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1. AGRICULTURE

   Applications of Hyperspectral Remote sensing
   G. Sashikala and B. Reddy Yamini
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   Remote sensing is a technique to observe the earth surface or the atmosphere from out of space using satelites (space borne) or from the air using aircrafts (airborne). Remote sensing uses a part or several parts of the electromagnetic spectrum. It records the electromagnetic energy reflected or emitted by the earth’s surface. The amount of radiation from an object (called radiance) is influenced by both the properties of the object and the radiation hitting the object (irradiance). Vegetation represents reflected solar radiation in the visible and the near infrared regions of electromagnetic spectrum.

   Hyperspectral remote sensing is one of the advanced technology which began in early 1980’s is one of the most significant breakthrough in remote sensing. It emerged as a promising tool for studying earth surface both spectrally and spatially. It is also known as imaging spectrometry. The broad band of the electromagnetic spectrum is broken down into hundreds of spectral bands to obtain geochemical information from inaccessible areas. There are many airborne, spaceborne and extra terrestrial hyperspectral sensors available, which collect information as a series of narrow and continuous wavelength bands at 10- 20 nm intervals.

   Hyperspectral remote sensing data sets are generally represented as a data cube with spatial information collected in X – Y plane, and spectral information represented in the Z- direction. Hyperspectral data is to be processed and analysed for radiometric correction, image enhancement, spectral reduction and dimension reduction, determination of end members, extraction of end member spectra, identification of end member spectra, spectral information and matching and classifications.

   Hyperspectral remote sensing can be applied in various fields like mineral targeting (identification and mineral composition of...
minerals), soils (organic matter, soil moisture content, particle size distribution etc.), vegetation (species diversity, environmental stress, photosynthetic activity, plant biomass and transpiration), atmosphere (clouds, aerosol condition etc.), oceanography (detection of phytoplankton, suspended matter etc.), snow and ice (types of snow cover, surface albedo), oil spills and food processing etc.

Absorption features of different parameters like depth, width area and asymmetry of absorption peaks of clay minerals were derived from spectral profile of soil samples using DISPEC tool of hyperspectral remote sensing (Suresh et al. 2014). Hyperspectral imaging observations with high spectral and spatial resolutions can be used to detect oil based on spectral signature matching to identify the level of oil contamination of polluted areas in shoreline, necessary for cleaning purpose (Salem and Kafatos, 2001). Reflectance in the sort wave infrared regions was found to monitor N, P, k and S status in plants in combination with reflectance at either visible (VIS) or near infrared (NIR) region. Newly developed and validated spectral algorithms specific to N, P, K and S can be further be used for monitoring in a wheat crop in order to undertake site-specific management (Mahajan et al. 2014).

Hyperspectral remote sensing has a wide array of applications including agriculture, oceanography, atmosphere, environment etc. the overall accuracy of hyperspectral imagery is far better than multispectral imagery. Using hyperspectral imagery and GIS land management system the precision agriculture could be implemented in developing countries. As the population is increasing and resources such as water and agricultural land is being limited, hyperspectral precision agriculture becomes important in the future.

References

2. SOIL SCIENCE

Importance of Potassium Nutrient for Plant Growth

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Introduction
Potassium (K) is one of 17 essential elements required by plants for healthy growth and reproduction. Along with nitrogen (N) and phosphorus (P), K is classified as a macronutrient, and is considered second only to nitrogen in terms of its importance to plant growth. Potassium is not only a constituent of the plant structure but it also has a regulatory function in several biochemical processes related to protein synthesis, carbohydrate metabolism, and enzyme activation. In recent decades, K was found to provide abiotic stress tolerance. Under drought stress conditions, K regulates stomatal opening and helps plants adapt to water deficits. In addition, this element provides some cellular signaling alone or in association with other signaling molecules and phytohormones.

Forms of potassium in soil
Potassium in soil is generally classified into four categories:

- Unavailable Potassium
• Fixed potassium or Slowly Available Potassium
• Exchangeable potassium or Readily Available Potassium
• Soil solution potassium

**Unavailable Potassium** – found in crystalline structure of feldspars, clay minerals and micas which are part of the soil. Plants cannot use the potassium in these insoluble forms. However, with time, these minerals eventually break down, and small quantities of potassium are released to the soil solution.

**Fixed Potassium** – potassium that becomes slowly available to plants over the growing season. Clay minerals have the ability to fix potassium. During wetting and drying of the soil, potassium becomes trapped in-between the mineral layers (clay minerals have a layer structure). Once the soil gets wet, some of the trapped potassium ions are released to the soil solution. The slowly available potassium is not usually measured in regular soil testing.

**Exchangeable Potassium** – is readily available potassium, which plants can easily absorb. This fraction of Potassium is held on the surface of clay particles and organic matter in soil. It is found in equilibrium with the soil solution and is easily released when plants absorb potassium from the soil solution. Exchangeable potassium is measured in most soil testing.

**Soil Solution Potassium** – potassium dissolved in the soil solution and is readily available to plants. It is the smallest pool of potassium. Therefore, testing only potassium in the soil solution, does not represent the total amount of potassium available to plants.

**Factors that Affect Potassium Uptake by Plants**

Several factors can affect the ability of plant to absorb potassium from soil:

• Oxygen level - oxygen is necessary for proper root function, including uptake of potassium.
• Moisture - the more moisture found in the soil, the easier it is for plants to absorb potassium.

• Soil tilling - research has shown that regularly tilled soil allows for better potassium uptake.
• Soil temperature- 60-80 degrees Fahrenheit is the ideal soil temperature range for root activity and most of the physiological processes in plants. The lower the temperature, the slower absorption becomes.

**Role of Potassium in Plants**

Potassium (K) increases crop yield and improves quality. It is required for numerous plant growth processes.

**Enzyme Activation**

Potassium “activates” at least 60 different enzymes involved in plant growth. The K changes the physical shape of the enzyme molecule, exposing the appropriate chemical active sites for reaction. Potassium also neutralizes various organic anions and other compounds within the plant, helping to stabilize pH between 7 and 8 which is optimum for most enzyme reactions.

**Stomatal Activity**

Plants depend upon K to regulate the opening and closing of stomata. The pores through which leaves exchange carbon dioxide (CO₂), water vapour, and oxygen (O₂) with the atmosphere. Proper functioning of stomata are essential for photosynthesis, water and nutrient transport, and plant cooling. When K moves into the guard cells around the stomata, the cells accumulate water and swell, causing the pores to open and allowing gases to move freely in and out. When water supply is short, K is pumped out of the guard cells. The pores close tightly to prevent loss of water and minimize drought stress to the plant (Thompson and Bob, 2008).

**Photosynthesis**

The role of K in photosynthesis is complex. The activation of enzymes by K and its involvement in adenosine triphosphate (ATP) production is probably more important in regulating the rate of photosynthesis than is the role of K in stomatal activity. When plants are K deficient, the rate of photosynthesis and the rate of ATP production are reduced, and all of the processes dependent on ATP are slowed down. Conversely, plant respiration increases which...
also contributes to slower growth and development.

**Transport of Sugars**

Sugars produced in photosynthesis must be transported through the phloem to other parts of the plant for utilization and storage. The plant’s transport system uses energy in the form of ATP. If K is inadequate, less ATP is available, and the transport system breaks down. This causes photosynthates to build up in the leaves, and the rate of photosynthesis is reduced. Normal development of energy storage organs, such as grain, is retarded as a result. An adequate supply of K helps to keep all of these processes and transportation systems functioning normally.

**Protein Synthesis**

Potassium is required for every major step of protein synthesis. The “reading” of the genetic code in plant cells to produce proteins and enzymes that regulate all growth processes would be impossible without adequate K.

**Starch Synthesis**

The enzyme responsible for synthesis of starch (starch synthetase) is activated by K. Thus, with inadequate K, the level of starch declines while soluble carbohydrates and N compounds accumulate. Photosynthetic activity also affects the rate of sugar formation for ultimate starch production. Under high K levels, starch is efficiently moved from sites of production to storage organs (Patil, 2011).

**Crop Quality**

Potassium plays significant roles in enhancing crop quality. High levels of available K improve the physical quality, disease resistance, and shelf-life of fruits and vegetables used for human consumption and the feeding value of grain and forage crops. The effects of K deficiency can cause reduced yield potential and quality long before visible symptoms appear. This “hidden hunger” robs profits from the farmer who fails to keep soil K levels in the range high enough to supply adequate K at all times during the growing season. Even short periods of deficiency, especially during critical developmental stages, can cause serious losses.

**Conclusion**

Potassium is vital for plant survival under both physiological and stress conditions. It is not only apart of the chemical structure but also plays vital regulatory functions in biochemical and physiological processes that contribute to plant growth and development. Proper use of K with other nutrients helps to attain sustainable productivity and quality of crops and ensures nutritional food security for animals and human beings.

**Reference**


### 3. HORTICULTURE

**Stevia: A cure of Diabetes**

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**Introduction:**

Stevia (*Stevia rebaudiana*Bertoni) belongs to the family Asteraceae and is well known to the scientific world for its sweetness. It is a good source of carbohydrates, protein, crude fibers and minerals. The leaves of stevia have sweetening compounds called steviol glycosides (SGs), which contain different marker compounds, namely stevioside (St), rebaudioside (Rb)A, B,C,D and E, dulcoside and steviolbiosides, which are nearly 300 times sweeter than sugar. Stevioside (St) is
extracted from dried leaves in the form of a white amorphous powder. Since stevia is considered to provide low calories it is used in juices. It is becoming common in Japanese, United States and European Union markets and has been receiving considerable attention as its market potential grows. Stevia is a better substitute for sugar in the formulation of food products, reducing the harmful effect of sugar and improving the nutrient properties. Stevioside and rebaudioside A are safe for humans, without any side effects.

**Diabetes Problem in Word:**
In 2017, 425 million people had diabetes worldwide, up from an estimated 382 million people in 2013 and from 108 million in 1980. Accounting for the shifting age structure of the global population, the prevalence of diabetes is 8.8% among adults, nearly double the rate of 4.7% in 1980. Type 2 diabetes makes up about 90% of the cases. Some data indicate rates are roughly equal in women and men but male excess in diabetes has been found in many populations with higher type 2 diabetes incidence, possibly due to sex-related differences in insulin sensitivity, consequences of obesity and regional body fat deposition, and other contributing factors such as high blood pressure, tobacco smoking, and alcohol intake.

The WHO estimates that diabetes resulted in 1.5 million deaths in 2012, making it the 8th leading cause of death. However another 2.2 million deaths worldwide were attributable to high blood glucose and the increased risks of cardiovascular disease and other associated complications (e.g. kidney failure), which often lead to premature death and are often listed as the underlying cause of death certificates rather than diabetes. For example, in 2017, the International Diabetes Federation (IDF) estimated that diabetes resulted in 4.0 million deaths worldwide, using modeling to estimate the total number of deaths that could be directly or indirectly attributed to diabetes.

**Diabetes Problem in India:**
Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease. In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) with the United States (17.7 million) in second and third place respectively. According to Wild et al. the prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030 with a maximum increase in India. It is predicted that by 2030 diabetes mellitus may afflict up to 79.4 million individuals in India, while China (42.3 million) and the United States (30.3 million) will also see significant increases in those affected by the disease. India currently faces an uncertain future in relation to the potential burden that diabetes may impose upon the country. Many influences affect the prevalence of disease throughout a country, and identification of those factors is necessary to facilitate change when facing health challenges.

**Diabetes Mellitus:**
Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst, and increased hunger. If left untreated, diabetes can cause many complications. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, and damage to the eyes. Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced.

**Types of Diabetes:**
There are three main types of diabetes mellitus

1. **Type 1 Diabetes:** It results from the pancreas's failure to produce enough insulin due to loss of beta cells. This form was previously referred to as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes". The loss of beta cells is caused by an autoimmune response. The cause of this autoimmune response is unknown.

2. **Type 2 Diabetes:** It begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease
progresses, a lack of insulin may also develop. This form was previously referred to as “non insulin-dependent diabetes mellitus” (NIDDM) or “adult-onset diabetes”. The most common cause is a combination of excessive body weight and insufficient exercise.

3. **Gestational Diabetes**: It is the third main form, and occurs when pregnant women without a previous history of diabetes develop high blood sugar levels.

**Sign and Symptoms:**

The classic symptoms of untreated diabetes are unintended weight loss, polyuria (increased urination), polydipsia (increased thirst), and polyphagia (increased hunger). Symptoms may develop rapidly (weeks or months) in type 1 diabetes, while they usually develop much more slowly and may be subtle or absent in type 2 diabetes. Other symptoms of diabetes include weight loss and tiredness.

Several other signs and symptoms can mark the onset of diabetes although they are not specific to the disease. In addition to the known ones above, they include blurred vision, headache, fatigue, slow healing of cuts, and itchy skin. Prolonged high blood glucose can cause glucose absorption in the lens of the eye, which leads to changes in its shape, resulting in vision changes. Long-term vision loss can also be caused by diabetic retinopathy. A number of skin rashes that can occur in diabetes are collectively known as diabetic dermadeses.

**Stevia as a Cure of Diabetes:**

FDA approved and contains zero calories, Stevia is a natural plant-based sweetener that can be traced back to South America and has been used for several hundred years. The plant is known as Stevia RebaudianaBertoni and is a part of the sunflower family. The plant, which is native to Paraguay and Brazil, features many anti-diabetic and anti-oxidant properties.

Stevia contains 8 glycosides that are isolated and purified to get the sweetener in its rawest form. They are:

- Stevioside
- Rebaudiosides A, C, D, E, and F
- Steviolbioside
- Dulcoside A

Stevia also contains Steviol glycosides, which are the compounds that give the plant its sweet taste. The sweetness of these compounds is graded at 300 times higher than sugar. This means that a human require 20 percent of Stevia to provide the same level of sweetness as the other mainstream sugars. However, when consumed in its raw form, Stevia can have a bitter aftertaste.

The process of extracting Stevia begins with harvesting the leaves, drying them, extracting the water, and finally purifying it. Processed Stevia contains up to 18 percent of stevioside. Stevia does not contain carbohydrates, which means that it can affect neither insulin levels nor the blood sugar levels.

Several regulatory bodies across the world have approved high-purity stevia extracts for consumption by the general population in the recommended levels. The Acceptable Daily Intake (ADI) for stevia has been set at 4 milligrams per kilogram for both adults and children.

**Benefits of Stevia for Diabetes:**

1. **Blood Glucose Lowering**: Compared to artificial sweeteners, stevia can suppress the plasma glucose levels and raise your glucose tolerance. Stevia also has zero calories, which makes it highly beneficial for people seeking to lower their glucose levels. Sucrose makes people fat since it contains many calories. With the many sugar products available in the market, it is good to replace artificial sugars with stevia.

2. **Glucagon Hormone**: For people with type 2 diabetes, stevia has been found to trigger a glucagon response and reduce blood glucose. Glucagon is the hormone that regulates blood glucose levels in the blood. For people with diabetes, the system that produces glucagon is usually faulty.

3. **Glycemic Index**: Foods with a glycemic index of less than 50 are considered safe for people with diabetes and the lower the figure, the better it is. Table sugar has a glycemic index of 80 compared to stevia, which has an glycemic index of 0. This makes this sweet leaf the perfect substitute for processed sugar without compromising the sweetness in food.

4. **Blood Pressure Lowering**: Stevia has cardiotonic properties that normalize the
blood pressure and regulates heartbeat. This is made possible by certain glycosides in the stevia extracts that dilates blood vessels.

5. **Additional Benefits:**
   a. Compared to sugar, Stevia can regulate your appetite, thus reducing your calorie intake.
   b. Stevia also does not cause glycemic responses and has been shown to reduce blood sugar levels. It also reduces insulin sensitivity.
   c. Stevia does not alter the composition of food or their nutrients, meaning that minerals and vitamins remain at the same level.
   d. It increases the insulin effect on the body's cell membranes.
   e. Stabilizes blood sugar levels and increases the production of insulin.
   f. Counters the mechanics of the type 2 diabetes and its complications.
   g. It has anti-inflammatory, anti-tumor, and anti-diarrheal properties.

**Stevia Formulations:**

1. **Stevia Extract**: It is the most recommended stevia form because it is stevia in its pure form without any additives. However, in this state, the flavor is more intense and might not be appealing to most people. The upside is that people get all the benefits of stevia unadulterated without any impact on your blood sugar and no additional calories.

2. **Stevia Drops**: For people who find plain water boring, it can be used by adding few drops of this extract in water. Water will taste much better and no worry about the sweetener's impact on your blood sugar.

3. **Stevia Powder**: This is the most common form of stevia purchased from the market today. It is mixed with other ingredients to allow it to behave like sugar. It has less than 0.5 g of sugar per serving, an amount that is classified by the FDA as having zero calories. It is important to know the additives that have been added to this stevia before consumption to avoid complications and to get the right product for required sweetening needs.

**Who Should Not Use Stevia:**

Regular stevia use for non-diabetic people can bring about side effects due to its suppressing properties. Stevia for diabetes lowers blood pressure, blood sugar, and acts like a diuretic, which is what a diabetic person needs. Inhibiting some of the functions in the body for a non-diabetic person is dangerous. This means that the normal body functions will not run as expected in addition to the possibility of the product having harmful side effects. Moreover, stevia can also interact with medications; as such, it is important to inform physician before consuming it.

**Risks Associated with Stevia Use:**

Despite stevia is a great option for diabetics, some people might react to it with high blood sugar. It is important to understand the concept of individualism and consult with a doctor before using stevia for diabetes. It is important to monitor body when using stevia and make sure to use a glucose meter frequently.

Stevia is mixed with different ingredients that might cause sensitivity for different people. For instance, sugar alcohols, which are the main additives to stevia, can cause bloating, nausea, diarrhea, and abdominal cramps. Erythritol, which is a type of sugar alcohol that is mostly added to stevia, poses a less great risk compared to the others.

**Sale and Packaging:**

Stevia for diabetes is readily available in shopping stores and grocery stores. It is commonly sold under the following brand name: PureVia, Sweet Leaf, Truvia, Sun Crystals, EnlitenRebiana, Stevia Steviacane, and Stevia Extract Raw.
4. SERICULTURE: ENTOMOLOGY

Influence of Environmental Factors on Young Age (CHAWKI) Silkworm Growth and Development

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The rearing of young age silkworms up to II moult is called ‘chawki rearing’ which usually lasts for 7 to 8 days. The rearing of young age silkworms under ideal environmental conditions, feeding succulent, nutritious and tender leaves make the larvae robust and more tolerant to stress during late age rearing. The environmental factors such as temperature, humidity, light and air current during rearing have a remarkable influence on the growth of the larvae and ultimately on cocoon crop quality. However, these influences are not same throughout the rearing period, but varies in different stages of growth. Hence, it is necessary to provide most favourable climatic conditions suited to the silkworms at different stages.

The humidity also fluctuates widely not only from season to season but also within the day itself during any season. Yet, it should be the endeavour of every sericulturist to bring the rearing room temperature/humidity conditions as close as possible to the ideal requirements of the silkworm. This can be achieved within reasonable limits by manipulating the ventilation within the room.

1. Temperature: Rearing temperature can be divided into three groups in view of its effect on the physiology of silkworms.
   a. 20-28 °C - temperature which is harmless to the growth of silkworms. Temperature higher or lower than the range is harmful to the physiology of silkworms and cause unhealthy growth of silkworms.
   b. 25 °C - temperature which is favourable for the healthy growth of late age silkworms.
   c. 26 – 28 °C - Temperature which is favourable for making good quality cocoon. 28°C for first instar and 27°C for second instar. If silkworms are reared in such temperature it is absolutely necessary to feed them with rich nutritive leaves in sufficient quantity.

