Krishi Udyan Darpan

Volume 3 : Issue 2 : August 2023

(Innovative Sustainable Farming)

ISSN No 2583-3146

ISSN No. 2583-3146

Krishi Udyan Darpan

3/2, Drummand Road, (Opp. Nathani Hospital) Prayagraj-211001 (U.P),
Mob.-9452254524
website : saahasindia.org. E-mail.- contact.saahas@gmail.com,
Article Submission :– krishiudyandarpan.en@gmail.com

Editorial Board

ISSN No. 2583-3146

Krishi Udyan Darpan

(Innovative Sustainable Farming)

In This Issue

ISSN No. 2583-3146

Growing Strawberry under Greenhouse: A Profitable Venture to the Farmers

Maneesh Kumar*, Deepesh Keshari, Jaspreet Kaur and Aakash Deep Kamboj
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar
Corresponding Author: maneeshk38904@gmail.com

Introduction

Strawberry (*Fragaria ananassa Duch.*) is one of the most important and delicious soft fruits of temperate regions of the world, botanically known as accessory fruits because fleshy parts are derived from receptacles not from the ovary. It belongs to the family Rosaceae and fruits are achene type. Strawberry is a good source of minerals, vitamins and antioxidants including carotenoids, phenols and flavonoid. It is mostly consumed as fresh fruit but sometimes it is processed in various products like jam, jelly and squash used for ice-cream making on a large scale. It is grown commercially in North America and Europe on a large scale. Among European countries France, Italy, Poland and Spain are major grower countries. In India it is cultivated in Haryana, Jammu & Kashmir, Maharashtra, Uttarakhand, Uttar Pradesh and Punjab.

Strawberry is mostly cultivated in temperate climate and in hilly areas but restricted to semi-arid and arid conditions. Strawberry is a species of high economic importance in the horticulture sector at national and international levels. According to its demand in the market, we can produce in any season under protected conditions round the year. Growing of crops under protected environments is a new technology to protect the crop from natural climates like biotic and abiotic stress. By growing a suitable cultivar under protected conditions, farmers can get more income at a lower cost.

Health benefits of strawberry

Strawberries offer a variety of health benefits due to their immense nutritional value and unique phytochemicals. Strawberries are rich in antioxidants, including vitamin C, flavonoids, anthocyanins and ellagic acid. These compounds help to combat oxidative stress caused by free radicals, reducing inflammation and cellular damage in the body. Strawberries have been associated with improved heart health. The antioxidants and anti-inflammatory properties in strawberries contribute to reducing bad cholesterol levels, lowering blood pressure and improving overall cardiovascular function. Consuming straw berries as part of a heart-healthy diet may help lower the risk of heart disease. Despite their natural sweetness, strawberries have a low glycemic index, meaning they have a minimal impact on blood sugar levels. Ellagic acid in strawberry, has shown potential in inhibiting the growth of cancer cells and reducing inflammation.

Several studies suggest that the antioxidants and phytochemicals in strawberries may have a positive impact on brain health, cognitive function and contribute to healthy skin by protecting against damage from free radicals, UV radiation and environmental pollutants. Strawberries contain nutrients like vitamin C, vitamin E and carotenoids (lutein and zeaxanthin) that are beneficial for eye health (Fig.1).

Steps to consider while growing strawberry in greenhouse

Strawberry cultivation under greenhouse conditions is a popular practice as it allows for controlled environmental conditions, extended growing seasons and protection against pests and diseases. Here are some key points to consider when cultivating strawberries in a greenhouse:

a) Choose a greenhouse location that receives ample sunlight, preferably in an area with a mild climate. Good ventilation and access to water are also essential.

b) Select a greenhouse design that provides adequate space for plants and allows for proper airflow. Consider using a gutter-connected greenhouse or a high tunnel structure for strawberry cultivation.

c) Choose strawberry varieties that are well-suited for greenhouse cultivation. Consider factors such as yield, disease resistance and flavor. Some popular greenhouse strawberry varieties include Albion, Seascape and Chandler.

d) Prepare the soil by ensuring it should be well-drained and rich in organic matter. Strawberries prefer slightly acidic soil with a pH range of 5.5 to 6.5.

e) Disease-free, certified strawberry plants or runners should be used for planting. Space the plants according to the specific variety's recommendations, typically 30 to 45 centimeters apart in rows, with around 1 to 1.2 meters between rows. Ensure that the planting holes are large enough to accommodate the root system without crowding or bending the roots.

f) Install a drip irrigation system to provide consistent moisture to the plants. Strawberries require regular watering.

g) Maintain the greenhouse temperature between 60-75°F (15-24°C) during the day and slightly lower at night. Optimal humidity levels range from 60-70%. Ventilation systems, shade nets and evaporative cooling can help regulate temperature and humidity.

h) Supplemental lighting may be necessary, especially during the winter months when natural sunlight is limited. LED grow lights with a spectrum suitable for plant growth can be used to provide additional light.

i) Strawberries are primarily insect-pollinated, so ensure good air circulation within the greenhouse to facilitate pollination. Hand pollination using a small brush can also be done if necessary.

j) Regularly monitor the nutrient levels in the soil and provide necessary fertilization.

k) It is important to timely monitor the crop for common issues like aphids, mites and fungal diseases.

l) Regularly remove runners to encourage the mother plants to produce larger fruits.

m) Harvesting of strawberries is carried out when they are fully ripe but still firm. Pick the berries carefully to avoid damaging the plants.

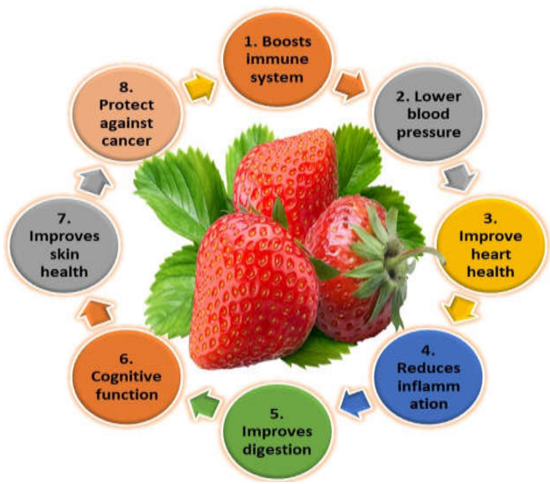


Fig.1: Health Benefits of Strawberry

Soil and climate

Strawberries can be grown in different types of climate ranging from temperate to tropical climate. Generally, strawberry requires 12 hours of daylight period or less and moderate temperature for bud formation. Each cultivar has a different day length and temperature requirement. Some cultivars require septentrional conditions (Short day in autumn and hard winter) and some require meridional conditions (Long day in autumn and moderate winter) and day neutral cultivars are also available. For better crop growth and development, the 22-27°C temperature range is considered better and frost damage and winter injury is the major problem in cold climates. Under greenhouse conditions, a temperature range should be maintained 18-25°C inside. A cool climate is the most important factor to fulfil its chilling requirement to stimulate flowering in next season.

Strawberry can be grown in any type of soil from poor sand to heavy clay provided proper moisture, aeration and drainage system and enriched organic matter. Generally, it prefers slightly acidic soil. Sandy loam to loamy soil with a range of 5.7-6.5 is ideal for its cultivation. Water logging should be restricted in the field and avoided to cultivate the strawberry in alkali soil. Upper most 15 cm soil layer should be porous and rich in humus as mostly roots are found on top of soil.

Fig.2: Strawberry cultivation under polyhouse with plastic mulch

Choices of cultivars

Numerous types of varieties of strawberry are available nowadays in which farmers may choose according to needed climatic conditions of the area. Selection of the right types of cultivar is crucial for round the year cultivation in a greenhouse. Even if you grow strawberries in greenhouse conditions, it will never change the bearing times of plants much. Some cultivars are listed below-

Chandler: It is the most suitable variety for growing in protected conditions and produces the best high desert quality fruits. Use of plastic tunnels in Chandler cultivar enhanced earliness in fruits ripening and produced higher yield. It is resistant to damage caused by rain and highly resistant to viral diseases.

Growing of Chandler cultivar under plastic tunnels: Low tunnels of 50cm height with transparent polythene film of 50 microns with the help of G1 wires can be installed in winter months from December to February to protect the plant from cold. Tunnels should be opened during day time for maintaining temperature inside to induce early flowering and better fruit yield.

- Day neutral cultivars-Selva, Fern
- Long Day cultivars-Pazaro, Tioga
- Sweet Charlie-Require short day condition, early maturing, well adopted to mild winter.

Fig.3: Cultivar Chandler with drip irrigation

Propagation and planting techniques

Strawberry is commercially propagated by vegetative means of runners. When runners attain sufficient growth and roots, then they are detached from the mother plant and planted in the main field. Runner production can be stimulated with the application of GA3 at 50-100ppm and or IBA @100ppm. Planting should be done on well-prepared raised beds or flat beds, hill rows and matted rows during August-October. In hilly areas, the ideal time of planting is March-April and September-October. It should be planted at the spacing of 30-60 cm apart. Matted row system of planting (90x45cm spacing) is best suited for strawberries which are simplest and least expensive.

Irrigation and weed control

Strawberry is relatively a shallow rooted crop that survives well under light wet field condition i.e., field should be kept wet during growth and fruiting time. Irrigation is essential during transplanting and rooting of runners. Moisture deficiency in the field restricts vegetative growth.

During the summer days, it should be irrigated frequently, however waterlogging conditions should be managed because this leads to disease expansion like crown rot and berry rot. Watering through the furrow system is better where sub-soil if heavy and land slopes are uniform (fig.3).

Weeds generate serious threats in strawberry cultivation. They contest with the strawberry plants for the nutrients and water. In the end we record poor quality fruits with low yield. The growth of weeds can be prohibited with mulching or spray of Oxyfluorten + napropamide @ 0.60+5.0 kg a.i./ha.

Fig.4: Growing of Strawberry plants in polybag

Mulching

Mulching is a crucial practice in strawberry cultivation because it helps in soil moisture conservation, retards weed growth and restricts the direct contact of berries with soil. Mulching can be done with organic and inorganic mulch material, before mulching soil should be fumigated or dusted with insecticide to avoid the problem of insect or disease infection. Wheat or paddy straw or dry grass can be used with organic mulch at 10-15cm thickness. In the case of organic mulch, Black polyethylene with 25-micron thickness is found very effective for mulching of strawberries. Mulching provides protection to strawberry plants from frost and cold in winter months during flowering and fruiting season (fig.2).

Nutrition management

Proper application of manures and fertilizers to the strawberry fruits is important to achieve high yield and qualitative fruits as well as healthy and vigorous growth of the plants. Farmyard Manure (FYM) mixed with field during the preparation of planting beds. 50-70 tonnes of FYM along with 40-80 kg Nitrogen, 40 kg P_2O_5 and 50-80 kg K_2O per hectare should be applied for adequate cropping. Full dose of Phosphorus and potash should be given at the time of planting and half dose of nitrogen after one month of planting.

Remaining half dose of nitrogen should be used at the time of flowering. It is advice to the grower, they do not use excessive nitrogen as it leads to excessive growth and resulting malformed fruits. Application of vermicomposting @ 10 t/ha has been found beneficial in improving the plant growth and yield.

Harvesting and yield

Strawberry plants start fruiting after 3-4 months of planting. Maturity time of berries is not completed uniformly thus, it requires many pickings. The berries should be harvested when they attain 75% of red colour and for processing purposes berries harvested at a firm ripe stage when they attain two to three for surface colour. From the one-hectare field, an average 50-60 quintals of strawberry can be harvested.

Protection from pests and diseases

Strawberries are vulnerable to several diseases and pests. White grubs, cut worms, hairy caterpillars, sludge and snails are the common pests which can be managed by spray of malathion 50 EC @300 ml in 200 liter of water. Grey mold or fruit rot and red stele are major fungal diseases under greenhouse condition. Grey mold and red stele can be managed by the application of carbendazim @ 10 and ridomil @1%, respectively before or 15 days after planting.

Conclusion

In conclusion, growing strawberries under greenhouse conditions can provide a controlled and protected environment that maximizes yields, quality and profitability. By harnessing the advantages of greenhouse cultivation, farmers can overcome the limitations of outdoor farming and meet the demands of consumers for high-quality strawberries throughout the year. Strawberries grown in greenhouses often fetch a higher market price due to their superior quality, extended availability and consistent supply. When strawberries are out of season, growers may have a distinct advantage by having the ability to supply fresh, locally farmed strawberries.

References

- Growing Strawberry in greenhouse. Gardening Tips, 2021.
- Oguz, I., Ibrahim Oguz, H. and EbruKafkas, N. 2022. Strawberry Cultivation Techniques. IntechOpen. doi: 10.5772/intechopen.104611.
- Tulipani, S., Mezzetti, B., Capacasa, F., Bompadre, S., Beekwilder, J., De-Vos, C.H.R., Capanoglu, E., Bovy, A. and Battino, M. 2008. Antioxidants, Phenolic Compounds, and Nutritional Quality of Different Strawberry Genotypes. J. Agric. Food Chem., 56(3): 696-704.

❖❖

ISSN No. 2583-3146

Canopy Management of Sapota

Soumyashree Mansingh

Department of Fruit Science and Horticulture Technology, O.U.A.T., Bhubaneswar

Corresponding Author: mansinghsoumyashree.16@gmail.com

Introduction

Sapota (Order: Sapodilla; Family: Sapotaceae; Genus: *Manilkara* and Species: achras) is fruit of the chicle tree and also known as sapota, chiku, ciku, nasberry, sapodilla plum, chicozapote, zapote, chico, néspero and sapota plum. It is a native of tropical America more specifically Southern Mexico or Central America. It is an evergreen fruit tree known for producing fruits of delicate flavour, melting pulp with sweet taste (Chada, 1992). In a hot, humid tropical climate, it continuously produces crop. It is resilient, extremely fruitful and typically free from harmful pests, illnesses and physiological abnormalities. Being an evergreen tree, the sapota's growth and development are ongoing. The well-grown sapota tree's lateral branches typically come in tiers. The tree generates a dense canopy at the top, which causes poor productivity at the middle and lower tiers due to insufficient sunlight, if left untrained or unpruned. After certain years of establishment, harvesting becomes cumbersome as the person who engaged in harvesting can have easy access with branches arising upto third or fourth tier only. In order to pick the fruits from branches reaching above the third or fourth layer, the harvester must utilise a specific tool. One strategy for avoiding this issue is to practise effective canopy management, which calls for early instruction and judicious pruning practices.

After planting, sapota starts to produce in the third year, but it takes until the fifth year to reach commercial yields. The two primary flowering seasons are October through November and February through March and the two harvesting seasons are January through February and May through June. Sapota blooms profusely in a variety of flushes all through the year. As opposed to July-August (Mrig bahar) flowering, the fruit quality of October-November flowering (Hast bahar), which matures between August-September, is a little less desirable.

Need of Canopy Management

Trees and their fruits require light to grow and flourish. The green leaves capture the sun's energy to create sugars and carbohydrates, which are then transferred to the locations where they are required, such as buds, flowers and fruits. A greater amount of light entering the tree canopy benefits a tree's development, productivity, yield and fruit quality.

Planting density and orientation in an orchard also affect light penetration. With close planting, quick shadowing typically becomes a problem. Larger fruits often grow on sturdy branches that can support them. The challenge for a fruit producer is to first establish a solid and balanced architecture of trees before outfitting them with the proper fruiting. Naturally, training-type pruning must be done in the early years to develop a robust and stocky foundation with evenly spaced limbs or any other desirable shape.

Objectives of Canopy Management

- To get a higher yield with good quality.
- To keep the growth of the root and the shoot in proportion.
- Emergence of strong crotches or crotch

angles.

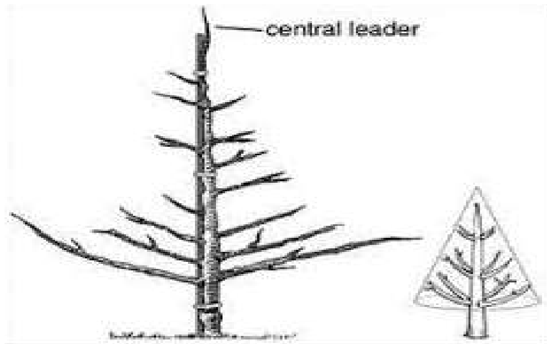
- To get rid of shoots that is not needed, crowded, dead from illness and pest-affected.
- To control the tree architecture or create the desired shape for a planting system with a high density.
- To effectively utilise temperature, light and air.
- To facilitate the management practices like spraying, harvesting etc.
- To regulate exposure of plants to light and air.

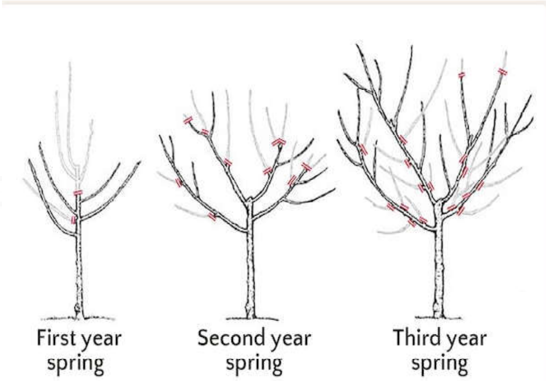
Principes of Canopy Management

- Avoidance of built-up microclimate congenial for diseases and pest infestation.
- Safety risk for the harvest of bigger trees.
- The best possible use of light.
- Cost-effectiveness in acquiring the necessary canopy architecture.
- Producing more fruit from smaller trees has increased productivity and fruit quality in several fruit crops.
- Rejuvenation of big, overgrown orchards that are suffering from decreased productivity and fruit quality.
- Compared to giant trees, little trees are better at capturing sunlight and turning it into fruit.
- Reduction in extra expense in harvesting at large trees.

Canopy Management through Training and Pruning

Sapota generates continuously taller trees that branch out in tiers from a central leader. In large trees, the top growth often results in shading of lower branches and by resisting wind penetration are susceptible to mechanical damages and the productivity is low. Training also helps to maintain the tree height, which facilitates hand picking of most of the fruits. Pruning also makes it easier for light to enter and circulate through the canopy, which alters physiological processes in a direct or indirect way to control yield and enhance fruit quality. Because it is an evergreen tree, the sapota only needs to control its vegetative development to increase fruit quality and yield (Singh, 2010). For sapota, no formal training programme has been created. A central leader mechanism is used to train the majority of trees. After emergence of new shoots below the cut point, 3-4 well spaced scaffold limbs are selected and allowed to grow to make strong frame work.





Currently, pruning in sapota trees is limited to removing diseased and dead branches and allowing more light to reach the tree. As flower blooms and fruits emerge in the terminal leaf axils of wood from the previous season, regular branch pruning is not done in sapota. All the growths that appear on the rootstock below the graft or bud joint must be removed. The lowermost branches, up to a height of 60 to 90 cm, may weigh down to the ground and become unproductive three to four years after planting. Similarly, over shaded and crowded branches are also removed periodically to permit adequate sunlight and air circulation. Recently, it has been established that centre opening of the grown up trees above 3-4 tiers of scaffold branches is beneficial to get higher yield with quality fruits. Similarly, pruning of side branches by retaining ½ to 2/3 lengths encourages new growth, flowering and yield (Kumar, 2010).

Canopy Management through Genetically Dwarf Cultivars

Sl No.	Genetically Dwarf Cultivars	Desirable Features
1	PKM 1	Tree is dwarf in stature
2	PKM 3	Tree has a vertical growth habit
3	CO-3	Trees grow upright with compact canopy

Pradeepha (2004) recorded the highest tree height in control and the lowest tree height with medium pruning in sapota cv. PKM 1. Sathiya (2005) observed that the sapota 'PKM (Sa) 4' increment in tree height was highest in control trees against pruning treatments and the mean fruit weight, length, breadth and girth of the fruits were significantly higher in severely pruned trees. Acidity level and ascorbic content was also found to be influenced by canopy management. Sathiya (2005) observed that in sapota cv. PKM (Sa) 4, the fruit quality attributes such as TSS, total sugar, reducing sugar, non - reducing sugars and ascorbic acid were significantly higher in severe pruning. On the other hand, acid content was found to decrease with increase in severity of pruning in sapota (Pradeepa, 2004 and Sathiya 2005)

Mathew (2007) studied that effect of canopy management under different planting densities in sapota cv. PKM 1 and reported that mild pruning for centre opening of sapota trees had resulted in lesser height increment compared to unpruned trees. However, higher production of lateral branches resulted in increased fruit yield, though there was reduction in the height increment. In general, pruned plants perform well both under wider spacing and narrow spacing in terms of yield and quality traits. Since, yield maximization is the prime objective, the plants under narrow spacing with pruning were found to be the best.

