Organic Horticulture

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Chapter - 1

Components of Organic Horticultural Systems

Abhishek Chandra, Upendra Maurya and Siddharth Kumar

Definition

The Organic Horticultural Systems are ecological production management systems that promote and enhance biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and management practices that restore, maintain and enhance ecological harmony. It mainly focuses on production based on a holistic biological system not towards input substitution as well as soil based systems.

Intensive management with routine observation of plant health and weeds, rule of thumb is that no synthetic fertilizers or pesticides including urea or round up with few exceptions e.g. pheromones while only nature based products except lead, arsenic, nicotine and no genetic modified organisms or seed or irradiated products used in the organic horticultural system.

Main components of organic horticulture is the maintain healthy soil through crop rotation including cover crops, tillage, fertilizers, mulch, irrigation, weed management, insect, arthropod and disease management.

Soil fertility management

Compost such as animal based provides more nitrogen, manure cannot be applied less than 120 days prior to harvest for a food crop. Cover crops can also be used such as legumes, grass mixtures. Fish emulsion, seaweed, plant based fertilizers such as alfalfa meal and soybean meal. The compost is beneficial as it has nutrient recycling which acts as cornerstone of ecologically based farming, assists in moisture retention in soils, slow release of nutrients, may reduce disease incidence due to an increase of microbial populations and may compete with disease causing organisms. Helps in reducing the odors of original feed stocks, destruction of weed seeds and pathogens, destruction of potentially harmful microorganisms such as *E. coli.* 0157:h7 or salmonella.

Composting rules

It can be applied to a crop at any time of it was composted according to NOP rules: made with palnt or animal materials, no bio solids or any other unapproved inputs such as C:N ratio of 15:1 to 40:1, in-vessel or static aerated pile system must reach a minimum of 131F for at least 3 days. A windrow system must reach at least 131F for at least 3 days. A windrow system must reach at least 131F for 15 days and be turned at least 5x so that all materials reach temperature and must be cured or aged. If compost does not met standards, follow the same rules as raw manure.

Crop rotations

Rotation must include a cover crop and work to maintain or improve soil organic matter, consider crop nutrition, soil fertility. Interrupt insect, weed and disease cycles, pests unable to find hosts when crops are changed, change the crop ecology, shallow/deep roots, cold/warm season, row/drilled crops, foliage density, heavy/light feeders.

10 years of rotation scheme

Year	Spring	Summer	Fall
1.	Tomatoes and leeks		Oat-crimson clover
2.	Flowers-cool seas	Sudan grass-soybean	Oat-crimson clover
3.	Spring lettuce	Flower, summer	Rye-hairy vetch
4.	Squash		Fall planted flowers
5.	Flowers-overwintered	Sudan grass-soybean	Rey-hairy vetch
6.	Pepper		Wheat-crimson clover
7.	Flower-summer		Oat-crimson clover
8.	Mixed spring veg	Cowpeas	Fall planted flowers
9.	Flowers-overwintered	Sudan grass-soybean	Oat-crimson clover
10.	Flowers-summer		Wheat-hairy vetch.

The planting diversity efficiency such as space, soil, water helps to minimize the insect pressure, increases beneficial insects. Perennial crops helps in soil building and biodiversity through groundcover management – mixed species, mulches, cover crops in strips, insectary plantings.

Weeds: With understanding the biology of weeds: annual fixed perennial, wandering perennial, the lifecycle, establishment. Good soil for crops also good for weeds. Action should be taken as removal or prevention of the establishment or changes the environment through many little hammers approach. Crop rotation and cover crops- remember crop ecology, cultivation (timely) through hand hoe, rototilling, cultivators, hoeing- dust mulch.

Mulches: Straw fabric, wool, flax, plastic (landfill issues), flamer, organic herbicides, biodiversity of insects, animals eat weed seeds.

Mechanical weed control through cultivation (timely and shallow): Hoe, cultivators- dust mulch. Push-pull hoes, ergonomic handles, hand scrapers and cultivators for tight spaces, rototilling, cultivators, and tine and basket welders can get close and in between plants. Exhaust root system (perennial weeds) deplete storage reserves. It requires 6-8 timely treatments in year 1, then 3-5 the following year.

Tillage and soil health: The criticism of organic agriculture is use of tillage, negative effects of tillage, offset by the use of cover crops and additions of organic matter (Compost, manures, mulch, etc.) USDA-ARS research showed organic methods can increase organic matter more than conventional no-tillage. It must use caution against excessive tillage.

Mulches: Prevent seeds from germinating, can smother out some weeds, and conserve water, minimal soil disruption, use local resources such as straw, fabric, wood, newspaper, plastics. Be careful of weed seed in straw especially good for perennial systems: blueberries, blackberries, flowers, trees. Living mulches e.g. plant fall clover crop, mow at flowering to kill it, plant into residue.

Other methods of weed control: Involves flamer-especially handy during wet conditions, no mechanical tools, broad-leaf weeds more susceptible to flaming. Organic herbicides such as matron, burnout II, green match. Phytotoxic burn plant tissues, thoroughly coat weed, non-selective.

Crop selection: The same crops are more competitive against weeds than other. Rapid germination, growth, dense canopy. Use transplants vs. direct seeding for crops if possible. Transplant or plant into a clean bed and allow a flush of weeds to emerge then till under.

Cover crops in weed management: Smother weeds by competing for light, water and nutrients, release allelopathic chemicals that suppress weed germination. As they decompose, abundant microbial communities suppress germination, prevent soil erosion, fallen leaves work as green manures, recycle and scavenge nutrients and provide organic matter. The time of planting cover crop before or after harvest of main crops e.g. plant buckwheat between spring greens and fall tomatoes. Space required for it is that the plant low growing cover crop within main crop, after establishment (e.g. plant legume into sweet corn).

Cover crops for southeast

Winter cover crops such as hair vetch, crimson clover, subterranean clover, Austrian winter pea, grain rye, wheat, oats and brassicas (radish and turnip). Summer cover crops are annual lespedeza, soybeans, southern peas, buckwheat, lespedeza and sorghum-Sudan grass.

Insect management

Practice crop rotation to suppress their hosts and also for healthy soil, it enhances natural plant defences, prevention by cleaning up after harvest and destroys all infested fruits/vegetable. Planting of row covers which keeps pests out; put over plants when young and remove at flowering stage. Companion planting and trap crops, harvest early through varietal selection, know your pest life cycle, natural enemies, relationship with climatic conditions and manage at vulnerable period. Biological control is critical component of organic insect management. Natural enemies such as predators, parasites, nematodes and pathogens are existing for nearly every pest. Conservation of beneficial insects is key to success of biological control. Augmentation (purchased beneficial) can work in certain cases (e.g. greenhouses). Conservation of beneficial insects are necessary as they maintain adequate supply of food (pre, pollen, nectar) through plant diversity in the farm landscape, insectary plants such as buckwheat, clover, herbs-dill, mint, yarrow; flowers such as gaillardia, allysum, daisies, and use of toxic pesticides limited to outbreaks. The toxic pesticides use as lart resort as it may affect beenficials, check with certification agency, check with national list, check with organic materials review institute at (OMRI) . *Bacillus thuriengiensis* (Bt.), lepidopteran are specific for insect pest control. Botanical insecticides such as pyrethrum, sabadilla and neem. Other natural treatments such as D.E., garlic, hot pepper, vegetable oils and soaps.

Chapter - 2

Constrains in Certification of Organic Horticulture and Export

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Chapter - 2

Constrains in Certification of Organic Horticulture and Export

Prashant Srivastav, Amrit Kumar Singh, Anupam Singh, and Devashish Rai

What is Certification?

Certification means having the farm and the farmers' methods inspected by an accredited organic certifying group to ensure that they comply with a Standard. Accredited certifying bodies are licensed by a statutory authority. Before apply for certification the following consideration should keep in mind that is Knowledge, tools and implements, labor and time, inputs, finances, farm location, markets as the certification entails documentation of inputs and their sources, documentation of the equipment used, documentation of organic crop planning, documentation of contamination sources, documentation of post-harvest contamination protection and documentation of market prices. The process of entail includes apply for certification, buffer period, inspections and audits, record keeping and cost.

Organic farming is not a new concept to our farmers. The Indian farmers were all organic farmers before the advent of synthetic fertilizers, pesticides, mechanization etc.

Before green revolution; the traditional India only organic farming was practiced. No chemical fertilizers and pesticides were used. Only organic techniques were natural pesticides and natural manures were obtained from plant and animal products were used. During 1950s and 1960s, the ever increasing population of India lead to a food scarcity. The government was forced to import food grains from foreign countries and also forced to increase the food grain production of India to increase the food security. Green revolution led to high yielding varieties, chemical fertilizer, synthetic pesticides, mechanization, irrigation resulting in high production with overcoming food crisis, self-sufficiency in food grain, buffer stock of food grain but it not found sustainable due to stagnation or fall in productivity, decline in soil fertility, salinity problem, lowering of water table, environmental pollution.

The positive side of green revolution are increased the county's food production, attained self-sufficiency, food deficit to food surplus, export of food products and higher income.

Demerits of green revolution are reduction in natural fertility of soil, destruction of soil structure, erosion and soil loss, killing of beneficial microbes and insects, ground water pollution and depletion, atmospheric pollution, soil acidification, chemical burn, mineral depletion etc.

With introduction of green revolution, use of chemical fertilizers although contributed 40% of crop production, continuous use of chemicals in agriculture seriously destroyed the soil health and environment. The scientists have realized that the Green Revolution with high input use has reached a plateau and is now sustained with diminishing return.

Definition of organic farming

As per the definition of the United States Department of Agriculture (USDA) term organic farming refers to "organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc.) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection. The aim of organic farming is to maintain optimum soil health and thus making the soil capable of supplying all essential nutrients to crop for its proper growth and development. Organic farming aims at sustaining and increasing the productivity by improving soil health and overall improvement of agro-ecosystem. Organic farming gives quality organic food and also helps to restore soil fertility on long term basis.

Importance of organic farming

Present burning issue in farming is the decline in fertility of soil and fall in productivity levels. Uses of chemical fertilizers and synthetic pesticides have deteriorated soil health as well causing harm to our natural eco-system by polluting our environment as well as water. Now we have reached a situation where productivity levels in soil slowly decreasing day by day. Now its time to go for organic farming and restore soil fertility and maintain soil fertility in sustainable basis so that future generations may not face problems.

Major organic products produced in India by organic farming

Types of product	Products
Commodity	Tea, Coffee,
Spices	cardamom, black pepper, ginger, turmeric, vanilla, tamarind,

	clove, cinnamon, nutmeg, mace, chilli
Fruits	Mango, banana, pineapple, orange, cashew nut, walnut
Vegetables	Okra, brinjal, garlic, onion, tomato, potato

The organic certification process required these four steps

1. **Accreditation** is the guarantees that the certification program is competent to carry out specific tasks. Authoritative body defines policies, standards and checks whether a certification system is operating according to standards.
2. **Standards** are the rules of the production for organic horticulture/agriculture or it is define as production methods, not the product quality, minimum requirements, not best practice. It is continuously developed and dynamic process and can be international, national or regional standards and certification standards. The organic certification is vital to the commercial success of organic producers and processors. It ensures credibility and enables greater access to markets for organic products. Many markets will only buy organic produce that is 'certified organic'. Contents in standards includes conversion to Organic Agriculture, crop production systems, livestock management and products, storage of organic agriculture produce, transportation and processing of organic products, producers' responsibilities, consumer rights and fair trade, management of resources and sustaining ecosystem.
3. **Inspection** is the onsite visit to verify that the performance of an operation is in accordance with specific standards.
4. **Certification** is the written confirmation that a process or product is in compliance with prescribed standards. India Certification Programme: in June 2001, under the NPOP, a set of 4 volumes, concerning: accreditation regulations, accreditation criteria, accreditation procedure and application forms were published. On 12 June 2001, by a Public notice No. 19 (RE- 2001/1997-2002 government regulation of export of organic produce. "an agricultural product will be allowed to be exported as organic product only if it is produced, processed or packed under a valid organic certificate issued by a certify agency duly accredited by one of the four accreditation agencies. Appointed accreditation agencies in India- Agricultural and Processed Food Products Export Development Authority (APEDA), coffee board, tea board and

spices board. Foreign certifying agencies in India are IMO, SKAL, ECOCERT, NATURALAND, and SOIL ASSOCIATION.

Issues in certification and standards for average India Organic farmer

Multiplicity of standards and certification such as Codex Aliment Arius (FAO and WHO), IFOAM Basic Standards, European Union, National Programme for Organic Production (NPOP), India, Indian Organic Standards (Voluntary) rather than these the Technical trade barriers, expensive certification costs and input quality.

List of accredited certifying and inspection agencies in India

1. Association for promotion of Organic Farming (APOF) Bangalore.
2. Indian Society for Certification of organic production (ISCOP) - Tamil Nadu.
3. Indian Organic Certification Agency (INDOCRT) - Cochin Kerala.
4. Skal Inspection and Certification Agency- Bangalore.
5. IMO Control Pvt. Ltd. - Bangalore.
6. Ecocert International- Aurangabad.
7. Bioinspectra- Cochin, Kerala.
8. SGS India Pvt. Ltd. - Gurgaon.
9. International Resources for Fair Trade (IRFD) - Mumbai.
10. National Organic Certification Association (INOCA) - Pune

International Organic Standards

IFOAM	International federation of organic Agricultural Movements, established in 1972. Headquarter situated in Germany. Umbrella organization for organic Agriculture Association. Developed international basic standards of organic agriculture. Established IFOAM accreditation programme (1992) to accredit certifying bodies. Set up International Organic Accreditation Service (IOAS) in July 2001.
CODEX	Codex Alimentations Commission- a joint FAO/WHO. Intergovernmental body, established in 1962. Produced a set of guidelines for organic production.
EU Regulation	Laid out a basic regulation for European Union's organic standards inn Council regulation No. 2092/91 (June 1991). Regulations give guidelines for the production of organic crops in the European community.

Demeter	Demeter International is a worldwide network of 19 International certification bodies in Africa, Australia, and Europe. Developed guideline for biodynamic preparation.
JAS	A set of guidelines Japan Agricultural Standards for organic production.

Prospects of Organic Farming are

1. Consumer acceptance
2. Environmental friendly
3. Higher biodiversity and
4. Better soils.

Advantages of organic farming

Organic matter supplies all the essential macro and micro plant nutrients. Organic matter improves physico-chemical and biological properties of soil. organic farming improves agro-ecosystem and helps in stopping environmental degradation. Organically grown crops are preferred by most people as it is believed to be compared to conventional ones hence beneficial for health and environment sustainability. Organic produce fetches more prices in national and international market.

The major constraints of organic farming

i) Organic manure contains fewer amounts of nutrients.
ii) Lack of awareness.
iii) Marketing problems of organic inputs and out puts.
iv) Shortage of organic biomass.
v) Poorly supporting infrastructure.
vi) High input cost.
vii) Lack of suitable agriculture policy.
viii) Lack of financial support.
ix) Low yields during conversion period.
x) Political and social factors.
xi) Complex certification procedure.
xii) Lack of organic input responsive variety.

Limitations of organic farming in India

Small land holdings, poor infrastructure facilities, lack of technology knowledge, convert organic farm, organic material such as animal dung and other crop waste used for fuel purpose, organic material are bulky in nature very difficult store and high price, city garbage contains heavy metal, plastic bags, stones and needles, biological control are available only few selected insect pest, complicated organic certification process and high fees cost and higher human population of India.

Chapter - 3

Organic Fruit Production in Humid Climate

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Chapter - 3

Organic Fruit Production in Humid Climate

Pragya Shrivastava, Yash Kumar Singh, Aditya Gaurha and Abhinav Singh

Major factors of humid climate

Solar radiation leads to permeability of protoplasm, intake and loss of water, enzymatic activity, respiration, photosynthesis, flower initiation, ripening of fruits etc.

Process	Effect of light
Germination	Effect of dark and light requiring seeds.
Stem extension	Etiological effects
Leaf expansion	Prolonged illumination is required for full expansion.
Chlorophyll synthesis	Illumination required for development of green pigment.
Flower production	Photoperiodism and control of flowering
Bud dormancy	Photoperiodic response induced in short days

Effect of solar radiation on fruit crop

The light intensity influence the crop growth through photosynthesis. Production rate of photosynthates depends on compensation point and saturation point. Light intensity a minimum of 500-1000 ft candles is required for effective rate of photosynthesis. Duration of light period influence time of lowering of many fruit crops. Quality of light affects the process of photosynthesis, assimilation of nutrients and dry mater distribution in fruit crop plants. (PAR-0.40-0.70 micron).

Effect of Temperature on fruit crop

Chlorophyll synthesis and leaf area development. Activity of plant growth promoting rhizobacteria are high. Temperature greater influence germination, leaf initiation and flowering of all fruit crops. Seedling development is more rapid as temperature increases.

High temperature leads to

1. **Sunburn and sunscald:** the symptoms are developed as burning of leaves and fruits, bark of trunk may splits in extreme case.

2. **Heat and thermal injury:** bleaching of chlorophyll, necrosis of fruit tissues.
3. **Desiccation:** Wilting of leaves and new seedlings in tropics.
4. **Metabolic disturbance:** higher rate of respiration results in stunted growth.

Humidity

It directly influences water relations of fruit crops and indirectly influences leaf growth, photosynthesis, occurrence of disease and finally economic yield. It also affects the rate of evapotranspiration and water requirement of the fruit crops. High humidity favors leaf enlargement due to high turgor pressure. High humidity favors easy germination of fungal spores on plant leaves.

Precipitation

It is the major source of soil moisture for crop growth in irrigated and dry land horticulture. Cell growth, cell wall and photosynthesis are adversely affected by the water stress. Stomatal closure due to water stress restricts CO2. Respiration increases and sugar accumulates under moisture stress results in reduced crop yield.

Wind

Direction and velocity have significant influence on fruit growth. Increases transpiration and photosynthesis. Hot wind accelerates the desiccation of crop. Alters the balance of hormones. Increases ethylene production and decreases GA3 of roots and shoots. Hot dry winds causes reduction in plant height due to cell cannot attain full turgidity. Crop lodging, shedding of flower and fruit drop-major injury.

The primarily concepts of organic fruit production

1. Build and maintain the soils organic content
2. Use nature materials as a source of mineral nutrients.
3. Use cultural and biological pest control methods.

Develop a plan for soil building: fruit crop will be in location for years, accumulate soil amendments such as compost, leaves, organic manures, bark chips, leaves, prepare a management plan. The use of organic and natural materials as a source of mineral nutrients to feed plants.

Organic matter as a fertilizer

Many choices of organic fertilizer, composted high nitrogen, phosphorus and potassium ratio applied and a two to four compost layer green manure crops composed and applied. The utilization of cultural practices, biological methods, and resistant varieties to control plant pests. (Do not use chemical pesticides to control insects, disease, and weeds).

The weed management strategies are: pre-plant practices, avoidance, tillage (Aerate/till), hand pulling, hoeing, mulching (soil temperature) through inorganic plastics, mowing/weed wacker, digging and hot water, burning, green mulch etc. are used as organic weed management strategies.

Pest management begins with proper training and annual pruning: open canopy for good air movement, allows for rapid drying of leaves, and allows for better penetration of pest management materials. The proper pest management strategies are- barriers, bagging, hand picking vacuuming, shaking, sticky traps, light traps (for beneficial insects), sanitation, organic sprays of products etc.

Insect control: through the use of *Bacillus thuriengensis* (Bt.), targets only caterpillars, once sprayed or dusted onto leaves, it will be effective for approximately 3-5 days, it acts as a stomach poison to larvae, it is a very safe organic pesticide that is much targeted to certain insects. Neem oil comes from the tropical tree *Azadirachta indica* and it works by causing insects to stop feeding and by acting as a growth regulator interfering with the insects' ability to molt. Horticultural oils coat insects and cause them to suffocate, very effective on insects such as a aphids, scale and mites, dormant oils are heavier and use only dormant season. Pyrethrum, derived from a species of chrysanthemum, acts as nerve toxin in insects. It is fast acting and very effective. It also just as toxic to beneficial insects as it is to pests. The spinosad fungal spores comes from a soil-borne fungus. It kills insects slowly be affecting their ability to feed and their nervous system. It has a long residual effect. Rotenone is a plant-derived pesticide, it causes insects to stop feeding and starve.

Diatomaceous earth is mined form the earth and it consists of diatom skeletons, made of silicon dioxide, which is basically glass. When insects crawl over diatomaceous earth, their cuticle is abraded and the insect eventually desiccates and dies. Garlic based pesticides can both a poison and a repellant to insects. There are commercial formulations available. Insecticidal soaps sprayed on insects can dissolve their waxy cuticle causing them to desiccate and die. Do not substitute dish detergents, since many have additives that can be phytotoxic to plants and won't be as effective. Capsaicin, derived from hot peppers, can be used as a repellent to deter pests. Some pest insects are repelled by the smell. Kaolin is a type of clay that can be applied to plants to create a barrier that prevents insects from feeding plants. Report success with plum curculio management.

Bagging products: Plastic sandwich bags, zipping plastic bags, Japanese paper/plastic, nylon socks and paper bags.

Bagging apples: Plastic or paper bags, silt corners for water drainage, apply when fruit are about the size of a dime, staple on either side of fruit stem, bag 30 to 50 fruit/hour.

Sticky traps (four per tree) or pheromones trap: Attract either male of female insects, selected pheromone for each insect pest, used to identify when adult insect are in flight and about to lay eggs.

Insect prevention and therapeutic products: Barriers, clay sprays, chitin/diatoms, Bt., insecticidal soaps, water spray (rain), alcohol, superior oils, neem oil and Bordeaux mixture.

Disease protection products *vs.* therapeutic: Bordeaux mixture, lime-sulfur, copper, sulfur, compost tea, horticultural oils, sodium bicarbonate/ oils, antitranspirants and bagging.

Disease control: Bordeaux mixture is a fungicide containing water, lime and copper sulfate. It should be applied before infection occurs, as it will not cure an existing disease. Copper sulfate can be toxic to mammals and aquatic organisms. Sulfur is an effective fungicide that controls such things as rusts, black post and powdery mildew. It also affects some insects including spider mites and thrips. It can damage plants when used during high daily temperature. Lime sulfur works as a fungicide and also kills some insects such as scale. It can damage plants especially if applied in warm temperature above 80 °F. Baking soda (sodium bicarbonate) and potassium bicarbonate are effective against powdery mildew and some other fungi.

Critter protection: Exclude critter before they get there, establish a barrier, plan ahead fence before you begin planting your fruit crop.

Monthly organic management

January: Remove mummified fruit hanging on trees, mummified fruit source of diseases, burn dead wood piles, raspberry and other woody pruning, pack snow around rodent wire mesh guards as a means of rodent control. Check for rodent, rabbit and deer activity.

February: Pack snow rodent wire mesh guards as a means of rodent control, write up nest seasons pest and fertilizer management program, begin fruit tree, grape and summer raspberry pruning, select disease resistant replacement fruit stock. Prune and burn all black knot infections on plums and cherries. Remove tent caterpillar egg masses. Use dormant oil for mites and aphids only if population is high enough to cause damage. Apply dormant peach leaf curl spray before bud break. Soil test (pH about 6.5 or 5.0 for blueberry).

March: Thin summer bearing raspberries' to 4 canes per linear foot of row. Prune grapes to 40 to 50 buds per plant. Spread grape fruiting canes for air movement.

April: Begin scab prevention sprays with first green tip. Do not apply dormant oil sprays after green tip. If you use oil sprays, you can flow with sulfur for 30 days leaf burn. Apply latex paint to tree trunks (1 part paint to 5 parts water). Watch for fire blight following bloom. Hang pheromone traps and sticky apples, check for curculio feeding, bag tree fruit near the end of May-dime size; apply disease prevention sprays, frost protection as needed.