Regarding rearing temperature of each instar, it is better that the temperature in the former period is higher than that in the latter period. In case sufficient amount of nutritive mulberry leaves are not given to silkworm, high temperature will be harmful to the physiology of silkworm injuring the health and produce poor quality cocoons. The desired temperature could be attained by selecting a smaller room fitted with heating arrangement and thermostatic control device. In the absence of electrical device for heating, charcoal heating has to be done in the night whenever temperature falls below the optimum.

2. Humidity: Humidity plays a very important role in the success of bivoltine silkworm rearing. The effect of rearing humidity upon the growth and health of silkworm is similar to that of rearing temperature. High humidity makes the length of the growing period of silkworms short, accelerating the physiological activities whereas low humidity makes the length of the growing period longer. Humidity influences the physiological functions of silkworms directly. The amount of ingestion, digestion and metabolism increase with rise in humidity. Indirectly humidity affects the rate of drying of mulberry leaves in the rearing bed thereby its suitability as a feed and its consumption. Low humidity causes drying of mulberry leaves, reduces consumption, retarded larval growth and larvae become weak and easily...
susceptible to diseases. Considering the overall effect humidity range of 85 to 90 per cent in first and second instar are ideal for young silkworm. But if the air of the rearing room is too moist it becomes favourable for the growth of pathogenic microbes and consequently silkworm suffer from diseases. During moulting period, low humidity of about 70 per cent is preferable for the drying of the rearing bed. Consequently, humidity has to be maintained by using paraffin paper/polythene sheet whenever the room humidity is found below 80% R.H. Humidifier can also be used.

3. **Light:** Silkworms are fond of dim light of 20-25 lux and avoid strong light and darkness. Light has little influence on the health and survivability of silkworms, but it influences the distribution of larvae in rearing bed. Longer photoperiod during early instars strongly affect the hibernating character in the next generation, silkworms require a minimum period of 16 hours light and 8 hours dark per day. In case of silkworms reared in such conditions the weight of cocoons and cocoon shell becomes heavier than that of the larvae reared in dark condition. It is also necessary that light is provided from upper surface of rearing bed while keeping the under-surface dark, otherwise late growing of larvae and missing number of larvae increases.

4. **Air current:** Silkworm breath through the 18 spiracles on both the sides of the body, supplying blood with oxygen through tracheae which are distributed throughout the body. Fresh air is required for silkworms. In the rearing room the air is polluted with CO₂ from workers and mulberry leaves, formaldehyde gas from disinfectants and ammonia from litter. The safe limit for silkworm rearing is CO₂ 1-2%, formalin gas 1%, SO₂ 0.02% and ammonia 0.1 per cent. The young silkworms are less resistant to toxic gases. Since the production of these gases are comparatively less during early instars, it is less important to ventilate during younger stages than during later instars. However, care should be taken to remove paraffin paper cover and keep rearing bed open before each feeding to allow the movement of fresh air. It should be remembered that high moisture in the bed helps harbouring of fungus and other pathogens.

5. **Moisture content:** In newly born larvae, water content is very low, but increases rapidly up to the second instar when feeding is given. Silkworms require high water content in mulberry leaves to supply the needed water increment in their bodies. The moisture content of leaves must be above 78% and should have 30% protein and 12% or more carbohydrate. The components of increasing moisture content in leaves are regular irrigation to the plot coupled with wider spacing (0.9m x 0.9m) and higher crown height (0.2 - 0.3 m).

The above steps go a long way to provide the near-ideal environmental conditions for the silkworm to grow and thrive well.

5. **SERICULTURE: ENTOMOLOGY**

**Mineral Deficiency Diseases in Mulberry**

Prashant Natikar¹ and Muniswamyreddy, P.M²

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Sericulture is a cottage industry par excellence with its agriculture base, industrial super structure and labour-intensive nature. Of late sericulture has become one of the most important rural industries due to certain inherent advantages like minimum gestation period and expenditure, maximum employment potentiality and quick turnover of investment. India is the only country in the world that produces all four types of silk, viz., mulberry, tasar, eri and muga. The 88.60 per cent of the country’s total silk production is the
mulberry type, the term sericulture normally refers to mulberry sericulture. Karnataka occupies the pride place in the sericulture map of India. Karnataka is known as the fables land of 'Sandal and silk', has more than 45.35 per cent of the total area under mulberry cultivation contributing over 44.25 per cent of silk produced in the country.

Mulberry leaf is the only food for mulberry silkworm (Bombyx mori) due to the presence of morin, β sitosterol and swallowing factors (Babu et al., 2009). The various diseases caused by microorganisms, like any other crops mulberry also suffer due to the deficiency of available minerals in the soil. Deficiency symptoms mainly occur due to the non-availability of minerals like nitrogen phosphorus, calcium, sulphur, zinc and magnesium in the soi. Disorders caused by the mineral deficiencies can overcome by the application of suitable fertilizer/chemicals to the soil. The deficiency symptoms and their management practices are as follows:

1. **Nitrogen Deficiency:** Slow and weak growth of plant with less branching/vigour- Young green leaves show chlorosis, stem is slender and yellowish green and stunted root growth. Management: Apply nitrogenous fertilizer like urea, ammonium nitrate and calcium nitrate for correction.

2. **Potassium Deficiency:** Marginal scorching of leaves in younger stage and later become coarse, non-juicy and necrotic. The stem and root systems become weaker. Management: Apply potassium fertilizers for correction.

3. **Phosphorous Deficiency:** Intra-venial chlorosis of older leaves. The chlorosis spreads throughout the leaf followed by marginal necrosis and defoliation. Stem is slender, without fresh growth and stunted growth of roots. Management: By adding of phosphorus and NPK fertilizer, the deficiency can be controlled.

4. **Calcium Deficiency:** The defoliation of young leaves with necrosis along the veins. The stems become woody and short with yellowish tips. Roots are stubby and dry. Management: Apply calcium ammonium nitrate or single superphosphate for correction.

5. **Magnesium Deficiency:** Chlorosis and necrotic spots on leaves. The leaf tip and margin become dry and scorched. Management: Apply magnesium sulphate or magnesium oxide for correction.

6. **Sulphur Deficiency:** The deficiency of sulphur is noticed as slight chlorosis of leaves, lack of plant growth with slender stem. Management: Apply gypsum or ammonium sulphate for correction.

7. **Zinc Deficiency:** Young leaves show interveinal chlorosis and yellowish white spots on leaves. Apply zinc sulphate for correction.

**References**

Introduction

Fruits and their wastes are rich source of bioactive compounds with substantial health benefits. This compound includes an extremely heterogeneous class of compounds such as polyphenolic compounds, carotenoids, tocopherols, phytosterols, and organosulfur compounds with different chemical structures as hydrophilic or lipophilic. Polyphenols are phytochemicals found abundantly in natural plant food sources that have antioxidant properties. Polyphenols mainly include phenolic acids and flavonoids and again divided into several classes, i.e., hydroxybenzoic acids, hydroxycinnamic acids, anthocyanins, proanthocyanidins, flavonols, flavones, flavanols, flavanones, isoflavones, stilbenes, and lignans. It plays an important role in maintaining health and wellness. These bioactive compounds found in small quantity in foods, so the extraction of this compound become difficult as well as it is more important to extract without change in other properties of food. Other conventional methods such as Soxhlet extraction (SE), hydro distillation extraction, and maceration extraction (ME) have been used from past decade for extraction of polyphenols. Application of these techniques quite uneconomical due to excessive consumption of time, energy, and polluting solvents. Therefore, the aim of this article to provide brief information about some of the novel extraction techniques for polyphenols.

Some Novel Extraction Techniques for Polyphenols

1. Ultrasound-assisted extraction: The procedure involves the use of ultrasound with frequencies ranging from 20 kHz to 100 MHz. This process based on a phenomenon known as cavitation, which leads in production, growth, and collapse of bubbles. The sound waves are spread through the medium (liquid) and thereby cause expansion and compression cycles. A large amount of energy can be produced during the conversion of kinetic energy of motion, and thereby, it helps in heating the contents of the bubble. Bubbles have temperature about 5000 K, pressure of 1000 atmosphere, heating, and cooling rate above 1010 K/s. The extraction mechanism by ultrasound process involves two main types of physical phenomena first is the diffusion across the cell wall and other one is rinsing the contents of cell after breaking the walls. This increase the permeability of cell walls and produces cavitation hereby releasing cell contents.

2. Microwave-assisted extraction: It is one of the faster extraction methods with high performance extraction ability and imposes less solvent consumption for thermolabile constituents (Chee et al., 1996). Microwaves are electromagnetic fields in the frequency range from 300 MHz to 300 GHz. The principle of heating using microwave is based on its direct impacts on polar materials. Electromagnetic energy is converted to heat following ionic conduction and dipole rotation mechanisms. During ionic conduction mechanism, heat is generated because of the resistance of medium to flow ion. Ions keep their direction along field signs, which change frequently. This frequent change of directions results in collision between molecules and consequently generates heat. The migration of dissolved ions increases solvent penetration into the matrix and thus facilitates the solvation of the analyte. This process complete in three stages first is separation of solutes from active sites of sample matrix under increased temperature and pressure. Second is the diffusion of solvent across sample matrix and third is to release of solutes from sample matrix to solvent.

3. Supercritical fluid extraction: Supercritical fluid extraction is a novel technique, which uses supercritical fluid to extract polyphenols. This is the process of separating one component from another using supercritical fluid as the extracting solvent. Extraction is usually from a solid matrix, but can also be from liquids. A SCF is a type of solvent that forms when the temperature and pressure of the fluid increase above its critical points. The SCF has generated the penetration power of the gas form and density of the liquid form.
usual SCF applied in this process are methane, carbon dioxide, ethane, propane, ammonia, ethanol, benzene and water. Supercritical CO₂ has a low critical temperature (Tc = 31.1°C), is a safe and non-toxic method and also the absence of light and air may reduce the risk of degradation reactions. Since CO₂ is non-polar, it is not a good solvent for polar polyphenols.

4. High hydrostatic pressure extraction: High hydrostatic pressure extraction is one of the most advanced techniques used for the extraction of natural products from numerous plant materials. This method utilizes non-thermal super-high hydraulic pressure (1,000–8,000 bar). It works on the basis of mass transport phenomena. The pressure applied increases plant cell permeability. The cell components diffuse under applied pressure. HHPE creates pressure difference b/w the cell membrane interior and exterior. It allows solvent to penetrate into the cell causing leakage of cell components.

5. Pulsed electric field extraction: The main principle of PEF extraction is to disintegrate the structure of cell membrane for increasing the rate of extraction. The electric potential passes through the cell membrane when it is suspended in an electric field, and this electric potential separates membrane molecules based on dipole nature, i.e. according to their charge in the cell membrane. At 1 V repulsion occurs between the charge carrying molecules that form pores in weak areas of the membrane, and therefore, it causes drastic increase in permeability PEF treatment at a moderate electric field (500 and 1000 V/cm; for 10–4 to 10–2 s).

Benefits of polyphenols

- Fighting against cancer cells.
- Protecting skin against ultra violet radiation.
- Fighting free radicals and reducing in appearance of aging.
- Promoting brain health and protecting against dementia.
- Reducing inflammation.
- Supporting normal blood sugar levels.
- Protecting cardiovascular system.
- Promoting normal blood pressure.

Conclusion

Novel extracting techniques suggest an exciting way to extract polyphenols from various processing industries without altering their quality, nutrition value, color and flavors. These techniques have been shown to be simple, rapid, convenient, energy efficient and eco-friendly with using non-toxic solvents. So it can be concluded that there are several possibilities of extending the research on extracting the polyphenols from this technique to the industrial level.

References


7. FORESTRY

Physic Nut – A Biofuel Plant
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Introduction

Jatropha curcas commonly known 'Kattamanakku' in Tamil, Jatropha in English belongs to the family Euphorbiaceae. It is found throughout the tropics in various countries. The economic importance of Jatropha has been increasing due to biofuel properties. It is used as production of soap, as traditional medicine in pharmaceutical and cosmetic industries. The large scale cultivation of Jatropha on wastelands with poor soils and low rainfall in drought prone areas could provide regular employment and could improve their living conditions by providing additional income. Use of biodiesel at the village level for operating oil engines for pumping water, operating small machinery and generating electricity is another good opportunity, which will be a boon for the farmers.

Description

Jatropha is a perennial, monoecious shrub or small tree up to 4 m height; bark pale brown, papery, peeling; slash exudes a copious watery latex, soapy to tough but soon becoming brittle and brownish when dry; branches glabrous, ascending, stout. Leaves alternate, palmate, petiolate, stipulate; stipules minute; leaf base deeply cordate, glabrous or pubescent only on the veins below, venation reticulate. Inflorescence a cyme. The plant is monoecious and flowers are unisexual; occasionally hermaphroditic. Female flowers with sepals up to 18 mm long, persistent; ovary 3-locular, ellipsoid, 1.5-2 mm in diameter, style bifid. Fruit an ellipsoid capsule 2.5-3 cm long, 2-3 cm in diameter, yellow, turning black. Seeds black, 2 per cell, ellipsoid, triangular-convex.

Distribution and Climatic conditions

Jatropha curcas is a tropical shrub native to Mexico and Central America, but is widely distributed in wild or semi cultivated stands in Latin America, Africa, India and South-East Asia. The tree is well adapted to arid conditions. It is suitable for sand dune stabilization and soil conservation areas. Jatropha curcas grows on a wide range of climates and soils. This tree can be established on degraded, gravelly, sandy or saline soil with low nutrient content. It grows in areas with higher rainfall with an average annual rainfall between 300 and 1000 mm. As Jatropha curcas occurs mainly at lower altitudes (0-500m).

Propagation

Jatropha curcas is propagated through seeds and cuttings. Direct seeding can also be done in the field. Natural regeneration also takes place when the seeds get mixed with moist soil.

Nursery

Nursery provides the necessary control of moisture, light, soil and predators and allows production of healthy and hardy seedlings. In general, the soil of the nursery site should have a good structure and porosity, well drained, deep sandy loam to clay loam in texture with sufficient water holding capacity, rich in organic matter, near to a permanent/reliable source of water.

Sowing in beds

Shallow furrows of 2 cm depth should be made by fingers or using a stick. Seeds should be placed in furrows at an interval of 2 cm. After placing the seeds, the furrow should be covered with a thin layer of soil and pressed so as to embed the seeds. Deep sowing should be avoided. Another method is to dibble the seeds. After germination the seedlings can be transferred in to the polybags.

Vegetative propagation

Cuttings are obtained from mother plants either raised for this purpose in the nursery or brought from adult plants growing outside in the field. Branches of about 2-3 cm thickness are suitable for cuttings. Cuttings should be taken from the lower portion of the shoot. Cutting
length may be 30 to 40 cm. Cuttings must be prepared in the right season. The longer and thicker cuttings gave better results. Large cuttings even up to 2 m, can be planted directly in the field for hedgerow plantation. The plants established from the large cuttings yield seeds of commercial value during the first year of establishment.

**Transplanting**

Transplanting is done during the rainy season. The recommended size of the pit is 30 x 30 x 30 cm (or) 45x45x45 cm. The pits are dug in May or June. Refilling of the pits is done by mixing 1 or 2 kg of FYM and 40 to 50 g methyl parathion (2%) dust per pit. The block planting may be carried out at 2x2 m or 3x3 m spacing. A wider spacing of 4x2m is used for agroforestry systems. For hedgerow/boundary plantation of fields, the spacing should be 1x1 m.

**Yield**

*Jatropha* plant comes in bearing from first year onwards. The yield is also influenced by the planting material and management practices. The expected yield from one hectare plantation is near about 200 – 1000 kilograms. However, it may vary from place to place.

**Utilization**

**Biofence:** *Jatropha curcas* can be maintained as a hedge and is commonly grown as a live fenced around agricultural fields. It can be cut or lopped at any desired height and shelters agricultural crops. *Jatropha curcas* may also be used as a biofence around pastures and plantation areas and in the rehabilitation of badly eroded areas.

**Biofuel:** Jatropha is known to be biofuel. Jatropha oil is an environmentally safe, cost-effective renewable source of non-conventional energy and a promising substitute for diesel, kerosene and other fuels. *Jatropha curcas* seed indicates the following chemical composition; moisture 6.62; protein 18.2; fat 38.0; carbohydrates, 17.30; fibre 15.50; and ash 4.5%. The oil content is 35 to 40% of seed weight and 50 to 60% of the kernel. The oil contains 21% saturated fatty acids and 79% unsaturated fatty acids.

**Seed oil:** The seeds yield up to 31-37% of oil. It is used to prepare varnish after calcination with iron oxides. It is also used in wool spinning and textile manufacture. Along with burnt plantain ashes, oil is used in making hard homemade soap.

**Soil improver:** Press cake contains animal feed due to its toxic properties, but it is valuable as organic manure due to nitrogen content similar to that of seed cake from castor bean manure. The nitrogen content ranges from 3.2 to 3.8%, depending on the source.

**Boundary:** Widely cultivated in the tropics as a living fence in fields and settlements. *J. curcas* is not browsed by cattle; it can grow without protection and can be used as a hedge to protect fields.

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8. AGRICULTURAL CHEMICALS

Fungicides: Importance and Evolution

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Background
Global agricultural productivity is adversely affected by plant diseases and weeds thus accounting for the economic losses ranging between 20-40% in crop management and post harvest system (Savary et al., 2012). Thus plant diseases and weeds pose a serious threat to food safety and security affecting the demand of quality food (Tejeswini et al., 2014). Thus for crop protection, pesticides are used where insecticide use is the highest as 77% of total pesticide in agricultural sector in India while fungicides are about 14% of the total pesticide applied.

Damages in crop production due to plant disease has resulted in the development of many excellent fungicides but wide spread use of side specific fungicide can cause pathogens to develop resistance in the field. During 1960s, fungicides were introduced that were able to move within plant and throughout crops, the so called systemic fungicide, which replaced the previously used surface bound non systemic (immobile) products (Morton et al, 2008). These are known as second generation fungicides. Carbendazim (methyl-2-benzimidazole carbamate) is a widely used systemic fungicide that controls a wide range of pathogens on a broad range of field crops like paddy, cereals, fruits, vegetables (Utture et al., 2011). Thiabendazole is also used as a broad-spectrum anthelmintic in various animal species, for control of parasitic infestations in humans (Cuckler, 1961).

Drawbacks of 2nd Generation Fungicide:

- Mostly they act as protectant fungicide cannot as curative or eradicant fungicide because they cannot control already established infection.
- Repeated application is required.
- The resistant problem is arising.

Emergence of New Generation Fungicides

Some of the new generation fungicides registered in India for use against important horticultural diseases include Strobilurins (azoxystrobin, kresoxim methyl, trifloxystrobin, pyraclostrobin) against powdery mildew, downy mildew in grapevine and cucurbits, Valinamides (Iprovalicarb, Benhiovalicarb) against Oomycere diseases in grapevine, potato, tomato and cucurbits, Oxazolidinediones (Famoxadone) against potato late blight, Phenyl-ureas (Pencycuron) against, black scurf of potato, Mandelamides (Mandipropamid) against late blight of potato and downy mildew of grapevine (Kumar 2013). The recent discovery of boscalid has produced a substantial broadening of the biological spectrum of this class of compound, as it is most active against, Botrytis spp., Sclerotinia spp., Sphaerotheca spp., Alternaria spp., Colletotrichum spp. on fruit and vegetables, Erisyphe spp., Podosphaera spp., Venturia spp., Mycosphaerella spp. on Stemphyllum on fruit (Dolores 2012, Miles 2013).