Canopy Management through Plant Growth Retardants

Agrawal and Dikshit (2008) made a study on the effect of plant growth regulators on growth and yield of sapota cv. cricket ball and he reported that spray of CCC 400 ppm at FBD, NAA 100 ppm at flowering as well as at pea stage of fruit development gave better response in growth and yield of sapota cv. Cricket Ball.

Agrawal and Dikshit (2008) observed that application of cycocel at Fruit bud differentiation stage resulted in the suppression of vegetative growth and found an effect in reducing the shoot length in sapota cv. Cricket Ball.

Sapota Orchard Salinity

The majority of sapota orchards in India are dilapidated and unproductive. They age prematurely and yield less both in terms of quality and quantity as a result of irregular canopy management procedures.

Rejuvenation Technique

Sapota plants get their first pruning in the first year, and in the following years, 3–4 healthy shoots with a favourable crotch angle are chosen to sustain the tree's main branch. The remaining shoots are periodically trimmed off to create a strong foundation with an open centre system. Thinning is done on secondary and tertiary branch trimmed trees. Tip clipping of terminal shoots, pruning of tertiary branches, pruning of secondary branches and pruning of primary branches are the four types of pruning that can be done. Four types of growth regulator treatments, such as 20 ppm GA_3, 50 ppm NAA, 100 ppm IAA and 20 ppm 2,4-D as foliar spraying, are also possible. However, according to Sahu *et al.*, (2018), tip trimming of terminal shoots and 50 ppm NAA hormonal therapy are associated with the highest yield.

Constraints Faced by Farmers in Adoption of New Rejuvenation Technologies

- Lack of understanding and awareness of technology for rejuvenation.
- Reluctance to prune trees' deep roots.
- Lack of confidence in rejuvenation methods and danger to the orchard following deep root pruning.
- Concern over possible economic loss from missing two crops.
- Lack of willingness to take risks.
- A lack of equipment and skilled labour.
- Aversion to the police and forest law.
- Workload complexity.

Conclusion

Canopy Management is therefore, an essential tree management operation that starts from the first year of plant establishment and enables the plant to produce or yield high quality and quantity by providing proper framework and more fruiting/yield per canopy area. In sapota care must be taken while canopy management, as sapota bears flowers in the past season growth, more pruning may lead to decrease in yield and it's essential to maintain senescent orchards. We can go for skirting or opening up for removable of low hanging branches and better light interception to increase fruit quality and yield. Pruning actions should be accompanied by timely broad spectrum fungicide application. Some fruit trees have responded quite well to the application of INM and organic materials. Even though PGR application is essential for managing senile orchards, many farmers still do not take it into account. The challenges that farmers face in this area should be taken into consideration and solutions should be provided.

References

- Agrawal, S and S.N. Dikshit. 2008. Studies on the effect of plant growth regulators on growth and yield of sapota (*Achras sapota l.*) cv. cricket ball. *Indian J. Agric. Res.*, 42 (3): 207 -211, 2008.
- Canopy Management in Fruit Crops Karan Kumar and Dr. Som Dev SharmaM.Sc (Horticulture) Fruit Science and Principal Extension Specialist (Horticulture) Dr. Y.S. Parmar U.H.F., Nauni, Solan (HP) ARTICLE ID: 04
- Canopy Management in Sapota (*Achras Sapota* L. Volume-4, Issue-7, July-2015

• ISSN No 2277 – 816

- Chada, K.L. 1992. Strategy for optimization of productivity and utilization of sapota (*Manilkara achras* L.). Indian J.Hort., 49 (1): 1 –17.
- Geetharani, P., Manivannan, M.I. and Sankaranarayananan, R., 2008. Ripening behaviour of sapota. *Asian Journal of Horticulture*, 3(2), pp.250-252.
- Kumar, N. 2010. Introduction to horticulture. Oxford & IBH publishing co. pvt. Ltd, New Delhi.
- Mathew, M. 2007. Effect of canopy management under different planting densities in Sapota (*Manilkara achras* (Mill.) Fosberg.) 'PKM 1'. M.Sc. (Hort.) Thesis, Submitted to Horticulture College and Research Institute, TNAU, Periyakulam.
- Meena, R., Senthilkumar, S. and Manivannan, S., 2022. Senile Orchard Management System in Tropical Fruit Production. *International Journal of Agriculture, Environment and Biotechnology*, 15(4), pp.861-866.
- Murugeswari, P. 2007. Canopy mangement in sapota (*Manilkara achras* (Mill.) Fosberg.) 'PKM (Sa) 4'. M.Sc. (Hort.) Thesis, Submitted to Horticulture College and Research Institute, TNAU, Periyakulam.
- Pradeepha, L. 2004. Effect of canopy management and nutrients spray on vegetative growth, fruit set, yield and quality characters in sapota (*Manilkara achras* L.) cv. PKM 1, M.Sc., (Hort.) Thesis, Agricultural College and Research Institute, TNAU, Madurai.
- Sahu, C.K., Patel, M.K. and Panda, C.M. 2018. Effect of pruning and plant growth regulator on plant growth and fruit yield of sapota (*Manilkara zapota* L.) cv. Cricket Ball. Int. J. Curr. Microb. Appl. Sci., 7(9): 1352-1357
- Sathiya, V. 2005. Studies on the effect of different levels of training and pruning on yield and quality of sapota (*Manilkara achras* L.) cv .PKM (Sa) 4. M.Sc. (Hort.) Thesis, Submitted to Horticulture College and Research Institute, TNAU, Periyakulam.
- Singh, G. 2010. Practical Manual on Canopy Management in Fruit Crops. Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India, New Delhi.
- Yahia, E.M., 2004. Sapodilla and related fruits. *US Department of Agriculture, Handbook, 66.*

❖❖

ISSN No. 2583-3146

Production Technology of *Kharif* Cucumber

P A Sable*, M K Sharma, K Z Vaghela, G S Patel and Piyush Verma

Department of Vegetable Science

College of Horticulture, Sardar krushinagar Dantiwada Agricultural University, Jagudan

Corresponding Author: sable.pating@gmail.com

Introduction

The cucumber (*Cucumis sativus* L.) is a very popular cucurbitaceous vegetable crop grown in *kharif* as well as spring (summer) season. It is a tender fruit has with a good taste and cooling effect. It is used as salad and for pickle preparation and also as cooked vegetables. Cucumber has a great economic importance because of its short duration crop. Due to good taste and low energy content it is regarded as a refreshing condiment. As a *kharif* season crop it is sown in June end to July-August. Cucumber responds to training system in *kharif* season. Trellis or bower system of training is preferred during *kharif* season to facilitate intercultural operation, to obtain high yield and disease free crops.

Varieties

Monoecious, gynoecious, parthenocarpic varieties are found in the cucumber. Some are summarized like Pusa Long Green (DC-83) having monoecious; flower solitary, yellow in colour and male flowers are borne in clusters, Munshi *et al*., (2022). Kashi Nutan-early maturing hybrid suitable for *kharif* and summer developed by ICAR-IIVR, Varanasi. Some are the parthenocarpic varieties like Pant Parthenocarpic Khira-2 and Pant Parthenocarpic Khira-3 suitable for polyhouse cultivation. Pusa Sanyog, Pusa Uday, Swarna Sheetal, Phule Prachi, Phule Shubhangi are some cucumber varieties.

Phule Shubhangi

Phule Prachi

Pant Parthenocarpic Khira-3

Swarna Sheetal

Female flowers in cucumber

Cultivation

Cucumber is sown in June-end as *kharif* season crop. It can be grown successfully on all type of soil but well-drained loam and sandy loam soils rich in organic matter are best suited for its cultivation. The seed rate is 1.5-2.0 kg/ ha. Munshi *et al*.,(2022). The seeds are sown in the hills 30 cm apart on the slope of ridges (channels) are prepared at a distance of 180 cm. The spacing between channels can be increased up to 2.5m when sowing is to be done on both the sides. Progressive cucumber farmers are also adapting the spacing of 180 cm x 30cm. Two seeds are to be sown 2cm deep at each hill. Gap filling and thinning is to be done if necessary, when the vine becomes 8-10 cm tall to maintain plant population.

Field view of cucumber raised in open field at spacing 180cm x 30cm

Training

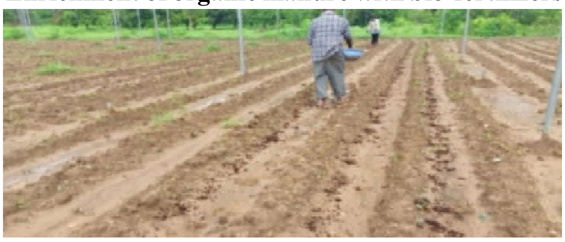
When cucumber fruits are come in contact with the ground, it is likely to decay and reduce the quality. The vines are tied with special training purpose threads and facilitated to grow vertically during *kharif* season to obtain high disease free fruit yield. The vine show the sign of twining a few days after germination. The vines are trained over the top wire at around 2.0-2.4 m height by tying with string and wire is supported by bamboo posts at sufficient distance. Disease incidence gets reduced, the insect finds no hiding places, fruit does not get direct contact with soil, sunlight is utilized by maximum numbers of leaves resulting in enhanced assimilation of carbohydrates and reflect into more yields are the advantages of training.

Training and staking in cucumber

Nutrient management

Apply FYM @ 20t/ ha. as a basal dose along with half dose of N (50 kg), full dose of P_2O_5 (50 kg) and K_2O (50 kg/ ha). The remaining dose of N (50 kg/ha) is to be top-dress in two equal splits at 30 and 45 days after sowing (Anonymous, 2021). Bio-fertilizers and bio-fungicides like *Azotobacter* 2kg, *Phosphorus Solubilizing Bacteria* (PSB) 2kg and *Pseudomonas fluorescens* 2.5kg /ha can be applied along with FYM 50kg (one week enriched) and neem cake @ 100kg (Anonymous, 2022).

Enrichment of organic manure with bio-fertilizers



Application of bio-fertilizers and bio-fungicides through FYM (enriched)

The bio-fertilizers and bio-pesticides should not be used with chemical fertilizers and pesticides. If the plant growth is poor 19:19:19 can be applied in the soil with water (2 g/ l) as per need at an interval of 10-15 days, 2-3 times.

Intercultural practices

When the vine become 8-10cm tall, gap feeling and thinning should be done to keep 1-2 vine (s) per hill. Since the crop is shallow rooted, earthing up is to be done to cover the roots and support the vine properly, especially in the rainy season. It is important to keep crop weed free at the initial growth stage. It requires 2-3 weedings at an interval of 15-20 days.

Weeding in cucumber

Irrigation

Irrigation is to be done at an interval of 8-10 days as per climatic condition and type of soil. Among the irrigation systems, drip irrigation is the most suitable for cucurbitaceous crops in summer season and under arid conditions. Single lateral lines (12-14mm) at 1.5 m distance with on line drippers at 60 cm or 50 cm distance with 4 l / hr or 3.5 l / hr capacity, respectively found to be the most suitable (Anonymous, 2022).

Plant protection

Integrated pest and disease management can be adapted for effective pest and disease management. Two rows of maize as boarder crop in the field 15 days before cucumber seed sowing is to be done. To manage pests biologically, NSKE (5%) can be sprayed against aphid. Set up the yellow sticky traps (25/ha) to monitor the activity of pest and to synchronize the botanical pesticide application, if need be, at the maximum activity stage. When the infestation of aphids and jassids is severe, Imidacloprid 70% WG @ 35 g/ ha. (through 500 l of water) can be sprayed (CIB&RC). Fruit flies can be managed by installing fruit flies traps (12/ha.) prior to flower initiation. When infestation of fruit fly and cucumber beetle is severe, Flubendiamide 8.33 % + Deltamethrin 5.56 % ww SC @ 200-250 ml/ ha (through 500 l of water) can be sprayed. Its waiting period is 5 days (CIB&RC). An approach comprising soil application of *Trichoderma harzianum* and *Pseudomonas fluorescens* enriched with FYM (@ 1 kg each with 100 kg FYM), prophylactic spray of Mancozeb @ 2-2.5 g/ l for downy mildew management can be adapted (Anonymous). Downy mildew can be managed by spraying Azoxystrobin @ 1 ml/ l of water. To prevent damping off and other root diseases alternative drenching of Metalaxyl 4 % + Mancozeb 64 % (composed) @ 2 g and Copper oxychloride 3 g/ l of water is to be done. Before the application of chemical pesticides and fungicides, all fruits reaching harvestable stage should be harvested and also wait for completion of waiting period of pesticides and fungicides for further harvest after spraying.

Fruit Fly Traps

Harvesting and yield

Fruit become ready for first harvesting 45 DAS. Its harvesting can be completed in 20-25 pickings at an alternate day or daily. Delay in harvesting makes the fruit over-matured and they lose their tenderness and taste.

a b

Tender (a) and over-matured (b) fruit of cucumber

Conclusion

Cucumber (*Cucumis sativus* L.) is a very popular vegetable grown in India. In order to increase its productivity, it is important to go for scientific cultivation practices like training, integrated nutrient management, integrated pest and disease management, harvesting at proper time etc., with selection of high yielding varieties.

References

- Anonymous. https:// agritech.tnau.ac.in (Updated on Nov., 2022).
- Anonymous. Department of Agriculture & Farmers Welfare, Directorate of Plant Protection Quarantine & Storage, Central Insecticide Board & Registration Committee, N .H.-IV, Faridabad-121 001 (Haryana), Major Uses of Pesticides (Registration under Insecticide Act, 1968) (Up to 31/05/ 2021).
- Anonymous. http:// www.celkau.in (KAU-Infotech Portal).
- Anonymous. www.mpkv.ac.in. (Krushidarshini-2021). Kakadi, Mahatma Phule Krushi Vidhyapeeth, Rahuri: 161.
- D Munshi, T K Behera, Amish K Sureja, J Singh and B S Tomar (2022). Pusa Long Green – A high yielding cucumber variety for spring summer and kharif season. *Indian Horticulture* (May-June): 3-5.

❖❖

ISSN No. 2583-3146

Cultivation of Ridge Gourd (*Luffa acutangula* L.)

Noopur Jaiswal[1] and Vivek Vishwakarma[2*]

[1]Department of Vegetable Science, Annamalai University, Chidambaram

[2]Department of Plant Pathology, SHUATS, Prayagraj

Corresponding Author: vivekvms94@gmail.com

Introduction

Ridge gourd is a cucurbitaceous summer vegetable grown throughout the year in North Eastern region and is used as vegetables. It is a creeper and has a climbing or trailing habit. There is a wide variation in shape and length of fruits. Among cucurbitaceous vegetable crops, ridge gourd is an important vegetable. It is quite rich in vitamins and minerals. A few of the health advantages are an excellent blood purifier, possessing laxative properties, a cure for jaundice, beneficial for diabetes, aiding weight loss, anti-inflammatory and anti-biotic, fortifying the immune system, Skincare, good for the stomach. The modern day intensive crop cultivation requires the use of chemical fertilizers. Use of inorganic fertilizers not only increases the cost of production but also adds to overall soil fertility related environmental pollution.

Origin and distribution

Origin of ridge gourd is not known. Smooth gourd may be a native of South Asia, Africa or Australia.

Developing Institution	Variety	Special Features
IIHR, Bangalore.	Arka Sumeet	Fruits lush green, cylindrical, 55 cm long 2.5 cm girth and 380 g weight with prominent ridges, delicate aroma. Days to first harvest 50-55.
	Arka Sujat	Fruits lush green, cylindrical, medium long (35-45 cm) and average weight (350g). Yield 63 t/ha in 100 days.
IARI, New Delhi.	Pusa Nasdar	Fruits club shaped, light green in colour, 15-20 fruits / plant, yield 15-16 t/ha.
GBPU&T, Pantnagar.	Pant Torai-1	Fruits 5 cm long and club shaped, yield 10 t/ha. More suitable for rainy season.
Tamil Nadu Agricultural University	CO.1	Fruits long (60-75 cm), first harvest in 55 days, 10-12 fruits / plant weighing 3-4 fruits/ kg.
	PKM-1	Fruits dark green, average weight 300g, yield 28-30 t/ha in 160 days.
	CO.2	Fruits very long (90-100 cm), weighing 350-400g., green with shallow grooves, duration 120 days, yield 25 t/ha.

HARP, Ranchi	Swarna Manjari	Tolerant to powdery mildew. Fruits elongated, medium sized, highly ridged, green with soft flesh. Days to first harvest 65-70 days. Yield 18-20 t/ha in 140-150 days.
	Swarna Uphar	Fruits elongated, medium sized (200g), ridges with soft weak flesh. Days to first harvest 65-70. Fruits lush green, cylindrical, 55 cm long 2.5 cm girth and 380 g weight with prominent, ridges, delicate aroma. Days to first harvest 50- 55

Climate and soil

Ridge gourd and smooth gourd are typical warm season crops and come up well during summer and rainy seasons. Optimum temperature required is 25-27°C. Ideal soil is fertile well drained loam rich in humus.

Cultivation practices

Ridge grown during summer and rainy season by sowing seeds during January – February and June – July, respectively. Seeds are sown in raised beds, furrows or pits @ 3.5-5.0 kg/ha for ridge gourd and 2.5-5.0 kg/ha for sponge gourd. Since seeds are with hard seed coat, it is advisable to soak seeds overnight in water. A row-to-row distance of 1.5-2.5 m and hill to hill distance of 60-120 cm is required for both crops under bower or trellis system. When it is trailed to ground under pit system, a row-to-row spacing of 1.5-2.0 m and pit-to-pit distance of 1.0-1.5m are recommended for both crops.

Harvesting

Crop is ready for harvest in about 60 days after sowing. Both crops are picked at immature tender stage. Fruits attain marketable maturity 5-7 days after anthesis. Over-mature fruits will be fibrous and are unfit for consumption. To avoid over-maturity, picking is done at 3-4 days interval. Harvested fruits are packed in baskets to avoid injury and can be kept for 3-4 days in a cool atmosphere.

Yield: 7-5 – 15.0 t/ha.

Pests and Diseases

Cucurbits are affected by a large number of insect pests, nematodes and diseases. Major pests and diseases affecting cucurbit vegetables are discussed below:

Pests

Fruit fly, red pumpkin beetle and epilachna beetle cause damage to most of cucurbits. In addition, insects like gall fly; aphids, leaf hopper, ants, worms, under-ground semi loopers, leaf miners, fruit borers and mites affect specific cucurbits. Intensity of infestation varies from place to place.

Fruit fly (*Bacterocera cucurbitae*)

This is a major pest of majority of cucurbits especially that of bitter gourd, snake gourd, pointed gourd, muskmelon, oriental pickling melon, watermelon, tinda and pumpkin. Adult fly has reddish brown body with transparent and shiny wings, bearing yellow-brown streaks. It lays eggs singly or in clusters of 4-12 in flower or developing fruits or ripening fruits with the help of sharp ovipositor of females. Eggs hatch in 2-9 days and maggots feed on internal contents of fruits causing rotting. Pupation is in ground at a depth of 1.5-15.0 cm. Infestation is more during rainy season.

Adopt following package for control of fruit fly

a. Cover developing fruits with paper cover or polythene cover immediately after anthesis and pollination.

b. Collect and destroy affected fruits by dipping in hot water or insecticide solution. Do not leave infested fruits on gourd.

c. Use light trap and poison baits during night. Spray a bait solution containing 200 g gur or sugar and 20 ml Malathion 50 EC in 20 l of water as coarse droplets on lower surface of leaves.

d. Spraying on under surface of leaves of maize plants grown in rows at a distance of 8-10 m in cucurbit field is also effective as flies rest on such tall plants.

e. Hang baits containing sex attractants like pheromones or protein hydrolysate with Furadan granules. Hanging coconut shells with pieces of fully ripened fruits of "Mysore poovan" banana or toddy or molasses along with Furadan granules also attract and kill fruit flies.