May: Monitor strawberry insects' activity and use prevention strategies. Thin fruit on tree fruits (1 per 4-6 inches). Raspberry cane borer, hand prune infected canes. Do not allow overripe strawberry fruit. Remove early tree fruit drops (contain larvae) and rub out water sprouts.

June: Cover fruit with netting to protect them from birds. Monitor weekly for insect and disease problems. Sulfur and Bordeaux sprays for diseases. Use oil products to manage egg masses and small larvae.

July: Cover fruit crops with netting to protect form birds. Monitor weekly for insect and disease problems. Sulfur and Bordeaux sprays for diseases. Use oil products to manage egg masses and small larvae. Mow strawberry leaves after harvest.

August: Remove insect damaged fruit. Harvest fruit early in the morning to avoid wasp activity. Keep windfalls cleaned up, weekly. Summer prune raspberries; follow with disease within 3 hours. Water newly planted trees.

September: Remove overripe fruit. Mow grasses and weeds to manage rodents. Remove dropped fruit. Check deer management fences as ripened fruit will attract feeding animals.

October: Have rodent guards in place, check deer management fences. Take soil tests, turn mulch to discourage rodents, remove fruit drops daily, rake and burn leaves if practical. Mow orchard grasses as short as possible.

November: Continue to mow grasses until snowfall. Plant trees with latex paint. Check deer fence and dropped fruit. Turn mulch and rake away from tree trunks. Prune fall raspberries after soil freezes. Mulch strawberries after soil freezes.

December: Remove and store insect traps, checks fences and rodent guards, renew deer repellents, cut and remove wind fruit plants.

Chapter - 4

Organic Horticulture in Quality Improvement

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Chapter - 4

Organic Horticulture in Quality Improvement

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Introduction

There are several definitions of organic farming but the most coherent and stringy definition is given by the US Department of Agriculture (USDA). According to it, organic farming is defined as a system that is designed and maintained to produce agricultural products by the use of methods and substances that maintain the integrity of organic agricultural products until they reach to the consumers. This is accomplished by using substances to fulfill any specific fluctuation within the system so as to maintain long term soil biological activity, ensure effective peak management, recycle wastes to return nutrients to the land, provide attentive care for farm animals and handle the agricultural products without the use of extraneous synthetic additives or processing in accordance with the act and the regulations in this part. The origin of organic farming goes back, in its recent history, to 1940s**.**

Status of organic farming-A world scenario

Organic agriculture is developing rapidly and today at least 141 countries produce organic food commercially. As per the estimates of the year 2007, about 32.2 million hectares (Mha) of organic food was produced globally, managed by more than 1.2 million producers, including smallholders. In addition to agriculture land, there 0.4 Mha of certified organic aquaculture. About 65% of the developing countries are involved in organic farming. The countries with the largest areas of organically managed agricultural land are: Oceania, Europe and Latin America, Australia, Argentina and Brazil. Almost 11 Mha i.e., about one-third of the world's organically managed land is located in the developing countries. Most of this land is in Latin American countries, while Asia and Africa take the second and third places, respectively. On a global level, in the year 2008, organic land area increased by almost 1.5 Mha compared to the data for the year 2006. About 28% (or 1.4 Mha) more land under organic management was reported for Latin America (including 0.9 Mha of in conversion land in Brazil for which no data was available previously). Organically managed land increased by 0.33 Mha

(+4%) in Europe and by 0.18 Mha (+27%) in Africa (Willer and Klicher, 2009). Austria has the highest percentage (8.4%) of area under organic farming, followed by Switzerland, UK and Germany. In India, only 0.03% of the area is under organic farming, though there is huge scope for bringing more land under organic farming.

Principles of organic farming

The main principles of organic farming are as follows (Chandrashekhar, 2010); work within a closed system and draw upon local resources as much as possible, maintain long – term fertility of soils, avoid all forms of pollution that may result from agricultural techniques, produce foodstuffs in sufficient quantity and having high nutritional quality, minimize the use of fossil energy in agricultural practices, give livestock conditions of life that confirm to their physiological needs, make it possible for agricultural producers to earn a living through their work and develop their potentialities as human being.

The main pillars of organic farming are:

- Organic threshold standards.
- Reliable mechanisms regarding certification and regulatory affairs
- Technology packages.
- Efficient and feasible market network.

Major pillars of organic farming based agriculture

Principle of health

` Organic agriculture should sustain and enhance the health of soil, plant, animal, human, and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems-healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but also the maintenance of physical, mental, social and ecological well-being, immunity, resilience and regeneration are the key characteristics of health. The role of organic agriculture , whether in farming , processing, distribution or consumption, is to sustain and enhance the health of ecosystems from the smallest organisms in the soil to the human beings In particular , organic agriculture is intended to produce high quality nutritious food that contributes to preventive health care and well-being . In view of this it should avoid the use of fertilizers, pesticides, animals drugs and food additives that may cause adverse health effects.

Principle of ecology

Organic agriculture should be based on living ecological systems and cycles, work emulates and helps to sustain them. This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms it is the aquatic environment. Organic farming, pastoral and wild harvest system should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling, and efficient management of materials and energy in order to maintain and improve environment quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming system, establishment of habitats and maintenance of genetic and agriculture diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principles of fairness

Organic agriculture should be built relationships that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties-farmers, workers, processors, distributors, traders and consumers. Organic agriculture aims at providing a good quality of life to everyone with it and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being. Natural environment resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environment and social costs.

Principle of care

Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations as well as the environment. Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods should be reviewed. The incomplete understanding of ecosystems and agriculture should be taken care of. This principle states that precaution and responsibility are the key concern in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. Along with scientific knowledge practical experience, accumulated wisdom, traditional and indigenous knowledge also offer valid solutions, which are tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

Components of organic farming

There are assumptions throughout the organic literature of differences between organic and conventional systems with respect to their effects on soil physical properties, soil insect fauna and nutrient flow within the soil insect fauna and nutrient flow within the soil, crop health and nutritional value of the harvested crop. Different components of organic farming are as follows-

Crop and soil management

Organic farming system encourages the use of rotations and measures to maintain soil fertility. Carefully managed soil with a high production of humus offer essential advantages with respect to the water retention capacity, ion exchange, soil erosion and animal life in the soil. Green manuring and inter-cropping of legumes is another important aspect for biological farming systems. It not only helps in controlling weeds, but also improving its chemical and physical properties by reducing the leaching of nutrient and reducing soil erosion**.** A green cover at most thought the year is one of the main goals of such farming methods. Depending on the green manure mixture or the legumes used for under sowing, these may be an increase in soil organic matter, soil nitrogen as well as increase in other nutrient level.

On farm waste recycling

Increase in price of chemical fertilizers has enabled organic wastes to regain an important role in the fertilizer practices on the farm. Food manure management means improved fertilizers value of manure and slurry and less nutrient losses. Composting of all organic wastes in general and farm yard manure (FYM) or feedlot manure in particular is important in organic farming.

Non-chemical weed management

Weed management is one of the main concerns in organic agriculture. Generally, all aspects of arable crop production play an important role in a system approaching to problems. The elements to consider in preventing weed problems are corp rotation, green manuring, manure management and tillage. Mulching on a large scale by using manure spreaders may also be useful in weed control.

Energy use: the energy required for production, measured per rupees of produce for organic farms is only one third compared to their conventional counterparts. Because nitrogen fertilizer and pesticides are not used by biological farmers, the comparison of total energy input/ha. With total energy output favurs biological farming systems.

Food quality is one ot the main issues, which concerns both scientitst and consumers. Nitrates in water and farm produce, desirable components, pesticides reduce keeping quality and physiological imbalances are some of the important aspects of food quality.

Ecological agriculture

The growing concern about environmental degradation, dwindling natural resources and urgency to meet the food needs of the increasing population are compelling farm scientist and policy makers to seriously examine alternatives to chemical agriculture. As reported by (Venkataramani, 1995), case studies show that when chemical farm incurred about 11.250 towards the cost of cultivation of rice. An organic farm spend rupees 10,590 to produce 5625 kg paddy and 8 tons of straw/ha. The net return from the ecological farming system at the current cost of rupees 3.34/kg paddy is rupees 8,197.50. In chemical farming, the net profit is rupees 7500. If one gets a premium price for the poison force of organically grown rice, the economic returns from the ecological farming system will be highly encouraging.

Integrated intensive farming system

It involves intensive use of farm resources. To be ecologically sustainable, such intensification should be based on techniques which are knowledge intensive and which replace to the extent possible, market purchased chemical inputs with farm grown biological inputs.

Chapter - 5

Organic Horticulture

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Chapter - 5

Organic Horticulture

Anupam Singh, Amrit Kumar Singh, Kinker Singh and Prashant Srivastav

Organic horticulture is the science and art of growing fruits, vegetables, flowers, or ornamental plants by following the principles of organic farming in soil building and conservation and pest management.

The organic horticulture defined as the production system of fruits, vegetables, flowers as well as medicinal and aromatic plants that sustains the soil health, safe environment and human through the use of ecological processes, biodiversity cycles adapted local conditions, rather than using inputs with adverse effects. The organic horticulture includes the tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved.

Organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc.) and to the maximum extent feasible relies upon crop rotations, crop residues, animal manures, and off-farm organic waste. It is a holistic production management system that promotes and enhances health of agro-ecosystem, including biodiversity, biological cycles and soil biological activity.

The horticulture mainly deals with five major areas of studies:

1. **Pomology:** Deals with the areas of fruit production and marketing.
2. **Floriculture:** It deals with the production and marketing of floral crops.
3. **Olericulture:** Consists of production and marketing of vegetable crops.
4. **Landscape horticulture:** Deals with production, marketing and maintenance of landscape plants.
5. **Post-harvest:** Includes maintenance of quality and also preventing spoilage of horticultural crops.

All these pursued according to the principles of organic cultivation. The production of high-quality of plants allows maintaining a healthy and balanced daily diet. The fruits and vegetables are our daily lives impacts by providing nutritious fruits and vegetables.

All these organic principles followed by organic farming system which excludes the use of synthetic inputs such as fertilizers, pesticides, hormones, feed additives etc. and the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection.

Principles of organic horticulture

1. **Human health:** Organic farming should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
2. **Ecology:** Organic horticulture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
3. **Fairness:** Organic horticulture should build on relationships that ensure fairness with regard to the common environment and life opportunities.
4. **Care:** Organic horticulture should be managed in a precautionary and responsible manner to protect the health and wellbeing of current and future generations and the environment.

Components of organic horticulture

Chemical free weed control through prevention, cultural practices, mechanical practices, competitive plant species, stale seed bed technique, biological weed management and bio-herbicides.

Biological pest and disease management through conservation of natural enemies of pests, resistant varieties and crop rotations.

Organic manures- manure is organic matter use as organic fertilizer in agriculture as well as horticultural crops cultivation. Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen that is trapped by bacteria in the soil. commonly used organic manures are Farm Yard Manure (FYM), Green Manure, Vermi-compost, Crop residues and Biofertilizers. These are readily available and important agricultural by-products. Organic manures improves the soil, tilth and aeration. Increases the water holidng capacity of the soil. It also stimulates the activity of micro-organisms that made plant food elements in the soil readily to crops.

Average % of NPK availability in the FYM

Animal refuse	N	P_2O_5	K_2O
Cattle dung and urine mixed (fresh)	0.60	0.15	0.45
Poultry manure (fresh)	1.0-1.8	1.4-1.8	0.8-0.9
FYM (dry)	0.5-1.5	0.4-0.8	0.5-1.9

Green manure: Is a type of cover crop grown primarily to add nutrients and organic matter to the soil. The practice of ploughing or turning into soil under-composed green plant tissue for the purpose of improving physical condition as well as fertility of the soil is referred to as Green Manuring. Green manure crops should have profuse leaves and rapid growth early in its life cycle, have abundance and succulent torps, be capable of making a good stand on poor and exhausted soils, have a deep root system, be legume with good nodular growth habit.

Vermicompost: is a stable fine granular organic matter, when added to the soil loosens the soil and provides passage to air. The mucus attached to the cost being hygroscopic in nature improves WHC of the soil.

Nutrient composition of vermicompost

Macronutrients	%	Micronutrients	(ppm)
N	1.5	Fe	3200
P	0.9	Mn	357
K	0.26	Zn	80
Ca	1.26	Cu	41
Mg	0.61		
S	0.16		

Crop residues: Application of mature crop residues such as dried wheat straw, rice straw, paddy husk etc. in soil is not a common practice of manuring but it has been observed by many workers that if such substances are plughed in the soil, they have high nutritional value.

Biofertilizers: Refers to various inoculants or cultures containing a specific micro-organism in concentrated form, which are derived either from nodules of plant roots, or from the soil of root zone (rhizosphere) and possess unique ability to fix atmospheric N either by living symbiotically with the roots of leguminous plants or non-symbiotically (free living) or to transfer native soil nutrients such as P, Zn, Cu, Fe, S etc. form the non-usable (fixed) for to usable form through biological processes.

Potential of different biofertilizer per season

Rhizobium	30-100 kg. N/ha.
Azotobacter	20-35 kg. N/ha.
Azospirillu	30-35 kg. N/ha.
Acetobacter	70-150 kg. N/ha.
PSB	20-30 kg. P/ha.
VAM	30-35 kg. P/ha.

Beneficial effects of organic horticulture

The use of synthetic fertilizers and pesticides that require significant amounts of energy to manufacture. Applies excessive amounts of nitrogen fertilizer that is released as nitrous oxide. Operates intensive livestock holdings that over produce manure and methane. Greenhouse gases especially nitrous oxide, as no chemical nitrogen fertilizer are used and nutrients losses are minimized due to organic cultivation practices in agriculture as well as horticulture. Stores carbon in soil and plants biomass by building organic matter, encouraging agro-forestry and forbidding the clearance of primary ecosystems. Minimizes energy consumption by 30-70 % per unit of land by eliminating the energy required to manufacturer synthetic fertilizers, and by using internal farm inputs, thus reducing fuel used for transportation.

Soil quality

The soil quality relates directly to the functions performed by soil. High quality soil is able to produce abundant plant material, which feed, clothe, and provide shelter to the humans. High quality soil protects the environment from degradation, by reducing soil erosion and nutrient runoff (i.e. water quality protection) and by storing carbon in soil and reducing greenhouse gas emissions. Low quality soil lacks sufficient organic matter to sustain productivity in the long term, leads to excessive soil erosion and poor water quality, has low soil biological activity and diversity, and could lead to an unhealthy food supply and human condition.

Conclusion

Organic horticulture is a viable alternative because it enlivens the soil, strengthens the natural resource base and sustains biological production at levels to commensurate the carrying capacity of the managed agro eco-system. In addition to this export market can also be tapped by group initiatives in organic farming. In country like India, food production has to grow steadily. A sudden switch over to organic farming is not feasible. There is acute dearth of evidences to show comparative crop performance under pure organic farming and intensive agriculture, in terms of crop productivity and food quality. The introduction and adoption of biological; and organic plant protection measure on a mass scale may be a hill sum task in Indian farming. In intensive farming integrated and judicious us eof all the inputs including the fertilizers and organic sources, coupled with minimal use of pesticides may be better choice than pure organic farming.

Chapter - 6

Organic Inputs in Horticulture

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Chapter - 6

Organic Inputs in Horticulture

Abhinav Singh, Kinker Singh, Amrit Kumar Singh and Yash Kumar Singh

The major organic inputs obtained from processing of plant and animal products that the farmer brings to his crop in order to express its production potential (basically they are biological inputs or organic inputs). The most commonly accepted organic inputs are manure, slurry and green compost.

Fertilizers and soil amendments

The following list of fertilizers and soil amendments commonly used in organic horticulture.

Alfalfa meal: It is a perennial legume that is used as fodder for animals feed, green manure for crops and when cut, dried and ground into a meal, it makes a great soil amendments. It provides nitrogen, phosphorus, potassium, calcium, magnesium, trace minerals, triacontanol (A growth stimulant), sugars, starches and a large amount of amino acids. It can be mixed directly into your soil or made into a tea and used as a soil drench or foliar spray.

Blood meal: This is dried, slaughterhouse blood. Very malodorous and rather expensive. High in nitrogen. Probably better off in garden than in soil mix.

Bone meal: Is the by-product of the meat industry, bone meal is animal bones that pasteurized, dried and ground into powder form. It is used as a calcium and phosphorus amendments, but it contains some amount of nitrogen also. It can be mixed into soil directly or by dipping plug roots that need extra dose of calcium into the meal before planting. It should be keep in consideration that both the bone meal and blood meal should be used in situation when there is nothing else available that will provide the same benefits. Avoid contamination of organic plants with inorganic products.

Calcium sulfate: Gypsum is commonly called mined or industrial by product material applied to the field to correct the calcium deficiency (especially in alkaline soils) and to loosen up tightly clay soils allowing better drainage, which can releases excess sodium if present. It can also use in garden soil for the most part, but it is good to know before use.

Colloidal phosphate: It is also called as rock phosphate, this is mined, crushed phosphate that has been suspended in clay. Good and long term source of calcium and phosphorus. Dipping of flowering and fruiting plug roots in the powder before planting to the main field.

Compost: It is made up by different kinds of organic substances, the fundamental nature of it is the same. The end product is the result of digestion of these substances by microorganisms such as bacteria and fungi etc. and some macro-organisms like earthworms. The process releases nutrients from the original material and creates a soil conditioner rich in humus, humic acid, vitamins, minerals and nitrogen.

Cotton burr compost: Another by-product of the cotton industry, is wickedly sharp calyx of the cotton flower in which the boll rests. There are cotton burrs and aerobically composts them into a wonderful, earthy soil amendment. It is also good as seed meal, releases slow nitrogen, phosphorus and potassium.

Earthworm castings: The excreta of earthworms are finely digested organic matter. It has all the same basic benefits of compost, but in more compact, easy to use form. It possess good addition to potting soil and can be safely used in plug mixtures.

Fish emulsion: As the name implies, it is an emulsified fish by-product in a concentrated form. It can be used as soil drench with water mixed or foliar spray. It contains nitrogen, phosphorus and trace minerals.

Granite: It is coarse grained, light colored, hard igneous rock is often used by landscapers in crushed like gravel form as mulch and in garden pathways. In case of organic horticulture the sand or meal is mixed with soil as a source of potassium and other trace minerals. It has also paramagnetic properties, which helps to other nutrients become more available to the roots. If possible, try to find the partially decomposed granite.

Green sand: These are mined from ancient ocean beds, this silica based material called as gluconite which is greenish colored sand that is located with potassium. It also consists of iron or other elemental nutrients.

Guano: This manure is aged, dried poop from bats and sea birds. The droppings of birds that live on sea cliffs. They are all high in nitrogen, humus which is a good soil builder, microorganisms, vitamins and minerals.

Lava sand: Generally the combination of crushed volcanic rock often including basalt can be applied as the soil amendment for drainage, minerals and paramagnetic properties.

Lime: This is general term referring to the various white, powdery materials containing a substantial amount of calcium carbonate.

Manure: Any manure from animal's origin can be used as the source of nitrogen in soil mixtures as long as it has been well aged, pasteurized and composted.

Molasses: It is sweet in nature, thick, black syrup which is the by-product of the cane sugar industry. It comes in various grades, but the blackstrap grade retains the most nutritional components and is good for people as well as plants. Molasses could be added to foliar sprays or to soil drench and adds iron, sulfur, potassium and other trace elements as well as sugar.

Seaweed: It is the product which kelp that is ecologically harvested, dried and ground into a powder. It comes in either powder or liquid concentrate. It mixed with water, and it can be used alone or with fish emulsion as a foliar spray or soil drence.

Microbial Functions of biofertilizer

Numerous species of soil bacteria which flourish in the rhizosphere of plants, but which may grow in around plant tissues, stimulate plant growth. These bacteria are collectively known as plant growth promoting rhizobacteria (PGPR). Some PGPR appear to promote growth by acting as both biofertilizer and biopesticides. The search for PGPR and investigation of their modes of actions are increasing at a rapid pace as efforts are made to exploit them com mercially as biofertilizers. Modes of PGPR action include fixing N2, increasing the availability of nutrients in the rhizosphere, positively influencing root growth and morphology, and promoting other beneficial plant-microbes symbiosis. The combina tion of these modes of actions in PGPR is also addressed, as well as the challenges facing the more widespread utilization of PGPR as biofertilizers.

MCRC have been interested in microorganisms mainly nitrogen fixers, phosphate solubilizer, cellulose degraders and mycorrhizae as main sources for biofertilizer and production of these strains in low cost medium. There are several limitations to the use of biofertilizer for agricultural system. Primarily, efficacy is not reliable for most biofertilizers. This is because the mechanism of action of the biofertilizer in promoting growth is not well understood. However, research into biofertilizer is increasing, attempting to deal with these issues. Research needs also to be conducted to determine if and how variations in soil type, management practices, and weather affect biofertilizer.

Uses of Biofertilizer

Nitrogen-fixing biofertilizers

The nitrogen-fixing biofertilizers contain microorganisms such as Rhizobium, Actinobacteria, Azotobacter, and Azospirillum. They help in transforming nitrogen into organic compounds. Biological nitrogen fixation is one way of converting elemental nitrogen into a usable form for the plants. It is the reduction of nitrogen (N2) to ammonia (NH3). Thus, increasing awareness of water pollution and nitrate emissions is driving the need for alternative sustainable sources such as nitrogen-fixing biofertilizers. Among all the microorganisms, Rhizobium is used widely due to its efficiency in nitrogen fixation. Rhizobium is a symbiotic, nitrogen-fixing bacterium, which integrates atmospheric nitrogen with the root nodules of crops. This bacteria doesn't have an unpleasant odor as well has no foam formation with pH range from 6.8-7.5.

Phosphorus solubilizing biofertilizer (PSB)

PSB can be used for all crops in- cluding paddy, millets, oilseeds, pulses and vegetables. Methods recommended for application are:

- Seed treatment
- Seedling dipping
- Soil application

Seed treatment

Dosage: 10 kg of normal size seeds such as moong, urd, arhar, cowpea, lentil and berseem may be treated with 200 g of PSB bioinoculant by slurry method. Large size seeds such as groundnut, chickpea, soybean and pea, etc., require 400 to 500 g of inoculant for 10 to 12 kg of seeds. In case, the seeds are to be treated with fungicides, insecticides and bio agents, apply PSB at the last. Apply PSB 24 hr after treating with other chemicals.

Dosage: 10 kg medium size seeds such as groundnut, wheat, cotton, maize etc., may be treated with 200 g of inoculant, whereas 100 g per acre bioinoculant is enough for treatment of small size seeds.

Seedling dipping: This method is useful where the transplantation of seedlings is required. It is ideal for vegetable crops.

- Prepare the inoculant suspension in water in the ratio of 1:10.
- Dip the roots of seedlings in suspension and keep them immersed for about 5 minutes

- Take out the seedlings from the suspension and transplant as early as possible.

Dosage: Suspension of one kg in 10 to 15 litre of water for treating of seedlings for one acre.

Soil application: Mix 3-5 kg bioinoculant with 50 kg finely powdered FYM. Broad casting this mixture at the time of last ploughing.

Note: In case of PSB, best results are obtained when applied with well decomposed organic manure.

