available.

Wind Energy

A special opportunity to profit from the expansion of the wind sector exists for farmers and ranchers. Farmers have a few options for gaining access to this market: they can rent out their property to wind developers, use the wind to power their farms, or start several wind farms. Wind energy can be used by farmers and ranchers to produce their own power. Small wind generators with capacities of 400 watts to 40 kilowatts or more can power an entire farm or be customised for particular uses. For instance, many ranchers in the West use wind generators to pump water for their livestock. As opposed to the outdated fan-bladed windmills that pumped water, electric wind turbines are significantly more efficient and reliable. In addition to being more practical and possibly less expensive than extending electrical lines.

Hydro Energy

The energy produced by hydropower is domestic, renewable, and clean. It doesn't pollute and offers affordable electricity. Hydropower, in contrast to fossil fuels, does not pollute water while generating energy. One renewable energy source, hydropower, is the only one that can both meet the world's expanding energy needs and completely replace the electricity generated by fossil fuels. Hydroelectric systems come in a variety of sizes and use. The smallest hydroelectric systems are known as micro-hydroelectric plants. They are perfect for supplying power to smaller facilities like processing equipment, villages, and farms because they have a power output range of 1 kW to 1 MW. It is possible to generate a lot of electricity using huge hydroelectric systems. Large towns and communities can be powered by these systems.

Role of Biomass

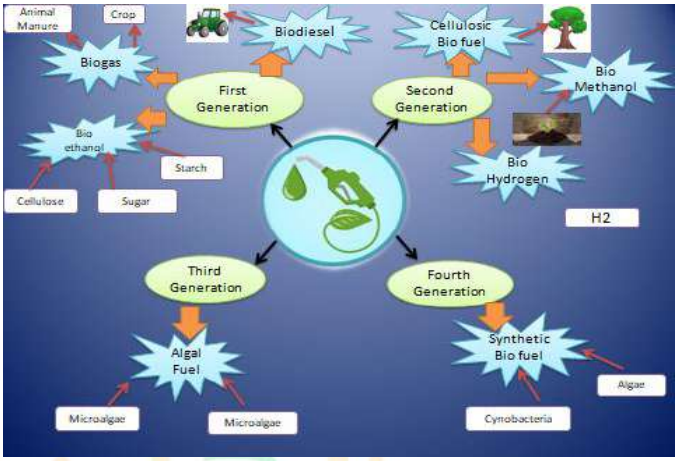
Biomass (including fuel wood, sawdust, crop and animal residue/waste, and biogas), wind, solar electricity, minor hydropower, etc. are potential alternative energy sources for the rural agricultural sector. Improved wood/solid fuel stoves and coal briquettes of various designs have been demonstrated to have 10 to 20% thermal efficiency,

whereas conventional stoves only have 5 to 7%. Cooking, smoking fish, and being required to properly all can be done on the wood/fuel stoves. However, if consumption is unchecked, it could lead to environmental deterioration such as deforestation, soil erosion, desertification, and carbon emissions.

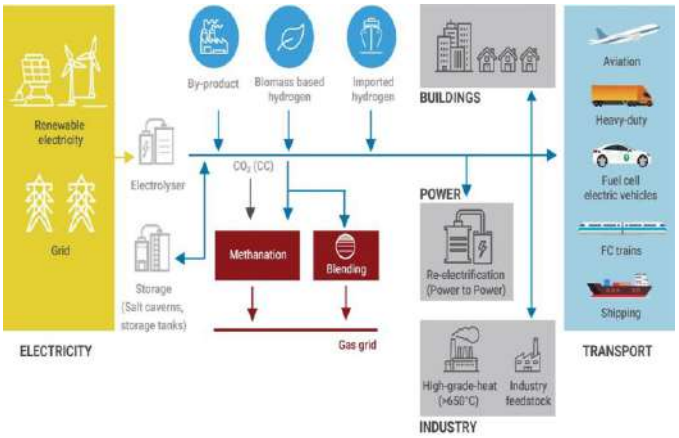
Large amounts of agricultural wastes, including livestock manure, corn cobs, cassava peelings, rice husks, peanut shells, sawdust, bagasse, and the resulting gas (biogas), can be turned into potential sources of energy that can be redirected into agricultural production and processing processes. Utilising a biodigester makes this possible. By using ethanol or biodiesel instead of conventional fuels like gasoline and diesel, you can cut back on the amount of crude oil you purchase from abroad. These purposes can be served by materials like sugarcane, sugar beet, rice, potato skins, etc. Due to their primary use as food and feed, conventional crops like corn and sugarcane are unable to supply the need for bioethanol production on a worldwide scale. Agricultural waste and other lignocellulosic materials are thus desirable feedstocks for the generation of bioethanol. Agricultural wastes are cheap, abundant, and renewable.

Role of Biofuels

The production of bioethanol from agricultural waste has the potential to be a promising technology, but there are a number of obstacles and restrictions in the way of biomass handling and transportation as well as effective pre-treatment techniques for complete lignocellulosic solubilization. After enzymatic saccharification, appropriate pre-treatment techniques can raise quantities of fermentable sugars, enhancing the effectiveness of the entire process. To make the entire process cost-effective, new fermentation technologies are required for the conversion of xylose and glucose to ethanol.



Green hydrogen is receiving more attention these days. Green hydrogen is distinct from grey hydrogen, which is made from methane and releases greenhouse gases into the atmosphere, and blue hydrogen, which captures those emissions and stores them underground to prevent them from causing climate change. Green hydrogen is produced using renewable energy and electrolysis to split water.



The generation of energy with lower greenhouse gas emissions, the diversification of agricultural resources, the development of jobs, and self-sustainability are all possible outcomes of these changes, all of which will ultimately have an impact on the economic situation.

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Climate Change: Impact, Mitigation and Adaptation in Vegetable Crops

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Introduction

For the past some decades, the gaseous composition of earth's atmosphere is undergoing a significant change, largely through increased emissions from energy, industry and agriculture sectors; widespread deforestation as well as fast changes in land use and land management practices. GHGs trap the outgoing infrared radiations from the earth's surface and thus raise the temperature of the atmosphere. The past 50 years have shown an increasing trend in temperature @ 0.13 °C/decade, while the rise in temperature during the past one and half decades has been much higher.

The Inter-Governmental Panel on Climate Change has projected the temperature increase to be between 1.1°C and 6.4°C by the end of the 21st Century. Concerted efforts are required for mitigation and adaptation to reduce the vulnerability of agriculture to the adverse impacts of climate change and making it more resilient. The adaptive capacity of poor farmers is limited because of subsistence agriculture and low level of formal education. Therefore, simple, economically viable and culturally acceptable adaptation strategies have to be developed and implemented. Furthermore, the transfer of knowledge as well as access to social, economic, institutional, and technical resources need to be provided and integrated within the existing resources of farmers.

Fig 1. Rise in Sea Level

Fig 2. Bushfire in Australia

Environmental Constraints Limiting Vegetable Productivity

- ✓ Climatic changes will influence the severity of environmental stress on the vegetable crops. Moreover, increasing temperatures, reduced irrigation-water availability, flooding, and salinity will be the major limiting factors in sustaining and increasing vegetable productivity. Plants may respond similarly to avoid one or more stresses through morphological or biochemical mechanisms.
- ✓ Environmental interactions may cause stress response of plants more complex or influence the degree of impact of climate change.
- ✓ Measures to adapt to these climate change-induced stresses are critical for sustainable vegetable production.

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Impact on Agriculture

Some of the important environmental stresses which affect vegetable production have been reviewed below:

A. High Temperature

Heat stress due to increase in temperature is a major agricultural problem in many areas of the world. A constantly high temperature causes an array of morpho-anatomical changes in plant which affect the seed germination, plant growth, flower shedding, pollen viability, gametic fertilization, fruit setting, fruit size, fruit weight, fruit quality etc. Heat stress above 35 ºC has become a major limiting factor for seed germination, seedling and vegetative growth, flowering & fruit setting, and ripening in tomato.

Fig 3. Tip Burn in Lettuce

Fig 4. Black Heart in Potato

Fig 5. Buttoning in Cauliflower

High temperatures also interfere with floral bud development due to flower abortion

Vegetables	Symptoms
Asparagus	High fibre in stalks and spears, feathering and lateral branch growth
Beans	High fibre in pods
Carrot	Low carotene content
Cauliflower	Blindness, buttoning, ricyness
Cabbage	Bleached and papery outer leaves
Lettuce	Tip burn, bolting at >30ºC
Tomato	Sun burn, sunscald
Potato	Black heart

Physiological Disorders due to Temperature

B. Chilling injury in Tomato

The cultivated tomato genotype (*Solanum lycopersicum*, earlier known as *Lycopersicon esculentum* L.) displays limited growth and development at temperatures under 12ºC. At temperatures between 0 and 12ºC, plants are damaged by the chilling stress. The severity of damage is proportional to the length of time spent in this temperature range.

C. Drought stress

The water requirements of vegetable crop range from about 6 inches of water per season for radishes to 24 inches for tomatoes and watermelons. Precise irrigation requirements can be predicted based on crop water-use and effective precipitation values. Lack of water influences the crop growth in many ways and the effect depends on the severity, duration, and time of stress in relation to the stage of growth. Nearly all vegetable crops are sensitive to drought during two periods: flowering and two-to-three weeks before harvesting.

Fig 6. Fruit cracking

Fig 7. Quick bolting

Fig 8. Blossom end rot

Vegetables	Symptoms
Brinjal	Reduced extension of main stem, reduced number of branches per plant
Beans	Few flowers, delayed flowering, low seed protein
Potato	Decreased starch
Cauliflower	Leafy, loose, yellow, small, hard curds
Tomato	Blossom end rot, fruit cracking
Lettuce	Bitter taste, accelerated development of tip burn
Spinach beet	Quick bolting

Physiological Disorders due to Water Stress

D. Salinity

20% of cultivated lands and 33% of irrigated agricultural lands worldwide are afflicted by high salinity. In addition, the salinized areas are increasing at a rate of 10% annually; low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices are the major contributors to the increasing soil salinity.

E. Flooding

Most vegetables are highly sensitive to flooding and genetic variation with respect to this character is limited, particularly in tomato and early cauliflower. In general, the damage to vegetables by flooding is due to reduction of oxygen in the root zone, which inhibits aerobic processes.

Methods

Mitigation Strategies to Climate Change

To mitigate the possible impact of climatic change on vegetable production as well as on national economy, several initiatives have been undertaken.

These include:

- ✓ Selection of better adaptable genotypes,
- ✓ Genetic manipulation to overcome extreme climatic stresses,
- ✓ Measures to improve water and nutrient-use efficiency and
- ✓ Biological nitrogen fixation as well as exploiting the beneficial effects of CO_2 enhancement on crop growth.

Adaptation Strategies to Climate Change in Vegetable Crops

To deal with the impact of climate change, the potential adaptation strategies are:

- ✓ Developing cultivars tolerant to heat and salinity stress and resistant to flood and drought
- ✓ Modifying crop management practices
- ✓ Improving water management,
- ✓ Adopting new farm techniques such as resource conserving

A. Water Management

There are several methods of applying irrigation water and the choice depends on the crop, water supply, soil characteristics and topography. Surface irrigation methods are utilized in more than 80% of the world's irrigated lands, yet its field level application efficiency is often 40-50%. To generate income and alleviate poverty of the small farmers, promotion of affordable, small-scale drip irrigation technologies are essential.

- ✓ Drip irrigation minimizes water losses due to run-off and deep percolation and water savings of 50-80% are achieved when compared to most traditional surface irrigation methods. Crop production per unit of water consumed by plant evapo-transpiration is typically increased by 10-50%. Thus, more plants can be irrigated per unit of water by drip irrigation, and with less labour.
- ✓ The water-use efficiency by chili pepper was significantly higher in drip irrigation compared to furrow irrigation, with higher efficiencies observed with high delivery rate drip irrigation

regimes.

- ✓ For drought-tolerant crops like watermelon, yield differences between furrow and drip irrigated crops were not significantly different; however, the incidence of *Fusarium* wilt was reduced when a lower drip irrigation rate was used.

Fig. 9 Drip irrigation

Fig. 10 Protected cultivation

Fig. 11 Relay cropping

B. Cultural Management

- ✓ The use of organic and inorganic mulches is common in high-value vegetable production systems. These protective coverings help reduce evaporation, moderate soil temperature, reduce soil runoff and erosion, protect fruits from direct contact with soil and minimize weed growth.
- ✓ During the hot rainy season, vegetables such as tomatoes suffer from yield losses caused by heavy rains. Simple, clear plastic rain shelters prevent water logging and rain impact damage on developing fruits, with consequent improvement in tomato yields. Fruit cracking and the number of unmarketable fruits are also reduced.

Fig. 12 Red plastic mulch

Fig. 13 Raised bed and plastic mulch

Fig. 14 Paddy straw mulch

- ✓ Another form of shelter using shade cloth can be used to reduce temperature stress. Planting vegetables in raised beds can ameliorate the effects of flooding during the rainy season.

C. Grafting of Vegetables for Stress Management

- ✓ Grafting of susceptible plant (scion) on tolerant plant (rootstock) helps to grow plant successfully under stress conditions, especially under salt and drought stress conditions. Grafting of vegetables has been used primarily to control soil-borne diseases affecting the production of vegetables such as tomato, eggplant, and cucurbits.
- ✓ It provide tolerance to soil-related environmental stresses such as drought, salinity, low soil temperature and flooding if appropriate tolerant rootstocks are used.

D. Use of Heat- and Cold-Tolerant Genotypes

- ✓ The key to achieving high yields with heat-tolerant cultivars is the broadening of their genetic base through crosses between heat-tolerant tropical lines and disease-resistant temperate or winter varieties.

E. Drought Tolerance

- ✓ Most of the vegetables are sensitive to drought; however brinjal, cowpea, amaranth, and tomato can tolerate drought to a certain extent.
- ✓ Transfer and utilization of genes from these drought-tolerant species will enhance tolerance of tomato cultivars to dry conditions, although wide crosses with *S. pennellii* produce fertile progenies.

F. Salt Tolerance

- ✓ Screening for salt tolerance in the field is not a recommended practice because of the variable levels of salinity in field soils. Screening should be done in soil-less culture with nutrient solutions of known salt concentrations.
- ✓ A few vegetables like, beet palak, tomato, etc. can tolerate salt to some extent.
- ✓ Most commercial tomato cultivars are moderately sensitive to increased salinity and only limited variation exists in the cultivated species.

G. Use of Biotechnological Tools in Stress Management

- ✓ Use of molecular technologies has revolutionized the process of traditional plant breeding. Combining of new knowledge from genomic research with traditional breeding methods has enhanced our ability to improve crop plants.
- ✓ Several QTLs have been identified to stress tolerance in tomato, i.e. for water-use efficiency in *S. pennellii and S. pimpinellifolium* as source of salt tolerance. Only a few major QTLs account for the majority of phenotypic variation, indicating the potential for marker-assisted selection (MAS) for salt tolerance.

Results

Development of Heat Tolerant Varieties

Crops	Genetic Material
Tomato	Pusa Sadabahar, Pusa Hybrid-1, Pusa Hybrid-8, Arka Meghali, Arka Vikas
Brinjal	Kashi Sandesh, Kashi Taru
Potato	Kufri Surya
Okra	Kasha Pragati, Kasha Kranti
Cauliflower	Pusa Meghna
Bottle Gourd	Thar Samridhi, Pusa Santushti
Cucumber	Pusa Barkha
Radish	Pusa Chetki
Carrot	Pusa Kesar

Development of Drought Stress Tolerant Varieties

Crops	Genetic Materials
Tomato	Arka Meghali, Arka Vikas
Brinjal	Supreme, Kasha Sandesh
Chilli	Samrudhi, Kasha Anmol
Potato	Kufri Sindhuri, Kufri Sheetman
Carrot	Ooty-1

Development of Salt Tolerant Varieties

Crops	Genetic Materials
Tomato	Pusa Ruby, Best Of All
Lettuce	Calmar
Okra	Pusa Sawani
Onion	Punjab Selection
Pea	Market Prize
Cucumber	Pi-177361

Conclusion

- ✓ A holistic approach is required to over stress tolerance rather than a single method.
- ✓ For reducing malnutrition and alleviating poverty in developing countries through improved production and consumption of safe vegetables will involve adaptation of current vegetable systems to the potential impact of climate change.
- ✓ Vegetable germplasm with tolerance to drought, high temperatures and other environmental stresses, and ability to maintain yield in marginal soils must be identified to serve as sources of these traits for both public and private vegetable breeding programmes.
- ✓ These germplasms will include both cultivated

and wild accessions possessing genetic variation unavailable in current, widely-grown cultivars.

Crop Improvement in Cardamom

E. Venkadeswaran, V. Kanthaswamy, J. Sherly and M. S. Marichamy

Introduction

Cardamom (*Elettaria cardamomum* Maton) of commerce is the dried ripe fruit (capsules of cardamom plant) often referred as the "queen of spices" because of its very pleasant aroma and taste. Cardamom is a perennial, herbaceous, rhizomatous plant belonging to the family Zingiberaceae. It is one of the most significant and profoundly valued spices. The major use is for the preparation of 'gahwa' - a strong cardamom coffee concoction which is a symbol for hospitality among Arabs. Apart from this cardamom is widely used as a flavouring material in whole and ground form. In Asia, it can add a lingering sparkle to every kind of dishes both traditional and modern. In Scandinavian countries, it is used in baked goods and confectionaries. In Europe and North America, it is an ingredient in curry powder and in some sausages products. Cardamom oil and oleoresin has applications in flavouring processed foods, cordials, and liquors and in perfumery and in Ayurvedic medicines. Cardamom is herbaceous enduring (2-5 m in height) with underground rhizomes and elevated verdant stems (tillers) made of leaf sheaths. The somatic chromosome number of cardamom is reported to be 2n = 48. Cardamom is generally cross-pollinated crop and propagated by seedlings and suckers; occasionally selfing also occurs.

Floral biology

The advancement of regenerative buds (panicles) takes place in about 10 to 12 months. Inflorescence is a long panicle emerging from the underground stem, but comes up above the soil. The direct development of panicles stretches over a period of seven months. Flowers are arranged in bunches (known as cincinni) subtended by scale leaves. Flowers are bisexual, bracts linear, oblong and persistent, sepals 3, petals 3, unequal, lip longer with violet tinge carpels 3, style 1, ovary is trilocular, axile placentation, ovules-many in each carpel. Normally flowering in cardamom could be seen throughout the year on panicles formed during the current as well as in previous year. The peak flowering is spread over a period of six months from May to October. The time required to a full bloom stage from flower/bud initiation ranges from 26 to 34 days and capsule development takes about 110 to 120 days from the full bloom stage. As a rule, most extreme number of flowers open during early hours of the day 3.30 - 8.00 AM immediately followed by

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the anthesis. The dehiscence of anthers took place immediately followed by anthesis with maximum pollen bursting between 5.30-6.30 AM. The pollen grains were round and mostly found in single, measured on an average 87.6 µ in diameter. Studies on the viability of the pollen grains indicated only 6.5% viability after 2 hours of storage and 0% after 6-8 hours of storage. Cardamom has bisexual flowers, self-compatible but cross-pollination is more common. *Apis cerana* and *Apis dorsata* are the predominant pollinators. Cardamom flowers remain in bloom for 15-18 hours and stigma receptivity and pollen viability were reported to be maximum during morning hours between 8 AM and 10 AM. Pollination during this time result about 72% fruit set. Thereafter, the stigma receptivity declined gradually giving in the minimum fruit set of 24%. The active foraging of bees is observed in the morning hours of the day, providing higher fruit set in cardamom.

Specific characteristic features of three varieties of cardamom

Based on the size of the fruit, two botanical varieties are broadly recognized in cardamom *viz*., *Elettaria cardamomum* var. *major* consisting of wild indigenous types and *Elettaria cardamomum* var. *minor* comprising the cultivated types *viz.*, Mysore, Malabar and Vazhukka (natural hybrid between Mysore and Malabar). These types are identified mainly based on the nature of panicle and shape and size of capsules as follows.

Characters	var. Malabar	var. Mysore	var. Vazhukka
Adaptability	Lower altitudes 600-900 m MSL	Higher altitudes 900-1200 m MSL	Wide range
Areas of cultivation	Karnataka	Kerala and parts of Tamil Nadu	Kerala
Plant growth	Medium	Robust	Robust
Panicles	Prostrate	Erect	Semi erect
Capsules	Round or oblong	Bold, elongated	Round to oblong
Leaf petiole	Short	Long	Long
Capsule colour at maturity	Pale/golden/ yellow	Green	Green

a) var. Malabar having prostrate panicle
b) var. Mysore having erect panicle
c) var. Vazhukka having semi erect panicle

Cardamom improvement

Genetic diversity and conservation

India is recognized as a rich source of genetic diversity for cardamom. Today, the conservation and use of the genetic resources of cardamom constitute one of the priority programmes adopted by the Indian Institute of Spices Research. Numerous exploration missions have been carried out leading to the collection of about 310 accessions. The collected germplasm accessions are conserved in *ex silo* and *in vitro* germ plasm repositories (short and long term). Accessions with distinct morphological marker char-

cters, such as compound panicle types, terminal panicle bearing, narrow leaf types, pink pseudostem types, dark green and bold capsules and high-yielding biotic-stress tolerant types, are conserved in the repository.

Breeding objectives

The main focus of Cardamom breeding in addition to high yield are resistance to biotic stress *viz.*, viral diseases like 'katte' and 'kokke kandu' and fungal diseases such as rhizome rot, clump rot and capsule rot; drought tolerance; plants with bold capsules with more number of seeds fruit^{-1}; higher percentage of capsule dry recovery (>22%); higher percentage of essential oils, α -terpenyl acetate which is responsible for the aroma and flavor and varieties with wide adaptability.

Methods of breeding

1. Clonal selection

All the existing improved varieties have been evolved by selection for desirable characters such as higher yield and superior capsule characters. Selection in cardamom is based on both qualitative and quantitative characters from preliminary, comparative yield trial and multi-location trials to confirm the superiority of the selected clone.

2. Hybridization

Inter-varietal hybridization was made between identified superior cultivars for deriving lines with high yield, 'katte' resistance and drought tolerance. A large number of crosses have been made to combine high yield and resistance to rhizome rot and cardamom mosaic diseases, which are currently under evaluation at Indian Institute of Spices Research, Appangala. Varying degrees of significant positive heterosis was recorded in both the seedling and pre bearing stage of cardamom crosses.

3. Inter-generic hybridization

In an effort to bring Katte resistance from wild relatives to cultivated cardamom , inter-generic crosses were made using *Ammomum subulatum*, *Alpinia neutans*, *Hedychium flavascence* and *Hedychium coronarium* as male parents. Cross with *Alpinia neutans* set a few fruits and in other cases no fruit formation was noticed.

4. Mutation breeding

Effort has been made to develop genotypes tolerant to cardamom mosaic (katte) virus, drought, and better quality through treatment of cardamom seeds and rhizomes with different mutagens such as γ-rays and Nitrosomethyl Urea (NMU), Diethyl Sulphate (DES) and Ethyl Methyl Sulphate (EMS) but no desirable mutant could be identified so far.

5. Polyploidy breeding

Polyploids were induced in cardamom by treating the sprouting seeds with 0.5 per cent aqueous solution of Colchicine. The polyploidy lines exhibited increased layer of epidermal cells, thick cuticle and thicker wax coating on the leaves which are the general characters associated with drought tolerance in nature.

Achievements

Sl. No.	Varieties	Type	Yield potential (dry capsules kg ha^{-1})	Other attributes
ICAR - IISR - Regional Station, Appangala, Madikeri, Karnataka				
1.	Coorg Cardamom Selection-1 (CCS-1)	Malabar	408	An open pollinated seedling of clone 37. Dry recovery 22%, Essential oil content 8.7%
2.	Appangala-1	Malabar	745	Suitable for intensive cultivation both under monocrop and mixed crop conditions. Early maturing variety, highly adaptive and produces 89% bold capsules. (Potential yield 1322 kg dry capsules ha^{-1}).
3.	Appangala-2	Malabar	927	High yielding and resistant to cardamom mosaic virus/Katte
Indian Institute of Spices Research, Calicut, Kerala				
4.	IISR - Kodagu Suvasini (CCS-1)	Malabar	745	Selection from OP progeny of CL-37 from RRS Mudigere, Malabar type. Early maturing, suitable for high density planting, long panicle. Tolerant to rhizome, rot, thrips, shoot / panicle / capsule borer.
5.	IISR - Avinash (RR-1)	Malabar	1483	A selection from OP progeny of CCS-1, a Malabar type. Rhizome rot resistant, high yielder and suitable for planting in valleys. Produces 51% bold, dark green capsules. Suited for hotspots of rhizome rot prone areas.
6.	IISR - Vijetha (NKE-12)	Malabar	979	Cardamom mosaic virus resistant (Katte) selection, recommended for moderate to high shaded mosaic disease prone areas. Suitable for Kodagu, Hassan, Chikmagalur and North Wayanad. Suitable for Katte prone areas. Adapted to moderate rainfall and moderate to high shade areas.
Indian Cardamom Research Institute (ICRI), Myladumpara, Idukki, Kerala				
7.	ICRI 1	Malabar	325 - rainfed 650 - irrigated	Selection from Chakkupalam collection, Malabar type. Dry recovery: 22.9%, Essential oil: 8.3%. An early maturing type globose, round and extra bold dark green capsules; medium sized panicle with profusely flowering, early maturing type
8.	ICRI 2	Mysore	375 - rainfed 760 - irrigated	Clonal selection from germplasm, Mysore type. Tolerant to Azhukal disease. Adaptable for Vandenmedu and Anamalai hills. Dry recovery: 22.5%, Essential oil: 9%. Performs well under high altitude and irrigated condition, medium long panicles, oblong bold and parrot green capsules
9.	ICRI 3	Malabar	599	Selection from Malabar type. Early maturing long pubescent leaves, tolerant to rhizome rot disease, oblong, bold parrot green capsules. suitable for hill zone of Karnataka
10.	ICRI 4	Malabar	961	Clonal selection from lower pulleys, a Malabar type. Suitable for low regions. Adapted to lower Palani hills. Early maturity, medium sized panicles, Globose bold capsules. Suitable for low rainfall areas, relatively tolerant to rhizome rot and capsule borer
11.	ICRI 5	Malabar	1543	Hybrid between MCC 260 x MCC 49. First hybrid variety, Early maturity Moderately tolerant to drought, High yield under intensive management, Capsule size 68% ; more than 70 mm
12.	ICRI 6 (MCC - 73)	Malabar	1900	Selection from the germplasm (acc. MCC-73). High yield, Medium maturity, Relatively tolerant to drought. High percentage of bold capsules Capsule size 71% ; more than 7 mm
13.	ICRI 7	-	-	Hybrid. Suitable for Wayanad, Kerala, Semi-erect panicles. Angular bold capsules, Oleoresin 7.99%
Cardamom Research Station (Kerala Agricultural University), Pampadumpara, Idukki, Kerala				
14.	PV 1	Malabar	500	A selection from Walayar collection, Malabar type. An early maturing type, short panicle, elongated slightly ribbed light green capsules, long, bold capsule
15.	PV 2	Vazhukka	982	Selection from OP Seedlings of PV-1, a Malabar type. Green bold capsules. Adopted to Cardamom Hill Reserves of Idukki. Early maturing, lengthy panicle, Long bold capsules, high dry recovery percentage, field tolerant to stem borer and thrips, suitable for elevation range of 1000-1200 m above MSL
16.	PV 3	Malabar	342	Drought tolerant and moderately tolerant to capsule borer. Suitable for partial shade (50-60%) in tropical evergreen forests of the State
17.	PV 5	Vazhukka	153	Tolerant to thrips. Suitable for cardamom growing tracts of Kerala
Regional Horticultural Research and Extension Centre, University of Agricultural and Horticultural Sciences, Mudigere, Chikkamagaluru, Karnataka				
18.	Mudigree 1	Malabar	275	Clonal selection from Malabar type. Erect and compact panicle, suitable for high density planting, moderately tolerant to thrips, hairy caterpillar and white grubs, pubescent leaf. Short panicle, pale green, oval bold capsule
19.	Mudigere 2	Malabar	475	Clonal selection from open pollination of Malabar type. Early maturing variety, suitable for high density planting, round/oval bold capsules
20.	Mudigere 3	Malabar	400	Tolerant to thrips and borers

IISR-Vijetha - 1 IISR-Avinash (RR1) Suvasini (CCS-1)

Conclusion

Generally, little have been done on the improvement of cardamom through traditional breeding mechanism, as it is the queen of spices. This limitation of research work on the crop can be used as a gap for the breeders in the world. The future breeding strategies in cardamom need to develop widely adaptable varieties by bringing together the various yields and quality attributes distributed in different cultivars, which perform well in changed climatic conditions.

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Integrated Approach for Management of Okra Shoot and Fruit Borer (*Earias vittella* Fab.)

Ashutosh Singh Aman, Arun Kumar, Pawan Kumar, Pramod Kumar Mishra and Avinash Chowdhury

Abstract

Okra Shoot and fruit borer (*Earias vittella* Fab.) is a major and key pest of okra causing harmful effects on crop in various growth stages. It is distributed throughout the country with various 72 species. Mostly, chemical pesticides have broad spectrum activities, which kill both harmful and beneficial insects and cause negative impacts on environmental ecology. The current scenario of Integrated Pest Management (IPM) in okra can have a great scope for getting higher yield of the crop with lower pest incidence. There is a need for massive extension training and demonstration programmes for motivating the farmers of the country to adopt integrated approach in pest management.

Introduction

Okra (*Abelmoschus esculentus* L.) belongs to family Malvaceae, it is also known as lady finger or bhindi in various parts of the country. The okra vegetable is cultivated in India mainly for its immature fruits. According to world scenario total area and production of okra is reported as 1.26 million ha and 22.29 million tones, respectively. Globally, India is the first largest producer of Okra with 5784.0 thousand tones production (72 per cent of the total global production). Its annual production 6346 million tones and productivity of 11.9 million tons/ha. While in Uttar Pradesh the area, production and productivity of okra is estimated as 12.19 ha, 148.64 tons, 12.2 metric tons ha^{-1}, respectively.

Its fruits have nutritious as well as dietary value. Though, it is mainly used as fresh vegetable and it is also consumed as canned, dehydrated or frozen forms. The productivity of okra is low due to many factors in which the attack of shoot and fruit borer, E. *vittella* is most serious pests of okra and cause about 45-57 per cent damage to fruits. There are several constraints in the cultivation of okra vegetable. Many of the pests occurring on okra crop, more than 72 species of insects have been occurred on okra in different parts of the country. Okra Shoot and fruit borer (*Earias vittella* Fab.) is distributed throughout India, Bangladesh, Sri Lanka, Pakistan, Indonesia, Burma, New Guinea, Myanmar and Fiji. It is a major and regular pest of okra which causes 69

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per cent loss in marketable yield due to attack of okra shoot and fruit borer.

Okra Shoot and Fruit Borer

(i) Scientific name: *Earias vittella* (Fab.)

(ii) Taxonomic position

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Lepidoptera
- Family: Noctuidae
- Genus: *Earias*
- Species: *vittella*

(iii) Host plants: Primarily it is feed on Okra crop beside this reported that to be the host of the plants belonging to malvaceae family like cotton and other plants like hibiscus and hollyhock etc.

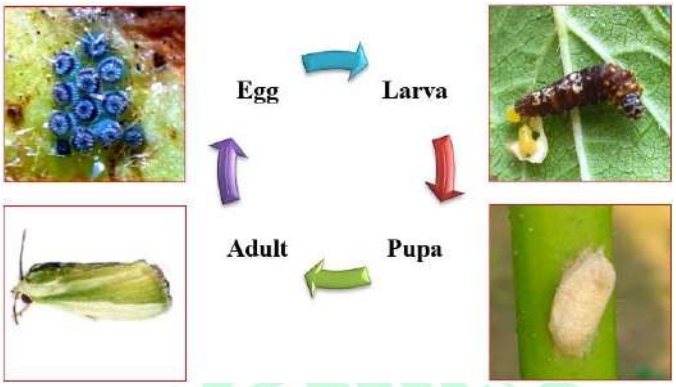
(iv) Distribution: It is distributed throughout India, Bangladesh, Sri Lanka, Pakistan, Indonesia, Burma, New Guinea, Myanmar and Fiji.

(v) Marks of identification: The eggs of Okra shoot and fruit borer, *Earias vittella* (F) are light greenish blue having longitudinal ridges. The fully matured larvae (caterpillar) measured 1.64 cm in length and its colour is green, black and orange the larvae brownish with white streaks dorsally and pale yellow ventrally. Its pupa is rough, chocolate brown, bluntly rounded, inverted boat shaped grey cocoon formed on the stem or fruits. Its adults are small measuring 1.25 cm across the forewing, while its head and thorax of adults borer are ochreous white in colour, its forewings are pale white with a wedge shaped horizontal green patch in the middle and hind wings are silvery creamy white in color. Moths of *E. Vittella* have narrow light longitudinal green band in the middle of the forewing. The major difference between male and female is that the female is greater than male in size and the female has V-shaped at the end of the anal part but the male has thick hair at the anal end of the body.

(vi) Nature of damage: Its caterpillars bored the terminal portion of growing shoots, which move down by making tunnels inside. As a result, the shoot drop downward or dry up. Second, the larvae enter the fruit by making holes, rendering them. Attacked fruits are with boreholes plugged with excreta making unfit for consumption and losing their marketable values.

(vii) Life cycle (Bionomics): The life cycle of Okra shoot and fruit borer, *Earias vittella* (F) is completed in four stages *viz.* egg, larva, pupa and adult. Its eggs are spherical and light bluish green colour with longitudinal ridges. Its adults laid eggs singly or in group about 385-400 eggs on leaves, tender shoots, flowers and developing fruits. Its egg incubation, larval and pupal period completed in 3-4, 10-17 and 6-10 days, respectively with 6 larval instars. Its larvae brown with longitudinal white stripes on dorsal side, while its adult medium sized head and thorax ochreous white. It bores into tender shoots and fruits and cause heavy damage. Attacked fruits are with boreholes plugged with excreta making unfit for

consumption and losing their marketable values. Its pupa makes an inverted boat shaped cocoon and emerges an adult with white wings with triangular brown and red markings on forewing. It is complete their entire life cycle within 20-25 days.



Integrated Pest Management

- ✓ Collect and destroy the damaged tender shoots, fallen fruits and fruits with bore holes to prevent population buildup.
- ✓ Destruction of debris, crop residues, weeds and other alternate hosts.
- ✓ Avoid continuous mono cropping of Okra.
- ✓ Deep summer ploughing is effective to kill the pupae.
- ✓ Adopt the proper crop rotation and avoid the malvaceae crops in sequence.
- ✓ Weeding and earthing up in rows should be done 25-30 days after sowing.
- ✓ Field should be kept free from weeds or other wild plants.
- ✓ Collect and destroy the infested fruits with Fruit and shoot borer infestation.
- ✓ Heavy infestations in plants may be uprooted and burning it is good.
- ✓ Pheromone traps @ 5 per acre should be installed for monitoring and mass trapping of shoot & fruit borer (*Earias vittella* Fab.). Replace the lures with fresh lures after every 15-20 day interval.
- ✓ Set up light traps @ 12 ha^{-1} to attract and kill the moths.
- ✓ Install bird perches @ 10 $acre^{-1}$ should be erected for facilitating field visits of predatory birds.
- ✓ Grow resistance varieties like Parkins Long Green, Karnual Special, AE-57, PMS-8, PKX-9275 etc.
- ✓ Avoid using insecticides at the time of fruit maturation and harvest because the synthetic pyrethroids cause resurgence in insects.
- ✓ Release egg parasitoid *Trichogramma chilonis* or T. *brasiliensis* @ 1-1.5 lakh ha^{-1} for shoot & fruit borer, 4-5 times at weekly interval.
- ✓ Conserve the existing bio-control agents like Spiders, Coccinalids, Syrphid flies etc. in the field by avoiding, delaying and reducing the use of chemical pesticides and promoting the use of bio-pesticides including botanicals and microbial.
- ✓ Augment the bio-control agents like egg parasitoids, *Trichogramma chilonis*, *Trichogramma achaea*, *Trichogrammatoidea sp*., *Telenomus sp*., *Encarsia spp*.; larval parasitoid *Bracon sp*., *Campoletis chlorideae*, *Chelonus blackburni*; predators like *Chrysopa sp*., *Coccinella sp*.
- ✓ In case of severe incidence, spray any one of the insecticide starting from one month after planting at 15 days interval, Neem oil 1500 ppm @ 1-1.5

ml lit^{-1} or NSKE 5% 50 gm lit^{-1} or *Beauveria bassiana, Metarhizium anisopliae* @ 5-10 ml lit^{-1} or *Bacillus thuringiensis* Var. Kurstaki @ 3-5 ml lit^{-1} of water.

- ✓ If the borer incidence crosses economic threshold level, spray Lambda cyhalothrin @ 2 ml lit^{-1} or *Emamectin benzoate* 5% SG @ 1 gm lit^{-1} or *Spinosad* 45% SC @ 0.20-0.30 ml lit^{-1} Water.

Conclusions

Okra is an important vegetable crop grown over 1.26 million ha in the world; its cultivation is done on a large scale in almost all the states of the nation. Okra shoot and fruit borer a major and regular pest of Okra which caused 45-57 % damage to fruits. For the management of the okra shoot and fruit borer, an integrated pest management (IPM) strategy is effectively used. This management strategy considered as eco-friendly approach, which act as anti-resistant mechanism in pests.

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Conservation Agriculture

S. K. Nayak and M. R. Punse

Introduction

Conservation Agriculture refers to system of raising the crops without tilling the soil while retaining the crop residue on the soil surface. (Bhale *et al.*, 2009). Conservation agriculture is an approach for the design and management of sustainable and resource-conserving agricultural systems. It seeks to conserve, improve and make more efficient use of natural resources through integrated management of soil, water, crops and other biological resources in combination with selected external inputs. Indian agriculture is entering a new phase. Resource conservation technologies are defined as any practice that improves the efficiency of use of natural resources, including water, air, fossil fuels, soils, inputs, and people (Gupta *et al.*, 2007). Adoption of the RCT's offers newer opportunities of better livelihood for the resource poor small and marginal farmers. At the same time, these technologies are generating alternative sources of productivity growth through diversification and intensification of production systems. The combination of RCT working in synergy is commonly referred as conservation agriculture.

Principles of Conservation Agriculture

Conservation Agriculture offers farmers an array of practices, but at its core are three interlinked principles that can be applied in a variety of combinations to meet the needs of resource- poor farmers:

1. Principle of Minimum Soil Disturbance

- ✓ Only disturb the soil where the seed, fertilizer and manure are to be placed.
- ✓ Reduces destruction of the soil structure;
- ✓ Does not expose soil to wind and water erosion;Improves water infiltration rates;
- ✓ Slows the rate at which organic matter is mineralized and oxidized, so organic matter build-up occurs; Reduces soil compaction because the crop plant roots are left undisturbed.
- ✓ Causes little disruption to the organisms that live in the soil.
- ✓ Saves time, energy, and money because less land is tilled.

2. Permanent organic soil cover

- ✓ Helps reduce direct raindrop impact and so reduces soil erosion;
- ✓ Helps reduce runoff and helps water to seep into the soil;
- ✓ Reduces evaporation and so conserves moisture for the crop;
- ✓ Suppresses weeds emergence;
- ✓ The organic residues improve organic matter

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Table 1: Components of Conservation Agriculture

Practice	Slope	Topography & rainfall	Soil type	Purpose
A. Mechanical measures				
Contour bunding	> 6%	Flat land with scanty and erratic rainfall	Medium deep black soil	To reduce length and degree of slope
Graded bund Channel terracing	6 to 10 %	> 800 mm	Red soil and clay soil under less rainfall condition	To make runoff water trickle rather than to rush out.
Graded border strips	2 to 3 %	High and low rainfall area	Deep red soil	Formed between contour or graded bund.
Bench terracing	6 to 33 %	Hilly area with high rainfall	-	To convert original sloe in to level field.
Compartmental bunding	< 1%	Rainfed areas	Rainfed vertisols	Storing initial rainfall and permitting increased infiltration rate.
B. Agronomic measures				
Contour farming	< 1%	Rainfed areas	-	Act miniature barrier to runoff over soil surface.
Close growing/Cover crops	< 1%	Rainfed areas with rainfall of high intensity	-	Reduce splash erosion and protect soil from beating action of rainfall.
Strip – cropping	0.5 to 3 %	Rainfed areas	-	Check runoff and increase absorption of water.
Vegetative barrier	2 to 3 %	Rainfed areas	-	Reduce length of slope, check runoff velocity and trap silt.
BBF	< 1%	Semi-arid	Deep black soil	Reduce runoff provide drainage.

content and soil nutrient status;

- ✓ Provides a beneficial environment for soil organisms, such as worms and millipedes, that are important for biological tillage;
- ✓ Moderates soil temperatures.