Mode of Action:

- Inhibition of energy production
- Interference with the biosynthesis of new cell material required for growth
- By disruption of cell structure

Advantages of New Generation...
Fungicide
- Potency against target diseases
- Eco-friendly
- Safe and selective

Conclusion
The use of synthetic pesticides in agriculture and public health is facing economic and ecological challenges worldwide due to human and environmental contamination caused by majority of the conventional agro-chemicals (Popp et al., 2013; Nicolopoulou-Stamati et al., 2016). Therefore, it is the need of the hour to shift into those agro-chemicals that degrade readily when in the soil as well as in the plant body and is eco-friendly in nature. So, these new molecules can show us the way forward in attaining our goal.

References

9. HORTICULTURE

Senna (Cassia angustifolia) – The Drought Tolerant Herb

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Senna (Cassia angustifolia) locally called “Avuri” in Tamil is an annual herb cultivated in the drought tract of the southern region of Tamil Nadu and several parts of India. The local cultivars are traditionally cropped by the farmers as irrigated or rainfed crop. Senna holds a lot of promise as an ideal drought tolerant herbal plant, which can be raised through out the year. As rainfed crop, the seeds are sown in the cool season so as to reach maturity during the hot months. In India, it is cultivated in 3,000 hectares and 5,000 tonnes of dried leaves and seeds are harvested annually.

India holds the 17th place in global herbal market and earns Rs 50 million annually through the export of dried leaves, seeds, fruits and rhizomes of the medicinal plants. France,
Belgium, Sri Lanka, Switzerland, Japan and European countries are the major consumer of Senna. It has vast potential in export due to its medicinal values.

"Sennocide" the medicinal alkaloid constituent of its leaves and seeds is used as Sidda and Ayurvedic medicine. Sennocide content in senna ranges from 2.5 – 4.0 per cent depending upon the variety. The medicine prepared from senna cures cough, jaundice, stomach and skin diseases.

The local variety "Tirunelveli Avuri" is cultivated in rainfed tract of Madurai, Viruthunagar, Ramnad, Tirunelveli and Tuticorin districts of Tamil Nadu. An improved variety of Senna KKM1(S-E-1) developed and released by the Agricultural College and Research Institute, Killikulam by selection from the local cultivar Thenkalam Avuri. It survives best in drought and is being grown extensively in this region.

**Crop Needs**

The plant grows well in red soil and black soil, even it grows well in saline and alkaline soil. The pH range for better growth is between 7.0 and 8.5 with adequate drainage. The crop is cultivated in sandy and sandy loam soil of the waste land of Ramnad, Tirunelveli and Tuticorin districts of Tamil Nadu.

The seed rate of 25 kg for rainfed crop and 15 kg for irrigated crop is required for one hectare. The best season for rainfed crop is September - October and January - February is ideal for irrigated crop.

Seeds are soaked in water for 12 hours and dried under shade condition for an hour before sowing the seeds.

**Field Preparation**

Field is ploughed three to four times, 10 tonnes of farm yard manure is incorporated with soil during the last ploughing. For irrigated crops ridges and furrows are formed at the spacing of 45 cm.

**Sowing**

The seeds are sown on the side of the furrows at the spacing of 30 - 45 cm. If seeds sown by broadcasting, the thinning should be done at the distance of 30 cm after germination.

**Irrigation**

Irrigation is given once in 10 days for first two of the crop and subsequent irrigations are followed once in 20 days, totally 4-6 irrigations are required. High moisture content or wet condition of field causes the root rot diseases.

**Manuring and Intercultural Operations**

As a basal dressing, 40 kg of Nitrogen, 80 kg of Phosphorus and 40 kg of Potash are applied along one side of the ridges and covered with the soil. 40 kg of nitrogen is applied as top dressing after four weeks after sowing. On the 30th day after sowing or upon necessity, a weeding is given. The other intercultural operations like weeding and hoeing are done, upon the necessity.

**Plant Protection Measures**

**Insects / Pests**

The minor pests cause not much more loss in yield. The pod borer and leaf eating caterpillars are also not given the huge damage. Even though, the preventive measures can be taken by spraying systemic insecticides one or two times at the rate of 1 ml/l of water.

**Leaf spot and Leaf Curl**

The matured leafs are affected by this diseases. Brown to black spots and burning symptoms appear on the affected plants and the leaves are dropped from plants. As leaves are important yielding component in senna, care should be taken to avoid the yield loss. To manage this leaf diseases Carbendazim at the rate 1 ml / l of water is applied thrice, at once in 15 days interval.

**Root rot and Wilt**

These diseases are generally found when field under water logging or over moist condition. To over come this problem make adequate drainage and seeds should be treated with Carbendazim at the rate of 1g / kg of seed before sowing.

**Harvest**

The matured leaves, seeds, and whole plant
are the major yielding component in senna. The first harvest is practiced for leaves. The well matured dark greenish leaves are manually collected at three months after sowing. Second harvest is done at 30 days interval from the first harvest. This time the 75% matured pods are harvested. The last harvest is done by removing of the whole plants and kept for drying.

**Duration**

150 – 160 days.

**Processing / Drying**

The harvested leaves, pods and plants are dried under shade condition to 10% moist. Minimum 7 – 10 days may needed for shade drying. Drying should be done only under shade condition, otherwise the sennocide content will be reduced and leads to poor marketing quality.

**Yield**

In rainfed crop the one tonne of dried leaves and 400 kg of seeds/ha and irrigated crop 1.5 tonnes of dried leaves and 600 – 800 kg of seeds/ha can be obtained.

**Economics and Conclusion**

In drought region the economics of this crop is much better than other crops. The total cost of cultivation of this crop is around Rs.- 36,000 in irrigated and in rainfed it may around Rs.- 20,000 per ha. The market rate of dried leaves varies from Rs./- 75-100 per kg and for the pods it varies from Rs./- 150-200 per kg. The grower of senna can get Rs./- 75,000 – 1,00,000 per ha from the irrigated condition and in rainfed it can be expected around Rs./- 65,000 per ha. Hence, senna a drought tolerant and pest and disease resistant herbal crop can be cultivated in low rainfall areas.

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**10. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

**Role of Molybdenum in Agriculture**

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**Introduction**

Molybdenum (Mo) is required for growth of most biological organisms including plants and animals. Mo is the only transition metal taken by the plants as molybdate ions (MoO₄²⁻), which can exist in several oxidation states ranging from zero to VI, where VI is the most common form found in most agricultural soils. Mo itself is not biologically active but is rather predominantly found to be an integral part of an organic pterin complex called the molybdenum co-factor (Moco). Moco binds to molybdenum-requiring enzymes (molybdenoenzymes) found in most biological systems including plants, animals and prokaryotes. The availability of molybdenum for plant growth is strongly dependent on the soil pH, concentration of adsorbing oxides (e.g., Fe oxides), extent of water drainage, and organic compounds found in the soil colloids. In alkaline soils, Mo becomes more soluble and is accessible to plants mainly in its anion form as MoO₄⁻. In contrast, in acidic soils (pH <5.5) molybdenum availability decreases as anion adsorption to soil oxides increase. Molybdenoenzymes include the primary nitrogen assimilation enzymes such as nitrate reductase (NR), and the nitrogen-fixing enzyme nitrogenase found in bacteroids of legume nodules. Other molybdenoenzymes have also been identified in plants including xanthine dehydrogenase/oxidase involved in purine catabolism and ureide biosynthesis in legumes, aldehyde oxidase (AO) that is involved in ABA biosynthesis, and sulfite oxidase that can convert sulfite to sulfate, an important step in the catabolism of sulfur-containing amino acids. Mo is involved in protein biosynthesis and affects the formation, viability of pollens and development of anthers.

**Availability of Molybdenum in soils**

Mo is present in the lithosphere at average levels up to 2·3 mg kg⁻¹ but can increase in concentration (300 mg kg⁻¹) in shales that contain significant organic matter. Mineral forms of Mo found in rocks include molybdenite.
(MoS₂), wulfenite (PbMoO₄) and ferrimolybdenite [Fe₃(MoO₄)]. Release of Mo from solid mineral forms is through weathering, a process involving continual solution and oxidation reactions. Dissolved Mo available to plants is commonly found in the soluble MoO₄⁻ anion form. Above pH 4.23, MoO₄⁻ is the common anion followed in decreasing order by MoO₄²⁻ > HMO₄⁻ > H₂MoO₄ > MoO₂(OH)⁺ > MoO₂⁺. Once in solution, the MoO₄⁻ anion is subject to normal anion adsorption/desorption reactions, which are dependent on the specific chemistry of the soil solution. MoO₄⁻ can adsorb onto positively charged metal oxides (Fe, Al, Mn), clay minerals, dissolved organic compounds and carbonates. The adsorption of Mo onto positively charged metal oxides is strongly pH dependent with maximum adsorption occurring between pH 4 and 5. As the soil solution becomes more alkaline MoO₄⁻ availability increases. Every unit increase above pH 4, MoO₄⁻ solubility increases approx. 100-fold primarily through decreased adsorption of metal oxides. Consequently, the application of lime to agricultural soils has been an important tool to adjust soil pH and increase soluble molybdate.

Soluble MoO₄⁻ can also form ionic complexes with various ions in solution including Na, K, Ca and Mg, and can also be complexed with organic matter, particularly humic and fulvic acids. The formation of these complexes can decrease the amount of MoO₄⁻ bound by metal oxides, increasing the amount of available MoO₄⁻ in solution. Soil moisture also influences MoO₄⁻ availability where poorly drained wet soils (e.g. peat marshes, swampy organic rich soils) tend to accumulate MoO₄⁻ to high levels. In contrast, well-drained sandy soils have been shown to leach significant amounts of applied molybdenum. Thus, soils rich in organic matter and with poor drainage traditionally accumulate soluble molybdate, while sandy soils are subject to Mo leaching but in a pH-dependent manner.

**Identification of Molybdenum as an Essential Plant Element**

The requirement of Mo for plant growth was first demonstrated by Arnon and Stout (1939) using hydroponically grown tomato. Plants grown in nutrient solution without molybdenum developed mottling lesions on the leaves, and altered leaf morphology where the lamellae became involuted, a phenotype commonly referred to as 'whiptail'.

In contrast, Mo toxicity in plants under most agricultural conditions is rare. In tomato and cauliflower, plants grown on high concentrations of molybdenum will have leaves that accumulate anthocyanins and turn purple, whereas, in legumes, leaves have been shown to turn yellow.

The greatest concern associated with high plant molybdenum levels is with crops used for grazing or silage production. Ruminant animals, which consume plant tissues high in molybdenum content, can suffer from molybdenosis, a disorder that induces copper deficiencies. Fortunately this disorder can be controlled by directly maintaining adequate Mo/Cu ratios in the rumen diet or by altering the availability of molybdenum to plants by changes in soil availability (pH adjustment).

**Visual Symptoms of Molybdenum Deficiency in Plants**

Mo deficiencies have been documented in many plant species where phenotypes range in severity and appearance. In the Brassicaceae family, molybdenum deficiencies are strikingly pronounced. Visual effects in young plants include mottling, leaf cupping, grey tinting, and flaccid leaves which are often found on seedlings that remain dwarfed until dying. In older plants, where deficiencies have been rescued or when deficiency levels are modest, the symptoms appear in younger leaf tissues with the characteristic loss of proper lamina development (whip-tail), leathery leaves and meristem necrosis.

Deficiency symptoms can also be masked by the indirect effect of Mo on nitrogen assimilatory enzymes (i.e. NR). Many horticultural, cereal and legume crops growing at deficient Mo levels in the presence of nitrate fertilizers will develop pale green leaves and, at times, necrotic regions at leaf margins with accompanied decreases in overall plant growth. Mo-deficient oat and wheat develop necrotic regions on leaf blades, and seeds are poorly developed and shrivelled. In maize, Mo deficiency shortens internodes, decreases leaf areas and causes the development of chlorotic leaves. In reproductive tissues in maize,
molybdenum deficiency can alter the phenotypes in developing flowers, including delayed emergence of tassels, small anthers, poorly developed stamens, and reduced pollen grain development. Pollen that is released from the anthers has been shown to be shrivelled and have poor germination rates. In grapevines, Mo deficiency has recently been suggested as the primary cause of a bunch development disorder called Millerandage or ‘hen and chicken’. Millerandage is characterized by grapevine bunches that develop unevenly, where fully matured berries are present in a bunch alongside a large number of fertilized underdeveloped berries as well as unfertilized swollen green ovaries.

11. SOIL MICROBIOLOGY

Soil Viruses-- A Threat to Human Development

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Viruses, the smallest infectious organisms which cannot live without hosts are one of the potholes in human development. Most of the devastating epidemics and pandemics are caused due to viruses. The recent example being the coronavirus (SARS-CoV-2) that shattered the whole world with the pandemic coronavirus disease 2019 (COVID-19) contracting more than 200 countries. Viruses are present everywhere and wait for a living entity to complete their lifecycle. They also survive in soil for prolonged period and can be considered as soil transmitted pathogens like poliovirus, hanta virus, influenza virus, etc. In this article, such viral pathogens and their infectious effects on mankind will be taken into account.

Polioviruses (Enteroviruses; F-Picornaviridae) is the causal agent of Poliomyelitis or infantile paralysis which is a widespread disease all over the world and US was the hotspot for polio epidemics. The first clinical description of polio was given by the British Physician Michael Underwood. During 1893-94 in Vermont, US, the first recognised polio epidemic occurred contracting 132 people including adults. In 1952, the history was even worse affecting nearly 60,000 people in US. In 1950s and 60s, 0.5 million were killed every year in polio. In 1988, WHO initiated polio eradication programme in 125 polio endemic countries.

Hantavirus (Orthohantavirus, F-Hantaviridae) causing HPS (Hantavirus pulmonary Syndrome) or HFRS (Haemorrhagic fever with renal syndrome) has also proved its fatality for human civilisation. It causes infection in rodents. Humans are infected directly or through contact with urine, saliva are faeces of rodents. Hanta River in South Korea where early outbreak was observed and was first isolated from a field rodent in 1978 by Ho Wang Lee. The outbreak of Hantavirus causing Korean haemorrhagic fever (initial name for HFRS) affected more than 3000 troops in the Korean War (1951-53). In 1993, HPS outbreak was seen in south western region of US (Arizona, New Mexico, Colorado and Utah). There may be as many as 150,000 cases of HFRS each year all over the world; with more than half occurring in China.

Rubella virus (Rubivirus, F-Togaviridae) causes the German measles or three-day measles. The first clinical description was given by Friedrich Hoffman. In 1940, there was a widespread pandemic of rubella in Australia. During 1962-65 there was a pandemic of rubella in US and Europe contracting nearly 12.5 million people in US in 1964-65. In Japan, 15,000 cases of rubella and 43 cases of congenital rubella syndrome were reported between 2012-14.

Mumps (Mumps orthorubulavirus, F-Paramyxoviridae) is also highly contagious causing painful swelling of one or both parotid salivary glands. It spread like a wildfire among the armies involved in World War I and II. Many other human viruses like rhinovirus, parainfluenza virus, etc have also found in external environment as well as soil.

Man, the most powerful living being on earth
have also conquered over these viruses by development of vaccines like polio vaccine, MMR (Measles, Mumps and Rubella) vaccine, Influenza vaccine, etc. By the time of development of vaccines, the viruses had already accomplished their work by taking the lives of people in huge numbers. So, these smallest entities cannot be ignored. Specific measures in maintaining sanitation and healthy food habits must be taken aptly.

“A sustainable co-existence and healthy lifestyle is the call of the hour.”

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12. AGRICULTURE ENGINEERING

Sprinkler Irrigation – Artificial Rainfall Irrigation

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Sprinkler irrigation is a system of applying rainfall-like irrigation to the crops. Water is supplied through a system of pipes usually by pumping. It is then sprayed through sprinklers into the atmosphere so that it breaks up into small water drops which fall to the ground similar to natural precipitation. Small orifices or nozzles in the sprinkler break the water molecules into fine droplets through the pressure. The pressure is usually obtained by pumping. With careful selection of the nozzle sizes, operating pressure and sprinkler spacing the volume of irrigation water required to replenish the crop root zone can be applied almost uniformly at the rate acceptable to the soil infiltration rate.

Recommended crops
It is suited for most row, field and tree crops and water can be sprayed over or under the canopy of the crop. Large sprinklers, however, are not approved for irrigating sensitive crops such as lettuce because the large drops of water created by the sprinklers may harm the crop.

Response of different crops to sprinkler irrigation

<table>
<thead>
<tr>
<th>Crops</th>
<th>Water Saving (%)</th>
<th>Yield increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilli</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Cotton</td>
<td>36</td>
<td>50</td>
</tr>
</tbody>
</table>

Fenugreek 29  35
Gram 69  57
Jowar 55  34
Maize 41  36
Onion 33  23
Sunflower 33  20
Wheat 35  24

Source: INCID (1998) adapted

Recommended slopes
It is adaptable to any farmable slope, whether uniform or undulating. The lateral pipes supplying water to the sprinklers should always be laid out along the land contour whenever possible. This will minimize the pressure changes at the sprinklers and provide a uniform irrigation.

Recommended soils
It is suitable for sandy soils with high infiltration levels and also it can be suitable for most soils. The typical sprinkler application intensity (in mm / hour) is often selected to be less than the basic soil infiltration intensity. So it may prevent surface ponding and runoff.

Recommended irrigation water
Good clean water source, clear of suspended sediments, is required to prevent sprinkler nozzle blockage problems and damage the crop by covering it with sediment.
Application rate
It is the average rate at which water is sprayed onto the crops and is measured in mm/hour. The application rate varies based on the height of the sprinkler nozzles, the operating pressure and the spacing between the sprinklers. While choosing a sprinkler system it is necessary to ensure that the average rate of application is lower than the minimum infiltration rate of the soil. In this way all the water added is readily absorbed by the surface, so no drainage will arise.

Types of Sprinkler Heads

Rotor-type sprinkler is applied by rotating water streams across the soil. This involve impact and gear-drive sprinklers that create flowing water streams and spray nozzles that still discharge water across the whole wetted pattern. Impact or gear-drive sprinklers may handle patterns of operation in entire or part circles only. Since each sprinkler covers a wide area, it can be used for larger plot sizes.

Impact sprinkler Is placed on a bearing that makes the entire body of the sprinkler turn in circles. It is rotated by the impact of a swinging arm which repeatedly strikes the sprinkler’s body and causes it to rotate slightly each time.

Gear-driven Only the nozzle on a gear-driven sprinkler head moves. The water that moves through the sprinkler spins a rotor, which twists a series of gears and twists the nozzle again. This gear drive rotors have one or more water streams which rotate.

Centre pivot Irrigation is a type of overhead sprinkler irrigation consisting of many pipe segments installed on wheeled towers with sprinklers positioned along their length. The volume of water added is regulated by rotation velocity. The center pivots can be modified to any crop height and are particularly suitable for lighter soils. In addition, a corner connection system can be mounted which helps the irrigation of missing corner areas by traditional center pivoting systems.

A linear move (also called lateral move) It is built exactly the same manner as a central pivot; the only distinction is that both towers are travelling at the same pace and direction. Water is diverted either to one end or to the other.

A travelling big gun: The system utilizes a wide capacity nozzle and high pressure to pour water onto the crop as it is dragged across a field lane. Travelling big guns come in two main configurations: hard-hose or flexible-hose feed.

A side roll (also called wheel roll) The machine comprises of large side pipes placed on wheels of 1 to 3 meters in diameter and a shaft that acts as an axle. By applying the correct amount of water to an field, a central petrol engine is used to move the side roll to the next one. The sprinklers are generally mounted on weighted, swivelling connectors so that no matter where the side roll is stopped, the sprinklers will always be on top.