The properties of a good carrier material for seed inoculation

- Non-toxic to inoculant bacterial strain
- Good moisture absorption capacity
- Easy to process and free of lump-forming materials
- Easy to sterilize by autoclaving or gamma-irradiation
- Available in adequate amounts
- Inexpensive
- Good adhesion to seeds
- Good pH buffering capacity and

Non-toxic to plant

Cautions and limitations of biofertilizer

- Never mix with chemical nitrogen fertilizers
- Never apply with fungicides, plant ash etc. at the same time
- Never directly expose to sunlight
- Do not keep used solution overnight
- Store at room temperature, not below 0°C and over 35°C

Chapter - 7

Post-Harvest Management of Organic Produce

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Chapter - 7

Post-Harvest Management of Organic Produce

Hemant Kumar, Amit Mishra, Aditya Pratap Singh and Amrit Kumar Singh

Introduction

Post-harvest management can be defined as methods and techniques applied to increase the shelf life of the products. Postharvest activities include harvesting, handling, storage, processing, packaging, transportation and marketing. Post-harvest system should be thought of as encompassing the delivery of a crop form the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return for all involved.

Fresh vegetables are highly perishable and subjected to the active process of senescence. Losses in fresh vegetables can be caused by high temperature, low atmospheric humidity and physical injury. Such injury often results from careless handling, causing internal bruising, splitting and skin breaks, thus rapidly increasing water loss.

Quality products are produced in the fields but the quality of product is maintained and enhanced during its harvest and post-harvest management.

Importance of Post-harvest Management

Maintain the quality of fresh vegetables as well as ripen fruits, reducing postharvest losses reduces poverty and food insecurity. It increases the market share and competitiveness of smallholders. Stimulate agriculture production and prevent postharvest losses. Provide extra foods to the consumer by reducing post-harvest losses. Provide extra foods to the consumer by reducing post-harvest losses. Improves human nutrition and health. It is difficult to increase 10 % of the consumer by reducing post-harvest losses.

Causes of Post-harvest losses: The immature/premature/over mature harvest. Faulty postharvest practices, poor sorting and grading practices, poor temperature and relative humidity management in storage, improper packing and washing, delay and improper transport to market, cause of exogenous factors such as rotting and insect pests. Lack of knowledge on postharvest techniques. Shrinkage and loss of weight caused by water loss. Poor air circulation in the stores. Limited level of production and small land holdings, small scattered, remotely located production pockets with limited access to market centers, careless handling, causing internal bruising, splitting and breaks' Inadequate modern technologies and skills.

CDC reports that those eating "organic" foods are eight times more likely to be attacked by *E. coli.* 0157:H7. A university of Minnesota study showed organically grown produce had 9.7 % positive samples for *E. coli* 0157:H7 compared to 1.6 % for conventional produce from farms in Minnesota.

The major areas of concern are water, manure and municipal bio solids, worker health and hygiene, sanitary facilities, field sanitation, packing facility sanitation, transportation and trace back.

FDA published a book entitled Good Agricultural Practices in 1998 as a guidance document for produce growers, packers and shippers in the U.S. The Good Agricultural Practices are sanitary procedures used during crop production, harvesting, packing and shipping to prevent or minimize produce contamination with human pathogens.

Important considerations are: Focus is only on microbial hazards, focus is on risk reduction, not elimination, based on broad scientific principles must keep up with new information and techniques.

Water quality and safety: Be aware of potential sources of pathogens from your water sources, maintain wells in good condition, be aware of current and historical use of land, consider practices to protect water quality, consider irrigation water quality and use, microbial testing of water.

Practices that ensure and maintain quality: Sampling and microbial testing develop SOP's for all processes using water, clean/sanitize water contact surfaces, install backflow devices and legal air gaps and routinely inspect equipment used to maintain quality. Consider the water temperature for certain produce, maintain efficacy of antimicrobials and use appropriate wash methods.

Transportation issues: Precooling, sanitation and proper air delivery are very important to maintain the quality and safety of produce.

Post-harvest handling

Handling practices: Seed selection and cultivar selection, cultural practices and environmental conditions at the time of fruit set such as wind velocity, frost and rain etc. the extreme of these factors may deteriorate the produce.

Management practices: Irrigation to much or to little, high rates of nitrogen leads to improper soil nutrition, prevent the mechanical injuries to the produce and use only composted manure of upto 60-120 day depending on certifying agency and crop.

Harvest handling: Quality cannot be improved after harvest so harvest at proper stage and size of produce. During the coolest part of the day, keep the produce in shade to prevent them from scorching sun, handle gently to minimize the moisture losses as much as 400% by single blemish.

Post-harvest and storage consideration: Such as temperature, packaging, chilling injury, preventing moisture loss, sanitation, ethylene level of produce, mixed loads and storage of crops.

Temperature is the single most important factor to prevent them from extreme of temperatures use of refrigeration which helps to retards the aging, undesirable metabolic changes, moisture loss, spoilage from bacteria, fungi and yeasts, undesirable growth, i.e. sprouting.

Pre-cooling is the first important step. To lowest safe temperature as soon as possible critical for crops with high respiration rates such as broccoli, asparagus, green beans, mushrooms and sweet corn etc. the room cooling is not as efficient as good as pre cooling method, it needs to good air circulation around containers.

Forced air cooling: Cooling rate depends on air temperature and rate of air flow, generally 75-90% faster cooling. It is important to avoid over cooling and dehydration, do not operate forced air fans after produce has been cooled to correct temperature.

Hydro cooling: Is very efficient method of cooling which removes heat five times faster than air but less energy efficient. It can serve as a means of cleaning and reduces water loss, chlorinate to reduce microorganisms. It is not appropriate for berries, potatoes, bulb onions, as they are unsuitable for wetting.

Liquid icing: Especially effective on dense products and palletized products difficult to cool, it works well on high respiration products such as sweet corn, broccoli. The one pound ice cools ~three pounds of produce.

Vacuum cooling: water leaves crop and take heat with it, produce sprayed with waster first= "hydrovac cooling". It is good for leafy vegetable which have a high surface to volume ratio, i.e. greens.

Chilling injury: some vegetables best stored just above freezing, others best stored at some vegetables best stored just above freezing, others best stored at 45°F - 55°F. Both time and temperature involved and the effects of chilling injury are cumulative. Very sensitive crops are- basil, cucumber, eggplants, pumpkins, summer squash, okra and sweet potatoes.

Preventing moisture losses: It is important in controlling moisture loss; best range 80-90 % relative humidity. It is difficult for small producers. Sanitation becomes even more critical, cool temperature is important and uses a hygrometer for measuring.

Sanitation: Pathogens traced to fresh fruit and vegetables such as *E. coli* 0157:H7, *Salmonella, Cryptosporidium, Hepatitis and Cyclospora*. Chlorine is most often used. Caution should be keep for organic growers; it is restricted material, ozone, and Hydrogen peroxide.

Ethylene: Natural hormone produced by some fruits, damaged fruit produces more, do not store ethylene producers with fruits and vegetables that are sensitive. Ethylene producers are apples, cantoaloupes, peaches, pears, plums and tomatoes etc.

Mixed loads: Combine only products that are compatible with respect to: temperature, relative humidity, oxygen and carbon dioxide, protect form odors and ethylene production.

High quality of good shelf life depends on: Sound production practices, proper handling during harvest, appropriate post-harvest handling and storage. Key factors are temperature and relative humidity.

Chapter - 8

Seedless Fruit Production by Hormonal Regulation of Fruit Set

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Chapter - 8

Seedless Fruit Production by Hormonal Regulation of Fruit Set

Kinker Singh, Abhinav Singh, Anupam Singh and Amrit Kumar Singh

Introduction

Prthenocarpy defined as a virgin fruit is the natural or artificially induced production fruit without fertilization of ovules. The fruit is therefore seedless. Or Prathenogenesis refers to the production of egg cells without fertilization e.g. mangosteen.

Comparison between parthenocarpic fruits and fertilized fruits

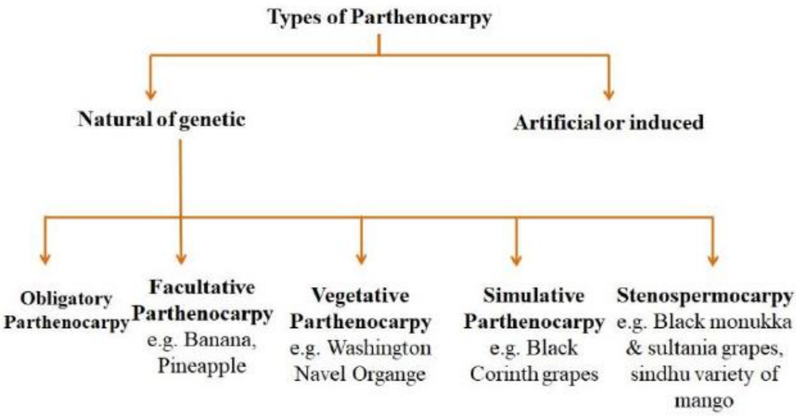
Fruits of wild and seeded banana *Musa acuminata banksia*, the domesticated prthenocarpic banana fruit. A fertilization-induced tomato fruit of the Monalbo variety. The Monalbo wild type fruit cut in half. The locule is filled with pulp and the seed are clearly visible. A parthenocarpic fruit from Monalbo containing the abnormal *arf8* mutant transgene. The same parthenocarpic fruit in € is cut in half. The central columella (c) is enlarged and the locule is filled with pulp, showing a seedless endocarp.

Examples of seeded and seedless fruits in parthenocarpic species are *Annona squamosal, Actinidia arguta* cv. *Isai, Cucumis sativus, Elaeis oleifera* (African oil palm) and *Citurs clementine.*

Importance of parthenocarpy

Seedless is a desirable trait in edible fruits with hard seeds such as pineapple, banana, orange, grapefruit. Also desirable in fruit crops that may be difficult to pollinize or fertilize. In dioecious species e.g. persimmon, parthenocarpy increases fruit production as staminate trees do not need to be planted to provide pollen. Increases shelf life due to reduced ethylene generated by seeds. It also improves processing quality and ultimately increases profitability.

Drawbacks of parthenocarpy: Parthenocarpy is undesirable in nuts e.g. pistachio, walnut, almond and pecan etc. it occasionally occurs as a mutation in nature in nature and is considered as a defect because the plant can no longer sexually reproduce.



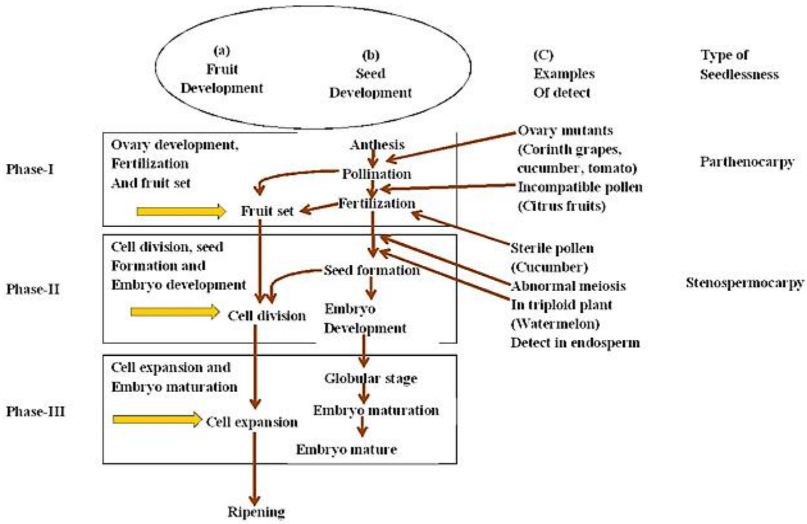
Triploid banana: The triploid banana fruit is vegetatively parthenocarpic. The grapes of growth in volume of seeded banana fruits are sigmoid in shape. Those of parthenocarpic fruits are variable but are not sigmoid and the shapes are related to specific origins. Growth rates are related to certain ovule behaviors, to seed content of the fruit, and to poloidy. NAA induces Parthenocarpy in seeded bananas and stimulates it in weakly parthenocarpic types. By contrast, coumarin, a hormone inhibitor, inhibits it in strongly parthenocarpic forms.

<table>
<tr><td>Musa accuminata
AA
(Fertile)</td><td>X</td><td>Musa balbisiana
BB
(Fertile)</td><td>=</td><td>Musa X paradisica
(Hybrid banana)
AAB or ABB (etc.)
(Sterile)</td></tr>
<tr><td colspan="5">Origin of triploid banana from Asian Parents</td></tr>
<tr><td colspan="5">A= one hapoid set of chromosomes form Musa accuminata</td></tr>
<tr><td colspan="5">B= one haploid set of chromosomes from Musa balbisiana</td></tr>
</table>

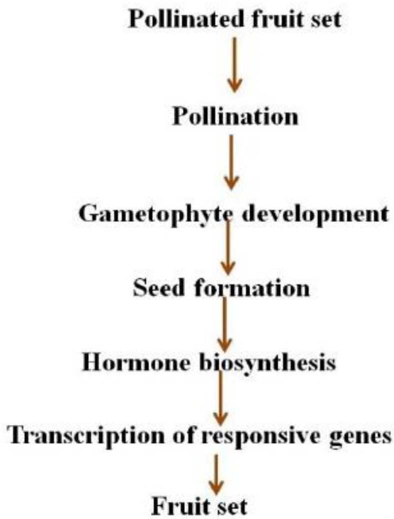
Stenospermocarpic Grapes: Normal pollination and fertilization occurs, but the embryos abort when they are young. Often, remnants of seeds can be seen in the fruits. Characteristic features of the group of **sultana**- raisin type cultivars, for e.g. Kishmish rozoviyi (pink sultana), black ksihmish, black monukka and Thompson seedless grapes.

Origin of Parthenocarpy: Due to absence of pollination and fertilization, male sterility, degradation of pollen mother cells, degradation of fertilized ovules, due to self-incompatibility e.g. citrus, embryo abortion e.g. grape and due to chromosomal irregulatries during meiosis leading to triploidy e.g. Tahiti lime, Oroblanco and Melogold.

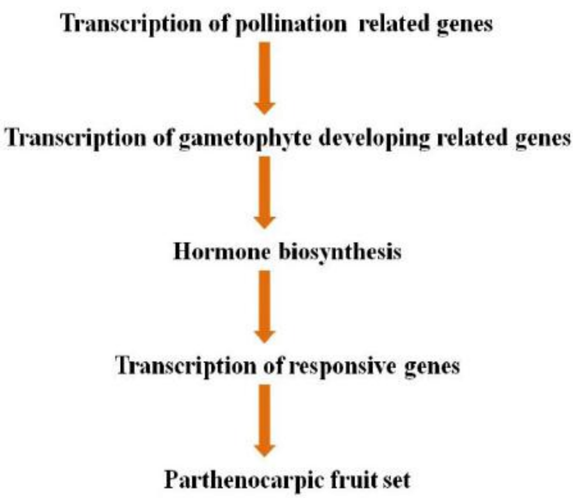
Physiological basis of Parthenocarpy: To obtain parthenocarpic fruit is a physiological challenge. Fruit development comprises early development and maturation. Early fruit development in most of the plants involves three phases **i)** fruit setting **ii)** cell division **iii)** cell expansion. The ovary takes decision to either abort or to go further in fruit development during first phase. During cell division phase of growth of fruit size is low because the dividing cells are small and tightly compressed and the number of cells decides final fruit size. The third and last phase begins after cell division stops, the fruit grows by the increase in cell volumes, until it reaches its final size. Cell expansion commonly increases fruit size by 100 folds and this makes the greatest contribution to the final fruit size.

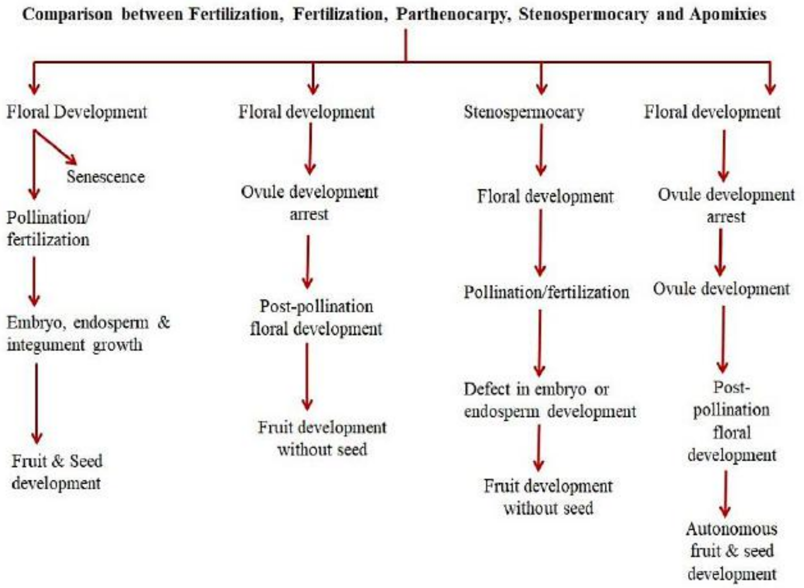


Auxin induces Parthenocarpy: The ovaries of parthenocarpic fruits have higher content of auxin than corresponding non-parthenocarpic cultivars.



Working hypothesis of parthenocarpic fruit set





Causes & induction of Parthenocarpy in fruit crops

Fruit crops		Causes
Guava e.g. Allahabad seedless	:	Due to triploid
	:	Fertilization of well differentiated ovules
	:	Degeneration of fridge ovules
Grape	:	Due to embryo abortion (Stenospermocarpy)
Citrus	:	Due to self-incompatibility (Mandarins)
	:	Cytoplasmic male sterility (Satsmuma mandarin)
	:	Chromosomal irregularities (Tahiti lime, oroblanco, melogold)
Apple	:	Lack of pollination
Banana	:	Due to triploidy

In case of Papaya: Rodriquez- Poster *et al.* (1990) have observed Parthenocarpy at the rate of 35 % in sunrise and 5 % in 298 F5. Parthenocarpic fruits are of adequate quality.

Litchi: Chicken tongue seeds to the shriveled seeds with rudimentary embryos. The percentage of fruits having chicken tongue seeds differ with the cultiivars, 8.4 % in Shahi to over 90 % in Bedana.

Banana: Seed sterility is due to cytogenetic factors and triploidy. Parthenocarpy is due to several (at least 3) complementary dominant genes

(P1, P2 and P3) which are present in wild forms of *Musa acuminate* (Simmods, 1976). Some modifier genes are also responsible for Parthenocarpy.

Citrus: Low pollen viability and a high degree of ovule sterility. In Tahiti lime and Oroblanco; chromosomal irregularitys during meiosis (triploidy). Wilking Mandarin; pollen as well as ovule, abortion and subsequent Parthenocarpy.

Apple: CPPU, GA_3 and GA, had a positive synergistic effect on parthenocarpic fruit production in apple cultivars such as Golden Delicious and Jonagold.

Pear: GA_3 and GA induced Parthenocarpy when applied before fruit bloom. In cv. Rocha, only a few pollen tubes reached the ovules 8 days after self-pollination. The slow rate of pollen tube growth in self-pollination of Rocha pear may prevent fertilization by loss of viability of embryo sacs (Medeira and Maia 2008).

Changes in physic-chemical characteristics in the fruits due to induction of Parthenocarpy

Size: In mango seedless fruits had smaller size than seeded fruits but had good quality and matured earlier than seeded fruits. In grapes also the size of seedless berries was smaller than the seeded ones of the same variety.

From: Parthenocarpic fruits (induced by GA) in apple were usually more elongated than the normal seeded fruits.

Composition and quality: In most grape varieties seedless fruits are sweeter than the seeded fruits of the same variety.

Maturity: Seedless fruits ripen later than seeded fruits which may be attributed to ethylene produced by seeds.

Chapter - 9

Essentials of Organic Horticulture

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Chapter - 9

Essentials of Organic Horticulture

Satvaan Singh, Ravi Pratap, Sudhanshu Singh and Saurabh Vishvakarma

Organic horticulture is a horticulture method that aims to work in harmony with nature rather than against it. It promotes sustainable health and productivity of ecosystem like soil, plants, animals and people. It includes keeping and building a good soil structure and soil fertility, as well as controlling pests, diseases and weeds.

Why organic horticulture?

Earlier seasons and climate of an area determined what would be grown and when, today it is the "market" that determines what it wants and what should be grown. The focus is now more on quantity and "outer" quality (appearance) rather than nutritional quality, "vitality". Pesticide and other chemical residues reduced quality of fruits and vegetables, increase in various diseases, mainly various forms of cancer and reduced body immunity. Fertilisers have a short term effect on productivity but a longer term negative effect on the environment where they remain for years after leaching and running off, contaminating ground water and water bodies.

Millions of people are still underfed and where they do get enough to eat, the fruits and vegetables they eat has the capability to eventually kill them. Organic horticulture has the capability to take care of each of these problems. Besides the obvious immediate and positive effects organic or natural horticulture has on the environment and quality of fruits and vegetables, it also greatly helps a farmer to become self-sufficient in his requirements for agro-inputs and reduce his costs.

Wide crop rotation

An efficient use of on-site resources. Absolute prohibition of the use of genetically modified organisms. Choosing plant and animal species that are resistant to diseases and adapted to local conditions. Raising livestock in free range, open air systems and providing them with organic feed. Using animal husbandry practices appropriate to different livestock species supply chain. Maintaining a stable ecosystem.

Beneficial effects

Manure supply plant nutrients including micro nutrients. It also improves soil physical properties like soil structure and porosity. Increases the availability of nutrients in soil as well succeeding plant. Co_2 released during decomposition of organic manure and helps to reduce alkalinity of soil. Increases the organic carbon content of the soil. Binds soil particles into aggregates increasing porosity, infiltration and water holding capacity in the soil. Reduces soil erosion through better soil structure. Increases potash and phosphate uptake by the plants. Acts as buffering agents which helps to reduce damage from excessive acid, alkalinity or salt.

It works as much as possible within a close system and draw upon local resources, maintains the long term fertility of the soil. Avoid all form of pollution caused by agricultural techniques and provide fruits and vegetables stuff of high quality. Possible for agricultural families to earn a living through their work and develop their potentiality as human being. Maintains the rural environment and also preserve the non-agricultural ecological habitats. Reduces the use of fossil energy in agriculture to a minimum tending to zero.

Methods of organic horticulture

Crop rotation, Mulching, Green manure and Composting

Crop rotation: Crop rotation means having times where the fertility of the soil is being built up and times where crops are grown which remove nutrients. Crop rotation also helps a variety of natural predators to survive on the farm.

Compositng: Compost is an organic matter (plant and animal residues) which has been rotted down by the action of bacteria and other organisms, over a period of time. Compost improves soil structure, water holding capacity and fertility by adding nutrients for plants to take up the nutrients already in the soil. It supplies part of 16 essential elements needed by the plants.

Mulching: Mulching means covering the ground with a layer of loose material such as compost, manure, straw, dry grass, leaves or crop residues. It always apply mulches to a warm wet soil. Care should be taken as to the thickness of the mulch applied.

Green Manures: Improve the availability of the soil to hold water**,** Control soil erosion**,** and Improves soil structure as well as soil fertility.

Prospects of organic horticulture in India

- Health conscious
- Selling of organic produce at premium -Rising income levels
- Growing demands. Rising demand for export, Awareness among farmers
- Environment friendly and Safe for the stake holders
- Enhances Soil Nourishment

Advantages of organic horticulture

Poison free healthy fruits and vegetables, Fruits and vegetables tastes better, Better shelf life and storage life, Grower benefits, Increase disease and Pest tolerance, Increase drought tolerance and Lower Input Costs.

Certification process: Certification of organic farms is required to satisfy the consumers that the produce is totally organic. Certification agency provides information on standards, fees, application, inspection, certification and appeal procedures. The producer then submits application along with field history, farm map, record keeping system etc. Then the contract indicating scope, obligation, inspection and certification, sanction and appeals, duration, fee structure is executed. Then the Inspector of agency comes and carries out inspection. Inspector gives inspection report with his recommendation to the agency, Then agency issues approval or denial of certificate. Certificate is given for current year's harvest only and hence annual certification is required.