3. Principle of Mixing and Rotating Crops

- ✓ Replenishes soil fertility: intercropping with nitrogen-fixing legumes adds 'top-dressing fertilizer' to the soil; enables crops to use the nutrients in the soil more effectively:helps to control weeds, diseases and pests by breaking their life cycles through the introduction of a new crop;
- ✓ Reducing the risk of total crop failure in cases of drought and disease outbreaks.

Goals of conservation agriculture

- ✓ Increasing the productivity of land, water, labour and capital to meet human needs, while preserving the integrity of the natural ecosystems.
- ✓ Aims to conserve and enhance the quality of natural and human resources
- ✓ Assured supply and better quality food for consumers
- ✓ Sustainable livelihood opportunities to raise standards of living broadly and equitably.

Benefits from conservation agriculture

Benefits of conservation agriculture have been demonstrated through its large scale adoption in many socio-economic and agro-ecological situations in different countries the world over.

Financial benefits for farmer

- ✓ Greater stability in yield
- ✓ Higher ratios of outputs to inputs, Reduction in cost
- ✓ Reduction in labour, time and farm power
- ✓ Great resilience to drought

Benefits to communities and society

- ✓ Greater supply of environmental services from landscapes
- ✓ More reliable and cleaner water supplies due to less erosion
- ✓ Less flooding
- ✓ Better food and water security
- ✓ Less impact of extreme climatic situations

Environmental benefits

- ✓ Less water pollution and soil compaction
- ✓ Greater carbon sequestration and retentions in soil
- ✓ Increased biodiversity both in soil and atmosphere
- ✓ Less leaching of soil nutrients, Practically no erosion
- ✓ Conserve soil and water hence better hydrology

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Cray Things about Yellow Crazy Ants (*Anoplolepis gracilipes* F. Smith)

Mogili Ramaiah and Vavilapalli Rajesh

Introduction

The Yellow Crazy ant (*Anoplolepis gracilipes* F. Smith) is listed among the 100 worst invasive species in the world by International Union for Conservation of Nature, based on its rapidly expanding range and the potential to cause dramatic changes in native ecosystems (Lowe *et al*., 2000; Holway *et al*., 2002). According to Australia's Wet Tropics Management Authority, yellow crazy ants are named after their distinctive erratic, uncoordinated way, with their movement becoming more frantic when disturbed. They are a category three restricted pest under the Biosecurity Act 2014. Mainly found in tropical and subtropical regions. The current distribution of yellow crazy ants extends through the tropical islands of the Indian and Pacific Oceans, including Papua New Guinea, Mauritius, and South East Asia where they are a major pest. Unlike other insects or ants, the yellow crazy ants don't sting or bite but spray formic acid. The ants are known to proliferate quickly and can do a large amount of damage to native wildlife. Yellow crazy ants can, directly and indirectly, alter the composition of invertebrate and plant communities and the abundance and behavior of forest birds (Hill *et al*., 2003). These ants are the greatest known threat to Red Crabs (*Gecarcoidea natalis*), which have a key role in the maintenance of ecosystems on Christmas Island. There is also evidence that these ants can harm larger vertebrates including chickens, pigs, and dogs (IUCN).

(Photo credit: Wikimedia Commons)

This ant species falls under the subfamily 'Formicinae' because they do not have a stinger, and their pincers are notably reduced. In place of a stinger, yellow crazy ants have an acidpore (a small opening at the tip of their abdomen that sprays formic acid) as their defense and attack mechanism. Recently, the outbreak started happening in Tamil Nadu, These ants are attacking everything - humans, animals, and crops according to a report published by the BBC, and also found difficult to get rid of them with regular management practices.

Yellow Crazy Ant - Habitat and Lifecycle

Yellow crazy ants prefer to nest in areas with access to water or some moisture, such as along creek

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banks, in utility service pits or piles of timber, or under logs, debris, or leaf litter. They will also nest at the base of trees, around perimeters of buildings, and within retaining walls where moisture is retained.

Worker ants have a life cycle of 76-84 days. Queens survive for several years. Workers are produced throughout the year, but production fluctuates. Sexual offspring are produced at any time in the year but generally 1-2 months before the rainy season.

Yellow Crazy Ant-How to Identify?

- ✓ Slender body, usually 4 mm long
- ✓ Long skinny legs
- ✓ Long antennae, equal to or exceeding the length of the body (11 segments in total)
- ✓ The Head is distinctly longer than broad
- ✓ Golden-brown body, with a darker brown abdomen, sometimes striped
- ✓ Day and night time foraging (they are less active in intense heat and heavy rain)
- ✓ Spray formic acid (do not bite or sting)
- ✓ Tend to be found in large numbers rather than by themselves

Yellow Crazy Ant are the ants dangerous?

- ✓ The ants can be painful and dangerous to people and animals. They don't sting or bite but spray formic acid when disturbed and it can be particularly painful if there is contact with the eyes.
- ✓ These ants, attack livestock and crops and affect crop yields, putting their livelihoods in danger.
- ✓ Experts say these ants proliferate quickly and can "do a large amount of damage to native wildlife". Many parts of Australia have reported infestations of these insects.
- ✓ Dr. Pronoy Baidya, an entomologist who has researched yellow crazy ants, says they are an "opportunistic species".
- ✓ "They don't have any dietary preferences. They eat anything and everything," he says, adding that they also prey on other ant species, bees, and wasps.
- ✓ Many farm animals have gone blind while snakes have died in a large number of villages in Tamil Nadu's Dindigul district due to the yellow crazy ant's menace.

Yellow Crazy Ant: Management approaches

In order to control and manage these ants, the available practices have to be followed under a wide area basis/community approach for better results.

- ✓ **Prevention and early eradication:** Checking for the presence of yellow crazy ants can help prevent the further spread of this pest. Landholders and businesses should check their properties and any materials that could harbour yellow crazy ants. This includes soil, timber, timber products, and other construction materials, agricultural and horticultural produce, packaging, and other potential vectors of spread.
- ✓ **Biological control:** This species is prey for the tiger beetle Cicindela duponti (a predator) in the Western Ghats, India (Sinu *et al*., 2006).
- ✓ **Chemical control:**

- Boric acid bait is readily taken up by foraging yellow crazy ants and has a knock-down effect on the colony's density.
- Baiting programmes using fipronil bait. Baits may be laid utilizing either hand-held spreaders, spreaders attached to motor vehicles, or aerial applications.
- Insecticides should always be used following the label instructions.

Conclusion

The outbreaks have been reported from Tamil Nadu state. The plague heavily affects the agricultural and their allied sectors, which is the foundation of national economies and social stability. Rapid change in climate is likely the main cause of crazy ants outbreak. Proper management practices should be followed to get rid of these tiny crazy things.

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Amla Production, Processing and Marketing in India

Sathish Kumar M., H. Y. Maheta, Kalpesh Kumar, C. R. Bharodia, Y. A. Lad and A. B. Mahera

Introduction

Amla (*Emblica officinalis*) or Indian Gooseberry is a minor subtropical deciduous tree. Amla belongs to the plant family phyllanthaceae. It thrives well throughout tropical India and is cultivated in the regions extending from the foothills of Himalayas to Sri Lanka and from Malaysia to China. The important varieties of Amla are Banarsi, Chakiya, Francis and Amrit. Amla is a good dietary source of vitamin C, minerals and amino acids. Vitamin C is found to be highly stable due to the presence of tannins and polyphenols. The fruit can be used as major constituents in ayurveda preparations. Amla is widely used for treatment of diarrhea, inflammatory disease, jaundice and act as glucose lowering agent in Type II diabetes (Anbuselvi and Manas, 2015).

Global Scenario

Amla is cultivated in many parts of the world. Indonesia was the top producer of amla in 2017 with production of 18,300,000 metric tons. Philippines was the second largest producer with production of 15,354,334 metric tons. India, Philippines and Indonesia contributed around 70 percent production in world (Anon., 2017).

Indian Scenario

India was the third largest producer in the world with production of 11,930,000 metric tons in 2017. Utter Pradesh was the largest producer in India having 3490 hectare of cultivating area and 3,80,700 metric tons of production. Average productivity was 5 metric tons (Anon. 2017).

Processing

Amla is the semi perishable fruit and provides astringent taste. Therefore, it is going to processing for attract the consumer. There are number of value-added products will be produced from amla like jam, jelly, juice, sauce, candy, pickles etc., after processing amla got high market value (Puranik *et al.*, 2012).

Financial Feasibility

Financial feasibility of amla juice processing plant located at Maharashtra was assess by using the Internal Rate of Return (IRR) and Break-Even Point

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(BEP). The initial investment of the business was 83,94,000 rupees. The capacity of the plant is 30,000 litres of juice per year. The total turnover of this industry was 90,00,000 rupees. The Internal Rate of Return was 30.3 % and the Break-Even Point (BEP) quantity is 12,000 litres of juice per year. According to this data, the amla juice processing industry is financially viable (Anon., 2014).

Review of Literature

Puranik *et al.* (2012) accessed the awareness of the farmers about amla processing and value addition. Amla is a rich source of ascorbic acid, antioxidant, polyphenol and many other bioactive compounds but due to its high acidity and astringency, it is not palatable for direct consumption particularly among children. Hence, amla juice, sauce, candy, pickle, jam that is also having a good source of bioactive components can use to reduce its acidity as well as increase its acceptance in senesce of consumers.

Dastagiri *et al.* (2014) studied marketing efficiency and marketing channels of amla in Jaipur and Ganganagar districts of Rajasthan. The information collected from 120 farmers, 30 wholesalers/traders/contractors and 30 retailers. The marketing channel-I was most famous as about 71 percent amla sold through it. In channel-II farmers directly brought produce in the mandi and sold it through commission agents either in local or distant markets in same or in other states. In channel-III producers sell the produce after grading and processing. The produce was either processed by farmers himself at his processing plant or on payment basis at grading plants situated around Ganganagar city.

Shah (2017) studied medicinal value of amla fruits, which astringents are beneficial in treating gastritis problems, constipation, anaemia, diabetes, asthma, weakness and fatigue. *Emblica officinalis* is also having hepatic protective, cardio protective, diuretic, laxative, stomachic, antipyretic and anti-inflammatory properties.

SWOT Analysis of Cultivation

The strength amla is making a strong relationship with rural community and it can be cultivated in mixed farming system. There is no availability of processing industries in production area and poor technological information is the major weakness in amla production. Development of new varieties and rapid acceptance of amla by health-conscious people will be good opportunities in amla production. The major threat is poor government policy regarding import and export of amla and pest affects the quality and production of fruit.

Conclusion

India is the third largest amla producer in the world. Consumers prefer healthy fruits and thus amla has better scope in future. Amla marketing is mainly in the hand of intermediary like traders, wholesalers, retailers, brokers and processors. Price spread is high in marketing of amla and so there is a need to increase producer share in consumer prices. High cost of farm inputs and lack of awareness of high yielding varieties are few constraints in Amla produ-

ction. The marketing efficiency was low, in order to regulate the expenditure on commission, transportation and packing, efforts should be developing the necessary infrastructure for the marketing of amla. Government and other organizations should facilitate trading of the produce and acquisition of farm input for use during production.

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Use of Solar Energy in Agriculture

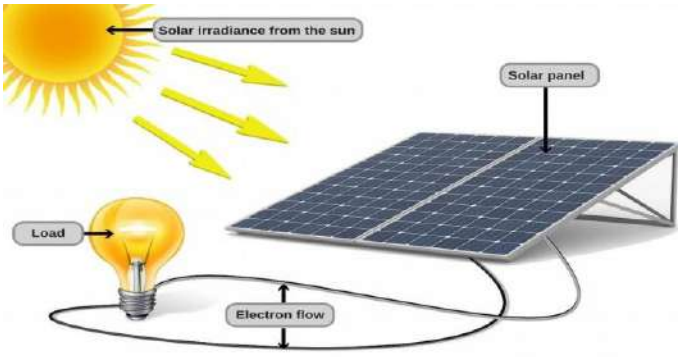
Shivam Kumar, Umara Rahmani and Pallavi Singh

Introduction

Solar energy is a very important source of renewable energy that is available in abundance as compared to any other resource of energy. The demand of energy in the agriculture sector has increased significantly to meet the needs of a growing population and an increasing demand for food. This demand along with the need for powering agricultural equipment like pumps, generators, motors, tillers, etc. Therefore, an alternative energy source that can decrease the dependency on fossil fuels and conventional energy. Many countries like USA, Australia, China and India have already started to promote the use of renewable energy sources for different applications in agriculture. Thus e use of solar energy can be a revolutionary advancement for the agricultural sector, by adding value in many ways like saving precious water resources, reducing dependency on the grid, saving power costs in the long run and even becoming an additional revenue stream.

Solar energy

Solar energy refers to capturing the solar radiation from Sun and subsequently converting it into thermal or electrical energy by using various available technologies like photovoltaic panels, solar heater etc.



Advantages of Solar Energy

- ✓ Solar energy is an inexhaustible source of energy and the best replacement to other non-renewable energies in India.
- ✓ Clean source of energy: It is a non-polluting source of energy and environment friendly. When in use, it does not release CO_2 and other gases which pollute the air. Hence it is very suitable for India, India being one of the most polluted countries of the world.
- ✓ Solar energy can be used for variety of purposes like as heating, drying, cooking or electricity, which is suitable for the rural areas in India.
- ✓ You don't need a power or gas grid to get solar energy. A solar energy system can be installed

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anywhere. Solar panels can be easily placed in houses. Hence, it is quite inexpensive compared to other sources of energy.

- ✓ No fuel required: Solar energy is itself the fuel, once installed, solar energy becomes a cheap source of sustainable energy in the long run.

Some of the technology that can revolutionize the energy sector are:

1. **Solar PV Technology:** Solar Photovoltaic (PV) cells convert solar light directly to electricity. The setup is directly installed on land or on top of homes where there is direct exposure to the sun and is used to power lighting and other electrical appliances we use on a daily basis.

2. **Solar Thermal Technology:** In this case, solar energy is used as a heat source for heating purposes for direct use and to generate steam for generating electricity through turbines. This is then supplied to residential buildings to be used directly.

3. **Floating Solar Technology:** This type of solar energy generation is similar to Solar PV but instead of land, the panels will be set up on floats resting on a water body. This is very helpful where the population density is high and the land area available is limited.

Need of solar energy

Energy security

- ✓ India energy demands is largely fulfilled by non-renewable source of energy.
- ✓ The scarcity of these fossil resources stresses the need for renewable energy sources.
- ✓ Abundance of solar energy can fulfill India clean energy demands.
- ✓ India is dependent on imports to fulfill its energy demands, thereby incurring huge expenditure and uncertainty with regards to energy security.

Economic development

- ✓ India being a developing economy needs proper electricity for industrial growth and agriculture.
- ✓ India also needs self sufficiency and minimal cost in power generation, assured regular supply, which will boost industries and economy.

Social development

- ✓ The problem of power cuts and unavailability of electricity especially in rural area, leads to impro-

per human development.

- ✓ Mostly energy demands are fulfilled by subsidised kerosene, leading to loss for exchequer.

Environment concern

- ✓ India's large part of energy demand is fulfilled by thermal energy largely dependent on fossil fuels. It also causes environment pollution
- ✓ Solar energy is clean form of energy resource, which can be a substitute.

Applications of solar energy in agriculture

1. Solar Energy-Powered Water Pumps

In many places where electric supply might be limited or not available, solar water pumps are lifesavers. Solar pumps use solar energy and pump water from reservoirs, and canals to the farms which would save hours of time for farmers. Here solar panels are employed to harness the solar energy and using inverters, DC power is supplied to the power grid or stored in batteries. This power will be used efficiently to run the pumps to supply water.

2. Water and Space Heating

Livestock and dairy technology have specific space and water heating requirements around the year at different seasons. Since, in most cases, cattle farming is done in closed structures, the temperature and air quality are vital for operations. By employing a solar-powered heating system, farmers can easily save costs incurred on electricity bills. These systems use solar panels that effectively power the temperature control systems as required.

3. Crop and Grain Drying

Using sunlight to dry crops and grains is one of the oldest applications of solar energy used by farmers. While this is a completely free, viable method that can easily be employed, it has a risk of exposing the crops to the wind, rodents, impurities, etc. contaminating them. With advancements in technology today, there are solar dryers that can help in harnessing maximum solar energy and concentrating it in a closed container where trays are used to dry the produce. These systems will also help in accelerating the process and reducing the time required.

4. Green House Heating

Greenhouse heating is essential for the proper growth of certain crops and plants. Commercial greenhouses use sunlight for lighting and not for heating. Mostly, they depend on oil and gases for maintaining the required temperatures. Solar green

housing heating systems are used to feature both the lighting and heating that is required. A solar greenhouse has a solar panel to collect the energy and batteries to store the energy. It also has insulation that will help in retaining heat during cold days and nights.

5. Remote Supply of Electricity

Farms might be located in remote areas where the electricity supply is limited and farmers may constantly face issues related to power outages and shortages for running their equipment, and tools on the farms. Solar PV systems are employed in the farms to produce the required electricity that is stored in the batteries and used when required. This not only helps in reducing the power consumption from the electricity supply but also saves money for farmers in the long run.

6. Solar-powered cooling systems

In many cases, farmers face huge losses due to the lack of availability of proper refrigeration and cooling systems in their farms. Even if they have a refrigeration system, it becomes very difficult to power them all day with constant power cuts and outages. Solar-powered cooling systems will help in tackling this problem. The refrigeration systems used will have a continuous supply of power from the batteries hooked to the solar panels where the power is supplied directly in the morning and the backup power stored is supplied during the night.

Benefits of using solar power in the agriculture sector

- ✓ Saves costs incurred in power and electricity in the long run.
- ✓ Continuous supply of uninterrupted power in many cases.
- ✓ Use of renewable energy sources.
- ✓ Availability of power systems locally, even in remote locations.
- ✓ Easy management of power usage

Challenges in adoption

Some of the most notable Solar Energy Challenges in India include:

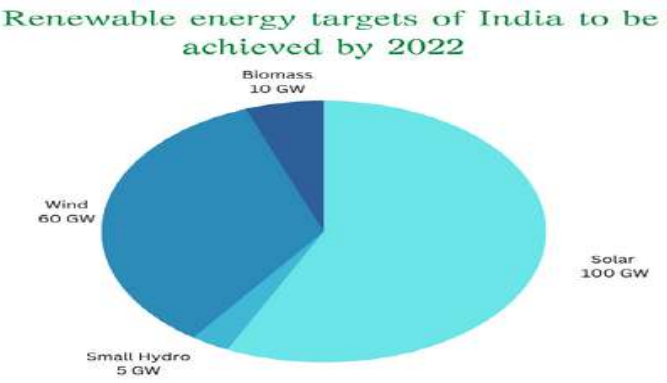
1. **Lack of Domestic Manufacturing of Solar Parts:** The domestic manufacturing industry of solar PV cells and modules is severely lacking in India due to the lack of infrastructure, skilled workforce and high cost of production.

This inevitably leads to increase in imports from countries like China, Germany, etc.

2. **Heavily Dependent on Imports:** India's solar energy is largely built over imported products. India doesn't have enough module and PV cell manufacturing capacity. The current solar module manufacturing capacity is limited to 15 GW per year, whereas the domestic production is around 3.5 GW only. Further, out of the 15 GW of module manufacturing capacity, only 3-4 GW of modules are technologically competitive and worthy of deployment in grid-based projects. Indian domestic manufacturers aren't technically and economically strong to compete with Chinese companies. China's strong manufacturing base is giving stiff challenge to domestic manufacturer.
3. **Raw Material Supply:** The silicon wafer, the most expensive raw material, is not manufactured in India. It currently imports 100% silicon wafers and around 80% cells. Further, other key raw materials, such as silver and aluminum metal pastes for making electrical contacts, are also almost 100% imported.
4. **Space Scarcity:** Another part of the major Solar Energy Challenges in India is the scarcity of land due to high population density to install large-scale ground-mount solar systems, solving which scope for greater R&D and innovation could be increased tenfold in terms of installation.
5. Lack of awareness amongst the general public is one of the key challenges slowing down the adoption of solar energy.

Present Status of Renewable Energy in India

- ✓ Government of India (GOI) has set an ambitious target to achieve a capacity of 175 GW worth of renewable energy by the end of 2022, which expands to 500 GW by 2030. This is the world's largest expansion plan in renewable energy.



- ✓ India is also targeting to reduce India's total projected carbon emission by 1 billion tonnes by 2030, reduce the carbon intensity of the nation's economy by less than 45% by the end of the decade, achieve net-zero carbon emissions by 2070.
- ✓ India was the second largest market in Asia for new solar PV capacity and third globally (13 GW of additions in 2021). It ranked fourth for total installations (60.4 GW), overtaking Germany (59.2 GW) for the first time.
- ✓ The total installed capacity for renewable energy in India is 151.4 GW. The following is the breakup of total installed capacity for renewables: Wind power (40.08 GW), Solar Power (50 GW), Biopower (10.61 GW), Small Hydro Power (4.83 GW) and Large Hydro Power (46.51 GW).

- ✓ Present Solar Power capacity: 45 solar parks with an aggregate capacity of 37 GW have been approved in India. Solar Parks in Pavagada (2 GW), Kurnool (1 GW) and Bhadla-II (648 MW) are included in the top 5 operational solar parks of 7 GW capacity in the country. The world's largest renewable energy park of 30 GW capacity solar-wind hybrid project is under installation in Gujarat.
- ✓ Recently, India achieved the 5th global position in solar power deployment by surpassing Italy. Solar power capacity has increased by more than 11 times in the last five years from 2.6 GW in March 2014 to 30 GW in July 2019. Presently, solar tariff in India is very competitive and has achieved grid parity.
- ✓ According to the Indian Renewable Energy Development Agency Limited (IREDA), India is endowed with abundant solar energy, which is capable of producing 5,000 trillion kilowatts of clean energy. India gets 300 sunny days a year in most parts of the country and solar insolation of 4-7 kWh per Sq. m per day.
- ✓ Today India is one of the biggest importers of energy in the world and about 85% of the total energy and fuels needed are imported from several other countries leading to a high expenditure on energy resources amongst all other expenses.
- ✓ Various schemes to encourage the generation of solar power have been launched in the country like Solar Park Scheme, VGF Schemes, CPSU Scheme, Defence Scheme, Canal bank & Canal top Scheme, Bundling Scheme, Grid Connected Solar Rooftop Scheme, PM- KUSUM, OSOWOG (One Sun One World One Grid) etc.

Way Forward

- ✓ Promote hybridization of solar and wind energy: The synergy in hybrid wind and solar plants will help reduce variability in power generation.
- ✓ Build enhanced evacuation infrastructure: We need greater investment in high-voltage transmission lines to transport bulk energy over vast distances quickly and efficiently from power-rich to power-scarce states.
- ✓ Develop battery storage solutions: Grid operators can store electricity generated from renewable projects in large battery systems in low-demand situations, and then promptly release that electricity into the grid when demand increases.
- ✓ Turnaround the distribution companies: Nearly a quarter of electricity generated is lost in transmission because India's distribution companies (known as DISCOMs) use outdated infrastructure, resulting in line faults and leakages, as well as undersized and over-utilized transformers. Immediate reforms are needed to revitalize the DISCOMs – privatization and greater autonomy may be the answer. There is a dire need to invest in upgraded infrastructure and formulate an action plan to enhance revenue collection.

Farm Mechanisation: Policies, Challenges and Strategies

Dr. M. Ravikishore, Dr. P. Supriya and Sri. K. Rama Subbaiah

Introduction

Over few past decades, agriculture has evolved into a highly diverse and complex sector globally, with operational units ranging from small and sustenance-based farm holdings to large corporate farm holdings. The agriculture sector in India has witnessed a considerable decline in the use of animal and human power in agriculture related activities. The trend has paved a way for a range of agricultural tools. A large number of these are driven by fossil fuel operated vehicles such as tractors, diesel engines. This has resulted in a shift from the traditional agriculture process to a more mechanized process. Agricultural mechanization is crucial in agriculture sector as it contributes towards improving the efficiency and effectivity of the inputs used in the crop production thereby also increasing the productivity of crops. This also reduces drudgery associated with various farm operations.

In India, though, there has been a considerable progress of mechanization in agriculture; its spread has, however, been most uneven. Some of the initial problems in farm mechanization had been the small and scattered size of farm holdings, financially challenged farmers, lack of awareness among the marginal farmers, and the issue of dry land agriculture. Majority of these problems have been addressed in our country with sustained focus on farm mechanization by the successive governments by way of extending financial aid by providing subsidy to the farmers in procuring farm implements suitable to their needs. The problems like small holdings and rain fed agriculture still remain, but there is a general air of concern regarding the further progress in this sector. What is really amiss is that we are still very much behind in respect of overall farm mechanization which calls for employment of contemporary highly mechanized farm machinery. Government of India (GoI) is committed to induce policy reforms in the agriculture sector to strengthen farm mechanisation sector in India. Given the labour scarcity and the launch of several Government programs, the adoption of farm mechanization is set to increase across the country in a more sustainable way for doubling the farm income.

Policies and Schemes to accelerate the growth of farm mechanisation in India

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Multiple initiatives have been taken by Government of India (GoI) to improve farm mechanisation in the country. Such initiatives comprise fiscal as well as nonfiscal support structures which provide several incentives and support at different stages of agricultural production to encourage farm mechanisation. GoI has launched various farm mechanisation programmes and schemes across the country, covering various aspects of incentives. Some of these important schemes are explained below. Department of Agriculture & Cooperation has integrated the components of agricultural mechanization under various schemes and programmes aiming at catalysing an accelerated but inclusive growth of agricultural mechanization in India. The following specific interventions with a special emphasis on 'reaching the unreached' will bring small and marginal farmers' at the core.

1. National Food Security Mission (NFSM)

- ✓ Under this programme, assistance (up to 50% the cost of machinery) to be provided for machinery such as pump sets, tractor mounted sprayers, seed drills, zero till seed drills to varying degrees.
- ✓ Funding/financing pattern of this scheme is 60% assistance from the Centre and 40% from the state

2. Rashtriya Krishi Vikas Yojana (RKVY)

- ✓ Farm mechanisation comes under production growth stream of RKVY with 35% of the outlay.
- ✓ Under this scheme, assistance for large equipment (tractors, combine harvesters, sugarcane harvesters, cotton pickers, etc.) is available for establishing custom hiring centres (CHCs)
- ✓ Funding/financing pattern of this scheme is 60% assistance from the Centre and 40% from the state

3. Mission for Integrated Development of Horticulture (MIDH)

- ✓ One of the key interventions under the scheme is 'horticulture mechanisation'.
- ✓ Assistance is provided for procurement of power-operated machines and tools, besides for import of new machines.
- ✓ Assistance is also available for grower associations, farmer groups, SHGs, women farmer groups (with more than 10 members), etc., that are engaged in cultivation of horticulture crops.
- ✓ Funding/financing pattern of this scheme is 60% assistance from the Centre and 40% from the state

4. Sub- Mission on Agricultural Mechanization (SMAM)

A flagship mission to strengthen the farm mechanisation sector in India. SMAM, a centrally-sponsored scheme for promotion of farm mechanisation was launched by the Ministry of Agriculture and Farmers' Welfare in 2014-15, to be implemented through state departments of agriculture, farm machinery testing and training institutes (FMT&TIs), selected agricultural universities and Indian Council of Agricultural Rese-

arch (ICAR) institutes for a duration of five years.

The key aspects of the SMAM scheme are:

- ✓ Training, testing and demonstrations of farm machinery and equipment
- ✓ Establishment of custom hiring centres
- ✓ Disbursement of subsidy through state departments of agriculture for purchase and distribution of farm implements
- ✓ Promotion of post-harvest technology for promoting primary processing.

Key objectives of SMAM

- ✓ Increasing the reach of farm mechanisation to small and marginal farmers and to the regions where availability of farm power is low.
- ✓ Promoting CHCs to offset the adverse economies of scale arising due to small landholding and high cost of individual ownership.
- ✓ Creating hubs for hi-tech and high-value farm equipment
- ✓ Creating awareness among stakeholders through demonstration and capacity building activities.
- ✓ Ensuring performance testing and certification at designated testing centres located all over the country.

5. Central Sector Scheme on Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue

The Ministry of Farmers Welfare, Government of India, has initiated the implementation of the approved the Agricultural Mechanization Promotion Scheme with the primary objective of reducing air pollution caused by stubble burning. One of the primary reasons behind this is said to be the burning of crop residue by farmers. Due to this, numerous other cities and villages are suffering the evil pangs of pollution and contamination of the air. Thus, in order to nullify this and control pollution, the Central Government of India is launching Agricultural Mechanization Promotion Scheme 2018-2019. The Government of India is taking all the necessary measures towards enhancing the Agricultural Mechanization Promotion Scheme, also known as Crop Residue Management.

On the context of Agricultural Mechanization Promotion Scheme, the Central Government of India provides some financial support to the Concerned State Government along with the Krishi Vigyan Kendras (KVKs). Such Kendras include an agricultural extension centre in India, ICAR Institutes, Central Government Institutes and Public Sector Undertakings. Besides this, the Government of India is hoping to continue this awareness by organising many campaigns through films, documentaries, radio and TV programmes, advertisement in print media, Camps, etc. for achieving Zero Stubble Burning.

6. FARMS Mobile App

This Multi-language Mobile App platform 'FARMS- Farm Machinery Solutions' will facilitate local farmers and citizens of the different States across the country with the Custom hiring services of

Farm Machinery Banks, Custom Hiring Centers and Hi-tech Hubs established under the various Schemes of DAC&FW, MoA&FW without any computer support system. This app will help the individual farmers, willing to provide their agricultural machinery & equipments on rental basis to increase their farm income besides making the optimum utilization of the available Agricultural machineries available in CHCs/FMBs/Hi-tech Machinery Hubs. This app will provide a platform for sell and purchase of old agriculture machinery to farmers also.

Constraints and Key challenges in Farm Mechanisation

India's position in terms of agricultural production and farm mechanisation presents a contradictory picture. While India is a leading producer of agricultural products globally, the level of farm mechanisation in the country is lower than the global average. However, there exists ample prospects for the sector despite the current challenges it faces. Indian agriculture is desperately looking for ways to enhance farm productivity. However, there are some inherent challenges for the adoption of farm mechanization. The constraints of the sector can be categorised into operational, financial, capacity-building and policy-related constraints (Industry Reports, 2019).

1. Operational constraints

Operational constraints comprise fragmented landholdings, diverse soil conditions and cropping pattern, supply-demand mismatch, dismal FPA in many states, tractorisation, quality and serviceability constraints, inefficiencies in farm equipment testing, etc.

1.1. Fragmented landholdings affecting economies of scale

The average landholding size in India (2 ha) is smaller in comparison to many other countries. 33% of all agricultural households in India own less than 0.4 ha of land, leaving minimal scope for mechanisation and resulting in low yields. It is not commercially feasible for famers owning small and discontinuous fields to possess farm machinery individually as doing so would not be cost-efficient.

1.2. Diverse soil conditions and cropping pattern

India is also home to 46 of the world's 60 soil types. Due to diversity in agri-climatic conditions and differing soil types, various cropping systems have evolved across the country over a period of time. Accommodating these variable conditions and ensuring optimal utilisation of precision farm equipment would require geographical and crop-based customisation.

1.3. Supply demand mismatch

It has been observed that despite high concentration of tractors and farm equipment in a specific geography or zone, poor mechanisation levels continue to exist due to high supply and demand mismatch. Due to disaggregated demand for agricultural implements and minimal synapse of same with supply points i.e., implements owners, utilisation of the equipment remains low.

1.4. Tractorisation, not mechanisation

Tractors dominate the farm equipment market

in India. The rest of the farm equipment (sowers, tillers, harvesters, etc.) contributes 15-20% of the market share, mainly due to absence of knowledge about the benefits of using additional equipment and practices in terms of productivity and yield, operative challenges, etc.

1.5. Quality and serviceability constraints associated with unorganised manufacturers

Several local and unorganised farm equipment manufacturers develop farm equipment without considering the quality and design required for the finished product and thus offers them at very competitive prices to the farmers in comparison with the same offered by the organised manufacturers. However, low-costing equipment leave much to be desired in terms of quality, break down more often, have higher operating expenses and result in lower yields.

1.6. Inefficiencies in farm equipment testing

Under SMAM, four FMT&TIs located in Madhya Pradesh, Haryana, Andhra Pradesh and Assam conduct tests of farm equipment. Apart from these four institutes, testing is also conducted at selected state agricultural universities (SAUs) and ICAR institutions. Despite the availability of such facilities, the overall number of centres which can accord certifications for farm equipment is low, which poses logistical challenges for farm machinery manufacturers.

2. Financial constraints

Financial constraints constitute of poor access to finance, high cost of precision equipment and a subsidy-boosted market with low demand drive.

2.1. Poor access to finance

Sale of tractors through financial schemes accounts for around 90% of the overall tractor sales in the country and these financing schemes depend on the applicant farmer's profile for determining eligibility. In this scenario, the uneven income levels for majority of the small farmers becomes a hindrance in gaining support as for short- and medium-term loans in rural areas, the interest rates can reach up to 40% per annum. In addition to high interest rates, especially on term loans, requirement of collateral in availing credit for CHS entrepreneurs and procedural difficulties involved in credit availing processes are other key impediments.

2.2. High cost of precision equipment

More sophisticated farm equipment such as potato combines, combine harvesters, paddy transplanters, sugarcane harvesters, laser-guided land levellers are highly priced and require financial investments. Most small and marginal farmers are unable to afford such high investments.

2.3. Subsidy-boosted market with low demand drive

In India, farm mechanisation requires heavy investments and the central and state governments have launched various schemes to share the financial burden of farmers through subsidies. As per the current trends and practices, the subsidies for farm mechanisation are dependent on the central and state governments' budget allocation. However, the same

should be altered from time-to-time to suit the farmers' needs (NABARD, 2018).

2.4. Lack of institutional credit mechanism to support and sustain CHCs

Project financing has been a key impediment in the farm mechanisation sector, leading to poor offtake of farm machines as well as CHS projects in country. Back-ended subsidy mechanisms increase the initial capital requirement and hinder large scale investment. This further gets worsened, as small and marginal farmers are less capable of furnishing secondary collateral for hypothecation to banks.

3. Policy-related constraints

Policy-related constraints include poor implementation of government support programmes and inefficiencies associated with Direct Benefit Transfer (DBT) and subsidy disbursal.

4. Capacity-building constraints

Capacity-building constraints comprise of insufficient trainings and awareness related issues, lack of skilled manpower in usage of high-cost farm machinery, etc.

4.1. Insufficient training and lack of awareness

The training programmes and other events conducted to increase awareness on farm mechanisation are inadequate. Awareness on incentive support under CHS, along with adequate know-how of schemes, business models and applications processes has been missing amongst farmers.

4.2. Lack of skilled manpower in usage of high-value farm equipment

There has been lack of in-house knowledge in the areas of operation, maintenance and repair of high-value equipment across key states in the country, which increases dependency on trained manpower resources from select states (mostly Punjab and Haryana).

Strategic interventions to promote Farm Mechanisation in India

1. Efficient scheme implementation and delivery mechanism

Effective and efficient implementation of government mechanisation schemes, especially SMAM will be pivotal for the successful dissemination of mechanisation technologies. Following are the sub-strategies identified under this category.

1.1. Ensure an enabling and rationalised subsidy support mechanism

- ✓ Providing frontend support to farmers on mechanisation rather than relying on back-ended subsidy support.
- ✓ An institutional mechanism to fix rational prices of equipment every year per state would be very useful.
- ✓ The hiring charges of farm implements at the CHC need to be decided by the market.
- ✓ The government may consider providing subsidy on the implements with a shelf life of three years, on repeated basis.

1.2. Ensuring proper dissemination of technology at the grass-roots level

- ✓ Relevant authorities should try to organise a

farm mechanisation exhibition cum sales fair at the block level at least twice a year.

- ✓ Organising a state level mechanisation fair cum exhibition at least once a year would facilitate effective dissemination of best mechanisation technologies suited to a specific region in a state.
- ✓ There is a need to establish FM demonstration cum skilling centres at each Krishi Vigyan Kendra (KVK)/DAO office.

1.3. Enhanced and faster implementation of government support

- ✓ There is need to enable time bound and deemed approval mechanism to improve overall operational efficiency in subsidy disbursal.
- ✓ There should not be any carry-over of subsidy disbursal. Subsidy to be disbursed should be released during the same financial year.
- ✓ Reduction in lead time from application to physical verification of implements to release of subsidy through improved traceability mechanisms.

1.4. Rationalisation of GST for improved offtake of farm equipment

GST rates applicable on tractors and their components vary from 12% to 28%. Most tractor spare parts come under the 28% GST slab, resulting in an overall increase in tractor costs and other farm equipment. Further, farm equipment requires several spare parts such as rubber, blades and gear box, and all come under different GST rates. This creates a practical and logistical burden on the distributors of spare parts and implements due to the varying GST rates and in many cases, requirement for separate invoicing. A uniform GST rate of 12% on tractors their spare parts would be ideal for promotion and further usage of mechanisation.

2. Forging PPP models

As per the Comprehensive Policy Recommendations of the Report of the Committee on Doubling Farmers' Income (September, 2018), agriculture machineries can be a part of Farming-as-a-Service (FaaS) so that farmers could gain ease in accessibility to mechanisation and associated services for hire in comparison to possessing the same. Hence, there is a need to establish CHCs at the required rate of minimum one CHC per village (when large) and one per gram panchayat or per primary agricultural credit society (PACS), covering a group of small villages. Hence, there is a requirement to promote and encourage sustainable CHCs and agricultural machinery banks via PPP models.

3. Ensuring future-ready farm mechanisation

Promotion of crop- and state-specific mechanisation priority plan, introduction of specialised equipment for small and marginal farmers through in-house manufacturing, promotion of shared utility or IT-enabled aggregation platforms, research and development (R&D) focus on scale- and gender-neutral machineries, and climate smart mechanisation are the key strategies proposed here-

with to make the Indian FM sector future ready globally competitive.

3.1. Promotion of crop-specific and state-specific mechanisation priority plan (C&S-MPP) and related strategies

Looking at the current status of Farm Power Availability (FPA) across the country, it is evident that mechanisation status and needs vary across states and there is need to promote and devise strategies customised upon crop- and state-specific needs. For example, considering significant cropping acreages in India under paddy, end-to-end paddy-based mechanisation in key paddy growing states must be promoted.

3.2. Promotion of specialised equipment for small and marginal farmers through in-house manufacturing

Tractor usage in India has increased from 6 per thousand hectares to 33 per thousand hectares in last few decades. But such increase has not been witnessed in usage of other segments of farm equipment. Looking at India's impressive rise in the World Bank's Ease of Doing Business (EODB) 2020 rankings and GoI's Make in India initiative, domestic manufacturing of specialised farm implements currently being imported could be promoted here.

3.3. Promotion of shared utility or IT-enabled aggregation platform

Stakeholders such as individual machinery owners, Custom Hiring Centers (CHCs), Agriculture Machinery Banks (AMBs) and regional/state service centres can be brought together on a common platform and their collective efforts could be used to fulfil real-time demands in a cost-effective manner.

3.4. Improved R&D focus on scale- and gender-neutral machinery

As small and marginal landholdings in India are more prevalent, R&D should aim at developing and designing scale- and gender-neutral machinery. Further, machinery suitable for varying terrains must also be prioritised and developed.

3.5. Promotion of climate-smart mechanisation

In the country's Indo-Gangetic Plain (IGP), where rice and wheat is predominantly grown, burning paddy straw is commonly practised in order to reach the timeline of sowing wheat. This is not only harmful to the environment but also results in loss of paddy straw's nutrient value. Hence, agricultural mechanisation plans should also take into consideration the development of farm waste management equipment and make residue management a productive operation.