Basic guidelines for operation of sprinkler systems
- Main should be laid up and down hill
- Lateral should be laid across the slope or nearly on the contour
- For multiple lateral operation, lateral pipe sizes should not be more than two diameter
- Water supply source should be nearest to the centre of the area
- Layout should facilitate and minimize lateral movement during the season
- Booster pump should be considered where small portion of field would require high pressure at the pump
- Layout should be modified to apply different rates and amounts of water where soils are greatly different in the design area.

Advantages
- Eliminates water conveyance channels, thereby reducing conveyance loss.
- Suitable in all types of soil except heavy clay.
- Water saving up to 30% - 50%.
- Suitable for irrigation where the plant population per unit area is very high.
- Helps to increase yield.
- Reduces soil compaction.
- Mobility of system helps system operation easy.
- Suitable for undulating land.
Disadvantages of sprinkler irrigation

- High initial capital costs and high operation costs due to energy requirements for pumping and labor costs.
- Sensitivity to wind, causing evaporation losses.
- Unavoidable wetting of foliage in field crops results in increased sensitivity to diseases.
- Highly saline water causes leaf burning when temperature higher than 35 degrees Celsius.
- Debris and sediments in irrigation water can cause clogging of sprinkler nozzles.

13. BIOTECHNOLOGY

DNA Microarrays: A Miniature tool

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Dr. Rajendra Prasad Central Agricultural University, Pusa

Introduction

DNA microarray is a laboratory tool in which specific DNA sequences are either deposited or synthesized in an array on a surface in such a way that the DNA is attached to the surface. (Bumgarner R., 2013). DNA microarrays are microscope slides that are printed with thousands of tiny spots in defined positions. Each spot containing a known DNA sequence or gene. Often, these slides are referred to as gene chips or DNA chips. Diversity of individual sequence in a complex DNA sample can be detected and determined by DNA chip (Shalon et al.)

Working Principle

- The principle of Microarray lies on the Hybridization between the nucleotides.
- The property of complementary nucleic acid sequences is to specifically pair with each other by forming H-bonds between complementary nucleotides base pairs.

Application of DNA Microarray

- Gene expression analysis
- RNA EXTRACTION
- cDNA
- Hybridization
- Detection
- Genotyping
- SNP Genotyping Allele discrimination by hybridization
- Transcription factor binding analysis

Fig. Working model of DNA Microarray
Limitation
- Need some sequence knowledge.
- Chip to chip variation
- Not every lab can afford experiment as it is expensive.
- Novel technology and therefore not yet fully developed.
- Detection principles may not always scale down in a positive way.

References

14. PLANT PATHOLOGY
An Epiphytotic Twister Disease of Onion in Perambalur -District of Tamil Nadu
K. Manikandan and V. Keerthana,
Assistant Professors, Imayam Institute of Agriculture and Technology, Thuraiyur –

Introduction
Onion (Allium cepa L.) rightly called as “Queen of Kitchen” is one of our country’s most important commercial bulb crops and oldest crops in cultivation. Onions are grown almost everywhere in India. The most important onion growing states in India are Maharashtra tops the list in onion production followed by Madhya Pradesh, Karnataka, Bihar, Rajastan, Andhra Pradesh, Haryana, West Bengal, Gujarat and Uttar Pradesh. In India, onion is cultivated in an area of 12.85 million ha with an annual production of 23.26 million tons (Horticultural Statistics at a Glance, 2018). The onion bulbs are rich in Phosphorus (50 mg/100 g) and Calcium (180 mg/100 g) and minerals. Onion is known for the characteristic odour, taste and pungency of its bulbs due to the presence of a volatile oil Allyl-Propyl-Disulphide. There are many factors responsible for the low yield of onion and among them fungal disease is one of the important plays a vital role. The fungal disease like Anthracnose-twister incited by Colletotrichum gloeosporioides caused high yield loss due to more than 85% mortality in the main field. This paper discussed the diseases and their effects in yield of the onion.

Diseases of onion
The onions are highly susceptible to different diseases and disorders. The disease caused by Fungi - Anthracnose-twister, Purple blotch, Fusarium basal rot, Black mold, Botrytis leaf blight (blast), Damping-off, Downy mildew, Rust, Smudge and Onion Smut, Bacteria - Bacterial Blight of leek, Bacterial soft rot, Sour skin and Xanthomonas leaf blight, Virus - Iris yellow spot virus, Leek yellow stripe virus and Onion yellow dwarf virus and Nematodes - Lesion nematode, Root-knot nematode, Stem and bulb nematode and Stubby-root nematode and disorders may be due to extreme environmental factors, air pollution, soil conditions, nutritional imbalances. Diseases play a very important role in the cultivation of onions, and can reduce the growth and yield of bulbs if extreme.

Among the diseases, the Anthracnose-Twister disease plays a very important role in onion production. In 2019, an unusual outbreak of onion anthracnose-twister has become epidemic on onion crops in the coastal tract and other onion growing districts (Perambalur) in Tamil Nadu. Ebenebe 1980, reported that the disease was observed to have been uniformly distributed in the fields during the period of
heavy rainfall and high humidity causing yield losses of as high RH is 90–100%. The causal organism was identified as *C. gloeosporioides*, one of the most common plant pathogenic fungi occurring in the tropics and subtropics and causing anthracnose, necrosis, leaf spot, and fruit rots (Guarro et al. 1998).

**Characteristic Symptoms**

- This disease is also called severe curl or anthracnose or colletotrichum blight.
- The disease is more severe during the rainy season.
- The infected crop is curling, twisting and chlorosis of the onion leaves with abnormal elongation of the bulb’s neck and formation of slender bulbs.
- Some diseased plants rot before harvest (Field) while others decay rapidly when stored.
- White, oval sunken lesions also appear on the blades and in advanced stages, roots become spares and the plants die.
- Plants attacked during bulb initiation and development 45 to 75 days oil crop are affected severely as diseased plants fail to initiate bulbs.

**Survey for incidence and severity of twister disease in major onion growing areas of the Perambalur**

An intensive roving survey was carried out during 2019 (Rabi season) in major onion growing areas *viz*, Yesanai, Kurumbalur, Siruvachur, Naranamankalam, Chathiramanai, Vellore, Chettikulam and Padalur to know the more incidence and more severity of twister disease.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Twisting (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No disease</td>
<td>No any symptoms</td>
</tr>
<tr>
<td>1</td>
<td>1 - 10%</td>
<td>Curling and chlorosis leaves</td>
</tr>
<tr>
<td>2</td>
<td>11-20%</td>
<td>Abnormal elongation of leaves and neck</td>
</tr>
<tr>
<td>3</td>
<td>21-40%</td>
<td>Leaf sheath showing cluster of acervuli in concentric rings along with shallow, sunken necrotic spots and root galling</td>
</tr>
<tr>
<td>4</td>
<td>41-60%</td>
<td>Elongation neck, slender bulbs and leaves show dieback symptom</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 60%</td>
<td>Severe dieback, rotten bulbs, root system under developed with discolored roots</td>
</tr>
</tbody>
</table>

Percent Disease Index (PDI) was calculated by using the formula (Wheeler, 1969)

\[
\text{PDI} = \frac{\text{Sum of disease ratings}}{\text{Total no of observations} \times \text{Highest disease grade}} \times 100
\]

**Pathogen character**

The Acervuli with mass of conidia of a *Colletotrichum* sp in pinkish colour.

**Favorable conditions**

Heavy rainfall, High relative humidity and High Soil moisture

**Diseases Cycle**

- Primary spread - Acervuli present in infected plant debris
- Secondary spread - Conidia spread through irrigation and wind born
Managements

- Use disease free onion seeds and bulbs.
- Seeds are treated with Fungicides - Captan or Thiram or Ziram or Carbendazim @ 2g/kg of seeds.
- Seeds are treated with Biocontrol - T. viride @ 4g/kg or P. fluorescents @ 10g/kg of seeds.
- Foliar spray with Bavistin @ 0.2% or Sprint or Emisan @ 1g / lit. to reduce the disease incidence.

Reference

15. HORTICULTURE
Use of Geographical Information System and Global Positioning System in Precision Farming
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¹College of Horticulture, Bengaluru, UHS, Bagalkote, ²College of Horticulture, Mudigere-UAHS, Shivamogga

Introduction
Precision farming or satellite farming is a farming management concept based on observing and responding to intra field variations. Today, precision farming is about, whole farm management with the goal of optimizing returns on input while preserving resources. In Precision agriculture, based on soil pH, nutritional status, pest infestation, yield rates, and other factors that affect crop production the field is broken into "management zones". Based on the requirements of each zone, the management decisions are taken with application of precision agriculture technologies such as field mapping, Global Positioning System (GPS) receivers, yield monitoring and mapping, grid soil sampling, variable-rate fertilizer (VRT) application, remote sensing and Geographic information systems (GIS) etc. But opinion about Precision Farming means to the large growers of the US or European countries. But, this is far from the truth as this approach has a large potential for improving the agricultural production in developing world too. Precision Farming in India could be unique in nature; it would be primarily based more upon knowledge and less upon sophisticated techniques.

Geographical Information System (GIS):
It is a software application that is designed to provide the tools to manipulate and display spatial data. It is an effective way of computerizing maps. An important function of an agricultural GIS is to store layers of information such as yields, soil survey maps, remotedly sensed data, crop scouting reports and soil nutrients levels. GIS technology allows the manager to store field inputs and output data as separate map layers in digital maps and to retrieve and utilize these data for future input allocation decision. Clark and McGucken (1996) refers to GIS as the brain of a precision farming system because precision farming is concerned with spatial and temporal variability and it is information based and decision focused. GIS has the capabilities to analyze spatial variability.

An important function of a horticultural GIS is to store layers of information such as yields, soil survey maps, remotedly sensed data, crop scouting reports and soil nutrients levels.
- This system comprises hardware, software and procedures designed to
analyze the feature attributes and location data to produce maps.

- Computerized GIS maps are different from conventional maps and contain various layers of information (e.g. yield, soil survey maps, rainfall, crops, soil nutrient levels and pests)

Global Positioning System (GPS)
The GPS was developed by American Military for accurate positioning of military personnel. It is a navigation system based network of earth-orbiting satellites that lets user’s record near instantaneous positional information (latitude, longitude and elevation) with accuracy ranging from 100 m to 0.01 m (Lang, 1992). The GPS technology enables precision farming because all phases of precision farming require positioning information. GPS is able to provide the positioning in a practical and efficient manner for field locations so that input can be applied to individual field segments based on performance criteria and previous input application.

GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping. GPS allows farmers to work during low visibility field conditions such as rain, dust, fog, and darkness.

- GPS is a navigation system based on a network of satellites that helps users to record positional information (latitude, longitude and elevation).
- GPS allows farmers to locate the exact position of field information, such as soil type, pest occurrence, weed invasion, water holes, Boundaries and obstructions.

GPS satellites broadcast signals that allow GPS receivers to calculate their position. The system allows farmers to reliably identify field locations so that inputs can be applied to an individual field, based on performance criteria and previous input applications.

References
Brown Manuring is a advanced weed management strategy which has emerged in India. It aimed at suppressing the weeds without affecting the soil physico and chemical properties and its associated microbes.

**Methodology**

Rising of green manure crops such as *Sesbania*, sunhemp etc as intercrops and killing the same by application of post-emergence herbicides. The killed manure is allowed to remain in the field along with main crop without incorporation/in-situ ploughing until its residues decomposes itself in the soil aiming to add organic manure besides weed suppression by its shade effect. *Sesbania* crop @ 20 kg/ha is broadcasted three days after sowing and allowed to grow for 30 days and was dried by spraying 2,4-D (0.5 kg/ha) which supplied up to 15 kg/ha N, dry matter, reduces weed by 50%, no second flush of weeds higher yield by 4-5 q/ha due to addition of organic matter in low fertile soils which can be practiced in rice, maize.

**Crops Suitable for Brown Manuring**

- **Non leguminous crops:** The non leguminous crops used as a green manuring crop which provide only organic matter to the soil which can be used for brown manuring.
  - Example: Niger, Wild indigo etc.

- **Leguminous crops:** Crops provide nitrogen as well as organic matter to the soils. Legumes have the ability of acquiring nitrogen from the air with the help of its nodule bacteria.
  - Example: Sunnhemp, Dhaincha, Mung, Cowpea, Lentil etc

**Advantages of brown manuring**

- Brown manuring has its positive impact on soil physico-chemical properties viz., soil structure, organic carbon, bulk density and pH of the soil.
- Integration of herbicides with brown manuring improved protein content in grain than other management practices.
- By the practice brown manuring can replace 25 per cent of nitrogenous fertilizer with the overall soil health.
- *Sesbania* crops were knocked down by herbicide after 30 days when it is tender and succulent so as to get maximum response and makes N available immediately after application.
- Nutrient use efficiency (NUE) was positively influenced by weed management practices.
- It aimed at suppressing the weeds without affecting the soil physicochemical properties and its associated microbes.
- The brown manuring practice improves the soil physical properties results in higher moisture holding capacity, hydraulic conductivity and decreases the moisture evaporation from the soil.

**Table 1: Brown Vs Green Manuring**

<table>
<thead>
<tr>
<th>Brown Manuring</th>
<th>Green Manuring</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is a no till version of green manuring, where herbicides are used to desiccate the manure crop and weeds.</td>
<td>It refers to the incorporation of a manure crop by tillage prior to seed set usually around flowering.</td>
</tr>
<tr>
<td>The plants are left standing, providing protection to lighter soils at risk from erosion.</td>
<td>Risk of Surface erosion</td>
</tr>
<tr>
<td>Moisture is conserved.</td>
<td>Moisture is necessary for incorporation and decomposition.</td>
</tr>
<tr>
<td>Delaying in development of</td>
<td>Microbial population is necessary for</td>
</tr>
</tbody>
</table>


resistance to herbicides | decomposition

Social Feasibility of the Technology

- The technology is more suitable for risk prone agro-ecosystems in which direct seeding of rice is done.
- As most of the Indian farmers are resource poor, the technology can add more benefit.
- As the brown manuring practice is eco-friendly and improves the overall soil health, it should be widely advocated by the extension agencies to realize its benefits for the farming community of the nation.

References Cited


17. HORTICULTURE

Role of Micronutrients in Fruit Production
Polu Parameshwar ¹, Bidyarani Devisenjam² and Novin Chamling ³
Ph.D Scholars, Department of Pomology and Post Harvest Technology, UBKV, Pundibari, West Bengal

The nutrient elements which are required comparatively in small quantities are called as micro or minor nutrients or trace elements. Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. The requirement of micronutrients (boron, iron, copper, zinc, manganese, chloride and molybdenum) is only in traces, which is partly met from the soil or through chemical fertilizer or through other. Farmers seldom apply micronutrients, even though intensive modern agriculture has a depleting effect. The result is widespread micronutrient deficiencies (Anon., 1999).

Novel approaches include application of crop-specific foliar formulations of micronutrients, application of chelated forms of micronutrients and the genetic biofortification of crops. (Edward Raja 2009). The response of crops to supplementation, in cases where deficiency exists, can be very marked (Balakrishnan et al., 2012).

Micronutrients assume significance in horticultural crop production:
1. Improve quality, size, colour, taste and earliness, thereby enhancing their market appeal
2. Provide disease resistance, thereby reducing dependence on plant protection chemicals
3. Increase post-harvest/shelf life of horticultural produce thereby avoiding wastage
4. Prevent physiological disorders and increase marketable yield
5. Enhance nutritional security by biofortification.

Need for micronutrient application in fruit crops
1. To produce food of high nutritional quality
2. To encourage and enhance biological cycles within the farming system, involving microorganisms.
3. To maintain and increase the long term fertility of soils.
4. To consider the wider social and ecological impact of the farming system.

Micronutrients for Fruit Crops:
Fruit crops suffer widely by zinc deficiency followed by boron, manganese, copper, iron (mostly induced) and Mo deficiencies. Cl, Cu, Fe and Mn are involved in various processes related to photosynthesis and Zn, Cu, Fe, and Mn are associated with various enzyme systems; Mo is specific for nitrate reductase only. The significance of micronutrients in growth as well as physiological functions of horticultural crops fruits are briefed here nutrient wise.
Iron
Banana: Iron deficiency is comparatively very rare in banana plantations. However, foliar spray of 0.2 – 0.5 % ferrous sulphate checks the disorder effectively.

Citrus: The element acts as a catalyst in chlorophyll synthesis. The deficiency of iron causes network of green veins against a light green or yellow background in leaves followed by bronzing of leaves.

Grapes: The leaves turn yellow (chlorosis) during iron deficiency and the entire shoot become yellow to yellowish green under extreme conditions. The corrective measure is two sprays of 0.2% ferrous sulphate, one before bloom and the second after fruit set.

Papaya: Iron deficiency is comparatively very less in papaya. However, it is reported that foliar application of ferrous sulphate 0.15% at monthly intervals from fifteen days after planting improved the total sugars and TSS of papaya.

Pomegranate: Pomegranate responds well to foliar application of iron. Ferrous sulphate 0.4 % prior to flowering, at full bloom and at fruit set increases the yield of fruits.

Zinc
Mango: The major nutritional disorder in mango is little leaf caused by the deficiency of zinc. This leads to stunted growth of roots, shoots and leaves.

Banana: Compared to other micronutrients, Zn is the most commonly reported deficiency in banana plantations. A fruit yield of 50t/ha removes 300g of Zn/ha/year.

Citrus: Zinc deficiency is also known as mottle leaf and indicates yellow blotches between veins or terminal shoot leaves, reduced leaf size, narrow pointed and chlorotic leaves.

Grapes: Small leaves (little leaf) or rosette, widened petioles and small sized fruits are the major symptoms. spraying of 0.5 – 1% zinc sulphate 10 days before flower formation is the control measure.

Guava: Small leaf and leaf chlorosis are the major symptoms of deficiency. spraying of 0.5% zinc sulphate 15 days before flowering.

Papaya: Micronutrient disorders are comparatively rare in papaya but zinc and boron deficiencies are commonly observed in the orchards where papaya is grown continuously. Zn 0.5% + B 0.1% foliar sprays at 4 and 8 month after planting.

Boron
Mango: Stunted growth with shortened internodes and the small leaves showing pale green colour are the symptoms. Remedy is spraying of 0.2 % boric acid.

Banana: A fruit yield of 50 t/ha removes approximately 700 g B /ha/year. Corrective measure is application of borax at 20 g/plant at the time of planting and foliar spray of 0.2% boric acid at fourth and fifth month of planting.

Citrus: Granulation is a serious problem of citrus and is related to B deficiency especially under North Indian conditions. spray of different microelements at a concentration of 25-50 ppm depending on the intensity.

Grapes: The presence of small sized fruits and large sized fruits in the same bunch is known as hen and chicken disorder. Spraying of 0.2% boric acid a week before bloom and another at full bloom.

Copper
Mango: Tip burning of old leaves with grey brown patches is the typical symptom of copper deficiency. Spraying of 0.3% copper sulphate checks the disorder effectively.

Grapes: Small green foliage, rough bark, short canes with short internodes, poor root development. Spraying of 0.2% copper sulphate between bloom and two weeks after bloom controls the disorder.

Citrus: The deficiency is called exanthema, red rust, die back, multiple bud or peach leaf conditions.

Manganese
Mango: The deficiency is exhibited by light green foliage gradually turning yellow with a band of green along the midrib and principal lateral veins. The corrective measure is foliar spray of 0.1 % manganese sulphate.

Citrus: Manganese is immobile in plant and is essential for chlorophyll formation. It causes green bands of varying width along mid-rib and veins followed by leaf mottling. Spraying
Manganese chloride or Manganese sulphate at 0.5 % controls the disorder.