Organic cultivation of spices and plantation crops

Few spices and plantation crops like Black pepper, cardamom, chilli, turmeric and ginger, fenugreek, coriander, cumin, fennel, oleoresins and essential oil of chilli, coconut, areca nut, oil palm betel vine have tremendous export potentialities. Organically cultivated spice and plantation crops get myriad importance in fruits and vegetables products in countries of Europe, USA and Japan and other countries.

Black pepper

Application of 2 kg compost with 125 g rock phosphate /vine at the time of planting. Compost or FYM during May-June from 2nd year onwards @ 4kg/vine and gradually increased up to 10 kg. In bush pepper, application of leaf/vermicompost at.

Weed and moisture management

Mulching is an important cultural operation practice in pepper to suppress weeds and conserve soil moisture. Cover crops (*Calapogonium muconoides* & *Mimosa invisa*) are grown to provide effective soil cover and to prevent soil erosion

Pests and disease management

Pollu Beetle (*Longitarsus nigripennis*): Spraying neem oil at 400ml/100 litres of water. Scale Insect (*Lepidosaphes piperis*)-Neem-garlic suspension at 2% was found effective. Foot Rot (*Phytopthora capsici*)-Application of Trichoderma spp. At 75g/vine alongwith neem cake at 2kg/vine. Nemtodes (*Radopholus similis, Melodogyne incognita*)-Apply Crushed neem seed @1kg/vine/year. Capsule rot (*Phytopthora meadii*) and Clump Rot- Soil application of T. harzianum or T. viride to the main field resulted in high disease control ranging from 62.3 to 64.8%.

Cardamom

Nutrient Management: Apply neem cake at 1kg or poultry manure/FYM/compost /vermicompost at 2kg/plant once in a year during May-June. Apply rock phosphate or bone meal. Coir pith compost fortified with rock phosphate can be used as a substituted for FYM in the potting mixture for during nursery phase.

Pest and disease management

Root Grub (*Balepta fuliscorna*): Mechanical collection and destruction of larvae reduce the pest damage. Stem Borer (*Conogethes punctiferalis*) - Injection of *Bacillus thuringiensis* preparation into the bore hole (0.5 ml in 10 ml water) will kill the larvae. Whitefly (*Dialeurodes cardamomi*)-Spraying neem oil with soft soap (500 ml neem oil and 500 gm soft soap in 100 litres of water). Capsule rot (*Phytopthora meadii*)- Soil application of *T. harzianum or T. viride* to the main field resulted in high disease control ranging from 62.3 to 64.8%. Katte Disease (virus) Use of disease free planting material is important. Regular rouging of virus affected plants should be made to reduce the spread. Root knot Nematodes (*Meloidogyne* sp.) *Trichoderma* sp improved growth of cardamom seedlings by suppressing root knot nematode population.

Chilli

Nutrient Management: Organic manure such as FYM applied @4to 5 t/ha. It is always advisable to use enriched compost than FYM alone. Restricted use of permitted mineral fertilizers under organic system can be done depending on requirement. Use of biofertilizers can also be resorted in combination with organic inputs.

Weed management: Use of crops and varieties which are Tolerant. Well adapted to the environment. Fertile soils of high biological activity. Crop rotations, green manures etc.

Pest and Disease management

Thrips-Application of neem seed kernel extract can be done. Root Grub-Application of neem cake @250 kg/ha is advisable. Fruit pod borers-Restricted use of *Bacillus thuringensis* @ 1kg/ha are beneficial. Root and die back and Bacterial wilt- Seed treatment with Trichoderma takes care of seedling rot in nursery. Roughing and destruction of affected plants help in checking the mosaic virus.

Ginger and Turmeric

Nutrient Management: Application of FYM/compost at 25 t/ha every year. Coir pit compost at 2.5t/ha along with FYM and bio fertilizer significantly increased the yield and quality. Organic manures such as FYM, neem cake and groundnut cake in turmeric cultivation gave rhizome yield of 48.2, 48.1 and 46.3 quintals/ha in comparison to 48.8 q/ha with chemical fertilizers. Organic manures improved the curcumin content in the rhizome more than chemical fertilizers. Application of FYM at 25t/ha and vermicompost at 2.5 t/ha gave higher yield of ginger and turmeric.

Weed management

Mulching the beds with green leaves at 10-12 t/ha 40 and 50 days after planting is recommended in turmeric to suppress weeds. Application of compost provides better soil aeration and helps in growing of fingers. In case of Ginger mulching after planting + hoeing at 40 DAP + grubber at 60 DAP + hand weeding at 90 DAP + mulching showed superiority in terms of plant height, tillers/ clump, number of leaves/clump and tiller, leaf area index and leaf area/clump.

Pest and disease management

Hot water treatment of the seed rhizomes at 510C for 10 min eliminated nematodes and surface bound pathogen also. *T. harzianum* in combination with *Pseudomonas fluorescens* showed a synergistic effect in reducing the soft rot infection. Apply *T. harzianum, T. viride, T. hamatum* and *T. virens* as seed treatment and soil application along with neem cake at 100 kg/ha gave production and increased yield.

Coriander

Nutrient Management: Well rotten FYM @ 4-5 t/ha may be applied at the time of sowing.

Pest Disease and Weed Management

Aphids can be controlled by using fish oil rosin soap or neem seed karnel extract 3%, neem oil (50ml/liters + 50 ml soap solution). Seed treatment and soil application with T. harzianum was effective for the management of the disease. *T. viridi* as seed treatment (4g/kg) and soil application (5kg/ha) reduced the Fusariaum wilt incidence by 58% with a yield of 575kg/ha compared to 433kg/ha in control. Follow crop rotation.

Chapter - 10

Good Agricultural Practices

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Chapter - 10

Good Agricultural Practices

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Definition

Good agricultural practices are set of principles applied through the food production cycle to produce, safe healthy food taking into consideration economic, social and environmental sustainability. Such as the soil management through the avoid of mechanical soil tillage to the extent possible, maintain soil organic matter through the use of soil building crop rotations, follow soil test based fertilizer application, maintain soil cover to minimize erosion by wind and water to avoid contamination with agrochemicals, organic and inorganic fertilizers.

Crop production and protection through the selection of cultivars on an understanding of their characteristics, its responses to sowing/planting time, quality market acceptability, devise suitable crop sequences, recycling of crop and other organic residues, use of resistant cultivars, practice of IPM techniques, keep record of agrochemical use, assure equipment handling and application of agrochemicals comes with established safety and maintenance records.

Good agricultural practices that address environmental, economic and social sustainability for on-farm processes, and results in safe and quality of food and non-food agricultural products. It has been developed by the food industry, produces organizations, governments and NGOs, aiming to codify agricultural practices at farm level. Good Agricultural Practices benefits with quality and safety improvement, facilitating market access, reduction in non-compliance risks are permitted pesticides, MRLs and other contamination hazards.

The major challenges are increase in production cost like recordkeeping, residue testing and certification, and adequate access to information and support service.

Good Agricultural Practices includes: Water for the agriculture and processing, manure, compost and other similar fertilizers, sanitary facility, field sanitation, packing facility sanitation, transport and trace back.

Good Agriculture Practice encompasses with

i) Process,

ii) Knowledge,

iii) Value and Ethics,

iv) Skills.

Strategy-I for Good Agriculture Practices

Improvement in Crop Productivity of Major Crops

MAIZE: The good agriculture practices include less hybrids area. Non adoption of weed control, less use of fertilizer and the strategies should be Increase in area under hybrid maize, balance nutrient use on soil test basis, effective weed control.

RICE: The good agriculture practices for rice are low plant population, less use of fertilizer, cold irrigation water, losses due to Blast and other insect pests and diseases. Strategies should be seed treatment, integrated pest management, adoption of SRI for proper plant population, balanced fertilizer use, adoption of rice hybrids, increase in system of seed replacement rate.

WHEAT: The good agriculture practices for wheat crop are maximum area under rainfed conditions which leads to the rust and loose smut problem and less use of fertilizer is also a major issues. Strategy must adopt with lifesaving irrigation through micro irrigation system, seed treatment, and increase in seed replacement rate by 13 % to 35 %. Balanced fertilizers must use, adoption of moisture conservation and application of drought resistant varieties.

Strategy-II

Soil health management: With the help of providing Soil Health Card to each farmer and to make it online. It can be manage through balance use of nutrients such as NPK ratio, promotion of organic farming, strengthening of soil/fertilizers testing services, setting up of Mobile Soil Laboratory, Strengthening of Lab, Capacity building training/demo, District Digital Soil Map, Promotion of integrated nutrient management (ha.)

Strategy-III

Conservation and Management of Natural Resources as maximum area is under rainfed, annual rainfall is 1617 nm. U even distribution of rain fall, problem of soil erosion/degradation. The natural resources could be possibly conserved and managed through watershed development programme and creation of water potential through water harvesting system.

Strategy-IV

Seed Development/Seed Chain includes the production of certified seed, increase of Seed Replacement Rate (SRR %) and seed village programme.

Strategy-V

Precision Farming

The precision farming or precision horticulture is about doing the right thing, in right place, right way, at the right time. This approach recognizes site-specific differences within fields and regulates management actions accordingly. Managing crop production inputs such as water, seed, fertilizer etc. to increase yield, profit, reduce waste and becomes eco-friendly concept based on observing, measuring and responding to inter and intra-field variability in crops.

New technologies such as Global Positions Systems (GPS), sensors, satellites or aerial images and Geographical Information Systems (GIS) are utilized to assess and analyze variations in agricultural and horticultural production.

Need of Precision Farming

For assessing and managing field variability: Cultivable field have variable yields across the landscape because of variations to management practices, soil properties and environmental characteristics.

For doing the right thing in the right place at the right time: After assessing the variability precision agriculture allows management decisions to be made and implemented in right time in right places on small areas within larger fields.

For higher productivity: Since precision farming, proposes made management practices, it will definitely increase the yield per unit of land.

For increasing the effectiveness of inputs: Increased productivity per unit of input used indicates increased efficiency of the inputs.

For maximum use of minimum land unit: After knowing the land status, a farmer tries to improve each and every part of land and uses it for the production purpose.

The precision farming includes: Land preparation, inputs such as seeds, planting materials, fertilizer and irrigation etc., plant protection, harvesting, post harvesting, storage and transportation.

i) **Crop Characteristics:** Stage of crop, crop health, nutrient requirement etc.

ii) Detailed soil layer with physical and chemical properties, depth, texture, nutrient status, salinity and toxicity, soil temperature, productivity potential etc.

iii) Micro climate data (seasonal and daily) about crop canopy, temperature, wind direction and speed, humidity etc.

iv) Surface and sub-surface drainage conditions, irrigation facilities, water availability, and other planning inputs of interest.

v) Farm machinery and equipment equipped with sensors.

Benefits of Precision Farming: precision farming not only is potentially more economical, but it also reduces the amounts of chemicals released into the environment. Other benefits such as improves crop yield and profits, provides more details and useful farm records, reduces fertilizer costs, reduces pesticide costs and reduces pollution.

Precision farming ensures: 40-60% increased yields, 90% plus first grade marketable produce, weight by volume is 25% higher, 30% premium price in the market, 5-6 days more shelf life, less labour dependence, 30-40 % water economy, extended crop harvest, empowerment of farmers.

Precision farming is useful guidance for adopting the systems of integrated management of soil health, nutrients, pests, water, energy and different crop genetic resources. The main objectives of precision farming in India is to improve horticultural production, quality of environment and economic status of the farmers.

Steps in Precision Farming: i) assessing variation, ii) managing variation and iii) evaluation. It is an information and technology-based management system. These include- Global positioning systems, geographic information systems, yield monitoring devices, soil, plant and pest sensors, remote sensing and variable rate technologies. This information and technology for site-specific farming allows farmers to identify, analyses and manage the spatial and temporal variability of soil and plants for optimum profitability, sustainability and protection of the environment.

Global Positioning System (GPS) the most common use of GPS in agriculture is for yield mapping and variable rate fertilizer/pesticide application. The GPS are important to find out the exact location in the field to assess the spatial variability and site-specific application of inputs. The GPS operating in differential mode are capable of providing location accuracy of 1m.

Geographical Information System (GIS) the GIS is an organized collection of computer hardware, software, geographical data, and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information. The GIS is the key to extracting value from information on variability. It is rightly called as the brain of precision farming. It can help in agriculture in two ways. One is in linking and integrating GIS data such as soil, crop, weather field history etc. with simulation models. Other is to support the engineering component for designing implements and GPS guided machineries (variable rate application) for precision agriculture.

Strategy-VI

Crop Protection and IPM: Reduction in chemical pesticides, promotion of integrated pest management, IPM Demonstrations and farmers field school, seed treatment to prevent them from any kind of infections of severe disease as well as insect pest. There are lots of strategies has been developed to control the insect pests population without desorbing the environment such as different types of traps, mulching and time manipulations in sowing as well as transplantations.

Strategy-VII

Crop Diversification/Niche Farming: The need for crop diversification is to household food/ nutritional security, risk coverage like mono cropping high risk, rural employment opportunities, and sustainability of production systems.

Strategy-VIII

Extension and Transfer of Technology through crop demonstrations, skill training programme for farmers, exposure visit, mass media support, implementation of AGRISNET portal.

Strategy-IX

Insurance and credit through distribution of Kisan Credit Card, crop loan scheme, loan on fertilizers and insurance of the crop.

Strategy-X

Mechanization with the help of tractors/power tillers, power thresher, other equipment, demonstration of new equipment.

The Good Agricultural Practices initiated in 1997, by European Retailers, and other members of input and services side of Agriculture. First version released in Europe in 2001. GAP standard is designed to reassure consumers about how food is produced on farm by minimizing detrimental environmental impacts of farming operations, reducing the use of chemical inputs, ensuring responsible approach to worker health and safety as well as animal welfare. Good Agricultural Practices benefits as food quality and safety improvement, facilitating market access, reduction in non-compliance rises regarding permitted pesticides and other contamination hazards.

Main challenges are increase in production cost like record keeping, reduce testing and certification, inadequate access to information and support services.

Chapter - 11

Improving Fruit Size, Appearance, and other Aspects of Fruit Crop, Quality with Plant Bioregulating Chemicals

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Chapter - 11

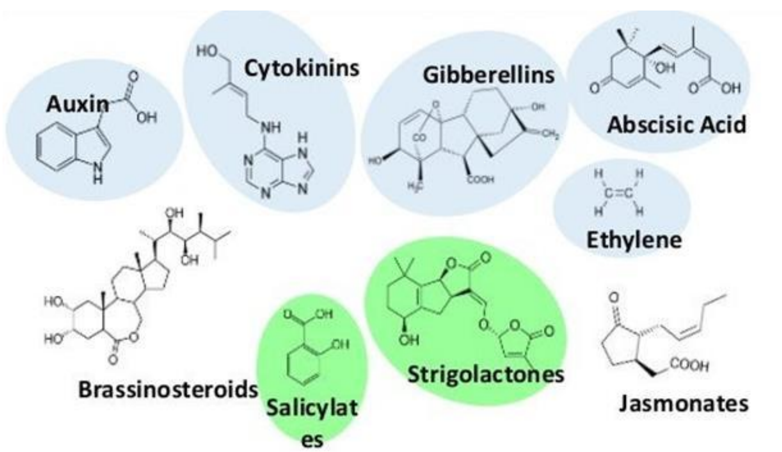
Improving Fruit Size, Appearance, and other Aspects of Fruit Crop, Quality with Plant Bioregulating Chemicals

Avdhesh Kumar and Rupesh Kumar

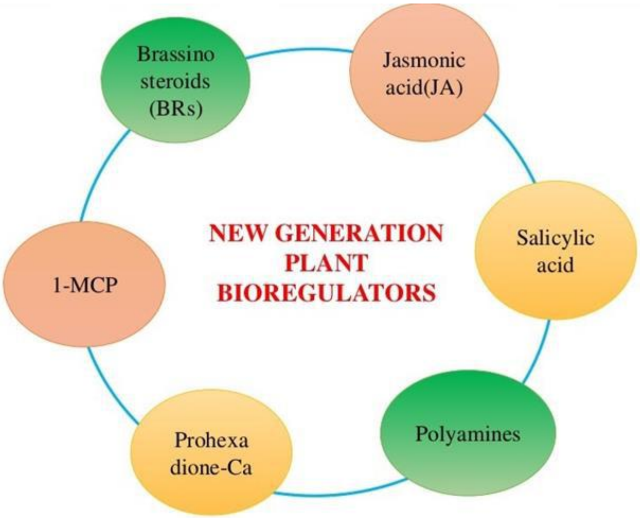
Definition

Plant bio regulators, previously termed as plant growth regulators. In 1992 at Jerusalem in the 7th international symposium, the name changed from plant growth regulators to plant bioregulators. "Plant bio regulators usually are defined as organic compounds, other than nutrients, which used in small concentrations, affect the physiological processes of plants" is known as plant bioregulators.

Bioregulators are **endogenous or synthetically** produced substances that can control one or more specific bio chemical and physiological function of many spp. probably by their influence on gene and enzyme interaction (Olaiya, 2013).



Physiological responses that are regulate/influenced by plant bioregulators: Vegetative growth control and increase fruit set, increase/inhibit flower bud formation, reduction of fruit/flower abscission, fruit colour and ripening, reduce pre-harvest drop, improve fruit shape, routing water sprouts and stress tolerance (Greene 2010).



Types of bioregulators based on chemical nature

Chemical based PBRs: Thiourea, Silicon, Potassium, Polyamines, Hydrogen Peroxide, Hydrogen Sulfide, H_2–Rich water.

Hormone based PBRs: Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.

Chemical based PBRs, their mode of application and effect on plants

1. Thiourea @ 75mM reduces drought stress apply as seed soaking and foliar application helps to increase plant growth and yield (Sahu et al., 2006).
2. Silicon @ 2mM Sodium Silicate prevents K and Ca stress apply in soil which helps to enhanced potassium use efficiency (Miao et al., 2010).
3. Potassium @ 2mM KNO3 minimizes salt stress apply with soil which benefits in stress alleviation of salt stress symptom with enhanced K+ accumulation (Zheng et al., 2010).
4. Polyamines @ 2mM reduces flooding stress apply with soil which enhance antioxidant capacitance and flooding tolerance (Yiu et al., 2009).
5. Hydrogen peroxide@ 100µM copes the drought and salts stress apply in culture medium and foliar spray effective in activation of myoinositol pathway and maintenance of leaf water content (Ishibashi *et al.*, 2011).

6. Nitric oxide @ 10µM Sodium nitroprus side reduces the risk of drought apply as seed soaking leads to improved photosynthetic performance of leaves and stress amelioration (Liao et al., 2012).
7. Hydrogen sulphide @ 400 µM Sodium hydroulfide helps in multiple stress and it is applied in growth medium which enhances antioxidant capacitance (Yu et al., 2013).
8. Hydrogen rich water @ 50 % saturation helps in slat stress apply in growth medium activates the zinc-finger transcription factor and related antioxidant defence (Xie et al., 2012).

Hormone based PBRs their origin and role on crop plants

1. **Auxin:** Discovered by F.W. Went in 1926, Produced by the growing apex of roots and stems of the plant. It plays an important role in apical dominance, cell division and cell enlargement, shoot and root growth, flower initiation etc.
2. **Gibberellins:** Discovered by Kurosawa *et al.*, in 1926, originated from fungus (Gibberella fujikuroi), prevent genetic dwarfism, bolting and flowering, germination, fruit setting, breaking of dormancy etc.
3. **Cytokinines:** Discovered by Miller, Skoog and their cowerkers in 1951. Isolated from coconut milk, helpful in cell division, cell and organ enlargement, seed germination, breaking dormancy bud development and shoot growth etc.
4. **Ethylene:** Discovered by Neljubow in 1901 from colorless gaseous hormone, effective in fruit ripening, growth inhibition, epinasty, thining in apple, flowering and sex expression etc.
5. **Abscisic acid:** Discovered by Addicot *et al.*, in 1946, acts as anti-Gibberellins such as abscission, dormancy, inhibit seed development and germination, stomatal closing, antagonism etc.

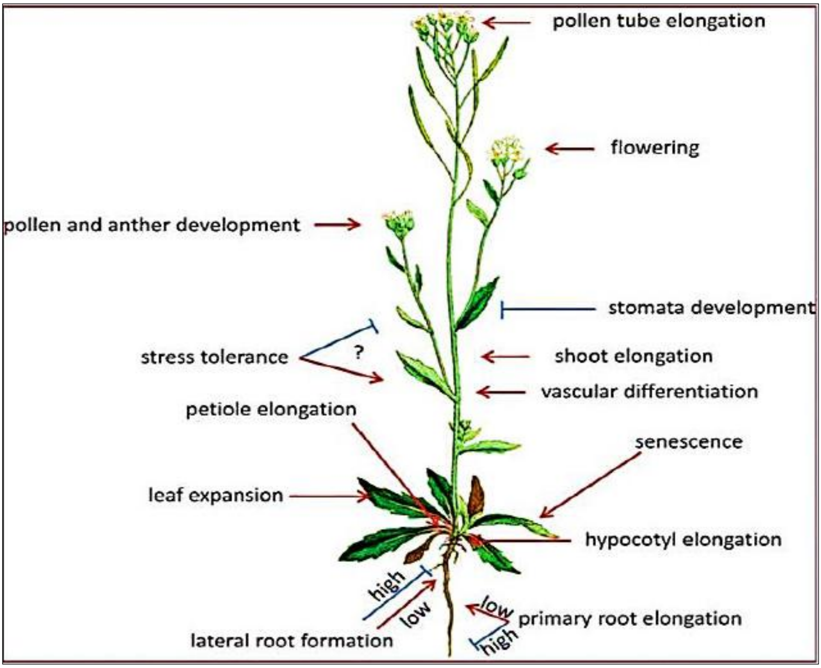
Brassinosteroids are steroidal substances which have been isolated from the pollen of rape plants (*Brassica napus* L.). The exogenous brassinosteroids application in submicromlar concentration stimulates various physiological and bio chemical responses in various systems in plants.

Commercially available brassinosteroids in Inida are introduced homobrassinolide (Double) and introduced brassinolide (Cadmore) in the market.

Applications of Brassinosteroid

Increasing yield of yellow passion fruit plants and produced the highest number of fruits per plant. In case of grapes increase the cluster weight, berry weight, berry softening, maintained external colour and stabilized anthocyanin.

Role of Brassinosteroids in palnts



Jasmonic acid is a plant immune hormone derived from Linolenic acid, its role in plant defence was first shown by a Farmer nad Ryan in 1990. The Jasmonic acid plays an important role in plants as Methyl jasmonate, initially discovered as a secondary metabolite in essential oils of jasmine. Regulated plant growth and development, senescence, flower development, leaf abscission, response to wounding of plants and transcription.

Application of Jasmonic acid: N-propyl di-hydrojasmonate improve apple fruit quality and colour, regulates ethylene biosynthesis and influence arom volatiles, defence against environmental stress and decreased low temperature injuries such as splitting and spotting in apple fruit.

Salicylic acid: Ortho-hydroxybenzoic acid works as secondary metabolite and it has been extracted as Saliciline, from White willow (*Salix alba*). The role of salicylic acid are sex polarization, endogenous signal molecules, stomatal conductance, transpiration, photo synthesis and glycolysis, ion uptake and transport, disease resistance and seed germination. Chitinase β-1,3-glucanase, Phenylalanine ammonia-lyase and Polyphenoloxidase enzymes increased total phenolic compounds and lignin in mango. It provides multiple stress tolerance in strawberry plants and maintained fruit firmness.

Polyamines: it is low molecular weight compound having two or more primary amino groups; linear polyamines perform essential functions in all living cells. Polyamines interfering with ethylene biosynthesis and perception, lead to a less ripe fruit-quality control in the postharvest handling chain. Polyamines play important role in cell divisions, embryo development, regulate fruit ripening, flower development, microbial infection, abiotic stress tolerance. It apply as anti-senescence, potassium and proline induction, reduce respiration rate, reduce chilling injury and ethylene production rate.