4. Farm Machinery (FM) skill upgrade through promotion of skill development centres (SDCs)

Lesser availability of skilled hands as technical service providers is the key constraint in promoting CHCs in India. There has been minimum impetus on capacity building and skill enhancement of service providers and operators of precision farm equipment like combine harvesters and laser levellers.

Conclusion

The programs and schemes of GOI on farm mechanization have resulted in progressive increase in the availability of farm power per unit area for performing various agricultural operations. There has been significant increase in adoption of agriculture machines over a period of time which has found expression in the phenomenal expansion of cropped area, cropping intensity and the country's agricultural production. The strategies outlined in this article have been devised so that they address the needs of the farm mechanisation industry as well as those of other stakeholders (farmers, farmer groups/FPOs, government organisations, academicians and researchers) engaged directly or indirectly with the agriculture value chain of the country. Business friendly policies, rules and regulations, physical and institutional infrastructures development to boost commercial activities and entrepreneurship development in agriculture, agricultural input supply, output handling, processing, popularizing and marketing are important factors for the success of farm mechanization in several states of India. Financial assistance or procurement subsidy may be provided for the purchase of agriculture machinery and equipment on individual ownership or custom hiring basis.

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Nanotechnology in Seed Sector

Sudhanshu Singh, Riya Jakhwal, Shashank Tomar, Harshit Tomar and Rupesh Kumar

Introduction

"Nano" means one-billionth, thus nanotechnology deals with materials measured in a billionth of a meter. Nanotechnology has the potential to advance agricultural productivity through genetic improvement of plants, delivery of genes and drug molecules to specific sites at cellular levels, and nano-array based gene-technologies for gene expressions in plants and animals under stress conditions. With the discovery of effective methods and sensors for precision agriculture, resource management, early disease and contaminant detection in food products, smart delivery systems for agrochemicals like fertilizers and pesticides, smart systems integration for food processing, packaging, and other areas like monitoring agricultural and food system security, the potential is growing. Long-term economic growth in this industry is predicted to be primarily driven by further advancements in nanotechnology, which will also benefit consumers, producers, farmers, ecosystems, and society at large.

Why We Need Nano?

Nano-particles (NPs) have superior properties than the bulk substances:

- ✓ NPs can be arranged into layers on surfaces, providing a large surface area result in enhanced activity.
- ✓ Can alter the strength or electrical characteristics of materials, making them more chemically reactive.
- ✓ At nano-scale the physical, chemical, and biological properties of materials differ from properties of its molecules or bulk matter.
- ✓ NPs have increased permeability through biological barriers (membranes).
- ✓ NPs have antimicrobial property- react uniquely to the targeted species.
- ✓ Attach to the membrane by electrostatic interaction and disrupt the membrane integrity.
- ✓ Ultra-Hard: reduced probability of defects.

Applications

Detecting contamination in seed field: In wind pollinated crops, producing seeds is a laborious process. Genetic purity can be assured with certainty by identifying pollen loads that will lead to contamination. Air temperature, humidity, wind speed, and crop pollen production all influence poll-

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en flight. Utilizing bio-nanosensors tailored to contaminated pollen can assist detectpotential contamination and then limit it. The pollen from genetically modified crops can also be avoided from contaminating field crops using the same technique. Provision of Nano - sensors specific to a seed crop pollen helps to alert the seed farmer - activation of light / sound - Michigan State University, USA.

Advantages

1. Fixing up the isolation distance
2. Quantify the contaminants

Nanotechnology in seed health management

Nano-coating using elemental forms of Zn, Mn, Au, Ag etc., protect seed from pathogens. Seeds coated with nano particles encapsulated with specific bio-agents will reduce seed rate, ensure optimum field stand and improved crop performance by managing the seed and soil borne pathogens. Nano core shell biosensors with protein-ligand (antigen) and protein-nanoparticles can be employed for detection of pathogens associated with seeds. Nano biosensors can also be integrated into seed packages for detection of insect activity by sensing the metabolites released by insects at early stage. Nano cores loaded with insecticides can be treated with seeds for effective management of infestation. These nano cores can also be upgraded to programmed products known as “gut busters” which release insecticides only in alkaline environments like insect stomach.

Nano smart seeds

Existing commercial technologies allows coating of seeds with fertilizers, pesticides, herbicides, growth hormones etc. along with some inert material as a carrier with limitations of runoff, leaching, narrow stability against degradation and uncontrolled release. In smart delivery system many nanoscale carriers like zeolite, magnesium sulphate, calcium carbonate and mesoporous silica core shells may be used to store, protect, deliver and control release of intended payloads in crop production processes. Nano lignocellulosic materials like organic polymers, dendrimers, polystyrene etc. in pure forms or in the biocomposite forms can be used for encapsulating the nanocarriers in controlled release formulation delivery systems. One of the advantages of nanoscale-controlled release formulation delivery vehicles in seed applications is improved stability of payloads, thereby increasing its effectiveness.

Nano seed biotechnology

With the use of nanoparticles, nanofibres, and nanocapsules, nanotechnology provides a new set of instruments for manipulating and delivering genes. When nanomaterials are properly functionalized, they can act as carriers for many genes as well as chemicals that can activate gene expression or regulate the spread of genetic material throughout plants. Such targeted gene delivery to seeds may be exploited for transient gene expression for only one generation at the site of interest. Nanotechnologists believe they can advance genetic engineering all the way to the atomic level. Atomic engineering could make it possible to rearrange the

DNA of seeds to produce various plant phenotypes, such as colour, growth season, and yield. In Thailand, Chaing Mai University has developed white grain rice variety from a traditional purple grained variety through nanotechnology-based mutation process, where a nano sized hole was drilled in embryos and it is bombarded with N_2^+ ions which stimulate rearrangement of genome and resulted in change in phenotype of rice variety. The GM seeds can be separated by the conventional seeds by the help of tagging the event involved in the GMO by radio nano-frequency tags which in turn detected by a specially modified processing unit by sensors which alerts about presence of GMO and allows its removal from seed lots.

Nanotechnology in seed packaging and handling

Ligno-cellulosic nanomaterials has opened up new area for novel and value-added nano biomaterials and products for example, cellulosic nano crystals can be used as light weight reinforcement in polymeric matrix as nano-composite, such application can be used for development of light weight, highly durable and cost-effective packaging material for seeds. In future bio and gas sensors could gain importance, when these sensors are integrated with packaging materials, they can monitor the changes in microenvironment.

Nano barcode technology

Nowadays noval genes are being inserted into seeds and distributed for sale. Nanobarcodes (Nicewarner Pena *et al.,* 2001), which are durable, machine-readable, encodable, and sub-micron sized tags, could be used to track sold seeds.

Nowadays barcode is most widely used in marketing of goods both in national and international markets. Barcodes essentially carry digital signatures in the form of black and white horizontal bar upon which product details can be deciphered using electronic code reader. With advance in nanotechnology, nano-based bar codes are constructed by nanoscale electroplating of metal in desired pattern that can do the same functions of conventional barcodes for tracking and controlling the quality of seed moving in the market. In the era of proprietary rights seed sector can utilize nano barcoding system where novel genes are being incorporated into seeds and sold in the market.

Nano barcodes can also be attached to seed packages for tracing of breeder, foundation and certified seeds with all relevant information like lot number, name of producer, varietal details, parentages, date of seed testing and its complete results etc.

Nano sensors for seed storage

Seeds during storage emit several gases that are determined by their degree of ageing. Electronic nose (E-nose) detects an array of gases; estimate the concentration of the odorant. Such volatile aldehydes can be detected and seeds showing signs of deterioration can be separated and invigorated prior to their use. Scientists now have planned to develop a plastic storage bag lined with nanoparticles.

Nano polymer coating

Coating seeds with moisture sensitive nano polymer membrane that senses the availability of water and allow seeds to imbibe only when time is right for germination *i.e.*, 45-50 % moisture availability (Korishettar *et al*., 2016).

Nanoparticle pesticides

Monsanto, Syngenta and BASF are developing pesticides enclosed in nanocapsules or made up of nanoparticles. The pesticides can be more easily taken up by seeds if they're in nanoparticle form; they can also be programmed to be "timely-release".

Conclusion

Utilizing the special qualities of nanoparticles, nanotechnology is playing a bigger role in the seed industry. Aerial dispersal of seeds embedded with magnetic nano particles, moisture content detection during storage to take appropriate action to reduce damage, use of bioanalytical nanosensors to determine seed ageing, coating seeds with nano membranes that sense the availability of water and allow seeds to imbibe only when the time is right for germination, and nanosensors capable of detecting pathogens at levels as low as parts per billion are some potential thrusts. Researchers are still looking for new uses for nanotechnology in the seed business. In fact, there will be significant improvements to the agricultural and seed industries in the upcoming years.

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Crop Improvement Approaches in Castor

Naresh and Paras

Introduction

Castor belongs to the genus Ricinus, a member of the Euphorbiaceae, which contains a vast number of plants mostly native to the tropics. The genus Ricinus is considered to be monotypic and *R. communis* is the only species, which includes many polymorphic types. The cultivated types are dwarf annuals. Castor is a monoecious plant with raceme type of inflorescence, upper portion of which bear female flowers and lower portion has male flowers (fig. 1).

Fig. 1: Monoecious flower of castor

It is both wind and insect pollinated and 5 to 46 % natural pollination also occurred. The fruit is round glaucous capsules with three projecting sides covered with tough spines or smooth, 3 loculed and three seeded (fig. 2). In castor whole process from planting to processing is done manually. The plants of this crop are long cycled and show uneven seed maturation. Farmers are compelled to use local varieties which are not input responsive. Because of this, farmers have low-income. So there is urgent need to focus on the improvement of this crop using both conventional and modern tools of breeding.

Fig. 2: Spined capsules of castor

The Castor Research Station established at Junagadh of Gujarat state with the objectives to breed and develop high yielding, disease and pest resistant and better quality varieties of different oilseed crops like groundnut, castor, sesame, sunflower, soybean and mustard.

Oil and its Applications

Germplasm lines of this crop have oil content ranges from 37 to 60 per cent while commercially released varieties have 48-50% oil in their seeds. Due to the ricinoleic acid (>80%), castor oil and its derivatives are of great versatility in industrial and pharmaceutical area. The castor seed oil is also unique in the sense that it is alcohol-soluble, highly viscous, and suitable for biodiesel production and an

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eco-friendly source of fuel due to its reduced greenhouse gas emission as compared to other oils, including mineral oils. Discovery of a natural mutant with low ricinoleic acid and high oleic acid came as a boon to biodiesel application castor bean seed oil.

Objectives

Viewing the vast importance of the crop, following objectives have been laid down for its breeding programme:

- ✓ To develop varieties and hybrids of castor crop with high yield potential, early maturity, better quality and disease and pest resistance.
- ✓ Use of biotechnological tools for improving tolerance to salt, drought and heavy metals.
- ✓ Devising breeding tools for improving oil quality.
- ✓ Conventional approaches for decreasing anti nutritional factors making it suitable for oil seed cake.

Methods for Crop Improvement

Flowers of this crop show cross-pollination which results in a great variation in phenotypic expression. Both conventional and biotechnological methods are being used for the betterment of the oil quality. Every method has its own unique way of handling the generation and evaluation of the material. No doubt, conventional methods are time consuming but free from the ethics of being dangerous to environment and health of animals in way one way or other, while transgenic have to be culprit of this. Biotechnological methods and tools are fast and helpful in early evaluation of the desired gene in the material under study. The conventional methods are following:

1. **Mass Selection:** The characters with high heritability in those population having high levels of natural genetic variability are ideal for improvement through mass selection. e.g. AKC-1 (1998) an important castor cultivar selected from B-7 variety.
2. **Individual Plant Selection with Progeny Tests:** It is based on the principle that the breeding value of a plant may be measured by the performance of its progeny. Cultivar 'Guarany' was developed by this method.
3. **Methods Involving Sexual Hybridization:** When there is lack or insufficient genetic variability in the population, and then it becomes to generate variability by crossing cultivars with different genetic background.

The Pedigree Method is adequate for simultaneous selection of several traits. This method has been used to develop the cultivar IAC-2028, a dwarf and not-shattering genotype in Brazil. The Bulk Method is the most effective option when the main objective is to improve the adaptation of castor to stress conditions such as drought, acid soils, high levels of salt and resistance to diseases. The Backcross Method of selection is the most effective when there is a need to improve some simply inherited, qualitative characteristic in a commercial cultivar or promising elite line. The method of backcrossing is especially effective in castor for the improvement of characteristics such as seed shatter-

ing, flower height, and disease resistance. Recurrent Selection is defined as successive cycles of selection and recombination of selected lines or individual plants. It is not often used for castor selection, but it has been successful on the reduction of height of the cultivar Guarani.

India has made significant progress in the development of hybrids. The availability of Pistilate lines, several pistillate lines were developed using VP-1 source of pistillate expression. The first commercial castor hybrid, 'GCH 3', was developed in India and had high seed yield potential (88% superior to the most planted cultivars at that time), drought tolerance, medium maturity time (140-210 days) and high oil content (46%). Since then, a total of 15 hybrids were released in India, some of them with resistance to fusarium wilt and high seed yield potential.

Tissue Culture and Genetic Engineering: Besides the use of the conventional approaches now gates are open for the application of the biotechnological tools. Now these approaches are proven to be promising in the improvement of the various parameters of the crop. Whole genome and transcriptome sequencing efforts in castor have expedited the identification and development of a large number of sequence-based molecular markers, including SSRs and SNPs. Molecular markers have utility in many structural, functional, and comparative genomic studies because of important attributes like codominance, high reproducibility, genome-wide distribution, chromosome-specific, and multi-allelic nature. Simple sequence repeats (SSRs) which are the markers of choice have now been utilized in many marker-based genotyping applications, including varietal identification, DNA fingerprinting, genetic diversity, phylogeny studies, QTL mapping, comparative mapping, and marker-assisted selection (MAS). The development of the Transgenic Plants by the incorporation of the foreign gene in the host crop using genetic engineering has gain importance towards the development of castor varieties which are resistant to the insect pest attacks.

4. Apart from the above there are some strategies or methods which are genome based like Mutation Breeding and Gene Pyramiding which can be used for the reduction or elimination of anti-nutritional factors.

Research Projects & Schemes (On Going)

All India Coordinated Research Project on Castor (AICRP) was initiated in 1993 with ICAR as funding agency. In 1998 Front line demo (FLD) was started under the AICRP. From 2008 a state scheme named, 'Strengthening Research in Castor' is on-going.

Recently released varieties of castor are JC-24 in 2018 (DCS-108 x JC-5, Inbred line), YTP-1 in 2019 (TMV-6 x Salem Local) and GAC-11 in 2019 (Local Selection from base population of ANDCI-8). Similarly recently released hybrids are GCH-8 (JP-96 x DCS-89) & GCH- 9 (SKP-84 x PCS-124) in 2018 and ICH-66 (SKP-84 x ICS-164) in 2019.

Major Achievements of Castor Research Station (Junagarh)

Variety	Parentage	Year of release	Oil Content (%)	Yield (kg ha^{-1})	Important characters
GAUC-1	VI-1 x VI-9	1973	47.50	2100	Suitable for irrigated and rainfed region
GC-3	(JP-65 x JI-8) x 48.1	2007	49.60	2340	Wilt and root rot resistant
HYBRIDS					
GCH-3	TSP-10R x J-1	1969	46.00	1543	Shattering habit
GCH-2	VP-1 x II-35	1985	47.80	1500-1700	Drought tolerant and resistant to root rot
GCH-6	JP-65 x JI-96	1998	49.90	2349	Resistant to wilt and tolerant to root rot
GCH 9	SKP-84 x PCS-124	2017	48.30	3781	Higher yield potential and resistant to wilt and root rot disease

Plant Growth-promoting Rhizobacteria as Biological Agents of Plant-parasitic Nematodes

Sharmishtha Thakur and Suman Sanjta

Soil bacteria which are free-living and beneficial, colonizing the plant roots and enhance the plant growth are usually referred to as plant growth-promoting rhizobacteria (PGPR). PGPR are highly diversified and in this article we emphasis on rhizobacteria as biological agents of plant-parasitic nematodes. Plant-parasitic nematodes are one of the most destructive pests, causing huge losses of crop production worldwide. Significant losses have recorded in crops due to the attack of plant-parasitic nematodes. These plant-parasitic nematodes are commonly known as hidden enemies of the farmers due to being microscopic in size, soil-borne in nature and feeder of below-ground plant parts.

Plant growth-promoting rhizobacteria can suppress plant-parasitic nematodes through two ways *i.e.* direct and/or indirect antagonistic mechanisms. Predation, release of anti-nematicidal metabolites and semiochemicals, competition for nutrients, and niche exclusion comes under direct antagonism. On the other hand, indirect antagonism may occur from the induced systemic resistance (ISR).

Direct Antagonism of PGPR against plant-parasitic nematodes

Egg hatch, and/or the growth and reproduction of plant-parasitic nematodes, can be prevented by direct antagonism of PGPR mainly through predation, and release of toxins or hydrolytic enzymes including hydrogen cyanide, 2,4-diacetylphloroglucinol, chitinases, glucanases, proteases, and lipases. Nematicidal compounds are produced by a number of PGPR mainly belonging to *Bacillus* spp. and *Pseudomonas* spp. For example, several strains of *Pseudomonas fluorescens* reduce potato cyst nematode (*Globodera* spp.) and root-knot nematode (*Meloidogyne incognita*) levels in vitro and/or in soil conditions by releasing DAPG, a phenolic antiphytopathogenic metabolite.

PGPR are also able to inhibit the synthesis and maintenance of cell walls and membranes, as well as prevent the formation of cellular organelles through production of various hydrolytic enzymes. For example, chitinases and discrete proteolytic enzymes produced from *Bacilus cereus, B. firmus, B. licheniformis, B. megaterium* and *B. subtilis*, as well as Corynebacterium pauro-metabolu are proposed to be responsible for reducing the reproduction of root-knot nematodes and cysts nematodes.

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Indirect antagonism of PGPR against plant-parasitic nematodes

ISR, is also referred to as PGPR-mediated priming, which systematically equips the "whole" plants to better cope with environmental constraints, actuating faster and/or stronger defense responses (adaption) to a subsequent exposure to various biotic and abiotic stresses is known as indirect antagonism of PGPR against plant-parasitic nematodes. ISR is nonspecific in nature, and provides plants "a long-lasting protection" and "a broad-spectrum disease resistance (defense responses)" against various pathogenic microbes, insect herbivores and pests including plant-parasitic nematodes; e.g., *M. incognita, M. javanica, Heterodra glycines, H. cajani* and *Globodera pallida*. In fact, ISR developed by various *Bacillus* spp. and *Pseudomonas spp., including B. subtilis, B. amyloliquefaciens* and *P. fluorescens* have demonstrated promising results reducing plant-parasitic nematodes in both dicotyledonous (Arabidopsis, bean (Fabaceae spp.), carnation (*Dianthus caryophyllus* L.), cucumber (*Cucumis sativus* L.), radish (*Raphanus sativus* L.), tobacco (*Nicotiana tabacum* L.) and tomato (*Solanum lycopersicum* L.) as well as monocoty-ledonous (rice, maize and sugarcane) plants (Subedi *et al.,* 2020).

Plant growth promoting rhizobacteria as bilogial agents

PGPR have been identified as potential agents for containing the losses caused by plant-parasitic nematodes, resulting in effective plant-parasitic nematode management. The use of PGPR has a notable effect on plant growth and can cause the death of plant-parasitic nematodes. Therefore, PGPR represent an excellent option for upgrading agriculture practices and are a critical part of nematode managements. Various PGPR strains are known to exhibit a suppression in gall number of root-knot nematode species, including *Bacillus frmus* T11, *B. cereus* N10w, *B. aryabhattai* A08, *Paenibacillus barcinonensis* A10, and *P. alvei* T30. A greenhouse experiment conducted on cucumber with the strains *Pseudomonas fuorescens* and *Serratia marcescens* resulted in a remarkable decrease in gall index and egg mass of root-knot nematode compared with the untreated control, and these strains are now considered biological agents compared with *M. incognita* (Ali *et al.,* 2021). Examples of PGPR shown in Table 1 are used as biological agents for plant-parasitic nematodes suppression.

Conclusion: Chemical based nematicides have been widely used for the management of plant-parasitic nematodes, but these may have adverse effects on human health and the environment. At the present time, the search for eco-friendly options has become a primary concern. Consequently, biological agents have become a substitute for the management of plant-parasitic nematodes, since they are environment friendly and cost effective. Several rhizobacteria strains are able to control nematodes promoting plant development through secretion of secondary metabolites.

Table 1: Plant growth-promoting rhizobacteria act as bio-control agents for the management of plant-parasitic nematodes

PGPR	Target plant-parasitic nematodes
Pasteuria pentrans	*Aphelenchoides besseyi, Globodera rostochiensis, Meloidogyne incognita, Pratylenchus penetrans, Radopholus similis*
Agrobacterium radiobacter (G12)	*Meloidogyne spp*
Bacillus cereus	*Meloidogyne javanica, Meloidogyne incognita,*
B. amyloliquefaciens	*Meloidogyne incognita*
B. amyloliquefaciens FR203A	*Xiphinema index*
B. thuringiensis	*Meloidogyne incognita*
B. frmus	*Meloidogyne incognita*
B. coagulans	*Meloidogyne incognita*
B. subtilis	*Meloidogyne javanica*
B. pumilus	*Meloidogyne incognita*
Pseudomonas fuorescens	*Meloidogyne incognita, Globodera rostochiensis*
P. putida	*Meloidogyne incognita*
Serratia marcescens	*Meloidogyne incognita*

Although, current efforts to commercialize PGPR for the management of plant-parasitic nematodes has had limited success. A crucial concern has been that PGPR is not consistent in managing plant-parasitic nematodes in the field, possibly due to numerous endogenous and exogenous factors limiting PGPR root colonization. Factors include other plants, variable soil conditions, and various rhizospheric metabolites and organisms. Thus, there is a need to further look into optimizing the biological agent's activity of PGPR.

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Post-harvest Processing of Aromatic Crops

Shazia Paswal and Sardar Singh Kakraliya

Introduction

Post-harvest management can be defined as methods and techniques applied to increase the shelf life of the products. Postharvest Management is the stage of crop production immediately following harvest. Instan the cro is emoved from the ground or separated from its parent plant, it begins to deteriorate. Post harvest management largely determine final quality, whether a crop is sold for fresh consumption or used in an ingredient in a processed food products. Some plants are known to render great aroma and are known as aromatic crops. Ancient Unani manuscripts Egyptian papyrus and Chinese writings described the use of herbs. Indigenous cultures in Rome, Egypt, Iran, Africa, and America used herbs in their healing rituals, while other developed traditional medical systems such as Unani, Ayurveda and Chinese Medicine in which herbal therapies were used systematically. Traditional systems of medicine continue to be widely practiced on many accounts. Population rise, inadequate supply of drugs, the prohibitive cost of treatments, side effects of several synthetic drugs and the development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments. Aromatic plants are now a major part of horticulture as it is associated with the health of mankind since time immemorial. India has a wealth of 2500 aromatic plants among the 20,000 species occurring in the world. Postharvest Management of Horticultural Crops Ayurvedic ethical formulations contribute to the remaining sum. The cosmetic industry, as well as aromatherapy, are two important areas where Indian medicinal plants and their extracts, essential oil can contribute globally. Aromatic plants have high market potential with the world demand for herbal products growing at the rate of 7 percent per annum. Annually, India's aromatic plants export is worth of Rs. 1250 crores and essential oil amounts Rs. 260 crores In India, aromatic crop has emerged as a major economic activity and witnessed a rapid growth in this sector . This kind of demand for plant-based origin drugs would, unfortunately, create pressure over high-value medicinal plants that are present in the wild population due to over-harvesting. Hence it could lead to bringing down the quality of products due to improper handling of crops after its harvest. Therefore, an effort to be made prior to harvest through which it would achieve quality, safety, and efficacy of these important resources. Improper handling after harvesting often results in quality deterioration and a significant fall of the price of the produce. Post-harvest loss ofaromatic plant has been defined as the loss of weight of the product (loss of

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moisture content) which would be normally utilized or consumed for drugs by mankind. Post-harvest losses are due to several factors like improper handling of the crop, packaging, storage, low-level technology, lack of basic equipment and facilities at the collection centers or packing houses, and lack of trained personnel. Therefore, the trend may play a vital role in achieving socio-economic benefits and sustainable development in developing countries like India through improving Good Agricultural Practices (GAP), Good Harvesting Practices (GHP) and Good Manufacturing Practices (GMP). Thus by knowing the importance of aromatic plant and its post-harvest losses, a sincere effort has been made in this article to discuss about the improved post-harvest technologies which are being carried out.

Importance of Post Harvesting Management

- ✓ Maintain the quality of fresh Aromatic plants.
- ✓ Reducing postharvest losses reduces poverty.
- ✓ Increase market share and competitiveness of smallholders.
- ✓ Stimulate agriculture production and prevent post-harvest losses.
- ✓ Provide plants to the consumer by reducing post-harvest losses.
- ✓ It is difficult to increase 10% yield but it is easy to reduce 10% loss

General Rules of Post Harvest

- ✓ Good hygiene along the entire production process, from cultivation through harvesting, drying to primary processing is essential to obtain a high-quality product.
- ✓ Provide an adequate training on hygiene rules to all the persons who are in contact with the plant material, including the persons working in the fields. Explain them their responsibility to ensure hygienic end products.
- ✓ Ensure that all primary processing procedures comply with regional and/national guidelines on food hygiene.
- ✓ Ensure that all the persons who are in contact with the plant material, including the persons working in the fields, maintain a high level of personal hygiene.

Personal hygiene starts at home

- ✓ Ensure that the personnel involved in post-harvest handling cleanes the hands after:-Each pause, Working in storage and transport Waste disposal, Cleaning and disinfection of equipment
- ✓ Ensure that means of hygiene, such as clean water, soap, and towels are available wherever aromatic plants are handled, including on the field at harvest time.
- ✓ Ensure that farmers or workers who suffer of a disease that can be transmitted by food (Including diarrhea) are excluded from all activities with plant material.

- ✓ Ensure that staff with open wounds, infections and skin diseases are not involved in activities dealing with plants until they have full recover.

Inspection and Sorting

- ✓ Raw aromatic plant materials should be inspected and sorted prior.
- ✓ Visual inspection for cross-contamination by untargeted aromatic.
- ✓ Visual inspection for foreign matter.
- ✓ Organoleptic evaluation, such as: appearance, damage, size, colour.

Avoid sorting goods on the floor. Due to this the risk of contamination by dust or other residues is very high

A professional sorting table offers a higher working comfort and contributes to a better product quality

Primary Processing

At the farm or collector level

After drying of APs, a final sorting must be carried out by hand on the sorting table. Dust, sand, non-desirable impurities, and too small plant parts are eliminated with a sieve.

Plant parts and impurities to be removed

- ✓ Discoulored plant parts
- ✓ Mouldy plant parts
- ✓ Damaged plant parts
- ✓ Stones
- ✓ Weeds
- ✓ Soil and other impurities

Drying aromatic plant material directly on bare ground should be avoided. If a concrete or cement surface is used, aromatic plant materials should be laid on a tarpaulin or other appropriate cloth or sheeting. Insects, rodents, birds and other pests, and livestock and domestic animals should be kept away from drying sites. For indoor drying, the duration of drying temperature, humidity and other conditions should be determined on the basis of the plant part concerned (root, leaf, stem, bark, flower, etc.) and any volatile natural constituents, such as essential oils. If possible, the source of heat for direct drying (fire) should be limited to butane, propane or natural gas, and temperature.

Aromatic plant species have individual optimum drying temperatures. However, for practical reasons the following general drying temperatures may serve as thumb rule:

Flowers: 35-40°C
Entire herbs/leaves: 40-45°C
Seeds: 45-50°C
Roots/rhizomes: 50-60°C
Aromatic herbs: 38-42°C

Labeling

A label affixed to the packaging should clearly indicate the scientific name of the Aromatic plant, the plant part, the place of origin (cultivation or collection site), the cultivation or collection date and the names of the grower/collector and the processor, and quantitative information.

The label should also contain information indicating quality approval and comply with other national and/or regional labeling requirements.

The label should bear a number that clearly identifies the production batch. Additional information about the production and quality parameters of the aromatic plant materials may be added in a separate certificate, which is clearly linked to the package carrying the same batch number. Records should be kept of batch packaging, and should include the product name, place of origin, batch number, weight, assignment number and date. The records should be retained for a period of three years or as required by national and/or regional authorities.

Storage

Packed dried crop should be stored in a dry, well ventilated building, with minimal variation in diurnal temperature and with good air ventilation.

When necessary, be equipped with air-conditioning and humidity control equipment as well as facilities to protect against rodents, insects and livestock. Shutter and door openings should be protected by wire screens to keep out pests and farm and domestic animals. The floor should be tidy, without cracks and easy to clean. Plant material should be stored on shelves which keep the material a sufficient distance from the walls; measures should be taken to prevent the occurrence of pest infestation, mould formation, rotting or loss of oil; and inspections should be carried out at regular intervals. It is recommended that packed dried crops should be stored: in a building with concrete floors. Processed aromatic plant materials should be packaged in clean, dry boxes, sacks, bags or other containers in accordance with standard operating procedures. Materials used for packaging should be non-polluting, clean, dry and in undamaged condition and should conform to the quality requirements for the aromatic plant materials concerned. Fragile aromatic plant materials should be packaged in rigid containers. Dried aromatic plants/herbal drugs, including essential oils, should be stored in a dry, well-aerated building, in which daily temperature fluctuations are limited and good aeration is ensured. Fresh aromatic plant materials should be stored at appropriate low temperatures, ideally at 2-8°C; frozen products should be stored at less than -20°C. Small quantity of crude drugs could be readily stored in air tight, moisture proof and light proof container such as tin, cans, covered metal tins or amber glass

containers. Wooden boxes and paper bags should not be used for storage of crude drugs (WHO, 2003; Anonymous, 2009).

Do's and don't during Storage

Storage of the sacks on wooden pallets ensures sufficient distance of the crop from the ground

These bags are stored too close to the wall. This can cause moisture to accumulate between the wall and the bags

Transportation

- ✓ Transportation is a big and often the important factor in the marketing of fresh produce.
- ✓ Ideally, transport would take produce from the grower directly to the consumer.
- ✓ Losses directly attributed to transport conditions can be high.
- ✓ The produce be kept in the best possible condition during transport and that the haulage of produce be quick and efficient.
- ✓ To this end, produce should be properly packaged and properly loaded on a suitable vehicle.

Labelling for transport

For transport and delivery of aromatic plant (e. g. from the farm to the collection point), all bags must be labelled. If the bags are not labelled, each lot of raw material must be accompanied by documents (way bill) with the information listed below.

Obligatory data for organic labelling

- ✓ Name and address of the owner or seller
- ✓ Name of the product
- ✓ Code number of the certification body
- ✓ Lot / batch number (for reasons of traceability, if possible)
- ✓ Address of the recipient.

Biochar Production Technology, Properties and its Application

R. K. Meena and Tulika Kumari

Abstract

Biochar is one of the important produces which obtained from the biomass. Biochar is reach in carbon content. Various methods are utilized to production of biochar. Out of various methods to employ to production of biochar pyrolysis techniques is most suitable technique to produce biochar. In the present time it is utilize in various purposes such as a soil amendment, to treat west, food industry, for energy production and carbon sequestration. Biochar productions from west biome an effective alternative option west management. India has great potential towards production of biochar, due to availability of biomass recourse in large quantity. The present article provide about over view about various methods of production of biochar, properties of biochar and utilization of Biochar.

Introduction

The word char is a commonly utilized for the byproduct of combustion process of plants material. Biocahr mainly consist with high carbon content e.g. charcoal. Biochar is mainly produced from the thermochemical conversion process of biomass. It is an important product in the soil, food, and agricultural sectors. Pyrolysis method widely practiced to the production of charcoal from wood material. The properties of biochar are affected by several factors which are heating rate, heating type, temperature, and composition of materials, particle size, and reactor conditions. Biochar main components are volatile matter, ash, carbon, and moisture. The composition content of biochar is mainly depending on the feedstock material and the operating parameters. Biochar from wood and other plants materials have higher carbon content (minimum 51%). Biochar has been utilize for various purpose like as soil amendment, to generate energy, to treat west water treatment, Carbon sequestration and mitigation of climate change, adding to increase the soil nutrients, and applying to improve the soil properties.

Biochar Production Technologies

Conversion of plant material into carbon is known as boichar production. By using waste materials, improved the biochar production techniques can contribute to fulfill the demand of energy needs of the future and enhance the soil carbon sequestration potential. Three technologies mainly utilize for the production of biochar which is namely pyrolysis, pyrolysis, carbonization and gasification.

Pyrolysis: It is thermochemical conversion of biomass into the biocha, bio oil and syngas under the

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absence of oxygen with the temperature ranging 400 ˚C to 1200 ˚C on the basis of time consuming into the process pyrolysis divided into three broad categories (1) Fast pyrolysis (2) Intermediate pyrolysis and (3) Slow pyrolysis.

A. Slow Pyrolysis

Slow pyrolysis has taken long time, more than one hour and its major output is biochar. Slow pyrolysis is traditional pyrolysis technique, where wood and other materials are heated at higher temperatures at 300 to 600°C with 5-7 °C/ minute heating rate. Low heating speed and longer vapor residence time provide favorable environmental condition the secondary reactions to proceed. This process leads to formation a solid carbonaceous biochar at the end of process. In the slow pyrolysis biochar is major product which is 35 to 45% and other products like bio-oil 25 to 35% and syngas 20 to 30% are produced.

B. Fast Pyrolysis

The fast pyrolysis process competes within few seconds or less. During the process solid biomass converted into biofuel, solids and gases produced. Fast pyrolysis is carried in the absence of oxygen at high temperatures more than 500°C with heating rate more than 300°C/minute. In the fast pyrolysis produces bio oil 60%, biochar 20% and 20% syngas.

C. Intermediate Pyrolysis

Intermediate pyrolysis is a combination of slow and fast pyrolysis methods for the production of biochar. Intermediate pyrolysis is very important to the production of solid and liquid products. Intermediate pyrolysis occurs at 500 and 650°C temperature with heating rates between 0.1 and 10°C/minutes. In the intermediate pyrolysis produce 40 to 60% liquid, 20 to 30% non condensable gases and 15 to 25% biochar.

Gasification

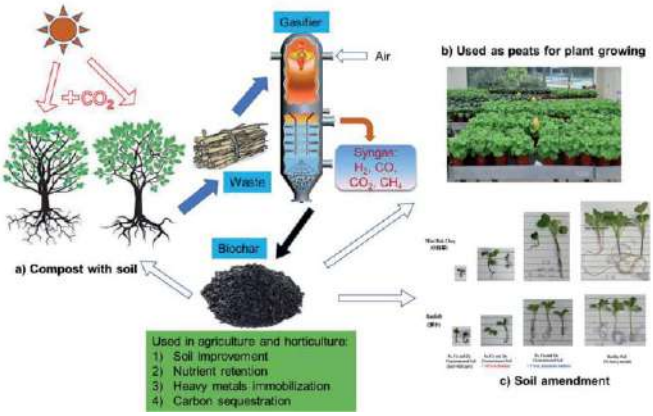
Gasification is a thermo-chemical conversion process in which biomass converted into combustible gases at higher temperature (more than 700 °C) under low amount of oxygen. Produced gas generally known as syngas. The composition of syngas is hydrogen (H_2), methane (CH_4) and carbon monoxide (CO).

Carbonization

In the carbonization process organic substances are converted into high carbon material. It represents different pyrolytic processes; this is similar to conventional methods which are used for charcoal production. The carbonization process is complete between 280^{o}C to 500^{o}C temperature. In the process of carbonization charcoal is the main produce and also produces some combustible and non combustible gases.

Applications of Biochar

Charcoal is important organic material at the present time charcoal widely utilize in deferent sectors like apply as soil amendment, apply for the west management and it is also apply to carbon sequestration and mitigation of climate. The following important use applications of carbon as follow.



Biochar uses in agriculture and horticulture and its contribution to the circular economy
Source: (Armah *et al.*, 2022)

Application for waste management

Every year large amount of waste material is generated from the various sources, like wheat and rice straw, rice husk etc), wood based industry wastages industrial, fruit and vegetable industries wastages, forest logging and animal wastages. All waste material are utilize for the biochar production with different techniques. production of bichar from the all waste material it is help in the achieving two different objectives first one is minimize the pollutant material and second is production of energy. In addition, it is also helps in mitigation of green house gases emissions.

Biochar application for soil amendment

Biochar is a good soil amendment. It has ability to improve the quality of soil. Biochar helps in increase the water holding capacity of soil and retention period of water into soil. Biochar are also helpful for the increase the soil pH to acidic soil increased Cation exchange capacity and nutrient use efficiency of the soil.

Carbon sequestration and mitigation of climate change

Biochar production has proved to be one of the best ways to sequester the carbon dioxide from the environment. As carbon removed by the various plants from the environment during its life cycle and stores permanently it in its structure. This method does not lead to straight sequester the carbon from the atmosphere but it converts biomass carbon into a highly stable form thereby decreasing CO_2 emission from soil due to decomposition.

Application for west water treatment

Biochar is most important substance which is utilize to the remove organic substance, due to high porosity and large surface area of biocahr. Biochar provide high surface area for the contaminants and impurities to interact with the active site of the biochar. Biochar mostley utilize to remove of organic compound of chlorine, certain metal, volatile compounds, pesticides, etc.

Application for energy generation

Biochar can be used as a substitute of coal for energy production. It is cheapest way to producing electrical energy from biomaterial by using the pyrolysis method. Also, syngas produced as a byproduct during biochar production can be used as a fuel in gas engines. Bio-oil can be used as a replacement for fuel oil.

Conclusion

Biochar is produce by the west material of plant and production of biochar is important because of through the production of biochar west material is

easily managed and it is also help to manage the pollutant martial from the various agriculture crops. Positive effects of biochar was noticed on agriculture and agroforestry systems, like soil health improved, improve plant growth performance, carbon sequestration and minimize greenhouse gases, it is ultimately improve the agriculture crops yield.

Refrence

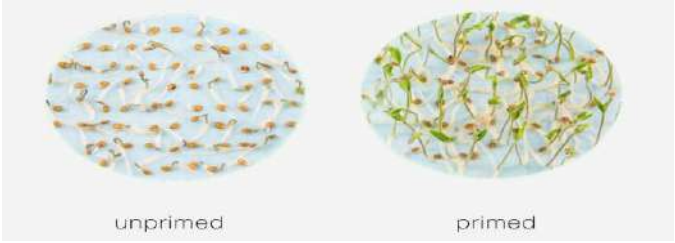
Armah E K., Chetty M., Adedeji J. A., Estrice D. E., Mutsvene B., Singh N. and Tshemese Z. 2022. Biochar: Production, Application and the Future In: Biochar - Productive Technologies, Properties and Application (Eds.) Bartoli, M., Giorcelli, M. and Tagliaferro, A. Intech Open. p. 15. DOI: 10.5772/intech open.105070.

Seed Priming as a Technique for Sustainable Agriculture

Vijay Kumar and Chanchal

Introduction

Effective seed germination is critical in agriculture. Plant species' emergence and growth are originally determined by seed quality. A good grade seed in good soil yields a better yield. The utilization of various inputs such as manures, herbicides, fertilizers, and so on is determined by the seed quality. Seed is an important element in maintaining food security and serves as a vehicle for technological adoption. Quality seed must have certain characteristics such as high physical and genetic purity, a greater germination percentage, improved vigour, and be free of pests and diseases. Many unfavorable situations, including climate change, may cause crop failure. For good crop development, an effective strategy must be implemented. Among these, seed priming is an important approach for aiding crop development establishment. Seed priming is a physical technique in which seeds are treated to regulated hydration and drying in order to enhance the adequate pre-germination metabolic process for swift and speedy germination. The seeds are partially moistened and kept at a specific temperature, moisture, and aeration level for a set amount of time. Priming forms are a practical and cost-effective strategy for consistent germination and development. Before spreading seeds, seed priming treatment is performed, which comprises hydration of seeds in sufficient quantities to allow metabolic processes before to germination to occur while avoiding radicle emergence. Priming is a method of treating seeds with various organic or inorganic compounds, as well as at high or low temperatures. It requires immersing seeds in various solutions for a certain period of time under controlled conditions, then drying them back down to their original moisture content so that radicles do not sprout before planting. This activates different metabolic processes that increase germination and emergence of a variety of seed species, including vegetables, tiny seeded grasses, and ornamental species, while also reversing the negative impacts of seed degeneration.