**Guava:** High calcium carbonate in the growing medium is likely to induce this deficiency. Spraying of 0.5% manganese sulphate before flowering checks the disorder.

**Molybdenum**

Molybdenum functions in enzyme nitrate reductase which is responsible for reduction of nitrate to nitrite during N assimilation in plants. Although molybdenum deficiency is observed in many soils and pasture legumes, vegetables and occasionally cereals, it is very rare in fruit crops.

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18. **AGRONOMY**

**Direct Seeded Rice: A New Technology for Enhanced Resource-Use Efficiency**

Makwana N. R, Kacha D. J.²Pampaniya A. G.³ and Dr. Chetariya Chana.⁴

¹Agriculture Officer²³ Assistant Research Scientist, and Ph.D. Scholars, Main Rice Research Station, Anand Agricultural University, Nawagam

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**Introduction**

Rice (Oryza sativa L.) is one of the most important food crops in the world, and staple food for more than 50% of the global population. Being the major source of food after wheat, it meets 43% of calorie requirement of more than two third of the Indian population.

Increasing water scarcity, water loving nature of rice cultivation and increasing labor wages triggers the search for such alternative crop establishment methods which can increase water productivity. Direct seeded rice (DSR) is the only viable option to reduce the unproductive water flows. DSR refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. Improved short duration and high yielding varieties, nutrient and weed management techniques encouraged the farmers to shift from traditional system of transplanting to DSR culture. Direct seeding offers certain advantages like saving irrigation water, labor, energy, time, reduces emission of greenhouse-gases, better growth of succeeding crops, Whereas, in alternate case of high wages and low water availability prefers DSR.

**Why there is a need of Direct Seeded Rice?**

The various reasons responsible for the shift from puddled transplanting system (PTR) to DSR are discussed as follows:

1. **Water scarcity**
   a. **Water -consuming puddled transplanted rice:** Conventional rice establishment system requires substantial amount of water. It has been reported that water up to 5000 liters is used to produce 1 kg of rough rice. Rice is a major freshwater user and consumes about 50% of total irrigation water used in Asia.
   b. **Increasing demand and competition of water from non-agricultural sector:** The share of water for agriculture is declining very fast because of the increasing population, lowering of the water table, declining water quality, inefficient irrigation systems and competition with non-agricultural sectors.
c. Water wise-direct seeding practices:
The establishment technologies, which inherently require less water, and are more efficient in water use are demanded by the grim water scenario in agriculture together with the highly inefficient traditional transplanting system. DSR being a water wise technology provides the solution. Both methods of DSR (Dry and Wet) are more water efficient, and have an advantage over PTR.

2. **The rising cost and scarcity of labor at peak periods**: DSR saves labor as it avoids nursery raising, uprooting seedlings, transplanting as well as puddling. Further the demand for labor is spread out over a longer period in DSR as compared to PTR, where more labor is required at the time of transplanting thus resulting in its shortage. Rapid economic growth in Asia has increased the demand for labor in non-agricultural sectors resulting in less labor availability for agriculture.

3. **Adverse effects of Puddling**: Puddling breaks capillary pores, destroys soil aggregates, disperses fine clay particles, form a hard pan at shallow depth, poor soil structure, sub-optimal permeability in the lower layers and soils compaction.

4. **Rising interest in conservation agriculture**: Conservation agriculture (CA) involves zero tillage (ZT) or reduced tillage (RT) followed by row seeding using a drill. Conservation tillage, when utilizes crop residue as mulch with improved crop and resource management methods, is termed CA or integrated crop and resource management. Declining/stagnating crop and factor productivity and a deteriorating resource base in cereal systems like rice-wheat have led to the promotion of conservation tillage-based agriculture. Now, the efforts are being made to develop ZT rice followed by ZT wheat-commonly referred to as “double zero tillage” to realize the benefits of ZT in toto.

5. **Best fit in cropping system**: Besides the savings in labor and water, economic benefits brought out by DSR through the integration of an additional crop (crop intensification) are another reason for the rapid adoption of DSR. Earlier maturity of DSR as compared to PTR fits this crop well in different cropping systems.

**Different methods of seeding**

Rice can be established by three principal methods:

1. **Transplanting**: Transplanting is the dominant crop establishment practice in Asia particularly in tropical part. In this method, the land is puddled and seedlings raised in nursery are transplanted.

2. **Dry DSR**: In Dry-DSR, rice is established using several different methods, including (i) broadcasting of dry seeds on unpuddled soil after either ZT or CT (ii) dibbled method in a well-prepared field and (iii) drilling of seeds in rows after CT, minimum tillage (MT) using a power tiller-operated seeder, ZT or raised beds. In case of both CT and ZT, a seed-cum-fertilizer drill is used, which after land preparation or in ZT conditions, places the fertilizer and drills the seeds.

3. **Wet DSR**: Wet-DSR involves sowing of pregerminated seeds (radicle 1-3 mm) on or into puddled soil. When pregerminated seeds are sown on the surface of puddled soil, the seed environment is mostly aerobic and this is known as aerobic Wet-DSR. When pregerminated seeds are sown/drilled into puddled soil, the seed environment is mostly anaerobic and this is called as anaerobic Wet-DSR. Wet-DSR under aerobic and anaerobic, seeds can either be broadcasted or sown in-line using a drum seeder or an anaerobic seeder with a furrow opener and closer

**Actual advantages from DSR**

The various benefits are enumerated below:

2. Sowing can be done in stipulated time frame because of easier and faster planting.
3. Early crop maturity by 7-10 days which allows timely planting of subsequent crops.
4. More efficient water use and higher water stress tolerance.
5. More profitability especially under assured
irrigation facilities.
7. Less methane emission in direct seeding

**Constraints associated with DSR**
1. Weeds are more competitive and Shift and Changes in weed flora
2. Development of herbicide resistance and Emergence of weedy rice
3. Increase in soil-borne pathogens and Diseases and insect pests
4. Nutrient disorders, especially N and micronutrients and Higher emissions of nitrous oxide
5. Lodging and Stagnant yield

**Possible solutions**
- Integrated weed management and Systematic weed monitoring programme
- Prefer slow release N fertilizers, nitrification inhibitors & split application of N.
- Biocide use for nematode control, Soil application of Zn, foliar application of Fe, Hill seeding, lodging resistant cultivars, optimum N dose, seeding rates, and Seed priming tools for improving stand establishment

**Future Outlook**
- Development of new rice varieties for direct seeding along with proper management practices can help in adoption of DSR.
- The change in the weed flora associated with switching over from PTR to DSR can be tackled by systematic weed monitoring program in association with integrated weed management strategies on sustainable basis.
- Proper management of microelements is also desirable since availability of microelements is reduced by direct seeding of rice.
- In direct seeding culture, WUE and productivity may improve if appropriate soil types from leveled land are selected. The various features of the crop like early crop vigor, short stature and short duration also helps in increasing WUE.
- Strategies to reduce NO$_2$ emissions can be worked out.

**References**


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**19. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

**Mine Spoil and Their Management**

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**Introduction**
Mining refers to the activities that extract ores or raw material from earth both from surface as well as subsurface. Mining industry is next to agriculture and is spread over vast areas throughout the world. In India an area of 683671 ha is under mining leases in 19 states. Maximum number of mines occurs in Rajasthan, Bihar, Orissa, Madhya Pradesh, Tamil Nadu and Maharastra.

Mining activities remove surface earth, piling it over unmined land and forming chains of external dumps i.e. mine spoil/ wasteland. Mine spoils possess very rigorous conditions for both plants and the microorganism culture. Biological functionality along with the nutrient cycle is disturbed leading to a non-functional soil
system. This is mainly due to low organic matter contents and other unfavourable physico-chemical and microbiological.

The color of a mine spoils or weathered mine soil can tell us much about its weathering history, chemical properties, and physical make up. Bright red and brown colors in spoil sand soils generally indicate that the material has been oxidized and leached to some degree. These materials tend to be lower in pH and free salts, less fertile, low in pyrites, and more susceptible to physical weathering than darker colored materials. Gray colors in rocks, spoils and soils usually indicate a lack of oxidation and leaching and these materials tend to be higher in pH and fertility. Very dark gray and black rocks, spoils, and mine soils contain significant amounts of organic materials and are often quite acidic. Dark colored spoils are also difficult to re-vegetate during the summer months because they absorb a great deal of solar energy and become quite hot. Natural succession process to recover this spoil may take hundreds of years.

Types of Mining

1. Open cast Mining: This mining refers the deep excavation of earth lithosphere in order to get the ores and raw materials. The characteristics feature of open cast mining is given below.
   a. High rock temperature
   b. Presence of explosive gases
   c. Presence of noxious fumes
   d. Out bursts of toxic fluids
   e. Radioactive features
   f. Unpredictable rock behavior
   g. Interference of subterranean water course

2. Surface Mining: This refers to the excavation of minerals and ores from the surface of the earth itself.

Impacting of Mining and Quarrying

- Extensive damages to the surface land
- Destruction of flora and fauna
- Massive disfiguration of landscape
- Effect on human habitat and eco balance
- Alteration in land use pattern
- Diversion of forest and agricultural lands
- Left ugly scar
- Shifting of towns, roads, railway lines etc.
- Destruction of ground water table
- Posed danger to mining workers
- Flora and fauna affected
- Air pollution and disease to workers

Problems Related to Revegetation of Mine Spoils

- Salinity and acidity
- Poor WHC of mined out soils
- Inadequate supply of nutrients
- Severe soil erosion
- Bulk density is less than (10-20%) the original soils
- Low infiltration rate and porosity

Rehabilitation Procedures

- Preservation of top soil for vegetation
- Selection of proper sites for disposal
- Proper configuration of the disposal dump
- Soil conversation measures- leveling, soil compaction, bunding, furrowing, trenching and mulching in reducing erosion and restoration of moisture
- Soil amendment- addition of pond slit or clay, organic manures. Inorganic fertilizer
- Selection of plant material
- Planting techniques
- Water bodies

Management

1. Rebuilding Soil Structure: Gypsum is normally incorporated into soil at about 5-10 tonnes/ha. Application of gypsum results in replacement of sodium with calcium on the soil exchange surfaces, which can improve the soil structure, reduce surface crusting and increase water infiltration. It may also reduce the pH of sodic soils (soil with
pH>8.5). An exchangeable sodium proportion of greater than 6% can indicate an unstable soil structure.

2. Management of Soil pH: Acidic mine soils can be effectively neutralized once they have been again spread at the reclamation site by applying either cement kiln dust (CaO) or limestone (CaCO₃). Lime application rates must account for both past and future pyrite oxidation in order to maintain neutral soil pH levels over time. Lime addition is a common method to decrease the heavy metal mobility in soils and their accumulation in the plant as it increases the pH of soil. Plants like Gravelliarobusta, can be planted at acidic dumps (pH 3.6-3.9), which increases the soil pH. Organic amendments such as wood chips, composted green waste or manure, biosolids etc, also increases the soil pH, in addition improves soil structure, water holding capacity, cation exchange capacity, provide as low-release fertilizer and serve as a microbial inoculum

3. Increase Soil Fertility: Areas reclaimed for agriculture or other intensive use will normally require maintenance of the fertilizer programmed. There are also certain amendments which have show promise for improving spoil as a plant growth medium. Sawdust and bark mulch are also helpful in increasing the initial mine soil organic matter contents but are generally low in N content. Saw dust and sewage sludge have been widely recognized as effective short-term fertilizers and sources of long term slow release nitrogen, besides serving as microbial inoculums. In addition, organic matter improves soil structure, reduces erosion and increases infiltration. Furthermore, organic wastes can increase the water holding capacity of mine spoils. Therefore, use of these materials as soil amendments will also require heavy fertilization with N-fertilizer. The maintenance of plant available phosphorus (P) in mine soils over time is hindered by two factors: (i) fresh mine spoils are generally low in readily plant available (water soluble) P; (ii) as mine soils weather and oxidize they become enriched in Fe oxides that adsorb water soluble P which is then "fixed" into unavailable forms. The tendency of mine soils to fix P increases over time. Because organic bound P is not subject to P-fixation, it is critical to establish and build an organic-P reservoir in the soil to supply long-term plant needs through P-mineralization

4. Afforestation measures: Over burden of coal mine soil is sodic or alkaline in nature. Vetiver is suitable to stabilize this soil suitably even to the slope of 20% or more. Fresh gold tailing are sodic in nature, poor in plant nutrients, high in sulphur and sodium. But old tailing are highly acidic, poor in nutrients and high in heavy metals. Bentonite tailing is sodic with high ESP (>35%) and hence it is susceptible to erosion. It is rich in sulphur and poor in nutrients.

The pit size is kept 45cm³ or 60 cm³ at a spacing of 2 m x 2 m. this varies with species to species. This is made on trenches of size 2 m x 60 cm x 30 cm in sloppy areas. The number of trenches per ha is 200 to 250. Soil conservation work is done wherever necessary to arrest soil erosion. The pits are filled up good soil and planted after monsoon. Watering, weeding and initial care is done for first 2-3 years till trees establishes safely.

References

20. SERICULTURE

Major Insect-Pests of Mulberry and Their
Management
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India is the second largest producer of silk in the world. India shares 14 per cent in the global raw silk production (Giridhar et al., 2009). In the year 2016-17, the Indian Silk Industry has crossed 30,000 MT mark in terms of total raw silk production for the first time and recorded a production of 30,348 MT as compared to 28,523 MT in 2015-16 indicating an annual increase of 6.4% (Central Silk Board, 2016-17). Mulberry tree is recognised as an economic tree as well as food plant for silkworm (Jaiyeola and Adeduntan, 2002). Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest. Mulberry leaf is the only food for mulberry silkworm (Bombyx mori) due to the presence of morin, β sitosterol and swallowing factors (Babu et al., 2009).

There are several factors that reduce the productivity and quality of mulberry leaves. Incidence of pests and diseases acts as major one amongst them. There are about 300 insect and non-insect pest species known to attack mulberry. The perennial nature of mulberry plants in combination with monocultural practices, increases the chances of infestation of several pests throughout the year (Santhi and Kumar, 2010). The important insect pests of mulberry are mealy bugs, hairy caterpillars and leaf webbers/rollers.

1. **Pink Mealy bug, Maconellicoccus hirsutus** (Pseudococcidae: Homoptera): Mealy bugs are hard to kill pests. They live in protected areas such as cracks and crevices of barks at the base of leaf petioles, leaf whorls and on lower side of leaves which make them inaccessible for insecticide sprays. The later instar nymphs and adult females are protected by a water repellent, white filamentous waxy coating over their bodies. Even the ovisacs in which the eggs are laid are covered by waxy filamentous coating.

**Life cycle:** The female lays about 350-500 eggs in a loose cottony egg sac during a week time. Eggs hatch in 5-10 days. The emerging crawlers are orange in colour. The females have 3 nymphal instars, while males have 4. Males, when fully grown forms a white case, inside which they transform into tiny, active two-winged fly like insects. The crawlers feed by sucking the sap from leaves or tender stem portions. Life cycle lasts for about a month. Females are bigger and wingless throughout their life.

**Damage symptoms in mulberry**

The nymphs feed by sucking the sap from tender leaves and stem portion. Hence the affected apical shoots show bunchy appearance due to curling of leaves, shortening of internodes and thickening of stem. This symptom is popularly known as 'Tukra' in India. In advance stages of infestation black sooty mould is developed in the affected area due to growth of fungus on the honeydew secreted by the mealybug. The leaf yield is tremendously reduced and are depleted in nutritive value. They occur on mulberry throughout the year, but the incidence is high in summer months (March to August). Their population is negligible during rainy season.

**Management:**

- Clip off infested apical shoots and destroy by burning or dipping in soap solution.
- Do not grow alternate host plants of the mealybug in the vicinity of mulberry gardens.
- Spray 0.05% Dimethoate (36 % EC) 12-15 days after pruning. Safe period to silkworm is 20-25 days. During summer second dose of 0.2% DDVP (76% EC) 10 days after first spray is essential to avoid recurrence of the pest during growing phase of mulberry plants. Safe period is 15-17 days.
- Release predatory ladybird beetles Cryptolaemus montrouzieri @ 250 adults or Scymnus coccivorus @ 500
adults /acre/ year in two split doses at an interval of six months.

2. **Leaf roller, Diaphania pulvurulentalis (Pyralidae: Lepidoptera):** Major seasonal pest in the southern states and infestation coincides with the onset of monsoon. Peak period of infestation is from September-December. Infestation is observed from 15 days through 70 days after pruning. It causes considerable reduction in leaf yield.

**Damage symptoms in mulberry**
The target area of the leaf roller is apical portion of the mulberry leaves, The young caterpillar binds the leaflet together by silky secretion and settle inside and devour the soft green tissues of the leaf surface. Grown up caterpillars feed on the tender portion and their faecal matter can be seen on the leaves below the affected portions.

**Management:**
- Clip off infested portion along with the larva into polythene bag and destroy by burning or dipping in 0.5% soap solution (5 g of soap in 1 litre of water).
- Collect and burn the dry leaves to destroy pupae.
- Install light traps @ 1-2 trap/acre to attract adult moths and destroy them.
- Plant dry sticks in all the sides of the garden to attract birds which feed on the larvae.
- Deep ploughing exposes pupae to sunlight and natural enemies.
- Flood irrigation also helps in destroying the pupae in the soil.
- Install light traps to attract and kill the adult moths.
- Spray of 0.1% Dimethoate 30 % EC (safe period 20 days) or 0.15% DDVP 76% EC 20 days after pruning (safe period15 days).
- Release Trichogramma chilonis @ 4 cards per acre, a week after the spray of insecticide. Do not spray any insecticide after the release of parasitoid.

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Botanicals: a Promising Alternative of Pesticides

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Introduction
Plant diseases and weeds are reported to adversely affect global agricultural productivity and altogether accounts for economic losses ranging between 20-40% in crop management and post harvest system (Savary et al., 2012). Thus plant diseases and weeds pose a serious threat to food safety and security that can affect the demand of quality food (Tejeswini et al., 2014). The use of synthetic pesticides in agriculture and public health is facing economic and ecological challenges worldwide due to human and environmental contamination caused by majority of the conventional agro-chemicals (Nicolopoulou-Stamati et al., 2016). Thus botanicals as crude extracts and active molecules of some plants have immense potential to act as alternative to synthetic pesticides for disease management which can reduce not only crop losses but also pose little threat to the environment or to human health (El-Wakei, 2013; Murugan et al., 2016).

Importance of plant extract:
The use of natural products for the control of diseases in plants is considered as an alternative source to synthetic pesticide due to their lower negative impacts on the environment, harmless and non-phototoxic. It has been proved that plant extracts exhibit inhibitory effect on pathogens. Many plant species such as Tagetes erecta L. (Du et al., 2017); Cistus ladanifer leaves (Barros et al., 2013); Helianthus tuberosus leaves (Chen et al., 2010); bark (Nguyen et al., 2013), etc. have been reported to possess anti-fungal properties due to the occurrence of natural substances.

Plant extracts possessing fungicidal activity
Ginger
The rhizome of Zingiber officinale Roscoe, one of the most widely used species of the family Zingiberaceae, is a common condiment for various foods and beverages. Ginger is a natural dietary component which has antioxidant and anti-carcinogenic properties (Manju and Nalini, 2005).

Distribution: The ginger family is a tropical group especially abundant in Indo-Malaysia, consisting of more 1200 plant species in 53 genera and about 85 species of aromatic herbs from East Asia and tropical Australia
Use: Ginger is as popular a home remedy in India today, as it was 2,000 years ago (Wu et al., 2008). The rhizomes of ginger are used as spice in food and beverages and in traditional medicine as carminative, anti-pyrexia and treatment of waist pain rheumatism and bronchitis.