1-Methyl Cyclo Propane: It is synthetic cyclic oliphene, gaseous plant bioregulators which delays fruit softening and improves quality, ripening, senescence and pigment changes, checks softening and cell wall metabolism, flower and aroma, retaining nutritional properties. It play important role in plants as interacts with ethylene sensitive site, delays ripening, softening and senescence, maintains firmness, decreases storage disorders and delays chlorophyll degradation. The application of 1-Methyl Cyclo Propane are less weight loos and retention of more green colour. Colour blue mould and postharvest pitting, more firmness at 6 DAS.

Prohexadione-Ca: it is the member of Carboxylic group works as anti-gibberellin. It is a mimic of 2-oxoglutaric acid and ascorbic acid. Reduces longitudinal shoot growth by blocking dioxygenases, involved in biosynthesis of gibberellin, reduces ethylene formation, reduces alternate bearing, alternative for paclobutrazol.

The biotechnological tools to determine the use of plant bioregulators

Expression analysis of certain genes regulating the physiological functions in fruit crops can help to improvise the stages specific usage of plant bioregulators. Genes regulating polygalactouronase activity for ripening and storage related studies. Genes modulating flowering pathways-FT, SOCI, and FLY, determining their expressions elucidate the interactions among these integrators, genetic analyses performed.

Advances and unique applications of plant bioregulators in fruit crops

Fruit thinning by transiently blackening flowers and leaves of apple trees with the water soluble food colorant (Brilliant Schwarz). They have compared the efficiency of Brilliant Schwarz food colorant with common chemical flower and fruit thinner, fruit set calculated as number of fruit per 100 flower clusters for two years. Chemical thinning agents- Ammonium thisulphate (ATS)- (67.2%, 47 %), ATS+BA- (66.3%, 40.3 %) with significant decrease in fruit weight, blackening with Brilliant Schwarz reduced fruit set by 33.1 and 26.6 % with an increased rate of fruit weight.

Lime sulphur, fish emulsion, fish oil, potassium bicarbonate and sodium chloride are potential blossom thinners for reduction of crop load in apple (Bound 2017). AVG has been developed to increase fruit set in walnut trees by controlling pistillate flower abscission (PFA) (Retamales *et al.*, 2015). Application of methyl jasmonate can reduce FDF, promote the development of dry stem scars in grapes, avoiding post-harvest infections (Fidelibus and Cathline 2016). *In vitro* treatment with low molecular weight humic acid @ 0.5 and 1 mg/per lit. extracted from peat sphagnum can improve growth and mineral uptake of pear plantlets during acclimatization and Application of a soybean oil adjuvant plus ethephon reduce peach flower bud survival, acting as potential thinning agent (Marino *et al.,* 2017). Treatment with 1-MCP along with MAP significantly increase the shelf life of fruit, maintain firmness and reduce chilling injury in nectarine fruit (Ozakaya *et al.*, 2014).

Constraints in the use of plant bioregulators

Unpredictable response, high cost of traditional plant bioregulators, human health hazards e.g. Dominozoid and moulting hormone, lack of knowledge, supply and support.

Important consideration with use of plant bioregulators: It should be sprayed in afternoon, avoid windy hours, spray uniform and rationally distribute, always use distilled water, use surfactant or adhesive material with bioregulators, keep appropriate stage, dissolved uniformly before spraying, always use fresh solution, hand atomizer and wash thoroughly after use.

Chapter - 12

Indigenous Practices of Organic Farming

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Chapter - 12

Indigenous Practices of Organic Farming

Satvaan Singh, Shashank Tomer, Harshit Tomar and Rishabh Shukla

"Local or indigenous knowledge refers to the cumulative and complex bodies of knowledge, know how, practices and representations that are maintained and developed by local communities who have long histories of interaction with the natural environment " (UNESCO, 2012).

Characteristics of indigenous knowledge

Dependence on health of local environment, Indigenous Knowledge Based on experience, Sustainable use of resources, Focus on local attributes, Understand relationship between individual component and ecosystem.

Importance of indigenous knowledge

In the emerging global knowledge economy a country's ability to build and mobilize knowledge capital, is equally essential for sustainable development as the availability of physical and financial capital (World Bank, 1991). The bases component of any country's knowledge system is its indigenous knowledge. It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood. Significant contributions to global knowledge have originated from indigenous people for instance in medicine and veterinary medicine with their intimate understanding of their environments. Indigenous knowledge is also the social capital of the poor, their main asset to invest in the struggle for survival. Accordingly, indigenous knowledge is of great relevance for the development process in the following sectors: Agriculture, Animal husbandry and ethnic veterinary medicine. Use and management of natural resources. Primary health care (PHC), preventive medicine and psychosocial care, Saving and lending. Community development and Poverty alleviation

Indigenous Knowledge System – Sustainability

Indigenous knowledge plays an important role in sustainability through farming system approach (FSA). In FSA, researchers and farmers meet together on a common platform to diagnose the problems that farmers are facing and to develop suitable technologies to solve the priority problems of the farmers using both indigenous and scientific knowledge. The knowledge that researchers are bringing is referred to as scientific knowledge, while the technical knowledge of farmers is collected under the term indigenous technical knowledge (ITK). ITK includes information, practices and technologies, beliefs, tools. Experimentation, human resources and materials as farmers participation is key for the success of FSA, their input in the form of ITK is essential for sustainable agricultural development.

Integration of Indigenous Knowledge System with Scientific Knowledge

Farmers comparative vis - à - vis scientists it often includes:

The experience and discipline from actual farming system and its physical, social and economic development. Continuous observation of changing processes of natural resources. Freedom to make progressive change, managing and adapting sequences, unrestricted by rapid experimental design. Development and adaptation of technology for diverse local condition. The understanding, development and management of technology with many elements and linkages. A long time horizon (unless insecure and desperate).

Scientists comparative competence vis - à - vis farmers usually include:

1. Processes where reductionism and precise measurement work well.
2. Breeding and biotechnology
3. Minute and microscopic phenomena
4. Developing package technology for uniform and widespread conditions
5. Access to knowledge and genetic material from other environment

Indigenous Knowledge System may provide solutions for low external input but intensive agricultural production. A systematic documentation of available ITK facilitates a process in which researchers and farmers learn from each other. In this way, researchers may be facilitated to build on to existing ITK (Chambers, 1991: 82).

Integration of ITK, with scientific knowledge system is vital for sustainable agriculture. The efficacy and efficiency of locally available treatments can also be improved significantly through modern science.

- Scientific procedures can identify the active ingredients and could come up with appropriate recommendations in terms of effective application rates.
    - To understand scientific rationale

Role of indigenous knowledge in development

The very basic fact that sustainable development relies upon participatory approach makes IK an important ingredient for development.

Indigenous knowledge is relevant on three levels for the developmental process: Local community in which the bearers of such knowledge live and produce Development agents (CBOS, NGOs, government, donor, local leaders and private sector initiatives) need to recognize it, value it appreciate it in their interaction with the local communities. Before incorporating it in their approaches, they need to understand it- and critically validate it against the usefulness for their intended objectives. Indigenous knowledge form part of the global knowledge. Indigenous knowledge can be preserved, transferred or adopted and adapted elsewhere.

Techniques for documentation of Indigenous Technical Knowledge Recording and Using

“Documentation is the conversion of traditional knowledge information provided by Indigenous Knowledge information provided by communities into written documents, drawings or audio recordings". The main aim of documentation is to ensure information is not lost and to protect communities by presenting information is prior art.

Reasons for documentation of ITK in agriculture sector

For understanding the scientific rationale, accelerate technological change, enable better understanding technology development and development of newer concept, increase awareness among the younger generation and develop appreciation of traditional system, revive and restore pride among the farmers and other practitioners themselves.

Recording Indigenous Knowledge

Various techniques have been developed to gather and discuss indigenous knowledge on specific topics. Some techniques that individually or in combination can be used for documentation: such as- Mapping, Case histories, Critical incident, Preference raking, Inventory of farmer's indicators

Sources of Indigenous Knowledge

Farmers, community members, especially elders are the best source of ITK. Folklore, songs, poetry and theatre can reveal a great deal about people's values, history and practices. These are often not written down and need to be recorded. Sources of ITK • Community records- although ITK is mostly transmitted by word of mouth. Some indigenous forms or record keeping may exist. These include writings, paintings and carvings and many other forms. \ !!! People working with communities such as extensionists can be valuable sources of ITK. Other resource persons are local school headmaster, credit cooperative society officials, village milk co-operative members, men and women labourers and village panchayat, sarpanch. Secondary sources include published and unpublished documents, databases, videos, photos, museums and exhibits.

Quantification of Indigenous Knowledge

In this methodology, the PRA tool “matrix ranking" is combined with a semi-structured interview to elicit numerical data from experienced farmers. The matrix is designed through preliminary discussions with farmers and is then used as part of a systematic process to obtain quantitative data. The same matrix is used to interview a number of farmers and the data from each farmer is treated as an independent result. The data set from all the farmers can then be subjected to statistical analysis. Nuffic - CIRAN (Centre for International Research and Advisory Network (CIRAN) is a division of Netherlands Organisation for International Cooperation in Higher Education (Nuffic).) In this way Qulk is used to test hypothesis about crop performance in what amounts to a simulated trial, very similar to the traditional fields trials used in agricultural research (de Villier 1006)

TNAU Agritech Portal: TNAU has documented ITK information crop wise, operation wise, district wise, other related information related to ITK with related websites and ITC mailing address which can be accessed http://agritech.tn.ac.in/sk/ itk sub topics.html

Anne K. de Villiers (1996) developed a farmer oriented participatory methodology for quantifying indigenous knowledge (Qulk) with the basic premise that farmers know and understand the environment in which they farm and their answers to many agronomic questions can be found in the collective experience of the farming community.

ITK Resource Platforms

The honey bee network = Memory banking Protocol "FARMESA: The Farm level Applied Research Methods for Eastern and South Africa (FARMESA) is regional collaborative institute operating is five countries including Kenya, Tanzania, Uganda, Zambia and Zimbabwe with associate countries including Botswana, Malawi Mozambique and South Africa.

Unesco-Mont: (Management of social transformation programme) is a research programme designed to promote international comparative social science research.

CD of Inventory of Indigenous Technical Knowledge (ITK) in Agriculture by ICAR, New Delhi

Inventory of Indigenous Technical Knowledge (ITK) in Agriculture by ICAR, New Delhi Name of the CDs Inventory of indigenous Technical Knowledge in Agriculture. Inventory of indigenous Technical Knowledge in Agriculture. Inventory of Indigenous Technical Knowledge in Agriculture, Validation of Technical Knowledge in Agriculture, Cross Sectorial Validation of Indigenous Technical Knowledge in Agriculture, Indigenous Technical Knowledge in Agriculture - Geographical Indication of Plant Species.

Indigenous Technical Knowledge and water management

ITKs Documented under study are: People used to erect stone bunds across the larger streams and their tributaries. Plant Material accumulated near the stream banks to form a type of compost known locally as marwa. People applied traditional practices to the location of ground water. For example, the tribal and rural people used to worship a tree, Ficus glomerata, known locally as umbar, for various reasons. It is also an indicator of shallow ground water. Infiltration (recharge) pits, in the vicinity of dug wells, had the effect of improving water yields. Existing bore wells were given an extensive work over in order to improve their yields.

Various preferred ITK applications in Hill Agriculture

Indigenous nutrient management practices: Application of farmyard manure (FYM), Use of mixture of ash and manure science research, Crop rotation and fallow land preparation and method of sowing. Land preparation is done with the local implements.

Seed treatment: The seed is treated with the mixture of ash of cow dung and cow urine. Farmers believe that this helped in enhancing productivity and minimizing damage to the seed by the pests.

Post-harvest ripening of mustard

The farmers harvests mustard crop before it reaches to full ripening stage. The crop is harvested in green stage because harvesting of fully matured crop results in considerable loss of the grain due to shattering. The farmers then collect the harvested plants and make a pile of these on threshing floor. These green plants are not spread on the threshing floor, as grains have not been ripened properly. So the pile is left as such for about one week period. After one week the harvested plants are spread on the threshing floor and dried under the sun. Scientists reported that the reason for ripening of the grains when kept in a pile is ethylene production by the crop. Ethylene is a plant hormone, which has been released by the crop during the ripening stage and piling of the crop. Increases the ethylene concentration, which further helps in crop ripening.

Threshing by bullock trampling

For bullock trampling sun dried crop plants are spread on thrashing floor. This crop is covered with a layer of straw. Then bullocks made to walk over the crop in a circle. Care should be taken to collect the dung at the time of operation. The layer of straw help in separating the dang from the threshed grains.

Indigenous Technologies in selected crops of tribal area of Vizianagaram district: (Jayaprakash Sahu. 2002) the study documented ITKs and scientific lines and rationality for the documented practices was fixed by farmers and extent of adoption of those rational ITKs was found. In addition, constraints faced by farmers while cultivating ITKs were enlisted. The study documented 134 ITK practices in paddy, red gram, groundnut, ragi, mesta. Out of 134. 38 practices documented as miscellaneous practices comprising podu cultivation, storage practices.

- The 134 practices had 86.54 % of rationality. Out of 134 practices, 119 practices were rational and were applied at field level. The constraints observed in application of ITKS are labour intensive and time taking, non - availability of inputs, inclination towards modern practices. 3 sudden Conclusion
- The Indigenous Technical Knowledge (TTK) is socially desirable, economically affordable. Sustainable, involves minimum risk and focus on efficient utilization of eco-friendly resources.
- The context of local knowledge systems combining traditional skills, culture and artefacts with modern skills, perspectives and tools is not something that has happened only in the recent past The need of the day is to establish a foundation at the national level, that helps in building national register of innovations, file applications for patents, provides micro - venture capital support for enterprises based on indigenous knowledge and non- material incentives such as recognizing or honouring innovators and community holding indigenous knowledge.
- Policy reforms need to be aimed at building local ecological knowledge in educational curriculum, development of markets for the indigenous and organic products and supporting collective resource management institutions reinforcing conservation ethics.

- **It is only through multi:** Pronged comprehensive approach that the sustainable agriculture can be accomplished on a long term

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Chapter - 13

Molecular Approaches to Control Diseases in Medicinal Plants

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Chapter - 13

Molecular Approaches to Control Diseases in Medicinal Plants

Rupesh Kumar and Avdhesh Kumar

Introduction

Important agricultural crops are threatened by wide variety of plant diseases and pests. These can damage crops, lower fruits and vegetable quality and wipe out entire harvests. About 42 % of the world's total agricultural crop is destroyed by diseases and pests. The early and accurate diagnosis of plant diseases is crucial component of any crop management system. Plant diseases can be managed most effectively if control. Measures are introduced at an early stage of disease: development. Disease detection is required to diagnose the cause of a disease and to assay propagating material for the presence of pathogens. The advents of molecular biology and biotechnology have opened the rapid, specific and sensitive tools for the detection of plant pathogens. Plant pathogen detection based on molecular techniques has several advantages compared to other conventional methods. Detection is possible using cultures or in plant with equal facilities. In contrast to more conventional methods, samples can be tested directly, and isolates do not require culturing. They are rapid, highly specific and can be used to detect minute quantities of fungal DNA from environmental samples before symptoms occur, therefore allowing implementation of early control methods.

Molecular Methods Used For Detection of Plant Pathogens:

1. Polymerase Chain Reaction
2. Molecular hybridization
3. Molecular markers
4. Nucleic acid sequence/Probes
5. Micro - arrays

Polymerase Chain Reaction

PCR is an in vitro method of nucleic acid synthesis by which a particular segment of DNA can be specifically replicated. This was invented first by

Karry Mullis in 1987. PCR is a technique to amplify a single / few copies of a particular DNA and generating thousands to millions of copies of a particular DNA sequence. The method relies on thermal cycling, consisting of cycles of repeated heating and cooling of the reaction for DNA denaturant and enzymatic replication of the DNA. Primers containing sequences complementary to the target region along with a DNA polymerase are a key enzyme to enable selective amplification.

Priniciple: PCR is used to amplify a specific region of a DNA strand (the DNA target). Most PCR methods typically amplify DNA fragment of up to 10 kb although some techniques allow for amplification of fragments up to 40 kb in size.

Procedure

1. **Initialization step:** This step consists of heating the reaction to a temperature of 94-96 % for 1-9 minutes. It is only required for DNA polymerases that require heat activation by hot - start PCR.
2. **Denaturation step:** This step is the first cycling event and consists of heating the reaction to 94-98 ° C for 20-30 seconds. It causes DNA melting of the DNA template by disrupting the hydrogen bonds between complementary bases.
3. **Annealing step:** The reaction temperature is lowered to 50 65 ° C for 20-40 seconds allowing annealing of the primer to the single stranded DNA template. Stable DNA hydrogen bonds are only formed when the primer sequence very closely matches the template sequence. The polymerase binds to the primer - template hybrid and begins DNA synthesis.
4. **Extension step:** At this step the DNA polymerase synthesizes a new DNA stand complementary to the DNA template stand by adding primer (dNTPs) that are complementary to the template in 3' to 5' direction.
5. **Final extension:** Any remaining single stranded DNA is fully extended in this step for that temp. Range is 70-75 ° C for 5-15 min.
6. **Final hold:** This step at 4-5 ° C for an indefinite time may be employed for the short - term storage of the reaction.

Diagnosis

The act or process of identification of the nature of an illness or other problem by examination of the symptoms. Diagnosis helps in implementing right control method. Diagnosis is important with the increasing global trade of plants and plant produce and associated risk of movement of pathogen and their vectors from one country to another. The basic techniques used in basic diagnosis such as host range and symptomatology, morphology of the causal organism, selective growth medium, and biochemical markers like FAME and protein analysis.

Molecular techniques are more appropriate for pathogens that are difficult to detect, identify or test for susceptibility with conventional methods. Molecular methods are those used for identifying genetic variation within pathogen population. Various molecular techniques in use are as follows: antibody based method and nucleic acid based methods.

Antibody based methods

Serology methods are most widely used in diagnostic systems in plant pathology. In this method antibodies are raised in animals against specific antigens from the pathogen which are purified and used or diagnostic purpose. Different techniques are as follows- use of polyclonal antibodies, use of monoclonal antibodies, ELISA (Enzyme Linked Immuno Sorbent Assay) and Lateral flow technique.

Polyclonal antibodies

Antibodies secreted by different B-cell lineages within a body. They are a collection of immunoglobin molecules that react against a specific antigen, each identifying a different epitope such as part of pathogen is used as antigen, purity of antigen is crucial, purified antigen is injected into the animal with subsequent booster injections. Resultant antiserum contains a population of antibodies that react with different determinants of antigen which is used for detection. For example- polyclonal antibodies are used for diagnosis of seed transmitted plant pathogenic bacterium *Xanthomonas campesteris*. Healthy seeds are treated with pure suspension of *Xanthomonas campesteris*. Healthy seeds are treated with pure suspension *X. campestris* and shaken for 5 minutes at 125 rpm and incubated at room temperature for 2.5 hrs. The suspension centrifuged at 11000 rpm for 5 minutes and resuspended in saline. These used to inject the animal to produce polyclonal antibodies which later filtered and used for diagnosis of seeds. 10000 seeds selected per plot and added into 0.85 % saline. The seed extract treated with fluorescent taged polyclonal antibodies incubated for 30 ins. at room temperature in dark. Then the suspension is centrifuged and the cells are suspended in saline. 5µl of stained sample is placed on Neubauer counting chamber and read with fluorescence microscope. They give information about sensitivity and specificity, not cell count.

Monoclonal antibodies

An antibody produced by a single clone of cells or cell line and consisting of identical antibody molecules. They are produced and are commercially available against a wide variety of viruses. They are also produced against specific oligosaccharide side chain of *Erwinia* bacteria and phytoplasmas. For example, the identification of *Botryits cinerea* in grape juice and discrimination of cereal eye-spot and other stem based diseases of fruits.

Enzyme linked Immuno sorbent assay

This technique is based on the principle of antigen and antibody interaction with a detection system involving enzyme conjugated antibody. The activity of the enzyme is measured spectrophotometrically by adding an appropriate that results in colour change.

Advantages: The major advantage of PCR is sensitivity. The technique is able to detect one molecule of nucleic acid within 1,00,000 cells, It can detect infections at an early stage, Useful in detection of non - replicating virus. PCR tests are more rapid than most virus detection techniques and able to provide a result within 24-48 hours.

Disadvantages: False positive results due to contamination from operator, residual matter in testing utensils or air contamination can result in false positive reaction. Reagents used are still very expensive. Useful only for those pathogens for which primers have been specifically designed.

Application: Diagnosis and quantification of diseases. Study of pathogen mating type, Production of virus free material, Field surveys to assess the incidence and geographic distribution of plant pathogens. Domestic and international plant quarantine programmes, Detection of mixed virus infections, Analysis of virus distribution in different plant tissues, Identification of alternative host plant, Evaluation of levels of resistance of cultivars, of virus transmission by vectors.

Types

1. RT - PCR.
2. IC - RT - PCR
3. Bio - PCR.
4. Nested PCR.
5. Co - operational PCR.
6. Multiplex PCR
7. Multiplex Nested. **8.** Real time PCR

Molecular hybridization: Molecular hybridization - based assays were first utilized in plant pathology to detect Potato spindle tuber viroid (Owens and Diener, 1981) and adapted to virus detection (Hull, 1993).

Principle: Denaturation (i.e. disruption of the hydrogen bonds) of the double stranded DNA can be achieved by exposure to high temperature or alkaline pH. Dissociated strands of DNA can be immobilized on a solid phase support, such as latex, magnetic beads, microtitre plates, nitrocellulose or nylon based membrane, and then hybridized with single strand, labelled nucleic acid (usually DNA) probe. The probes will hybridized only with the denatured strand of complementary nucleic acid. **a)** Dot-Blot Hybridization Assay: It is the simplest and most effective method for detection of plant pathogens. (Burrows, 1988; Miller and Martin, 1988; Chu *et al.*, 1989). Samples of denatured nucleic acid from healthy and infected plants are directly spotted on to rewetted, solid matrices such as a nitrocellulose or nylon based membrane. Nucleic acids are then firmly immobilised on a solid support by baking the membrane in an oven for 2hr. at 80 °C. To block the remaining Free DNA binding sites, the membrane is incubated several minutes in a sealed plastic bag with prehybridisation solution (hybridization solution minus the probe).

After removing the prehybridisation solution, the hybridization solution containing the denatured specific DNA probe is added to the plastic bag containing the sample membrane, and incubate for several hours to allow hybridization between the probe and the target nucleic acid. The membrane is washed several times to remove the unbound DNA probe following hybridization. Hybridization between the target nucleic acid immobilized on the membrane and the DNA probe is detected either by autoradiography on X - ray film, if the probe was labeled radioactively, or by a calorimetric reaction, if an enzyme labeled probe was used. • The sensitivity of dot - blot hybridization may equal or exceed that of ELISA (Sela *et al.*, 1984; Ronser *et al.*, 1986; Varveri *et al.*, 1988; Polston *et al.*, 1989). b. Fluorescence in situ hybridization Fluorescence in - situ hybridization (FISH) combines microscopical observation of bacteria and the specificity of hybridization (Wullings *et al.*, 1998; Volkhard *et al.*, 2000) and is dependent on the hybridisation of DNA probes to species specific regions of bacterial ribosomes. FISH can detect single cells but in practice, the detection level is near 103 cells / ml of plant extract. There is a high affinity and selectivity of DNA probes because FISH takes place under very stringent hybridisation conditions, where a difference of one nucleotide in a 15-20 oligonucleotide probe is sufficient for discrimination.