Priming Mechanism

Seed germination is a complex process involving several metabolic activities that culminate in a transition from the stored food reserve to the

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activation phase, where the radicle and plumule develop. In general, the seeds absorb water in three stages. The first phase is known as the Imbibitions phase, and it includes rapid water intake via forces generated by seeds. During this phase, changes like as metabolic activity and translation take place, while DNA and mitochondria are repaired.

The second phase is the lag phase, in which there is reduced water absorption, resulting in a slight rise in seed fresh weight. This phase is also known as the Activation phase since it is physiologically and metabolically active. It aids in mitochondrial maturation (ATP generation), protein synthesis from new mRNAs, and the mobilization of stored macromolecules into molecules essential for radicle expansion. Germination is the third stage. Germination is complete at this point, and seedling development begins with the resumption of the radicle and rapid water intake.

Priming happens in the first and second phases, preventing seeds from entering phase III. Phase II happens for a longer period of time to conduct procedures and precludes phase III. As a result, the lag phase in primed seeds is decreased because phase III preparation is already completed.

As a result, many benefits are imposed on seeds, such as synchronization of radicle emergence, increased growth rate, and increased number of seeds germinating. Seeds have already completed the first two phases of germination during priming, thus upon planting, these seeds have the capacity to finish the process faster (imbibition) if water is introduced. This shortens the time necessary for cellular functions to occur. The activation and/or production of nucleic acid enzymes increase DNA content, resulting in a rise in total RNA and proteins. It also repairs cell membrane damage induced by storage/drying.

Physiological and Metabolic changes in seed from seed priming

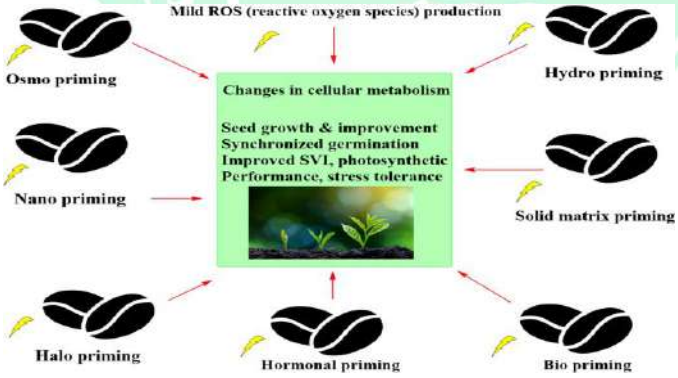
Seeds undergo several biochemical and physiological changes as a result of priming. It synchronizes germination after breaking dormancy, reduces imbibition lag time, hydrolyzes or metabolizes inhibitors, activates enzymes, mobilizes stored food, and promotes embryonic tissue expansion. Starch metabolism is critical during seed metabolism, since it impacts seedling vigour under stress. -amylases catalyze this metabolism by hydrolyzing starch reserves into metabolizable sugars, which provide energy to the growing embryo. Seed priming increases the activity of -amylase and dehydrogenase, which may hydrolyze starch macromolecules into smaller and simpler sugars, resulting in enhanced ATP generation and respiration. Phytase, amylase, and protease activity rises as well.

Similarly, primed barley seeds had 2.8 times the activity of unprimed seeds, whereas primed wheat seeds had 2.7 times the activity of unprimed seeds. This might have resulted in more germination events in primed seeds. Priming also improves the performance of malate synthase and isocitrate lyase, which convert lipids to carbohydrates, as well as

antioxidant enzymes (POD, SOD, CAT, and GR), which scavenge ROS (Reactive Oxygen Species).

As a result, the seeds are protected against lipid peroxidation and oxidative damage to membrane phospholipids, resulting in seed life. There have also been reports of proline accumulation and glycine formation in primed rice seedlings, which operate as an osmotic agent, radical scavenger, and boosting GSH synthesis, respectively, shielding the plants from the oxidative damage caused by cold stress.

On priming, β -mannanases activity increases, weakening the endosperm layer and allowing the radicle to emerge, breaking thermodormancy. Priming also keeps cell division and structure (cytoskeleton) under check by producing an abundance of alpha and beta tubulin subunits.



Seed priming techniques

There are several priming strategies that have been used. The following are some priming techniques:

1) **Hydropriming:** The seeds are steeped in water for a certain period of time. This method is commonly employed in arid farming areas. The water affinity of the seed tissue influences the water entering the seeds. Hydropriming is both inexpensive and environmentally beneficial. The water soaking duration, volume of water, and temperature at which the priming is performed are the most important factors in hydropriming.
2) **Halopriming:** During halopriming, the seeds are immersed in inorganic salt solutions (NaCl, KCl, etc.). These salts may have direct or indirect nutritional effects. It promotes consistent and improved crop performance even in difficult situations. It also tolerates salinity by increasing Ca_2^+ and K^+ accumulation, decreasing Na^+ accumulation, and increasing osmosis through proline accumulation.
3) **Osmopriming:** Osmopriming, also known as osmoconditioning, is the process of soaking seeds in osmotic solutions such as polyethylene glycol, mannitol, glycerol, sorbitol, and so on. Because of the reduced water potential in the osmotic solution, seeds absorb water slowly, allowing seed imbibition. The osmotic potential of priming solution ranges from -1 to -2 MPa in general, but varies depending on the length and species in the priming solution.
4) **Solid matrix priming:** In this procedure, seeds are incubated in a solid insoluble matrix such as peat moss, vermiculite, diatomaceous earth, sand, charcoal, and clay with a restricted amount of water, resulting in sluggish imbibition. Matrix materials should have a low matrix potential, a low water holding capacity, attach to the bed

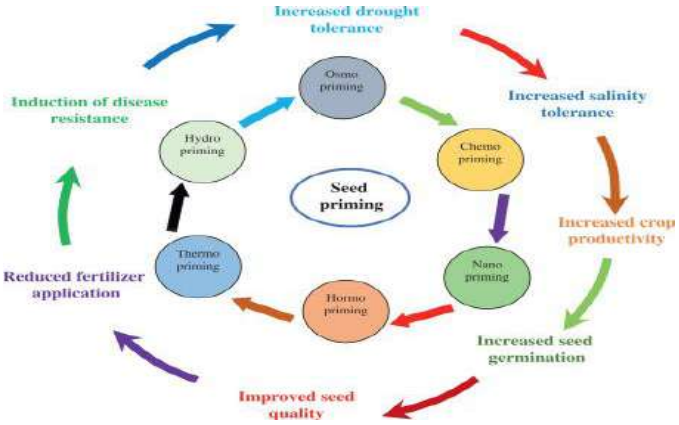
surface, and be non-toxic to the seeds.

5) **Biopriming:** Biopriming combines seed inoculation with helpful microorganisms and regulates seed hydration for the control of biotic and abiotic stress. Microorganisms grow, colonise, and create PGRs (Plant Growth Regulators) during biopriming. Biopriming also promotes seed germination and protects against seed and soil-borne illnesses. Beneficial bacteria can colonise and multiply in the rhizosphere, benefiting the plant both directly and indirectly.

6) **Hormonal priming:** Hormopriming, also known as hormonal priming, is the treatment of seeds with different hormones that promote seedling growth and development. Auxin, abscisic acid, kinetin, gibberellins, ethylene, salicylic acid, and polyamines are examples of regularly utilised hormones.

7) **Nutripriming:** In this step, the seeds are primed with a nutrient solution to increase seed quality by increasing seed nutritional content. Micronutrients are essential for plant growth because they participate in two major processes, photosynthesis and respiration, which contribute in total plant growth.

8) **Nano priming:** A revolutionary seed priming method that uses nanoparticles such as iron oxide, zinc oxide, silver nanoparticles, titanium dioxide, and others. Plants do not absorb nutrients or fertiliser because they are drained off or broken down by exposure to water and light. The delivery of nanoparticulate nutrients/ material to plants allows for controlled and appropriate nutrient utilisation at the exact spot necessary for plant development.



Benefits of Seed Priming

1. Faster and more uniform seed germination.
2. Aids in overcoming thermal dormancy.
3. Alleviates a variety of impacts induced by different conditions.
4. It helps to overcome chromosomal damage caused by ageing.
5. It reduces soil-borne illnesses.
6. It increases the viability of low vigour seed.
7. It improves crop development and production overall.

Conclusion

When the seeds are in good condition, the seed priming approach is thought to be the best remedy for germination difficulties. Priming seeds has been an effective, realistic, and wise choice for plant development during the last few decades. It is ecologically friendly, easy to implement, and advantageous in a variety of ways. Furthermore, all priming strategies would not result in considerable germination and development, although some ineffe-

ctive approaches may promote protective protein breakdown. As a result, substantial study must be conducted to determine a suitable priming technique for diverse species in connection to germination and growth under varied environmental circumstances.

Recent Trends in Orchard Management

Ram Singh Choudhary, Dr. Virendra Singh, Anuj Kumar and Dr. R. K. Yadav

Introduction

An orchard is an intentional planting of trees or shrubs that is maintained for food production. There are many traditional practice which are carried out by the growers but existing practices could not fulfill the requirement of quality and quantity production. Recent innovations like use of HDP, use of resistant rootstock against biotic and abiotic stresses, efficient irrigation systems, Hi-tech cultivation are common advances which gained popularity.

High density planting system

Planting of fruit trees at a closer spacing. First established in apple in Europe during sixties and common use in Pineapple, banana, mango, apple and citrus guava crops. In this system, four planting densities are recognized for apples *viz.*, low HDP (< 250 trees ha^{-1}), moderate HDP (250-500 tree ha^{-1}), high HDP (500 to 1250 trees ha^{-1}) and ultra-high HDP (>1250 trees ha^{-1}). Recently, super high density planting system has been also established in apple orchards with a plant population of 20,000 trees ha^{-1}.

Advantages of HDP are

Early cropping and higher yields for a long time, reduced labour costs, improved fruit quality, efficient utilization of land and other resources, better canopy management, farm mechanization, convenient spray of pesticides.

Characteristics of HDP are

The trees of HDP should have maximum number of fruiting branches and minimum number of structural branches. The trees are generally trained with a central leader surrounded by nearly horizontal fruiting branches. The height should be one and half its diameter at the base. A key to successful HDP depends upon the control of tree size.

Use of Nano fertilizer in orchard

Nano fertilizers are the important tools in agriculture to improve crop growth, yield and quality parameters with increase nutrient use efficiency,

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reduce wastage of fertilizers and cost of cultivation. Nano-fertilizers are very effective for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period.

Application and use of Nano fertilizer

Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces.

Micro-irrigation systems

Application of small quantities of water directly above and below the soil surface to plant root zone; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line.

Advantages of micro-irrigation systems

Orchard management, lower labour requirements, control over water and nutrients, control of weeds, use of saline water, irrigation of poor soils.

Smart drip irrigation system

Drip irrigation is the most advanced and the most efficient of all irrigation methods. The goal is to place water directly into the root zone and minimize evaporation

Components

Water source and pumps & pumping stations, filtration main, sub-main, distribution pipes and fittings, water meters and pressure gauges, valves, dosing unit, dripper lines (laterals) and connectors, end of dripper lines, sensors and controller.

Use of rootstocks in orchard

Selected rootstocks often are grafted to scions to increase crop yield, fruit quality, resistance to disease and frost & adaptability to soil. Use of resistant rootstock against biotic and abiotic stresses. Because fruit yield and quality often are inversely related, the use of rootstocks for increasing yield of fruit sometimes is undesirable, because of environmental interactions with scion rootstock combinations, it usually is essential to evaluate different combinations under local conditions.

Advantages

Yield increase, use of resistant rootstock against biotic and abiotic, enhanced water uptake high salt tolerance, wet soil tolerance, quality changes, extended harvest period, convenient production of organic wastes, ornamental values for exhibition and education.

Protected cultivation

Protected cultivation (PC) is most intensive agricultural production systems to minimize the chemical, pesticides residue in pomological produce and accelerate with climate change and changing

cropping pattern. Greenhouse were first introduced in India during 1960's for research purpose and commercial cultivation started in 1988. Recently 50 to 80 % subsidy on greenhouse construction vary to location.

Advantages

Uniform and better quality production, fresh fruits availability, higher productivity, weed free cultivation, efficient use of resources, regulate harvesting time to reduced post-harvest losses, round the year as well as off-season cultivation is possible in hostile climates, better insect pest and disease control with lesser use of pesticides, create micro-climate for optimum plant performance, conservation of biodiversity, breeding for resistance to abiotic stresses.

Sod culture

This practice is followed in the orchard located on sloppy land, particularly when the gradient of the slope is greater than 10 per cent. In this system, grasses are allowed to grow in the interspaces between the trees without tillage or mulching.

Advantages

Controls soil erosion, maintains optimum soil moisture to ensure water and nutrients supply to trees, maintains organic matter, provides better aeration to the roots, enhances microbiological activity in the soil through better aeration, avoids bruising of falling fruits.

Reflective groundcover

Must pull the mulch aside so you can plant the ground cover in the soil. Then pull the mulch back over the soil, but be sure not to cover the base of the plant. The mulch will help conserve moisture and discourage weeds and that will help your ground cover get established quicker.

Plant responses to light quality in fruit trees

Growth and development, leaf morphology and function, fruit color development, early fruit onset, increased flower bud formation and yield, moisture and weed control.

Innovation description

The existing flood irrigation system requires ample amount of water. Drip and sprinkler irrigation systems utilize water efficiently but it is very difficult to irrigate long and dense crops by them and in short duration. In these moving discharge sprinklers, the deflector and the nozzle assembly have each been separately driven by gear connections to the transmission.

Neonicotinoids: Implications and their Substitutes

N. P. Pathan, R. D. Dodiya and D. B. Sisodiya

Introduction

Neonicotinoids, the most important new class of synthetic insecticides of the past four decades, are used to control sucking insects both on plants and companion animals (Tomizawa and Casida, 2003). Nicotine is natural compound while neonicotinoids are developed from replacing the nitromethylene by nitromine yielded imidacloprid in February 1985 (Moriya *et al.*, 1992). Based on total global insecticide sales, the market share of neonicotinoids was more than 25 per cent, thiamethoxam, imidacloprid and clothianidin accounting for almost 85 per cent of the total neonicotinoid sales in crop protection (Chris Bass *et al.*, 2015). Neonicotinoids are used for controlling sucking insect pests and periodically replacing organophosphorous and methylcarba-mates groups. It is also important for animal health care. Due to the selective toxicities (Yamamoto and Cassida, 1999), it is attributed to the specificity of insect and mammals on nicotinic receptors.

In the recent past, the deleterious outcome of neonicotinoids was reported on honey bee (Takao *et al.*, 2004), predators and parasites (Anon., 2010), insect resistance (Cahill *et al.*, 1996), residues in soil (Sreekumar and Shah, 2014) and in vertebrates (Anon., 2010).

History

The first neonicotinoid launched was imidacloprid in 1991 followed by nitenpyram and acetamiprid in 1995, and others such as thiamethoxam in 1998, thiacloprid in 2001, clothianidin in 2001 and dinotefuran in 2002 (Chris Bass *et al.*, 2015).

Mode of action

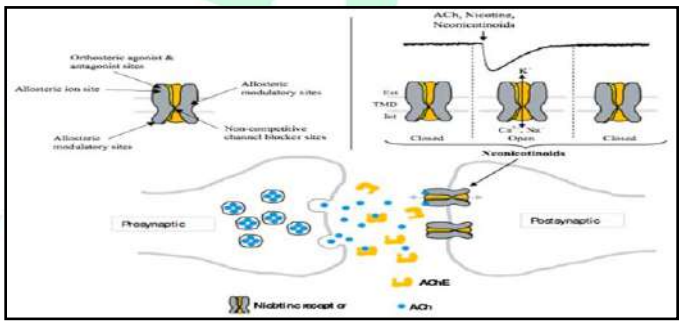

Fig. 1: Representation of mode of action of neonicotinoids (Source: Houchat *et al.*, 2020)

Neonicotinoids act as agonist at the insect nicotinic acetylcholine receptor (nAChR) (Tomizawa and Casida, 2003). This causes excitation of the nerves and results in paralysis and ultimately death. These insecticides are selectively

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more toxic to insects than to other classes of animals (Hopwood *et al*., 2012). The botanical insecticide nicotine act at the same target without the neonicotinoid level of effectiveness or safety (Tomizawa and Casida, 2003) (Fig. 1).

Impact on pollinators

Toxicity of neonicotinoid insecticides on workers of honeybee revealed that cyano-substitation (thiacloprid and acetamiprid) were less toxic than nitroguanidine-substituted *i.e.* imida-cloprid and thiamethoxam (Takao *et al.,* 2004). Neonicotin-oids, a class of systemic insectcides are more frequently associated with the pollinators declines in Europe (Grimm *et al*., 2012).

Honey bee dies due to effect of neonicotinoids (Source: https://www.thestar.com/news/queens park /2015/06/09/ontario-first-in-north-america-to-ban-bee-killing-neonicotinoid-pesticides.html)

Impact on natural enemies and other invertebrate

Imidacloprid applied at field rates caused significant mortality of nymph and adult of the predatory stink bug, *Podisus maculiventris* (De Cock *et al*., 1996). A deleterious impact of imidacloprid was observed on *Chrysoperla carnea* (Elbert *et al*., 1998) and earthworm (Wang *et al.,* 2012). Clothianidin when applied at 60 g *a.i.* ha^{-1} was found to be safe to natural enemies in okra (Sreenivas *et al.,* 2014).

Residue in food

Devee and Baruah (2010) suggested waiting period of four days after application of imidacloprid at recommended dose (20 g *a.i.* ha^{-1}) on rapeseed. Pandiselvi *et al.* (2010) reported that the residues of imidacloprid on cotton plant dissipated to below detectable level after tenth day. Contaminations other than the neonicotinoids (organochlorines and synthetic pyrethroids) were found in the fruit samples analyzed in Assam (Chaudhry *et al.,* 2014). Washing plus steam cooking dislodged imidacloprid residue in tomato by 65.93 per cent (Dharmarajan and Dikshit, 2010). Maximum residue level of acetamiprid was higher in Japan compared to US and UE (Anon., 2010).

Residue in soil and water

Maximum availability of imidacloprid in water and soil from controlled released formulations was ranged from 24.2-42.1 and 25.1-46.9 days, respectively (Kumar *et al.,* 2004). Residue was found up to 90 days in the field cultivated with imidacloprid treated seeds of groundnut (Singh and Singh, 2004). Singh and Gajbhiye (2004) reported that a residue of thiacloprid was not detected after 22 days of soil application and it was detected only up to 15 cm soil depth. Thiamethoxam has a potential to leach down under heavy rainfall condition (Gupta *et al.,* 2008). Estimated dissipation times (DT_{50}) in soil for neonicotinoids studied by Goulson (2013) revealed that half lives appeared to be shorter for cyanoimine. The degradation of imidacloprid was faster in soil

having higher clay content (Pandiselvi *et al.,* 2011). Concentration of thiamethoxam in leachates was higher compared to organophosphates while retention at various depths was higher in case of imidacloprid and thiamethoxam (Sreekumar and Shah 2014). Gopal *et al*. (2011) reported bacteria, *Burkholderia cepacia* as potential candidate for biodegradation of imidacloprid.

Resistance in insect

More than 330 cases of insecticidal resistance were reported against imidacloprid followed by 130 and 50 cases against thiamethoxam and acetamiprid (Chris Bass *et al.,* 2015). Mealybug, *Phenacoccus solenopsis* Tinsley was monitored for its resistance to insecticides and showed in the range of 4.0-30.9 fold for nitenpyram, 12.6-105.0 fold for acetamiprid compared to susceptible strain (Saddiq *et al.,* 2015). As per guideline (IRAC, 2015), always apply products at their recommended doses and spray intervals, do not manage the pest exclusively with neonicotinoids and follow 'escape' principle of host plant resistance.

Toxicity to human and other vertebrates

Forrester (2014) reported abnormality in respiration, nervous system paralysis, coma and death of human being. Neonicotinoids are systemic and long persistence in soils and reported chronic toxicity in birds and affect in their reproduction (Minue and Palmer, 2013).

Conclusion

Neonicotinoids constitute a major class of insecticides with a broad and versatile spectrum of applications in agriculture. Neonicotinoids can persist and accumulate in soils, prone to leaching into water ways as well as high toxicity to pollinators and natural enemies including beneficial invertebrates. Residue in food and plants can be minimized by adopting some local methods before cooking. Development of resistance in insect towards this group can be managed by following some precautions and guidelines.

Future thrust

- ✓ Need to understand, how concentration of neonicotinoid in pollen and nectar may vary with application method.
- ✓ Need to encourage the farmers to avoid prophylactic uses of neonicotinoids where the pest is sporadic in nature.
- ✓ Need to re-evaluate the use of neonicotinoids on the basis of its profitability.
- ✓ Need to evaluate the use of neonicotinoids in relation to short term v/s long term sustainability of an ecosystem.

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Asafoetida (*Ferula asafetida*): A High Value Crop with Potential Health Benefits

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Abstract

Nowadays it is a popular ingredient in the Indian cuisine, most probably because its odor is reminiscent of the flavour of garlic and onion, as well as meat. Asafoetida is a dried powdered gum resin extruded from rhizome and roots of Ferula herb. It is a strong and pungent spice and important part of Indian cuisine with good medicinal properties. It is a good source of nutrients like iron, potassium, calcium and volatile essential oils. It has good antioxidant, anti-inflammatory properties and used in the treatment of respiratory problems, flatulence, hypertension and menstrual cramps. It has potential antimicrobial and antiseptic properties helps in treating of toothache, bad breath, bleeding gums, stimulates pancreatic cells to secrete more insulin and helps in maintenance of glucose levels. It is also used as a pesticide and insecticide for protecting crops from pests and for repelling mosquitoes and certain other insects.

Introduction

Ferula asafoetida is commonly known as Devil's drug, Ferula, Food of Gods, Incense of Devil and stinking gum. The word ferula means "carrier" or "vehicle". The Asa is a latinized form of Farsi asa "resin", and Latin foetidus means "smelling, fetid". It belongs to family Apiaceae. Stem and roots of the plants are the sources of the oleo resin. Due its stinking flavour and pungent odour it cannot be palatable in its pure form and so, it can be blended with flour and edible gums for consumption. Presence of sulphur compounds is responsible for the acrid taste and displeasing pungent odour. Asafoetida contains 25% endogenous resin, 40-64% resin, 10-17% volatile oil and 1.5-10% ash. The sulphur compounds present in its resin had various biological activities and therefore had great medicinal value. Asafoetida is used as flavouring agent in many Indian recipes like curries, dal, sambhar and pickles (Sood *et al*., 2020).

About 130 species of asafoetida are available across the world but only two species are grown in India like *Ferula jaeschkeana* (Chamba) and *Ferula narthex* (Kashmir and Ladakh), but only *Ferula assa-foetida* L. species yields asafoetida. Even though asafoetida is a high value spice started cultivation in India, it has many climatic challenges. Dry and cold conditions, sandy soil with very litter moisture and annual rainfall of not more than 200mm is suitable conditions. Under proper conditions the grow up to 6 feet and take 5 years to develop fleshy roots from which this oleo resin gum can be extracted

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Asafoetida history and cultivation in India

Asafoetida has its historical roots in the Afghanistan. India is one of the major importers of this spice from Afghanistan, Uzbekistan, United Arab Emirates, Tajikistan and Iran. India mainly imports white variety from the Afghanistan and red variety from the Uzbekistan, Tajikistan and Iran. White variety is very popular in India and about 130.5USD million of asafoetida was imported during the year 2019-20 and account for 98.2% of total imports of Afghanistan. Currently asafoetida imported in raw form and processing in India to reduce the costs. In order to reduce the import costs, Council of Scientific and Industrial Research (CSIR)-Institute of Himalayan Bioresource Technology (IHBT) (Palampur, Himachal Pradesh) made an initiative to cultivate this expensive crop in India. It has procured 6 accessions of asafoetida seeds during 2018 from Iran through ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR). As the seeds remain dormant for prolonged periods as a part of adaptation technique to survive in desert conditions, germination was a challenge and only 1% of the seeds germinated. To tackle IHBT developed an agro technology which included special chemical treatment. 800 saplings of Ferula asafoetida were planted in the cold desert region of Lahaul and Spiti. Further cultivation will be done in a staggered manner.

Cultivation in cold desert areas of Ladakh and certain areas of Himachal, Uttarakhand and Arunachal Pradesh will be suitable for its growth and will in turn also change the economic condition of people in these regions. It is estimated that each plant can yield about 500 gm of resin and is processed to yield 250 gm of asafoetida powder. So, with the investment of 3 lakh ha^{-1}, from the 5^{th} year onwards farmers get the profit of about 10 lakhs. In the next 5 years in Himachal Pradesh, government of India planning to cover a total of 750 acres of land under asafoetida saffron cultivation. With the government support, asafoetida cultivation will ensure livelihood support for farmers in cold regions of India and also reduces the cost of the asafoetida.

Botanical description

Asafoetida is herbaceous, monoecious and perennial plant grow 2.5-3 meters. It has circular mass of leaves with 30-40 cm diameter. The inflorescence is densely pubescent and the flowers are pale greenish-yellow in colour borne in large compound umbels. It has about 10-20 flowers in main umbels and 5-6 in the partial umbels. Only the female plant produces the oleo gum or asafoetida. Fruits of the pant are 0.8cm long with tender hairs, oval, flat, thin and reddish-brown. The flowers and fruits generally appear in March-April month. The shrub of Asafoetida needs 4 to 5 years for producing seed and after that plant dies. Roots are carrot shaped with thick, massive and covered with bristly fibres. After about five years, the fusiform taproots attain a diameter of 12 to 15 cm at the crown which gives the indication that plant is ready for extraction of asafoetida. Roots yield a resin similar to that of the stems. All parts of the plant have a distinctive putrid

smell. Tapping is usually done before flowering (March-April), when the plant sprouts from the taproot. After a month, the green foliage turns yellow. At this stage, the stem is cut near the crown. The milky juice exudes from the cut surface, which coagulates on exposure to air. After a few days, the exudate gum resin is scraped off (Sood *et al*., 2020).

Asafoetida (*Ferula asafoetida*)

Chemical composition

The chemical composition of asafoetida per 100 gm contains 68% carbohydrates, 16% moisture, 4% protein, 1% fat, minerals 7.0% and fiber 4.1%, calorie-297 kcal, 40-64% resinous material composed of ferulic acid, umbel-liferone, asaresinotannols, farnesiferols A, B, and C etc., and 25% gum composed of glucose, galactose, l-arabinose, rhamnose, and glucuronic acid and volatile oil (3-17%) consisting of disulfides as its major components, notably 2-butyl propenyl disulfi de (E- and Z-isomers), with monoterpenes (α- and β-pinene, etc.), free ferulic acid, valeric acid, and traces of vanillin (LAF). The disagreeable odor of the oil is reported to be due mainly to the disulphide $C_{11}H_{20}S_2$.

Processing and Value Addition

Asafoetida is processed and marketed either as lumps or in powdered form. The lump asafoetida is the most common form of pure asafoetida. The trading form is either the pure resin or so-called "compounded asafetida" which is a fine powder consisting to more than 50% of rice flour and gum arabic to prevent lumping. The advantage of the compounded asafoetida is that it is easier to dose. The gum-resin is also steam distilled to obtain the essential oil known as Oil of Asafoetida.

The main products of asafoetida are:

- ✓ Volatile oil
- ✓ Tincture of gum resin
- ✓ Compounded asafoetida

Health benefits

Ease anxiety due to its sedative qualities, remedy for cough, cold, asthma, and chest congestion. Anti-flatulent and effective digestive aid. As a natural contraceptive. Treats dysmennorhea or painful menstruation, excessive bleeding, irregular or delayed periods, leucorrhea, nausea, fatigue, anxiety, and other symptoms associated with menses. Addresses male and female reproductive problems in a natural way. Effective in improving the quality and quantity of breast milk in nursing women. Post-pregnancy use period is recommended for relieving colic, indigestion, and other digestive difficulties in both the mother and the baby. The ethanolic ferula assa-foetida oleo-gum-resin extract can regulate hyperglycemia and complications of diabetes and its antidiabetic and hypolipidimic activities are related to its antioxidant activity. In this mechanism of action, phenolic and flavonoids compounds like ferulic acid, unmbelliferone and

quercetin may play an important role.

Mouth-washing with asafoetida can be recommended as an effective herbal mouthwash for improving the indices of gingival health. Its extract has showed significant anti-helmintic activity at the highest concentration of 100 mg mL^{-1}. The hydroalcoholic extract of F. assa foetida exhibited anti-diarrheal activity due to its inhibitory impact on intestinal fluid accumulation. Its aqueous extract of resin has a great influence on the healing of diabetic ulcers by increasing epithelial cell proliferation and blood vessel formation and accelerate the inflammatory process. Asafoetida has potent anti-tumor and anti-metastasis effects on breast cancer and is a potential source of natural antitumor products. Ethanolic extract of Ferula asafoetida has potent antidepressant-like activity, due to the anti-oxidant property of Ferulic acid, umbelliferone and other neuro-protective compounds.

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Pusa Decomposer: A Fantastic Solution to Stubble Burning

Umesh Kumar Singh, Hritik Srivastava and Yashvant Singh

Punjab, Haryana, and Uttar Pradesh in northern India have developed extensive action plans to combat stubble burning in the upcoming winter season, with a potential increase in the use of the bio-decomposer solution developed by the Indian Agriculture Research Institute (IARI) in Pusa, according to the recently established Commission for Air Quality Management (CAQM). The plans call for the use of bio-decomposer solutions on more than 6 lakh acres in Uttar Pradesh, 1 lakh acres in Haryana, 7413 acres in Punjab, and more than 4,000 acres in the capital city of the country, Delhi, according to the Commission.

The Issue

Each year, it is estimated that over 5.7 million acres of rice stubble are burned on fields in Punjab and Haryana alone, resulting in severe environmental issues, deteriorating soil quality, and the extinction of flora and animals. From October to December, there is stubble pollution in Delhi and the surrounding areas. Toxins turn Delhi's air into an unpleasant mixture of pollutants, irritating the city's residents' eyes, skin, and lungs. The WHO reports that Delhi is one of the world's most polluted cities, and that breathing in this pollution reduces people's lifespans by an average of nine years. A significant percentage of this pollution is caused by farmers from the neighbouring states of Punjab and Haryana burning agricultural waste. These farmers are forced to burn stubble because they have no other viable options, not out of spite or malicious intent. Their meagre income is not further diminished by burning because it is less expensive.

PUSA bio-decomposer: what is it and how does it work?

PUSA biodecomposer is a bioenzyme that IARI developed. A combination of seven fungus called Pusa Decomposer produces enzymes that break down the cellulose, lignin, and pectin in paddy straw. When paddy is harvested and wheat is sown, the temperature is between 30 and 32 degrees Celsius, which is when the fungi flourish. As the stubble breaks down, it transforms into manure, improving soil quality and reducing farmers' input costs for fertilisers for the subsequent crop cycle. 300 grammes of PUSA spray will break down an acre of stubble. What is PUSA's acronym for? In the village of Pusa in the Bihar district of Samastipur, the

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Imperial Agriculture Research Institute, the first agricultural institute in Asia, was established. It is claimed that Pusa was given its name in honour of Henry Phipps from the US, who donated the initial funding for its establishment.

How PUSA bio-decomposer is used on fields?

- ✓ To ensure quick bio-decomposition of agricultural stubble, a liquid formulation is made utilising decomposer capsules and fermented over 8-10 days. The mixture is then sprayed on areas with crop stubble.
- ✓ The farmers can blend 4 capsules, jaggery, and chickpea flour to make 25 litres of liquid. One hectare of land can be covered using the combination.
- ✓ The degrading process takes about 20 days to finish.

Advantage of PUSA Decomposer over Happy Seeder or another technique

Any solution must be cost-effective to be universally accepted, and this is especially true when dealing with farmers whose livelihoods are at risk. Despite obtaining government aid, a Happy Seeder requires powerful tractors to install and is a significant investment. These models make up only 15% of all tractors in the country. It is not a practical option for farmers who would rather burn their fields than utilise heavy machinery because of this. Balers carry out similar operations.

Why is burning of stubble such a huge problem?

Since modern harvesters are speedier and don't impair the grain's quality, many farmers use them to harvest their crops. The disadvantage of this, meanwhile, is the massive amounts of stubble that are created; in the case of paddy crops, this stubble can reach heights of 5 to 6 inches. The farmer chooses a speedier and less expensive alternative to burning the garbage because it would be time- and money-consuming to remove them using physical labour or other tools. The farmer also needs this so that he may promptly sow his following crop. If he doesn't, his harvest after that will have a lower yield or come later, which will affect his ability to make money.

The harmful effect of stubble burning

- ✓ It taints the environment. The smoke in Delhi has angered the general people and decision-makers.
- ✓ Along with other plants and animals in the fire's path, it also destroys soil microorganisms.
- ✓ Raises the carbon effect of the agricultural sector substantially.
- ✓ Puts the economy and the environment in jeopardy.

Downsides of PUSA decomposers

Many experts and farmers agree that it takes a very long time for the stubble to break down in the fields after using the decomposer, and that farmers have a very limited window of time to harvest their standing paddy before the subsequent wheat crop is sowed. In some cases, paddy stubble can take up to 40 days to completely break down, but the window of time between paddy harvest and wheat sowing is much shorter.

Ber (*Ziziphus maruitiana*): Pest and their Management

Pooja Sharma and Sushila Choudhary

1. Ber Fruit fly (*Carpomyia vesuviana*)

This fruit fly is the most destructive pest of Ber. It is a monophagous that infests only on Ziziphus species growing under arid and semiarid region in India and also in oriental Asia, Middle East, Temperature Asia, China and South Europe. It contributes toward low yield and poor quality of fruits and causes yield loss up to 80% under severe infestation. Among these *C. vesuviana* has been observed to damage as much as 80% of the crop under severe infestations (Cherian and Sunderam, 1941).

Nature of Damage

The maggots start infestation with the onset of fruit setting. The fly lays eggs singly in the young developing fruits. After 2 to 5 days the newly hatched maggot's starts feeding on the pulp and make galleries with accumulated excreta and result in rotting of fruits. The Larva burrow the flesh round the Centre leaving excreta that give fruits a bitter taste. In arid region, the infestation starts from end of September and the higher incidence is during December-January.

Management

- ✓ The fruit fly cause internal damage, preventive measures are essential and synthetic insecticides are major tools for the successful management.
- ✓ Clean cultivation surrounding the orchard through destruction of pruned parts of cultivated as well as the wild bushes.
- ✓ Collection of all fallen, bird damaged and infested fruits at periodical interval and proper destruction and feed such fruits to sheep goats, camels or other farm animals or bury them at least on one meter deep in compact soil can avoid the fly's emergence.
- ✓ Deep and through racking up of soil during hot summer to expose the residual pupa to hot summer it also been destroy the over wintering pupae through mechanical injury during the operations.
- ✓ Use of resistance varieties like Tikadi, Katha and illaichi for fruit fly management.
- ✓ There is no successful record of parasitoids, predators and pathogens against the *C. vesuviana*. The braconid, *biostres vanden-boschi*, *Bracon fletcheri* and *Omphalia* sp. on Ber fruit fly were reported.
- ✓ The Wasp parasitoid, *Fopius carpomyia* was found at larval stage of fruit fly and ovipositor is very suitable to parasitize the hidden host in fruits. The rate of parasitization was up to 28.8% under natural condition. The extract of azadiractin 1% and Ocimum sanctum 1% were

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effective up to 10 days after spraying.

- ✓ Bait spray combining molasses or jaggery 10 g L^{-1} and one of the insecticides, Malathion 50 EC 2 ml L^{-1}, dimethoate 30 EC 2 ml L^{-1} of two rounds at fortnight interval before ripening of the fruits.
- ✓ According to Singh *et al*. (2000) the schedule consisting of monocrotophos (0.05%), malathion (0.05%), malathion (0.05%) resulted in the lowest percentage of fruit infestation at 15 days after the 1st, 2nd and 3rd sprayings (9.30, 7.30 and 4.60%, respectively).

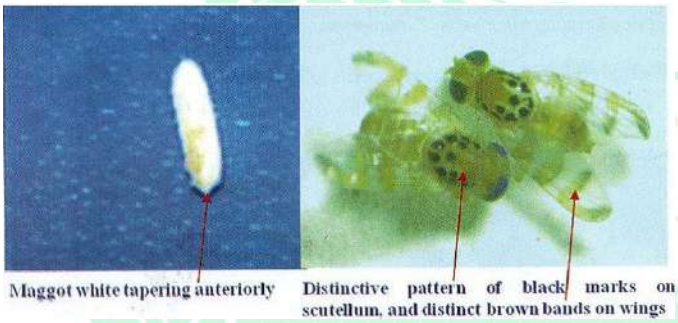

Fig. 1 Ber Fruit Fly

2. Ber stone weevile (*Aubeus himalayanus*)

Ber stone weevil, *Aubeus himalayanus* was recorded as a new pest of ber for the first time from Karnataka state of India in 1993.

Nature of Damage

When damaged fruit are cut open, the developing seed is completely eaten away by the pest. In the hollowed area, each of these fruits have a grub, a pupa or an adult which is identified as Ber seed weevil. The infested fruits are round in shape and varied in size ranging from pea to pebble. The fruits do not attain maturity and never increase in size more than pebble.

Management

- ✓ Collection and destruction of adult weevil immediately after detection can also reduce the population. Infested dropped fruits should be collected and burned to break the generation cycle.
- ✓ Deep and through racking up of soil during hot summer to expose the residual adult to hot summer, it also been destroy the over wintering adult through mechanical injury during the operations.
- ✓ The variety of ber like kali, katha, Ilaichi and Tikadi were found resistance to stone weevil.
- ✓ NSKE 5% and azadirachtin 2000 ppm and 1000 ppm were also found to be superior over control treatment in minimizing the weevil incidence.
- ✓ Application of Spinosad 2.5 SC and indoxacarb 14.5 EC before the fruit setting and repeat the sprays at three week interval was found effective and showed significant reduction in weevil incidence.

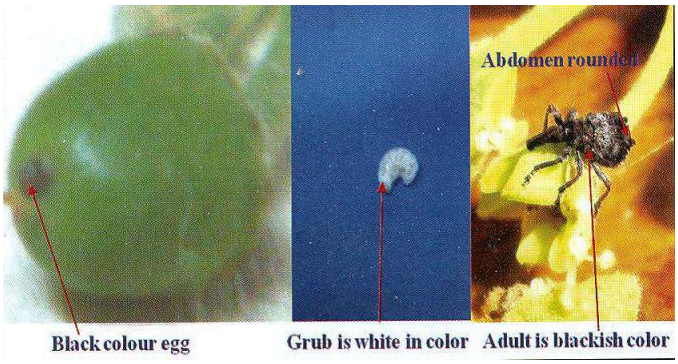

Fig. 2: Ber stone weevile

3. Ber fruit borer (*Meridarchis scyrodes*)

It is distributed all over the country. It is not a major pest of Bikaner area but it is major in Sirohi, Jalore, Barmer district of Rajasthan and Gujrat.

Nature of damage

The larva bore into the fruit feeding on the pulp and accumulating faecal frass within. Up to 40% of the fruits are damaged during July and August. According to Gopali *et al*. (2003) the activity of pest was from the first week of November (3.27%) reaching its peak (43.50%) during the fourth week of December and continued up to the second week of January (27.40%).

Management

- ✓ Removal of wild ber tress around the ber orchard.
- ✓ Rack the soil under the tree or near the trees to destroy the maggots and residual pupae present in the soil.
- ✓ Collection and proper destruction of infested fallen fruits. Harvest of fruits at immediate after maturity (green stage)
- ✓ Growing of resistant cultivars like safeda, Illaichi and Tikadi to found less incidence of fruit bore
- ✓ The cultivars Banarsi Pewandi, Ajmeri, Gola Gurgaon and Jhajjar Selection have been found to be resistant to the pest (Azam-Ali *et al*., 2006).
- ✓ The Neem Seed kernel Extract (NSKE) at 5% found as effective as like synthetic chemicals. Methanol extract of *Annona reticulata*, *Azadirachta indica* and *Ocimum sanctum* at 1% concentration recorded 60-70% mortality after 48 h after spray.
- ✓ Sprays of dimethoate 30 EC + jaggery solution (1.0%) at marble stage and one spray at maturation stage resulted in minimum infestation and found to be more economical.
- ✓ Control schedule comprise of malathion at 2 ml or fenvalerate at 1 ml lit^{-1} of water first spray at marble stage, second spray at 15 days later and third spray at fruit ripening stage by alternate use of insecticides would be effective against the fruit borer.