Chemical constituents: The pungency of ginger is due to gingerol (major active components and most abundant constituent in the gingerol series), an oily liquid consisting of homologous phenols. It is formed in the plant from phenylalanine, malonate and hexonate (Ali, 2008).

Antifungal activity: (Arora and Kaushik, 2003) screened ginger with 40 different plant extracts for their activity against soybean fungal pathogens as F. oxysporum and they reported that ginger inhibit mycelial growth of F. Oxysporum in tomatto.

Clerodendrum infortunatum
C. infortunatum Linn. (Family-Verbenaceae, Bhat in Hindi, Ghentu in Bengali, Bhania in Oriya) have botanical importance due to randomly use as traditional medicine.

Use: It is very important in the treatment of bronchitis, asthma, fever, diseases of the blood, inflammation burning sensation, tuberculosis,
hepatoprotective (Sannigrahi et al., 2009). It is considered as anti-epileptic in Indian folk medicine (Pal et al., 2009).

**Distribution:** Clerodendrum infortunatum is found along margin of evergreen to semi-evergreen forests up to 1800 m. and distributed in the Indo-malaysia, throughout Western Ghats.

**Chemical Constituents:** The leaves of the plant were reported to contain saponin, alkyl sterols, some enzymes (Shukla et al., 2010). The chemical compound isolated from the roots is Luperol, β-sitosterol, the sterol known as Clerosterol.

**Antifungal activity**

(Anitha, 2006) reported that the ethyl acetate and hexane extracts of leaves and stems of Clerodendrum inerme and Clerodendrum phlomidis (Verbenaceae) were screened for antifungal activity. Both ethyl acetate and hexane extracts of C. phlomidis stem and leaf exhibited appreciable inhibition on all the studied plant and human pathogenic fungi. However, leaf hexane extract (1 mg/ml) of C. Inerme inhibited the plant pathogenic fungi better than the human dermatophytes.

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### 22. SOIL SCIENCE

**Fertiliser Management for Soil Health and Sustainable Agriculture**

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The global landscape is rapidly changing and the world faces an uphill challenge of ensuring food supply for everyone on the planet today and in the future. Increasing global food production in a sustainable manner will be possible only if a complex set of factors are taken into account, putting soil health management first – an objective that can be achieved only with a balanced and rational use of fertilizers and organic farming. Fertilizer impact as input on India’s food grain-driven agriculture remains of vital interest. At least 50% or more of recent increases in agricultural production are credited to fertilizers. In India, the fertilizer use efficiency (FUE) over the years has gradually declined mainly due to imbalanced and rational use of fertilizers and organic farming. Fertilizer impact as input on India’s food grain-driven agriculture remains of vital interest. At least 50% or more of recent increases in agricultural production are credited to fertilizers. 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**The need for Fertilizer**  
Although fertilizer use can contribute to environmental contamination unless managed properly, it is often an indispensable source of the nutrients required for plant growth and food production. Unless the nutrients removed are replaced in proper amounts from both organic and inorganic sources, crop production cannot be sustained: the soil will become degraded. In meeting the twin challenges of food security and environmental protection in the next quarter century, developing countries must increasingly rely on science-based agriculture because there is limited scope for area expansion or grain imports from developed countries. In science-based agriculture, mineral fertilizer combined with other modern inputs plays a critical role. In the nutrient-poor soils of the tropics, proper and balanced use of fertilizer can create a win-win situation by increasing crop production and preventing soil degradation from nutrient mining. By promoting food production in high potential areas through agricultural intensification, fertilizer use can reduce pressures on marginal lands and forest clearing. By creating additional biomass, fertilizer use can help reduce global warming by increasing the sequestration of carbon in soil organic matter.

**Organic Vs Inorganic Fertiliser**  
Unfortunately, the debate on sustainable soil fertility management is often polarised, with one reason for pure organic farming and prohibition of fertiliser use. The advocates of this view argue that mineral fertilisers are always harmful to both the soil and human health. The second reason shows that high-input inorganic fertilisation is the only way to address the worsening soil
fertility problem. Both positions are on the extreme and are rarely helpful to the fight against hunger and malnutrition. In fact, food production based on 100 percent organic inputs does not necessarily imply a good soil health management and may not always ensure long-term sustainability. Nutrient imbalance and micronutrients deficiency can reduce yield and have implications on the nutrition of consumers. On the other hand, research has also showed that heavy use of mineral fertilisers have their negative consequences, including soil acidification, ground water pollution, greenhouse-gas emissions and other effects. Long-term yield decline over time is inevitable even with the same level of fertiliser dose. There is need for balance.

**Fertilizer use, Misuse and Overuse**

In the last 50 years, the global fertilizer use has increased by 500 percent. The world fertilizer nutrient \((N+P_2O_5+K_2O)\) consumption has increased from 162 million tonnes in 2008 and is projected to reach 203 million tonnes in 2019, at annual growth rate of 1.8 percent per (FAO, 2015). Overall, mineral fertilizers have resulted in over 40 percent of the increase in food production. This is due to the fact that, nitrogen availability is the most important determinant of yield in most major crops. Excessive use of chemical fertilisers, specifically phosphorus and potassium, which have to be mined from reserves held in rocks and minerals, poses major threats to future food security. The high-energy required for production of synthetic fertilisers make agriculture and soil fertility.

Nitrogen use efficiency (NUE) is generally low, usually less than 50 percent and averaging 33 percent globally. This has been estimated to 15 billion annual loss of N fertiliser. As a result, farmers have to apply far more N fertiliser than is needed, and most of it is wasted through denitrification, volatilization losses. Nitrate levels in water in excess of the upper limit of 50 mg/litre set by the World Health Organization (WHO) are likely to pose health hazards. Fertilizer contamination also poses the danger of eutrophication of lakes, rivers, and coastal waters, with damaging consequences on aquatic ecosystems. Much of the chemical fertilizers applied to the soil, especially nitrogen, is leached and can easily become pollutants to the underground water.

**Maintaining Soil Health**

Soils are fundamental for the production of food, crops, feed, fibre, fuels and many essential ecosystem services, and regulate water resources and climate. Most of global human food production depends on the soil. Farming practices through the ages have led to accelerated soil fertility depletion through erosion and nutrient removal. Scientists have warned that modern agriculture is increasingly transforming the planet and is gradually throwing the soil’s cycle out of balance. Recent studies show that about 33 percent of global soils and more than half of agricultural soils are moderately or highly degraded due to unsustainable management practices. Soil is the world’s major storehouse for carbon, which also helps to regulate CO2 emissions and other greenhouse gases. Soil organic matter is the principal sources of other nutrients. It is a good indication of good soil health, and crop response to fertilisers. In general, soil organic matter levels are declining and the use of chemical inputs is intensifying. Thus judicious use of chemical fertilisers can create the necessary synergistic effect when combined with organic nutrient sources.

**Conclusion**

The challenge for producing enough food is not just that of intensification but how to ensure sustainability of agricultural production systems; otherwise it will be tantamount to mortgaging the resources needed by the future generation in order to meet the current needs. Soil fertility depletion cannot be addressed simply by pumping more and more chemical fertilisers to the soils. Efforts that reduce the use of chemical fertilisers without compromising soil productivity, maintaining the natural resource base and human health, is the future of agriculture. There is great urgency and perils of deferment as we transition to a more sustainable agriculture. Food and nutrition security strategies must ensure that the soil is healthy to produce healthy plant, nutritious diet and human health. This requires viewing the crop production with the lens of soil health, nutrition and with
sustainability perspective, within the wider context of food systems.

References

23. AGRONOMY

Biochar to Improve Soil Health -3R Principles

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Introduction
As a legacy of ancient inhabitants who added biomass-derived char to barren land, Terra Preta (in Portuguese meaning "dark earth") in the central Amazon basin remains more productive relative to the surrounding highly leached, strongly acidic Oxisols and Ultisols. The discovery implicates that biochar is an effective amendment for persistently enhancing and sustaining soil health—"the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans". Decades of intensive research have indicated that biochar, "the fine-grained or granular charcoal made from heating vegetative biomass, bones, manure solids or other plant-derived organic residues in an oxygen-free or oxygen-limited environment and used as a soil amendment for agricultural and environmental purposes," is capable of improving soil health by ameliorating soil physical, chemical, and biological properties [Guo et al., 2016]. In general, biochar is porous, environmentally recalcitrant (stable) and high in specific surface area (SSA) and Cation Exchange Capacity (CEC). Amendment with biochar reduces the bulk density and increases the water holding capacity and nutrient-retention of major agricultural soils.

The Mechanisms for Biochar to Improve Soil Health
Biochars normally have a high pH (1:10 w/w water extract) in the range of 8–11. Hence for acidic soils, coarse-textured, highly leached soils, biochar amendment reduces the soil acidity and subsequently improves the soil health; for alkaline soils, however, addition of biochar with significant liming values may deteriorate the overall soil health by introducing additional alkalinity. Biochar products capable of everlastinglly sustaining soil health are those with high stable organic carbon (OC) content and high water and nutrient holding capacities that are manufactured from uncontaminated biomass materials of coarse textured soils but influences little or even decreases the WHC of clayey or organic matter-rich soils [Ouyang et al., 2013]. At different application rates ranging from 0.5 mass% to 10.0 mass%, biochar amendments altered soil physical, chemical, and biological properties to different extents and enhance the seasonal crop productivity [Peake et al., 2014]. When the application rate was too low or too high (varying with the biochar source and the soil type), the biochar effect on modifying the soil health became either insignificant or even unfavorable, respectively.

- Enhances soil aggregate stability
• Increase Water-holding and nutrient-retention capacities
• Increases soil porosity and hydraulic conductivity
• Increases available water capacity (AWC) and elevates soil CEC
• Improves soil fertility by introducing mineral nutrients
• Reduce nutrient leaching losses
• Reduce Cd toxicity
• Reduces soil bulk density and penetration resistance
• Reduces soil acidity
• Facilitates soil biological activities

[Blanco Canqui, 2017]

Principles of 3R

Amending soil with biochar is a promising approach to persistently improve soil health and thereby promoting crop growth. The efficacy of soil biochar amendment depends on the soil specific, biochar (feedstock) used and application rate. To maximize the benefits of biochar application, there are the 3R principles for applying biochar to soils:

- Right biochar source
- Right application rate
- Right placement in soil.

The Right Biochar Source

Carbonization of biomass residues to biochar is mostly realized through pyrolysis and gasification. Processing biomass materials by torrefaction and hydrothermal liquefaction generates black, char-like solids (known as biocoal and hydrochar, respectively) that should not be viewed as biochar owning to the low stability of the products in natural soils [Naisse et al., 2013]. The carbonization conditions as described chiefly in pyrolysis temperature (highest treatment temperature or peak temperature), reaction (solid residence) time, heating rate (heat transfer rate) and O₂ availability influence greatly the yield and characteristics of the biochar products. In general, carbonization transforms the biodegradable feed OC into more recalcitrant forms and enriches the ash minerals in biochar, with the effects increasing at higher pyrolysis temperature. Provided complete pyrolytic transformation of the feedstock at a particular peak temperature, the biochar products decreased in yield, total N content, CEC, and acidic surface functional groups while increased in stability, pH, electrical conductivity (EC), mineral ash content, and specific surface area (SSA) as the peak temperature was elevated in the range of 300–700°C [Gai et al., 2014]. The OC content of biochar is feedstock-dependent: The OC content of wood- and crop residue-derived biochars increased with raising the peak pyrolysis temperature between 300–700°C, while the OC content of manure-derived biochars decreased gradually.

The Right Application Rate

Biochar amendment enhances soil health and promotes plant growth and the effects, may not be evident if the application rate is not significant. Hence overly high application rates, negative effects may occur. In accordance with the biochar source and the soil type, appropriate amendment rates should be determined for achieving maximal benefits from amending soil with biochar. A wide range of biochar amendment rates was employed, from 0.1 to 15 mass% soil and mostly within 0.5–10 mass% soil and more frequently in 1–5 mass% soil (roughly equivalent to 20 to 100 Mg/ha assuming the top 15 cm of field soil at a typical 1.4 g/cm³ bulk density is amended with biochar) [Kolb et al., 2009]. At application rates <1 mass% soil (20 Mg/ha or 8 Mg/ac), the effects of biochar amendment on soil physical properties such as bulk density, hydraulic conductivity, and water-holding capacity may be undetectable after a few months of natural weathering if the biochar is not highly porous to yield a tapped density <0.1 g/cm³.

The Right Placement in Soil

Soil texture, pH, EC, OC content, available nutrient level, and other properties influence the beneficial effects that could be attained through biochar amendment. Meta-analysis of the reported biochar studies illustrates that strongly acidic (e.g., pH <5.5), coarse-textured soils generally respond more in improved overall health and crop productivity to biochar amendment than neutral or alkaline, fine-textured soils [35,67]. For instance, application of...
biochar at >10 Mg/ha was able to enhance the P availability of pH <7.5 agricultural soils but had little influence on that of alkaline (pH>7.5) soils [89]. Therefore, the type of soil should be examined upon biochar amendment. To maximize its benefits, biochar should be applied to acidic (i.e., pH <6.5), strongly leached soils with low OC contents (e.g., <10 g OC/kg soil or organic matter content <2%). To alkaline soils (e.g., pH >7.5), biochar amendment may not be appropriate. If practiced, wood-derived biochars (relatively low in mineral ash content and lime equivalence) should be considered over other sources of biochars. High-quality biochars are rather recalcitrant in the natural environment and can remain in soil over hundreds of years [Guo et al.,2016]. The short-term benefits (e.g., acid neutralization and nutrient supply) of biochar amendment may dissipate in one or several growing seasons, but the long-term benefits (e.g., improved water and nutrient retention and soil aggregation) will everlastingly persist. At sufficiently high rates, biochar amendment should be a “once-a-life” practice; applying biochar to each crop is clearly not necessary. Consecutive biochar applications may be implemented to bring the cumulative amendment rates to the optimal levels if single applications were carried out at lower rates.

Conclusions

Biochar is a promising soil amendment able to persistently improve soil health and promote crop production through ameliorating soil physical, chemical, and biological properties is largely determined by its environmental recalcitrance and water and nutrient-holding capacities. Accordingly, best management programs need to be developed to maximize the benefits of biochar amendment by following the 3R principles: right biochar source, right application rate, and right placement in soil. Optimal amendment rates of particular biochar soil systems should be prescreened to ensure the pH of newly treated soils is less than 7.5 and the electrical conductivity (EC) below 2.7 dS/m (in 1:1 soil/water slurry). To maximize the soil health benefits while minimizing the erosion risk, biochar amendment should be implemented through broadcasting granular biochar in moistened conditions or in compost mixtures to cropland under low-wind weather followed by thorough and uniform incorporation into the 0–15 cm soil layer. Biochars should not be expected to serve as a chemical fertilizer alternative and function as a major nutrient source to crops but realize the synergic beneficial effects.

Reference


**Importance of Mycorrhizal interaction in Phosphate Nutrition of Plants**

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**Introduction**

Plants that develop AM symbioses can in most cases be colonized by AM fungi from different taxa. In other words, there seems to be very little specificity in the symbiosis. However, plant species can have preferences for individual AM fungi, resulting in different densities of colonization, and in some cases colonization can be very low (Smith *et al.*, 2009). These effects have been mostly demonstrated with fungi from culture collections and with plants that show positive growth responses. The variation in extent of colonization by different fungi is also applicable to natural ecosystems, where the symbionts may have coevolved over millennia, or in agricultural systems, where individual AM fungi may have been preferentially selected by particular crop management strategies.

**Uptake of phosphate from the soil**

The positive effect of mycorrhizal fungi on phosphate (P) nutrition is long known and has been attributed to:

1. The exploration of large soil volumes by the ERM (Extraradical mycelium) in which orthophosphate (Pi) is scavenged and delivered to plant cortical cells, bypassing the plant pathway for P uptake.
2. The small hyphal diameter that allows the fungus to penetrate into small soil cores in search for P, and higher P influx rates per surface unit.
3. The capability of mycorrhizal fungi to store P in form of polyphosphates, which allows the fungus to keep the internal Pi concentration relatively low, and allows an efficient transfer of P from the ERM to the IRM (Intraradical mycelium).
4. The production and secretion of acid phosphatases and organic acids that facilitate the release of P from organic complexes.

**Similar to plants, fungi have two uptake systems for P:** (1) a high affinity system that works against an electrochemical potential gradient, which takes up Pi from the soil via proton co-transport and (2) a low affinity system which facilitates the diffusion of P across the fungal plasma membrane AM and ECM fungi express high affinity P transporters in the ERM that are involved in the P uptake from the soil. The expression of these transporters is regulated in response to the externally available P concentration, and to the P demand of the fungus. Under Pi starvation the transcript levels generally increase. Interestingly, in the ERM of the ECM fungus *Hebeloma cylindrosporum* two P transporters are expressed, one transporter is up-regulated under low (HcPT1), and one transporter is up-regulated under high P supply conditions (HcPT2). The simultaneous expression of two fungal P transporters that respond differently to the P level in the soil, could enable the ERM of the fungus to take up P efficiently also from locally varying P concentrations in the soil (e.g. from nutrient hot spots or from the root rhizosphere with its low Pi concentrations (Hata *et al.*, 2010).

![Figure 1](image-url) P uptake of the plant via the plant pathway or mycorrhizal pathway. Abbreviations: Extraradical mycelium of the fungus (ERM), vesicles (V) and spores (S) of the arbuscular mycorrhizal fungus.
Fungal phosphate metabolism
Orthophosphate (Pi) that is absorbed by the ERM can (a) replenish the cytoplasmic, metabolically active Pi pool; (b) be incorporated into phospholipids, RNA-, DNA- and protein-phosphates; (c) or can be transferred into a storage pool of short- or long-chained polyphosphates (polyP). Inorganic polyP are linear polymers in which Pi residues are linked by energy-rich phospho-anhydride bonds.

Two types of polyP can be distinguished in mycorrhizal fungi: short chain polyP with a length of up to 20 Pi residues and long chain polyP with more than 20 Pi residues. The average length of short chained polyP in AM fungi has been estimated as 11-20 Pi, and of long chained polyP as 190 to 300 Pi residues. Mycorrhizal fungi can rapidly store a significant proportion (more than 60%) of their cellular P as polyP. In the mycorrhizal symbiosis, polyP are involved in:

P homeostasis in the hyphae and maintenance of low intracellular Pi levels: Low Pi levels in fungal hyphae increase the efficiency with which P can be absorbed and reduce the osmotic stress at high internal P concentrations.

Long-distance transport from the ERM to the IRM: Based on the high flux rate of P through the hyphae of mycorrhizal fungi, it has been suggested that P is transferred mainly as polyP from the ERM to the root (Grace et al., 2009). The chain lengths of polyP in the ERM are longer than in the IRM, suggesting that polyP are primarily formed in the ERM and remobilized in the IRM. In ECM and AM fungi a motile tubular vacuole system has been identified that allows the polyP transport through the hyphae separately from the cytoplasmic compartment and enables the fungus to fine-tune its local cytoplasmic Pi concentration.

Regulation of P transport: It has been suggested that mycorrhizal fungi control the intracellular Pi concentration in the IRM and the P flux to the host by regulating the formation and/or turnover rates of polyP in the IRM or in the Hartig net region. Long-chain polyP are mainly involved in long term storage of Pi, whereas short-chain polyP are correlated to the P transport in the symbiosis.

Cation homeostasis: PolyP are polyanions and their negative charge is balanced by cations. The cations K+ and Mg2+ are mainly involved in charge balance but polyP can also serve as trap for toxic cations such as heavy metals. The basic amino acid Arg+ can also be involved in the charge balance of polyP and it has been suggested that in ECM fungi polyP can also store significant amounts of N.