Molecular marker

a) **Restriction fragment length polymorphisms:** This technique makes use of restriction enzymes to fragment DNA, which is then separated by agarose gel electrophoresis. Each restriction enzyme recognizes a specific nucleotide sequence (usually 4-6 bp long), and cuts the DNA specifically every time the sequence occurs. The fragmented DNA is separated by gel electrophoresis, and the banding pattern is made visible by staining (ethidium bromide) or by autoradiography. When mitochondrial DNA (mtDNA) which ranges from 10 200kilobase pairs (kbps) in length, from different species are examined, differences in the size and number of restriction fragments can be detected.

b) **RAPD Markers:** RAPDs are DNA fragments amplified by the PCR using short synthetic primers (generally 10bp) of random sequence. These oligonucleotides serve as both forward and reverse primer, and are usually able to amplify fragments from 1-10 genomic sites simultaneously. Amplified fragments, usually within the 0.5-5 kb. size range, are separated by agarose gel electrophoresis, and polymorphism are detected, after ethidium bromide staining, as the presence or absence of bands of particular sizes. These polymorphisms are considered to be primarily due to variation in the primer annealing sites, but they can also be generated by length differences in the amplified sequence between primer annealing sites.

Nucleic acid Sequence

a. **Nucleic Acid Sequence Based Amplification (NASBA):** A non-PCR isothermal nucleic acid amplification procedure known as Nucleic Acid Sequence - based Amplification can be used to detect RNA targets. It is based on exponential amplification of single stranded RNA molecules by simultaneous activities of reverse transcriptase and polymerase enzymes (Kievits *et al.,* 1991). The reaction requires the use of three enzymes, avian myeloblastosis virus reverse transcriptase (AMV - RT) for reverse transcription and to obtain double stranded cDNA, RNase H to hydrolyze the RNA fragment of the hybrid molecule DNA - RNA and T7 RNA polymerase to produce a large amount of anti-sense, single strand RNA transcripts corresponding to the original RNA target. It can be achieved by using two specific primers, one of them including at 5' end the T7 promoter, NTPs and also dNTPs.

The detection of NASBA products can be assessed by chemo luminescent or colorimetric detection using an internal specific probe digoxigenin labelled or in a real - time assay using molecular beacons (Amplidet RNA) (van Beckhoven *et al.*, 2002 ; van der Wolf, 2004). NASBA - beacon assay yields results in less than 1 h (Robert and Kerst, 2001), and offer the advantages that no contaminating DNA is amplified, is performed at 41ºC without the need of a thermal - cycler, and requires only 60 minutes reaction affording high levels of sensitivity, superior in some cases to real - time PCR (Scuderi et al, 2007). This technology has been applied for detecting plant viruses such as Apple stem pitting virus (Klerks *et al.*, 2001), PPV (Olmos *et al.*, 2007a), Potato virus Y, ArMV and the bacteria C. michiganensis subsp. sepedonicus and R. solanacearum (Szemes and Schoen, 2003). The sensitivity of this method has proven similar to that obtained by real - time RT - PCR when applied to PPV detection (Olmos *et al.*, 2007a). b. Loop - mediated isothermal amplification (LAMP): Loop-mediated isothermal amplification (LAMP) is another type of isothermal amplification that it is being increasingly used in the diagnostic field offering sensitivity and economic costs (Notomi *et al.*, 2000). The method requires a set of four specifically designed primers that recognize six distinct sequences of the target and a DNA polymerase with strand displacement activity. The amplification products are stem-loop DNA structures with several inverted repeats of the target and cauliflower - like structures with multiple loops, yielding > 500 g/ml. The LAMP reaction was enhanced by the addition of loop primers (Nagamine *et al.*, 2002), reducing time and increasing sensitivity. • The amplification takes place at 60-65 ° C for 60 min. Although it was initially developed for DNA it can be adapted to amplify RNA (RT - LAMP) (Fukuta *et al.*, 2003). The method has only been applied to the detection of some plant viruses such as PPV, with a sensitivity level similar to that obtained by real - time PCR (Varga and James, 2006).

Microarry technology

Microarrays are generally composed of thousands of specific probes spotted onto a solid surface (usually nylon or glass). Each probe is complementary to a specific DNA sequence (genes, ITS, ribosomal DNA) and hybridisation with the labelled complementary sequence provides a signal that can be detected and analysed Until now, the microarray technology focuses its use in multiplex format of similar or very different pathogens, taking advantage of the number of probes that can be employed in one chip (Bonants *et al.*, 2002; Schoen *et al.*, 2002 and 2003; Fessehaie *et al.*, 2003 ; Franke- Whittle *et al.*, 2005 ; Bonants *et al.*, 2005; Boonham *et* *al.,* 2007; van Doorn *et al.,* 2007; Pasquini *et al.,* 2008). The probes can be prepared in at least three basic formats.

a) PCR fragments arrayed on nylon membranes, hybridised against cDNA samples radioactively labelled, called macroarrays (Richmond *et al.,* 1999);

b) PCR products spotted onto glass slides and DNA labelled with fluorescent dyes (Richmond *et al.,* 1999; Zimmer *et al.,* 2000; Wei *et al.,* 2001); and **c)** Oligonucleotide of different length (rom 18 to 70 bp) arrayed and hybridised with the same type of labelled DNA material (Lockhart *et al.,* 1996; Loy *et al.,* 2002 and 2005; Fessehaie *et al.,* 2003; Peplies *et al.,* 2003). For bacterial detection, the material spotted until now is almost universally oligonucleotides targeting the 16S- 23S rDNA genes (Crocetti *et al.,* 2000; Loy *et al.,* 2002; Fessehaie *et al.,* 2003; Peplies *et al.,* 2003; Loy *et al.,* 2005; Franke Whittle *et al.,* 2005). The microarrays are analysed either by scanning or by a direct imaging system.

Chapter - 14

Organic Production of Fruits and Vegetables

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Chapter - 14

Organic Production of Fruits and Vegetables

Satvaan Singh, Ravi Pratap, Saurabh Vishvakarma and Rishabh Shukla

Organic farming

Organic farming is a production system which avoids or largely excludes the use of synthetic compounds like fertilizers, pesticides, weedicides and livestock feed additives. It based on crop rotations, legumes, green manures, farm organic wastes and biofertilizers, biological method of pest control which result into the maintenance of soil health, supply of plant nutrients and controls insects and weeds.

Before 19th century most food in the world was organically produced. In 1924 Austrian philosopher Dr. Rudolf Steiner conceptualized and advocated organic agriculture. In 1927 a trademark "Demeter" was introduced for organically grown food. Ill effects of modern agriculture forced people to demand food grown without fertilizers and pesticides and this paved the way for organic farming. In 1972, International Federation of Organic Agriculture Movements (IFOAM) gave an international frame work for discussion and codification of internationally recognized principles of organic farming.

Principal of Organic Farming

Produce food of high quality in sufficient quantity, encourage and enhance biological cycles within the farming system, involving micro-organisms, soil flora and fauna, plants and animals. Maintain the genetic diversity of the production system and its surroundings, including the protection of wildlife habitats and maintain and increase the long -term fertility of soils, use, as far as possible, renewable resources in locally organized production systems, minimize all forms of pollution. Allow organic production and processing to meet the basic needs, returns and satisfaction from their work, including a safe working environment.

Benefits of organic farming

Contributes to preservation of biodiversity. Produces healthy food, Ensures jobs in agriculture, food processing and marketing, Improves soil health, Low water consumption, High demand due to social awareness, Hug export potential, Promotion of sustainable agriculture for small farmers.

Need of Organic Farming

Balanced supply of nutrients (primary, secondary and micronutrients), Improved physical, chemical and biological properties of soil, Reduced need for purchased inputs, Environmental security, More healthy and nutritionally superior food for man and animal, Organically grown plants are more resistant to diseases and pests and hence require less protective measures.

Accredited certifying and inspection agencies in India

Association for promotion of organic farming (APOF), Indian society for certification of organic production (ISCOP), INDIAN organic certification agency, Skill inspection and certification agency, IMO control Pvt. Ltd., Concert international, BIOINSPECTERA, SGS India Pvt. Ltd., LACON, International Resources for fair trade (IRFD), One cert Asia, National organic certification association(NOCA)

Main crop organic Grown in India

Cereals	:	Paddy, Wheat, Maize.
Pulses	:	Red gram, black gram , green gram, Bengal gram
Spices	:	Cinnamon, black paper, ginger, turmeric, clove, vanilla
Vegetables	:	Okra, tomato, Brinjal, Potato, Onion, garlic, cucumber, Chilly cauliflower, cabbage
Fruits	:	Mango, Banana, Pineapple, Grapes, Orange, Cashewnut
Commodity	:	Tea, coffee
Cash crop	:	Cotton

Organic fruit production

The fruit quality satisfies the highest expectations of the food industry and consumers. On-farm practices should ensure that arable and vegetable crops are produced under sustainable economic, social and environmental conditions. The organic fruit production based on the principles of health, ecology, fairness and care.

The organic fruit production reduces the soil erosion and also helpful in keeping the environment pollution free, it is cost saving technology and save the expense at the large extent. It is also helpful in the soil fertility and ready future farming.

The issues in organic fruit production are protection and enhance the existing native vegetation for greater biodiversity and security of the rural environment at large, manage the use of scarce water resources to ensure greatest efficiency, productivity and protection of surrounding catchments and waterway from salt, soil, fertilizers and chemicals carried in run-off water. Manage for healthy soils through protection from degradation and loss by erosion, organic matter depletion and unbalanced and inappropriate fertilizer usage and impact of pest and diseases while minimizing the usage of chemicals and maximizing profitability over the short and long term.

Principles and practices of organic fruit production

Site selection: planning and managing the farm activities, be aware of the site history. Production sites should be checked for any contaminant or pollution risk, risk assessment shall be undertaken for new agricultural sites.

Planting materials: verities or rootstock adapted to local conditions-resistant or tolerant to commercially important pests and diseases. Planting spacing- optimize fruit quality and homogeneity. Fruit that originates from genetically modified plants, rootstock, or grafting material must be identified, traced and segregated.

Integrated crop management: the cultivation practices such as use of specific cultivation techniques to maintain or improve the physical and biological characteristics of the soil, balance fertilization in order to provide the appropriate nutrients to the crops. Integrated pest management (IPM) helps to protect crops against pest, diseases and weed.

Safety, quality and transparency: ensure the safety, quality and transparency of the products thought the production methods and storage facilities.

Financial stability involves achieve long-term stability of the farm income for proper investments and workforce payment.

Market stability seeks to get organized and to select efficient trading channels in order to optimize benefits.

Soil: maintain good soil fertility and prevent damage to the environment, soil erosion and pollution. Soil erosion shall be prevented by biological control methods.

Water: irrigation shall be adjusted to take into account predicted rainfall and evaporation. The most efficient and commercially practical water delivery system shall be used e.g. drip irrigation.

Biodiversity: maintain or enhance biological diversity on the farm. The objective is to be creating biodiversity habitats which can host a variety of flora and fauna playing a significant role in the prevention and defines against pest and diseases.

Waste: use crop by-products as much as possible on the farm. The farm shall continuously reduce, reuse and recycle the quantity of waste and by-products of the harvest and processing that it generates.

Canopy management

Training refers to giving shape/architecture of plant. Pruning refers to removal of pars of a tree, especially shoots, roots, limbs, buds of the terminal parts. Pruning is done to make a tree more productive and to make a tree more productive and bear quality fruits. Pruning make it more manageable shape and to get maximum returns from the orchard.

Bagging and wrapping of fruits

Fruits can be easily protected against fruit flies by bagging them in newspaper bags. The bag provides a physical protection to the fruit by preventing adult female flies laying eggs. Bagging is inexpensive and easy to apply and guarantees nearly complete protection from fruit flies.

Harvesting practices for pest control

Remove fruits with dimples and oozing clear sap. This method is more effective although laborious than picking rotten fruits from the ground as the maggots may have left the fruits to pupate. Harvest crops early when mature green. This is the stage of maturity when crops are not susceptible to fruit fly attack. Pick overripe fruits. These are good breeding sites for fruits flies.

Latent Needs of Organic Farming of Vegetables India

MOST Of the vegetable crops are eaten fresh or care; hence any contamination (chemical residue) may lead to various kinds of health hazards. In India majority of the vegetable growers are poor, small and marginal farmers, Decrease in land productivity due to ever increasing use of chemical fertilizers. There are not many scientific breakthroughs in improving quality and production of vegetable of vegetable crops. The ever-increasing cost of production due to fertilizers, pesticides, and irrigation etc. despite massive cause of concern, which are very low in organic farming. High environment pollution, Organic farming of vegetable crops generates income through international exports or by saving production costs. Organic farming also able to secure a place of India on international markets but producing high value vegetable crops. Excessive use of chemical fertilizers as well as pesticides not only increases the cost of production but also poses threat to the environment quality, ecological stability and sustainability of production, we have gained quantity but at expense of quality.

Objectives of organic farming in vegetable crops

1. To produce food of high nutritional quality in sufficient quantity
2. To encourage biological cycles within farming systems by involving the use of microorganisms, soil flora &fauna, plants and animals
3. To maintain and increase the long term fertility of soil and biodiversity
4. To use renewable resources in locally organized production systems
5. To work with a close system with regard to organic matter and nutrient elements
6. To avoid all forms of pollution that may results from agricultural techniques

Technology Packages for Organic Vegetables

Timely preparation of soil to a fine with 2-3 ploughings to remove all debris, stubbles, stones etc. and to avoid infestation of ants and termites. However, minimum tillage is considered as an important component of organic farming. Use of organic, manures as basal dose @25038t/ha. Through FYM, poultry manures, fish manures, sheep co-hosts, bio fertilizers etc. use of organic cakes from neem, groundnut, pongamia, and caster becomes imperative. Raising of green manure crops like sesbania or dhanicha and incorporating into the soil, besides using biomass of other plant species. Always include legume crop like beans, peas, cowpea etc. in the crop rotation not only to improve the soil fertility by fixing atmospheric nitrogen but also to increase the yield up to 30-35%. Use of crop residues is essential in organic vegetable production, which increases the soil organic matter content, maintains soil fertility status, and in turn increases the crop yield. Choice of vegetable varieties should be based on climate, resistance to pest &disease and disease and market preference; adopting optimum spacing and timely planting, raising plants /seedlings with enough organic manures and bio-fertilizers.

The following products are permitted for use in manuring /soil conditioning in organic field

FYM ,slurry, green manure, crop residues, straw , vermicomposting, sheep manure and other mulches from own farm, Saw dust wood shaving from undated wood, Calcium chloride, lime stone, gypsum, Sodium chloride, Bacterial preparation (bio fertilizers), e.g. *Azospirrillum*, *rhizobium* etc., Bio dynamic preparations, Plant preparation and extracts, e.g. neem cake etc.

Issue and Strategies of Organic Vegetable Farming in India

The following issues and their viable strategies are suggested to make organic vegetable production more e vibrant, dynamic, and responsive to changing consumer demand both locally and globally as well.

1. The research organic farming in vegetable crops must be on a system basis. It must be integrated one and must not be looking at in isolation.
2. The task research would be to produce technologies, which can not only increase more food but also more jobs and more incomes. That means, research must aim at achieving triple goal of more job, more incomes and more food.
3. The research for organic farming should be focused on developing technologies which may attract the vegetable growers to adopt them, keeping in view of the requirements of small holdings of resource poor small and marginal farmers.
4. The research should be in a holistic manner with long -term evolution of different organic substrates.
5. Identification go suitable cover crop and smother crop in a given cropping system.
6. There should be strategy for monitoring of changes in groundwater quality with reference to heavy metal toxicity, besides nitrate pollution.
7. Identification of soil improving crops under major agro-climatic zone.

Chapter - 15

Plant Growth Regulators

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Chapter - 15

Plant Growth Regulators

Satvaan Singh, Sudhanshu Singh, Saurabh Vishvakarma and Rishabh Shukla

Introduction

Plant Growth Regulators conventionally called plant hormones, these substances play vital role in plant growth and development. These are signal molecules, present in trace quantities in plant tissues and make changes in their concentration and tissue sensitivity can mediate a whole range of developmental processes in plants, many of which involve interactions with environmental factors. Plant growth regulators function as chemical messengers for intercellular communication.

There are five major plant growth regulators namely-

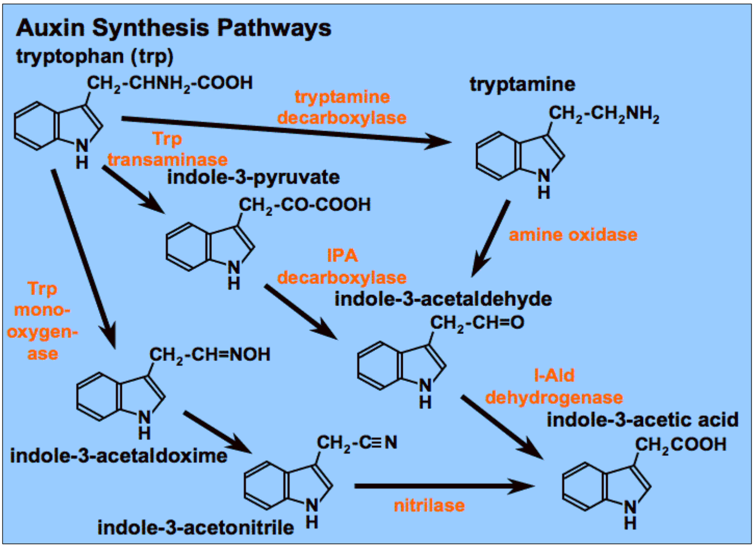
1. Auxin
2. Cytokinins
3. Gibberellins
4. Abscisic acid (ABA)
5. Ethylene

Some other compounds which also affect and regulate growth and development such as

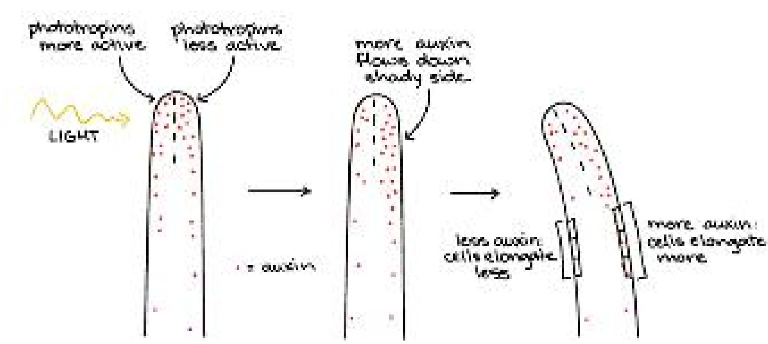
i) Brassinosteriods
ii) Polymines
iii) Jasmonic acid
iv) Salicyclic acid
v) Novel compounds

Auxin

It is synthesized in stem and root apices and transported to axial portion of plants. Its concentration in tissue is regulated by its synthesis. Precursor of auxin is tryptophan.



Role of Auxins: Plays important roles in a number of plant activities, including development of embryo, leaf formation, phototropism and gravitropism.



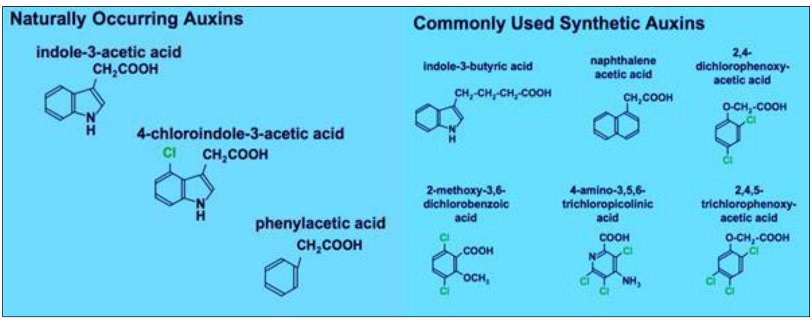
The development of embryo from the very fisrst mitotic divisionof the zygote, gradients of auxin guide the patterning of the embryo into the parts that will become the organs of the plant. The gravitropism defined as the plant shoots display negative gravitropism when placed on its side, a plant shot will grow up and roots display positive gravitropism i.e. they grow downwards.

The plant hormone auxin causes plant cells to elongate. When a shoot is directly under light, auxin produced in the growing tip spreads equally down both sides of the plant. If light is from one side only, auxin collects on the shady side causing the cells on that side to elongate. That lopsided elongation produces a bend in the plant stem.

Apical dominance: The growth of shoot apex (terminal shoot) usually inhibits the development of the lateral buds on the stem beneath. This phenomenon is called apical dominance. Apical dominance seems to results from the downward transport of auxin produced in the apical meristem.

Fruit development: Pollination of the flowers of angiosperms initiates the formation of seeds. As the seeds mature, they release auxin to the surrounding flower parts, which develop into the fruit that covers the seeds.

Abscission: Auxin also plays a role in the abscission of leaves and fruits, young leaves and fruits produce auxin and so long as they do so, they remain attached to the stem. When the level of auxin declines, a special layer of cells-the abscission layer forms at the base of the petiole or fruit stalk. Soon the petiole or fruit stalk breaks free at this point and the leaf or fruit falls to the ground.



Root initiation and development: the localized accumulation of auxin in epidermal cells of the root initiates the formation of lateral or secondary roots. Auxin also stimulates the formation of adventitious roots in many species. Adventitious roots grow from stems or leaves rather than from the regular root system of the plant.

Cytokinin

In 1913, Gottlib Haberlandt discovered a compound found in phloem that can stimulate cell division in potato parenchyma.

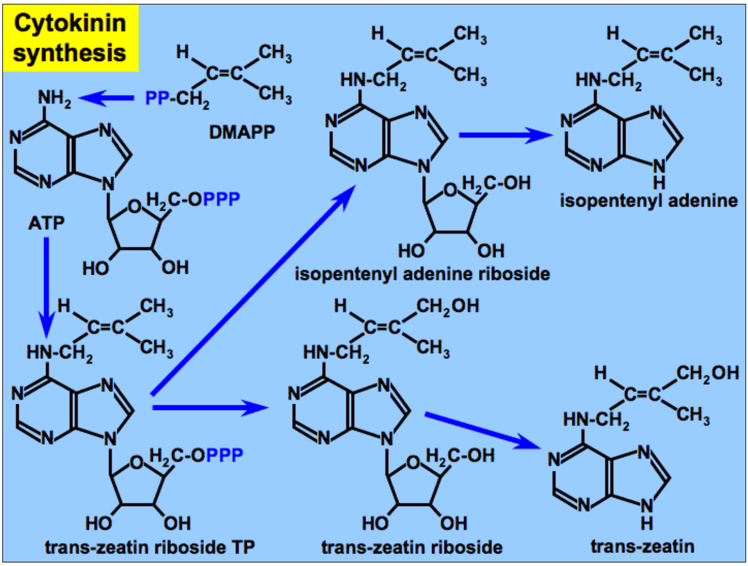
In 1941, Johannes Van Overbeek discovered the milky endosperm form coconut also had the ability of division.

In 1955, Carlos Miller, a graduate student in Folke Skoog's laboratory, identified kinetin from herring sperm.

In 1961-1963, Miller and Letham independently isolate zeatin, a naturally occurring cytokinin, form maize.

Synthesis of Cytokinin

Cytokinins are synthesized de novo from 5'-AMP and dephosphorylated hermiterpene and it can be defined structurally as adenine derivatives with an isopentenyle based side chain attached to the N^6 amino group.