Red Pumpkin Beetle (*Aulacophora foveicollis*)

Beetle attacks most of cucurbits especially melons, bottle gourd, pumpkin, cucumber, water melon etc. Bitter gourd is not seen attacked by beetle. Beetles eat the leaf lamina causing defoliation particularly at cotyledon stage of crop. Grubs feed on underground stem and root portion of plants causing holes / galleries and result in drying up of plants. As insects pupate in the soil, deep ploughing soon after the crop exposes and kills grubs and pupae. Application of Furadan @ 3 G granules 3-4 cm deep in soil near base of just germinated seedlings will take care of young seedlings from attack of beetle.

Epilachna beetle (*Epilachna seplima*)

Epilachna beetle is a serious pest of bitter gourd and snake gourd. Adult flies feed on foliage causing holes and defoliation. A large number of yellow coloured thorny grubs are seen on under surface of leaves and feed on chlorophyll resulting in skeletonisation of leaves. Mechanical control by way of collection and destruction of egg masses and grubs are very effective as they are seen as a colony. It can also be controlled by spraying Carbaryl (0.2%) or Metacystox (0.15%).

Aphids (*Aphis gossypii*)

Aphids suck sap from leaves of cucurbits like ash gourd, snake gourd, mush melon, water melon, cucumber etc., causing crinkling of leaves.

It also transmits mosaic virus. Control aphids by spraying Malathion (0.1%) or tobacco decoction.

Leaf hopper (*Amrasca biguttula biguttula*)

During summer months, jassids cause heavy loss to bitter gourd crop. Green coloured hopper and its nymphs are seen in large numbers on under surface of leaves and suck sap causing typical hopper burn symptoms. Initially neem oil garlic mixture at fortnightly interval is effective for control of hopper. Spraying of Acetaf, Imidachloprid etc., control hoppers effectively.

Red spider mites (*Tetranychus* sp.)

Larvae, nymphs and adults of mites lacerate leaves from under surface and suck sap resulting in production of white patches between veins in Cucurmis melo. Infested leaves turn yellow and fall of prematurely. In severe cases, intense webbing occurs giving a dusty appearance to under surface of leaves. Mites can be controlled by spray of neem oil garlic mixture or Kelthane or Dicofol on under surface of the leaves.

Leaf miner (*Lyriomyza trifolii*)

This polyphagous pest causes characteristic white twisting lines in ash gourd, *Cucurmis sativus* and Cucumis melo. Severe leaf mining accelerates leaf drop and retards growth and yield of plants. Mated females puncture leaves and lays eggs in leaf tissues. After hatching, larvae start feeding in palisade mesophyll cells of leaves while moving inside. Mines start from margins of leaves and progress towards centre. Yellow larvae can be seen at the end of mines. Larval duration is 4-6 days. When larva is ready to pupate, it cuts a semicircular slit on leaf surface and fall down on ground. Larvae emerge from leaves during early morning before 8.00 a.m. For control of miner, trap adults to yellow cards applied with adhesives. Burning infested dried leaves will help in reduction of population. Spraying neem oil garlic mixture early in the morning before sunrise will be an effective control.

Diseases

Fusarium wilt (*Fusarium oxysporum*)

Fusarium wilt is a serious disease water melon, musk melon, bottle gourd etc. In young seedlings, cotyledons drop and wither. Older plants wilt suddenly and vascular bundles at the collar region show brown discolouration. Being a soil borne disease, chemical control is very difficult. Cultivation of resistant varieties and crop rotation with resistant crops are viable methods for overcoming the disease. To some extent, the disease can be checked by hot water treatment of seeds at 55°C for 15 minutes and by drenching soil with carbendazim.

ISSN No. 2583-3146

Collar rot (*Rhizoctonia solanii*) / Pythium rot (*Pythium* sp.)

Characteristic sym-ptom of the disease is appearance of dark brown water-soaked lesions girdling the base of stem at soil level followed by death of plants. It is more serious under water logged conditions and during rainy seasons. Treating seeds with Thiram @ 3 g/kg of seed before sowing, sowing of seeds on raised beds, drenching vines with Redomyl (0.2%) or Carbendazim (0.1%) are recommended for control of the disease.

Powdery mildew (*Sphaerotheca fuliginea*)

This disease is more destructive in pumpkin, squashes, bottle gourd, melon and cucumber, that too, during rain free periods. Symptoms appear as white to dirty grey spots or patches on leaves which become white powdery as they enlarge. Powdery coating covers entire plant parts and causes defoliation. Fortnightly spray of Karathane (0.5%) or Calixin (0.05%) or Carbendazim (0.1%) are recommended for control of powdery mildew.

Downy mildew (*Pseudoperonospora cubensis*)

Disease is prevalent in areas of high humidity, especially during rainy season, on crops like bitter gourd, snake gourd, melon, bottle gourd and ridge gourd. Symptoms appear as water soaked lesions on under surface of leaf lamina and angular spots on upper surface corresponding to the water-soaked lesions on under surface. Disease spreads very fast. Plucking and destruction of affected leaves and spraying Dithane M-45 (0.2%) on under surface of leaves give effective control.

Conclusion

The ridge gourd is a key vegetable crop grown all over the nation. Due to the numerous bacterial and fungal infections, productivity is declining. If we carefully manage the growing of ridge gourd crop, production will consequently increase and nutritional value of the crop will remain high.

References

- Karthik D, Varalakshmi B, Kumar G, Lakshmipathi N. (2017). Genetic Variability Studies of Ridge Gourd Advanced Inbred Lines (*Luffa acutangula* (L.) Roxb.), *Int. J Pure App. Biosci.* 5(6):1223-1228.
- Rabbani MG, Naher MJ, Hoque S.(2012) Variability, character association and Diversity analysis of ridge gourd (*Luffa acutangula roxb.*) Genotypes of Bangladesh, Saarc j. Agri. 10(2):01-10.
- Yawalkar KS. Vegetable Crops of India. (3rd Edition,1985). Agric. Horticultural Publishing House. Nagpur. 440010, 1985, 166-170.

❖❖

ISSN No. 2583-3146

Regenerative Agriculture: The Need of the Hour

Anmol Giri[1]* Arijit Karmakar[2] and Narendra Nath Hansda[3]

[1]Department of Agricultural Economics

[2]Department of Agronomy, [3]Department of Vegetable Science

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia

Corresponding Author: anmolgiri@giet.edu

Introduction

A farming method known as "regenerative agriculture" emphasises soil health, food quality, increased biodiversity, water quality and air quality. Before Robert Rodale of the namesake institute introduced the emotionally and spiritually laden term in an essay in the Futurist in 1983, it was twice used as an adjective accompanying agriculture by Gabel and Sampson (O'Donoghue, T *et al.,* 2022). Through techniques that raise soil organic matter, biota and biodiversity, it enhances the health of the soil. Additionally, it attempts to increase carbon sequestration and water storage capacity. Regenerative farming improves soil health, fosters biodiversity and replenishes the soil with nutrients and carbon.

The main factor causing soil carbon sequestration and other beneficial effects on ecosystems is biodiversity. In all parts of the world, soil fertility and biodiversity are declining. To feed the world, keep global warming below 2°C and stop the loss of biodiversity, soil regeneration is required across more than four billion acres of cultivated agriculture. For plants to develop, the organic matter and carbon in the soil are vital. Assembling soil, water infiltration, holding onto water and nutrient cycling are all made easier by it. Furthermore, regenerative agriculture lessens erosion, offers a habitat and food source for a variety of species and is more sustainable than conventional farming (Singh, 2022).

Recently, producers, policymakers, scientists and consumers have all paid close attention to regenerative agriculture. In the report "Climate Change and Land" by the Intergovernmental Panel on Climate Change (IPCC), the significance of regenerative agriculture was also stressed. According to the paper, it is a "sustainable land management practice" that is centered on ecological functions and can be useful in enhancing the resilience of agroecosystems. Degradation of the soil and ongoing losses are results of the existing intensive agriculture system. International scientists have predicted that there may not be enough soil available to feed the world in the next 50 years.

Regenerative agriculture: why it is the need of the hour?

When we look into the environmental aspects then an improvement in the fertility and health of the soil, which is the basis for a healthy cycle of water, nutrients and carbon, as shown by healthier crops, higher yields, better soil test results and active microbial communities can be observed. Enhancements to the soil's ability to hold water, management of soil erosion along with diversification in land, in the air and in the water, including better plant, bird and insect populations (after improved biodiversity in the soil). Less chemical input results in decreased water contamination, including a reduction in toxic algal blooms.

It can also benefit individuals and the local economy. The reduced usage of antibiotics and chemical pesticides, herbicides and fertilizers improves overall health as well as reduces cost. Diversified revenue sources provide better financial security and the encouragement of local jobs and healthier food options to support rural economic development. Since regenerative agriculture does not need farmers to enter into contracts with corporate agribusiness, debt and risk are frequently reduced. In general, it generates revenue and well as provides employment opportunities for the masses.

Fig. 1. Representative figure of Regenerative agriculture

Source: (ITBSSD, 2022)

Regenerative agriculture has the potential to benefit communities as a whole. Grower networks that share knowledge, benefit from one another and foster a sense of goodwill among the different sectors of a community. Visits to farms and ranches, as well as networks of farmer's markets that assist farmers and ranchers in strengthening customer relationships with their food. Overall improvement in health will in turn provide better advantages for the community as a whole. Many farmers and ranchers who practice regenerative agriculture claim to find joy in their work. Reducing the usage and exposure to toxic pesticides benefits the health of farmers, farm workers and the society at large. Healthy food and improvement in lifestyle provides a better way of life and also protect them from diseases. Farmers claimed that working with nature rather than against it gave them more leisure time.

Regenerative Agriculture Techniques

- **Cover cropping:** Cover crops are another effective soil conservation practice to reduce runoff and water erosion. Cover crops are not a new practice, but there is renewed interest in using cover crops to conserve soil and improve soil productivity. The benefits of cover crops for reducing soil erosion are well recognized. Cover crops provide permanent surface cover between growing seasons of main crops. After termination, residues from cover crops continue to protect the soil from erosion (Baumhardt, 2014).

Fig. 2 Cover crops

- **Holistically managed grazing:** Holistic management is a method of managing the land in a way that mirrors nature. The idea is to keep or return the land to a healthy, productive state by using the resources already available. This means using minimal equipment, technology and money. Livestock is used as a tool to increase soil fertility and plant life.

- **No-till farming:** No-tillage practices lessen the probability of soil erosion in sandy and dry soils on sloping terrain. It

Fig. 3. No Till Farming

increases soil retention of organic matter, water absorption, and nutrient recycling. It can also save time and money compared to conventional tillage (Chadha, 2023).

- **Composting:** Composting is another tenant of regenerative agriculture. Composting has major potential to provide beneficial outcomes for the climate and

Fig. 4. Composting
Source: (EESI, 2021, Wikipedia, Healthline)

beyond. Many agricultural practices are site-specific, but composting is one fundamental element of organic and regenerative agriculture that can be adopted by anyone growing and/or eating food. It is a practice that can be used on any size and type of food-producing operation, which is why it is one of the methods we encourage the most in regenerative agriculture (Jwalton, 2018).

- **Reduced or no fossil fuel–based inputs, including pesticides:** The majority of the chemicals used in insecticides and fertilizers are derived from fossil fuels like oil and gas. Regenerative agriculture techniques could be used to replace these in the agricultural sector, which could aid in lowering global GHG emissions associated with agriculture. Regenerative agriculture offers alternatives to pesticide use through crop diversity and crop covering, which uses plants to manage "pests" instead of chemicals (Anonymous, 2022).

- **Agroforestry:** Agroforestry is a method of land management that blends trees, crops and livestock in a way that benefits all parties involved. It has the potential

Fig. 5 Agroforestry

not only to curb current agriculture's CO_2 output but even absorb CO_2 from other human activities (Clerkx, 2022).

- **Silvo-pasture:** Silvo-pasture mixes grazing by livestock with the use of trees. The trees provide protect the animals from the sun and rain, lowering their risk of heat exhaustion and enhancing their welfare. Additionally, having a number of trees promotes biodiversity, reduces soil erosion and helps sequester carbon.

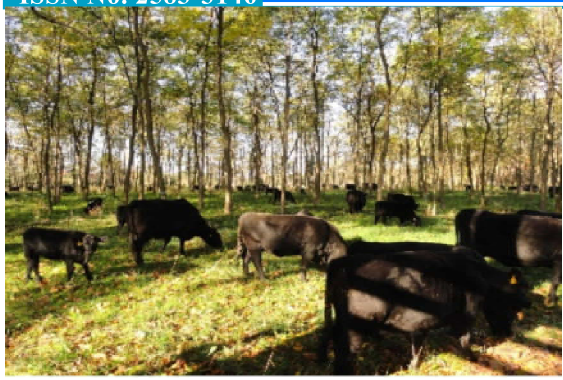


Fig 6. Silvo-pasture

- **Bio-char:** Because of its various benefits as a soil amendment, biochar is a particularly stable form of carbon. Nitrogen loss, phosphorus leaching, nitrous oxide production, ammonia volatilization, and greenhouse gas emissions can all be decreased by amending soil with biochar. The application of biochar has beneficial effects on plant development, water-holding capacity as well as drought resistance. These characteristics make

Fig.7 Biochar

Source: (Reforest action, Greener land, phys.org)

biochar a fantastic tool for restoring our soils (Smith and Peterson, 2023).

The following advantages, both on a national and global level, can result from the adoption of regenerative agriculture.

A variety of problems can be addressed right from the abolition of hunger to improved nutrition and sustainable climate promotion due to decreased Greenhouse Gas Emissions and work towards reversing climate change as there is reasonable evidence that suggests that climate change can be reversed by increasing the soil carbon stocks. The soil can be made drought resistant, improve the water holding capacity of the soil and also builds soil organic matter, resulting in improved yields in comparison to conventional farming. It can also revive local economies, preserve the traditional knowledge of the farming community, promote biodiversity and restore grasslands which have been on a decline for some time now.

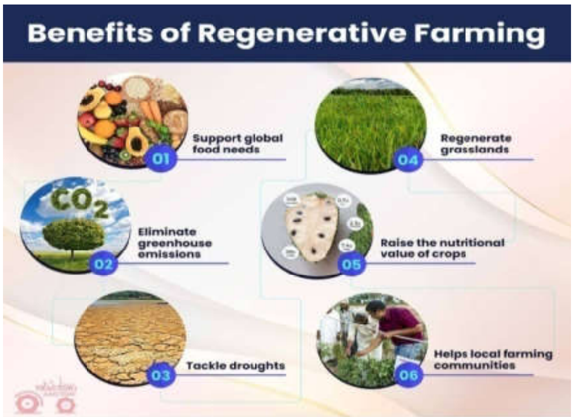


Fig. 8 Benefits of Regenerative farming.

Source: (Tractor Junction, 2022)

Conclusion

Among the negative effects of conventional farming include soil erosion, water pollution and deforestation. In addition, it is mostly dependent on chemical inputs like pesticides and synthetic fertilizers, which can further harm the environment and endanger biodiversity. By restoring soil health and fostering biodiversity, regenerative agriculture may change that and contribute significantly to the fight against climate change. Since sustainable agricultural practices are not brand-new, certain farmers are already making progress in this direction. At scale, switching to regenerative agriculture can lessen soil deterioration for long-term beneficial effects.

At this critical juncture in human history, all that can be done to lessen the consequences of climate breakdown must be done and the potential of regenerative agriculture to cut carbon emissions, enhance ecology and biodiversity and in the process, ultimately render agriculture more sustainable, cannot be overlooked. These behaviours must co-exist with a larger worldwide shift away from animal consumption towards more vegan and plant-based diets. To mention a few, our use of animals for food and entertainment contributes to climate change, the unwarranted misery of countless sentient beings, the devastation of ecosystems, the extinction of species and grave harm to human health. Regenerative agriculture doesn't answer all the questions but can help us in seeking valuable answers to a majority of problems the world is facing today.

References

- Singh, K., A. (2022). Here is why the world needs regenerative agriculture. *Down to Earth*. Available at. https://www.downtoearth.org.in/blog/agriculture/here-is-why-the-world-needs-regenerative-agriculture-86328.
- O'Donoghue, T., Minasny, B. and McBratney, A. (2022). Regenerative Agriculture and Its Potential to Improve Farmscape Function. *Sustainability*. 14(10):5815. https://doi.org/10.3390/su14105815
- Anonymous (2021). Regenerative Agriculture 101. *NRDC*. Available at. https://www.nrdc.org/stories/regenerative-agriculture-101#what-is
- Baumhardt, R. L., & Blanco-Canqui, H. (2014). Soil: conservation practices. *Encyclopedia of agriculture and food systems,* 5, 153-165.
- Chadha, A. (2023). Advantages and Disadvantages of No-Till Farming. *Krishi Jagran*. Available at. https://krishijagran.com/farm-mechanization/advantages-and-disadvantages-of-no-till-farming/
- Jwalton (2018) Methods of Regenerative Agriculture: #4 Composting. *Green America*. Available at. https://greenamerica.org/blog/methods-regenerative-agriculture-4
- Anonymous (2022).What is regenerative agriculture and how does it work?*GenV.* Available at. https://genv. org/regen-agriculture/
- Clerkx, L. (2022)What is regenerative agroforestry? *This side up*. Available at. https://thissideup.coffee /stories/2022/5/3/what-is-regenerative-agroforestry
- Smith, S. and Peterson, R. (2023). Biochar's Role in Farming and Soil Health. *Biomass Magazine*. Available at. https://biomassmagazine.com/articles/19638/biocharundefineds-role-in-farming-and-soil-health
- Fighting climate change via 'regenerative agriculture Available at. https://www.iybssd2022.org/en/fighting-climate-change-via-regenerative-agriculture/
- A Step Towards Sustainable Farming. Available at. https://www.tractor-junction.com/blog/regenerative-agriculture-a-step-towards-sustainable-farming/
- Silvopasture. Available at. https://www.greener.land/index.php/product/silvopasture/
- Cover Crops for Climate Change Adaptation and Mitigation. Available at. https://www.eesi.org/images /content/Ag_Series_-_Cover_Crops_(4).png

❖❖

ISSN No. 2583-3146

Importance and Benefits of Organic Farming in India

Nachiketa* and Bhawna Soni
Department of Agronomy, SHUATS, Prayagraj
Corresponding Author: nikkuyadav301@gmail.com

Introduction

A crop production method known as organic farming forgoes the use of synthetic substances like fertilisers, insecticides, growth promoters and additives to feed livestock. By fusing tradition, innovation and science, it can maintain the wellbeing of soils, ecosystems and people since it integrates crop management and animal husbandry in agro-ecosystems that are both socially and environmentally sustainable. By renewing and enhancing the biological processes and functions of farm ecosystems, this approach minimises the usage of external inputs and expertise and strives to optimise crop yield rather than maximise it (Shukla *et al*., 2011).

Food quality and safety are two critical elements that have received widespread attention. Growing environmental knowledge, as well as many food risks have significantly eroded consumer trust in food quality in recent decades. Intensive traditional farming can pollute the food chain. For these reasons, people are seeking safer and better foods produced by more environmentally and genuinely local systems. These demands are thought to be met by organically farmed food and food products (Rembialkowska, 2007).

Organic produce is farmed without the use of synthetic pesticides, antibiotics, growth hormones, genetic alteration techniques (such as genetically modified crops), sewage sludge, or chemical fertilizers.