References

25. GENETICS AND PLANT BREEDING

Genetic Enhancement: Enhancing Genetic Potential of Plant

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The term "enhancement" was first used by Jones (1983) which according to him can be defined as transferring useful genes from exotic or wild types into agronomically acceptable background. Rick (1984) used the term pre-breeding or developmental breeding to describe
the same activity. Thus "genetic enhancement" or "pre-breeding" refers to the transfer or introgression of genes or gene combinations from unadapted sources into breeding materials. However, enhancement has been more popularly adopted by PGR scientists. It is an emerging concept emphasizing the use of plant genetic resources. There is very little difference between genetic enhancement and traditional breeding. Enhancement does not include cultivar development and refers only to the improvement of germplasm. Enhanced germplasm can be more readily used in breeding programmes for cultivar development. Pre-breeding does not differ significantly from general framework of plant breeding and is considered as prior step of sustainable plant breeding. The pre-breeding consists of identifying a useful character, capturing its genetic diversity and putting those genes into usable form. Pre-breeding leads to value addition in the germplasm.

Who Does Genetic Enhancement?
This is evident because there is no group of scientists or professionals who call themselves "genetic enhancers", or "pre-breeders"; There is no "American Society of Generic Enhancers," no "National Council of Commercial Pre-Breeders." Nor is there a recognized body of pre-breeding theory, nor textbooks on the subject, yet the job gets done exotic germplasm is incorporated into adapted, elite stocks. By and large, the job of genetic enhancement is done by a special subset of plant breeders and geneticists in the public sector, scientists who either know they must pre-breed in order to make further progress in variety development of their crop, or know they like the challenge of finding, incorporating, and adapting useful germplasm from unlikely places.

Breeding Methods for Genetic Enhancement
1. Main purpose- Broadening of genetic base
2. Main steps-
   a. Identifying useful character
   b. Capturing its genetic diversity
   c. Putting those genes in to usable form.
3. Base material-
   a. Agronomic base: Recipient parent
   b. Exotic germplasm and wild species: Donor parent
4. Impact- Value addition
5. End product- Improved germplasm lines.
6. Time frame- Long term improvement as compared to traditional breeding.
7. Undertaken by- Public sector plant breeding organizations.
8. Phase of breeding- Prior stage of plant breeding.
9. Adaptation-
   a. Create genetic diversity
   b. Broadening the genetic base of population.

Base Material used
1. Adapted cultivars
2. Exotic germplasm
3. Land races
4. Wild species

Three breeding methods or procedures which are commonly used for genetic enhancement:
1. Backcross method
2. Convergent improvement
3. Marker assisted backcross method

Gene Pool for Genetic Enhancement
1. Primary Genepool (GP1)- Intermating is easy and leads to production of fertile hybrids. Its of prime breeding importance.
2. Secondary Genepool (GP2)- It leads to partial fertility on crossing with GP1. (related species)
3. Tertiary Genepool (GP3)- It leads to production of sterile hybrid on crossing with GP1. (unrelated species)
4. Quaternary Genepool (GP4)- It refers to crop cultivars that have been developed through biotechnological approaches. It includes transgenic varieties and other value added genotypes.

Advantages Of Genetic Enhancement
1. It helps in broadening the genetic base of the population.
2. Its useful for restoring of genetic diversity in extinct crops.
3. It helps in combining useful genes or gene combination from landraces, perennials and wild species in to cultivated species.
4. It helps in developing plant types which are
suitable for mechanical harvesting.
5. It also leads to creation of new genetic variability in various economic traits, thus it leads to value addition in germplasm.
6. The germplasm lines developed through genetic enhancement become usable in traditional breeding programmes for development of productive cultivars.

Limitations of Genetic Enhancement
1. In the introgressive hybridization using wild species, there are problems of cross incompatibility, hybrid inviability and hybrid sterility.
2. Linkage between desirable and undesirable alleles pases problems in utilization of desirable alleles.
3. In general genetic recombinations are restricted in transgressive breeding.
4. Small populations are available due to poor seed setting in interspecific crosses.

26. PLANT PATHOLOGY

Recent Developments in Prions
Ashwini, R. and Vijayalakshmi, N. R

Prions are self-propagating particles of proteinaceous origin, which share the ability to transmit disease with typical infectious organisms such as viruses and bacteria, but in contrast to them prions do not have genetic material and are 100 per cent fatal. Although we do not understand completely the mechanism of prion replication, it is widely accepted that the prion protein (PrPSc) is the main or perhaps only, component of the infectious agent. When a prion enters into the healthy organism, it induces existing, properly folded normal protein to convert into the disease associated prion form. Thesenewly form prion than can go on to convert more proteins themselves, this trigger a chain reaction that produces a large amount of the prion form. The normal form of a protein is called “PrPc”, while the infectious (prion) is called “PrPSc”.

Prion diseases are transmissible, progressive and invariably fatal neurodegenerative disease of unknown cause, characterized by seizures, massive incoordination and dementia. CJD mainly affect the cerebral cortex, sporadic (CJD) accounts for 85 per cent of all CJD cases with annual worldwide incidence of 1-2 Cases/million population.

The human prion disease variant (CJD) however, is believed to be caused by a prion which typically infects cattle and causing Bovine Spongiform Encephalopathies (BSE). The disease is transmitted and caused by the consumption of BSE infected meat products (Ironside, 2006).

Protein from Arabidopsis thaliana was involved in flowering, called Luminidependens (LD). When they inserted LD into yeast, it folded incorrectly, causing other proteins to misfold and clump together (Chakrabortee et al., 2016).

Pritzkow et al. (2015) analyzed the binding and retention of infectious prion protein (PrPSc) to plants. Small quantities of PrPSc contained in diluted brain homogenate or in excretory materials (urine and feces) can bind to wheat grass roots and leaves. Wild-type hamsters were efficiently infected by ingestion of prion-contaminated plants. The prion-plant interaction occurs with prions from diverse origins, including chronic wasting disease. Furthermore, leaves contaminated by spraying with a prion-containing preparation retained PrPSc for several week in the living plant.

Prion protien is a wondering protien as well
as a devastating disease causing agent. Prion diseases have no treatment yet. Prevention is the only way to avoid prion diseases. CJD is the main disease caused from prions and future studies for the treatment of these disease will lead to curing of several other neuro degenerative disorders.

References

27. PLANT PATHOLOGY
Mechanisms of Plant Virus Strain Evolution
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Over the years, agriculture across the world has been compromised by a succession of devastating epidemics caused by new viruses that spilled over from reservoir species or by new variants of classical viruses that acquired new virulence factors or changed their epidemiological patterns. However, virus strain evolution is more complex process in which the main players are ecological factors, genetic plasticity of viruses and host factors.

The diversity in nucleotide sequences among viruses, both within and between the species is enormous when compared to other life forms on earth. Plant viruses utilize several mechanisms to generate the large amount of genetic diversity. Among them, mutation, recombination and reassortment are major mechanisms of evolution and other mechanisms such as gene duplication and overprinting are not frequent.

Amongst the Closteroviridae family, in case of Citrus tristeza virus (CTV) recombination rather than mutation has been shown to be the major factor in the strain evolution, producing six extant strains (VT, T68, T3, T30, T36 and RB). Strains of CTV have evolved and diversified across the adaptive landscape which includes many hosts and vector species leading to diversity within non-functional domain regions, while some structural and replication associated proteins were much more conserved.

Characterization and phylogenetic analysis of a begomovirus isolate (OY136A) infecting okra plants revealed the presence of the highest nucleotide identity with isolates of Cotton leaf curl Bangalore virus (92.8 %) and Okra enation leaf curl virus (81.1- 86.2 %). The recombination analysis suggested the exchange of genetic material between Bhendi yellow vein mosaic virus and Cotton leaf curl Multan virus (Venkataravanappa et al., 2013).

The fate of newly produced variants are usually decided by selection pressure and genetic drift operating in nature. Further, genetic bottlenecks accelerate the gradual accumulation of deleterious mutations in the absence of recombination leading to extinction or mutational meltdown that ends in sudden decrease in population of strain as put forth by Muller (1964) and is popularly known as Muller’s ratchet. The evolutionary history of Tobacco mosaicvirus (TMV) and Tobacco mild green mosaicvirus (TMGMV) are the two type examples of Muller’s ratchet (Fraile et al., 1997).

The world is undergoing a period of accelerating climate change accompanied by rapid expansion in human activity. Both of these factors are impacting on plants, vectors and viruses causing increasing instability within virus-plant pathosystems. This has led to the emergence of new viruses and strains of the classical viruses. Advances in molecular biology
has provided the better understanding of changing dynamics of viral epidemiology, ecology and evolution in different regions and their implications to manage the epidemics that threaten crop production and biodiversity.

References:

28. AGRONOMY

Aerobic Rice
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Rice (Oryza sativa L.) is a major food crop for more than half of the global population, is grown in over 95 countries worldwide and about 90% of the world rice is produced and consumed in Asia [Coats, 2003]. The stability and sustainability of rice production are important for world’s food security and transplanted flooded rice is still the main rice production system worldwide. Farmers were usually preferred transplanted flooded rice over aerobic rice because of better weed control with the practices of transplanting, puddling and continuous flooding. However, the sustainability and productivity of transplanted flooded rice systems are at risk owing to labor shortage, water scarcity and high greenhouse gas emissions in this system. Effective and eco-friendly herbicides have been developed to suppress the weeds in rice fields, which makes a transplanted flooded rice system unnecessary for weed control. Compared with wheat and maize, transplanted flooded rice consumes two or three times more water because a huge amount of water is lost through percolation, surface evaporation and puddling.

Tuong and Bouman (2003) indicated that 39 million ha of transplanted flooded rice may face “physical water scarcity” or “economic water scarcity” in Asia by 2025. At present, per capita water resource share in China is the lowest amongst different countries in Asia. Therefore, the need to make better use of the limited water resource is inevitable, particularly, for rice cultivation. Furthermore, continuous flooding has been proven to be unnecessary for rice physiological requirement, because aerobic cultivation and AWD (alternation of wetting and drying) irrigation have both provided suitable conditions for rice growth and recorded equivalent or an even better grain yield (Buckle, 2010).

The transplanted flooded rice is also a major source of greenhouse gas emissions, especially methane (CH₄), since puddling and continuous flooding provides an anaerobic condition in the rice field, which promotes the activity of methanogenic bacteria to produce CH₄. Several previous studies have reported that reducing the flooding period through decreasing water input is an effective way to reduce CH₄ emissions (Tao et al., 2016). Kang and Eltahir (2018) indicated that climate change and heavy irrigation in the North China Plain has led to deadly heatwaves and an increase in air temperature, which could be a significant threat to crop growth and human health in the near future. All these issues support the need for an alternative rice production system, particularly, for those regions having limited availability of water and labor resources.

Aerobic rice has the potential to replace transplanted flooded rice, as rice cultivation is seriously threatened by environmental and social factors. Aerobic rice system is a new production system in which rice is grown under:

- Nonpuddled,
- Nonflooded
Nonsaturated soil conditions.
Although the recently released upland rice cultivars have higher drought tolerance, low yield potential of these cultivars makes them less feasible for high-yielding rice planting regions under aerobic cultivation.

Target area- Aerobic rice can be a suitable technology, in the following areas:
1. **Favorable uplands**: these are areas where the land is flat and where rainfall with or without supplemental irrigation is sufficient to frequently bring the soil water content close to field capacity and where farmers have access to external inputs such as fertilizers.
2. **Fields on upper slopes** or terraces in undulating, rainfed lowlands; quite often, soils in these areas are relatively coarse-textured and well-drained, so that ponding of water occurs only briefly or not at all during the growing season.
3. **Water-short irrigated lowlands**: these are areas where farmers do not have access to sufficient water anymore to keep rice fields flooded for a substantial period of time.

**Varieties**
Suitable variety PMK (R) 3

**Spacing**
Optimum plant population: 50 hills per m² (20 x 10 cm)

**Land preparation & Sowing method**
Aerobic rice usually established with direct dry seeding method. Aerobic rice also allows practices of conservation agriculture as used in upland crops, such as mulching and minimum tillage. **Ridges and furrows were suitable for Aerobic rice.** Green manure intercrop in aerobic rice: Daincha intercropping and incorporation at 25 DAS.

**Water Management**
Aerobic rice can be rainfed or irrigated. Irrigation can be applied through flash-flooding, furrow irrigation (or raised beds), or sprinklers. Unlike flooded rice, irrigation when applied is not used to flood the soil but to just bring the soil water content in the root zone up to field capacity.

**Irrigation**
IW/CPE ratio of 1.0 with 3 cm depth of water – total water requirement of 650 mm.

**Surface drip fertigation:**
Under aerobic rice conditions, schedule surface drip irrigation (with the lateral distance of 80 cm) at 125 % Open Pan Evaporation (PE) for clay soil / 150 % PE for sandy soil along with fertigation of 500 ml / ha of Azophosmet (composite biofertilizer) as seed treatment (@ 200 g / 10 kg seeds) and fertigation through drip system @ 500 ml / ha to be given during panicle initiation and flag leaf stages.

**Sub-surface drip biogation:**
Under aerobic rice conditions, schedule sub-surface drip fertigation (laterals concealed at 10 cm soil depth at a distance of 80 cm) scheduled at 125 % Open Pan Evaporation (PE) for clay soil / 150 % PE for sandy soil along with fertigation of Azophosmet as seed treatment @ 200 g /10 kg seeds and fertigation @ 500 ml / ha and along with biogation of seaweed extract @ 500 ml / ha to be given during panicle initiation and flag leaf stages.
Advantages of Aerobic rice

- Lowland rice planting system without puddling
- Saves water and labor
- Reduce the emissions of greenhouse gases as compared with transplanted flooded rice.
- Water use <60% of lowland irrigated rice
- Total water productivity was around 1.8 times higher and net returns to water use were two times higher (Wang et al., 2002).
- Grain yield of 5 to 6 t/ha with high-yielding rice cultivars (Kato et al., 2009).

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29. SEED SCIENCE AND TECHNOLOGY

The Glassy State in Seeds

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Introduction

Desiccation tolerance is a rare phenomenon in angiosperm vegetative tissues but it is common, although not ubiquitous, in seeds. It implies the ability of a plant or plant part to come into equilibrium with atmospheric relative humidity (RH) and to survive under this state for ecologically significant periods. When in equilibrium with the atmosphere, the tissue will generally have a water content in the range of 0.05 to 0.15 g H₂O • g⁻¹ dry mass and a water potential [ψ] ≤ - 100 MPa. Desiccation tolerance in seeds is of particular importance, not only for its ecological consequences but because the ability of seeds of many species to survive severe dehydration has been exploited by humans to store them for relatively longer periods.

Requirements for desiccation tolerance

A spectrum of requirements exists for the acquisition of desiccation tolerance and its maintenance in the dry state in seeds. These include

1. **Proteins**: Two main classes of stress-associated proteins that are associated with seed development are the small heat-shock proteins (HSPs) and the late embryogenesis abundant (LEA) proteins.

2. **Carbohydrates**: Accumulation of sucrose and particularly the raffinose series oligosaccharides and galactosyl cyclitols has been recorded to accompany the acquisition of desiccation tolerance and to persist in the dry state in seeds.

3. **Reactive (Active) oxygen species (ROS) and the vital role of antioxidants**: ROS are formed when high-energy-state electrons...
are transferred to molecular oxygen (O₂), which include \( \text{O}_2 \) (singlet oxygen), \( \text{H}_2\text{O}_2 \) (hydrogen peroxide), \( \text{O}_2^- \) (the superoxide radical), and \( \text{OH}^- \) (the hydroxyl radical), which have long been considered as toxic species that can cause oxidative damage to lipids, proteins and nucleic acids. Consequently, activity of the spectrum of enzymatic and nonenzymatic antioxidants, which include superoxide dismutase (SOD), catalase (CAT), peroxidase (POX), glutathione reductase (GR) has generally been considered as vital in the context of inactivating the ROS- that is, in intracellular protection.

4. Glassy state: A glass can be defined as an amorphous, non-equilibrium condition in which a liquid achieves such a high viscosity that it resembles a solid. The very high viscosity of a glass is due to closely packed molecules in which long-range order is lacking. Low moisture content contributes to the formation of this intracellular glass.

**Glass Transition Temperature (Tg):** It is the temperature at which glassy state is lost or melts. It depends on molecular weight of sugars, composition of sugars, and presence of plasticizers.

Polyols are particularly prone to become glassy as they dry. The larger sugars (e.g., sucrose, the oligosaccharides) are somewhat more favourable to glass formation in seeds than the reducing sugars, in part because of higher molecular weight, and hence they have a higher glass transition temperature (Tg). Mixtures of sugars form more stable glasses, a feature which is utilized in food technology where sugar mixtures are purposely introduced into dry foods to increase the stability of their glassy state in storage. The stabilizing effect of mixed sugars is partly due to the elevation of the Tg and more importantly, to the lesser tendency of the mixture to become crystallized. Of course, crystallization of the sugars in a drying system can suppress or even obliterate the formation of a glass. It is noteworthy that most orthodox seeds contain mixtures of sucrose with raffinose or other oligosaccharides.

**What Results in Glass Formation?**

Removal of water induces a supersaturation of the cytosolic components leading to increase cohesive forces between molecules and restriction of the molecular mobility within the cytoplasm. As the concentration of solutes increases, viscosity of the solution increases, resulting decrease in molecular mobility of molecules and it also true for the cytoplasm of seeds upon drying. Hence, drying results in intracellular glass formation.

**Analysis of Glassy State is Done Using the Following Techniques**

- **Differential Scanning Calorimeter (DSC):** It is a thermo analytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature. As glass forms or melts, the heat capacity of the sample changes indicated by a stepwise drop or rise in the apparent baseline of the power/time plot.
• **Electron Spin Resonance (ESR):** The general principle is based on the interaction of an unpaired electron with an external magnetic field (Zeeman Effect).

• **Thermally Stimulated Depolarization Currents (TSDC):** It is based on measurements of dielectric relaxation events occurring in polarized and frozen tissue during controlled heating.

• **Thermal Mechanical Analysis (TMA):** It is essentially a temperature-programmed penetrometer. It measures the mechanical properties, the expansion in volume and the softening of a sample, as it passes through the temperature region of interest.

• **Dynamic mechanical analysis (DMA):** It measures the mechanical properties of a sample, specifically, the storage (elastic) modulus and the loss (viscous) modulus as a function of temperature and the resonant frequency to an applied vibration stress.

### Conclusion

- The ability to probe the entry or exit from the glassy state has led to evidence that the glassy state does provide protection of dry seeds from deteriorative reactions.
- The loss of the ability to enter the glassy state may be followed by a relatively rapid loss of seed germinability.
- Glasses can also be found in desiccation-sensitive tissues, indicating that the lack of desiccation tolerance was not related to an absence of a glassy state.
- The glassy state alone probably does not itself account for desiccation tolerance in orthodox seeds.

### References


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### 30. BIOTECHNOLOGY

#### A Step to Low-Cost Tissue Culture Technology

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**Introduction**

Low-cost tissue culture technology is the adoption of practices and use of equipment to reduce the unit cost of micropropagule and plant production. Low cost options should lower the cost of production without compromising the quality of the micropropagules and plants. In low cost technology cost reduction is achieved by improving process efficiency and better utilization of resources. Low-cost tissue culture technology will stay a high priority in agriculture, horticulture, forestry, and floriculture of many developing countries for the production of suitably priced high quality planting material.