4. Termite (*Odontotermes obesus*)

Termite or white ants are warmth loving insects and inhabit the entire tropical and subtropical regions of the world except higher altitudes where temperature is too low and the deserts where there is no food. They devour not only the live plant material but also the dead wood.

Nature of damage

The internal part of plants are eaten away up to 1-2 feet height of stem and filled with earth. The damage is more severe in nurseries and young newly planted orchards where the entire seedlings or saplings may dry and die away.

5. Ber butterfly (*Tarucus theophrastus*)

It is found in northern and western Africa, Arabia, Persia, Baluchistan, N. W. Himalayas, Assam, Punjab, western, central and southern India, Sri Lanka and upper Burma.

Nature of damage

The Ber trees are always severely pruned during may-June and the newly sprouting tender shoots and leaves are attacked by Ber butterfly. Due to its attack, the leaves dry up and tender shoots do

not grow properly. Larvae feed on sprouting tender shoots leaves and flower buds. Infested leaves gives whitish look due to feeding of chlorophyll and finally the leaves remain with long streaks.

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Major Insect Pest of Coffee and their Management

Pooja Sharma and Om Prakash

Major pests of coffee are the white stem borer (*Xylotrechus quadripes*), Coffee berry borer (*Hypothenemus hampei*), Short-hole borer (*Xylosndrus compactus*), Mealybugs (*Planococcus citir* & *P. lilacinus*), Green scale (*Coccus viridis*) and root lesion nematode (*Pratylencbus coffeae*).

1. White stem borer (*Xylotrechus quadripes*)

Identification

Adult is a slender beetle, 1 to 2 cm long. The forewings are black with white bands. Adults are active in bright day light. Female beetles deposit eggs in the cracks and crevices and under the loose clay bark of the main stem and thick primaries preferring plants exposed to sun light.

Damage

The Larvae enters the hard wood and burrows up to the roots. Infested plants show yellowing and wilting of leaves, presence of ridges on the stem; wilting of branches and occasional drying (Jayraj 2013).

Management

- ✓ Timely harvest reduces carry over inoculums and thorough harvest breaks the life cycle. Removal of off-season berries to break the continuity of the breeding Spread gunny/plastic sheets (picking mats) below the plants minimizes the gleaning.
- ✓ If gleanings could not be collected they may be swept along with the mulch and buried below a depth of 0.75 m in the soil. Avoid excess shade. Train bushes properly. Avoid planting tree coffee Dry coffee to the prescribed specification: Arabica/robusta parchment-10.0% (15.5 kg for lit) *Arabica* cherry - 10.5% (16.0 kg for lit).

2. Coffee berry borer (*Hypothenemus hampei*)

Identification

The adult berry borer is a small black beetle with a sub-cylindrical body covered with thick hairs. Females are approximately 2.5 mm long. Males are smaller. The female beetle bores into the berry through the navel region. Though berries in various stages of development are attacked, tunneling an ovipositon occur only in hard beans. The mother beetle lays about 15 eggs in the tunnel. Eggs hatch in about 10 days. The larvae feed on the beans making small tunnels. Larval period lasts for about 20 days and the pupal period for a week.

Damage

A typical pin hole at the tip of the berries indicates the presence of the pest. In case of a severe infestation, two or more holes may be seen, either in

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the navel or on the sides. A powdery substance pushed out through the holes reveals the active tunneling and feeding within the beans.The pest damages young as well as ripe berries.

Management

Timely harvest reduces carry over inoculums and thorough harvest breaks the life cycle. Removal of off-season berries to break the continuity of the breeding. Spread gunny/plastic sheets (picking mats) below the plants minimizes the gleaning.

If gleanings could not be collected they may be swept along with the mulch and buried below a depth of 0.75 m in the soil. Avoid excess shade. Train bushes properly. Avoid planting tree coffee. Management strategies have focused on the use of African parasitoids (*Cephalonomia stephano-deris*, *Prorops nasuta* and *Phymastichus coffea*), fungal entomopathogens (*Beauveria bassiana*), and insect traps (Francisco, 2018).

3. Shot hole borer (*Euvallacea forhicatus Eichh*.)

Identification

The adult xyleborus beetle is minute measuring 3-4 mm in length. It lays eggs at junction and opening of side branch and covers with a wad of damp saw dust.

Damage

The grub tunnel in to the stem which interferes the flow of sap, weakening the stems. Presence of round shot holes in primary branches, mortality of buds, dieback in branches and circular or longitudinal tunnels inside the stem are the symptoms of attack.

4. Mealy bugs (*Planococcus citri*)

Identification

Adult females are small oval, elongate, soft bodied and wingless, covered with mealy wax. Of the two common species, *Planococcus citri* is oval, elongate and lays eggs in a fluffy ovisac, while *P. lilacinus* is globose and the eggs are not laid in ovisac. The mealy bug lays 100-1000 eggs. The females attain maturity in about a month.

Damage

Mealy bug attack nodes, spikes, berries, tender branches, leaves and roots leading to debilitation of the plant and crop loss. In some cases, the mealy bugs infest the roots. Mealy bug population increases if warm and humid conditions prevail. Continuous monsoon, high humidity and low temperatures are detrimental to mealy bug development. The migration of mealybugs starts in September/October from the ground to the aerial parts of the coffee plant through the main stem. The attack of mealybugs becomes severe during summer and with intermittent showers/irrigation.

Management

Maintain optimum shade. Control ants by dusting Quinalphos 1.5% or methyl parathion 2% or Malathion 5% dust around the base of the bush and shade trees and destroy ant nests. Remove and destroy weeds, as many of them harbor the pests. Spray the affected patches with Quinalphos 25 EC or Fenitrothion 50 EC @ 300 ml or Fenthion 1000 @ 150 ml or 4 liters of kerosene in 200 litres of water along with 200 ml of an agricultural wetting agent.

While spraying kerosene. The spray solution should be stirred frequently to avoid setting of kerosene. If the root zone is affected, drench it with any one of the above insecticide solutions, except kerosene emulsion. Release the parasitoid, *Leptomastix dactylopii* against *P. citri* or the Preadtor, *Cryptolaemus montrouzieri* irrespective of the species of mealybugs.

5. Green Scale (*Coccus viridis*)

Identification

The adult scale is flat, oval, light green with an irregular dark distinct loop on the middle of the dorsum. The adult is sedentary and spends its whole life in one place, it lays 50-60 eggs. The duration of the life cycle is 4-6 weeks. Adult lives up to 2-5 months.

Damage

The scale attacks tender parts, setting down on the underside of the leaves close to midrib, veins, and tips of green shoots. The continuous sucking results in excess loss of sap from the plant which leads to debilitation of the older plants and death of nursery plants. The honey dew secreted by the scale forms a film on the leaves and a black fungus (sooty mould) grows on it, which hinders photosynthesis.

Management

Control ants by dusting quinalphos 1.5% or methyl parathion 2% or malathion 5% dust around the base of the bush and shade trees. Destroy ant nests. Remove and destroy weeds, as many of them harbor the pest. Use recommended dose of insecticide when the attack is above ETL.

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Use recommended dose of insecticide when the attack is above ETL.

7. Root lesion nematode

Identification

The nematode lays eggs in the root-lesions. Development from egg to adult takes about a month. All stages of the nematodes are attracted to the young and vigorously growing roots but only the second stage juveniles enter the roots at the piliferous zone.

Robusta exhibits tolerance to the nematodes at all stages, and the nematode takes more time to complete its life cycle in robusta than in Arabica. The nematode spreads to other areas through estate implements, rain water, plants taken from the infested nurseries and soils taken from infested blocks. The pest is persistent in the soil and roots all round the year. Higher population is noticed during the months of July, August and September when there is heavy rainfall and increased root activity. The population declines from December to March.

Damage

Nematodes feed and destroy the tap root, secondary roots and feeder roots. Affected plants put forth adventitious roots at the collar region during rainy season. Such plants have loose anchorage and could be easily dislodged. Affected old plants lack secondary and tertiary roots. Affected young plants become unhealthy with lean and lanky stem.

Management

In the nursery dig up the nursery site and expose the soil to the sun during summer. Sieve and dry jungle soil and farmyard manure thoroughly before use. Avoid obtaining nursery plants from infested areas.

In the filed uproot and burn the affected plants. Dig up pits and expose the soil to the sun for at least one summer.

Take care to keep the pits free from weeds. Plant the area with Robusta (if suitable) or Arabica - Robusta grafted plants (Arabica scion grafted on to Robusta root stock at ‘topee’ stage).

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Importance of Forecasting Agricultural Prices using Time Series Models

Umesh Kumar Singh, Dr. Pawan Kumar Goutam, Yashvant Singh and Hritik Srivastava

Introduction

Agriculture is at the heart of the Indian economy, and any significant changes in the sector have a multiplier effect on the entire economy. It employs more than 50% of the workforce and contributes approximately 17% to the Gross Domestic Product (GDP). The country's largest industries, such as sugar, textiles, and food processing, rely on agriculture and allied services for raw materials. Paddy, wheat, pulses, edible oil, and horticulture are among the major crops grown in India. Other important allied services include poultry, fishery, and animal husbandry. Despite robust demand, attractive opportunities, and policy support, the sector is plagued by high price volatility, low farmer income, skewed MSP rates, and a lack of credit facilities. As a result, a long-term strategy for assessing demand and supply and forecasting crop prices is required.

Crops of Importance

In cereal-centric agriculture, the prices of paddy, wheat, and pulses are critical. Prices of vegetables such as potatoes, tomatoes, and onions must also be closely monitored because they affect the country's food inflation rates. Furthermore, under the MSP regime, the prices of 24 commodities, including 8 oil seeds, raw cotton, raw jute, and copra, are critical in determining minimum support prices as well as procurement prices for the Public Distribution System (PDS).

As a result, agricultural prices have a direct impact on producer income and the nation's food security. Data Sources, The Ministry of Agriculture's Directorate of Economics and Statistics, Agriculture (DESAg) is the primary source of agricultural statistics. Other data sources include the National Sample Survey Organization (NSSO), the State Directorate of Economics and Statistics (DES), and the Central Statistical Organization.

A significant portion of this data is time series data, which measures agricultural prices at various time intervals - yearly, monthly, quarterly, or daily. These price series demonstrate trends, as well as the seasonality and cyclical nature of agricultural prices. These agricultural price time series data can be used to forecast short-term and long-term price estimates.

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It can aid in identifying price patterns and seasonal variations, particularly concerning production during the *kharif*, *rabi*, and *zaid* seasons. Agricultural price forecasting is also important for determining subsidy rates, minimum support prices, export prices, and so on. Thus, agricultural price volatility is being monitored and controlled, and policies to mitigate any adverse situations are being planned. Crop price time series can also aid in understanding, interpreting, and explaining instances of the economic crisis in the agricultural sector. Such time series intervention analysis can also help us understand the impact of sudden price changes on other sectors and the overall economy.

Time Series Models

There are several time series models available in the literature to analyse the agricultural price series (time series data). Statistical models such as Autoregressive Moving Average (ARMA), Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), and others, as well as recently developed machine learning models such as Artificial Neural Network (ANN), Support Vector Machine (SVM), and others, can be used to efficiently predict time series data and make accurate forecasts.

Conclusion

Forecasting future values using historical data and appropriate models is extremely useful in assisting farmers and policymakers in making sound decisions. This article emphasizes the significance of forecasting agricultural prices.

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Liquid Organic Manures

Umesh Kumar Singh, Yashvant Singh and Hritik Srivastava

Introduction

Farmers in the present period rely on the adoption of cutting-edge technology and the indiscriminate use of chemical fertilisers to increase crop production, which has an indirect impact on the health of the soil and reduces soil fertility. Chemical fertiliser use not only increased agricultural productivity but also caused poisonous compounds to build up in the soil, which plants then absorbed, having an indirect negative impact on human health and harbouring soil conditions vital for crop growth. Restoration of soil health through the addition of organic matter, green manuring, crop rotation, use of environmentally friendly organic fertilizers, etc. is urgently required in order to maintain the soil fertility status. Adopting natural or organic farming with no budget can assist farmers in preserving the fertility and productivity of their soil. These days, using liquid manures has been beneficial in preserving the health of the soil and crops. The fermentation or decomposition-derived byproducts of organic matter, *i.e.,* animal and plant waste, are liquid organic manures. Macro- and micronutrients, growth regulators, and other advantageous substances are now easier to get thanks to the use of liquid manures. The plant can withstand biotic and abiotic stress thanks to the substances' ability to support and enhance its physiological and biochemical processes. The liquid manures increase the availability of microorganisms and microflora, which increases their microbial activity in the soil. Liquid manures offer farmers greater benefits and are more affordable to generate than commercial fertilisers. The liquid formulations are used as a foliar treatment on the leaves or applied to soil and are only needed in small amounts because all the required ingredients are readily available. Jeevamruth, Beejamruth, Panchgavya, Vermiwash, Biodigested Liquid Manure (BDLM), and Biogas Spent Slurry are the various liquid manures.

Beejamruth

A treatment for plants, seedlings, or any type of planting material is called Bijamrita or Beejamruth. Young roots are effectively shielded from fungus as well as soil- and seed-borne diseases that typically afflict crops after the rainy season. It has similar components to Jeevamruth: Take a handful of soil from the farm's bund, 20 litres of

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water, 5 kilogrammes of local cow dung, 5 litres of local cow urine, 50 grammes of lime, and 20 litres of water.

Preparation

Take 5 kg of the local cow dung and bind it with tape in a cloth. Hang this for up to 12 hours in the 20 litres of water. Take one litre of water, add 50 grammes of lime to it, and let it sit for the night. The following morning, continually squeeze this bundle of cow dung into that water three times to ensure that all of its essence has been dissolved. Stir thoroughly after adding a little amount of dirt to the water solution. In the end, add 5 litres of desi cow urine or human urine to that solution together with the lime water and thoroughly stir.

Application

Any crop's seeds can be treated with Bijamrita by coating, mixing by hand, drying thoroughly, and then using for sowing. Leguminous seeds can simply be quickly dipped and allowed to air dry.

Jeevamruth

Jeevamruth is a traditional biopesticide and organic manure from India that is made using a special method that involves fermenting a mixture of cow dung, cow urine, jaggery, flour from pulses, soil, and water. Jeevan and Amrit, two words, make form the phrase. Jeevan, the first word, means “Life,” and Amrit, the second, means “Medicinal Potion.” Farmers that spend a lot of money on pesticides and fertilisers can utilise this incredible natural plant medicine instead and save money.

Preparation

Add 1 kg of jaggery and 1 kg of gramme flour to 100 kg of Desi cow dung (cow dung is only usable for 21 days; store it by maintaining moist, sprinkle water, and store in shade). Additionally, thoroughly combine the mixture and keep it in a shaded area for 48 hours. It is entirely organic and has no negative effects on the health of the soil. In addition to being economical, it is good for the soil and plants.

Application

It can be used as a liquid. Jeevamruth can be sprayed by combining with water and a 5-10% concentration. For an acre of land, 200 litres of jeevamruth are sufficient. It is sprayed every seven to fourteen days.

Advantages of liquid manures

- ✓ They are easier to find in water than bulky organic manures.
- ✓ Nutrients applied both topically and in the soil can be absorbed by plants 20 times more quickly, increasing crop production.
- ✓ By influencing the crop's photosynthetic activity, Jeevamruth and Beejamruth application boost grain output.
- ✓ The use of organic liquid formulations produces crops that are healthier and of higher quality.
- ✓ The application of organic liquid manures has enhanced soil structure and boosted soil's ability to retain water.
- ✓ Integrated pest control and integrated disease management are two crop management elements that are improved by the use of Panch-

gavya.

- ✓ Beejamruth can be sprayed to seeds and mixed with them before to planting a crop in order to boost the activity of the microorganisms and serve as a growth-promoting agent.
- ✓ Beejamruth enhances the crop's nutrient status, seed vigour, and seed germination rate.
- ✓ Liquid formulations assist in enhancing crop quality and advancing crop maturity.
- ✓ Earthworms, cow dung, urine, and other ingredients used in the preparation led to the creation of environmentally friendly organic liquid manures.

Disadvantages of organic liquid manures

- ✓ Liquid formulations have an unpleasant smell.
- ✓ They cause significant losses from volatilization
- ✓ Waterlogged areas are not suitable for spraying or applying liquid manures.

Weed Management under Organic Crop Production

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Introduction

Weed management in organic crop production systems must involve the use of many techniques and strategies, all the goal is achieving economically acceptable weed control and crop yield. Weeds can always be pulled or cut, but the question is simply how much time and money can a grower expend to reduce weed pressure. Ideally growers would like to achieve level of zero weeds on the farm. In practice, this may not be achievable, but any reduction in weeds and in the amount of weed seed or perennial propagules reaching the soil will make subsequent weed control operations less expensive. The cultural practices used in crop production (For instance, using transplants, pre-emergent, flaming of weeds, pre-germination of weeds) often provide opportunities for the crop gain. The goal is for the crop to outcompete the weeds, reducing the availability of resources to the weeds. If it can be given the crop a competitive advantage through organically acceptable techniques, subsequent hand weeding operations and costs can be minimized. The following are common techniques available to organic growers to manage weeds in crop production operations.

Cultural Practices

Water management: Effective water management is key to controlling weeds in crop operations. There are a number of ways to careful irrigation management can help to reduce weed pressure on the crop.

Pre-germination of weeds: The newly germinated weeds can be killed by light cultivation of flaming. pre-germination should occur as close as possible date of planting to ensure that change in weather condition do not have an opportunity to change the spectrum of weeds (cool vs. warm season) in the field.

Planting to moisture: Another technique is similar to pre germination *i.e.*, planting to moisture. After weeds are killed by cultivation, the top 2 to 3 inches soil is allowed to dry and form dust mulch. At planting, the dust mulch is pushed away and large seeded crops such as corn and beans can be planted into the zone of soil moisture. These seeds can germinate, grow and provide partial shading of the soil surface without supplemental irrigations that would otherwise provide for an early flush of weeds.

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Buried drip irrigation: Drip tape buried below the surface of the planting bed can provide moisture to the crop and minimize the amount of moisture that is available to weeds closer to the surface. If properly managed, this technique can provide significant weed control during periods without rain.

Crop Competition: Crop that grows vigorously can often outcompete weeds. Weeds grow best where competition is sparse, for instance, between rows or gaps in a crop stand. Crops that are well adapted to their planted areas are often better competitor since they will tend to occupy a site rapidly. The increase in the density of the crop by decreasing the in-row spacing or by reducing the space rows it will improve the crop competitiveness. A close planted crop will close the canopy more rapidly, reducing the weeds ability to compete. Some crop (Tomato, bean and sweet corn) compete effectively with weeds if given an early competitive advantage. The use of transplants give the crop an advantage over the weeds because transplants enter the field larger and more developed that the weeds. With help from subsequent cultivation or hand weeding operations, a transplanted crop can develop a full canopy and crowd out weeds.

Reducing the Weed Seed Bank: Practices that reduce the production of weed seed also weed pressure and can help keep weeding costs down over time. In an ideal situation, no weed would be allowed to go to seed. Any that do go to seed can aggravate weed problems for many years to come. As an example, common perslane seed has been sown to remain viable for over 20 year in soil, and black mustard seed survives for over 40 years. The longevity of weed seed, together with the large number of seed produced by individual plants can lead to the long-term build up of enormous seed banks in the soil. Highly competitive cover crops can also significantly reduce the seed bank.

Cultivation: Cultivation is probably the most widely used weed control method in organic crop production. Mechanical cultivation uproots and buried weeds. Burial works best on small weeds, while larger weeds are better controlled by destruction of the root-shoot connection or by slicing, cutting or turning the soil to eliminate the root system's contact with soil. Cultivation is effective almost against all weeds, with the exception of certain parasitic forms such as dodder. Effective cultivation must precisely and accurately target weed-growth areas, and so requires good land preparation and bed shaping. Shallow cultivation is usually best, since it brings fewer weed seeds to the surface. Level beds allow more precise depth of tillage. Cultivation requires relatively dry soil; subsequent irrigations should be delayed long enough to prevent the weeds from re-rooting. In addition, cultivation should be carried out early enough in the growth cycle to kill weeds such as burning nettle and perslane that set seed early in the growth cycle.

Flamers: Flamers are useful for weed control. Propane fuelled models are the most common. Flaming does not burn weeds to ashes; rather the

flame rapidly raises the temperature of the weed to more than 130°F. The sudden increase in temperature causes the plant cell shapes to expand, rupturing the cell walls for greatest flaming efficiency, weeds must have fewer than the true leaves. Flaming can be used prior to crop emergence in slow germinating crops. In addition, flaming can be used post emergence on crops.

Sterilization: Soil sterilization in organic agriculture involves the use of heat or naturally generated biocides to kill weeds. Heat is applied as steam or by soil solarisation. In steam soil sterilization, the steam injected into the soil to kill weeds seeds. The large quantities of fuel and water required by this technique make it an expensive choice, so its use is limited to small acreages of high value crops and landscaping. Ozone is a naturally occurring biocide that is being researched for use as a soil sterilant. The ozone is generated mechanically and then injected into the soil. Ozone injection shows promise as a weed reduction tool, but it is unclear at this time whether this technique will be considered an organically acceptable practice.

Mulches: Mulching is another weed control measure, a mulch block light, preventing weed germination and growth. The materials that can be used as mulches are varied and include plastic and organic materials such as municipal yard waste, wood chips, straw, hay, saw dust and newspaper. To be effective, mulch needs to block all light to the weeds, and some mulch materials require a thicker application layer that others to accomplish this. The most common colour for weed control plastic is black since it completely black light. More recently, a clear infrared transmitting plastic has been introduced. Organic mulches such as municipal yard waste, straw, hay and wood chips must be maintained in a layer 4 or more inches thick in order to block out light. Organic mulches break down over time and the originally thickness typically reduce by 60 percent after one year. Coarse green waste works better as mulch. Organic mulches are used for permanent crops, landscaping and non crop areas, although they are also very effective for transplanted vegetables.

Beneficial Organisms: Weeds are subjected to disease and insect attacks just as crops are. Most biological control of weeds occurs in range or non crop areas. As a result, biological control has little relevance for vegetable growers. Geese have been used for weed control in tree, vines and certain row crops. Most types of geese will graze weeds but Chinese weeder geese are considered the best for row crops. If confined, geese will even dig up and eat johnsongrass and burmudagrass rhizomes.

Chemical Control: Herbicides are chemicals that kill or suppress plants by affecting their physiological processes. Only a limited number of herbicides are organically acceptable, and these include contact materials such as acetic acid, citric acid, and solutions of sodium nitrate as well as preemergent material, corn gluten. Herbicides can be used for selective weed control by manipulating the timing of application or placement of material or by exploiting differences in the chemical tolerances of

the crop and the target weed. Weeds that emerge before the crop can be killed with contact herbicides (acetic acid) these herbicides kill plants that have emerged, but have no residual activity on those that emerge later. Corn gluten is a pre-emergence material that is applied to the soil to suppress weeds as they germinate. Currently, the efficacy of these organically acceptable herbicides is marginal at best.

Hydroponics: A Modern Approach for Quality Fodder Production

Dashrath Singh Chundawat and Meenu Choudhary

The disparity between demand and supply for household fodder at the moment is 20 to 25 per cent, with 60-65 per cent of it being immature dried fodder. The amount of available feed is restricted, though. Only 4 to 5 per cent of the cultivable land in the nation is utilised for the production of fodder. However, 10 to 12 per cent of the area must be used for the production of fodder, according to veterinary scientists. The ability to supply animal with fresh forage throughout the year is severely hampered by climate change and a shortage of water resources. But if we used contemporary technologies, we can address this issue quickly. Producing fresh, high quality feed in shorter amount of time and on less land is made possible by hydroponic system. The cost of producing feed is reduced with the use of this technology.

The "hydroponics" word is derived from two words in which "hydro" means water and "ponics" means work. In that approach, crops are grown in nutrient culture medium or soilless media like cocopeat, peat moss, perlite and vermiculite.

Dr. Alen Copper was the first person to employ this method in 1930. In America, Australia is countries where this technology is most common.

Growing maize, wheat and other fodder crops can be grown hydroponically in a small amount of space with little or no need for water. Fodder crops are occasionally grown in hydroponic system using the nutrient culture method.

How to use hydroponics system for fodder production

- ✓ In that technology, trays are used to assist plants grow in soilless media. Greenhouses. Particularly inexpensive greenhouses, and shade net are needed for that purpose. If they are not available, open shade is a good alternative.
- ✓ Choose maize for fodder production since it can grow in any habitat and during any season. Crops like wheat, barley, oats and others also appropriate. However, because bajra contains hydrocyanic acid, it cannot be used in hydroponic system.
- ✓ Before planting, high quality seeds are given a 12 to 14 hours soak in plain water. These seeds are then placed and wrapped with a cool cloth for 24 hours. Additionally, periodically sprinkle water on it. Because of this, seed germinate and

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grow exceptionally well.

- ✓ 2 kg of germinated seeds are added to each tray of seeds. Depending on their needs, seeds can receive water up to 4 to 6 times daily.
- ✓ Fodder grows to a height of 20-30 cm after 7-8 days. Compared to an open field, 10-12 kg of green fodder can be grown and cultivated.

How to serve fodder to animals: The easy digestion of hydroponics feed makes it palatable to animals. At the bottom of fully developed fodder crops, which resemble a mat, are trapped grains, roots, and other plant parts. As a result, emptying the feed tray becomes simple. Additionally you can chop this food into pieces or serve it whole. Only giving animals hydroponics feed has an impact on their digestion and increase the risk of stomach infections. In order to get over this issue, dry and hydroponics feed are mixed together and given to the animals. A single animal can be fed with 20 kg of fodder. 1 kg feed of ready feed is replaced with 7-8 kg fodder, which also lowers the cost. All animals, regardless of age, benefit from this meal.

Advantages of hydroponics fodder

- ✓ Hydroponics fodder is one of the solutions to give fresh and green fodder in cases of fodder scarcity.
- ✓ This feed is organic fodder.
- ✓ Production costs are lower.
- ✓ Daily food is provided, which lessens the need for storage, additionally, there is less nutritional value lost.
- ✓ Hydroponics fodder endures in all conditions, including drought and climate change.
- ✓ 7-8 days are needed for the finish the fodder growth process in a hydroponics system, but 45-60 days are needed in traditional method.
- ✓ Less space was needed for the growth of fodder. 400 square foot space are enough for 10 animals feed.
- ✓ Up to 25-40 per cent less cost is spent on animal feed, and 90 per cent of grain is digested by animals. Animal immunity has increased.
- ✓ Greater output with less energy, water, and labour expenditure.
- ✓ Increased intake of vitamins, minerals, and protein for the animals.
- ✓ Improvement to animal's reproductive efficiency.
- ✓ Require less solar radiation, thus we can also produce fodder in a container under a shade net.
- ✓ An increase in milk production and milk capacity. Additionally, milk contains more fat.
- ✓ Comparative speaking, traditional farming only uses 5-10 per cent of the water.

In less time and on less acreage, a hydroponics system makes it easier to grow fresh, high quality food. Money spent on the production of fodder and production times are kept under control with the aid of this technology. Plus, you may produce more with less money, water, and energy.

Cold Stress in Dairy Animals: Cause and Control

Dashrath Singh Chundawat and Meenu Choudhary

Climate plays a very important role farm animal production. Because weather elements like temperature, rainfall, humidity and wind affected to physiological process of livestock. Increasing and decreasing rate of these weather elements have effect on animal welfare and productivity. India are large country which divided into number of regions, most part of India has come under tropical climate.

Temperature are most important weather animals that has direct effect on biological functions of animal's body and affected to reproduction efficiency and milk production efficiency. Temperature above the critical temperature of body results heat stress and physiological system of body fail to regulate the body temperature within normal range. During the winter time due to wind chill and humidity the body temperature below the lower critical temperature results cold stress in dairy animals. When the body temperature below the critical temperature, dairy animals burn must energy for maintain body heat which create body condition losses. Cold stress also increases metabolic rate of body which increase energy expenditure for maintain normal body temperature range.

Signs of cold stress in dairy animals

In the cold stress behavioural response may provide useful information. When cold stress occurs due to low temperatures, heart rate, hyperthermia, decrease rectal and core temperature, deeper breathing and increase metabolism rate, resulting in and energy intake and even death. Fat layer and thicker coat are affected to cold stress because these are providing safety against it. During the cold stress metabolic rate also increase heat production in body and decrease old stress.

- ✓ Its decrease water consumption in animals.
- ✓ Cold stress has lower respiration and heart rate and delayed return to stress in animals.
- ✓ During cold stress blood is diverted from body development to protect vital organs.
- ✓ It decreases dry matter intake.
- ✓ Decreasing in milk production.

Effect of cold stress on dairy animals

Generally, two types of effect are seen during cold stress that are:

1. Direct effect

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- ✓ Production
- ✓ Reproduction
- ✓ Body condition score
- ✓ Feed utilization efficiency
- ✓ Health of animals

2. Indirect effect
   - ✓ Forage production in field.
   - ✓ Water quality and quantity.
   - ✓ Shelter over burn.
   - ✓ Mud accumulation.

Management of dairy animals during cold stress

Extra management practices are essential during cold stress because efficiency of production seriously affected by it. Some management practices are followed that reduce the cold stress in dairy animals that are:

1. Feeding management

In the time of cold stress extra energy required to animal because after use of body requirement some energy is required for maintain body temperature. Modification in feeding habit are essential in this time. Rate of eating increased by 22-31% for chopped hay and up to 10% for pellets at fixed intake, its reduce time of taking feed. Provide extra concentrate feed during this time and include high energy contain meals like grains. Addition of fibrous ingredient in the feed reduce the effect of cold temperature. Production of forage and fodder crops are directly affected by cold. This time scarcity of fodder is found. So conservation of fodder in form of hay and silage provide safety against it. Present time some special feeding materials are gaining popularity that are urea molasses mineral blocks and apple pomace. They have a high energy contain products. In urea molasses mineral block contains urea, molasses, minerals and binding agent. During the winter season, green grass scares and shortage of feed, so poor qualities straw utilization are essential, urea improve the quality of low quality straw.

2. Housing management

Housing of dairy plays very important role in high milk production by providing comfortable and hygienic environment. Orientation of house is to be done in east to west direction provide maximum benefit of sunlight. Covering of windows of house by using of plastic sheets in winter season control movement of cold air and reduced coldness. Providing dry and good bedding material reduced loss of heat from body. Proper shelter management also helps in efficient utilization of feed by maintaining body temperature and reduced wastage of feed materials. In northern region using of heaters in shelter also helps in cold stress management.

3. Weather forecasting

It also reduced chance of cold stress through timely preparation for it. Keep animals clean and dry in cold time. Provide good, clean and ample water for drinking during this period.

Human cannot control the weather conditions but some reasonably possible measures reduce the effect of cold stress on dairy animals. This will help reduce costs and improve production efficiency.

Conservation Agriculture: A Sustainable Approach for Soil Health and Food Security

Meenu Choudhary and Dashrath Singh Chundawat

Tillage are provide good environment to a crop through loosening and aerating the soil and mixing of crop residue that are available from former crops. Tillage eliminates weeds, dries the soil prior to sowing, and produces a uniform, smooth soil surface that makes planting easier. But extensive tillage can cause many problems like soil erosion, reduce water quality, decrease in aggregate stability and soil structure. Tillage also increase surface runoff, reduce soil infiltration and reduced root growth. Some new techniques like conservation agriculture, zero tillage are helpful in reducing these problems.

Conservation agriculture is a concept for crop products that conserves resources and aims to produce high quality products consistently while simultaneously preserving the environment. Enhancing natural processes above and the below the earth surface is foundation of conservation agriculture. The use of external inputs like agrochemicals and nutrient of organic origin are applied at ideal place, in a way and volume that does not interfere in the natural processes.

The collective word is typically used to describe no-tillage, direct-drilling, minimal tillage are used for conservation tillage. The lower limit of the bracket for conservation tillage is typically defined as the retention of 30 per cent surface cover by residues, but other conservation goals for the practice include the preservation of time, energy, earthworms, soil-water, soil structure and nutrients. As a result, describing all conservation tillage techniques solely in terms of residual circumstances is inadequate.

Difference between conservation and conventional agriculture

S.N.	Conservation Agriculture	Conventional Agriculture
1.	Minimum interference with natural processes.	Cultivation of crops through using science and modern technology.
2.	Low soil and wind erosion problem.	High soil and wind erosion problem.
3.	Permanent cover is maintaining on soil surface.	Residue removal or burning.
4.	High water infiltration.	Low water infiltration.
5.	Use inorganic chemicals for control weeds. Insect and diseases.	Integrated methods are used for controlling pest like mechanical, cultural, organic origin chemicals.
6.	Use of in-situ materials.	Use of ex-situ materials.
7.	Productivity is high with declining order.	Sustainable production without declining order.

According to Food and Agriculture Organization “Conservation agriculture is a farming technique that supports maintaining permanent soil cover, promoting plant species diversity and causing the least amount of soil disturbance. It improves biodiversity and ground- level natural biological

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processes that help boost the efficiency of water and nutrient utilizationand support improved and sustained crop output".

Three important principles that are followed in conservation agriculture

1. Direct seedling and the application of fertiliser cause the least amount of mechanical soil distribution, *i.e.*, no tillage.
2. Permanent soil cover with residue and cover crop (at least 30 per cent).
3. Diversification of crop species.

Benefits of conservation agriculture

1. Agronomic advantages

a) Rise in organic matter.
b) Soil water conservation, in situ.
c) Improvement of soil structure, which lower lodging.

2. Benefits for the environment

a) Reduces soil erosion.
b) Enhancing the water quality.
c) Conservation of biodiversity.
d) Sequestration of carbon.
e) Good air quality.

3. Economic benefits

a) Time savings, which low ers the need for labour.
b) Cost saving measures (energy, costs).
c) Advanced effectiveness in the sense of further affair for a lower input.

Disadvantage of conservation agriculture

1. The most significant disadvantage of conservation agriculture is the absence of early understanding in all regions where it is practiced.
2. Exorbitant up-front costs for specialised planting tools.
3. A fresh, dynamic farming system that calls for farmer to learn new management techniques.
4. Some people worry that the adaptation of conservation agriculture will increase the use of herbicides, which in turn will result in an increase in the impurity of water by herbicides, at least during the initial stages of adaptation.
5. Lessening of pesticides leaching through conservation agriculture may result from more organic matter adsorbing pesticides or from increased microbial activity decomposing pesticides more quickly.

Limitations to the use of conservation agriculture

To achieve changes in the stations of growers, an internal shift of growers, technical and experimenters away from soil demeaning tillage operations toward sustainable product systems like no tillage is required. However, it was noted that presumably the most crucial aspect of the adoption of CA is prostrating the bias or mind set regarding tillage. Several significant obstacles that prevent the

widespread implementation of CA include the following:

1. The absence of seeders that are appropriate, particularly for small and medium sized farmers. Examples of this would be creation of permanent bed and furrow planting system and harvesting practices that manage crop residue.
2. Widespread use of crop residues for animal feed and fuel:
    a) Farmer often struggle to find crop residues when it rains because less biomass is produced by various crops.
    b) The use of crop residue for animal feed and CA practise are in competition. This poses a significant obstacle to the development of CA in rain fed environments.
3. Burning crop residues: Farmers prefer to sow the crop on schedule by burning the residue in order to sow the crop in the time without using machinery under the CA system.
4. Lack of awareness among agricultural scientists, extension agents, and farmers of potential of CA.
5. Scientific and technological talent:
    a) Enhancing scientist's abilities to approach problems from a systems viewpoint and to collaborate closely with farmers and other stakeholder will be necessary to manage conservation agriculture systems.
    b) Mechanism for sharing knowledge and information must b strengthened.

Organic Poultry Farming: Increasing Demand in the Market

Dashrath Singh Chundawat and Meenu Choudhary

The goal of organic farming is to develop environmentally and economically sustainable agricultural production system. It can be described as an integrated agricultural approach. Production of crops of an acceptable quality for livestock and human nutrition while safeguarding them from pests and diseases to ensure the best possible returns on the human and other resources invested is one of the main goals of organic farming.

Due to the indigenous technical knowledge and farming practices used by Indian farmers, organic livestock farming is most suited to our country's conditions, but organic poultry production is still lagging behind. India has an enormous poultry population, and a small switch from conventional to organic poultry farming could open up a sizable market for both domestic consumption and export.

People's changing preference for organically grown food over conventionally produced food has been influenced by a rise in health and well-being awareness among people. Due to rising demand for organic milk, meat and egg products as well as growing consumer awareness of the quality of milk, meat and egg products, organic livestock production is gaining popularity at a rapid rate across the globe. Lifestyle-related illnesses or concerns like diabetes and cancer have become more prevalent as a result of the presence of numerous pesticides, insecticides, chemicals, medications and hormone residues. In affluent nations compared to underdeveloped ones, the rate of cancer is significantly higher due to intensive and mechanised agriculture. Nations have been inspired to manufacture organic poultry products by the rising demand for organic meat.

Basic requirement for organic poultry production are

1. Housing management

The fundamental goal of the organic housing and management regulation is to let poultry birds display all of their normal behavioural patterns while undergoing the least amount of stress possible. In accordance with their life stage, climate, and surrounding, poultry birds should have access to the outdoors, exercise spaces, shade, and direct sunshine. For poultry birds to maintain their natural maintenance, comfort behaviours, and opportunities for exercise, appropriate clean, dry bedding and shelter should be provided. One of the main issues with housing is protecting birds from predators because caged poultry is not allowed in organic poultry production. Birds should be raised in a system with deep litter.

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2. Breeding management

Eggs or meat from genetically modified breeds are not used as organic, organic farming cannot be practiced without choosing local and indigenous breeds. It is best to use natural reproductive methods. Purchases of poultry should be made from facilities that adhere to organic standards or from farms where the parents were produced organically. Vaccination permitted against common diseases, however genetically engineered vaccines are not permitted. Non-organic poultry can only be introduced under specific circumstances, such as starting up an organic poultry farm for the first time, introducing a breed, renewing the group on the farm etc., after acquiring information from a recognised body.

3. Feeding management

The birds should be fed high-quality, organically farmed feed. Feed should not contain more than 20 per cent non-organic ingredients. All ingredients, with the exception of vitamin and mineral supplements, must be organically grown. The meal should be provided in a way that allows birds to demonstrate their natural eating habits and digestion requirements. A concentrated, balanced feed diet made from organic ingredients should be supplied. You can use locally cultivated protein sources like peas, beans and rapeseed. For meat birds, peas can be added at a rate of 250-300 g kg^{-1}, and for laying hens, 150-200 g kg^{-1}. Pulses that have been sprouted are a good source of vitamins. Utilised more frequently in place of synthesised amino acids.

Dietary trace minerals should preferably be organic in compositions. It is possible to give organic soybean, skim milk powder, potato protein, maize gluten etc. to meet the required amount of essential amino acids. It is important to provide constant access to a plentiful supply of drinking water of acceptable quality and purity. The results of routine water testing should be kept on file. Animal products, growth-promoting hormones, urea, manure, feed or forage that has been treated with antibiotics, including ionospheres and feed, additives or supplements that are prohibited by the food and drug administration are not permitted in the feed that is utilised.

4. Health management

In organic poultry, prevention is preferable to treatment. Therefore, birds will achieve maximum resistance to diseases and recover from many infections when all management practises are focused on their welfare.

- ✓ Breeds that are suitable for site-specific conditions and resistant to common diseases and parasites must be chosen by organic poultry producers as part of preventative health care practises.
- ✓ Creation of suitable housing and pasture conditions for poultry farming.
- ✓ Adopting proper sanitation and disinfection procedure to reduce the occurrence and spread of disease and parasites.
- ✓ Providing an adequate feed ration to meet nutritional requirement.