Needs of Organic Farming

Farmers embraced plant nutrition-responsive crop hybrids with more potential in crop yields, the use of synthetic agrochemicals, farm mechanisation and enhanced cultural practices as part of the Green Revolution, which was implemented in the late 1960's to increase food supply in the country. As a result, crop yield could be raised three to fourfold, and crop security, together with environmental security, was attained to some extent (Sinha, 2008; Gahukar 2011). However, previous claims of increased crop output have been unsatisfactory due to decreased or static crop productivity, soil salinity/alkalinity, declining soil fertility levels and crop susceptibility to pests and diseases (Gahukar, 2010a). Crops grown under low-input sustainable agriculture are less vulnerable to insects, mites and other pests, as well as pathogens that cause soil-borne, seed-borne and foliar diseases (Biswas, 2011). Furthermore, illness incidence is lower in soil with soil antagonists such as *Trichoderma* spp. and *fluorescent Pseudomonas* fluorescens (Chandra *et al*., 2007).

Aside from these disadvantages, environmental issues and risks to human health have emerged in a number of areas. Consumption awareness is growing, with a preference for organic foods over those containing hazardous chemicals that pose health risks. Organic agriculture produces food with no artificial flavours, preservatives or pollutants. Consumers agree, despite the fact that proof is dispersed and difficult to obtain, that food cultivated organically is tastier and healthier than food grown chemically. This is most likely due to nutritional qualities. Pollution of ground water and air with synthetic fertilisers and pesticides is avoided and natural environmental degradation is reduced.

Organic farming is not cost-effective for the first 3-4 years but the long-term economic benefits increase year after year since it decreases production costs by 25-30% and improves or at least maintains soil fertility levels while reducing soil erosion. It has a good impact on the ecosystem, including wildlife survival in the lowlands and grass for grazing animals. Similarly, agricultural interventions have a favourable impact on the restoration and maintenance of natural ecological balance in the medium and long run. Crop rotations, mix-/inter-cropping, symbiotic associations, cover crops, organic fertilisers and low tillage are examples of cultural practices used in organic farming.

The negative effects of climate change are becoming increasingly serious as people consider conservation of the environment and biodiversity as a crucial criterion for achieving food sufficiency and saving our planet from calamities (Gahukar, 2010 b). Organic farming contributes to the reduction of greenhouse gases (GFIG) and global warming by sequestering carbon in the soil. Many cultural practices have been implemented to increase carbon return in the soil, increasing productivity and encouraging carbon storage (Gahukar, 2010). Because of their resistance to pests and diseases, as well as their endurance to climatic stress, local genotypes/cultivars of numerous crops are choosen.

Organic Farming Process

Organic farming and food processing practices are diverse, necessitating the development of a food production system that is socially, ecologically and economically viable. The International Federation of Organic Agriculture Movements (IFOAM) has proposed four core principles of organic farming: health, ecology, fairness and caring. The main principles and practises of organic food production are to inspire and improve biological cycles in farming systems, to maintain and improve deep-rooted soil fertility, to reduce all types of pollution, to avoid the use of pesticides and synthetic fertilisers, to conserve genetic diversity in food, to consider the vast socio-ecological impact of food production and to produce high-quality food in sufficient quantity (IFOAM, 1998).

Agriculture requires specified prerequisites for both agricultural cultivation and animal husbandry, according to the National Organic Programme administered by the USDA Organic Food Production Act (OFPA, 1990). Crops must be grown in fields free of synthetic pesticides, chemical fertilisers and herbicides for three years before harvesting, with a sufficient buffer zone to reduce contamination from neighbouring farms. Genetically modified organisms, sewage sludge and ionising radiation are all severely prohibited. Soil fertility and nutrient content are generally regulated by farming practices such as crop rotation and the use of cover crops enhanced with animal and plant waste manures. Pests, illnesses and weeds are primarily controlled by the use of physical and biological control techniques rather than herbicides and synthetic pesticides. Organic cattle should be raised without the use of growth hormones or antibiotics on a regular basis and they should have adequate outdoor access. Preventive measures such as routine vaccination and vitamin and mineral supplements are also required.

Benefits of Organic Farming

Organic farming has a protective role in environmental conservation. The effect of organic and conventional agriculture on the environment has been extensively studied. It is believed that organic farming is less harmful to the environment as it does not allow synthetic pesticides, most of which are potentially harmful to water, soil and local terrestrial and aquatic wildlife (Oquist *et al*., 2007). In addition, organic farms are better than conventional farms at sustaining biodiversity, due to practices of crop rotation. Organic farming improves physico-biological properties of soil consisting of more organic matter, biomass, higher enzyme, better soil stability, enhanced water percolation, holding capacities, lesser water and wind erosion compared to conventionally farming soil. Furthermore, organically managed soils have higher quality and water retention capacity, resulting in higher output in organic farms even during drought years.

Organic farming necessitates greater labour, resulting in more income-generating positions per farm (Halberg, 2008). An organic product typically costs 10%-40% more than comparable conventional crops and the price is determined by a variety of factors in both the input and output arms. On the input side, factors that raise the price of organic foods include the high cost of gaining organic certification, the high cost of labour in the field, and the lack of subsidies on organics in India, as opposed to chemical inputs. However, as health knowledge grows, people are willing to pay a premium. Some organic products are also in short supply due to strong demand, resulting in an increase in price.

Organic products have greater dry matter, minerals and antioxidants such as polyphenols and salicylic acid, according to a review by Lairon (2010) based on the French Agency for food safety (AFSSA) report. In comparison to conventionally grown foods, organic foods (94%-100%) contain no pesticide residues.

Fruits and vegetables include a wide range of phytochemicals, including polyphenols, resveratrol, pro-vitamin C and carotenoids, which are plant secondary metabolites. Organic fruits and vegetables have 27% more vitamin C than conventional fruits and vegetables, according to Lairon (2010). These secondary metabolites have significant regulatory effects at the cellular level and have thus been discovered to be protective against diseases such as cancer, chronic inflammation, and others (Lairon, 2010).

Organic foods typically have significantly less nitrate than regular vegetables. Nitrates are utilised as soil fertiliser in agriculture, but they are easily converted into nitrites, which are hazardous to public health. Nitrites are extremely reactive nitrogen species that can compete with oxygen in the blood to bind to haemoglobin, causing methemoglobinemia. It also binds to the secondary amine to produce nitrosamine, a carcinogen (Lairon, 2010).

As a result, organic foods have greater nutritional value and health safety. Environmental and socioeconomic consequences.

Constraints

The key problems include quality and certification credibility, food safety and breaking the notion that contamination from conventional farming and GM crops (Kulkarni, 2011). Of course, customers in cities and towns are aware and willing to pay higher prices for organically produced farm commodities, but the rural population cannot. Furthermore, incentivizing production is not enough; market demand must also be created. Crop yields are initially rather poor. Skilled labour is required, and significant rates will be paid. Organic manures are expensive and difficult to obtain. The cost of certification is prohibitively expensive for small growers. Because most seeds are treated with synthetic pesticides and fungicides, it is difficult to get non-treated seeds. In some states, this treatment is required for the sale of seeds. With the increased use of GM crops in conventional agriculture and due to gene transmission through pollen, separating fields with organic crops is necessary. However, this presents challenges because surrounding areas are mostly under GM crops or chemically-grown crops, making it difficult to ensure that organic products are entirely GM free in nature. Transparency is necessary throughout the supply chain. Farmers must therefore be organised in a group/association for crop production, such as the Organic Farming Association of India or the Institute of Natural Organic Agriculture.

India's Organic Farming Situation

Production, Popularity, Economic Growth and Future Prospectus.

Organic food and farming have grown in popularity around the world. Over the previous three decades, the overall area of cropland under organic farming has continuously expanded (Willer and Lernoud, 2019). By 2017, there were 69.8 million hectares of organically managed land documented globally, representing a 20% increase or 11.7 million hectares of land over 2016. This is the highest increase in organic farming ever documented (Willer and Lernoud, 2019). The nations with the most organic agricultural land recorded in 2017 are shown below. Australia has the most organic lands with 35.65 million hectares, whereas India ranks ninth with 1.78 million hectares of total organic agriculture land (Willer and Lernoud, 2019).

Organic farming in India has grown slowly, with approximately 41,000 hectares of organic land accounting for only 0.03% of total planted area. Organic farming produced around 14,000 tonnes in India in 2002, with 85% of it exported (Chopra *et al.*, 2013).The most significant hurdle to the advancement of organic agriculture in India was the lack of a strong determination by the government to encourage organic agriculture. Furthermore, there were several major barriers to the growth of organic farming in India, including a lack of awareness, a lack of good marketing policies, a lack of biomass, insufficient farming infrastructure, high farming input costs, inappropriate marketing of organic input, inefficient agricultural policies, a lack of financial support, an inability to meet export demand, a lack of quality manure and a low yield (Bhardwaj and Dhiman, 2019).

According to the Agricultural and Processed Food Products Export Development Authority and the Research Institute of Organic Agriculture, India ranked eighth in terms of organic agriculture land and 88th in terms of the ratio of organic crops to agricultural land. However, significant expansion in the organic sector in India has been recorded in recent decades.

India is an agriculture-based country, with farming and allied sectors employing 67% of the population and 55% of the labour force. Agriculture provides for the basic necessities of India's rapidly rising population and accounts for 30% of total income. Organic farming has been discovered to be an indigenous Indian discipline that has been conducted in many rural and farming communities for millennia. The introduction of contemporary technology and the rising population burden resulted in a preference for conventional farming, which entails the use of synthetic fertilizers, chemical pesticides, genetic modification techniques and so on. India has a solid conventional farming system, astute farmers, vast drylands and only minimal usage of artificial fertilizers and pesticides. Furthermore, abundant rainfall in the country's north-east hilly regions, where few minor chemicals are used for a long period of time, results in naturally organic lands. Indian traditional farmers have a deep insight based on their knowledge, thorough observation, tenacity and pest management practices that have been deemed helpful in improving organic output and consequent economic progress in India. Organic agriculture has made significant advances. Currently, India is the world's largest organic producer (Willer and Lernoud, 2017, 2019), with 1.78 million ha of organic agriculture land in 2017. Willer and Lernoud, 2019).

Perspectives

Although organic farming is labour intensive, it gives opportunities for rural employment and long-term resource enhancement. Integrating animal husbandry into organic farming, for example, gives available manure and organic materials. Organic fabric is popular and organic farming has been shown to benefit sericulture (Babu and Dandin, 2009). This principle could be applied to other related industrial items.

Organic farming can be adopted gradually and supported by a solid research and development network, resulting in sustainable agriculture that appears to be appropriate to Indian farming circumstances in order to make the country self-sufficient in food production.

As a result, policymakers should encourage organic farming for improved quality of life, soil health restoration, national economic development and environmental protection. Subsidies may be provided to encourage farmers. Farmers are not enticed to purchase premium fixed or organic products. Contract farming may be an effective alternative for this goal (Gahukar, 2007).Farmers will be encouraged to adopt organic practises and green agricultural inputs in this manner.

Farmers would be encouraged and motivated to increase crop production if there was a separate minimum support price for organic produce. Organic zones may be segregated from other areas to maintain a distance for isolation, particularly for seed production. Farmers can use the farmer-centric certification system known as the "Participatory Guarantee System" to their advantage. Organic farming in India has increased 25-fold in the last seven years as a result of the combined efforts of farmers, NGO'S, government interventions and market forces. Further improvement will undoubtedly raise awareness about organic farming, transforming it with future commercial potential.

Conclusion

Organic agriculture produces more healthy and safe food. Organic food is becoming increasingly popular as consumers seek out organic foods that are regarded to be healthier and safer. As a result, organic food may ensure food safety from farm to plate. Organic farming is more environmentally friendly than conventional farming. Organic farming promotes consumer health by keeping soil healthy and maintaining environmental integrity. Furthermore, the organic produce market is now the world's fastest expanding market, including India. Organic agriculture enhances a nation's consumer health, ecological health, and economic growth by generating money in a holistic manner. India is currently the world's largest organic producer (Willer and Lernoud, 2019), therefore we may conclude that boosting organic farming in India can help construct a nutritionally, environmentally and economically healthy nation in the near future.

Refrences

- Babu, C.M. and Dandin, S.B. 2009. Organic farming for mulberry: An overview. Indian Journal of Sericulture. 48 (2): 100-110.
- Biswas, A. 2011. Organic farming in relation to crop disease management. Pestology.35 (1): 44-49.
- Bhardwaj, M., Dhiman, M. (2019). Growth and performance of organic farming in India: what could be the future prospects? Journal of Current Science, 20: 1–8.
- Chandra, B., Ram, B. and Singh* U.S. 2007. Impact of organic farming on plant and soil health. Journal of Mycology and Plant Pathology. 37 (1): 181.

- Chopra, A., Rao, N.C., Gupta, N., Vashisth, S. (2013).Come sunshine or rain; organic foods always on tract: a futuristic perspective. International Journal of Nutrition, Pharmacology Neurological Diseases, 3: 202–205.
- Dangour, A.D., Allen, E., Lock, K., Uauy, R. (2010). Nutritional composition & health benefits of organic foods-using systematic reviews to question the available evidence. Indian Journal of Medical Research, 131: 478–480.
- Fliessbach, A., Mäder, P. (2000). Microbial biomass and size—density fractions differ between soils of organic and conventional agricultural system. Soil Biology and Biochemistry, 32: 757–768.
- Gahukar, R.T. 2007. Contract farming for organic crop production in India. Current Science. 93 (12): 1661 -1663.
- Gahkar, R.T. 2010a. Role and perspective of phytochemicals in pest management in India. Current Science. 98 (7) : 897 - 899.
- Gahukar, R.T. 2010b. Climate change and sustainable agriculture in India. Chapter 10, pp. 204-217. In: Climate Change (Ed. S.P. SAIKIA). International Book Distributors, Dehradun, India
- Gahukar, R.T. 2011. Food security in India: The challenges of food production and distribution. Journal of Agricultural and Food Information.13 (3) in press.
- Gour, M. (2016). Organic farming in India: status, issues and prospects. SOPAAN-II, 1: 26–36.
- Halberg, N. (2008). Energy use and green house gas emission in organic agriculture. In: Proceedings of International Conference Organic Agriculture and Climate Change. 17–18 April 2008, ENITA of Clermont, France, pp. 1–6.
- International Federation of Organic Agriculture Movements (IFOAM). (1998). The IFOAM basic standards for organic production and processing. General Assembly, Argentina, November, IFOAM, Germany. Organic Food Production Act of 1990 (U.S.C) s. 2103.
- Lottter, D. 2003. Organic Agriculture, J. Susatinabel Afric., 21 PP 1-63.
- Lairon, D. (2010). Nutritional quality and safety of organic food. A review. Agronomy for Sustainable Development, 30: 33–41.
- Oquist, K. A., Strock, J. S., Mulla, D. J. (2007). Influence of alternative and conventional farming practices on subsurface drainage and water quality. Journal of Environmental Quality, 36: 1194–1204
- Rembialkowska, E. (2007). Quality of plant products from organic agriculture. Journal Science of Food and Agriculture, 87: 2757–2762.
- Sinha, R.K. 2008. Organic farming: An economic solution for food safety and environmental security. Green Farming. 1 (10-11): 42-49.
- Shukla, A., Patel, B.R., Patel, A.N. and Patel, A.R. 2011. Organic farming for sustainable agriculture. Kisan World.38 (3): 39- 42.
- Willer, H.Lernoud J, eds. (2019). The World of Organic Agriculture. Statistics and Emerging Trends. Research Institute of Organic Agriculture (FiBL), Frick and IFOAM—Organics International, Bonn. https://www.organicworld.net/yearbook/yearbook-2019.html.

❖❖

ISSN No. 2583-3146

Bee Keeping: Honey Bee Farming and their Management

Kirandeep Kaur

Department of Horticulture, Khalsa College Amritsar, Punjab

Corresponding Author: kirandeepkaur.kdk97@gmail.com

Introduction

Apiculture is the branch of science which deals with the study and maintenance of honey bees (Kaiser and Ernst, 2022). Beekeeping is an art of caring and managing colonies of honeybees. Honey bee belongs to order "Hymenoptera" and family "Apidae". Italian bee and Indian bee are domesticated species, whereas, Rock bee and Little bee are wild species. Beekeepers often begin it as a fascinating hobby and later expanding their interest into a small business. Kishan *et al.,* (2017) noticed that in India, beekeeping is mostly practised as a full-time occupation to produce great income and table honey. Honeybees are special gift to mankind because beekeeping can be done for their pollination services and their popular products such as honey, beeswax, propolis, bee venom, etc. These products have their wide spread use in different small and large scale industries in India

Honeybee Species in India

Rock Bee / Giant / Dumna (*Apis dorsata*)

They are huge and savage bees that build a single comb on the underside of the branch. They can be seen in the forests and also in concrete jungles. In hilly regions, they construct their hives up to an altitude of 2700 m. Crane (2004) noticed that these bees occur from Pakistan in the west, through the Indian subcontinent and Sri Lanka to Indonesia in the east. According to Ramchandra *et al.,* (2012), as these bees are aggressive in nature, they will attack the intruders and their stings can turn fatal to the humans. Approximately 50-80 kg of honey can be squeezed from a single colony of rock bee per year. It is generally priced high locally because of the danger involved in harvesting rock bee honey.

Little / Dwarf Bee (*Apis florea*)

These bees are small and less dangerous than rock bees. According to research findings of Hepburn and Radloff (2011), these bees construct single vertical combs encircling the twigs. They also build palm sized combs in the bushes, hedges, buildings, caves, empty cases, etc. The honey produced by these bees is dramatically less and produce only about half a kilo of honey per year per hive. They are excellent pollinators.

Indian Bee (*Apis Cerana indica*)

It was the only rearable bee species in India before the introduction of Italian bee. It is also found in Pakistan, Nepal, Burma, Bangladesh, Sri Lanka and Thailand. These bees are smaller in size as compared to rock and Italian bees, whereas, are bigger than little bees. These are comparatively non-aggressive and can rarely shift locations. These bees construct multiple parallel combs in dark places such as clay pots, logs, wall, tree openings, etc. Brood comb consists of cells of two sizes. The smaller cells are for worker brood, while the larger ones are for the drone brood. The queen cells are built on the lower edge of the comb. These bees generate 7-9 kg of honey per colony per year.

European / Italian Bee *(Apis mellifera ligustica)*

These bees were introduced from Europe because the native Indian bee colonies were vanishing because of the Thai sacbrood virus. Presently they are well established in northern India because of the rich flora such as mustard, safflower, sunflower, etc. They are bigger than all other honeybees except rock bee. They can produce about 25-40 kg of honey per colony per year.

Stingless / Dammar Bee (*Meliponini*)

These bees are smallest in size (less than 5 mm). They belong to the family Apidae and subfamily Meliponinae. It consists of two genera Melipona and Trigona. Michener (2000) noticed that these bees can't sting as their stingers are highly reduced, but they try to defend their colony from intruders by using their mandibles. These bees are important pollinators of various food crops and can be domesticated. Their colonies can be kept in tree logs, wooden boxes and clay pots for harvesting the small quantity of highly prized medicinal honey. The honey yield per hive per year is very low approximately 100 g.

Site selection of apiary

According to the research findings of Kaiser and Ernst (2022), the apiary or the place where bees are kept in bee hives must be dry without dampness. Hives should be located within 1 to 2 miles of nectar and pollen sources. According to previous research, hives need to be kept in a shaded area, whereas the latest information indicates that it is best to place them in full sunlight to help combat the beetle. A source (natural or artificial) of water should be located nearby for honey bees. Avoid locations near large rivers, highways, public areas or on hilltops. Hives should be protected against cold winter winds. The hives that are located near the cultivated crops are in danger of exposure from insecticides.

Foraging by honeybees

India is a vast country with different climatic zones providing rich flora for honeybees. By foraging, honeybees collect pollen and nectar where pollen is a protein source and nectar is carbohydrate source which together fulfils their nutrient requirements. Farnesi *et al.,* (2009) reported that there are two types of foraging bees, i.e, nectar collectors and pollen collectors. They have to visit hundreds of flowers for collecting a sufficient amount of nectar and pollen. According to research findings of Bankova *et al.,* (2000), the foragers also collect water and propolis (plant resins) in addition to nectar and pollen in case of Italian and stingless bees. Koetz (2013) noticed that the foraging distance of Indian bee (*Apis cerana*) is about 200-300 m from the hive, while, the research studies of Hyatt (2011) showed that it can forage up to 900m. Italian bee (*Apis mellifera*) have a great foraging range of around 10 km in accordance with Abrol (2011).