**The Need for Low Cost Technology**

In many developed countries, conventional tissue culture-based plant propagation is carried out in highly sophisticated facilities that may incorporate stainless steel surfaces, sterile airflow rooms, expensive autoclaves for sterilization of media and instruments, and equally expensive glasshouses with automated control of humidity, temperature and day-length to harden and grow...
plants. Many such facilities established at a high cost are high-energy users, and are run like a super-clean hospital. The requirements to establish and operate such tissue culture facilities are expensive, and often are not available in the developing countries. For example, the cost of electricity in the developed countries is much lower, and its supply far better assured than in the developing countries. The same can be said of the supply of culture containers, media, chemicals, equipment and instruments used in micropropagation. Hence, alternatives to expensive inputs and infrastructure have been sought and developed to reduce the costs of plant micropropagation.

**Conventional Carbon Sources and Low Cost Alternatives**

Sucrose is the most commonly used carbon source in the micropropagation of plants. Sucrose adds significantly to the media cost. Household sugar and other sugar sources can be used to reduce the cost of the medium. Household sugar and other sugar sources can be used to reduce the cost of the medium. Sugar sold in grocery stores is sufficiently pure for micropropagation.

**Conversion of House into Tissue Culture Lab**

![Diagram of Tissue Culture Lab]

**Alternatives to Agar**

- Cheaper alternatives to agar include various types of starches and plant gums.
- Gelrite can be replaced with starch-Gelrite mixture.
- The use of liquid media eliminates the need of agar.
- Other options include wheat flour, laundry starch, semolina, potato starch, rice powder and sago.
- The use of laundry starch, potato starch and semolina in a ratio of 2:1:1 reduces the cost of gelling agent by 70-82%.

**Low Cost Option for Media Making**

- The volume of medium prepared in large sized-laboratories can range from 200 to 500 liters per day.
- The media should be made and used in small batches.
- Non-sterile media should not be stored at room temperature for more than 24 hr, especially when it contains high amounts of sucrose. These should be refrigerated until further use.
• Media are usually dispensed into containers either manually or with a peristaltic pump. Manually, one person can fill more than 200 containers an hour.

• In some large-scale laboratories, the distribution of sterile media is automated. To be economical, the automation must be able handle many hundred containers per hour.

Low Cost Lighting
Changing the method of illumination from artificial to natural light is a decisive low cost option in tissue culture. This not only reduces electricity and capital costs, but also improves the plant quality.

Expensive artificial lights can be replaced in several ways. One option is to grow the in vitro cultures in diffused natural light under plastic or glass. This works very well in temperate climates, but under tropical conditions, heat build-up has to be reduced by installing thermostat-controlled exhaust fans.

It is also possible to redesign the existing laboratories in tropical and subtropical countries, and replace the artificial lights with ‘Solatube’, which can be installed in any roof, and redirects the daylight through reflective tubing.

Another method is to incorporate Southwest facing glass windows in the growth rooms that allow indirect diffused natural daylight.

By using either muslin or Venetian curtains made of bamboo or plastic, the light can be diffused to the desired intensity. The growth room is usually located on the upper storey of the house to allow sunlight from all directions.

Low Cost Temperature Regulation
• Maintaining in vitro cultures at a regulated temperature with air conditioners adds to the cost but does not contribute to specific plant quality. In fact, as in the case of artificial lighting, plants grown under a narrow temperature range are at a disadvantage during hardening and later under the field conditions.

• Elimination of this factor significantly contributes to reduction in electrical costs. Contrary to the common belief that the day- and night-temperature in the growth room must be strictly controlled at an even level, many in vitro growing plants can tolerate wide fluctuations in temperature.

• High daytime temperatures of up to 28-30°C and as low as 10-12°C at night do not damage plant growth. On the contrary, fluctuations in temperature promote better growth.

Reducing Energy Costs for Water and Autoclaving
• Normally, distilled water is produced from water stills operated by electricity. Some water stills and autoclaving require a three-phase connection. For small facilities, it is prudent to operate the units on a single-phase electrical connection.

• In small units, tap water may be used after autoclaving rather than distillation. Pressure cookers heated with gas can also be used where capital is a constraint. In case of large-sized facilities, autoclaves and water distillation equipment operated on electricity is still the most economic.

31. AGRONOMY

Integrated Weed Management – A Way to Control Weeds without Damaging Soil Health
Varshini S.V.
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Integrated weed management (IWM) can be defined as a holistic approach to weed
management that integrates different methods of weed control to provide the crop with an advantage over weeds. It is practiced globally at varying levels of adoption from farm to farm. IWM has the potential to restrict weed populations to manageable levels, reduce the environmental impact of individual weed management practices, increase cropping system sustainability, and reduce selection pressure for weed resistance to herbicides. (Harker and O'Donovan 2013).

**Need for integrated weed management**

- One method of weed management may not be effective and economical
- Single herbicide is not effective for controlling wide range of weed flora
- Continuous use of same herbicide creates herbicide resistant weeds and shift in weed flora
- Continuous use of one practice results in undesirable effect Eg. Rice – Wheat cropping system – *Phalaris minor*
- Only one method of weed control may lead to increase in density of particular weed
- Indiscriminate herbicide use leads to deleterious effect on environment and human health.

**Preventive measures**

This is one low cost technology which can be adopted by any farmers. Preventive measures has to be adopted to avoid the entry of weed seeds onto the farm through one of these means i.e., manures, seeds or planting material, mulching material, farm implements, animals and water.

These preventive measures also include implementation of some policy issues and quarantines.

- Selection of good quality seeds preferably certified seed is one of the prime factors in managing the weeds. “One year seeding is seven years of weeding” if weed seeds once sown will take seven years to eradicate those seeds by weeding. Therefore, with the aim of reducing the weed seed bank relevance of the principle of “Prevention is better than cure” is a must.
- The inundation of weed seeds can be checked without investing any extra money by using well decomposed manure/compost.
- Practice of clean cultivation also aids as preventive measure in weed management. These preventive measures are low cost technologies which further reduce the menace of weeds during the cropping season. (Shubhashree and Sowmyalatha 2019)

**Component of integrated weed management**

- Physical weed management approaches include mechanical techniques such as hoeing and tillage and thermal techniques such as flame weeding.
- Chemical weed management is dominated by the synthetic herbicides, but, there are also "natural" herbicides.
- Biological weed management uses an understanding of plant biology, for example germination, to manage weeds.
- Ecological weed management uses the interactions among species to achieve weed control, e.g., crop-weed competition, allelopathy and crop rotations.

**Advantages**

1. The shift in crop weed competition in favour of crops.
2. Prevents the weeds from changing into perennial nature.
3. Prevents the resistance to herbicides in weeds.
4. Minimum pollution of the environment.
5. Contribute towards the economic crop production.
6. Minimisation of the danger of herbicide residue in soil or in plants.

**Conclusion**

The key to a successful weed management programme is the effective insertion into crop management programmes of those control techniques that will minimise the impacts of weed not controlled by the competing crop.
dependence on overly generalized and increasingly expensive chemical input packages should be minimized.

The integrated weed management systems approach fits into the work habit of many farmers and gives more effective control than when only chemical methods are used. In addition, yield improvements in the order of 40 to 100 % are realized. While integrated weed management systems are considered technologically sound, the social and environmental advantages, as well as the economic costs associated with the practice, need to be ascertained. By adopting integrated weed management soil and crop productivity can be increased without affecting the environment.

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### 32. POST HARVEST TECHNOLOGY

**Major Medicinal Values of Minor Fruit Crops**

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India’s diverse agro-climatic regions facilitate large production of wide variety of fruits and vegetables. There are hundreds of edible fruits growing in our country and some are considered as Major fruit crops and some are as Minor fruit crops. They are considered as major fruit crops because of their growing area, adaptability and likeness of the consumers, for example, mango, banana, citrus etc., minor fruit crops are those which are not under intensive cultivation, whose acreage is less and commercial production is not yet systematised, for example, aonla, ber, fig, pomegranate, jamun etc. The nutritional value of minor fruits is nearly comparable with the major fruits and these minor fruits are cheap and efficient source of many medicinal properties compared to major fruits (Arora and Pandey, 1996).

**Importance of minor fruits**

- Helps in treating many health disorders like Diabetes, Coronary heart diseases, Blood pressure etc.,
- Helps in curing many nutritional disorders, nutrient deficiencies
- Also provides four F’s i.e., Food, Fodder, Fibre and Fruits which can provide alternative and a basis for sound farm economy
- Provides raw materials for processing, pharmaceutical, drug industries (Chadha, 2003)

**Aonla**

Also called as Indian gooseberry and is considered as treasure house of medicinal properties. The fruits are rich source of proteins, ascorbic acid and amino acids like, glutamic acid, proline, aspartic acid, alanine and lysine. Aonla contains 20 times more vitamin C than orange. They possess expectorant, cardio-tonic, anti-pyretic, anti-oxidative, anti-viral and anti-emetic properties. Aonla juice along with bitter gourd juice taken daily stimulates pancreas to produce more insulin. Similarly, mixture of aonla powder, jamun seed powder and bitter gourd powder has prominent effect in treating diabetes. Dried aonla mixed with jaggery is used to treat rheumatism. Regular dose of aonla juice with honey improves eyesight, cures glaucoma and conjunctivitis (Aykroyed, 1956).

**Bael**

Also known as stone apple. The fresh halfripe possess laxative property and helps in treating dysentery, diarrhoea, hepatitis, tuberculosis, dyspepsia and are also good for good for heart and brain. A poultice of bael
bark on wounds of insect sting nullifies the poison and helps in healing. The decoction of bael root, castor root and ashwagandha root with rock salt is considered good for cardiac patients. Juice of young leaves is mixed with milk and sugar is given as remedy for biliousness and intestinal troubles in children.

**Jamun**
Fruits are rich source of iron and are used as effective medicine against diabetes, heart and liver disorders. Consumption of fresh fruits or fruit juice purifies blood stream, avoids bad breath, strengthens gum and teeth, and cures throat pain. Fruits are good for people suffering from phlegm, constipation and piles. Seed powder is rich in fibre and this fibre content delays glucose absorption and there by reduces the quantity of sugar in urine. Fruit juice sherbet is good for treating diarrhoea and dysentery.

**Annona fruits**
Custard apple improves blood level, improves digestion and good for heart. Crushing fresh leaves with fingers and sniffing, helps patients suffering from hysteria, fits and fainting. Paste of unripe custard apple and salt is applied to treat tumours. Washing hair with seed powder and gram powder will give lustre to hairs and also controls head lice.

Ramphal juice has diuretic property and hence used in treating haematuria and urethritis. It is also used to treat liver ailments and leprosy. Decoction of young leaves is used to treat cough, diarrhoea, dysentery, indigestion and gall bladder diseases. Leaf extract is also used for treating eczema and other skin problems.

**Jackfruit**
Considered as “Jack of all fruits”, it is one of largest fruits in nature. Pulp and seeds are considered as cooling and nutritious tonic. Consumption of fruits reduces hangover of alcohol and starch obtained from its seeds is used in treating biliousness. Seed extract and roasted seeds possess aphrodisiac property. Leaf stalk decoction is good for diabetes. Application of milky juice of plant alone or along with vinegar helps in curing abscess, glandular swelling, snakebite and boils. Wood has sedative property and root is used to treat skin diseases, asthma and diarrhoea.

**Ber**
Also known as Indian plum, Indian jujube. Aids in improved digestion and also purifies blood. Decoction of bark has laxative property and hence can be used as purgative and it helps in reducing bleeding. Since fruit is rich in Vitamin C, it possesses antispasmodic property and helps preventing attack of cold and influenza. Gargling with fresh tender ber leaf juice and salt helps in curing soar throats and mouth ulcers. Leaves possess antibiotic properties and hence its paste is applied over boils, wounds, sores etc.

**Pomegranate**
This fruit is richest source of antioxidants, aids in digestion and is considered good for heart patients. Consumption of juice enriches haemoglobin content in blood. Fruit juice is tonic for intestine and liver ailments. Two spoons of rind paste in juice extract along with jaggery controls dysentery. Applying leaf paste on eyelids relieves from eye irritation and common eye pain. Applying leaf paste along with hair promotes good hair growth. Rind powder is the main constituent in ayurvedic preparations like ‘Dadimastaka choorna’ and ‘Bhaskara lavana choorna’.

The minor fruits are reservoirs of numerous essential nutrient elements, vitamins and minerals. They have latent potential to cure many deficiency disorders and also to increase immunity against several diseases and ailments. Therefore, it can be called more aptly as ‘Medicinal fruits’ instead of ‘Minor fruits’ (Martin et al., 1987).

**References:**
Introduction
Fruits and vegetables are widely used as an excellent source of micronutrients and phytochemicals. Habitual inclusion of fruits and vegetables in the diet may prevent or reduce the risk of several chronic diseases. However, as they are perishable products that contain living tissues, the quality retention and prevention of postharvest loss during handling, storage and retailing is critical. Postharvest treatments are used to minimize the loss of fresh produce as well as to maintain the quality, thereby increase the shelf life. They can be divided into three main categories as chemical, physical and gaseous treatments.

Chemical treatments
Chemical treatments include usage of hydrogen peroxide, chlorine-based solutions, nitric oxide, sulphur dioxide and calcium chloride to retard browning reactions, inhibit ethylene bio synthesis, reduce respiration rate and water loss and reduce the incidence of postharvest diseases.

Chemical treatments include usage of hydrogen peroxide, chlorine-based solutions, nitric oxide, sulphur dioxide and calcium chloride to retard browning reactions, inhibit ethylene bio synthesis, reduce respiration rate and water loss and reduce the incidence of postharvest diseases.

H$_2$O$_2$ is a compound which has bactericidal, sporicidal and inhibitory ability based on oxidation of fungi and bacteria, and it was successfully used to control vegetable pathogens during storage. Treatment with H$_2$O$_2$ can extend the shelf life and reduce natural and pathogenic microbial populations in melons, oranges, apples, prunes, tomatoes, whole grapes and fresh-cut produce.

Chlorine-based solutions are commonly used as a disinfectant due to its very strong oxidizing properties and cost effectiveness, but chlorine have been associated with the formation of carcinogenic compounds. In addition, Chlorine-based compounds have a limited effectiveness in the reduction of microbial load on fresh produce. However, high levels may cause taste and odour defects on treated products.

NO is a highly reactive and acts as a multifunctional signalling molecule in various plant physiological processes, such as fruit ripening and senescence of fruits and vegetables. Exogenous application of NO by gas fumigation or dipping in a solution has been demonstrated beneficial effects to reduce the production of ethylene, reduce rate of respiration and reduce ion leakage resulting from better maintenance of cellular integrity. Successful application of NO has been reported for apple, banana, kiwifruit, mango, peach, pear, plum, strawberry, tomato, papaya, loquat, Chinese winter jujube fruit and Chinese bayberry.

SO$_2$ treatment is widely used due to its universal antiseptic action and economic application. SO$_2$ technology has been tested for control of postharvest decay on fruits such as table grapes, litchi, fig, banana, lemon or apple.

Calcium chloride is used to reduce chilling injuries, suppress senescence, enhance the storage and marketable life of fruits by maintaining their firmness and quality. Calcium application also delays aging or ripening, reduces postharvest decay, reduce the incidence of physiological disorders and increase the resistance to diseases. It has been suggested that calcium treatment can increase tissue firmness and reduced the susceptibility to physiological disorders.

Physical Treatments
Heat treatments, edible coating and irradiation are the major physical treatments used to prevent postharvest loss of fruits and vegetables. Heat treatments are used for insect infestation, disease control and to prevent chilling injuries. Edible coatings provide a barrier for moisture and preserve colour, texture and natural aroma. Irradiation is used to inhibit sprouting of tubers, bulbs and roots.

Heat treatments: During the past few
years there is a higher demand for heat treatments in post-harvest technology instead of chemicals. However, usage is limited due to the high cost. Mode of action of heat treatment is to wash off the spores from the surface of the commodity. In addition, due to heat energy there is a considerable reduction of microorganisms such as bacteria and fungi. There are different types of heat treatments including hot water dip, saturated water vapor heat, hot dry air and hot water rinse with brushing.

Heat treatments have shown beneficial effects for insect control, prevention of fungal development, delayed ripening through inactivation of enzymes and prevention of postharvest storage disorders including chilling injury. Heat treatments have been used to preserve the colour of asparagus, broccoli, green beans, kiwi fruits and celery, to prevent the development of off flavours, to prevent development of overripe flavours in cantaloupe and other melons, to the longevity of grapes, plums and peaches.

**Irradiation:** Food irradiation is a process of exposing the produce to rays for improving the shelf life. It is also serve as a quarantine treatment for many fruits and vegetables. However, all fruits and vegetables are not appropriate for irradiation including cucumbers, grapes, and some tomatoes as they are sensitive to radiation.

Irradiation can be used on alone or in combination with other methods to improve the microbiological safety and extend shelf life. Dose of application on fruit products are limited by their impact on quality. The maximum doses which can be applied on fruits and vegetables range between 1 and 2 kGy. However, these maximum values depend on the type of products and might modify with new, resistant cultivars. Irradiation can be recommended for sprouting inhibition (in the range of 50-200 Gy) and disinfestations purposes (at doses like those used for other dry foods) in sprouting foods such as potatoes, garlic, onions and yams.

**Edible coatings:** Edible coatings are thin layer of material which provides a barrier to moisture, oxygen and solute movement for the food. It can be a complete food coating or can be disposed as a continuous layer between food components. Polysaccharides, lipid-based substances and protein films are commonly used as edible coatings. Edible coatings provide a barrier to moisture and minimize the loss of moisture during storage. They can also act as a gas barrier and slow down the respiration, senescence and enzymatic oxidation. In addition, edible coatings help to preserves colour, texture and volatile compounds of fresh fruits and vegetables.

**Gaseous Treatments**

Gaseous treatments include ozonation, 1-methylcyclopropene, control atmospheric packaging and modified atmospheric packaging. They are also helping to maintain cell wall integrity, peel colour, retard senescence, reduction in decay, slow down the respiration rate and deterioration.

**Ozone:** Activated oxygen is the best available technology that can replace traditional sanitizing agents. It is strong and ideal, germicide, sanitizer, sterilizer, antimicrobial, fungicide and deodorizer and detoxifying agent. It has been reported that shelf life of fruits and vegetables can be increased when they are subjected to ozonation. Ozone oxidizes the metabolic products and neutralizes the odours generated during the ripening stage in storage of fruits. This helps preserve and almost double the shelf
life on fresh produce. It also enhances the taste by retaining the original flavour of the products.

1-Methylycyclopropene (1-MCP): 1-MCP is a synthetic cyclic olefin which can block the access to ethylene-binding receptor thereby inhibit the action of ethylene. It has found that fruits treated with 1-MCP showed significantly less weight loss and retained its original colour than control fruit at the full-ripe stage. Treatment with 1-MCP controls the blue mould rot, postharvest pitting and effectively suppressed endogenous ethylene production in citrus fruits. Moreover, it has increased the firmness of apple and pears.

Modified Atmosphere Packaging (MAP): MAP is a technique used to extend the shelf life of commodities by sealing them in polymeric film packages to modify the oxygen and carbon dioxide concentration levels within the package atmosphere. Composition of the air inside the package is changed due to the respiration and transfer of gases through the package. In contrast, it creates an atmosphere richer in carbon dioxide and lower in oxygen. Reduced oxygen and elevated carbon dioxide levels effectively reduce the rate of respiration of fruits and vegetables. Elevated carbon dioxide levels inhibit the production of ethylene hormone and suppress plant tissue sensitivity for the effects of ripening.

The use of MAP also reduces the incidence of decay, compositional changes and softening of tissues [54]. Furthermore, it can retard the browning reactions and senescence thereby extends the post-harvest life [56]. MAP is widely used in the long-term storage of apple, pears, kiwi fruits, cabbage, and temporary transport of strawberries, guava, banana and tomato.

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