Role of Cytokinins

1. **Control morphogenesis:** In plant tissue culture, cytokinin is required for the growth of a callus (an undifferentiated, tumor-like mass of cells): ratio of cytokinin and auxin are important in determining the fate of the callus.
2. **Crown Gall:** Tumor-like mass of undifferentiated cells that typically occurs near the crown (Junction of root and stem) of the plant caused by the bacterium *Agrobacterium tumefaciencs* carries a plasmid (Ti plasmid; a plasmid is a small loop of non-chromosomal DNA) with loci/genes for auxin production (tms), zeatin production (tmr) and opines (are nitrogen-containing molecules that provide food for the bacteria) upon infection, the plasmid is incorporated into the plant cell genome which begins to overproduce auxin and cytokinin and stem forms an undifferentiated tumor known as crown gall.
3. **Regulates the cell cycle/cell division:** Thatswhy the name "cytokinins" especially by controlling the transition from G2 to mitosis.

4. **Delay senescence:** It is the programmed aging process that occurs in plants and other organisms for that matter. The loss of chlorophyll, RNA, protein and lipids. Cytokinin application to an intact leaf markedly reduces the extent and rate of chlorophyll and protein degradation and leaf drops.
5. **Greening** promotes the light-induced formation of cholorophyll.
6. **Promote lateral bud development:** Cytokinin application to dormant buds will cause them to develop. A witch brom is causes by a pathogen such as the bacterium *Corynebacterium fascians* that produces cytokinin lateral bud development which leads to branching.
7. **Promotes cell expansion:** Cytokinins stimulate the expansion of cotyledons.

Cytokinins

- 6-Furfurylaminoopurine (Kinetin) (K)
- 6- Benzylaminopurin (BAP)
- N-Isopentenylaminopurine (2iP)
- Zeatin (Zea)

Gibberellins

It was discovered by Japanese Scientist **E. Kurosawa** in 1926; isolated from the fungus ***Gibberella fujikuroi*** which causes **Bakanae** disease also called foolish seedling in rice which leads to excessive shoot elongation, yellowish green leaves, tallter plants with absent or poorly developed grains and frequent lodging due to long stature.

Synthesis of Gibberellins: Gibberellic acids are produced by the terpenoid pathway and are tetracyclic diterpenes containing either C_{19} or C_{20} carbon atoms.

Role of Gibberellins

1. Most important characteristic of Gibberellic acid on shoot growth which leads to increased internode extension, increased leaf-growth and enhanced apical dominance.
2. Influence many reproductive process.
3. Induce formation of cones in conifers.
4. Many forms of dormancy are broken by gibberellic acid. These include seed dormancy, dormancy of potato tubers and dormancy of shoot internodes and buds.

5. Gibberellins are involved in the natural process of germinaton. Before the photosynthetic apparatus develops sufficiently in the early stages of germination, the stored energy reserves of starch nourish the seedling.
6. Usually in germination, the breakdown of starch to glucose in the endosperm begins shortly after the seed is exposed to water. Gibberellins in the seed embryo are believed to signal starch hydrolysis through inducing the synthesis of the enzyme α-amylase in the aleurone cells.
7. Gibberellic acid also breaks certain forms of dormancy broken in natural conditions by exposure to low temperature called as vernalization.
8. Retard leaf and fruit senescence.
9. Exogenous gibberellic acid application can induced flowering in species that ordinarily require cold treatment to bloom.
10. Some of them are isolated from both fungus and plants.

Abscisic acid (ABA): Abscisic acid plays an important role in adaptation to abiotic stresses, seed development, and seed germination.

Synthesis: ABA is sesquiterpenoid (15 carbon) and is sysnthesized form C_{15} and C_{40} compounds in plants.

Role of abscisic acid

1. Abscisic acid owes its names to its role in abscission layer formation in plant leaves.
2. In preparation for winter, ABA is produced in terminal buds.
3. This slows plant growth and directs leaf primordial to develop scales to protect the dormant buds during the cold season.
4. ABA also inhibits the division of cells in the vascular cambium, adjusting to cold conditions in the winter by suspending primary and secondary growth.
5. It causes seed dormancy (inhibits seed germination).
6. Abscisic acid is also produced in the roots in response to decreased soil water potential and other situations in which the paltn may be under stress.
7. ABA translocates to the leaves, where it rapidly alters the osmotic potential of stomatal guard cells, causing them to shrink and stomata to close.

8. The ABA-induced stomatal closure reduces transpiration, thus preventing further water loss form the leaves in times of low water availability.

Ethylene

Ethylene is small hydrocarbon gas and it is the most commercially produced organic compound in the world and is used in many industrial application. It is also naturally occurring gas. In 1934, Gane identified that plants could synthesise ethylene and in 1935 Crocker proposed ethylene to be the hormone responsible for fruit ripening and senescence of vegetative tissues.

Apples and pears are examples of fruit that produces ethylene with ripeninig. Ethylene is responsible for the changes in texture, softening, color, and other processes involved in ripening. Commercial ripening rooms use “catalytic generators” to make ethylene gas form a liquid supply of ethanol.

During the life of the plat, ethylene production is induced during certain stages of growth such as germination, ripening of fruits, abscission of leaves, and senescence of flowers.

Ethylene production can also be induced by a variety of external aspects such as mechanical wounding, environmental stresses, and certain chemicals including auxin and other regulators.

Synthesis

Ethylene is synthesized in plants form S-adenosyle-L-methionine (SAM) via the intermediatate 1-aminocyclopropane-1-carboxylic acid (ACC) diffuses out from the cell after its synthesis.

Role of Ethylene

Ethylene induced many physiological responses like-

- **Growth effects:** inhibits longitudinal but promotes horizontal growth.
- **Geotropic** response regulation.
- **Apical dominance** togather/downstream of auxin.
- **Breaks dormancy**
- Gas produced by one plant will affect nearby plants.

Application of Ethylene

There is great interest in down-regulation of ethylene biosynthesis as its high concentrations can trigger and subsequently over ripening in banana, apples, tomatoes, mangoes etc. therefore two important enzymes ACC oxidase or ACC synthase are target of antisense technology.

Brassinosteroids

It was discovered by Mitchell *et al.,* reported promotion in stem elongation and cell division by the treatment of organic extracts of rapseed (*Brassica napus*) pollen.

Brassionolide was the first isolated brassionosteroid in 1979. A crude extract of pollen form *Brassica napus* induced a rapid elongation of bean internodes that was distinct from GA mediated stem elongation. The work lead to the isolation and identification of the first steroidal plant growth regulator. Bressiono steroids are a group of some 40 different steroids that are synthesized by plants and are potent hormones affecting many aspects of plant growth. These hormones act synergistically, or at least additively, with several other hormones such as auxin and the gibberellins. Hardly credible report on tissue culture use.

Synthesis: they are synthesized from campesterol, structurally they are C_{27}-C_{28}.

Role of Brassinosteriods

It promotes apical dominance and leaf senescence, enhances seed germination, increases the production of ethylene, inhibits the formation of stomata, promote the formation of xylem, prevent premature abscission of fruit, and increase resistance to freezing, increases the yield of wheat and rice, pollen elongation, pollen tube growth, reorientation cellulose microfibrils.

Polyamines

The polyamine is an organic compound having two or more primary amino groups-NH. Polyamines concentrations correlate with cell division frequency. They stimulate many reactions involved in the synthesis of DNA, RNA and proteins. Polyamines are essential for all living organisms and without the ability to synthesize polyamines, living cells will not survive.

Role of polyamines

In plants, polyamines elicit diverse physiological responses including-cell division and root initiation, tuber formation, embryo genesis, flower development, fruit ripening.

Most frequently found polymers are: Puterscine, spermidine, cadaverine.

Jasmonic acid

Jasmonic acid was isolated from cultured filtrates of a fungus as a plant growth inhibitor. Jasmonic acid is derived from the fatty acid linolenic acid. Methyl jasmonate and cis-jasmonate and cis-jasmone are well known in the perfume industry as fragrant components of the essential oils of jasmine. Jasmonic acid shows stimulatory effect on the development of isolated garlic buds, after two weeks of culture.

Role of Jasmonic acid

The major function of jasmonic acid and its various metabolites is regulating plant responses to abiotic and biotic stresses as well as development. Regulate plant growth and development processes include growth inhibition, senescence, tendril coiling, flower development and leaf abscission. JA is also responsible for timber formation in potatoes, yams and onions. It has an important role in responses to wounding of plants and systemic acquired resistance. When plants are attacked by insects, they respond by releasing JA, which activates the expression of protease inhibitors, among many other anti-herbivore defense compounds. These protease inhibitors prevent proteolytic activity of the insects' digestive proteases or "salivary proteins", thereby stopping them form acquiring the needed nitrogen in the protein for their own growth.

Salicylic acid

Salicylic acid is a phenolic phytochrome. It is found in plants with roles in plant growth and development, photosynthesis, transpiration, ion uptake and transport. SA is involved in endogenous signaling, mediating in plant defense against pathogens. It plays a role resistance to pathogens by inducing the production of pathogenesis-related proteins. It is involved in the systemic acquired resistance (SAR) in which a pathogenic attack on one part of the plant induces resistance in other parts. The signal can also move to nearby plants by salicylic acid being converted to the volatile ester, methyl salicylate. Tissue culture uses are not well documented.

Medicinal and cosmetic uses

Salicylic acid is known for its ability to ease aches and pains and reduce fevers. Methyl salicylate is used to soothe joint and muscle pain. Choline salicylate is used typically to relieve the pain of mouth ulcers. Salicylic acid is a key ingredient in many skin-care products for the treatment of dermatitis, acne, calluses and warts. Aspirin (*acetylsalicylic* acid) is used to reduce fever and relieve mild to moderate pain.

Chapter - 16

Role of Biofertilizers, Biodynamics in Organic Horticulture

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Chapter - 16

Role of Biofertilizers, Biodynamics in Organic Horticulture

Upendra Maurya, Siddharth Kumar and Abhishek Chandra

"Bio-fertilizers are substances that contain micro-organisms, which when added to the soil increase its fertility and promote plant growth." Bio-fertilizers are believed to be a potent component of integrated nutrient management (INM) which have shown encouraging results in terms of increase in crop yield and income. Bio-fertilizers are eco-friendly, low cost agricultural inputs that have supplementary role with chemical fertilizers which improves both soil fertility and nutrient availability to the plants. On an average, bio-fertilizers add up to 20-30 % increase crop yields.

Bio-Dynamics

The biodynamic agriculture born in 1924. Father of Biodynamic farming is Rudolf Steiner. Steiner is Austrian philosopher and scientist. Biodynamics fist modern organic agriculture. bio-dynamic method are based on Antrhoposophy. His born Anthroposophy, or the wisdom (knowledge) of the human being. Biodynamic techniques were used on 161,074 ha. In 60 countries. Leading Germany for 45 % accounts of the global total.

It provides a better option to augment the fertilizer use efficiency (FUE) and maintain soil health and quality of produce. Bio-fertilizers are non-toxic in nature and they do not have any residual effects unlike chemical fertilizers. They also produce phyto-hormones such as auxins (IAA) and gibbrellins which are very helpful in promoting root growth and development.

Bio-fertilizers supply mixtures of nutrients, maintenance of symbiotic relationships, maintain microbial consortia in soil, enhanced crop productions, suppress soil born pathogenic diseases in crops, improved soil health.

Major bio-fertilizers are

Nitrogen	*Azotobactre*, *Rhizobium*, *Azospirillum*
Phosphorus	*Pencillium* sp, *Bacillus subtili*
Potassium	*Rhizoctonia solani*, *Glomus* sp.

Rhizobium is a genus of bacterial associated with the formation of root nodules on plants. These bacteria live in symbiosis with legumes. They take in nitrogen from the atmosphere and pass it on to the plant, allowing it to grow in soil low in nitrogen.

Azolla is a fast growing, free floating fresh water fern having a symbiotic relationship with blue green algae *Anabaena azolla.* It is a potent biofertilizer often grown is shallow water or submerged rice fields in tropical and subtropical climates.

Azotobacter is a free-living nitrogen fixing aerobic bacteria which is commonly found in neutral to alkaline soils. It is used for non-leguminous plants especially vegetables; vegetables respond better to azotobacter compare to other crops as it fixed atmospheric nitrogen and is able to promote plant growth.

Azosprillium is a free living, nitrogen fixing bacterium found in the rhizosphere of several grass species which fixes nitrogen in association with the roots of monocots. It fixes 20-40 kg nitrogen per ha. In case of cereals, cotton, oilseed and millets. It produces auxins, gibberellins and cytokinins.

Phosphate solubilizing bacteria: Phosphate solubilizing micro-organism (PSM) such as *Pseudomonas* and *Bacillus* helps in converting insoluble inorganic phosphate into simple and soluble forms. These bacteria are useful in utilization of rock phosphate with low content of phosphorus penta oxide.

The major role of biofertilizers in horticultural crops

Effective varieties of *Azotobacter, Azospirillum, Phosphobacter* and *Rhizobacter* can provide the maximum amount of nitrogen available as a nitrogen cycling. It produce plant hormones, including indlole acetic acid (IAA), gibberellins (GA) and cytokinins. It improves the performance of photosynthesis to provide plant tolerance to stress and increase pathogen resistance which in turn improves growth of plant. Kumar *et al.* (2014) suggested that the effect of AMF and *Azospirillum* showed highest growth of aonla plants. They concluded that nutrient availability may be increased by the application of the bio-fertilizers and also enhancing the growth of the pat and improves the fruit quality and fruit size.

Effect of bio-fertilizers on yield

The use of bio-fertilizer in the soil increase biodiversity that makes up all kinds of beneficial bacteria and fungi including arbuscular mycorrhiza fung (AMF) called plant growth promoting rhizobacteria (PGPR) and nitrogen fixers. There are many small organisms that thrive in the soil, especially in the rhizosphere of a plant. A large number of these microorganisms have active relationships and form a complete system with plants. They have beneficial effects on plant yield. Das *et al.* (2017) stated that the combination of two bio-fertilizers i.e. *Azospirillum brasilense* + *Arbuscular mycorhizal* showed the highest fruit retention and fruit yield i.e. 41.3 kg per plant along with highest fruit size (cm), fruit weight (g) and pulp weight (g) in guava plant. They also concluded that the application of *Azospirillum brasilense* along with AMF also gave the highest yield in the guava growers.

Effect of bio-fertilizer on soil character

Azotobacter and *Azospirillium* are free living bacteria that congregate near the root zone and enhance the nitroeng found in the soil by nitrogen modification, whereas, Phosphate Solubilizing Bacteria (PSB) dissolve insoluble phosphorus in the soil and make it available to plants. Vesicular-Arbuscular Mycorrhizae (VAM) helps to build- strong root system, increase root zone, improve growth, nutrient uptake and increase root tolerance for soil-born pathogens which improves the soil production.

Effect of bio-fertilizers on quality parameters

Application of bio fertilizer increases the availability of soil minerals; soil microbial biomass and respiration. Leaf nutrient concentrations vary during growth and the use of bio-fertilizer increases potassium, phosphorus and zinc concentrations in mature leaves. Its application reduces total soluble solids and boron concentration, without affecting the firmness of the fruit. It has a positive effect on the mineral N-dynamics and the micro flora of the soil, converting the nutrient content in the leaves. It quality by increasing biomass roots; root facilitate higher absorption of nutrients and increase yields by reducing the use of natural energy resources and ultimately improves fruit quality. Singh *et al.* (2000) suggested that the effect of combination treatment of % P+VAM+N was found to be best treatment for producing maximum growth and yield of high quality fruit in Mosambi.

Biodynamics

The word biodynamics derived from two Greek words, *Bio* (life) and *dynamics* (energy). "Biodynamics refers to a working with the energies which create and maintain life." It is a method of farming that aims to treat the farm as a living system which interacts with the environment, to build healthy living soil, and to produce food that nourishes, vitalises and helps to develop humanity. The bio-dynamic ides of the farm as an 'organism' or living entity.

Anthroposophy

Steiner defied Anthrosophy as "A path of knowledge whose objective is to guide the spiritual in man to the spiritual, which pervades the universe.

There are five sources of energy i) Earth, ii) Air, iii) Water, iv) Fire and iv) Cosmos

Advantages of Biodynamic Farming

Production of top quality fruits and vegetables, with strong flavours and high levels of nutrients, yield always above the average level, no chemical reduce for grain, fruit and vegetables, little trouble with livestock and plant diseases, no spreading of insect pests, and no great economic damage due to their presence and the important criterion is to sustain the fertility of a farm that lasts for future.

Concept of biodynamic farming

Two field sprays these are called BD 500 which is make from horn manure and BD 501 made from horn silica.

Five compost preparations these preparations are a mix of herbs that are added to compost protection sprays preparations- BD505, BD 508.

Other compost preparations CPP, Vermi-compost, Vermi wash and Nadep.

A moon and astrological planting calendar: It is a correlation between different parts of rhythems, the cycles of the moon, and an astrological chart. BD500 works in the roots of plants and second sprays, DB 501, works its magic by influencing light and growth of plants when sprays onto leaves.

Composting creates healthy soil, humus, nitrogen to support healthy crops. Consists of different herbs, vegetative matter, sheep manure, straw, cow manure etc., compost improves the structure of the soil. This allows more air into the soil improves drainage and reduces erosion. Compost improves soil fertility by adding nutrients and by making it easier for plants to take up the nutrients already in the soil. This produces better yields. Compost improves the soil's ability to hold water. This stops the soil from drying out in times of drought. Compost can reduce pests and diseases in the soil and on the crop.

Cover crops: Biodynamics farmers make use of cover crops for dynamic accumulation of soil nutrients, nematode control, soil loosening, and soil building. Used in the areas which are prone to soil erosion e.g. green gram, cowpea, sesame, chilli, leafy vegetables.

Mulching saves time, water and money. Mulch keeps sunlight from reaching the soil, minimising evaporation, mulch works as an organic mulch breaks down, to releases nutrients that plants use. It also suppresses the weeds seeds to germinate, prevent moisture loss, helps in heat builds up.

Crop rotation provides soil enrichment, natural habitat, encourages beneficial insects while reducing soil compaction and recycling plant nutrients into our soils. They also stabilize soil during heavy rains and hold moisture during drought periods. Rotations is the alternate types of crops grow in the one area to help manage disease, improve soil health, reduce erosion and ultimately produce more crops in the long term.

Companion plants are planned association of two or more plant species in close proximity so that some cultural benefit (Pest control, higher yield) is derived. Increases biodiversity on the farm which leads to a more stable agro ecosystem.

Green manure is the natural way to improve soil grow green manure to add organic matter to soil. Discourages the spread of weeds, helps to prevent valuable nutrients leaching away over winter.

BD 500 Cow Horn Manure: Preparation 500 is made by filling a cow's horn with cow dung. It is buried in the soil during the cooler months (Nov-Feb) and cow should be fed with good quality fodder two days before filling the horns. The horns should be buried in a pit about 16-18 inches. The preparations after four months have turned into dark humus. It is sprayed up to four times a year.

BD 502- Yarrow Flowers: BD 502 is prepared by using Yarrow Plant Flowers (*Achillea millifolium*) the yarrow flowers are cut from the plants in summer or autumn. In spring season, the yarrow flowers are dried and place into a stags bladder. Hang the bladder in a tree facing the sun. The bladder is taken down and buried in the soil within an earthen containers.

Biodynamic Yarrow	Compost preparations 502-508
Yarrow (BD 502)	Yarrow flowers are placed in a stag's bladder and are used to attract potassium and trace elements such as selenium and sulphur.
Chamomile (BD 503)	Chamomile flowers are placed in the small intestines of a cow and are used to help stabilize nitrogen, calcium and sulphur as well as manganese and boron.
Stinging nettle (BD 504)	Nettle is buried without an animal sheath and enhances decomposition, aids in chlorophyll formation, and stimulates iron, potassium, calcium, magnesium and sulphur activity in the soil.
Oak bark	Oak bark is placed in a cow skull and in water over winter; it is

(BD 505)	used to help restore water balance after too much rain or a full moon. It also helps protect against fungal diseases and stimulates calcium and phosphorus activity in the soil.
Dandelion (BD 506)	Dandelion flowers are placed in a cow's mesentery (Abdominal membrane), this is used to increase flowering and filling of fruit.
Valerian (BD 507)	Valerian flowers are tinctured and used to mobilize phosphorus-activating bacteria, as well as selenium and magnesium.
Horsetail (BD 508)	Horsetail shoots are boiled in rainwater and used against fungal diseases as a foliar spray or root dip.

Organic farming: Is a production system which avoids or excludes the use of synthetic preparations-artificial fertilizers, pesticides, growth accelerators and fodder additives. As an alternative to these means, organic farming applies a number of modern preventive methods to maintain the natural soil fertility, such as: alternating sowing of culture (with leguminous plants inclusive), suited use of manure, stimulating the populations of useful insects, vegetation associations (combined cultivation of two or more culture in one and the same place), use of mechanical methods for weed control and use of sustainable plant varieties and livestock breeds that are well adapted to the relevant environmental conditions.

Principles of organic farming: Production of enough high quality and nutritious food, organic farming, pest control and wild harvest systems should fit the cycles and ecological balances in nature. Organic management must be adapted to local conditions, ecology, culture and scale. Maintenance of natural soil fertility. Inputs should be reduced by reuse, recycling and efficient management of material and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food control and reduction of poverty. Practioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of health and well-being. Consequently, any harmful action should be stopped.

Basic steps of organic farming: Organic farming approach involves following five steps:

1. **Conversion** of land from conventional management to organic management.
2. **Management** of the entire surrounding system to ensure biodiversity and sustainability of the system.
3. **Crop production** with the use of alternative sources of nutrients such as crop rotation, residue management, organic manures and biological inputs.

4. **Management of weeds and pests** by better management practices, physical and cultural means and by biological control system.
5. **Maintenance of livestock** in tandem with organic concept and make them an integral part of the entire system.

Techniques of organic farming

i) Zero cultivation/no till cultivation

ii) Practice clean culture.

iii) Integrated pest management (IPM) and GAP

iv) Insect traps, lure and attractants,

v) Use of biological pest control (natural enemies of pest)

vi) Use of organic compost fertilizer and bio micro inoculants,

vii) Use of organic pest and disease control materials

viii) Use of indigenous resistant plant varieties and strain.

ix) Practice crop rotation and flowing (resting the soil for some time).

x) Growing and inter-cropping of pest repellent and herbal plants.

xi) Integrated weed management (IWM).

xii) Gowning the right crop on the right soil, climate and at the right time.

xiii) Solarisation of soil to destroy the pathogenic inoculums and eggs of insect pests the hosts.

xiv) Integrated nutrient management (INM)

xv) Vermicomposting

xvi) Integrated farm management.

Zero tillage is a way of growing or pasture from year to year without disturbing the soil through tillage. No-till is an agricultural technique which increases the amount of water that infiltrates into the soil and increases organic matter retention and cycling of nutrient in the soil.

Clean culture is the cultivation and weed control will also help not only in soil aeration and softening of soil mass but will also reduce or disturb the breeding place of insect pest and fungal diseases.

IPM: the integrated pest management is a pest control program using combination of all practices to reduce or eliminate pest damage. This includes natural, biological and mechanical practices as well as bio and chemical pesticide application.

Good agricultural practices

1. **Seeds and propagation material:** Seeds in use are to be identified botanically, indicating plant variety, cultivar, chemotype and origin. The material used should be100 % traceable. The same applies to vegetatively propagated parent material. Parent material used in organic production has to be certified as authentically organic.
2. **Cultivation:** Depending on the method of cultivation e.g. conventional or organic, growers should be allowed to follow different standard operating procedures for cultivation (to be elaborated). In general, care should be taken to avoid environmental disturbances. The principles of good crop husbandry must be followed including an appropriate rotation of crops.
3. **Soil fertilization:** Medicinal and aromatic plants should not be grown in soils that are contaminated by sludge; furthermore, soils should not be contaminated by heavy metals, residues of plant protection products and any other unnatural chemicals. It should therefore be endeavoured to apply the use of chemical products with as minimum negative effect as possible.
4. **Irrigation:** Should be minimized as much as possible and only be applied according to the needs of the plant.
5. Tillage should be adapted to the growth and requirements of plants.
6. Pesticides and herbicide application should be avoided as for as possible.
7. **Harvesting:** Should be take place when the plants are of best possible quality, according to their different utilizations.
8. **Primary processing:** After harvest includes such processing steps as washing, freezing, distilling, drying etc. all these processes, whether from food or medicinal use.
9. **Packaging:** After the repeated control and eventual elimination of low-quality materials and any foreign bodies, the product should be preferably packaged in new, clean and dry sacks, bags or chests. The label must be clear, permanently fixed and be made of non-toxic material. Information must confirm with the national labelling regulations.
10. **Storage and transport:** Packaged dried materials and essential oils should be stored in a dry, well aerated building, in which the daily temperature functions are limited and good aeration is guaranteed.