Biology of honey bees

Honeybees have three developmental stages and an adult stage. The developmental stage of a honey bee consists of an egg, larvae and pupa. However, in adult stage there are three castes (single queen, hundreds of drones and thousands of workers). A drone (male honey bee) is haploid having chromosome number n=16, whereas, queen and workers (female honey bees) are diploid having chromosome number 2n= 32. The queen is a fertile, well developed and functional female that can produce males and females. The worker is an unfertilized female that is capable of producing only males due to the haplodiploid sex determination system and the drone is a male. Their caste depends on the food item that they are fed during the larval stage. The queen larva is fed with royal jelly by nurse bees throughout its larval period. According to the research findings of Kamakura (2011), a 57 k Da protein-royalactin present in royal jelly is the only reason for larvae to become queen.

Honey bee castes

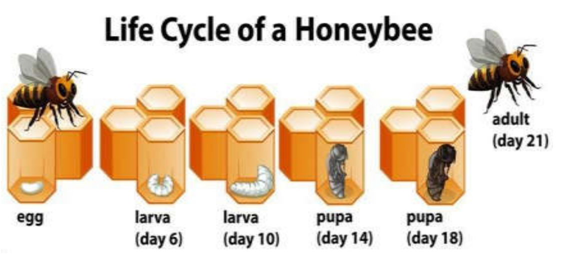
Honey bees are social insects and live in colonies with a highly organised system of division of labour. In accordance with Kishan *et al.*, (2017), following are the members of a colony.

The Queen: Every colony has one queen which is the mother of all other bees. She is the only sexually developed female and her reproductive organs are well developed. After 5-10 days of its emergence, she mates with the drone and lays eggs throughout her life. She is the only individual which lays eggs in a colony and can lay up to 2,000 eggs per day. A well-developed queen is generally two or three times bigger than the workers measuring about 15-20 mm in length. She can be identified by her short wings, long abdomen provided with a combined sting and ovipositor (egg laying organ). Her productivity depends on the amount of food that the worker bees bring in and the amount of brood space in the colony. Queen lives for 2 to 5 years and when she is weak or unable to lay eggs it is replaced by one of the daughter queens. She can prevent swarming (moving in large group) and absconding (leave hurriedly and secretly) of colonies.

The Worker: There are thousands of workers in a colony. They are smaller in size than the queen and drones. They are under-developed females which are produced from the fertilized eggs but remain sterile due to non-availability of royal jelly. Workers may lay eggs which develop into drones because they never mate and they have no sperm to fertilize their eggs. Workers have adult life span of around 6 weeks. They have a sting on the terminal end of abdomen, while the wax glands are found on the ventral side of abdomen. Their hind legs are modified for pollen collection. They are responsible for building of comb with wax, to maintain the temperature of the hive and to take care of the queen. They perform

all the duties in the colony including foraging, defending, brood rearing and cleaning activities. For defending the colonies, worker bees possess sting which is a modified ovipositor and venom is pumped out at the time of stinging. They perform indoor duties at their young stages (for first three weeks), whereas, they go out for foraging only when they are old enough (for rest of the life i.e, after 21 days).

The Drone: There are about hundreds of drones in a colony. The drone is a male bee and is smaller than queen measuring about 15-17 mm in length. It can be easily identified by their dark colour and eyes touching the top of their head. Their only function is to fertilize the queen and enjoy the food inside the hive. They are not permanent members of the colony and are raised only when new queens are reared. They are driven out of the hive before setting of monsoon and winter, therefore, die due to starvation. They are raised from the unfertilized eggs and do not possess structural modifications, hence they are incapable of collecting food or defending themselves against enemies. They do not sting as they lack stingers. Drone cells have enlarged cappings and as the drones consume the stored honey, the beekeepers decapped these drone cells. They have excellent navigation abilities.



Life cycle of honey bee

The special cells are constructed at the lower border of the brood comb (beeswax structure of cells). Single egg is laid by the queen bee in each cell which hatches after three days. The newly hatched grubs are fed with royal jelly for 2-3 days and after that they are provided with honey and nectar. The grub is fully developed in 5-6 days. The grubs are cylindrical and light yellow in colour. The queen cell is caped where grub changes into pupa and after a week adults come out by biting the cap of the queen cell. The adult that come out earlier become the queen daughter and it kills the remaining before their emergence. The queen and workers are developed from the fertilized eggs of the bees, whereas the drones are borne from the unfertilized eggs.

Economic importance of honey bees

Apart from providing the pollination services, honeybees also gift some valuable products to the mankind. The first and foremost gift by honey bee is honey. Moreover, other products which the honey bee provides include beeswax, pollen, royal jelly, propolis, bee venom, soap, lip balm, candles, etc.

Pollination: Honey bees play an important role in the pollination of plants. The orchards which are not visited by bees bear comparatively less fruits. About 80 to 90 % pollination is done by the bees on the plants.

Honey: Singh *et al.,* (2012) found that honey is the substance made when the nectar and sweet deposits suck from the flowers are gathered, modified and stored in the honeycomb by honeybees. It is colourless to light brown viscous fluid produced by honey bees. Honey is a rich carbohydrate source which mainly contains fructose and glucose. Water is the other main constituent of honey and it also contains sugars, acids, vitamins, proteins and minerals. Honeybees seal the honey in comb cells after evaporating the excess moisture to reduce it to less than 20%. Honey can be marketed in several forms as reported by Kaiser and Ernst (2022). Comb Honey consists of chunks (thick solid piece) of honey-filled combs taken directly from the hive. It is usually preferred by older adults. Extracted Honey is the liquid portion that has been separated from the comb. It is generally preferred by most of the consumers. Chunk Honey is a combination of comb honey and extracted honey that is bottled together.

Beeswax: Wax is the secondary byproduct of honeybees. Previously it was thought that the beeswax is produced by the nectar of the flowers, but now it is reported that it is secreted by the wax glands situated in the ventral side of the abdomen of worker honey bees, when it is about 14-18 days old. The colour of the wax is white but it may change due to the influence of pollen source. Beeswax consists of complex esters of mono atomic alcohols, fatty acids and saturated hydrocarbons. Normally, wax is obtained from the damaged combs. Beekeeping industry is also one of the largest user of beeswax because it is used to form wax foundation sheets for the comb frames in the hive and also to seal the honey chambers. Wax is used in preparing candles, polishes, furniture, pharmaceutical products and perfumes. It is also a vital constituent of cosmetics like cold creams, lipsticks because it adheres better to the skin (Mishra 1995).

Bee Venom: Hossein *et al.,* (2015) reported that bee venom is a complex mixture of proteins and peptides. It contains proteins such as phospholipase and melittin which have anticoagulation factors and it increases the

blood clotting time. It is present in the venom sac and will be injected using sting.

Propolis: Propolis is a sticky, resinous and dark coloured substance that is collected by honey bees from the tree buds. It is used in the construction of honey bee combs and also to cover the cracks and crevices of the hive. The colour of the propolis ranges from a light yellow or brown to a dark brown. Its colour also varies according to the trees and plants from which it is harvested (Fearnley 2005). It can be used to treat wounds, infections, dermatitis and cancer. It is a strong fungicide, disinfectant and has an inhibitory activity against bacteria, fungi and yeast.

Royal Jelly: According to the research findings of Abrol (2013), it is a milky white and acidic substance that is secreted by worker honey bees (at the age of 6-12 days) to feed the queen. The main components of royal jelly are proteins, sugars, vitamins, RNA, DNA and fatty acids. It is also a very nutritious food for human beings as it increases vigour and vitality. It contains eight essential amino acids that are required for human beings are present in royal jelly. Apart from this, it also contains vitamins A, B and C, iron, copper, phosphorus, silicon and sulphur.

Pests and Diseases of honey bees

Wax Moth- Wax moths are the major pest of honey bees in Asia and India. It includes greater wax moth (*Galleria mellonella*) and lesser wax moth (*Achroia grisella*). Their activity will be highest during June to October. Larval stage is the damage-causing stage. It causes considerable damage if the beekeeper doesn't follow the proper storage of empty combs, rendered wax, comb foundation sheets and bee-collected pollen. It generally occurs due to the poor management practices followed by beekeeper. Maintaining hygienic beekeeping practices is the best way to prevent the honeybee colonies from wax moth attack. In north India, as beekeeping is mainly concerned with Italian bees, so there is less problem with the wax moth as the Italian bee itself closes the cracks and crevices by using propolis. The larvae can be killed by keeping the infested combs in hot water (60°C) for 4-5 hours. Fumigation of the affected wax combs with paradichlorobenzene (PDB) will be effective. Biocontrol agents like *Bacillus thuringiensis*, Galleria Nuclear Polyhedrosis Virus (GNPV) are also used as a protection measures.

Hive Beetle (*Aethina tumida*): This pest will cause considerable damage to honey bees. It is small and black beetle which will eat and destroy the cells constructed by the bees. It will also feed on pollen, eggs and small honey bee grubs. Fume boards can be placed over the beehive and the hive may be kept on a concrete floor for controlling the beetle because it is a soil pupator.

Ants: Ants are enemies to both honeybee and beekeeper as they cause pain to the beekeeper by their bites. They will feed on everything that they get from the honeybee colony which includes the dead and live honey bees, honey and the brood. They can cause the honey bee colonies to abscond. Engine oil or grease is applied to the ant stand for obstructing their movement. Chemicals like ethyl or methyl alcohol, sodium fluoride, borax powder, salt or powdered sulphur can be used for ant control.

Wasps (Vespa spp): Wasps are the pest that swallow the honey bees and weaken the colonies. Peak activity of the wasp was reported from August to November in Himachal Pradesh by Rana *et al*., (2000). The bees can kill wasps through shimmering behavior by forming balls around them. The wasps are killed due to high temperature at center of ball (43-46°C) and suffocation. Destruction of wasp nest, use of protective screens and baits are suggested for wasp control.

Birds: According to research findings of Ramchandran *et al.,* (2012), honey bees are prone to hunting by birds because they have aerial movements. King crow (*Dicrurus* sp.), Swifts (*Apus* sp.), Shrikes (*Lanius* sp.), Bee eater (*Merops* sp.) are some of the major bird enemies that attack the honey bees. Among all of these birds, bee-eater possess the major threat to honey bees.

For controlling the birds, making high pitch noises, producing scaring sounds by beating the empty tins can be done so that the birds get scare (Gulati and Kaushik 2004).

Viruses: Honey bees are affected by various viruses such as Thai sacbrood virus (TSBV) and Kashmir bee virus. Devanesan and Jacob (2001) found that TSBV was a major one and caused a disastrous outbreak and destroyed more than 90 % of honey bee colonies in India. Both the larval and pupal stages are susceptible to this disease, but the adult is an immune stage (Ramchandran et al, 2012). Brood will die in prepupal unsealed stage due to viral attack.

Bacterial Diseases: American foulbrood (AFB) disease caused by *Paenibacillus* larvae and European foulbrood (EFB) caused by *Melissococcus plutonius* are the dangerous bacterial diseases infecting the honeybee colonies (Oldroyd and Wongsiri 2006). AFB is the one of most widely spread and more harmful bacterial disease. AFB infected larvae normally die after their cell is sealed. Caps of these dead brood cells are usually darker than the caps of healthy cells. Young larvae of 4-5 days old are highly susceptible EFB disease and it is a stress related disorder. Sterilization of equipments can be done using formalin @ 6 ml per litre for their control. Terramycin @ 250–400 mg in 5 litre of sugar syrup can be fed to diseased colony twice at weekly intervals for effective control. Other mechanical methods namely shookswarm (where the adult bees are shaken into new hives discarding the infected brood combs) can be adopted to avoid use of antibiotics.

Mites: Boecking *et al*., (2000) noticed that mites are important pest of honey bee and they spread from one place to another as the beekeeper moves the colonies to floral-rich. The mites were first reported in India by Oldroyd and Wongsiri (2006).

***Varroa jacobsoni*:** It was noticed by Suwannapong *et al.,* (2011) that this mite can pierce and tear open the integument and feed on the haemolymph of the honeybee. Larval stage of honeybee is the most susceptible stage. Sugar powder, sulphur and Acorus calamus (sweet flag) can be dusted over the honeybees and in the frames to control the mites. A mixture of sugar powder + chloropropylate or bromopropylate at the rate of 50–100 mg per colony can be dusted in passages between the frames. Presently some commercial products such as Coumaphos, Bayer Bee Strips or CheckMite are also practised in India.

***Acarapis woodi*:** Suwannapong *et al.,* (2011) reported that this mite was first named as Tarsonemus woodi, but later it was renamed as Acarapis, Acar from Acarus (mite) and Apis from bee. It attacks the tracheal system of all the three castes of honeybee. The typical symptom is K-winged condition in which the bees cannot fly and the wings are disjoined. It also feeds on haemolymph of honeybee and its life span is reduced. For controlling this mite, formic acid, menthol or thymol can be applied and fumigation should be done by using Folbex strips.

***Tropilaelaps clareae*:** According to Suwannapong *et al.,* (2011), this mite attacks the pupae and prepupae stages of bees. It sucks the haemolymph from the larvae and adults. Infected honey bees have poor wings and irregular brood pattern are the typical symptom of this mite. Sulphur dusting is an effective control method. Cramp (2008) suggested that the use of organic products like formic acid, oxalic acid and other essential oils at the right time can be effective for all mite species.

Management of Bee Pest and Diseases

Hive inspection must be taken up at least twice a week to look for the presence of queen, eggs, brood, honey, pollen, bee enemies and diseases. Honeybees are attacked by many pest, diseases and viruses and they are strong enough to protect their colonies from various pests but when they are weak, beekeeper should assist the bees for defending the colony. Various protection measures include narrowing of entrance hole, combs should not be kept open for long time, isolation of diseased colonies, maintaining hygienic conditions, checking drifting (movement of bees), avoiding transfer of hive parts from diseased to healthy colonies and destruction of the severely infected colony help in checking the incidence and further spread of the bee diseases to healthy colonies, etc.

Conclusion

Honey bees are very useful to mankind and are one of the most brilliant products of nature. Beekeeping enterprise can provide marketable honey. Honey bees also serve as an effective source of pollination for field crops and other natural flora. They are reported to pollinate about 70 % of the world's cultivated crops. The orchards which are not visited by honey bees bear comparatively less fruits. Honey bees also provide beeswax, royal jelly, pollen, bee venom, propolis, etc. The beekeeper will need to regularly visit and inspect each hive to examine the condition of the brood, check food stores and to look for symptoms of disease and pests. It is concluded that Italian bee (*Apis mellifera*) is resistant to Thai sacbrood virus (TBSV), have a great foraging range (can go even up to 10 km) and is also highly suitable for commercial beekeeping. Italian bee (*Apis mellifera*) and Indian bee (*Apis cerana*) are commercially reared for honey production, while Little bee (Apis florea) produces the sweetest honey but in less amount.

References

- Abrol D P (2011) Foraging. In: Hepburn H R, Radloff S E (eds) Honeybees of Asia. Springer, Heidelberg/ Berlin, pp. 257-92
- Abrol D P (2013) Beekeeping a comprehensive guide to bees and beekeeping. Scientific publishers, Jodhpur, pp. 499
- Bankova V, De Castro S L and Marcucci M C (2000) Propolis: recent advances in chemistry and plant origin. *Apidologie*. 31: 3-15
- Cramp D (2008) The practical manual of beekeeping. Spring-hill house, Oxford, pp. 201-02
- Crane E (2004) A short history of knowledge about honey bees (Apis) upto 1800. *Bee World*. 85(1): 6-11
- Devanesan S and Jacob A (2001) Thai sacbrood virus disease of Asian honeybee (Apis cerana indica) Fab, in Kerala, India. *Proceedings 37th International apiculture congress, 2001, Durban, South Africa*.
- Farnesi A P, Aquino-Ferreira R, De Jong D, Bastos J K and Soares A E E (2009) Effects of stingless bee and honey bee propolis on four species of bacteria. *Genet Mol Resor Dent*. 8(2): 635-40
- Fearnley J (2005) Bee propolis natural healing from the hive. *Souvenir Press*.
- Gulati R and Kaushik H D (2004) Enemies of honeybees and their management- a review, *Agric Revue*. 25(3):189-200
- Hepburn H R and Radloff S E (2011) Honeybees of Asia, Springer, Berlin.
- Hossein Z, Mohammad M and Mahdi B (2015) Honey Bee Venom (*Apis mellifera*) contains anticoagulation factors and increases the blood-clotting time. J *Pharmacopuncture*. 18(4): 7-11
- Hyatt S (2011) Asian honey bee (*Apis cerana javana*) in Cairns, Far North Queensland. Department of employment, Economic Development and innovation (DEEDI).
- Kaiser C and Ernst M (2022) Beekeeping and Honey Production. Center for Crop Diversification Crop Profile. CCD-CP-78.
- Kamakura M (2011) Royalactin induces queen differentiation in honeybees. *Nature*. 473: 478-83.
- Kishan M T, Aruna R, Mishra G and Srinivasan M R (2017) Beekeeping in India. *Industrial Entomol*.
- Koetz A H, Hyatt S (2013) Asian honey bee (*Apis cerana*) remote nest treatment. Asian honey bee transition to management program, Department of Agriculture, Fisheries and Forestry (DAFF); Cairns, Queensland, Australia.
- Michener C D (2000) The bees of the world. John Hopkins University Press, Baltimore.
- Mishra R C (1995) Honeybees and their management in India. Publications and information division. *Indian Council of Agricultural Research. Krishi Anusandhan Bhavan, Pusa, New Delhi*.
- Oldroyd B P and Wongsiri S (2006) Asian honey bees. In: Biology, conservation and human interactions. Harvard University Press, Cambridge, Massachusetts.
- Ramchandra T V, Subashchandran M D, Joshi N V and Balachandran C (2012) ENVIS technical report: 49, Centre for ecological sciences. *Indian Institute of Science, Bangalore*.
- Rana B S, Kumar A and Gupta J K (2000) Influence of environmental factors on the population of predatory wasps of honey bees and evaluation of methods for controlling the wasps. *Indian Bee* J. 62(1-2): 47-54
- Singh M P, Chourasia H R, Agarwal M, Malhotra A, Sharma M, Sharma D and Khan S (2012) Honey as complementary medicine. *Int J Pharma Bio Sci*. 3(2)
- Suwannapong G, Benbow M E and James C N (2011) Biology of Thai honeybees: natural history and threats. *Nova science publishers, New York,* pp. 1-98

❖❖

ISSN No. 2583-3146

Yacon (*Smallanthus sonchifolius*): A Prebiotic Fuel for Probiotic Health

Gadha Sreekumar[1], Abhilash Padhan[2]*, Manjusha M R[3] and Thiruppathi M[4]

[1]Department of Vegetable Science, [3 & 4]Department of Fruit Science,
HC & RI, TNAU, Periyakulam

[2]Department of Fruit Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan

Corresponding Author: fruitbreederabhilash9020@gmail.com

Introduction

Consumption of plant foods that have positive physiological and biochemical effects is rising globally. Yacon (*Smallanthus sonchifolius*), a member of the artichoke family Asteraceae is regarded as a functional food due to the presence of biologically active components that may offer physiological advantages above and beyond those of basic nutritional needs to lower the risk of chronic illnesses (Delgado *et al.*, 2013). It has several bioactive components, which are strongly tied to its health-related qualities. Yacon is a novel source of prebiotics, which has a lot of potential in the application of food technology and in the prevention of chronic illnesses. There are currently few clinical investigations using human subjects. Several investigations have shown that Yacon consumption has beneficial health effects, such as immunity improvement in young children, diabetes management in the elderly, weight management and obesity prevention in overweight adults. These effects have all been linked to the presence of fructose oligosaccharides (FOS) and inulins, which have been shown to have anti-cancer, anti-inflammatory and antioxidant activity related to their phenolic compounds (Doyon and labrecque, 2008). Additionally, Yacon has potential prospects in the creation of fresh food items and novel dietotherapy uses.