Antibiotic use should be avoided, but immunization is only allowed in cases where illnesses are anticipated to be concern. The organic council should give its prior approval for any immunisation used on poultry. For the treatment of diseases, the use of complementary therapies like homoeopathy and Ayurveda should be promoted. As an alternative to antibiotics, probiotics and extracts can be used in organic poultry farming to enhance the growth and general health of poultry birds. Growth boosters are strictly forbidden, however hormonal treatments that are medicinal in nature can be carried out under supervision.

Constraints in organic poultry production

- ✓ Lack of awareness among consumer and improper knowledge of organic poultry farming.
- ✓ Inadequate supporting infrastructure, such as lack of sufficient funding, certifying organisation, marketing channels etc. there are no facilities for poultry producers to receive adequate training.
- ✓ Lack of support from government in form of subsidies for organic production.
- ✓ Sanitary condition and quality are main problem.

The livestock revaluation attempts to boost productivity while also enhancing consumer food security and safety. India has enormous potential for producing organic animals and the negative effects of conventional farming are pressuring consumers to switch to organic food items.

Natural Enemies of Fall Armyworm

R. D. Dodiya and N. P. Pathan

The Fall Armyworm, *Spodoptera frugiperda*, (J. E. Smith) (Lepidoptera: Noctuidae) FAW, is an insect native to tropical and subtropical regions of the Americas. The scientific name is derived from the feeding habits of the larval life stage, *frugiperda* meaning "lost fruit" in Latin, as the pest can cause damage to crops resulting in severe yield loss. The FAW caterpillars feed on the leaves, stems and reproductive parts of more than 100 plant species (CABI 2017), causing major damage to economically important crops, such as maize, rice, sorghum, pearl millet, sugarcane and cotton, as well as other vegetable crops including cabbage, beet, peanut, soybean, alfalfa, onion, tomato, potato and pasture grasses. FAW is a most destructive nocturnal insect pest endemic to the tropical and subtropical regions of America and spread in Africa and Asia since 2016. Its high migratory behavior leads rapid expansion which reached to India in May 2018 and up to August 2019 it is spread almost in all states of country leading to huge damage to crop thus causing loss of economy of nation. A combination of control methods should be used to reduce fall armyworm (FAW) infestation *viz*., cultural, mechanical, biological and chemical methods. The use of natural enemies such as predators or parasitoids for FAW control is more economically viable and environmentally safer than currently recommended synthetic insecticides. Natural enemies of key agricultural pests offer an economically sustainable and environmentally safer alternative to synthetic insecticides, if they can be identified and incorporated into an integrated pest management (IPM) system. Augmentative release of native species or introduction of imported exotic species of parasitoids and predators are environmentally safe management options for introduced exogenous insect pests. Parasitoids spend at least one stage of their life in an intimate association with specific life stages of the host pest. They attack either the eggs (egg parasitoids) or larvae (larval parasitoids) of the host. The development of larvae stage of the parasitoids results in death of the insect host. Predators can kill all insect life stages but they do not live on the host.

List of natural enemies recorded on *Spodoptera frugiperda* in the maize fields in India

Parasitoid		
Egg parasitoid		
Trichogramma sp.	Trichogrammatidae: Hymenoptera	
Telenomus remus Nixon	Scelionidae: Hymenoptera	

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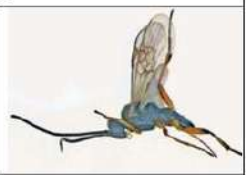
Egg-larval parasitoid		
Chelonus formosanus Sonan	Braconidae: Hymenoptera	
Endo-larval parasitoid		
Coccygidium melleum (Roman)	Braconidae: Hymenoptera	
Coccygidium luteum (Roman)	Braconidae: Hymenoptera	
Coccygidium transcaspicum (Kokujev)	Braconidae: Hymenoptera	
Campoletis chlorideae Uchida	Ichneumonidae: Hymenoptera	
Eriborus sp.	Ichneumonidae: Hymenoptera	
Exarista sorbillans (Wiedemann)	Tachinidae: Diptera	
Winthemia trinitatis	Tachinidae: Diptera	
Larval parasitoid		
Odontepyris sp.	Bethylidae: Hymenoptera	
Larval-pupal parasitoid		
Cotesia ruficrus (Haliday)	Ichneumonidae: Hymenoptera	

Predator		
Forficula sp.	Forficulidae: Dermaptera	
Harmonia octomaculata (Fabricius)	Coccinellidae: Coleoptera	
Coccinella transversalis Fabricius	Coccinellidae: Coleoptera	
Eocanthecona furcellata Wolff	Pentatomidae: Hemiptera	
Andrallus *spinidens* (Fabr.)	Pentatomidae: Hemiptera	
Entomopathogen		
Spodoptera frugiperda (NPV)		
Metarhizium rileyi (Farlow) Samson		
Bacillus thuringiensis		
Beauveria bassiana		
Entomopathogenic nematode		
Heterorhabditis indica Poinar, Karunakar, and David	Heterorhabditidae: Rhabditida	

Eco-friendly Approach for the Management of Anar Butterfly/fruit borer: *Virachola* (*Deuodorix*) *isocrates* (Fab.)

Ashutosh Singh Aman, Arun Kumar, Pawan Kumar, Pramod Kumar Mishra and Naval Datt

Abstract

Anar butterfly/Fruit borer: (*Virachola =Deuodorix) isocrates* (Fab.) also known as the common guava blue, Pomegranate butterfly is a major and key pest of Pomegranate fruit, causing harmful effects in various growth stages from initiation of buds to flowering, calyx formation to fruit prematurity stage until outer rinds of fruit gets harden. It is reported to cause 40-90 per cent damage to pomegranate fruits. There are no satisfactory control measures for the pest after it enters into the fruits that is why eco-friendly approaches need to be focused or should be adopt in Integrated Pest Management strategies as compare to pesticides that has broad spectrum activities, which kills both harmful and beneficial insects and cause adverse effect on environmental ecology. The eco-friendly approach measures in the management of pomegranate fruit crop can have a great scope for getting higher yield of the crop with lower pest incidence. There is a need for massive extension training and demonstration programmes for motivating the farmers of the country to adopt eco-friendly approach in pest management.

Introduction

The pomegranate (*Punica granatum* L.) commonly known as Anar, dalim or dalimbe belongs to the family Punicaceae. It is one of the most adoptable subtropical fruit crops of the world. Pomegranate is originated from Iran and later spread to the other mediterranean countries. Now in India it is being cultivated in Maharashtra, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh and Uttar Pradesh. Globally, India is the second largest producer of fruits with 102.48 million metric tonnes production during 2021-22 after China.

The area under Pomegranate cultivation in India is 288 thousand hectare with estimated annual production of 3271 thousand metric tonnes. Pomegranates are rich in antioxidants and flavonoids, both are known to prevent free radicals from damaging your cells. Pomegranates show high potential in preventing prostate, breast, lung, and colon cancers and also rich in fibre content, vitamins and minerals. The insect pest incidence reported that, there are about 91 insect pests, found feeding on pomegranate crop in India. The most destructive enemy is pomegranate (Anar butterfly) butterfly,

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(*Deudorix/Virachola*) *isocrates* Fab. Which has been reported to cause 40-90 per cent damage to pomegranate fruits. The female of Anar butterfly lay eggs on flowers-buds and the calyx of developing fruits, after a few days the caterpillars enters the fruit and feed on the aril and internal content (Pulp and seeds). The incidence of the pest is at its highest peak during the month of August (monsoon season), while in winter crop heavey infestation occurs during November/December. Presently the fruit borers may cause yield loss of an entire crop unless the flowers are sprayed two times 30 days interval. The hole made by the larva invites secondary infection causing fruit to rot and drop and attacked by bacteria and fungi which finally falls down and give offensive smell. For management of pest, the basic pre-requisite is to have a good knowledge on biology, important characteristics and feeding behavior of the pest which has been discussed below:

Anar butterfly/Fruit borer

Scientific name: *Virachola (Deuodorix) isocrates* (Fab.)

Taxonomic position

- ✓ Kingdom: Animalia
- ✓ Phylum: Arthropoda
- ✓ Class: Insecta
- ✓ Order: Lepidoptera
- ✓ Family: Lycaenidae
- ✓ Genus: *Virachola*
- ✓ Species: *isocrates*

Host plants

Primarily it infects/feeds on Pomegranate fruit besides it is also reported on Aonla, Apple, Ber, Citrus, Guava, Litchi, Loquat, Peach, Pear, Sapota, Mulberry and Tamarind fruits.

Distribution

It is distributed throught India, Sri Lanka, Nepal, Mynamar, Thailand, Laos, Vietnam and Indo-China in the Indo-malayan realm.

Marks of identification

The eggs are laid singly on tender leaves stalks and on flower buds. Fully grown larva is dark brownish in colour and body surface covered by short hair and white patches and it measures about 16 to 20 mm long. Pupation occurs either inside fruits or on the stalk holding it. In case of male adults are glossy bluish violet in colour and in case of female brownish violet in colour and forewings have distinct orange patches on it.

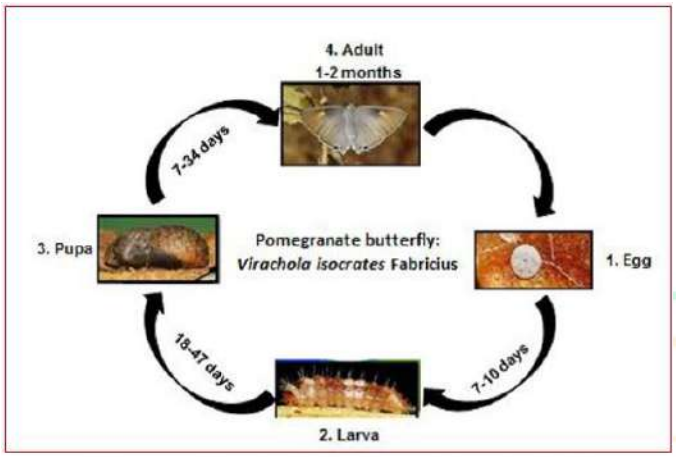
Nature of damage

The female of Anar butterfly lay eggs on flowers-buds and the calyx of developing fruits, in a few days the caterpillars enters the fruit and feeds on the Arils and internal content of fruit (pulp and seeds), excreta of caterpillars coming out of the entry holes which ultimately fruit rotting and dropping may occurs. The hole made by the larva invites secondary infection and attacked by bacteria and fungi, fruit fall off and give odoriferous foul smell.

Damaging Symptoms of Anar butterfly

Life cycle (Bionomics)

Adults lay eggs on the stalks or flower buds with incubation period lasts about 7-10 days. The larva hatches and bores into the fruit and its larval period extend up to 18-47 days. Pupation lasts for 7-34 days and the total life cycle of *Virchola isocrates* ranged from 30 to 40 days in case of male, while 35 to 44 days in case of female.



Life cycle of Anar butterfly: *Virachola isocrates* (Fab.)

Eco-friendly management Practices

- ✓ Removal and destruction of all the affected fruits that helps to reduce the infestation.
- ✓ If the fruits are covered with polythene or paper bags before its maturity may escape infestation.
- ✓ Bagging is a cultural technique to reduce insect and pathogen injury, it provides a physical barrier for pests and pathogens.
- ✓ Cultural practices such as regular weeding, should be done to remove unwanted plants which may act as alternate host for this pest.
- ✓ Grow less or moderately susceptible varieties *viz.*, Dholka and Kashmiri local.
- ✓ Once the tree has started flowering, monitor this pest by using light trap.
- ✓ Spray applications of fenvalerate 0.005%, or decamethrin 0.0028% effectively controls the pest.
- ✓ The new generation insecticide, chloran-traniliprole 18.5 SC @ 0.15 ml l^{-1} can be recommended for effective management of Anar butterfly in pomegranate.
- ✓ Lamda-cyhalothrin (Karate 2.5 Ec) @ 1.5-2 ml $litre^{-1}$ is also seen very effective management against Anar butterfly pest.
- ✓ The parasitoids namely, *Telenomus sp.*, *Ooencyrtus papilionis* and *Trichogramma chilotraeae* are known to cause up to 60% parasitism on *D. isocrates* in Peninsular India.
- ✓ Release *T. chilonis* at 2.5 lakh ha^{-1}, four times at ten days interval has been recommended.
- ✓ The eggs of *D. epijarbas* were found to be parasitized up to 62% by *Trichogramma sp.* in nature.
- ✓ Application of biocide *i.e.*, Neem oil @ 0.5 per cent, NSKE @ 5.0 per cent and *Bacillus thuringiensis* (Bt.) @ 0.15 per cent were found most effective against Anar butterfly.
- ✓ Covering the entire orchard with nylon net followed by spray with contact insecticide has been recommended.

Cultural practices: Bagging of Anar Fruits

Covering the entire orchard with nylon net

Conclusions

Pomegranate is an important fruit crop grown over 288 thousand hectare with estimated annual production of 3271 thousand metric tonnes in India. Its cultivation is done on a large scale in almost all the states of the nation. *Virachola isocrates* is a major and regular pest of Pomegranate which causes 40-90 % damage to fruits. For the management of the Anar butterfly/ Pomegranate fruit borer, an Integrated Pest Management (IPM) strategy is effectively used. This management strategy considered as eco-friendly approach, which act as anti- resistant mechanism in pests.

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GM Mustard Approval after Long, Exhaustive Process

Rukoo Chawla, Dr. Hemlata Sharma and Dr. Amit Dadheech

Introduction

The ability to change crops for better agronomic qualities such as pest and disease resistance, superior nutritional quality, and increased productivity exists attributable to genetic engineering of plants. There might be a revolution in molecular agriculture if the transgene is generated from unrelated plant species or even from non-plant sources.

Nearly 15 years after its invention, India's biotech regulator, the Genetic Engineering Appraisal Committee (GEAC), has approved genetically modified (GM) mustard for commercial cultivation, laying the foundation for the country's first genetically modified food crop. The government, on October 18 has told the Supreme Court that approval for the "environmental" release of transgenic mustard hybrid DMH-11 has been given to the Centre for Genetic Manipulation of Crop Plants (CGMCP) after a long and exhaustive review process, which started in 2010. According to the affidavit, conditional approval (of DMH-11) referred to an environmental release that took place before the its commercial distribution and was subject to technical and regulatory review. In addition to the permission, GEAC has called for more studies before genetically modified mustard may be grown commercially. A Post Release Monitoring Committee (PRMC), which will be established by GEAC during the approval period, shall visit the growing locations of the authorized biological material(s) at least once during each season and provide a report to GEAC on compliance-related issues.

Reason for its approval

- ✓ The application of new genetic technologies is important in lowering dependency on imports since the Center estimates that 50-60% of the edible oil in India is imported. India spends tens of billions of dollars annually importing cooking oils since it is the largest importer of edible oils in the world. More than 70% of the nation's vegetable oil needs are imported from countries including Malaysia, Indonesia, Brazil, Argentina, Russia, and Ukraine.
- ✓ About 16% of India's total imports of edible oils are sunflower oil, which is also a staple in practically all Indian kitchens. Historically, 20%

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of India's imports of sunflower oil came from Russia and 70% from Ukraine. The situation in Russia and Ukraine had a significant impact on imports of the same.

- ✓ The two main justifications used to promote GM mustard are that it would yield 25-30% more and that it is not an herbicide tolerant crop.
- ✓ For the benefit of farmers, DMH-11 could reduce the use of pesticides and insecticides during farming thereby leading to better yield production.
- ✓ GM crops can produce more even in small areas of farmland which in the long term can ensure the betterment of the food supply.

Source- Edited pic from *https://www.opindia.com*

Hybrid mustard

The process of hybridization entails mating two genetically distinct plant kinds, which may even belong to the same species. Such crossings typically result in first-generation (F_1) offspring with larger yields than each parent could produce alone. Because mustard plants are generally self-pollinating and have blooms with both female (pistil) and male (stamen) reproductive systems, such hybridization is difficult. Contrary to cotton, maize or tomatoes, where this is possible by straightforward emasculation or the physical removal of anthers, it restricts the potential for generating hybrids since the eggs of one plant cannot be fertilized by the pollen grains from another.

Using genetic engineering (GM), the hybrid mustard DMH-11, which contains two foreign genes derived from a soil bacteria called *Bacillus amyloliquefaciens*, was created by researchers at Delhi University's Centre for Genetic Manipulation of Crop Plants (CGMCP). They claim to have developed a reliable and practical mustard hybridization method using the barnase-barstar GM technology. By mating the popular Indian mustard variety "Varuna" (the barnase line) with an East European mutant called "Early Heera-2," the technique was utilized to create DMH-11 (barstar). According to the Indian Council of Agricultural Research's confined field experiments, DMH-11 demonstrated an average 28% yield improvement over Varuna (ICAR).

Cause of concern

- ✓ Given that this crop is truly herbicide resistant (unaffected by heavy herbicide usage) and that GM technology is a living, irreversible technology when put into the environment, the ramifications would be severe and irrevocable.
- ✓ The bar gene, which is present in both parental lines, DMH-11, and any other novel hybrids that ICAR will produce from both parental lines, confers herbicide resistance.
- ✓ Another concern is over GM mustard threatening or undermining the population of

honey bees. Mustard flowers are a source of nectar for honey bees and many other pollinator insects.

The possible benefits of genetic engineering in general include

- ✓ More nutritious food.
- ✓ Tastier food.
- ✓ Disease and drought-resistant plants that require fewer environmental resources (such as water and fertilizer)
- ✓ Less use of pesticides.
- ✓ Increased supply of food with reduced cost and longer shelf life.
- ✓ Faster growing plants and animals.

Disadvantages of Genetic Engineering in general?

- ✓ The nutritional value of foods can be less.
- ✓ Pathogens adapt to the new genetic profiles.
- ✓ There can be negative side effects that are unexpected.
- ✓ The amount of diversity developed can be less favorable.
- ✓ Copyrighted genetic engineering can have costly consequences.
- ✓ This knowledge and technology can be easily abused.

Conclusion

If allowed, the first such food crop to be made commercially available in India will be genetically modified mustard. In the following ten to twelve years, this will let in a flood of additional crops of this type, making India one of the world's top users of GM crops. India would end up trading its independence for the happiness of a select few given that its agriculture is mostly controlled by foreign seed and pesticide businesses.

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Adoption of Modern Technologies in Agriculture

Lata Devi, Sapna Birania, Manthan Chaudhary and Lovleen Arora

Abstract

The adoption of Modern technologies in Agriculture whose main aim to introduce the modern technology adoption its importance, usage and role in agriculture. However, the modern technology is changing the way that humans operate the machines, GPS locators, as computer monitoring systems and self-steer programs allow the most advanced tractors and implements to be more precise and less wasteful in the use of fuel, fertilizer or seed. Information about modern agricultural development projects/schemes is a necessary factor for adoption of modern technology.

Introduction

Sustainability has advanced during the previous fifty years. For instance, best management practices in agriculture and laws that have been modified to improve agriculture are now successfully used broadly to emphasis the need for more external inputs, lower food output and new hybrids with disease resistance. Due to this, the use of pesticides worldwide has increased, as well as the use of biological pest management methods, organic fertilizer, cultural practices, and GIS, crop models, and methods for eradicating weeds, diseases, and pests. Adoption of agricultural technologies has been linked to increased income, decreased poverty, better nutritional status, decreased pricing of basic foods, more employment options, and higher wages for landless labourers. Numerous studies have been done on innovation, new technology adoption, and the effects of new technology adoption in developing nations. However, while being viewed as a key step toward ending poverty in the majority of developing nations, new agricultural technology is frequently adopted slowly and a number of adoptions-related factors are still not fully understood.

Why is the adoption of technologies important?

Up until recently, the technologies available to farmers were mostly influenced by the need to boost output, profits, and productivity. The main obstacles were a lack of finance, technical expertise, and market dangers, which in many nations were protected by government regulations. Since the goal of agricultural policies was to boost productivity in agriculture, "good policy practices" in the past were very straightforward and mostly related to improving production. For instance, agricultural research and extension services might focus on raising the productivity of small farms. Agriculture nowadays must accomplish a number of goals, including being globally competitive, producing high-quality agricultural goods, and achieving sustainability obje-

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ctives. Agriculture producers require quick innovation if they want to stay competitive. Farmers now have a lot more opportunities as well as much more restrictions. They must deal with direct and indirect customer pressures, lobby group pressures, environmental standards and regulations, and be profitable in addition to doing so. Additionally, they may be inundated with information from numerous government and industry sources, which makes picking the right technologies more challenging. In response to agricultural policies that take into account environmental conditions, farmers also need to alter their production and management methods, and I am certain that they have the ability to do so. Future events could see an even greater rise in uncertainty. The future policy environment may also be uncertain, particularly in light of support, trade, and challenges from the agro-food sector. Farming technology adoption requires financial investment. However, it takes time for the benefits to materialize, and farmers could be hesitant to make investments in an unstable environment with more restrictions, where part of the advantages are for society.

Increasing agricultural production and fostering agricultural development have been made possible by technological change. Through the development of new technologies, research influences the productivity of farming systems. If these technologies are suitable for farmers' needs, they will be quickly implemented. In the past, it has been the responsibility of researchers and extension specialists to identify and incorporate economic and environmental aspects into the process of creating and introducing an agricultural innovation. Researchers create the invention, extension workers advocate for its usage, and farmers either accept or reject the innovation depending on the aspects that are significant to them. This process is generally referred to as top-down.

Modern Agricultural Technology and Machinery usage in Agriculture:

1) **Autopilot Tractors:** New GPS tractors and sprayers machines can accurately drive themselves through the field without drivers. On the board of computer system, a user has told how wide a path a given piece of equipment will cover he will drive a short distance setting A and B points to make a line. The GPS system will have a track to follow and it extrapolates that line into parallel lines set apart by the width of the tool in use. The tracking system is tied to the tractor steering, automaticallykeeping it on track freeing the operator from driving. This allows the operator to keep a closer eye on other things.

2) **Drones:** The use of drones in agriculture will continue to grow and evolve as producers harness this is very powerful technology in various aspects of their production. Drones can carry a wide array of sensors and cameras that can continually monitor crop growing conditions.

3) **Crop sensors:** Crop sensors are going to help farmers apply fertilizer in a very effective manner, maximizing uptake. Sensing how your crop is feeling and reducing potential leaching and runoff into ground water. This is taking variable rate technology to the next level. Instead of making a prescription fertilizer map for a field before you go out to apply in real time. Optical sensors are able to see how much fertilizer a plant may need based on the amount of light reflected back to the sensor.

4) **Biotechnology:** Biotechnology or genetic engineering is not new technology, but it is an important technology with much more potential yet to be unleased. The form of genetic engineering, most of the people have probably heard of is herbicide resistance. Crops can be made to express toxins that control particular pests. Biotechnology provides farmers with tools that can make production cheaper and more manageable. Biotechnology crops can be engineered to tolerate specific herbicides, which makes weed control simpler and moreefficient.

5) **Ultrasounds for livestock:** Ultrasound is not only for checking of baby animals in the womb, also can be used to discover what quality of meat might be found in an animal before it goes to market. The testing of DNA helps producers to identify animals with good pedigrees and other desirable qualities. For improving the quality of the herd, this information can be used to helps the farmer to improve quality.

Merits of Modern technology in Agriculture

- ✓ Supply water according to the requirements of crop.
- ✓ By adopting technology farmer change their sowing method from manual to mechanical.
- ✓ Through technology increase the profit of farmer and reduce the cost operation.
- ✓ Tunnel forming is a basic perception for the production of the off-season vegetables.
- ✓ Through technology increase the profit of farmer and reduce the cost operation.
- ✓ Due to technology, we can provide nutrient to plant on their calculated requirement

Disadvantages of Modern Technology

- ✓ If we use the more fertilizer as compared to recommended, then it will reduce the soil fertility.

- ✓ Due to lack of education farmer are unable to run the machine properly.
- ✓ Due to high cost of maintenance of machine, it will increase the financial burden on farmer.
- ✓ It may be lead to environmental hazard.

No doubt technology has some merits and demerits but if we can use it moderately, we can increase our production.

Conclusion

As discuss about the Modern technologies it should be concluded that with the help of technologies, we can increase agricultural productivity and promoting agricultural development. The adoption of modern technology such as Precision farming, Drones, Crop sensors, Autopilot tractor, Biotechnology a new technique that boosts crop yields and reduces waste by using satellite maps and computers match seed, fertilizer and crop protection applications to local soil conditions.

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Role of Microorganisms in Agriculture

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Abstract

The breakdown of resistant elements of plant and animal tissue is what gives rise to microorganisms. Between the soil and the plant, they are extremely important in agriculture. They are in charge of enhancing soil quality and structure for effective plant growth and enhance crop production and protection. The use of both organic manures and biofertilizers in combination is one method for enhancing the soil fertility. They are used as bio control and biofertilizers in agriculture. Biofertilizers are microbial inoculants that can fix nitrogen, phosphate solubilising, and break down organic matter as bacteria, fungi, actinomycetes, and protozoa while balancing the biological balance in the soil. As a result of microbial decomposition, unavailable form of nutrients converted into available form of nutrients. The fertility of the soil is influenced by a variety of microorganism species that affect the quantitative composition of the soil in addition to the presence of inorganic and organic matter. Consequently, microbes play a crucial role in agriculture.

Introduction

Microbes are present in every aspect of agriculture as there are few helpful microbes, including bacteria, actinomycetes, fungus, and protozoa, the majority of the microorganisms found in compost are bacteria. In the soil, there is a more prevalent group of microbes, including Arthobacter, bacillus, clostridium, and micrococcus. Molds and yeast, which are fungi, assist bacteria in breaking down compounds such as lignin in woody materials. They are numerous in the top layers of well-cultivated, aerated soils that are predominately acidic. Bacteria, fungus, and microscopic organic particles are all consumed by protozoa.

They make the soil better and create favourable circumstances for plant growth. Soil microbes act as biochemical agents as they transformed complex organic compounds into simpler inorganic compounds or their component elements. This transformation of organic substances into inorganic substances serves as plant nutrition. As a result the number and quality of agricultural goods and services both are increased.

Importance of Microorganism

Microorganisms play an important role in decomposition of organic matter as they take part in the production of humus as well as soil's quality and structure are greatly influenced by microbes.

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They participate in the preservation of biological equilibrium, recycling of nutrients between the soil and roots and in the process of transforming nutrients. They aid in the surface blooming lessens erosion losses. While maintaining soil pH, microorganisms also maintain mineral and nutrient balance and increase the fertility of the soil. Some microbes, like Rhizobium, create root nodules and symbiotic relationships with plants. These organisms help in fixing the atmospheric nitrogen to soil which is further available to plants.

Microbes as Biofertilizers

Biofertilizers are specialised microorganisms that can fix atmospheric nitrogen, including bacteria, fungi, and algae and convert insoluble phosphate in the soil into available to plants. They are crucial in enhancing soil fertility and increasing agricultural yields. Biofertilizers are microbial inoculants that can fix nitrogen, solubilize phosphate, and break down organic materials more quickly. Plant Growth Promoting Rhizobacteria (PGPR) and Vesicular Arbuscular Mycorrhizae (VAM) are very important microbes that help improve soil fertility and boost crop productivity.

Rhizobium

Rhizobium is more popular and effective than other bacteria. They, present in the root nodules of the leguminous plants, which adds nitrogen to the soil that is delivered to the plants to promote growth. Root nodules that fix atmospheric nitrogen are formed as a result of the legumessymbiotic relationship with the rhizobium bacterium. The first widely utilised microbial fertiliser was rhizobium. Every bean has a unique Rhizobium. In order to increase nitrogen uptake and improve crop yields, effective Rhizobium strains must be used during inoculation.

Azospirillum

Azospirillum comprises Azospirillum bacteria, which may colonise plant roots and fix atmospheric nitrogen. Azospirillum is known to have a close associative symbiosis with the higher plant system. It produces photohormones, particularly indole-3-acetic acid, and is thought to improve a plant's ability to withstand biotic and abiotic stress. These bacteria are linked to fodder grasses as well as cereals like sorghum, maize, finger millet, pearl millet, and other minor millets. The bacteria that colonise the root do not just stay on the root surface; a significant number of them also enter the root tissues and coexist hormonally with the plant.

Azotobacter

A typical soil bacterium is called Azotobacter which enhances the germination of seeds. For better crop response, it helps to boost nutrient availability and restore soil fertility. The main element influencing this bacteria's proliferation in the soil is organic matter. Poor organic matter concentration in the soil is a limiting factor that affects Azotobacter growth in the soil as well as its ability to fix nitrogen.

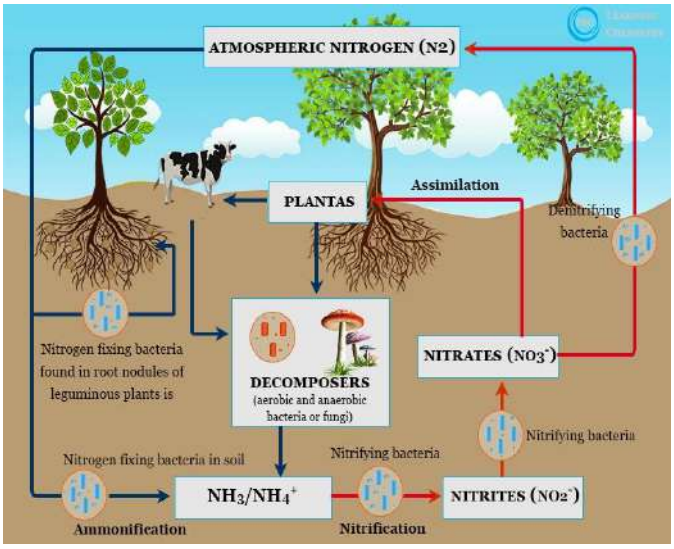
Blue Green Algae (BGA)

Due to their prevalence in rice fields, blue green algae are often referred to as rice creatures. BGA are free-living, photoautotrophic microorgani-

sms. The majority of nitrogen-fixing BGA are filamenters, which are made up of a chain of vegetative cells, some of which are specialised cells termed heterocyst that serve as tiny nodules for the machinery needed for synthesis and nitrogen fixation. Additionally, they coexist harmoniously alongside the water fern Azolla.

Nitrogen fixing Bacteria

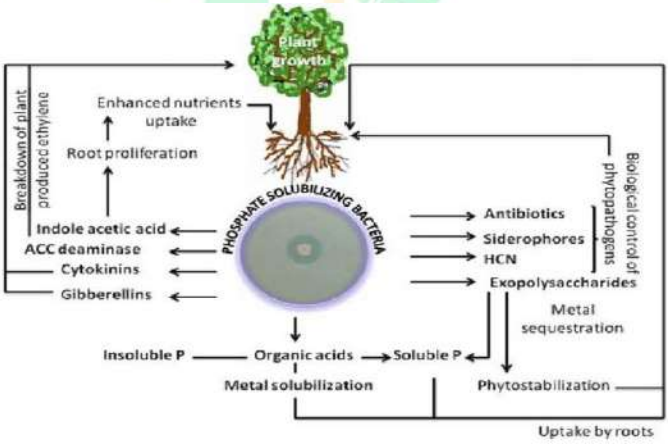
Nitrogen promotes vegetative growth. It is a essential component of hormones, enzymes, alkaloids, phosphatides, vitamins, amino acids, proteins, and other compounds. Organisms that fix nitrogen are either free-living or work in symbiosis with plants. They provide agricultural plants with nitrogen nutrients, either directly or indirectly. Numerous varieties of blue-green algae and some bacteria, such Azotobacter, are included in the free-living category. Grass roots and root symbionts that are associative symbiotic. In a cooperative relationship with the blue-green alga Anabaena azollae, the water fern Azolla fixes atmospheric nitrogen in the rice habitat.



Role of nitrogen fixing bacteria in agriculture

Phosphorus Solubilisation

Phosphorus is necessary for root development. It is essential energy storage and transfer of energy. Microorganisms that solubilize phosphorus are crucial for the uptake of phosphorus by plants. Bacteria like *Bacillus megaterium, B. circullans, B. subtitis,* and fungi are among these organisms. Different organic and inorganic acids are secreted by these species. In the rhizosphere, they act on insoluble phosphates and change them into soluble phosphates. The solubilizing power of the microorganisms is increased by the addition of organic manures. The phosphorus solubilisation process lowers the soil's pH by generating organic acids.

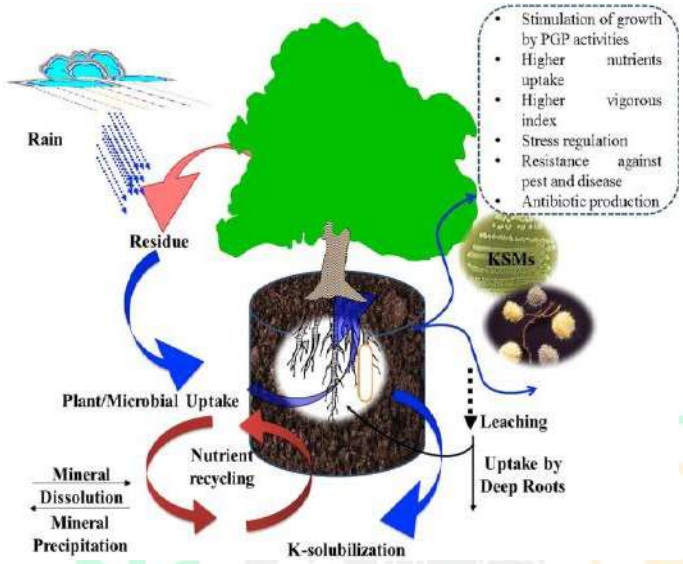


Role of Phosphorus solubilisation in Agriculture (Zaidi *et al*., 2009)

Potash mobilisation

Potassium promotes plant development and aids in the production of chlorophyll. Potassium slows down transpiration while speeding up photosynthetic activity in plants. Utilizing microbes helps mobilise potassium. They transform unavailable potassium into a form that plants can use. They are essential in the process by which ammoni-

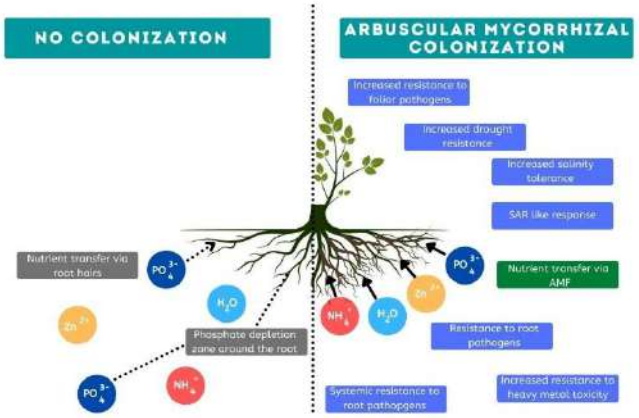
um ions are converted into monoacids and proteins, which are then taken up by roots from the soil. They decreases the need for chemical fertilisers with a potash basis. They helps crops retain water and have better flavour, colour, texture, yield, and disease resistance.



Role of Potassium solubilisation in agriculture

Vesicular Arbuscular Mycorrhizae (VAM)

Vesicular Arbuscular Mycorrhizae, a beneficial interaction between a plant root and its endophytic fungal companion that aids in boosting phosphorus availability, are more active when legumes are inoculated.



Role of Vesicular Arbuscular Mycorrhizae in Agriculture (Source: agrotexglobal.com)

The majority of agricultural crops grown in temperate and tropical regions have mycorrhiza, which is a symbiotic relationship between plant roots and fungal mycelia. They can be found in a wide range of biological settings, from aquatic to desert, but they are not grown on nutrient media.

Plant Growth Promoting Rhizobacteria (PGPR)

Root and shoot growth are encouraged by Plant Growth Promoting Rhizobacteria (PGPR). Rhizobacteria are a genus of bacteria that are present in the rhizosphere and are known for promoting plant growth. Numerous genera are represented in the group, including Arthobacter, Azotobacter, *Bacillus*, *Xanthomas*, Streptomyces, and Pseudomonas. They not only encourage plant development but also help crops develop resistance to many plant diseases. They shield plants from biotic and abiotic stressors and promote root hair development.

Microbes as Biopesticides

Biopesticides play an important role in crop production, helping farmers to protect their crops from pests and disease. They promotes plant growth, manages pests and diseases, and gives plants the necessary support to thrive. They are microbial pesticides that may consist of the organisms themselves or the metabolites they produce. Microbial biopesticides, such as bacteria, fungi, and viruses, are used to manage pests that are harmful to crop plants. They use various methods to battle insects, weeds, and nematodes.

Beneficial of Bacillus spp. for plant

Bacillus has been used as biopesticides and

biofertilizers. There are various species there. An antagonistic bacterial biocontrol agent called Bacillus subtilis prevents the spread of numerous soil and air-borne illnesses that affect crops like soy, cotton, groundnuts, and paddy. Many crops leaf diseases are controlled by foliar treatment of *Bacillus subtilis* and *Pseudomonas fluorescence*. Using them, plant pathogens can be controlled. *Bacillus thuringiensis* subspecies and strains are the most commonly utilised microbial insecticides.

Conclusion

Without microbes, soil is unable to adequately maintain its structure and biological balance. Therefore, it may have an impact on plants due to nitrogen loss, soil fertility, and water-holding capacity. Additionally crucial to the breakdown of organic materials are soil microorganisms. Microbes can offer defence against some soil-borne illnesses and drought. In an environmentally friendly setting, microbes enhance agricultural productivity, soil health, and plant growth. Beneficial microorganisms are found in the plant's root zone and are engaged in the process of transforming nutrients. The production of high yields is dependent on microorganisms. Consequently, it demonstrates the significance of microorganisms in agriculture.

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Weed Management in Organic Farming

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Abstract

Modern agriculture is focused on productivity and relies heavily on synthetic input to control weeds. However, the improper application of these synthetic herbicides could lead to problems with the environment, human health, and herbicide resistance. The main obstacle to successful organic farming is effective weed management. An altogether different method of managing an agricultural system is used in organic weed control, which is a holistic strategy. The goal of organic farming is to keep weed levels at a tolerable and affordable level rather than to completely eradicate them. Weeds are plants that compete with the main crop for resources like nutrients, light, water, and space. Since the beginning of agriculture, these have been an issue. These also serve as hosts for various diseases and insects, which results in health issues skin, allergies that cause respiratory problems, and scientists who harm living things. Herbicides used for weed management are hazardous because of their lingering effects, which contaminate the soil, cause air pollution, and kill creatures that are beneficial to agriculture. Preventative measures, cultural practises, water management, mulching, usage of prepared seed, plant geometry, mechanical control, biological control, etc. are just a few examples of non-chemical methods that can manage weeds. Sustainable weed management requires careful cropping system selection and weed control during the critical crop weed competition phase. Since the last two decades, attention has been focused on using organic substances obtained from plants as an alternative to organic herbicides for the control of weeds.

Introduction

Weeds are plants that proliferate, persist, resist, compete, are destructive, and may even be poisonous in nature. They also have the ability to flourish in unfavourable climatic conditions. Although increasing cultivation is a simple answer, it might also help with objectives like improving soil quality or reducing fuel consumption. Although the majority of weed species are well-represented in the literature, it is rare for weed biologists to directly relate their findings to real-world management issues. Crop sequence should group diverse species with temporally different disturbance regimes that confront weeds at various points in their life histories and on an individual basis from the perspective of weed management. Crop successfully caused weed

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to capture resource. Herbicides made by chemicals cannot contain it. Only by hand is weeding possible. Different cultural practises, such as tillage, floods, and mulching, can be used to manage weeds. On the other hand, we also applied biological methods to control the weed-related loss. Drop watering can be used to control weed development as well.

Why organic weed management?

To control weeds organically, test the soil for deficiencies, then naturally amend and fertilize the soil in accordance with the test results. Chemical herbicides are not permitted in organic farming. It is possible to employ a wide range of tools. As the weed population changes, productive organic farmers modify their weed control strategies. In an organic system, effective weed control takes into account soil management, crop rotation, machinery, weather, time, and labour. Healthy soil encourages plant growth, which inhibits weed growth. Herbicides can be used to boost crop yields as well as cut down on the labour needed to eradicate weeds. Additionally, it's been discovered that some weed species can become dominant in an area when herbicides are employed because they become resistant to them. Weed growth can be controlled by mulching and drip irrigation, which also restricts the water's flow to the plant line.