Fresh products (except basil) should be stored between 1°C and 5°C while frozen products should be stored below 18°C while frozen products should be stored below -18°C (or below -20 for longer term storage).

11. **Personal and facilities:** Should receive adequate botanical education before performing tasks that require this knowledge.
12. **Documentation:** All parent materials and processing steps, including the location of cultivation, have to be documented. Field records showing previous cropping and used inputs should be maintained by all growers.
13. **Education:** It is highly advisable to educate all personnel dealing with the crop or those engaged in the management of production, in production techniques as well as the appropriate use of herbicides and pesticides.
14. **Quality guarantee:** Consultation between producers and buyers of medicinal and aromatic plants, with regard to quality. Questions, e.g. active principles and other characteristic ingredients, optical and sensoric properties, limited germ numbers, plant protection chemical residues and heavy metals, must be based on internationally recognized or national specifications and should be laid down in written form.

Insect traps, lure and attractants such as light traps, lure with attractants, chemical sex attractant, blue electric lamp and yellow pads.

Use of biological pest and disease control

The use of living plant and animal or living organisms to control pest and disease are called biological control. They may be microorganisms such as bacteria, fungi, virus or bigger life forms like insects, worms, reptiles, mammal and birds.

Use of organic fertilizer

Farm yard manure: Manure is obtained from the solid and liquid excrements and the padding of livestock animals after being left to decay. The manure which has matured is good for agricultural use.

The bird manure: Is the riches one of all organic types of manure. It is three times richer in nitrogen and potassium and about four times richer in phosphorus than the ordinary missed manure produced from livestock animals.

Ashes are alkali fertilizer: It has the effect of neutralizing the soil acidity and improving the functioning of nitrogen-fixing bacteria. Ashes may also be used for whitewashing.

Chapter - 17

Improved Practices in Banana Cultivation

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Chapter - 17

Improved Practices in Banana Cultivation

Amrit Kumar Singh

Economic Importance of Banana

Banana is a rich source of carbohydrate and is rich in vitamin B. it is also a good source of Potassium, Phosphorus, calcium & magnesium. It helps in reducing risk of heart diseases, arthritis, ulcer, gastroenteritis and kidney disorders. The processed products like chips, banana puree, jam, jelly, juice, wine and halwa are made from the fruit. Plantains or cooking bananas are rich in starch and have a chemical composition similar to that of potato.

Alternative use of banana is that, Uganda are largely used in their fresh form and usually eating ripe and used forming pancakes (Kabalagala).The most common form of processing is beverage production from beer juice banana cultivars (juices, beer, waragi). Many handcrafted products are also made with banana fibers.

Introduction

Banana (*Musa paradisica* L.) belongs to family Musaceae originated from South-East-Asia and it is the oldest fruit in India. Second most consumable fruit after mango in India. It considered as the rich source of energy, per 100 gm contains Fat 0.3 g, sodium 1 mg, potassium 358 mg, carbohydrate 23 g, dietary fiber 2.6 g, sugar 12 g, protein 1.1 g, vitamin C 14 %, bitamin B6 20 %, magnesium 6 % and all the plant parts is useful. A total area of 7.70 lakh ha. Under banana cultivation in India which is 20 % of total fruits. India produces 21 % of total word's banana production.

Banana is one of the oldest known frit in India. It is second after mango in our country. Besides rich source of energy, its unriped fruits are used for powder and ripe fruits are used for jam, fruit slald, religious purpose. It is cultivated in various states in India. South India (Kerala, Tmil Nadu, Karnatak), Western India- (Gujrat, Maharastra), Eastern India- (Assam, Bihar).

Soil

Banana can be grown well in all type of soil having plenty of soil moisture. Dee well drained, fertile, loamy soil with adequate organic matter and moisture content is ideal for its cultivation. Shallow rooted nature of plant needs depth and drainage of excess water. Banana could not survive in saline soil.

Climate

It is a tropical crop, grows well in the temperature range of 15 °C to 35°C with relative humidity of 75-85%. Loamy soils are good for banana cultivation with the pH range between 6.5-7.5. Rich in organic material with high nitrogen content, adequate phosphorus and plenty of potash. The average rainfall requirement is 650-750 mm.

Cultivated Varieties

Dwarf Cavendish, Robusta, Monthan, Poovan, Nendran, Red banana, Nyali, Safed Velchi, Barasai, Ardhapuri, Rasthali, Karpurvalli, Karthali and Grand nine etc.

Land preparation and planting of Banana

Before the planting of banana, green manuring crops like daincha, cowpea, etc. is used to break the clod and bring the soil to a fine tilt. The green manuring helps with minimum application of chemical fertilizers such as NPK as well as prevents form become land unfertile.

Planting materials

Suckers and tissue culture seedlings are suitable for planting but sometimes the sword suckers with well-developed rhizome, having actively growing conical bud and weighing approximately 450-700gm are commonly used as propagating material.

The planting suckers should be 3-4 months old, separated form mother rhizome and planted. The panting rhizome which is pseudo stem of suckers is completely removed from rhizome. Such rhizomes are stored under shade in cool & dry place for 2 months. The conical rhizomes with sound heart & few side buds are used for planting.

Planting season

The important seasons for planting followed in different states of India are:

State	Planting time
Maharashtra	Kharif: June-July Rabi: October- November
Tamil Nadu	February-April November-December
Kerala	Rainfed: April-May Irrigated crop: August-September

During 15^{th} june to 15^{th} july, if early planting, bunch will emerge during severe winter, which reduces the yield. High temperature of September-october and severe cold of winter reduceds the growth of bunch. Pits of 30 x 30cm are dug during summer. Filled with FYM 10-15kg + soil. Before planting, planting material is treated with Aureofungin 6gm in 135 liter of water for 1.5 hour or with KM_n04 100g + 100lit. Of water.

Spacing in Banana Planting

Traditionally banana growers plant the crop at 1.5m x 1.5m with high density

Season	Spacing
Kharif	1.5 x 1.5m., 2.2 2m. OR 2.5 x 2.5m.
Rabi	1.5 x 1.2 m., 1.5 x 1.37

Tall varieties panting at the distance of 2.5 x 2.5 m. and dwarf variety planting at 1.8 x 1.8 or 1.2 x 1.2 m, a total 31.6 tones of rhizomes i.e. 3000 number required per ha.

Nutrient Requirement

FYM 10 kg. per plants, 200-250gm N/plant, incorporate as top dressing in three equal parts at interval of 60, 90 & 120 days. Amount of phosphate is 60-70gm/plant and 300gm potash/plant. The urea must be applied in 3-4 split doses.

Irrigation

Water requirement of banana varies according to topography, soil, climate, cultivar, and type of culture. If there is no rain, the plants should be irrigated immediately after planting. Banana requires high amoung of water ranging from 1800-2500 mm annually. The requirement is met either through well distributed rainfall is an important aspect to be considered before growhing bananas. Banana need plenty of water throughout life. Summer 7-8 days interval, winter 10-12 days interval totally 40-50 irrigatons.

Intercultural Operations

Keep the field free form weeds with the help of 4-5 hand weeding's. The suitable herbicide is hlyphosate @ 2 lit/ha. Before the planting. Harrowing of the field with 3-4 times for loosen the soil. Earthing up is essential in banana cultivation by 3-4 months after planting. Desuckering, Bunch Covering and Mulching are also essential inter culture operations in banana cultivation.

Inter-cropping

The short duration crops (45-60 days) like, mung, cowpea, daincha are to be considered as green manuring crops. The leguminous croops beetroot, ginger, turmeric and sunhemp are grown as an inter-crop during the first 3-4 months.

Growth Regulators

The application of growth regulators are practiced for good yield and healthy banana fingers. 2, 4D @ 25ppm improves the grade of bunches, CCC @ 1000ppm at 4^{th} and 6^{th} months. Plantozyme @ 2ml/lit. at 6^{th} and 8^{th} month. Potassium dihydrogen phosphate @ 0.5% and urea 1% or 2, 4D solution @ 10ppm give after bunch development improves banana size & quality.

Plant protection from Insect/pests

Root stock or rhizome weevil *Cosmopolites sordidus*, stem borer *Odioporus longicollis*, Banana beetle *Nodostoma subcostatum*, banana aphid *Pentalonia nigronervosa*, nematodes and thrips are commonly attacks on banana crop.

To prevent from these pests the application of 0.04 % endosulfan, 0.1 % carbaryl or 0.05 % of monocrotophos depending upon the type of pest infestation.

Banana weevil infects the young plants causes stunting of growth, production of small bunches and sometimes plants death. For control of weevil follow cultural practices like clean planting material, proper field sanitation and trapping should be done.

Diseases of banana are Panama wilt *Fusarium oxysporum*, Anthracnose *Gloesporium musarum*, Sigatoka leaf spot *Mycospphaarell musicola* & *Cercospora musae*, shoot rot *Ceratostomell paradoxa* are the diseases occurs in banana.

The Black sigatoka with the help of *Mycosphaerella jjiensis*, leaf speckles by the *Periconiella sapienlwlicola*, yellow sigatoka by the *Mycosphaerella micola* and all other severe diseases can be controlled by use of resistant cultivars and it is the most effective and cheapest method of disease control.

Anthracnose caused by the fungus *Colletrotrichum musae* and it attacks on fruit. It is most commonly occurs in cooking banana.

Transportation system of banana

Road transport by the trucks/lorries is the most popular mode of transport due to easy approach from orchards to the market. Transportation to the distant markets followed by the rail wagons.

Harvesting & Yield of banana

Varieties	Average yield (Tones/ha.)
Barsai, Rasthali	40-50
Shrimanti	70
Grand Naine	65
Andhapuri, Meanyham	55
Hiral, Safed Velchi, Red banana, Lal Velchi	45
Poovan	40-50
Monthan	30-40
Dwarf Cavendish, Robusta Champa & Chini desi	50-60
Nendran	30-35

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Chapter - 18

Seed Production of Chilli (*Capsicum frutescense*)

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Chapter - 18

Seed Production of Chilli (*Capsicum frutescense*)

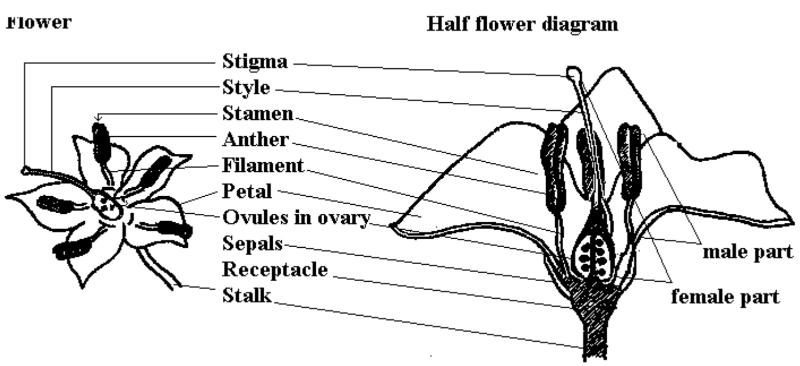
Sarfaraz, Veersain, Swatantra Yadav, Prashant Srivastav

Introduction

Chillies widely used as vegetable and spice is an often-cross pollinated crop, where the extent of cross pollination is up to 7 to 36 per cent. It belongs to the family Solanaceae. It is also known as hot pepper and botanically it is known as *capsicum annuum.* Chilli have rich nutrition like Beta Carotene Capsaicin and vitamin A, C; Provitamin E, P, B_1 B_2 and B_3. Chilli rich in medicinal value control cholesterol, blood pressure, diabetes, Cancer, blood clotting, cold and fever; improve digestion etc. The quality seed production techniques of chillies comprises of the following steps.

Botany: Often Cross-pollinated vegetable. The flower is protogynous. Flowers white with blue to purple anthers. Anther dehisces only half to 5 ½ hr after stigma becomes receptive. Anthesis in chilli occurs between 6.00 and 9.00 hr. Flower remains open for 2 to 3 days, receptivity of stigma was the highest at the day of flower anthesis.

Chilli flower



Climate: Chilli can be grown in both tropical and sub-tropical areas at altitudes ranging from sea level to 2000 meters above mean sea level. Temperature ranging from 20 to 250 C is ideal for chilli production, but it is susceptible to frost. A warm and humid weather with moderate rainfall (60-120 cm) favors growth while dry weather enhanced fruit maturity.

Method of seed production: Seed to seed

Stages of seed production: Nucleus Seed→ Breeder seed→ Foundation seed→ Certified seed.

Varieties: K.1, K.2, K.3, Co.1, Co.2, PKM.1, MDU.1, Bagyalakshmi, Arka Suphal, Arka Lohit

Hybrids: KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira,

Lario, Hira, Bharat, Arka Sweta, Arka Harita, Arka Khyati.

Season: June-July, February-March, September- October.

Soil: A well-drained sandy loam or loamy or clay loam soils rich in organic matter and lime are best suited for chilli production. Acidic and alkaline soils are not suitable for chili seed production. Well drained clay loam soil is considered ideal. The ideal soil pH for chili is 6.0-6.5.

Land requirement: The land should be free from volunteer plants. Generally, areas affected by wilt or root rot may be avoided. Crop rotation must be followed to avoid endemic Solanaceous pests.

Isolation requirement: Minimum isolation distance of 400 M for foundation and hybrid seed and 200 M for certified seed production are necessary.

Seed rate: Seed required for one hectare is 500g to 1kg for variety; for hybrids - Female = 200g and male = 50g

Spacing

- Row to row - 45 to 70cm
- Plant to plant - 30 to 45cm

Nursery: Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10 days before pulling out of seedling.

Transplanting: The seedlings of 30-35 days old are ready for transplanting. Transplanting may be done on the ridges in the evening.

Foliar spray: To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/L. Very light irrigation is also done arrest the flower drop.

Manuring: Apply 50 tons of FYM/ha for irrigated crop. Basal 0:70:70 kg of NPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45th days after transplanting.

Roguing: Field inspection and roughing should be done both for varieties and hybrid at different stages based on the plant height and its stature, flower colour and pod characters. The plants affected with leaf blight, anthracnose and viral diseases should be removed from the seed field.

Weed Management

i) **Dead mulch:** Crop residues like straws or stovers of rice, maize, sorghum, mustard or wheat can be used if they are available or left as a waste.

ii) **Frequent weeding:** Hand weeding at least three or four all through the growing period of chilli due to continuous germination of weed seeds. Hand weeding at initial stages may be replace by chemical weeding and later it may be supplemented with chemical weeding. Chemical weeding may reduce the cost of weeding.

Pest and disease management: The important pest attacking chilli and capsicum are thrips, aphids, pod or fruit borer and mites. The thrips and aphids can be controlled by spraying Dimecron (systemic pesticide), pod borer can be controlled by spraying Nuvacron and the mites can be controlled by spraying Kelthane. The major diseases affecting the plants are die back or fruit rot, powdery mildew and bacterial leaf spot. Spray Dithane M-45 for control of die back, Karathane for powdery mildew and Agromycin for leaf spot disease control.

Pest: Pests typically are more mobile and multiply more quickly than beneficial insects. Chilli is affected by number of pests attack on chillies crop during the growing season. For example- Aphids, thrips, leaf hoppers, ear wigs, crickets, mites, root grubs, pod borers, cut worms, flea Beatles, etc damage or destroy the crop.

Crop Stage	Possible Pests
Vegetative stage	
Seedling	Root Grub, Mite, Aphid and Thrips
Branching	Mite, Aphid, Thrips and Cut worm
Reproductive stage	
Flowering	Mite, Aphid, Thrips and Cut worm
Fruiting	Fruit borer, Gram caterpillar

Control

- If any sucking insects is found in any part of the plant should be killed by hand or agricultural tool.
- Affected plant should be discarded and buried approximately one meter deep in the earth.
- Read the label before using any pesticide.
- Always used standard and agricultural registered pesticide spray.
- Try to protect the beneficial insects.
- Insecticides applied to the crop before, during or after planting can reduce insect damage.

Trap crops: The major benefit of trap cropping is that it reduces the quantum of pesticide usage on the main crop besides enhancing the natural control of pests. Usually, the trap crop will be used after every 5 rows interval depending upon nature of the crop and economics. Chilli interspersed with marigold (trap crop) in the row proportion of 20:1, 18:1 or 16:1 resulted in significantly reduced incidence of chilli fruit borer. Marigold also helped in trapping the eggs and larvae of *Helicoverpa armigera*.

Banker crops: Banker crops are grown to provide the food like pollen and nectar to non-carnivorous stages of adult predator besides providing shelter and required microclimate. Many natural enemies feed directly on plant products such as pollen and nectar. Banker crops provide balanced diet for natural enemies. Insects like coccinellids require pollen for completion of their life cycle. Research findings confirmed the usefulness of banker cropping in many crop situations.

Pathogens

Beside different pests, pathogens are also a serious threat for chilli crops such as fungi, bacteria, viruses, nematodes etc.

Fungal Disease

Commonly fungal diseases cause more damage than diseases cause by other pathogens. Several fungi cause various diseases in chilli plants. Sometime these fungi can cause similar symptoms and confused to one another. There are some pre-harvesting fungal diseases such as; Anthracnose, Cercospora (frogeye) leaf spot, Charcoal rot, Choanephora blight (wet rot), Damping-off root rot, Downy mildew, Fusarium stem rot, Fusarium wilt, gray leaf spot, gray mold, Phytophthora blight, Powdery mildew, Southern blight, Verticillium wilt and White mold are grown in chilli crop.

Fungal diseases and their causal agents attacking on chilli plant at different crop stages

Crop Stages	Disease	Causal Agents
Vegetative Stage		
Seedling	Damping off, Phytophthora Blight, Fusarium wilt.	*Pythium spp*., *Phytophthora capsici*, *Fusarium oxysporium* f. sp. capsici.
After Transplantation	Frog eye leaf spot, Damping off, Fusarium wilt.	*Cercospora capsici*, *Pythium spp*., *Fusarium oxysporium f.sp.capsici.*
Root diseases	Phytophthora root rot, Verticillium wilt, Rhizoctonia root rot	*Phytophthora capsici, Verticillium wilt sp., Rhizoctonia solani*
Reproductive stages		
Flowering	Powdery mildew	*Leveillula taurica*
Fruiting	Anthracnose, Powdery mildew, Phytophthora pod rot, Black mold.	*Colletotrichum capsici, Leveillula taurica, Phytophthora capsici, Alternaria spp.*

Control

- Always used pathogen free seeds.
- Crop rotation.
- Disease resistant variety should be used.
- Discard the weeds from the crop.
- Chilli should be not planted in the same field more than once every 3 years. ¬
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- Excessive irrigation prior to seedling emergence should be avoided and, after establishment, water should not
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- Excessive irrigation prior to seedling emergence should be avoided and, after establishment, water should not stand in the field for more than 12 hours.
- Before sowing, the seed should be dried by artificial (machine) method or sun light method.

Chemical Control

- Disinfect containers, seed trays, propagators thoroughly. Dettol is good but tea-tree oil and camomile tea make good alternatives and are safe to use on plants.
- The strobilurin fungicides azoxystrobin (Quadris), trifloxystrobin (Flint), and pyraclostrobin (Cabrio) have been labelled for the control of anthracnose fungus in chillies crop.
- Soil sterilization by drenching the soil 4" deep with Formaldehyde diluted 50 times with water or with some other effective chemical soil sterilant.
- Soil drenching with 1% Bordeaux mixture or 3g Copper Oxychloride like Blue copper per litre of water at 12 and 20 days after sowing is also useful.
- Seed treatment with 3g Captan or Thiram per kg seed.

Bacterial Diseases

The bacterial diseases are also affected the chilli crop. Some common bacterial diseases are Bacterial spot, bacterial wilt, Bacterial canker, Syringe seedling blight and leaf spot.

Crop Stages	Disease	Causal Agents
Vegetative Stage		
Seedling	Bacterial leaf spot. Syringe seedling blight.	*Xanthomonas campestris* pv. *vesicatoria*.
After Transplantation	Bacterial wilt.	*Ralstonia solanacearum*
Reproductive stages		
Flowering	Bacterial leaf spot	*Xanthomonas campestris* pv. *vesicatoria*
Fruiting	Bacterial soft rot, Bacterial leaf spot	*Erwinia carotovora* pv. *carotovora*, *campestris* pv. *vesicatoria*.

Control

- Always used pathogen free seeds.
- Avoid excessive use of nitrogen fertilizers.
- Crop should be sown according to given measurement.
- Chose suitable bactericide and proper doze should be applied.
- All plant debris should be turned under soil after harvest, particularly in the presence of diseases which can survive on plant debris.

Viral diseases

These are about 17 viruses which cause diseases in chilli crop. Mostly, viruses are spread or transmitted by infected seeds, insects and or by the mechanical tools. Most of the viral diseases are very difficult to diagnose due to the heavy overlap of symptomatology. Symptoms produce by different viruses are mosaic pattern on leaves, yellowing, ring spots, leaf deformation, curling of leaves and stunting of plants. Common viral diseases are; Alfalfa mosaic, Beet curly top, Cucumber mosaic, Pepper mottle, Tobacco mosaic, leaf curl and Pepper Gemini Virus.

Crop Stage	Possible Viruses
Vegetative stage	
Seedling	Beet curly top virus (BCTV)
Reproductive stage	
Flowering	Leaf Curl
Fruiting	Pepper Mottle Virus, Alfalfa Mosaic Virus, Cucumber Mosaic Virus, Tobacco Mosaic Virus (TMV), Pepper Gemini Virus.

Control

- Use suitable pesticide for whitefly and other vectors.
- The affected plants should be discarded from the field as soon as possible.
- The seeds should be properly mixed in copper Oxichloride before sowing.
- Avoid overwatering.
- Expelled the weeds from field.
- Avoid the using of tobacco or smoking the cigarette in field.
- Don’t irrigate same time in healthy and infected crop.

Harvesting and processing: Harvesting should be done in different pickings. First and last one or two pickings can be harvested for vegetable purpose. The well ripened fruits with deep, red colour alone should be collected in each picking. After harvest, fruit rot infected fruits are to be discarded. The harvested pods are to be dried under shade for one (or) two days and then under sun for another 2 or 3 days. Before drying pods are to be selected for true to type and graded for seed extraction. The seed are extracted from graded dried pods. The pods are taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned by winnowing and dried to 10%

moisture content over tarpaulin. Then seeds are processed with BSS 8 wire mesh screens. For large scale seed extraction, the TNAU model chilli seed extractor may be used.

Seed Yield: 100-180 Kg/ha as per latest varieties.

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,
2. The second inspection shall be made during flowering to check isolation, off types and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

Specific standards

Factors	Foundation	Certified
Off types	0.1%	0.2
Designated diseased plant	0.1%	0.5%

The designated diseases are caused by *Colletotrichum capsici* and leaf blight caused by *Alternaria solani.*

Seed standards (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed	98%	98%
Inert matter	2%	2%
Other crop seeds	5/kg	10/kg
Weed seeds	5/kg	10/kg
Germination	60%	60%
Moisture content	8%	8%
For VP Container	6%	6%

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