Yacon tubers has a unique delicacy that can be eaten raw, cooked or in the form of juice, jam, syrup, flour or dried slices. The Yacon root can be consumed raw, boiling, roasted, dehydrated, in drinks or processed into jam, syrup, vinegar, flour, chips (dried Yacon cut into slices), juice and other products. It has a sweet flavour and crunchy texture that is akin to a blend of apple and watermelon. The tuberous roots are produced in Japan into pickles, freeze-dried powder or pulp, bread goods, fermented drinks and other items.

Yacon Nutritional and Chemical Composition

Yacon is native to South America consumed as food and used in medicines for treating constipation, diabetes and other diseases (Pedreschi *et al.*, 2003). The plant thrives in warm, low-frost climates and, in most cases, doesn't need pesticides to protect it from fungus and insects. It is a perennial herbaceous plant with roots having a pleasant flavour. Fresh Yacon roots are mostly composed of water (more than 70%), carbs (20%, of which 80% are FOS and inulin), 2% protein, 1% fat and 2% ash (Cao *et al.*, 2018). Yacon has a substantial concentration of bioactive substances in both its leaves and tubers. The leaves have antidiabetic and antioxidant properties to infusions (herbal teas). Phenolic compounds (about 200 mg in

100 g of edible fresh matter) are also found in roots.

Fig . Yacon growing wild in the Hills of North-eastern states of India (2300 metres above MSL)

Fig : Complete cycle of the Yacon plant

Value added products and health benefits

Yacon tea

- Yacon leaf-based medicinal teas has hypoglycemic and hypocholesterolemic effects.

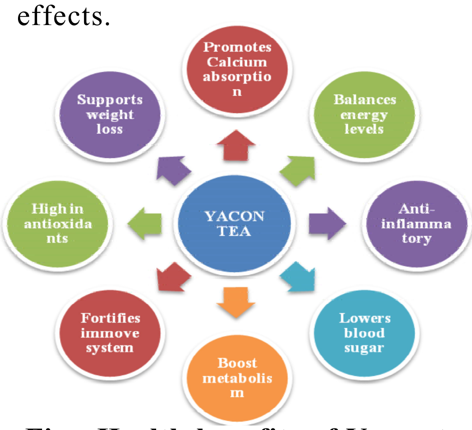


Fig.: Health benefits of Yacon tea

Yacon syrup

- Yacon syrup is rich in fructo-oligosaccharides (FOS), inulin and a small amount of glucose and fructose. As prebiotics, FOS and inulin provide a food supply for the fermentation of healthy bacteria in the gut. These helpful bacteria are essential for digestion, the production of essential vitamins and immune system regulation. They also prevent the growth of bacteria that cause disease.
- Consumption of Yacon syrup decreases the body weight, waist circumference and body mass index (Genta *et al.*, 2009).
- Due to the extremely low glycaemic index, it helps control insulin and blood sugar levels.
- Yacon syrup overuse may result in stomach discomfort, gas, bloating and diarrhoea so only so only about 20 g of Yacon syrup per day is the maximum amount advised.

Medicinal Supplements

- Helps to reduce glycemia, as well as potential prebiotic effects
- Beneficial effects on intestinal health, improves digestion and prevents constipation
- Boost immunity
- Healthy weight loss
- Relief from intestinal problems due to its antifungal and antibacterial activity

Yacon juice

- High in prebiotics
- Helps in weight loss
- High in potassium
- Helps to reduce blood sugar levels

Yacon root powder

- Great natural sugar alternative

- Very helpful for diabetic patients
- Low calorie sweetener which helps in weight loss

Conclusion

Yacon is been known to offer many potential health advantages and uses in diets related to the ailment for health and wellness, as well as the prevention of chronic illnesses. The dietary supplement of yacon is risk-free and has no side effects. Labelling, branding, marketing and distribution to the right markets are all necessary for yacon products like syrup and tea which are highly valued for better human health. Although the plant has many uses, they have not been utilised to their full potential. Therefore, the commercialization of yacon is in need to be assessed for the distribution and consumption in India.

References

- Cao, Y.; Ma, Z.F.; Zhang, H.; Jin, Y.; Zhang, Y.; Hayford, F. 2018 Phytochemical properties and nutrigenomic implications of yacon as a potential source of prebiotic: Current evidence and future directions. *Foods* , 7, 112-117.
- Doyon, M.; Labrecque, J. 2008 Functional foods: A conceptual de?nition. Br. Food J. 2008, 110, 1133–1149.
- Delgado, G.T.; Tamashiro, W.M.; Marostica Junior, M.R.; Pastore, G.M. 2013 Yacon (*Smallanthus sonchifolius*): A functional food. *Plant Foods Hum. Nutr*. 2013, 68, 222–228.
- Genta, S., Cabrera, W., Habib, N., Pons, J., Carillo, I. M., Grau, A., & Sánchez, S. 2009. Yacon syrup: Beneficial effects on obesity and insulin resistance in humans. *Clinical Nutrition*, 28(2), 182-187.
- Pedreschi, R.; Campos, D.; Noratto, G.; Chirinos, R.; Cisneros-Zevallos, L. 2003. Andean yacon root (*Smallanthus sonchifolius* fructooligo-saccharides as a potential novel source of prebiotics. *J. Agric. Food Chem*. 2003, 51, 5278–5284.

❖❖

ISSN No. 2583-3146

Growing Media: Unravelling the Components and Properties

Bharti Choudhary[1]*, Rahul Dongre[2], Sant Kumar Sharma[3] and Sandhya Bakode[4]

[1]Department of Horticulture, [2]Department of Forestry, College of Agriculture, JNKVV, Jabalpur

[3 & 4] Zonal Agricultural Research Station, Chhindwara, JNKVV, Jabalpur

Corresponding Author: bharati.choudhary06@gmail.com

Introduction

As horticultural practices continue to evolve and the demand for efficient and sustainable crop production increases, the use of growing media has gained popularity. It enables growers to optimize plant nutrition, irrigation and overall management, resulting in higher productivity and resource conservation. Whether in small-scale home gardens or large-scale commercial operations, the choice of an appropriate growing media is a critical factor in achieving successful plant cultivation.

A growing medium can be defined as a substance through which plant roots grow and extract water and nutrients. Selecting a good growing medium is fundamental to good nursery management and is the foundation of a healthy root system. Growing media for use in container nurseries is available in two basic forms: soil based and organic based. Use of growing media is proved effective for higher production of horticultural crops, due to their good water holding capacity, aeration and more uptake of nutrients. A good quality growing media plays an important role for obtaining luxuriant vegetative growth in various fruit crops and successful propagation of fruit crops in nurseries. The success of plant propagation depends largely on the quality of the growing media used.

Compared with soil based media that has field soil as a major component, organic based media (a base of organic materials that may be compost, peat, coconut coir or other organic materials, mixed with inorganic ingredients) promotes better root development. In temperate areas, nurseries can choose from a wide range of commercial products for their growing media, including peat moss, vermiculite, perlite and premixed blends of these ingredients. Most nurseries in the tropics, however, do not have easy and affordable access to these materials and even nurseries in temperate areas are seeking to replace some of these ingredients with more local and sustainable materials. In the tropics, growers often create their own media using locally available ingredients.

Growing media serve several functions to support plant growth

a. Physical Support: The growing medium must be porous yet provide physical support. Young plants are fragile and must remain upright so that they can photosynthesize and grow. With larger nursery stock in individual containers, a growing medium must be heavy enough to hold the plant upright against the wind.

b. Aeration: Plant roots need a steady supply of oxygen to convert the photosynthetic from the leaves into energy so that the roots can grow and take up water and mineral nutrients. The by-product of this respiration is carbon dioxide that must be dispersed into the atmosphere to prevent the build-up of toxic concentrations within the root zone. This gas exchange occurs in the large pores or air spaces in the growing medium. Because nursery plants grow rapidly, they need a medium with good porosity.

c. Water Supply: Nursery plants use a tremendous amount of water for growth and development and this water supply must be provided by the growing medium. Growing media are formulated so that they can hold water in the small pores (micropores) between their particles. Many growing media contain a high percentage of organic matter such as peat moss and compost because these materials have internal spaces that can hold water like a sponge. Therefore, growing media must have adequate porosity to absorb and store the large amounts of water needed by the growing plant.

d. Supply of Mineral Nutrients: Most of the essential mineral nutrients that nursery plants need for rapid growth must be obtained through the roots from the growing medium. Most mineral nutrients are electrically charged ions. Positively charged ions (cations) include ammonium nitrogen ($NH4+$), potassium ($K+$), calcium ($Ca+2$) and magnesium ($Mg+2$). These cations are attracted to negatively charged sites on growing medium particles up to the point when the roots extract the cations. The capacity of a growing medium to adsorb these cations is referred to as cation exchange capacity.

Physical Properties of growing media

Water-Holding Capacity: Micropores absorb water and hold it against the pull of gravity until plants can use it. The water-holding capacity of a medium is defined as the percentage of total pore space that remains filled with water after gravity drainage. A good growing medium has a high water holding capacity but also contains enough macropores to allow excess water to drain away and prevent waterlogging. Water-holding capacity varies by the types and sizes of the growing medium ingredients. For example, a peat moss particle will hold much more water than a similarly sized piece of pumice.

Aeration: The percentage of pore space that remains filled with air after excess water has drained away is known as aeration. As we have already discussed, oxygen for good healthy roots is supplied through the larger macropores, which also allow the carbon dioxide from respiration to dissipate. A good growing medium, especially for rooting cuttings, contains a high percentage of macropores.

Porosity: The total porosity of a growing medium is the sum of the space in the macropores and micropores; plants need both. A growing medium composed primarily of large particles will have more aeration and less water-holding capacity than a medium of smaller particles, which will have less aeration and more water-holding capacity. For a single component medium, the ideal particle range to promote both water-holding capacity and aeration is about 0.03 to 0.24 in (0.8 to 6 mm).

Bulk Density: Media bulk density is the weight per volume and varies with the inherent bulk density of its ingredients and how much they are compressed. An ideal growing medium is lightweight enough to facilitate handling and shipping while still having enough weight to provide physical support. For a given container type and growing medium, excessive bulk density indicates compaction. Bulk density and porosity are inversely related; when bulk density increases, porosity decreases.

Chemical Properties of Growing Media

Fertility: Rapidly growing young plants use up the stored nutrients in their seeds soon after emergence. Thereafter, plants must rely on the growing medium to meet their increasing demands for mineral nutrients. If fertilizers are difficult to obtain or cost prohibitive, organic amendments such as manure or compost can be included in the growing medium. Some plants grow better under low fertilization; in addition, beneficial microorganisms, such as mycorrhiza fungi, sometimes require low fertility to become established on plant roots.

pH: The pH of growing medium is a measure of its relative acidity or alkalinity. pH values range from 0 to 14; those below 7 are acidic and those above 7 are alkaline. Most native plants tend to grow best at pH levels between 5.5 and 6.5, although some species are tolerant of higher or lower pH levels. The main effect of pH on plant growth is its control on nutrient availability.

Cation Exchange Capacity (CEC): CEC refers to the ability of a growing medium to hold positively charged ions. Because most growing media are inherently infertile, CEC is a very important consideration. In the growing medium, plant roots exchange excess charged ions for charged nutrient ions and then these nutrients are transported to the foliage, where they are used for growth and development. Because the CEC of a growing medium reflects its nutrient storage capacity, it provides an indication of how often fertilization will be required.

Biological Properties of Growing Media

Growing media may contain pathogenic bacteria or fungi. Growing media ingredients that may contain pathogens can be treated with sterilization or pasteurization before use. Organic-based growing media are preferred in nurseries because they are generally pest free. Although peat moss is not technically sterile, it does not contain pathogens or weed seeds when obtained from reliable sources. Vermiculite and perlite are rendered completely sterile during manufacturing, when they are exposed to temperatures as high as 1,832°F (1,000°C). Well-prepared composts are generally pest free because sustained, elevated temperatures during composting kill most pathogens. Another benefit of composting is that beneficial microorganisms increase in the final stages of the process. Composted bark of some tree species, for example, contains microbes that suppress common fungal pathogens and nematodes.

Ingredients of growing Media

Once the functions and characteristics of growing media ingredients, an effective and affordable growing media can be developed. A typical growing medium is a composite of two or three ingredients selected to provide certain physical, chemical or biological properties. Mixtures of organic and inorganic ingredients are popular because these materials have opposite, yet complementary, properties.

Organic Ingredients

- Compost
- Coconut coir or Cocopeat
- Peat moss
- Bark
- Rice hulls
- Sawdust
- Other appropriate, locally available material

Compost: Composts are an excellent sustainable organic component for any growing medium and significantly enhance the medium's physical and chemical characteristics by improving water retention, aeration porosity, and fertility. Some composts have also been found to suppress seedborne and soilborne pathogens. Compost quality can vary considerably between different source materials and even from batch to batch so growers need to always test new materials before general use. Raw materials for compost include any plant wastes such as vegetable or fruit scraps, leaves, weeds or byproducts, such as cacao pods, coffee pulp, sugarcane bagasse, orchard prunings and rice hulls; aquatic wastes such as aquatic weeds (such as the noxious weed water hyacinth) or fish parts from fish processing; animal wastes such as manures, feathers and bedding and wood wastes such as bark or sawdust.

Coconut Coir: A by-product of processing coconut husks is known as coir dust, coco peat, or simply coir. This material has proven to be an excellent organic component for container growing media and is readily available in some tropical locales. Coconut coir has many desirable qualities: high water-holding capacity; excellent drainage; absence of weeds and pathogens; slow decomposition; easy wettability and acceptable levels of pH, cation exchange capacity and electrical conductivity. Coir is very similar to peat in appearance and structure. Peat, physical and chemical properties of coir can vary widely from source to source and coir is low in nitrogen, calcium and magnesium but can be relatively high in phosphorus and potassium (Noguera and others 2000).

Peat Moss: Sphagnum peat moss is currently the most common organic component of growing media in temperate zone nurseries. Although types of peat moss may appear similar, they can have very different physical and chemical properties. Most peat moss comes from Canada, some comes from New Zealand and the one known tropical source is Indonesia (Miller and Jones 1995). Therefore it is expensive and problematic to import peat for most tropical nurseries. In addition, extraction and transportation of peat moss on a large scale is a sustainability concern and even temperate nurseries are considering alternatives. Some nurseries may use peat as a transition component, comparing peat's properties to local materials such as composts or coir to develop local alternatives for growing media.

Sawdust: Raw sawdust, with its high C: N ratio can negatively affect nutrient availability, especially nitrogen but its properties can be improved with composting (Miller and Jones 1995). Also, because of inherent differences in chemical properties between different woods, the suitability of sawdust as an organic growing media component is extremely variable. Some species produce sawdust with phytotoxic effects. Only consider using sawdust from sawmills because other wood residues, such as from treated boards, may contain preservatives or harmful chemicals. Sawdust from coastal sawmills can contain high levels of salts, so all potential sources need to be tested before general use in the nursery.

Rice Hulls: Rice hulls are the sheaths of rice grains, a waste product of rice processing (Landis and Morgan 2009). Rice hulls or husks have been used as a component of potting medium with locally obtained peat for many years in Indonesia (Miller and Jones 1995). Several nurseries have used composted, screened and hammer-milled rice hulls in place of composted bark (Landis and Morgan 2009).

Organic Ingredients

Any other organic material that is locally available has the potential to be an important addition to nursery growing media. Composted material takes longer to produce, but has a more reliable texture and nutrient content than raw material.

For example, composted manure from livestock pens and other organic waste from agricultural operations are excellent candidates and are frequently available for free if you can haul them. All "homemade" materials will take effort to process and fine-tune to create a consistent product.

Inorganic Ingredients

Inorganic materials are added to growing media to produce and maintain a structural system of macropores that improves aeration and drainage (Mastalerz 1977). Many inorganic ingredients have a very low CEC and provide a chemically inert base for the growing medium. Inorganic materials with high bulk densities provide stability to large, freestanding containers. Several materials are routinely used as inorganic ingredients in growing media in native plant nurseries, including gravel, sand, vermiculite, perlite, pumice and polystyrene beads.

Vermiculite: Vermiculite is a common component and is a hydrated aluminium-iron-magnesium silicate material that has an accordion-like structure. Vermiculite has a very low bulk density and an extremely high water-holding capacity, approximately five times its weight. This material also has a neutral pH, a high CEC and contains small amounts of potassium and magnesium. Vermiculite is produced in four grades based on particle size, which determines the relative proportion of aeration and water-holding porosity.

Perlite: Perlite is a siliceous material of volcanic origin. Perlite particles have a unique closed-cell structure so that water adheres only to their surface; they do not absorb water as peat moss or vermiculite do. Therefore, growing media containing perlite are well drained and lightweight. Perlite is also rigid and does not compress easily, which promotes good porosity. Because of the high temperatures at which it is processed, perlite is completely sterile. It is essentially infertile, has a minimal CEC and has a neutral pH. Perlite grades are not standardized, but grades 6, 8 or "propagation grade" are normally used in growing media. Perlite grades often contain a range of particle sizes, depending on the sieve sizes used during manufacturing.

Pumice: Pumice is a type of volcanic rock consisting of mostly silicon dioxide and aluminium oxide with small amounts of iron, calcium, magnesium and sodium. The porous nature of pumice particles improves aeration porosity but also retains water within the pores. Pumice is the most durable of the inorganic ingredients and so resists compaction.

Cinder: Cinder (often called scoria) is another type of volcanic rock and a common growing media component in volcanic areas such as Hawai'i, where growers may sift the cinder rocks to obtain the desired sizes for their containers.

Sand: Sand is one of the most readily available materials and is relatively inexpensive. The composition of sand varies widely. When considering if local sand is a suitable component, the type of sand and sand particle sizes must be considered. For example, some silty river sands with small particle size can have a serious negative effect on growing media by making them excessively heavy and not contributing to improved aeration or drainage. Nurseries with access to siliceous (granite or schist derived) sands may be able to use local sand as an inorganic component. Sand is used to increase porosity, but small sand particles can lodge in existing pore spaces and reduce aeration and drainage. In general, sizes of 0.002 to 0.010 in (0.05 to 0.25 mm) are too small and will block drainage holes and reduce aeration (Wilkerson 2011). Larger (medium to course) particles are more suited to increase porosity.

Polystyrene Beads or Flakes: Polystyrene is more commonly known by its trade marked name Styrofoam. Beads or flakes of polystyrene are a processing byproduct. Polystyrene increases aeration and drainage, decreases bulk density and is highly resistant to decomposition (Wilkerson 2011). New polystyrene is unlikely to be a locally available material and many people are phasing out the use of polystyrene for sustainability concerns. It may be possible to recycle polystyrene and use pieces in growing media although it is not biodegradable and is often considered undesirable to outplant on project sites.

Development of Growing Medium

Three general types of growing media are used in container nurseries.

a. Seed Propagation Media: For germinating seeds or establishing germinants (sprouting seeds), the medium must be sterile and have a finer texture to maintain high moisture around the germinating seeds.

b. Rooting Cuttings Media: Cuttings are rooted with frequent misting, so the growing medium must be very porous to prevent waterlogging and allow good aeration necessary for root formation.

c. Transplant Media: When smaller seedlings or rooted cuttings are transplanted into larger containers, the growing medium is typically coarser.

Conclusion

Growing media can control water retention, ensuring that the plants receive the right amount of water. This is particularly important for fruit crops as they require consistent and adequate moisture for optimal growth and fruit production. Prevents soil-borne diseases: Growing media can be sterilized to prevent the spread of soil-borne diseases. This is especially important in nurseries where disease management is crucial to the success of plant propagation. Overall, the choice of growing media is critical for the successful propagation of fruit crops in nurseries. By selecting the right growing media, growers can ensure healthy, vigorous plants that produce high-quality fruit.