Essential used of Organic Weed Control

Scheduled irrigation: It can be tempting to water the grass excessively, but this is one of the quickest

Use the right organic "chemical": Some organic weed preventatives include corn gluten meal and vinegar. It is possible to acquire organic items in place of synthetic chemicals. Additionally, there are numerous natural pest-safe herbicides and organic weed killers on the market. Ways to get weeds. Pests, fungi, and unhealthy grass.

Weed Control Methods in Organic Farming

Cultural method: Crop rotation, boosting the ability of crops to compete, incorporating cover crops and green manure, and intercropping are all components of the cultural approach. By choosing the suitable crop and cultivators, taking into account the weeds that are already there and the environment, properly preparing the seed bed, and increasing planting density, it is possible to boost the crop's ability to compete against weeds.

Physical method: Physical exercises include hand weeding and hoeing, as well as digging, mowing, cutting, dredging, and mulching. Depending on the crop and weed situation, one of these methods is utilised.

Thermal method: These techniques include electrocution, freezing, hot water, steam, microwave, UV radiation, and directed flame. Exposure to extremely low temperatures can destroy weed.

Mechanical process: The oldest weed control method was probably mechanical, which includes tillage as well as cutting and pulling weeds. Tillage is a technique that is performed extremely early in the weed growth cycle. The management of weeds in biological systems requires the use of mechanical weed control methods. It involves pre-plant tillage techniques like disking, ploughing, and field cultivating.

Biological weed control: The natural method for weed management in organic agriculture would seem to be biological control.

Allelopathy: Allelopathy is the chemical reaction between two plants that affects their neighbouring plants' germination, growth, and development. Barley, rye, alfalfa, wheat, red clover, and sunflower are some of the crops that are susceptible to Allelopathy. The roots of vegetables including horseradish, carrot and beet emit an especially potent allopathic toxin.

Beneficial organism: A caterpillar is perhaps the most effective natural enemy at controlling prickly pear, followed by a rust for skeleton weed and a weevil for salvinia, an aquatic weed.

Why do you need to control weed?

Weeds can affect crop yields, compete with crops for space, nutrients, light, moisture, and other resources, and raise production and processing costs. Severe weed infestations can also affect the quality of the products.

Organic weed management technique

1. **Soil:** Organic soil is intended to ensure a healthy, balanced soil, therefore organic farms shouldn't experience issues with inadequate nutrients, pH levels, or soil structure**.**
2. **Mulching:** It effectively prevents weed seeds from sprouting. Their capacity to block weed seed from landing on their surface may alter. Mulches can be made from a variety of organic materials, including straw, leaves, pine needles, and wood chips. At the end of the growing season, mulch can be tilled in and will degrade swiftly.

3. **Green manure and cover crop:** The highly competitive nature of green manure can weaken perennial weeds and lengthen the time it takes for annuals to reach full maturity. After harvest and through the first few weeks of spring, before planting crops, cover crop is used to help supp-

ress weed.

4. **Solarizing:** In this procedure, the area is covered with transparent plastic to heat the ground and destroy weevils and seeds in the top six inches of soil. It can be a successful method of weed control for several annual weeds, including Bermuda grass and bindweed.

5. **Fertilizer and Irrigation Carefully:** Fertilizer mainly offers the chance to use some weed control. To just hydrate the roots of the plants and not the empty space around them, use drip irrigation.
6. **Boiling water:** A small amount of water should be brought to a boil before being powered. Proper water management is crucial for managing during production in this method, which is fantastic for weeds growing in pavement cracks and emerging in garden walks.

Conclusion

The impact of using multiple hammers to manage weeds will be larger than relying on a few techniques. Create a weed control approach that is tailored to the needs of the farm. Diversity was necessary for eco-based weed control. The most crucial tool in this regard are cash or cover crops with the opportunity for high levels of weed control and different disturbance regimes, which can prumpt weed seed production that characterises modern farming systems and restricts the potential internal biological control that is likely to be crucial to the development of whole farm systemic resistance to weeds. Complex, ecologically based "Many little Hammer" weed management strategies come with significant management costs, educational investments, and trial-and-error learning curves. Some of this proof is currently provided by professional farmer testimonies.

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Potential of Biofertilizers over Chemical Fertilizers for Enhancing Soil Fertility

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Abstract

With the use of chemical fertilizers, the green revolution has significantly increased food production in order to satisfy the demands of the expanding human population, but with insufficient attention to sustainability. But the excessive usage of these conventional chemical fertilizers is having a lot of negative repercussions. Additionally, continued use of chemical fertilizers has a negative impact on human health in addition to destroying the ecological balance, degrading soil fertility, and harming the ecosystem. For these reasons, biofertilizers have been recognised as safe additions to chemical fertilizers that support soil health preservation, increase soil fertility, and improve crop product quality. They provide an alternate method of obtaining plant nutrients without endangering sustainability or the environment. They are more commonly referred to as "microbial inoculants," artificially multiplied cultures of specific soil organisms that can increase the activity of specific beneficial bacteria, improve soil fertility, and increase crop productivity. They also add nutrients through the natural processes of nitrogen fixation, phosphorus solubilisation, and plant growth stimulation through the synthesis of growth-promoting compounds. Biofertilizers are cost-efficient, environmentally friendly, and renewable source of plant nutrients that can be used in place of chemical fertilizers.

Introduction

Chemical fertilizers were initially introduced to boost agricultural yield in order to satisfy the demands of the growing population and to increase agricultural production, but this has also resulted in an increased dependence on chemical fertilizers and pesticides. But over time, chemical fertilizers began to show their negative effects, including leaching out and polluting water basins, destroying beneficial insects and microorganisms, increasing crop susceptibility to disease, lowering soil fertility, and ultimately causing irreparable harm to the system as a whole.

In this regard, a number of intellectuals across the world began focusing on the alternatives and discovered that biofertilizers can assist in boosting the produce without creating the damage associated with chemical fertilizers. In sustainable agriculture, biofertilizers can be used as an alternative to chemical fertilizers to improve soil

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fertility and crop yield. They are inexpensive inputs that don't have the negative effects on the environment like chemical fertilizers do. When applied to the soil, biofertilizers have a number of advantages as they increase the biodiversity of the soil, which contains a variety of beneficial bacteria and fungi, including the arbuscular mycorrhiza fungi (AMF), also known as the plant growth promoting rhizobacteria (PGPR), and nitrogen fixers. They protect the ecosystem and ensure that nutrients from natural sources are available as there are no signs of harmful or hazardous ingredients in the farm products as a result these goods are therefore recognised as organic. The use of biofertilizers in Indian agriculture helps to make up for many of the drawbacks of using traditional chemical fertilizers. Dependence on chemical fertilizers for future agricultural growth would result in greater deterioration of the soil, the potential for water contamination, and environmental damage. In light of this, using biofertilizers in agriculture is essential for its development in a sustainable manner.

What is bio fertilizer?

Biofertilizers, sometimes referred to as microbial inoculants, are intentionally multiplied cultures of particular soil organisms that can increase crop yield and soil fertility. They not only boost the yield of subsequent crops in addition to being effective for the one in which they were employed. In the soil, specific microbial processes are accelerated, increasing the amount of nutrients that are available in a form that plants can easily absorb.

They are environmentally benign, and using biofertilizers is a crucial part of integrated nutrient management. In India, common biofertilizers include Rhizobium, Azotobacter, Azospirillum, Blue Green Algae and Azolla, Phosphate solubilizing/mobilizing biofertilizers etc.

Application of Biofertilizers (Source: Pixabay)

Advantages of biofertilizers over chemical fertilizer

Chemical fertilizers have detrimental impacts when used in excess or insufficiently. Continuous use of chemical fertilizers causes hazardous chemicals to build up, reducing soil fertility and raising soil acidity. As they are easily soluble in water, inorganic fertiliser in the soil may be leached deep into the soil and into underground water, causing contamination. Biofertilizers, on the other hand, reduced all of these issues and were able to do everything that was possible with inorganic fertilizer and even more without any negative side effects.

To restore the soil's fertility, biofertilizers are necessary. Plants receive atmospheric nitrogen directly from the microbes in biofertilizers. They aid in solubilisation and mineralization of other plant nutrients like phosphates. By enriching the soil with

nutrients, they assist in obtaining high agricultural yields. When using biofertilizer, the issues associated with excessive or insufficient application do not exist. Long-term usage of biofertilizer increases the overall fertility of the soil by causing nutrient build up in the soil. The soils retain its natural fertility, which is good for the environment and for the plants and also eliminates the toxic elements in the soil that lead to plant diseases which is favourable for useful bacteria required for plant growth to stay in the soil. Farmers can easily create or collect biofertilizers and use it because it is significantly more cost-effective and also being friendly to the environment and protect it from contaminants.

Bio fertilizer and chemical fertilizer

Classification of biofertilizers

They are classified into different types depending on the groups of microorganism they contain-

Nitrogen-fixing biofertilizers (NFB): It has been estimated that 78% of the atmosphere's gaseous components are nitrogen, however because most plants are unable to fix atmospheric nitrogen, the majority of this nitrogen remains unused. N-fixing biofertilizer contains a set of microorganisms that can fix atmospheric nitrogen and transform it into organic (plant-usable) forms in the soil and root nodules of legumes, making it available to plants. Example includes Rhizobium sp., Azospirillum sp., Azotobacter and blue green algae.

Phosphate Solubilizing biofertilizers (PSB): Many bacteria belonging to Bacillus, Pseudomonas, Micrococcus, Streptomyces, Flavobacterium and fungi belonging to Aspergillus, Penicillium and Trichoderma efficiently solubilize insoluble phosphate of rock phosphate groups. These microorganisms release organic acids that solubilize soil-added insoluble phosphorus, which then becomes available for plant absorption.

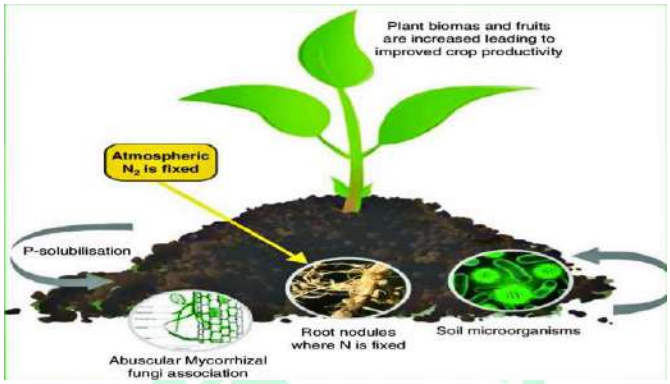
Phosphorus Mobilizing biofertilizers (PMB): Phosphorus mobilizing microbes are involved in the transformation processes of soil phosphorus. Both the fixed and soluble forms of phosphorus in the soil were mobilised. As a result, Soil phosphorus availability rises and plants may absorb phosphorus in a sustainable way. Examples include Mycorrhiza.

Potassium Solubilizing biofertilizers (KSB): These biofertilizers have the ability to dissolve minerals that contain potassium and transform the insoluble potassium into soluble potassium that plants can absorb. Examples include Bacillus sp. and *Aspergillus niger*.

Potassium Mobilizing biofertilizer (KMB): It has specific strains of bacteria that mobilise potash, converting insoluble potash to soluble potash and

making it available to plants. Examples include Bacillus sp.

Sulphur Oxidizing biofertilizer (SOB): These biofertilizers work by oxidising sulphur to sulphates, which plants can absorb. Sulphur oxidizing biofertilizer include Thiobacillus spp.



Source: Raimi *et al.* Cogent Food and Agriculture 2017

Different microorganism used in biofertilizer production and their groups

Groups	Examples
N_2-fixing biofertilizers	
Free living	*Azotobacter, Beijerinckia, Clostridium, Klebsiella, Anabaena, Nostoc*
Symbiotic	*Rhizobium, Frankia, Anabaena azollae*
Associative symbiotic	*Azospirillum*
P-solubilizing biofertilizers	
Bacteria	*Bacillus megaterium* var. *phosphaticum, Bacillus subtilis, Bacillus circulans, Pseudomonas striata*
Fungi	*Penicillium* spp., *Aspergillus awamori*
P mobilizing biofertilizers	
Arbuscular mycorrhiza	*Glomus* spp., *Gigaspora* spp., *Acaulospora* spp., *Scutellospora* spp., *Sclerocystis* spp.
Ectomycorrhiza	*Laccaria* spp., *Pisolithus* spp., *Boletus* spp., *Amanita* spp.
Ericoid mycorrhiza	*Pezizella*
Orchid mycorrhiza	*Rhizoctonia solani*
Biofertilizers for micronutrients	
Silicates and Zn solubilizers	*Bacillus* spp.
Plant growth-promoting rhizobacteria	
Pseudomonas	*Pseudomonas fluorescens*
Singh et al. (2014a, b)	

Conclusion

Long-term usage of chemical fertilizers reduced the soil's fertility, rendering it unfit for growing crop plants. The over use of these inorganic inputs has also resulted in serious environmental and health issues, such as water poisoning, soil erosion, and biodiversity loss. The use of biofertilizers can replenish the soil's natural fertility and safeguard it from aridity and soil-borne illnesses. They can naturally activate the microorganisms present in the soil, stimulating plant growth and boosting crop production. They are affordable, environmental friendly, and renewable. It is a crucial element of Integrated Nutrient Management (INM) since it aids in reducing the problems caused by population growth outpacing food production as a result of widespread chemicalization in agricultural ecosystems.

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Green Revolution in India: Miracle or Tragedy

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Abstract

"You can't build a peaceful world on empty stomachs and human misery. This was quoted by none other than the pioneer scientist communitarian known for his role in developing semi dwarf, high yielding varieties and disease resistant varieties, Norman Borlaug, also known as father of green revolution. Will that green revolution turn red? This is the big query in the recent and highly publicized upsurge in third world food production. Food production is rising but so is the number of unemployed in the nation. Scholarly studies echo the same fear. In this paper we are going to study the factors contributing the green revolution in India and its objectives and going to pay heed on positive and negative impacts of green revolution. As it was a miracle at some time even more than 100 crore people were raised from starvation. but Today due to increase in mechanization unemployment increases and excessive use of chemicals cause health hazards like cancer and birth defect Forced us to think that green revolution in India was a miracle are at tragedy.

Introduction

There have been many such revolutions in human life history that not only improve the quality of life but also change it completely one of these revolution was also seen in India. In 1947 when India became an independent nation, 75% of Indian population was dependent on agriculture due to old technology and absence of proper infrastructure. Productivity was at its lowest level Indian agriculture was absolutely dependent on rainfall. If monsoon was less than the expectations, it would have a deep impact on agriculture. The only solution of this problem was irrigation facilities. Which are available with only few farmers that time?

According to colonial rule, this stagnation was breakdown by green revolution. Green revolution? what is it? To increase crop production manifold by using fertilizers pesticides and high yielding variety seeds. Better management techniques are also used in green revolution. Green revolution did not happen only in India. Green revolution was started by an American agronomist Norman Borlaug in the middle of the 20th century. He is also known as the father of green revolution. Because of Norman Borlaug, More than 100 crore people were raised from starvation. He got the Nobel Prize in 1970 for his contributions the green revolution. In India the main leader for green revolution MS Swami Nathan known as father

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Green revolution.

History

In 1943, Bengal famine was India's worst food crisis, it's killed almost 40,00,000 people in eastern India 1947 to 1967, Indian government concentrated on expanding farming areas without focusing on productivity and technological advancements whereas population was growing more rapidly in comparison to food production., India was on the brink of mass famine in 1961, it became very crucial to take an immediate and drastic action to upsurge yield of agriculture. The result of this action was green revolution. Norman Borlaug was invited to India by the advisor to the Indian minister of agriculture doctor MSswami Nathan. Despite bureaucratic hurdles imposed by India's grain monopolies, the Ford foundation and Indian government collaborated to import wheat seed from the international maize and wheat improvement center (CIMMYT). The State of Punjab was selected by the Indian government to be the first side to try the new crops because of its reliable water supply, presence of Indus plains which make it one of the mostfertile plains on the earth, and a history of agricultural success. India begin its own green revolution program of plant breeding, irrigation development, and financing of agrochemicals.

Borlaug Hypothesis

'Borlaug Hypothesis' advocates that by reducing the demand for new farmland and increasing the productivity of agriculture on the best farmland can help to control deforestation.

High yielding techniques are ultimately saving ecosystems from destruction, and increase profits from high yield production may also induce crop land expansion in any case, although as World Food needs decrease, this expansion may decrease as well. Whereas according to this view, assuming that global food demand is on the rise, restricting probe uses to traditional low yield methods would also require at least one of the following. The world population to decrease, either voluntarily or as a result of mass starvation; or the conversion of forest land into crop land.

Objectives of Green Revolution

With upsurge in population, India was facing hunger crises. So fighting hunger crisis was a short term objective and primary objective.

Whereas long term objectives are:

1. Agricultural modernization.
2. Rural development.
3. Industrial development.
4. Infrastructure.
5. Raw materials.

Employment is given to agricultural workers and industrial workers. This revolution also promoted scientific works and studies where those plants were produced which can tolerate extreme environment and conditions and pests.One of the objective is globalization of agriculture. Technology transfer innon-industrialized nations and corporations set up in large agricultural areas resulted in globalization.

Basic elements of green revolution

- ✓ Expansion of farming areas
- ✓ Double cropping System: Double cropping system includes monsoon cropping and the cropping in which we use irrigation projects like sprinklers and drip irrigation dams
- ✓ Seed with improved genetics: Using seed with improved genetics is the third element of green revolution.
- ✓ High yielding varieties: ICAR developed new stains of HYV seeds of wheat, rice, millet and corn.

Positive impacts of Green revolution

- ✓ In 1978, Tremendous Increase in crop produce within 10 years. Output reached 131 million tones and India joined the team of the biggest agricultural producer. Due to which India became the biggest agricultural producer.
- ✓ Reduced import of food grain: Green revolution transformed India from food deficient country to self deficient country. Per capita availability of food grains increases.
- ✓ The green revolution helped to increase farmer's income and promoted capitalism farming.
- ✓ Industrial Growth: Due to increased demand for farming machinery like tractor, Harvesters, Threshers, Combines, diesel engines electric motors, pumping sets.
- ✓ Demand for pesticides, fertilizers etc used as raw materials in agro based industries.

Negative Impacts

- ✓ Non food grains like coarse cereals pulses oil seeds commercial crops like jute, sugar cane work kept out of green revolution.
- ✓ HYV seats were limited only for five crops wheat rice jar bajra maize but not four known food greens.
- ✓ Regional disparities in economic development, green revolution increased inter regional and intre regional disparities. The green revolution covered only 40% of the total cropped area as Assam, Bihar, West Bengal and Odisha were left out Arid & semi arid of western and southern India did not benefit from the green revolution.
- ✓ Excessive use of chemicals the farmers were unaware of the harmful effects of pesticides which in the long term resulting in environmental and soil pollution.
- ✓ Soil degradation, increase production, double cropping resulting in soil degradation increase in soil pH, replenishment of minerals etc.

Conclusion

Overall green revolution was India's major achievement and made India strong in food security as industrialized nations a successful scientific revolution was witnessed in agriculture in IndiaBut for food security some factors like environment, use of chemicals and poor farmers are ignored somewhere. In short terms, famines and food shortages were averted, but in long term cost of depending on Borlaug's new varieties, was reduced soil fertility, reduced genetic diversity, soil erosion and increased vulnerability to pests. Further, the focus should be on poor farmers and the safety of environment. New technology should be environmentally sustainable.

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Lumpy Skin Disease: An Emerging Threat to Livestock Worldwide

Maninder Singh, Surpreet Singh and Pranav Kumar

Lumpy Skin Disease (LSD) disease is caused by a virus called the Capri poxvirus and is "an emerging threat to livestock worldwide". It is genetically related to the Goat pox and Sheep pox virus family. LSD infects cattle and water buffalo mainly through vectors such as biting flies, mosquitoes and ticks.

An assessment study by the FAO concluded that the economic impact of LSD for the south, east and southeast countries is estimated to be up to $1.45 billion in direct losses of livestock and production. These losses may be higher due to the severe trade implications for infected countries, the report said. The disease is known to also affect meat production, hide quality and reproductive efficiency in cattle.

Major Symptoms include

- ✓ Round nodules on the skin all over the body
- ✓ Fever (41ºC/106ºF)
- ✓ Reduction in Milk Yield
- ✓ Lymph node enlargement
- ✓ Other symptoms include excessive nasal and salivary secretion (Source: Animal Husbandry Department, Jammu)
- ✓ Pregnant cows and buffaloes often suffer miscarriage and, in some cases, diseased animals can die due to it as well.

Recovery period: About 2-3 weeks

Morbidity Rate: 10-20%

Mortality Rate: 1-5%

Have such outbreaks occurred earlier; and are humans at risk?

This is not the first time LSD has been detected in India. The disease has been endemic in most African countries, and since 2012 it has spread rapidly through the Middle East, Southeast Europe and West and Central Asia.

Since 2019, several outbreaks of LSD have been reported in Asia. In May this year, Pakistan's Punjab also reported the deaths of over 300 cows due to LSD.

In September 2020, a strain of the virus was

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discovered in Maharashtra. Gujarat too has reported cases over the last few years sporadically, but currently, the point of concern is the number of deaths being reported, and whether vaccination catches up to the rate at which the disease is spreading.

The disease is not zoonotic, meaning it does not spread from animals to humans, and humans cannot get infected with it. The milk produced by an infected animal will be fit for human consumption after boiling or pasteurisation as these processes will kill the viruses, if any, in the milk. (Source: Indian Express Newspaper).

Spread of LSD: It is known to be spread by insects, specifically bloodsuckers such as some species of biting flies and mosquitoes. It also spreads through contaminated food and water (such as common sources of drinking water, or even grazing grounds). Studies have found that instances of the disease increase significantly during summer and with the onset of seasonal rains which coincides with the peak activity of the disease-transmitting vectors (such as flies and mosquitoes). Studies suggest that apart from the increased movement of livestock or vectors across borders, climate change and increased illegal trade could be causing the spread of LSD as well.

Scientists reported the first case of LSD from Zambia in 1929. It later surfaced in several south and north African countries. Scientists have also identified LSD in wild animals in Africa (in giraffes, impalas etc). Later on, it spread to countries in the Middle East, including Israel, Kuwait, Oman and Yemen (in the 1990s). LSD was thought to be endemic to parts of Africa and the Middle East, but the disease has now surfaced in several countries across the world, including the European Union. As per a qualitative risk assessment conducted by the Food and Agriculture Organisation in 2020, the disease had spread to 23 countries in south, east and southeast Asia by October 2020. In fact, the expansion of LSD's geographic range in south Asia is emerging as a challenge for Asian livestock management and food security, a recent study concluded (As reported by the online The Wire Magazine, 8th August 2022).

In India, LSD was first reported in cattle in 2019 in West Bengal. By January 2021, it had spread to 15 states in the country, as per several news reports. According to one study, the disease may have spread to India from other adjoining countries due to livestock movement across international borders, or even due to the movement of disease-causing vectors across neighbouring countries.

Prevention and Control

- ✓ Separation of affected animals from healthier ones.
- ✓ Do not introduce suspected animals into unaffected farm/herd.
- ✓ Control of vector population using insect repellents.
- ✓ Banning of Cattle fairs/shows/trade markets upon confirmation of disease.

- ✓ Strict control over animal movement in affected areas.
- ✓ Cleaning & disinfection of affected premises, sheds using phenol (2% for 15 minutes)/ Formalin (1%) / Sodium Hypochlorite (2-3%) / Ether (20%).

Treatment

- ✓ Vaccination against these diseases is covered under the Livestock Health and Disease Control Programme of India. One should seek immediate help from the nearest veterinary centre.
- ✓ There are no specific antiviral drugs available for the treatment of lumpy skin disease. The only treatment available is supportive care of cattle Symptomatic treatment using antibiotics, antipyretics, antihistamine, multivitamins & antiseptic skin ointments/ sprays (with fly repellent properties), under the direct supervision of a veterinary doctor.
- ✓ Feeding of liquid feed, soft feed & succulent fodder is recommended.

Ethno veterinary treatment/ Herbal treatment

An effective and safer traditional treatment using medicinal herbs is given for the benefit of farmers to combat the lumpy skin disease in cattle. The medicine can be prepared by the farmers using locally available medicinal herbs and administer to the animal.

Oral treatment for first 3 days of infection

Ingredient	Quantity
Beetel leaves	10 no.s
Black pepper	10 no.s
Crystal salts	10 gms
Jaggery	Required volume

Grind the above ingredients well, mix them up with jaggery to form a paste and feed the paste to the animal every 3 hours once, for the first three days.

Oral treatment for 3 to 14 days of infection

Ingredient	Quantity
Garlic	2 no.s
Coriander leaves	15 grams
Cumin seeds	15 grams
Tulsi	1 hand full
Clove leaves	15 grams
Black pepper	15 grams
Betel leaves	5 no.s
Shallots (small onions)	2 no.s
Turmeric powder	10 gms
Neem leaves	One hand full
Jaggery	Required volume

(Source: NDDB)

Grind the above ingredients well, mix them up with jaggery and feed the paste to the animal in the morning, evening and night.

For external application (if there are wounds)

Ingredient	Quantity
Acalypha indica leaves	1 handful
Garlic	10 pearls
Neem leaves	1 handful
Cocunut or sesame Oil	500 ml
Turmeric powder	20 grams
Mehndi leaves	1 handful
Tulsi leaves	1 handful

(Source: NDDB)

Preparation

- ✓ Blend all the ingredients thoroughly
- ✓ Mix with 500 ml coconut or sesame oil and bring to cool.

Application: Clean the wound and apply directly.

If maggots are seen

Apply Anona leaf paste or camphorated coconut oil for the first day only if maggots are present. (Source: NDDB)

Carcass disposal: In case of mortality due to lumpy skin disease the animal should be disposed of by deep burial.

Role of Sulphur on Oilseed Quality

Balu Ram

Introduction

- ✓ Atomic no. 16
- ✓ Atomic weight 32
- ✓ 13th abundant mineral in the earth crust (0.06%)
- ✓ It is being recognized as 4th major plant nutrient after N, P and K.
- ✓ Essentiality established by Slam Horst mar in 1857
- ✓ It resembles N in its role and function in plant production, is comparable to P in terms of overall crop needs and could be equated with K in terms of per unit cost.

Role of sulphur in plant

- ✓ Part of every living cell
- ✓ Neccesary for the formation of chlorophyll
- ✓ Constituent of three Important amono acid namely cysteine (26%s), cystine (27%s) and methionine (21%s)
- ✓ Help in synthesis of fat or oil
- ✓ Involved in the formation of glucosides and glucusinolates, synthesis of glutathione
- ✓ Constituent of Fe-S protein called ferrodoxins for activity of ATP.
- ✓ Sulphurylase which involved in S metabolism
- ✓ Helps in synthesis of coenzyme-A, vitamin B_1, biotin and thiamin.
- ✓ Constituent of the sulphydril linkage (-SH) which provides pungency of mustard oil.
- ✓ Improve the nutritrional value of fodder and forages by narrowing the N: S ratio
- ✓ Improve the oil percentage in seeds, seed protein content, flour quality for milling and backing quality of wheat, leaf quality of tobacco

Critical limit of available soil S (ppm) for different crops according to common methods of extraction

CROP	CaCl	KHP	CaHP	Morgan	AmAc	Mean
Groundnut	10				11	10.5
Mustard	10	13	13	10	9	10.4
sunflower	18	10			30	18.8
soybean	14		14	8	8	11.7
Rice	10	10	10	13	11	11.6
Sorghum	8					8.0
Tandon, 1991						

Critical S concentration in plant parts for different plants

Crops	Critical level (%)	Stage
Rice	0.16	tillering
Pigeonpea	0.134	before flowering
Rapeseed	0.21	
Groundnut	0.24	60 DAS
Soybean	0.15	30 DAS
Sunflower	0.24	at prebloom
Tandon, 1991		

Sulphur uptake by different crops

Crop	Yield (kg ha^{-1})	S uptake (kg)	S uptake (kg/ton of main produce)
Groundnut	2550	8.5	3.33
Mustard	2596	44.9	17.29
Taramira	1500	31.0	20.66
Soybean	2500	22.0	8.8
Safflower	1909	24.3	12.73
Sunflower	2380	16.8	7.05
Sesame	1200	14.0	11.67
Rice	3131	10.0	3.19
Wheat	3900	11.9	3.05
Tandon, 1991			

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Sulphur Deficiency

General symptoms

- ✓ As sulphur is an immobile nutrient in plant, the deficiency symptoms first appear on younger leaves.
- ✓ Yellowing of younger leaves which persist even after N application.
- ✓ Stunted plant growth, slender shoot
- ✓ Delayed maturity of cereals, poor nodulation in legumes and nitrogen fixation
- ✓ An excess of sulphur free amino acid (e.g. asparagine, glutamine and arginine) due to the inhibition of protein synthesis

S deficiency symptoms in major oilseeds

1. **Groundnut:** Young plants are smaller, pale in colour and more erect from the petiole than normal plants .This gives the trifoliate leaves a V shaped appearance.
2. **Soybean:** New leaves continue to remain pale-yellow green, chlorosis starts from leaf margin and spread inwards.
3. **Rapeseed:** Cupped leaves and a reddening of the underside of leaves and stems.
4. **Sunflower:** Leaves and infloresence become pale, plants are markedly smaller.

Areas of Sulphur Deficiency

1. 45% Districts having more than 40% soil samples deficient in S
2. 40% Districts having 20-40% soil Samples deficient in S
3. 15% Districts having less than20% soil samples deficient in S
4. 1991: 130 districts were found deficient
5. 2001: 200 districts were found to deficient

Causes of sulphur deficiency

1. Progressively greater removal of soil Sulphur as a result of higher agricultural production and cultivation.
2. Low level of fertiliser use in pulses and oilseeds that have a higher requirement of S than cereals per unit of grain production.
3. Use of high analysis N and P fertiliser containing little or no sulphur like urea and DAP instead of using $(NH_4)_2SO_4$ and SSP.
4. Lesser use of organic matter, crop residue and S containing pesticides.
5. Leaching and erosion losses of S.

Commonly used sulphur fertilisers in India

FERTILISERS	S (%)	N (%)	P (%)	K (%)
Ammonium sulphate	24	21		
Ammonium sulphate nitrate	15	26		
Ammonium phosphate suphate	15	16-20	20	
Calcium sulphate (gypsum)	13-18			
Elemental sulphur	85-100			
Single superphosphate	12		16	
Potassium sulphate	18			50
Zinc sulphate	15			
Iron pyrites	22-24			

Effect of sulphur on the constituent acid content of linseed oil

S Level (kg ha^{-1})	Palmitic Acid (%)	Stearic Acid (%)	Oleic acid (%)	Linoleic Acid (%)	Linolenic Acid (%)
0	6.18	5.00	23.8	14.6	50.5
20	5.79	4.81	23.0	13.8	52.6
40	5.58	4.62	22.9	13.1	53.9
60	5.33	4.35	22.5	12.7	55.9
CD (p=0.05)	0.07	0.07	0.2	0.2	0.3
Jaggi *et al.*, 1993					

Mapping Populations in Crop Improvement

B. L. Meena, Sudhir Kumar, S. K. Meena and Reena Kumari

Abstract

Mapping population, consists of individual progenies that are originated from two or more parents of one species or related species. Hence, the first step in linkage or genetic map construction is the development of mapping population. A population that is suitable for linkage mapping of genetic markers is known as mapping population. Mapping populations are generated by crossing two or more genetically diverse lines and handling the progeny in a definite fashion. Mapping populations are used for determining genetic distances between pairs of loci/genes and to map them to specific locations in the genome. There are basically two types of mapping populations, viz., primary and secondary mapping populations. Primary mapping populations are created by hybridization between two homozygous lines usually having contrasting forms for the traits of interest. Secondary mapping populations are developed by crossing two lines/individuals selected from a mapping population; they are developed mainly for fine mapping of the genomic region of interest.

Introduction

Population used for mapping the genes, is commonly called as mapping population and they usually obtained from controlled crosses. Selection of parents is the 1st step for production of mapping population. Parents selected to develop mapping population should have sufficient variation for trait of interest both at DNA sequence level and at phenotypic level. Higher the variation, it is easier to find the recombination. Parents should not be so diverse that they unable to cross.

The primary mapping populations are of the following different types: (1) F_2, (2) F_2 derived F_3 (F_2:F_3), (3) backcross (BC), (4) backcross inbred lines (BILs), (5) doubled haploids (DHs), (6) recombinant inbred lines (RILs), (7) near-isogenic lines (NILs), (8) chromosomal segment substitution lines (CSSLs), (9) immortalized F_2, (10) advanced intercross lines, (11) recurrent selection back(RSB) populations, and (12) interconnected populations

Types of mapping population

F_2 population: A F_2 mapping population comprises

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the progeny produced by selfing or sib-mating of the F_1 individuals from a cross between the selected parents. The F_1 individuals would be heterozygous for all the loci for which their parents differ from each other. Each F_2 individual is expected to have a unique combination of linkage blocks from the two parents, and this difference is the basis for detection of linkage between pairs of loci. Since F_2 generation is the product of a single meiotic cycle (in the F_1 plants), only one round of recombination can occur between any of two loci. Therefore, the estimates of recombination frequencies between pairs of loci obtained from F_2 populations serve as a reference point. In a F_2 population the ratios expected for dominant and codominant markers are 3:1 and 1:2:1, respectively. F_2 populations are the best suited for preliminary mapping of markers and oligogenes. The F_2 populations provide estimates of additive, dominance, and epistatic components of the genetic variance. These populations capture the recombination events from both male and female parents of the F_2 plants.

F_2-Derived F_3 Population: A F_2-derived F_3 or $F_{2:3}$ population is obtained by selfing the F_2 individuals for a single generation and harvesting the seeds from each F_2 plant separately so that each F_2 plant is represented as an individual plant progeny. The DNA for genotyping is obtained from individual F_2 plants or it can be reconstructed from a bulk of at least 20 plants from each F_3 family since this bulked DNA may be expected to represent the genotype of the parental F_2 plant. $F_{2:3}$ populations are suitable for mapping of oligogenic traits controlled by recessive genes and of QTLs since data can be recorded on multiple plants in each $F_{2:3}$ family to compensate for sampling error.

Backcross Population: Backcross populations are generated by crossing F_1 plants with either of the two parents of the concerned F_1. Genetic analysis can be performed only when there is detectable phenotypic segregation for the target trait in the backcross generation. Therefore, the F_1 is, as a rule, back-crossed to the recessive parent, i.e., the parent having the recessive form of the target trait. Such a backcross is called test cross, is usually denoted by B_2, and exhibits 1:1 ratio for the trait phenotype, dominant molecularmarkers present in coupling phase with respect to the target trait, and codominant markers in either phase. However, it would show 1:0 ratio, i.e., no segregation, for dominant markers present in repulsion phase in relation to the target trait. In contrast, progeny from backcross with the dominant parent would display ratio for the trait phenotype and dominant markers present in coupling phase with respect to the target trait.

Doubled Haploids: Doubled haploid (DH) plants are obtained by chromosome doubling of haploid plants usually derived by culture of anthers/pollen grains produced by F_1 plants. Generally, colchicine is used to double the chromosome number of haploids, seeds from individual DH plants are harvested separately and maintained as DH lines. The expected ratio for the genes as well as markers in a DH population is 1:1 irrespective of the marker being

dominant or codominant. DH populations, can be evaluated in replicated trials and are suitable for mapping both qualitative and quantitative characters. Only additive and additive x additive interaction genetic variances can be estimated from DH populations as they consist of only homozygous plants. Therefore, DH populations are not suitable for mapping heterosis QTLs.

Recombinant Inbred Lines: Recombinant inbred lines (RILs) are a set of homozygous lines produced by continuous inbreeding/selfing of individual F_2 plants. The SSD method is the best suited for developing RILs, but bulk procedure and pedigree method without selection can also be used. It is important that the generation advance is carried out under an optimal environment that affords equal survival of the various genotypes and does not impose a selection pressure against some genotypes. The SSD procedure is followed for five ormore (usually >8) generations, during which one seed is harvested from each plant of the F_2 and the later generations and seeds from all the plants are composited and planted to raise the next generation. At the end of SSD procedure, seeds from each plant are harvested separately to obtain as many RILs as there are individual plants in the SSD population. The expected ratio of the two homozygotes in the population is l: l. RILs have been widely used for the development of molecular marker linkage maps; detection of markers linked with genes governing qualitative traits like racespecific vertical disease resistance, seed or flower color, seed/fruit shape etc.; identification of markers associated with QTLs involved in the control of traits like horizontal disease resistance, yield, days to flowering/maturity etc.; mapping of genes and QTLs; and the integration of the gene/QTL maps with molecular marker maps.

Immortalized F_2 Population: The population of single cross F_1s produced by intercrossing a set of RILs in pairs or as per some other scheme is known as immortalized F_2 population. IF_2 populations can also be developed by paired crossing of the randomly chosen RILs derived from a cross in all possible combinations, excluding the reciprocals; in this approach, the single crosses together with the parental RILs would constitute the IF_2 population. An IF_2 population provides a true representation of all possible genotypes, including the heterozygotes, expected in the IF_2 of the cross from which the RILs were derived. IF_2 populations support replicated evaluation of F_2 genotypes over locations and permit detection and mapping of QTLs, including heterosis QTLs, and estimation of various epistatic effects.

Near-Isogenic Lines: Near-isogenic lines (NILs) are pairs of homozygous lines that are identical in genotype, except for a single gene/locus. NILs are generally produced by backcross procedure. In which a donor parent (DP, a homozygous line having the trait/allele of interest) is crossed with a recurrent parent (RP, a homozygous line lacking this trait/allele), and the F_1 plants are backcrossed to the RP. The backcross generation (BC) so obtained and the subsequent BC progeny are backcrossed to the RP. In each BC generation, a strict selection is done

for the trait/allele being introgressed from the DP because each backcrossing reduces the proportion of DP genome in the progeny to 50 % of that present in the previous generation. NIL is essentially a segment substitution version of the RP. Repeated back-crossing eliminates the DP genomic segments unlinked to the target gene and reduces the size of DP genomic region flanking the target gene due to recombination in each BC generation (Schneider, 2005). NILS can be used to construct high-resolution mapping populations. Finally, they are quite useful in functional genomics; they can be used for gene expression profiling and for more direct hypothesis-driven experimentation.

Chromosomal Segment Substitution Lines: A series of homologous lines, each having a single distinct chromosome segment from a DP in the chromosome background of RP is known as Chromosome segment substitution lines (CSSLs). The CSSLs may be produced by backcrossing the F_1 and the subsequent progeny from a cross between the DP and the RP with the RP for six generations or so, followed by self-fertilization for two or more generations to isolate lines homozygous for the introgressed segments. Selection based on markers evenly distributed over the entire genome is used to ensure that each line of the set has a distinct but slightly overlapping DP genome segment. CSSLs are a perpetual mapping resource and are suited for mapping of both oligogenes and QTLs. They can also be used for fine mapping by raising large F_2 or backcross populations following hybridization with the RP (Eshed and Zamir 1994). Evaluation of CSSLs in replicated trials over locations and years would allow the identification of such lines that have DP genomic segments with favorable effects on the traits of interest. CSSLs can be used for the detection of QTLs with small additive effects that are ordinarily masked by QTLs with larger effects in the usual mapping populations like and RILs. QTL identification using CSSLs does not require linkage map construction or statistical analysis. Further, each CSSL can be directly used for mapping and cloning of QTLs/genes and for development of elite breeding lines.

Backcross Inbred Lines: Backcross inbred lines (BILs) are developed by backcrossing the F_1 from a cross between two homozygous lines to one of the parents and continued selfing of the BC_1F_1 progeny to obtain homozygous lines. The data from BIL population were analyzed using the method for backcross F_2 population and treating the heterozygotes as missing data since a method for analysis of BIL population was not available. A possible advantage of BILs may be the increased frequency of the alleles contributed by the parent used for backcrossing. Therefore, it would be desirable to use the parent with the higher value of the target trait for backcrossing with the F_1 hybrid.

Advanced Intercross Lines: An advanced intercross line (AIL) population is developed by intermating the individuals of F_2 and subsequent generations from a suitable cross. Intermating in the segregating generations maintains heterozygosity in

the population and allows recombination between the QTLs and the markers linked to them in every generation leading to a more precise location of the QTLs. It was estimated that the confidence interval of QTLs would be reduced by up to five-fold in AILS as compared to that in an F_2 population. In the case of AILS, mapping resolution seems to improve for up to eight generations of intercrossing only, while it continues to improve with generation in the case of recurrent selection backcross.

Recurrent Selection Backcross Population: It refers to the population developed by backcrossing the F_1 from a cross between lines having high (DP) and low (RP) values for a quantitative trait and the subsequent generations to the RP; in each backcross generation, a predetermined number of individuals with the top phenotypic value, i.e., value close to the DP phenotype, for the trait are selected for backcrossing. RSB is proposed to be used for high-resolution QTL mapping, for which a sufficiently large number of backcrosses need to be made. Recombination between the DP QTL alleles and the linked markers will take place in each generation. Therefore, the level of heterozygosity at these marker loci will go on decreasing with the increasing number of RSB generations. In addition, in a given generation, markers located farther from the QTLs will show greater reduction in heterozygosity than those located closer to the QTLs. Thus, the frequency of heterozygosity at marker loci can be used as a criterion of localizing the QTLs.

Interconnected Mapping Populations: Inter-connected mapping populations are produced by crossing a set of homozygous parental lines in such a way that two or more crosses have one parent in common. An interconnected population may consist of F_2 backcross, RIL, or DH populations generated from each of the crosses produced as per the mating design used. The usefulness of QTL findings in plant breeding depends on their general applicability and an understanding of the genetic architecture of the traits governed by the QTLs. Biparental mapping populations generate QTL information applicable to the concerned crosses, and they fail to take into account segregation of different allelic combinations of QTLs in different mapping populations and the influences of genetic background on QTL effects. Generalization of QTL findings from different biparental populations has been attempted by comparing the relative QTL positions determined from different populations by means of QTL meta-analysis, and bioinformatics tools are being developed to facilitate this analysis. In contrast, joint analysis of data from interconnected populations provides more generalized information about QTL positions and effects, increases QTL detection power, enables detection and assessment of QTL x genetic background interaction, and permits identification of markers located closer to the QTLs than do biparental populations, particularly when appropriate analysis tools are used.

Multiparent Advanced Generation Intercross Populations: The multiparent advanced generation

intercross (MAGIC) populations are a collection of RILs produced from a complex cross/outbred population involving several parental lines. The parental lines may be inbred lines, clones, or individuals selected on the basis of their origin or use. MAGIC populations are perpetual, lack population structure, can be used for both linkage and association analyses, and can be developed at an appropriate stage during the intermating process to afford the desired mapping resolution. They are an ideal resource for construction of high-density maps, and they allow modeling of cytoplasmic effects. These populations can be used as training populations for genomic selection.

Nested Association Mapping Population: In order to combine the advantages of both linkage mapping and association mapping strategies, a structured population generated by crossing a set of diverse founder parents to one or two common parents has been suggested (Yu *et al.*, 2008). Each selected founder is crossed to one or few common parents (nested parents) and a set of 250 RILs from each of these crosses is generated using the SSD method. The nested association mapping strategy enables efficient utilization of genetic and genomic resources for genetic dissection of complex traits.

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Breeding for Disease Resistance: Strategies and Challenges

B. L. Meena, Sudhir Kumar, S. K. Meena and Reena Kumari

Abstract

Plant pathogens represent a major threat to plant health use of pesticides and herbicides. Breeding for disease resistance and targeted genetic manipulation of plant immune components have efficiently helped to mitigate these threats. Plant diseases are responsible for substantial crop losses every year and carriage a menace to worldwide food security and agricultural sustainability. Improving crop resistance to pathogens through breeding is an environmentally sound method for managing disease and minimizing these losses. However, it is challenging to breed varieties with resistance that is effective, stable, and broad-spectrum.

Recent advances in genetic and genomic technologies have contributed to a better understanding of the complexity of host-pathogen interactions and have identified some of the genes and mechanisms that underlie resistance. This new knowledge is benefiting crop improvement through better informed breeding strategies that utilize diverse forms of resistance at different scales, from the genome of a single plant to the plant varieties deployed across a region. Resistance breeding is an important strategy for reducing crop losses caused by disease. The relevance and scope of developing resistant varieties lies in understanding and manipulation of interactive behavioral properties of host and pathogen.

Introduction

Plant disease resistance is crucial to the reliable production of food and it provides significant reduction in the agricultural use of land, water, fuel, and other inputs. Plant in both natural and cultivated populations carry inherent disease resistance, but this has not always protected them. Plant pathogens represent a major threat to plant health use of pesticides and herbicides. Breeding for disease resistance and targeted genetic manipulation of plant immune components have efficiently helped to mitigate these threats. Plant diseases are responsible for substantial crop losses every year and carriage a menace to worldwide food security and agricultural sustainability. Improving crop resistance to pathogens through breeding is an environmentally sound meth-

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od for managing disease and minimizing these losses. However, it is challenging to breed varieties with resistance that is effective, stable, and broad-spectrum. Recent advances in genetic and genomic technologies have contributed to a better understanding of the complexity of host-pathogen interactions and have identified some of the genes and mechanisms that underlie resistance. This new knowledge is benefiting crop improvement through better informed breeding strategies that utilize diverse forms of resistance at different scales, from the genome of a single plant to the plant varieties deployed across a region. Resistance breeding is an important strategy for reducing crop losses caused by disease. The relevance and scope of developing resistant varieties lies in understanding and manipulation of interactive behavioral properties of host and pathogen. The commonly observed responses of the plant in relation to the pathogen are (i) Escape, (ii) Tolerance, (iii) Resistance, (iv) Immune and (v) Susceptibility.

Types of Genetic Resistance

1. **Vertical Resistance:** A plant variety that exhibits a high degree of resistance to a single race, or strain, of a pathogen is said to be vertically resistant.
2. **Horizontal Resistance:** Protects plant varieties against several strains of a pathogen, although the protection is not as complete. Horizontal resistance is more common and involves many genes.
3. **Durable Resistance:** Durable resistance is one which remains effective in a cultivar during its widespread cultivation for a long sequence of generations or period of time, in an environment favorable to disease. The maintenance of resistance over a long period of cultivation in wider area favoring the development of disease is the only test of durability.

The Strategy of Resistance Breeding

The type of resistant varieties and the appropriate breeding procedures to be adopted is depending upon combined knowledge of genetics of resistance in host and of virulence in pathogen. Plant breeders have utilized knowledge of gene-for-gene relationship of host-pathogen interaction for efficient deployment of resistance genes in alternate forms. Use of major gene resistance, polygenic resistance or other strategies of gene management requires an appropriate source of resistance and breeding methodology for efficient management of resistance genes. Fehr (1984) categorized the alternate strategies as follows.

- ✓ Development of cultivars with single major gene against the prevalent pest.
- ✓ Combination of genes controlling prevalent and minor races of pest in the form of mixture of different genotypes especially as 'multiline' varieties.
- ✓ Placing genes controlling prevalent and minor races into a single cultivar i.e. pyramiding of resistance genes.

The Breeding Procedures

The resistance to diseases requires a thorough

knowledge of the genetic sources for resistance, racial composition of pathogen and genetic basis of host-pathogen interaction. The control of environmental conditions is essential in breeding for disease resistance to ensure a right type of pathogen, adequate quantity of inoculum and congenial environmental conditions for development of disease to identify resistant plants from those harboring genes for susceptibility. A sound screening procedure is required to differentiate between resistance and escape on one hand, and between resistance and susceptibility on the other. The screening techniques must involve creation of artificial epiphytotic.

The first step in resistance breeding is collection and maintenance of resistance genes which then can be used according to the breeding strategy i.e. for development of 'VR' or 'HR' or a combination of both. The sources of resistance may include:

- ✓ Advanced breeding lines or new genetic stocks developed through pre-breeding or genetic engineering.
- ✓ Commercial varieties under cultivation
- ✓ Landraces or primitive cultivars
- ✓ Wild relatives in the form of original progenitors or related species.

Availability of resistance from locally adapted commercial or obsolete varieties is preferred because it has minimum undesirable side effects as compared to resistance from wild species. The choice of specific breeding procedure depends upon the mode of reproduction of the crop, source of resistance, type of resistance and the strategy for the management of resistance genes.

Breeding for disease resistance assumes special significance with the appearance of new disease or increased virulence of pathogen of already prevalent disease. Both the situations put at stake the survival of varieties under cultivation which become the natural targets to incorporate resistance genes to recover and stabilize their inherent potential through stabilizing breeding. The evolution of new virulent races in the procrastinated co-existence of host and pathogen under intensive agriculture is now becoming the main basis of breeding for resistance.

Backcross is the most commonly used breeding method to incorporate resistance into existing adapted varieties. This method, indeed, owes its and existence in plant breeding for the transfer of selected major genes to varieties without disturbing their overall genetic constitution. Backcross method is equally applicable for quantitative characters but more number of plants has to be sampled for backcrossing where selfing generation has to be grown for conducting selection after first and third backcrosses. Relatively more number of backcross families and several plants in each family need to be grown. Use of molecular markers can increase the rate of recovery of genes of recurrent parent as well as to concentrate all the polygenes conferring resistance.

Backcross is the ideal method to develop multigene varieties i.e. varieties in which diverse res-

istance alleles for a particular disease are concentrated. The resistance genes to match different virulent races of a pathogen are deployed in one variety through backcross method. But it requires rigid screening techniques using cultures of specific races to identify plants in each backcross generation so that all the genes are ensured to be deployed. Moreover, component isogenic lines of multiline varieties are developed through backcross method. Backcross is the only breeding method by which the resistance genes available in wild relatives of crop plants can be transferred to cultivated varieties.

Use of Multiline

Jensen (1952) first suggested the use of multiline variety through a blend of multiple pure lines each of which is of different genotype. Such component pure lines were supposed to be phenotypically uniform for morphological and other characters of agronomic importance but with additional desirable genetic factors for resistance to a particular disease.

Advantages of Multiline Varieties

- ✓ Multilines Varieties provide greater protection against disease by exploiting strong vertical resistance in a convenient and workable manner.
- ✓ Linkage and allelism: Multiple alleles for disease resistance at a particular locus can easily be incorporated in a single variety.
- ✓ Prolonged life of res genes.
- ✓ Longer life of varieties: Multilines can stay in field for longer period due to reduced selection pressure on the pathogen that remains in a stable state for many years.
- ✓ Stability and adaptability of varieties

Problems in Breeding for Disease Resistance

The development of disease resistant varieties is most viable biological alternative to the use of other means of disease control but it has unique requirements and problems.

- ✓ Lack of Resistance Gene
- ✓ Breakdown of Resistance
- ✓ Development of New Races of Pathogen
- ✓ Combination of Resistance with High Yield and Adaptability

Conclusion

Disease resistant varieties have been developed in many crops all over the world. In India disease resistant varieties have been evolved in brassica, wheat, barley, maize, rice, sorghum, sugarcane, cotton, pulses, oilseed and many others crops. BIO-YSR, Heera, Donskaja released for white rust resistant in Indian mustard. Almost all the currently release varieties of arboretum cotton are resistant to fussarium wilt. The resistant varieties to Many varieties of wheat are resistant to rust. In sugarcane, several varieties are resistant to red rot and wilt. In okra, a yellow mosaic virus resistant variety Parbhani Kranti has been released in upland cotton variety MCU 5 VT, is tolerant to verticillum wilt.

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Alternative Oxidase is Positive for Plants

S. D. Pradeep and Gali Suresh

Introduction

Photosynthesis and respiration are the two major pathways of carbon fixation and energy metabolism in plants. The production of carbon intermediates, reducing equivalents, and ATP through respiration is subsequently used to promote growth and maintenance. The existence of two terminal oxidases is a distinguishing characteristic of the plant mitochondrial ETC. There is also an alternate oxidase (AOX) that directly connects the oxidation of ubiquinol with the reduction of O_2 to H_2O in addition to cytochrome c oxidase. Although AOX adds a branch to the ETC, electrons in ubiquinol are divided between AOX and the cyt route (complex III, cyt c, and complex IV). Notably, because AOX does not function as a proton pump and because the flow of electrons to AOX avoids the complexes III and IV which do proton pumping, it significantly lowers the energy (ATP) yield of respiration. In summary, plants have additional ETC components that allow for a dramatic modulation of ATP yield depending on the components of the path used for NAD(P)H oxidation and O_2 reduction (Finnegan *et al*, 2004). A limited subset of thermogenic plants potentially heat their reproductive tissues to temperatures above than ambient by sustaining a very high rate of uncoupled and thus heat-releasing AOX respiration. This can be utilized to attract pollinators or to ensure optimal conditions for floral development. However, most plants and tissues are essentially non-thermogenic, the presence of AOX must be for other reasons.

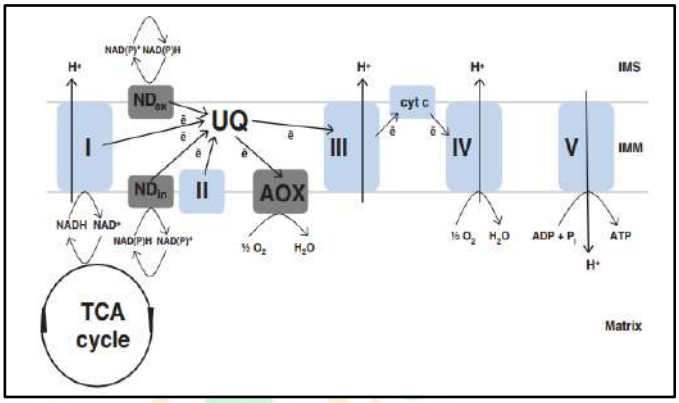

Fig.: Mitochondrial electron transport chain (Vanlerberghe *et al*., 2016)

Control of Generation of Mitochondrial Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) by AOX

The rate at which mitochondria generate ROS is determined by the reduction state of ETC components. When ADP is freely available and actively phosphorylated to ATP in animals, proton gradient dissipation decreases membrane potential and O_2 production is lower than when ADP is limited. The link between electron transport, oxidative phosphorylation, and ROS formation in plants, on the other hand, is more complicated since electron transport from ubiquinol to AOX does not contribute to membrane potential.

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As a result, AOX could provide a way to sustain considerable electron transport even when ADP is limited, while also preventing ETC over-reduction. Recent research has provided direct in plant evidence that AOX functions to limit the over-reduction of ETC components, which leads to a single electron leak. It was observed using fluorescent confocal imaging in tobacco plants with decreased levels of AOX due to RNA interference have higher amounts of mitochondrial-localized O_2. The study also found higher levels of nitric oxide (NO) in the leaves lacking AOX, a portion of which also localized to mitochondria. Since mitochondria have been proposed to generate NO via single electron leak from the ETC to nitrite, the results with tobacco leaf suggest that AOX, by controlling the reduction state of the ETC, also dampens NO generation. The conclusions of this study are further supported by experiments with the complex III inhibitor antimycin A that, by restricting electron flow, causes an over-reduction of ETC components. Both mitochondrial O_2 and NO increased considerably in wild-type plants in response to antimycin A. These however not observed in plants overe-xpressing AOX and thus capable of maintaining high rates of electron flow even in the absence of complex III activity (Cvetkovska *et al*., 2013).

Alternative Oxidase's Contribution to Metabolic Homeostasis

Because of the presence of AOX, the respiratory system has built-in flexibility in terms of the degree of connection between carbon metabolism pathways, ETC activity, and ATP turnover. The ability to quickly align cellular demands for ATP with cellular demands for pyridine nucleotide turnover and carbon intermediate supply for biosynthesis is provided by adjusting the absolute and relative rates of electron transport between AOX and cyt oxidase. The following are some basic aspects of how AOX can promote such metabolic balance to plant metabolism.

Homeostasis of Carbon Pools-An Example

Plants' carbon status is dependent on the uptake of atmospheric CO_2 during photosynthesis because they are autotrophic organisms. Carbon status is a crucial regulator of photosynthetic capability and activity, in addition to supplying the substrate for plant development. For example, switching plants from low to high CO_2 levels can significantly increase photosynthetic activity. However, this increased activity is frequently restricted because carbon buildup is considered to function in a feedback signal to reduce photosynthetic capability and activity (Leaky *et al*., 2009). The extent to which increased respiratory metabolism could function to absorb the excess carbon assimilated at high CO_2 levels is unknown. For example, AOX activity could allow respiration to absorb carbon without being hampered by the rate of ATP turnover. The response of the respiratory system could be essential in determining how photosynthesis will respond to future situations of greater atmospheric CO_2. Some reports have begun to investigate AOX's putative role.

Homeostasis of Redox State-An Example

Variable AOX activity may be crucial in controlling the reduction status of the pyridine nucleotide pool in the absorption of nitrogen (N) to amino acids. Nitrate assimilation to amino acids requires a lot of reducing power (to convert nitrate to ammonium), but ammonium assimilation to amino acids requires very little. As a result, when there is a greater potential for surplus reducing power, one may predict AOX respiration to be more prominent in plants cultivated on ammonium. As a result, when there is a greater potential for surplus reducing power, one may predict AOX respiration to be more widespread in plants growing on ammonium. The discovery that Arabidopsis plants grown on ammonium had a higher AOX capacity and total respiration rate than plants grown on nitrate supports this (Escobar *et al*., 2006). However, Arabidopsis plants without AOX exhibit the increased respiration rate typical of ammonium development, and it has been proposed that this respiration is predominantly mediated via the cyt pathway. As a result, the role of AOX during nitrate versus ammonium growth requires additional research to include other plant species, assessment of plants with altered AOX levels, and isotope discrimination measures of AOX activity during nitrate or ammonium growth.

Homeostasis of Energy Status-An Example

The active transfer of mineral ions into the plant is a high-energy process that is aided by plant respiration. As a result, plant respiration is frequently classified as supporting growth activities, supporting maintenance processes, and specifically supporting ion transport processes. Dynamic and flexible ion transport processes exist. As a result, the ATP demand for this process is likely to be dynamic and varied. Because of the variable requirement for huge amounts of ATP, a respiratory system with variable coupling to ATP synthesis may be required (Lambers *et al.*, 1983).

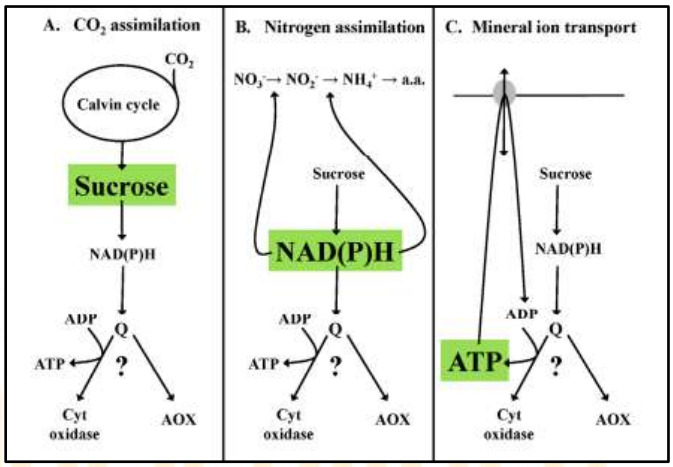

Fig.: Illustrating how changes in the partitioning of respiratory electron flow between cyt oxidase and AOX can act to maintain metabolic homeostasis (Vanlerberghe, 2013)

Conclusion

AOX activity has a direct impact on the level of potentially relevant signalling molecules, establishing an important relationship between mitochondrial function, signal transmission, and stress acclimatisation. The role of AOX in metabolic and signalling balance is especially crucial during stress. Overall, alternating oxidase is beneficial to plants.

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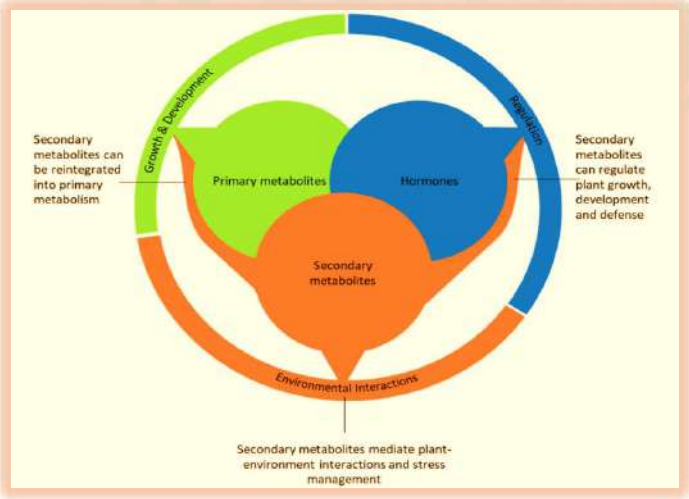
Plant Secondary Metabolites

Gali Suresh and S. D. Pradeep

Introduction

Secondary plant metabolites are a variety of chemical substances synthesized by the plant cell via metabolic pathways derived from the primary metabolic pathways. The secondary metabolite concept was first explained by Albrecht Kossel, Nobel Prize winner for physiology or medicine in 1910. Three decades later, Czapek described them as end-products. He claimed, that these products are derived from nitrogen metabolism by 'secondary modifications' such as deamination. Functionally, primary metabolites, secondary metabolites, and hormones are the three categories of low molecular weight chemicals in plants.



Many plant secondary metabolites also play regulatory roles, and some act as primary metabolite precursors, according to current research. Plant secondary metabolites (PSMs) have a variety of functions, including mediating communication between organisms, responding to environmental stresses, and plant defense against pathogens, pests, and herbivores.

Classification

Three major groups of secondary metabolites are distinguished:

1. **Isoprenoid or terpenes:** Biosynthesized from acetyl-CoA via the mevalonic acid pathway or synyhesized from pyruvate and glyceraldehyde-3-phosphate via methyl erithritol phosphate pathway. Examples: steroids, rubber, essential oils, etc.
2. **Phenolic compounds or phenolics:** Biosynthesized from acetyl-CoA via the malonic acid pathway or from erythrose-4-phosphate & phosphoenol-pyruvate via the shikimic acid pathway. Examples: flavonoids, lignins, tannins, etc.
3. **Nitrogen-containing secondary metabolites:** Biosynthesized from aromatic or aliphatic amino acids. Examples: alkaloids, non-protein amino acids, etc.

Secondary metabolites biosynthetic pathways

Isoprenoids (or) Terpenes

These compounds shows the properties of lipids, which are synthesized almost entirely from

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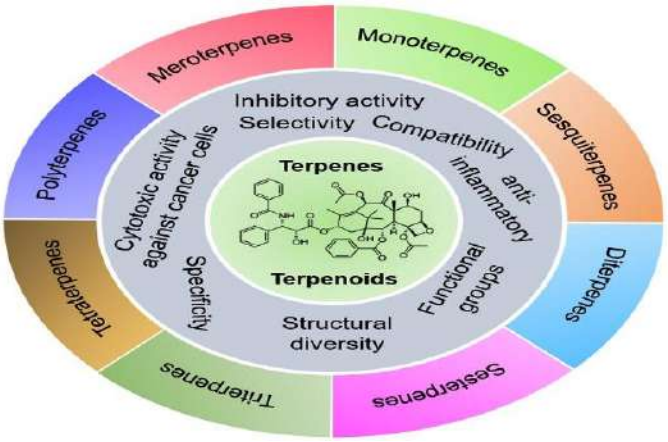
acetyl CoA through malonic acid pathway.



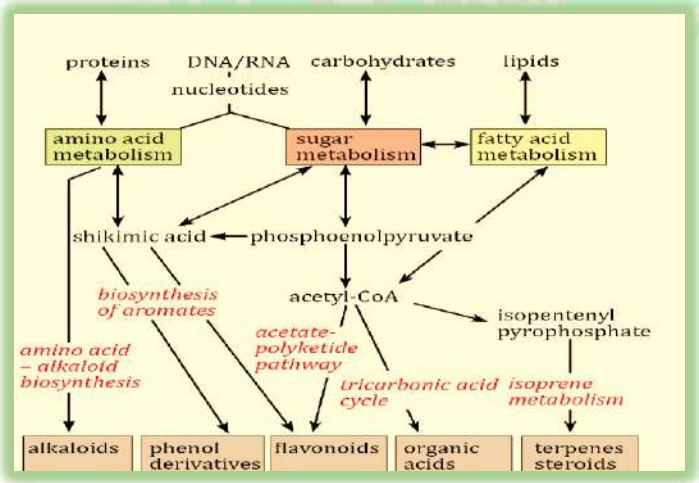
Phenolics (or) Aromatic compounds

I. Biosynthesized from Acetyl Co-A via malonic acid pathway

II. Biosynthesized from Erythrose-4-phosphate & PEP via shikimic acid pathway

Nitrogen-containing secondary metabolites (or) alkaloids

Biosynthesized in plants primarily from aliphatic amino acids



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Enhancement of Tolerance to Abiotic Stress in Mulberry (*Morus* spp.)

K. M. Lohithashwa and S. D. Pradeep

Introduction

Mulberry (*Morus* spp.; Family: Moraceae) is a fast-growing, cross-pollinated, perennial, dioecious and woody perennial tree or shrub (2n=28-308). Mulberry leaves are the sole source of food for the mulberry silkworm (*Bombyx mori* L.). Mulberry is cultivated in 2.37 lakhs ha in India (Central Silk Board, 2019) and the sustainability of the Indian silk industry is directly correlated with the production and supply of quality mulberry leaves. However, there is a significant demand for high-quality silk in both local and overseas markets that can't be covered by mulberry production extending horizontally on conventional agricultural land, due to competition with other food and cash crops.

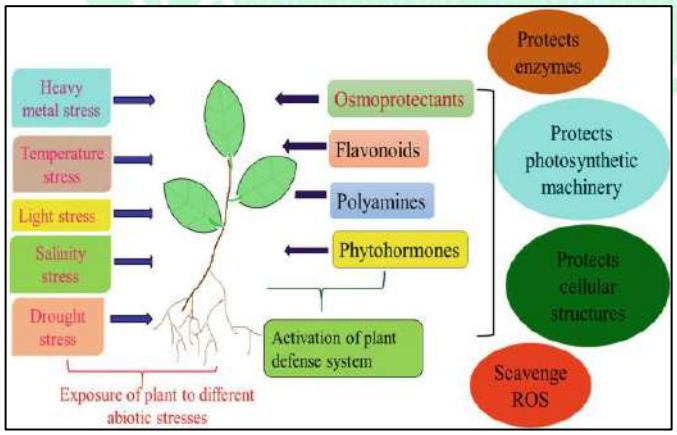

Fig.: Picture depicting types of abiotic stress and plant defence components to tolerate abiotic stress

As a result, it is crucial to use marginal, problematic soils and unconventional sites impacted by several abiotic factors such alkalinity, salinity, and moisture deficit for mulberry cultivation. Drought, excessive salinity, low temperatures, and oxidative stress are examples of abiotic stressors that pose a serious threat to plant growth and productivity. Yield losses caused by abiotic stresses of mulberry leaves is between 50% and 60% (Rao, 2002).

Abiotic stress tolerance in plant system is a polygenic trait and involves interaction among several genes through signal transduction pathways (Liu *et al*., 2015). Tolerance to abiotic stress is a complex quantitative trait governed by several small effects and development of varieties through physiological approach increases the probability of crosses resulting in additive gene action for stress adaptation. It has an advantage over empirical breeding because the germplasm is characterized more thoroughly than for yield alone (Reynolds and Trethowan, 2007). Reynolds *et al*., 2012 detailed key steps in strategic trait based crossing as 1) Characterizing the parents 2) strategic crossing among parents with different but potentially complementary physiological trait expression, thus ensuring cumulative gene action in the progeny 3) Early generation testing. The main objective of

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strategic trait based crossing is to accumulate traits that will be complementary for a given target environment (Jhansilakshmi *et al*., 2014).

Some important abiotic stress adaptive traits in mulberry

- ✓ Improved water conservation
- ✓ Wider and deeper root system
- ✓ Improved photosynthetic yield
- ✓ Water use efficiency
- ✓ Maintenance of macromolecules and ionic homeostasis
- ✓ Protection of biomolecules
- ✓ Cellular tolerance
- ✓ Antioxidants activity

Methods for improving stress tolerance in mulberry

- ✓ Conventional breeding
- ✓ Genetic engineering

Conventional breeding

Table 1: List of climate-resilient mulberry varieties developed through conventional breeding methods in India (Razdan and Thomas, 2021)

Variety Name	Trait/Type of cultivation area	Pedigree	Method of breeding
AR12	Alkaline soil	S41 x C776	Polyploidy
MSG2	Soil moisture stress prune area	BR4 x S13	Controlled hybridization
AGB8	Soil moisture stress prune area	(Sujanpur5 x Philippines) x (Kanva2 x Black cherry)	Controlled hybridization
S13	High temperature	Selection from OPV of K2	Selection
BC259	Frost tolerance	BC of Hybrid (Matigara x Kosen) with Kosen twice	Backcross breeding
S34	Soil moisture stress prune area	S30 x Ber. C776	Controlled hybridization
C776	Saline soils	*M. multicaulis* x Black cherry	Controlled hybridization
PPR1	Frost tolerance	Goshoerami x Chinese white	Controlled hybridization
C2028	Water logged condition	Chine white x S1532	Controlled hybridization

Conventional breeding accomplishes this by breeding plants with the necessary traits and selecting the progeny that has the desired set of traits as a result of specific gene combinations inherited from the two parents.

Genetic engineering

Recombinant DNA technology is utilized in the process of genetic engineering to change an organism's genetic make-up. Transgenic breeding is one type of breeding in which genes or traits from other organisms are introduced into crop plants, leading to higher yields or improved nutrition or tolerance to biotic and abiotic stress. Nevertheless, only a few transgenic crops have been utilized thus far as this technique randomly integrates foreign DNA into plant genomes and these genetically modified organisms (GMOs) are subject to strict government regulations.

Table 2: Transgenesis in mulberry for abiotic stress tolerance (Vijayan *et al*., 2011)

Transgene	Source of transgene	Expression profile
HVA1	Barley	Drought and salinity tolerance
Osmotin	Tobacco	Drought and salinity tolerance
bch	Mulberry	Drought and salinity tolerance
SHN1	*Arabidopsis thaliana*	Drought tolerance
NHX	*Arabidopsis thaliana*	Drought and salinity tolerance

HVA1, Hevea braziliensis abiotic stress gene; Osmotin, osmotic stress induced gene; bch, L inhibitor 2-aminobicyclo(2,2,1)heptane2-carboxylic acid; SHN 1, schnurri from Drosophila melanogaster; NHX, Na^+/H^+ exchanger

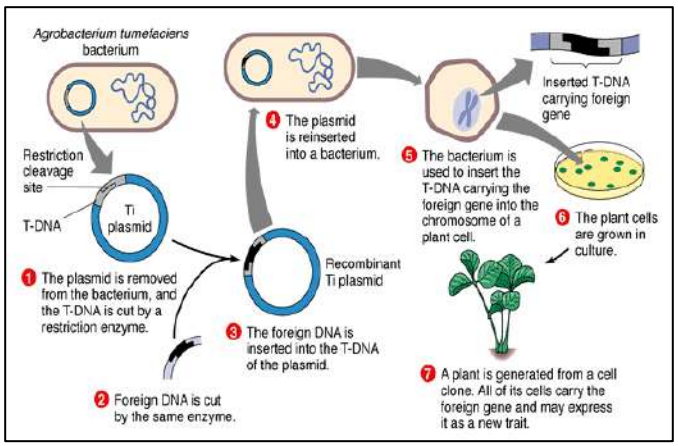

Figure 2: Method of developing transgenic plant

Conclusion

Abiotic stresses such as drought, high salinity, low temperatures and oxidative stress show a big threat to the growth and production in mulberry plant. To develop abiotic stress tolerant plants utilization of natural variations in breeding programmes is essential. Molecular engineering is a rapid and reliable method than the conventional breeding to develop salt and drought tolerant mulberry plants as conventional breeding taken 25-30 years to develop a variety (Vijayan, 2010). Thus, intense efforts are being made to refine the protocols of plant regeneration and transformation to improve the efficiency of transgenic plant development in mulberry.

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Mineralization of Soil Organic Nitrogen

Bhagyashree Phogat, Manish Yadav and Abhijeet Purohit

Introduction

Mineralization of soil organic nitrogen is the microbial process by which organic forms of N in soils are converted to inorganic forms (ammonium, nitrite, and nitrate). Mineralization takes place in three step-by-step reactions, namely, aminization, ammonification, and nitrification. Of these three reactions, the first two are carried out by heterotrophic microorganisms, while the third one is carried out by autotrophic bacteria. Heterotrophs derive their energy from oxidation of organic carbon compounds, while autotrophs obtain their energy from specific inorganic salts and their carbon from bicarbonate salts in the soil. Organic N in soils is ultimately derived from decomposition of plant material returned to the soil. This organic N may be present in both relatively labile forms (crop residues and microbial biomass) and in organic compounds more resistant to decomposition (lignoproteins, various types of humates, and condensed cyclic molecules).

Aminization

The heterotrophs, including bacteria, fungi, and actinomycetes, break down complex organic molecules releasing amines and amino acids; this process is known as aminization. Bacteria and actinomycetes often dominate in neutral and alkaline conditions, while fungi are more active under acid conditions. Most N undergoing aminization during a growing season originates from degradation of proteins and amino acids in decomposing crop residues and microbial cells, with lesser amounts originating from decomposition of the more resistant sources such as lignoproteins and humates.

Ammonification

Ammonification consists of the biological processes by which organic forms of soil nitrogen are converted to ammonia or ammonium ions. The final reaction in these processes is the hydrolysis of amino groups. The amines and amino acids released in aminization are reacted upon by other heterotrophs, and Nitrogen which release N in the inorganic NH_4^+ form. Both aerobic and anaerobic microorganisms are capable of carrying out this reaction. Also a very diverse population of bacteria, fungi, and actinomycetes is capable of releasing ammonium. The ammonium released may be

- ✓ Lost by ammonia volatilization
- ✓ Utilized by plants
- ✓ Absorbed on the exchange complex of clay minerals
- ✓ Fixed in the crystal lattice of 2:1 expanding clay minerals
- ✓ Immobilized by soil microorganisms
- ✓ Nitrified

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Ammonification can occur in both aerobic and anaerobic environments, although rates are generally more rapid in the aerobic environment.

Nitrification

This is a two-step process. In the first step ammonium is converted to nitrite $(NO_2)^-$, and in the second step nitrite is converted to nitrate $(NO_3)^-$. A group of obligate autotrophic bacteria known as *Nitrosomonas* is responsible for the first step, that is, conversion of ammonium to nitrite. Conversion of nitrite to nitrate is carried out by another group of obligate autotrophic bacteria known as *Nitrobacter*. It should be mentioned that, although *Nitrosomonas* and *Nitrobacter* are the most important organisms responsible for the reactions mentioned above, a few heterotrophs can also carry out these reactions, usually at much lower rates. Nitrates so formed may be

- ✓ Taken up by plants.
- ✓ Lost by leaching - creating health hazards by increasing nitrateconcentration in underground water.
- ✓ Under anaerobic conditions lost by denitrification - creating atmospheric pollution problems. Nitrous oxide (N_2O), one of the products of denitrification, is involved in depletion of the ozone layer.
- ✓ Immobilized by soil microorganisms.

Factors Affecting Nitrification

With the exception of rice most of our agricultural production is from well-drained soils, which favor nitrification. Nitrates therefore dominate as the form in which inorganic N is present in soil. A major exception is land continuously under perennial grasses where ammonium may be present in larger amounts. Some of the factors that have a pronounced effect on the activity of nitrifying bacteria affect nitrification are soil water content, aeration, pH, temperature, supply of ammonium, and population of nitrifying organisms.Therefore most crop plants have developed to utilize nitrate $(NO_3)^-$ as a major source of N. In recent years, however, considerable evidence has accumulated to show that even upland plants grow better when a mixture of ammonium NH_4^+ and nitrate NO_3^-N are present.

Reclamation and Management of Saline Soils

Bhagyashree Phogat, Deeksha Gautam and Abhijeet Purohit

Introduction

Saline soils are sometimes recognized by the presence of a white salt crust on the surface during hot summer months. However, gypsiforous soils may also have a white crust, but the restricted solubility of gypsum limits EC_e to about 2.8 dS m^{-1}. Some black mellow soils may be saline if salts have hydrolyzed and precipitated humic materials in the surface. During the crop growth period saline soils are generally characterized by spotty growth of crop plants, often with a blue-green tinge. In the field there may be barren spots and plant growth is generally stunted. Moderate salinity can often go undetected because it causes no apparent injuries. Succulent leaves with a darker, blue-green color could be an indication, but the final judgment can be made after soil analysis. Plants in salt-affected soils often have symptoms similar to those for stress (drought) conditions, although plants may not wilt because the osmotic potential of the soil solution usually changes gradually and plants adjust their internal salt content to maintain turgor and thus avoid wilting.

The reclamation of saline soils centers around removal of excess salt from these soils. Methods commonly adopted are scraping, flushing, leaching, and drainage.

Scraping

This refers to the mechanical removal of salts using the available tools. Disposal of scraped salts poses a problem. Thus this method has limited applicability.

Flushing

Washing away the salts by flushing water over the surface can be and is sometimes used to desalinize soils, but has limited application because only a small fraction of accumulated salt can be flushed away; a large part moves down the profile with water.

Leaching

Leaching salts out of the active root zone of crops is the most effective way to reclaim saline soils. For this purpose the first and foremost requisite is to have a reliable estimate of the quantity of water required to accomplish leaching of salts. The major factors determining the amount of water needed for leaching are (1) the initial salt content of the soil; (2) the desired level of salt content for good growth of crop plants; (3) the depth to which reclamation is required; (4) soil characteristics such as texture, permeability, etc.; and (5) the crop and its variety to be grown. Where groundwater tables are within a

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few m of the soil surface, leaching without drainage will have little lasting effect on soil salinity.

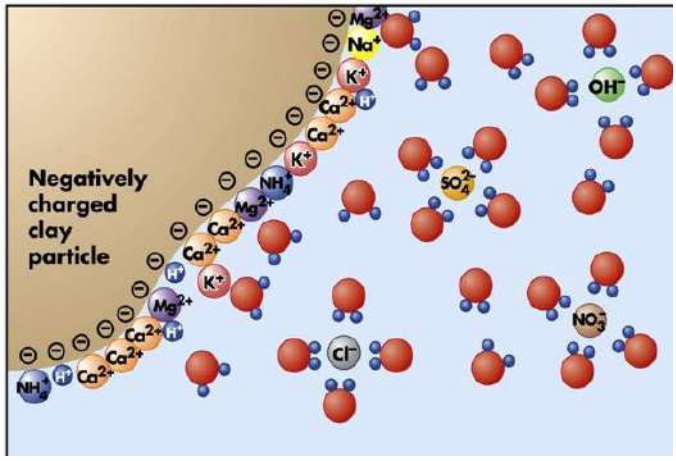

Fig. 1: Leaching

Fig. 2: Scraping

A useful rule of thumb is that a unit depth of water will remove nearly 80% of salts from a unit soil depth. Thus 1 m-ha water will remove 80% of salts from the top 1 m of soil from one hectare of land. However, soil properties, particularly texture, are important and for reliable estimates it is desirable to conduct salt-leaching tests on a limited area and prepare leaching curves. Regarding methods of leaching, sprinkling is better than flooding. Because of a slower wetting rate under sprinkling, the zone of complete leaching at the end of irrigation extends more deeply into the profile than under flood irrigation. Also when flooding is used as a method of leaching salts, more salts move upward and accumulate in the soil surface on evaporation.

Drainage

One of the most important requirements of the management of the saline soils is that the desired salt concentration in the root zone achieved by leaching is maintained for long periods. To achieve this, evaporation from groundwater must be prevented by keeping the groundwater table below the depth that will cause rapid soil salinization. Provision of adequate drainage is the only way to control the groundwater table. In addition to surface drainage, adequate subsurface drainage is essential. This is normally achieved by the use of open drain ditches or with buried tiles. For dryland saline seeps, salinity buildup from seepage of salt-laden water is prevented by cropping the recharge area above the seep with deep-rooted perennial crops such as grasses or alfalfa.

Conclusion: When irrigation is available and used for crop production, careful planning can help considerably to overcome the salinity problem. When furrow irrigation is practiced, most salts accumulate on the top of the ridge. Planting seeds on the sides of the ridges can help to overcome the salinity problem and permit satisfactory germination. Thus where soil and farming practices permit, furrow planting may help in obtaining better crop stands and yields.