References

- Evans, M.R.; Konduru, S.; Stamps, R.H. 1996. Source variation in physical and chemical properties of coconut coir dust. Hort Science. 31: 965–967.
- Jaenicke, H. 1999. Good tree nursery practices: practical guidelines for research nurseries. International Centre for Research in Agroforestry. Nairobi, Kenya: Majestic Printing Works. 93 p.
- Lilleeng-Rosenberger, K. 2005. Growing Hawaii's native plants. Honolulu, HI; Mutual Publishing.
- Longman, K.A. 1998. Growing good tropical trees for planting: volume 3, tropical trees, propagation and planting manuals. Edinburgh, United Kingdom: Commonwealth Science Council.
- Lovelace, W. 2011. Personal communication (with Thomas D. Landis). Elsberry, MO. President and CEO, Forest Keeling Nursery, Inc.
- Lovelace, W.; Kuczmarski, D. 1994. The use of composted rice hulls in rooting and potting media. International Plant Propagators' Society, Combined Proceedings. 42: 449–450.
- Miller, J.H.; Jones, N. 1995. Organic and compost-based growing media for tree seedling nurseries. World Bank Tech. Pap. No. 264, Forestry Series. Washington, DC: The World Bank. 75 p.
- Noguera, P.; Abad, M.; Noguers, V.; Puchades, R.; Maquieira, A. 2000. Coconut coir waste: a new and environmentally friendly peat substitute. Acta Horticulture. 517: 279–286.
- Wightman, K.E. 1999. Good tree nursery practices: practical guidelines for community nurseries. International Centre for Research in Agroforestry. Nairobi, Kenya: Majestic Printing Works. 93 p.
- Wilkerson, D. 2011. Texas greenhouse management handbook. College Station, TX: Texas A&M University, Texas Cooperative Extension, Extension Horticulture. http://aggie-horticulture.tamu.edu/greenhouse/nursery/guides/ green/index.html. (August 2011).
- Thomas D. Landis, Douglass F. Jacobs, Kim M. Wilkinson, and Tara Luna: Article Chapter 6Growing Media. ❖❖

ISSN No. 2583-3146

Apiculture

Garima Kaushik Parashar[1]* and Sakshi Dubey[2]

[1]Department of Agronomy, School of Agricultural Sciences S.G.R.R.U, Dehradune

[2]Department of Agriculture, GRDIMT, Rajpur Road, Dehradun

Corresponding Author: garimakaushik1991@gmail.com

Introduction

Apiculture or beekeeping is the rearing of honey bees for the production of honey, wax and other bee products. The word Apiculture is derived from latin word Apicultura, 'Apis' means bee and 'cultura' means cultivation. It is an agro-based activity which is undertaken by the farmers for increasing farm income. Beekeeping is an art of rearing bees in moveable frame hives for production of honey, bee wax, propolis, royal jelly, venom etc. Beekeeping not only increase farm income but also generates other source of income and employment opportunities by the development of industries. It is a very beneficial and profitable enterprise as it can be taken up as whole time profession or as subsidiary industry.

History of Apiculture

The first evidence of beekeeping came from rock paintings made by primitive human. According to archaeological evidences, about 4,000 years ago, Egyptians started beekeeping in clay pots for the production of honey, bee wax etc. Commercially beekeeping was started during second half of 19^{th} century. L.L. Langstroth discovered bee space concept and on this concept he developed modern age 'Langstroth beehive' with moveable parallel frame. L.L. Langstroth also known as father of modern bee keeping.

Aristotle wrote a book named 'Historia Animalum' in this book he mentioned about honey floral fidelity, division of labour, winter feeding and brood disease etc.

Greek athletes used honey as an energy booster.

Father of medicine, *i.e.*, Hippocrates talked about nutritional and pharmaceutical value of honey.

Apiculture In India

First attempt was made for rearing of honeybees in moveable frames in 1880 during preparation of Bengal and Punjab. During 1910, Newton devised moveable frame for rearing of 'Apiscerena' and commercial bee rearing was started in southern part of the country during this year. This moveable frames was named as 'Newton Hive'. During 1928 Royal commission on Agriculture recommended development of beekeeping as a cottage industry in India. In 1938-39 All India beekeeper's Association was established. First time Apismellifera was introduced in India during 1880 and it was Imported in the states like Maharashtra, Kerala, Tamil Nadu, Karnataka, West Bengal, Punjab & Kashmir but none of the state successfully established this species in the country. After many unsuccessful attempts Apismellifera was introduced in the country in 1962 by A.S. Atwal an Entomologist and his associates at

Beekeeping Research Station of Nagrota Bagwan (H.P.). He was successfully introduced Apismellifera by adopting the 'Inter-specific queen introduction technique'

Different Species of Honey bee

- Indian bee: Apisceranaindica.
- Rock bee: Apisdorsata.
- European bee: Apismellifera.
- Little bee: Apisflorea.
- Dammer bee or stingless bee: Melipona Iridipennis.

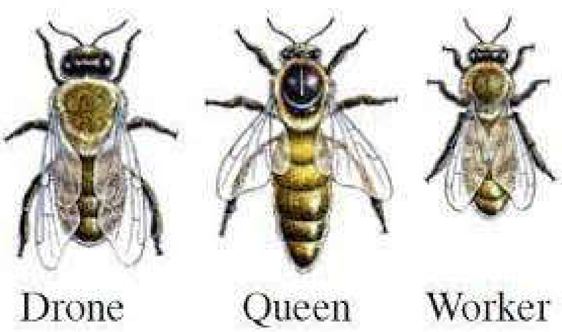
Bee Caste

Queen: Queen is the mother of all the bees. She is developed from fertilized eggs and only fertile female in the comb and feed with royal jelly during development period. She is 2-3 times bigger than worker and lays 800-1500 eggs per day. After 5-10 days of emergence, she mates with the drones and when her spermatheca filled with sperms, she starts laying eggs and not mates again. Her life is for 3years and when she is unable to lays eggs or become weak she will replaced by daughter queen. Queen lays 2 types of eggs.

Fertilized: eggs that produce females (either sterile workers or fertile females (new queens). 2. Unfertilised – eggs which produce drones.

Worker: These are sterile females and are smaller than the queen and the drones. These have strong wings to fly. Wax glands are present on ventral side of the abdomen. These have a large and efficient proboscis for sucking nectar. For pollen collection hind legs of the workers have pollen basket. A well-developed sting is also present. They perform many duties like hive cleaning, comb building, larvae feeding, guarding the hive, Foraging, collection of pollen and nectar as food.

Drone: Drones are the male bees produced from unfertilised eggs and these are darker and larger than the worker bees but smaller than the queen. They do not have sting and are not the permanent member of the colony. At the age of 14-18 days the drones mates with the queen in the air and they are stung and killed after mating.

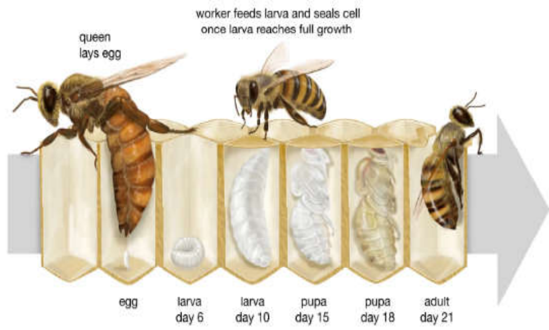


Caste	Egg	Larva	Pupa	Total	Adult longevity
Queen	3 days	5 days	7-8 days	15-16 days	5 years
Drone	3 days	4-5 days	11-12 days	18-20 days	2-4 months
Worker	3 days	5-7 days	13-14 days	21-24 days	3-6 months

Life Cycle of Honey Bee

Adult	Egg	Larva	Pupa	Total
Queen	3 days	6.5days	6.5days	16days
Worker	3days	8.0days	10.0days	21days
Drone	3days	9.5days	11.5days	24days

Life cycle of honeybees



Bee Products

Honey : Honey is a very nutritive food which is rich in energy and vitamins. Honey bee creates honey from the nectar which they derived from flowers. Honey is also used as a carrier in ayurvedic and unani medicines. It acts as a laxative and prevents cold, cough and fever. It is also useful to cure many problems like vomiting, stomach & liver problems. Honey is also used as blood purifier. It is used in religious ceremonies. It is used in the preparation of alcoholic drinks and also in cosmetics. It is used in scientific research for making bacterial cultures.

Pollen: These are the small male reproduction units that form in the anthers flowering plants. It is known as bee bread. Worker bee's stored pollen in brood cells, mixed it with saliva and sealed it with honey Pollens are very nutritive and having good mineral content so it is the source for royal jelly production feeding purpose.

Beeswax: It is secreted by the worker bees from wax glands present on abdominal segment. It is used to build bee combs in which the colony of the bees develops. Comb cells are made for the collection of honey, pollen & brood rearing Uses of bees wax Some uses are as follows: – making of candles, making pharmaceutical preparations, preparation of varnishes and paints, Water proofing and waxing of threads, formation of comb foundation, wound treatment etc.

Propolis: The term Propolis is derived from Greek word means to defend the city. Propolis is also known as bee glue which accumulates from different twigs and plants and it is a mixture of resins and beeswax. Propolis is used as a sealant for the hive. This product is also known to have germ-destroying properties.

Royal Jelly: This is a bee product that is secreted by nurse bees from its mandibular glands and is provided as food to larvae. It is a good source of protein works as a source of growing food for the queen bee as it helps her grow significantly bigger than most other bees in her colony. It is a combination of honey and dissolved pollen. It contains amino acids, proteins, vitamins, minerals, sugars and fats.

Bee Venom: Venom is a clear colorless liquid which is made up of combination of proteins that leads to inflammation. It is known as 'Apitoxin' and is present in the bee sting. It is extracted from bees can be very useful to humans.

Conclusion

India has a vast potential for beekeeping. It is an important activity which is helpful in increasing productivity of agricultural crops. Honeybees are the very good pollinators which plays a very crucial role for upgrading agricultural success. Beekeeping sector become more resilient to shock, seasonality, and stressors, provide income-generating opportunities without exacerbating environmental degradation, enhance crop production and become more efficient in providing profitable bee products and service. In India the flora diversity gives much opportunity for the development of beekeeping industry. Presently government is encouraging organic farming which is a very good step for saving bees from the use of harmful chemical and also for the production of organic honey. To remove the myths about honey & bees effective promotional and awareness camps are necessary to conduct.

Referances

- https://study.com/learn/lesson/apiculture-importance-advantages.html https://www.aakash.ac.in/important-concepts/biology/apiculture-in- indian
- https://www.embibe.com/exams/apiculture/
- https://www.unep.org/news-and-stories/story/why-bees-are-essential- people-and- planet#:~:text=The%20greatest%20pollinators,propolis%20and%20honey%20bee%20venom.
- https://www.medicalnewstoday.com/articles/why-are-bees-important-to-humans#how-to-help-bees
- https://www.fda.gov/animal-veterinary/animal-health-literacy/helping-agricultures-helpful-honey-bees
- https://royalsocietypublishing.org/doi/10.1098/rspb.2017.2140 https://www.britannica.com/animal/honeybee.

❖❖

ISSN No. 2583-3146

Importance of Terrace Farming in North-East Hilly Region of India

Ashwini Suryawanshi[1]* and Ampee Tasung[2]

[1]Department of Land & Water Management Engineering, [2] Department of Soil Science, ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar

Corresponding Author: ashisur22@gmail.com

Introduction

The only workable method for farming on hilly agricultural terrain is terrace farming. Additionally, it provides a number of benefits. Soil erosion is reduced and soil is preserved by this type of farming. The techniques used in this farming guarantee the growth of adaptable crops. This farming goes well beyond cultivating lands that would not typically be suited for agriculture. Hilly locations are where farming is primarily done. Numerous cutting-edge agricultural technologies and trends are now accessible for terrace farming and you can select them for simple and highly effective farming.

What makes terracing essential?

Terrace farming on slopes is typically done to reduce water flows and stop soil erosion. There are other options besides utilising it in the mountains, though. Terracing is appropriate for varying field elevations because there are relatively level platforms on gentle slopes or undulating lands in contrast to graduated step-like ones.

Fig.1: View of terrace farming on North East Hilly slopes

The most popular terracing techniques

Agricultural terracing in farmed regions is either level or inclined. They rely on the infiltration capabilities of the soil. For levelling, soil infiltration is sufficient.

Types of terrace farming

a. Bench Terracing: In farming, the bench system resembles benches or steps that are spaced out regularly and have platforms with flat or nearly flat surfaces. In this type of farming, paddy is frequently grown.

b. Contour Terracing: The terrace in this system has point rows and grassed waterways. Because of the abnormalities in the space, this type of system is easier to set up but more difficult to farm.

c. Parallel Terracing: Keep your farming activities as parallel as you can because that is the easiest method to build a parallel system.

What kinds of crops are cultivated in India's terraced fields?

Depending on the region and the climatic circumstances, a broad variety of crops are cultivated in India's terraced farms. In India's terraced farming, some of the most popular crops are paddy, maize, wheat, spices, tea, fruits and vegetables.

Fig.2: View of different crops and vegetables on terrace slopes

Benefits of Terrace Farming

- Prevention of soil erosion
- Efficient use of water
- Increased agricultural productivity
- Preservation of biodiversity
- Employment opportunities for rural communities
- Sustainable agriculture

How to Begin Your Own Terrace Farm

Identify and Mark off Contour Lines on the slope

↓

Cut a Drain Along Top Contour of the Planting Area

↓

Determine the Type of Soil in the Area

↓

Sloped fields extend farm ability and land productivity.

↓

Leave Enough Space for Access Planting and Drainage

↓

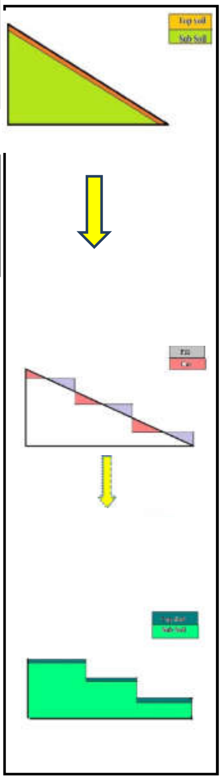
Allow Soil to Settle Before Preparing Beds on Terraces

↓

Cut Contour Drains on Slope Where You Intend to Start Terrace

↓

Start Shaping Terrace from the Bottom of the Slope



How Can Terrace Farming Aid in Soil Conservation?

The slope is not as severe as it was at first.

- Due to levelled terrain, water runoffs move more slowly.
- On the earth's surface, water streams do not flow as they do on mountainous terrain. Either water is collected in channels or it flows through outlets and pipes beneath the surface.

Conclusion

In conclusion, the Indian agricultural sector has greatly benefited from terrace farming, especially in hilly and mountainous areas where it has boosted agricultural production and increased food security.

By minimising soil erosion, preserving water and fostering the preservation of biodiversity, the practise has also aided in environmental conservation. Terrace farming is a sustainable agricultural practices that supports sustainable development and has given rural populations employment opportunities.

Terrace farming does, however, present significant difficulties, such as infrastructure gaps, soil degradation and a lack of government support. Overall, India has found terrace farming to be a valuable agricultural practices that should be promoted and encouraged in order to further the nation's sustainable agricultural development.

References

- Grogan, P., Lalnunmawia, F., & Tripathi, S. K. (2012). Shifting cultivation in steeply sloped regions: a review of management options and research priorities for Mizoram state, Northeast India. *Agroforestry Systems,* 84, 163-177.
- Hussain, W., Sohaib, O., Ahmed, A., & Khan, M. Q. (2012). Geographical information system-based model of land suitability for good yield of rice in Prachuap Khiri Khan Province, Thailand. *Science, Technology and Development*.
- Mishra, P. K., Rai, A., & Rai, S. C. (2020). Indigenous knowledge of terrace management for soil and water conservation in the Sikkim Himalaya, India.

❖❖

ISSN No. 2583-3146

Fungal Diseases of Rice and their Management

Shubham Singh*, Bawane Atul Suresh and Seyoun Raj Kar
Department of Plant Pathology, SHUATS, Prayagraj
Corresponding Author: shubhamsingh7894000@gmail.com

Introduction

Rice (*Oryza sativa*) is the most significant food crop in the world. The predominant diet of more than 3.5 billion people globally consists of rice. Rice cultivation dates back to antiquity, making it the likely first crop to be domesticated in Asia. In India, rice has been grown since the beginning of time. Archaeological discoveries and the numerous occasions rice is mentioned in ancient Hindu literature and scripture support this. The largest food crop in the world, rice, is farmed on 155 million hectares of land and generates 596 million tons annually (paddy) at a site that dates back to between 1000 and 750 B.C. In terms of productivity and acreage, it is behind wheat.

The largest rice-growing region is in Asia. The country with the largest rice-growing area is India, followed by China and Indonesia (44.8million hectares). With 131 million tons of paddy produced, India trails China by a significant margin (200 million tons of paddy). The average yield per hectare is highest in Egypt, followed by the USA. In India, only 2929 kg of rice are typically produced per hectare. Rice is grown in practically every state in India. Andhra Pradesh, Bihar, Uttar Pradesh, Chhattisgarh, Madhya Pradesh and West Bengal are the top states in the area. West Bengal and Uttar Pradesh produce the most rice among the states. Punjab produces the most on average per hectare (3346 kg/ha).

This article's main subject is of significant rice illnesses and how to manage them. Brown spot of rice, sheath blight, blast of rice and false smut of rice are a few of the most common fungal diseases that affect rice crops.

Diseases

Sheath Blight: The fungus that causes *Rhizoctonia solani* illness. One of the most important rice diseases in the world commercially is Sheath Blight. Significant losses in grain output and quality are brought on by this illness. The infection causes the leafs heath close to the water's edge to grow irregular, elongated black blemishes. These are as coalesce and the whole plant dries out. Both inside the culm and on the leaf sheath, several tiny, brown, spherical clerotia are formed. One of the following fungicides should be used to treat the disease. If necessary, a second spray of the medications hexaconazole 5 EC @ 2.0 ml/L, propiconazole 25 EC @ 1.0 ml/L should be administered 15 days following the initial spray. Before planting, treat seeds either dry with carbendazim 50WP@ 3.0g/kg of seed or wet with carbendazim @ 1.0gm/L of water/ kg of seed.

Rice Blast: Rice blast is caused by the fungus *Magnaporthe oryzae*, which develops lesions on the leaves, stems, peduncles, panicles, seeds and even roots. Due to the risk of crop failure, it poses this disease has been ranked as one of the most important plant disease sever.

Paddy's leaf, neck and node aerial portions and growth phases may be impacted by illness. The worst of the three leaves are the neck infections. Small spots on the leaves develop into spindle-shaped spots that are 0.5 to 1.5 cm long and 0.3 to 0.5 cm wide, with an ashy center. Several dots merge to form large, irregular areas. Infection from Leaf Blast leads to the crop that has been scorched or blasted, hence the name "BLAST." Crops must be lodged (after ear emergence) in extreme cases. Panicle hangs and breaks at the neck. Neck Blast. The panicle's neck area blackens sand completely or partially shrivels. Nodes that under go nodal blast form dark lesions all around them. All of the plant parts above the diseased nodes may die and split apart. Prior to planting, diseased seed can be treated with carbendazim 50 WP dry @3.0g/kg seed or wet@1.0gm/L of water/kg of seed for 24 hours.

False Smut of Rice: Ustilaginoidea virens is the fungus that causes the sickness. The majority of the grains in a panicle are usually healthy, with only a few infected grains. Every single rice grains transformed into a group of golden fruiting structures. Growing are spores that are smooth and contain flower parts. Smooth, golden, a little flattened and membrane-sealed described young spores. Spore proliferation leads to broken changing to yellowish green or greenish black. Chemical control achieved by treating seedlings with 2.0g/kg of carbendazim. Spray copper oxychloride (0.3%) or carbendazim (0.1%) when the panicle is just (0.3%) orcarbendazim (0.1%) when the panicle is just beginning to emerge.

Brown Spot of rice: The fungus *Helminthosporium oryzae* is the reason why rice develops brown spots. There will be rectangular to oval reddish-brown spots on the leaves, each with a grey core. The ear head and leaf sheath will ultimately get the markings as well. On the grains surface, brown lesions may be partially or

entirely visible. Treat the seeds with Mancozeb @ 0.3% and Thiram or Captan @ 4g/kg. Mancozeb @ 0.2% should be applied twice to the crop in the main field, once after flowering and again at the milky stage.

Conclusion

The main food crop farmed on a global scale is rice (*Oryza sativa*). It is affected by a number of diseases, which is why the output of yield is declining. Because of this, when we manage the rice crop properly, its yield and nutritional value will both increase.

References

- Mew, T. W., Hibino, H., Savary, S., Vera, C. C. M., Opulencia, R. and Hettel G. P. (2018).Rice diseases: Biology and selected management practices. Los Baños (Philippines): *International Rice Research Institute*. PDFe-book.http://rice-diseases. irri.org.
- Tripathi, D. P. (2019). Crop Diseases. Kalyani Publishers. Second revised edition. pp: 72-75.
- Rangaswami, G. and Mahadevan, A. (2022). Diseases of Crop Plants in India. PHI Learning Private Limited. Fourth Edition. pp: 160-182

❖❖

ISSN No. 2583-3146

Fungal Diseases of Maize and their Management

Bawane Atul Suresh*, Shubham Singh and Seyoun Raj Kar
Department of Plant Pathology, SHUATS, Prayagraj
Corresponding Author: atulbawane1995@gmail.com

Introduction

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m ha. in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 % (782 mt) in the global grain production. The United States of America (USA) is the largest producer of maize. In India, maize is the third most important food crops after rice and wheat. Its production mainly during Kharif season which covers 80% area. Maize in India, contributes nearly 9% in the national food basket. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc.

The maize is cultivated throughout the year in all states of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn in urban areas. The predominant maize growing states that contributes more than 80 % of the total maize production are Andhra Pradesh (20%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%), Himachal Pradesh (4.4%). Hence, the maize has emerged as important crop in the non-traditional regions i.e., peninsular India as the state like Andhra Pradesh which ranks 5th in area (0.79 m ha.) has recorded the highest production (4.14 mt) and productivity (5.26 t/ha.) in the country.

This article's main subject is of significant maize illnesses and how to manage them. Southern corn leaf blight, Northern corn leaf blight, Curvularia leaf spot, Banded leaf and sheath blight, Charcoal rot are a few of the most common fungal diseases that affect maize crop.

Southern Corn Leaf Blight (SCLB): Southern Corn Leaf Blight is caused by the fungus Bipolaris maydis. It normally attacks leaves. Lesions are tan, somewhat rectangular in shape and have reddish-brown margins. It also attacks, husks, stalks, leaf sheaths, shanks, ears and cobs. Lesions are rectangular to elliptical (¼ to ½ inch wide by ¼ to ¾ inch long) with a reddish-brown border that may be surrounded by a chlorotic zone. Stalk and leaf infections initially appear as purple spots that develop tan-gray centers. Ear infections result in a gray-black lesion on the husk that extends into the kernels, appearing as a black felt-like mold. Seedlings from infected kernels are often blighted. Some management strategies are Destroy infected crop residue from the field, Use of resistant/tolerant hybrids, Foliar spray of Mancozeb @ 2.5 g/L of water after about 15 days after sowing is effective and provide two more sprays at 10-day intervals or immediately after symptoms appearance. Foliar spray of Mancozeb @ 2.5 g/L of water after about 30-35 days after sowing is effective and provide two more sprays at 10-day intervals or immediately after symptoms appearance if needed.

Northern Corn Leaf Blight (NCLB): *Exserohilum turcicum* is the causal agent of the wide spread disease known as Northern Corn Leaf Blight (NCLB) of maize causing Green-gray, elliptical lesions that eventually turn necrotic are a symptom of NCLB disease. Temperature between 18 and 27°C, lesions grow larger and develop more, which reduces the host's ability to photosynthesize. Yield losses may surpass 50% if the symptoms develop before flowering. All lands where maize is grown, including India, exhibit substantial genetic diversity in the E. turcicum population. Some management strategies are Crop rotation with a non-host crop like legumes to reduce the disease severity, destruction of crop debris, use of resistant/tolerant hybrids, seed treatment with *Trichoderma* @ 6g per kg seeds or Thiram 75 WP @ 2 g or Capatn 50 WP @ 2 g per kg of seeds before sowing, Two sprays of Mancozeb spray (2-3gm/litre) has to be taken at 15 days interval immediately after disease appearance.

Curvularia leaf spot: Curvularia leaf spot is caused by the fungus *Curvularia lunata*. Symptoms include small, tan-colored lesions with brown margins that may be surrounded by a yellowish halo. Lesions can be scattered across the leaf or in dense groups and can join together into larger necrotic areas. Lesions are often observed on leaves in the mid to upper corn canopy but can appear at any growth stage. Symptoms of Curvularia leaf spot can look similar to those of eyespot. Some management strategies are the weeds in and around the field should be removed to make the crop safe from air borne infection, use of resistant/tolerant hybrids, seed Treatment with 20g Trichoderma chalk formulation + Mancozeb 63% or Thiram 40 F.S. @ 6 g/kg seed, foliar Spray should be done at 35 and 55 DAS using Carbendazim 12%+ Mancozeb 62% or Zineb 75% @ 2 g/lit of solution.

Banded leaf and sheath blight: *Rhizoctonia solanica* using banded leaf and sheath blight disease is one of the important pathogens of maize. It has rapidly gained economic importance in several parts of world and has potential to inflict economic loss up to 100 %. The disease, which is more prevalent in humid weather with temperature of around 28°C, poses challenge to maize growers due to its soil borne nature and lack of resistant cultivars. Some management strategies are Stripping of lower leaves along with their sheath, foliar spray Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top

325 SC) 1ml/L of water at 50 DAS or immediately after symptoms appearance. If needed, repeat the spray at 15 days interval.

Charcoal rot: *Macrophomina phaseolina* causing Charcoal rot first becomes noticeable when corn is in the tassel stage or later. Infected stalks become shredded; the pith is completely rotted, leaving stringy vascular strands more or less intact. Small, black, spherical sclerotia of the fungus are found on and in the vascular strands; they are numerous enough to give the internal stalk tissue a gray colour. As plants mature, the fungus grows into the lower internodes of the stalk, causing the plants to ripen prematurely and weakening the stalks, which may cause them to break. Some management strategies are Adopt crop rotation, Deep summer ploughing, Field sanitation, Avoid the water stress condition at the time of flowering, if stalk rot present, early harvesting reduces ear loss, Use of resistant/tolerant hybrids, Seed treatment with 25g PSB (Pseudomonas striata) and 6 g *Trichoderma harzianum* or 5 ml Thiram Flo 40 FS per kg seeds before sowing.

Conclusion

One of the main food crops farme dona global scale is maize (Zea mays L.). It is affected by a number of diseases, which is why the output of yield is declining. Because of this, when we manage the maize crop properly, it's yield and nutritional value will both increase.

References

- Niwas, R., Anwer, A., Ranjan,T., Ghatak,A., Jain, K., Kumar,K., Bharti,A., Kumari,N., and Srivastava, J. (2017). Banded Leaf and Sheath Blight of Maize: Historical Perspectives, Current Status andFuture Directions, *Bioengineering (Basel)*, 10(1): 7.
- Hooda, K., Khokhar, M.,Parmar, H.,Gogoi, R.,Joshi, D.,Sharma, S., and Yadav, O. (2021). *Exserohilumturcicum* (Passerini) Leonard and Suggs: Race Population Distribution in Bihar, India, *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 87,1041–1052.
  - https://cropprotectionnetwork.org/
  - https://farmer.gov.in/
  - https://iimr.icar.gov.in/
  - https://ipm.ucanr.edu/
  - https://cropprotectionnetwork.org/

❖❖

ISSN No. 2583-3146

Integrated Weed Management

Bhawna Soni[1]* and Nachiketa[2]

Department of Agronomy, SHUATS

Corresponding Author: bhawnasoni7419@gmail.com

Introduction

Integrated weed management is a weed management strategy that employs a variety of control methods. The goal of IWM is to include a variety of treatments throughout a growing season to provide producers the best opportunity of controlling difficult weeds.

A weed is a plant that grows where it is not desirable (Nikki, 2021). Weeds are notorious for their undesirable features since they compete with cultivated crops for resources such as water, nutrients, light and space (Nikki, 2021). Most weeds have a proclivity to spread quickly and take over farmland. They impede harvest, reduce crop yields and raise farm operating costs (Buhler, 2002). In addition, they serve as a breeding ground for illnesses and insect pests that impede agricultural growth and productivity (Bob, 2021). Weeds are classified into three types based on how they grow: annual, biennial and perennial weeds (Nikki, 2021). Annual weeds have a one-year life cycle, germinate and spread by seed. Biennial weeds have a two-year life cycle, germinate in the first year and produce blooms and seeds in the second. Perennial weeds generate constantly, with no life cycle ending and the formation of tap roots. Weeds are also categorised according to their leaf types and root systems. Dicot (broad leaf) weeds have bigger leaves and a tap or fibrous root system, whereas Monocot (narrow leaf) weeds have long narrow leaves with a fibrous root structure (Nikki, 2021).

Objectives of Integrated nutrient management

- Increase the availability of nutrients from all sources in the soil during the growth season in an economically and environmentally sustainable method.
- To reduce the need for inorganic fertiliser.
- Matching agricultural nutrient demand with crop nutrient supply from all sources.
- To improve the functioning of the soil biosphere in relation to a certain function.
- To reduce nutrient losses to the environment by volatilization, denitrification, surface runoff and leaching beyond the rooting zone.

Why INM is necessary?

It might be preferable to start by explaining why weed control is required. Weeds reduce crop yields, disrupt numerous crop production practices and weed seeds can contaminate grain. According to national study, ineffective weed control can reduce maize and soybean yield by 50%.Herbicide treatment is the most common weed management approach. The reliance on this one approach has resulted in the evolution of herbicide-resistant weeds. There are only a limited number of herbicides available for use and herbicide resistance is on the rise in the United States. As a result, herbicides require additional assistance to maintain adequate weed control. It is critical to implement non-herbicide weed management strategies now, rather than relying on the ag-chemical sector to continue developing new herbicides.

Methods of weed control

Weed control can be accomplished through a variety of approaches (Paolo, 2003).

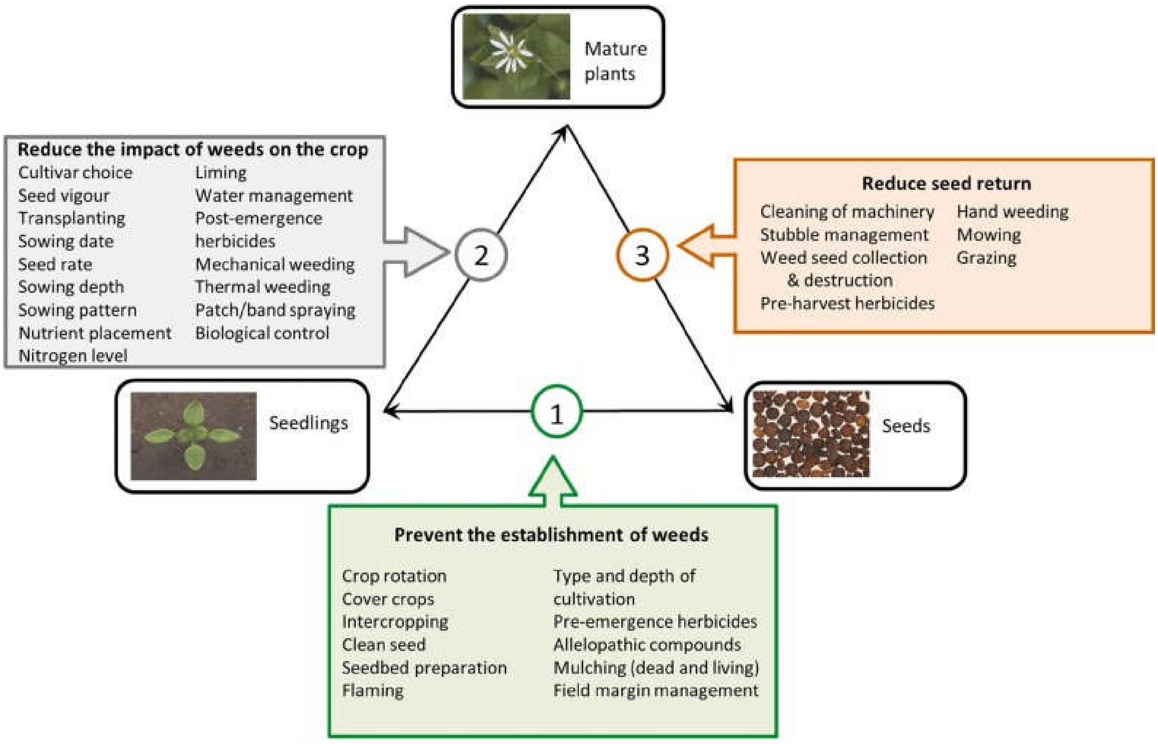


Fig. Crop Rotation

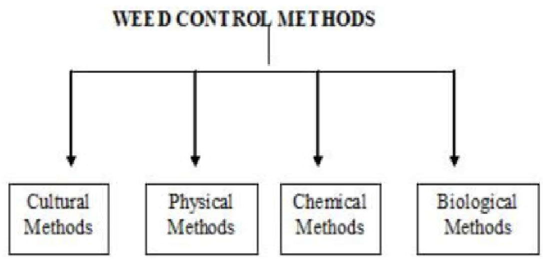
The approach to utilise is sometimes determined by the weed type (Nikki, 2021), and it may also entail utilising only one way or a combination of methods to accomplish successful control (Paolo, 2003). These approaches are classified into four types:

a. Preventative Weed Control: This is a weed control method that inhibits weeds from growing or establishing themselves in cultivated crops/farmland. This includes the practise of utilising pre-screened seeds with no weed seed present (Rahman, 2018). It also entails employing weed-free farm equipment and irrigation water (Rahman, 2018).

b. Cultural Weed Control: This entails creating prohibitive conditions that will not allow weeds to develop within a cultivated crop through crop rotation, cover crop planting, and maintaining adequate soil fertility. The goal is to manage the crop/weed environment by producing conditions that favour farmed crops but are detrimental to weeds (Robert *et al.*, 2012).

c. Mechanical Weed Control: This entails the use of mechanical techniques such as tilling and mowing agricultural equipment or robotic weeding devices, which aids in delaying weed development and reducing weed seed generation. It focuses on physical methods that interrupt weed germination by destroying weed tissues.

d. Chemical Weed Control: This is a weed control approach that uses herbicide to suppress weed development or prevent it from germinating. Various compounds, such as 2, 4-D Amine, Bicyclopyrone, Paraquat and others, are employed for this purpose. It is critical to detect the weed and apply the pesticide while it is still small and actively growing (Robert *et al.*, 2012).



Crop Rotation and weed control

Crop rotation is a planned sequence of producing varied crops in the same field year after year as part of the framework and strategies component for integrated weed management. Planting different crops on the same land on a rolling year basis diversifies the cropping system and improves the sustainability agenda. It encourages beneficial species interactions, breaks disease cycles, and reduces weed density.Growing a diversified crop with a variety of traits reduces the likelihood of specific plant species becoming dominant and resistant to weed control strategies (Harker, 2013). Crops competitive powers varies and this is reflected in their various planting dates, tillage practices and herbicide application systems. These intrinsic variances in cultural practices will affect the germination and growth life cycle of weeds. Crop rotation prevents weed population establishment and the development of herbicide-resistant weeds. Crop rotation is thus the foundation for long-term weed control. Other features of the crop management system, such as timing and tilling system, ploughing system, planting date, timing and herbicide application and fertiliser type and dose, can be varied and manipulated. It also aids in the maintenance of soil fertility, the improvement of soil structure and the management of soil-borne diseases and pests (Salwinder *et al.*, 2021). In addition to the ecological benefits of crop rotation techniques, the methodology has other economic and societal benefits. It generates cash flow at various periods of the year by alternating summer and winter crops or annual and perennial crops.

Crop management and weed control

Crop management strategy's purpose is to generate a vigorous and dense farmed crop that will dominate its growth region. This is a low-cost approach of weed management that permits crops to emerge and grow strongly to take use of light, water, nutrients and so on, while denying emerging weeds access to similar resources for their own development. This can be accomplished by using competitive crop cultivars or types at optimal seeding rates and under optimal soil moisture, nutrient, light and other conditions. This method gives crops a head start while also preventing weed emergence and establishment. To diminish black-grass seedbank in the soil, stale seedbed is one of the crop management strategies that may be used into an integrated weed management system (Oliver, 2015). It gives crops an edge over weeds by allowing weeds to emerge before controlling them with a non-selective herbicide like glyphosate or paraquat (Robert *et al.*, 2012).

Herbicides and Weed Control

Herbicides have become the most widely used weed control agent in many areas. In the United Kingdom, most farmers have depended completely on herbicides to efficiently control weeds (Sarah *et al.*, 2019). However, the development of herbicide-resistant weeds and the environmental impact of herbicide use have put pressure on the continued use of herbicide. Incorporating herbicide (chemical approach) into an integrated weed management plan with other strategies, on the other hand, will reduce reliance on herbicide for weed control (Sarah *et al.*, 2019) and prevent the establishment of herbicide resistant weeds. Herbicide application can be divided into two types: soil and aerial. (Perry *et al.*, 2017). Herbicides are applied to the soil surface and integrated into the soil to combat weeds through soil application (Perry *et al.*, 2017). Herbicides are administered directly to the weeds in foliar application, which is mostly utilised for selective herbicide treatment (Perry *et al.*, 2017).

Advantages

- It changes the crop-weed competition in favour of the crop.
- Prevents weeds from becoming perennial.
- There is no risk of pesticide residue in the soil or plant.
- Herbicide resistance in weeds is prevented.
- There is no pollution in the environment.
- Provides a higher net return

Conclusion

The goal of weed management is to find the most effective strategies or procedures for making cropping systems resistant to the emergence and establishment of weeds. The integrated management system is more proactive than reactive (Buhler, 2002). It combines various weed control approaches and scientific knowledge to combat the weed problem as it affects plant crops. As a result, the optimum solution is to combine the cropping system and weed control design into a long-term complete system that is both economically and environmentally viable.

References

- Amah, S. (2020) Integrated Weed Management (pdf). ResearchGate. Available from https://www.resea rchgate.net/publication/339512735_Integrated_Weed_Management accessed 31 December 2021].
- Bob, K. (2021) Weed Management in Winter Wheat. Crop watch. Available from https://crop watch.unl.edu/weed-management-winter-wheat [accessed 29 December 2021].
- Buhler, D.D. (2002) Challenges and Opportunities for integrated weed management. JSTOR. Available from https://www.jstor.org/stable/4046570?seq=1#metadata_info_tab_contents [accessed 31 December 2021].
- Kennedy, A. C. (1999) Bacterial diversity in agro ecosystem. Science Direct. Available from https://www. sciencedirect.com/science/article/pii/B9780444500199500078 [accessed 04 January 2022].
- Nikki, T. (2021) What is a weed: Weed Info and Control Methods in Gardens. Gardening Knowhow. Available from https://www.gardeningknowhow.com/plant-problems/weeds/whatis-a-weed.htm [accessed 29 December 2021].
- Oliver, H. (2015) How to create the perfect blackgrass stale seed-bed. Farmers Weekly. Available from https://www.fwi.co.uk/arable/create-perfect-blackgrass-stale-seed-bed [accessed 05 January 2022].
- Perry, D.H., McElroy, J. S., Walker, R. H. (2017) Effects of Soil vs. Foliar Application of Amicarbazone on Annual Bluegrass (Poa annua). Cambridge University Press. Available from https://www.cambridge.org/core /journals/weed-technology/article/abs/effects-of-soil-vsfoliar-application-of-amicarbazone-on-annual-bluegrass-poa-annua/481A95A3784A1E73642 [accessed 11 January 2022]
- Rahman, M.A. (2018) Preventive Measures for Weed Control in Agriculture. Arid Agriculture. Available from https://aridagriculture.com/2018/03/02/preventive-measures-for-weed-controlagriculture/ [accessed 30 December 2021].
- Robert, N. K., Drew, J. K., Stephen, L. Y. (2012) Annual Broadleaf Weed Control in Winter Wheat. NebGuide, G1241. Available from http://extensionpublications.unl.edu/assets/pdf/g1241.pdf [accessed 04 January 2022].
- Salwinder, S. D., Vivek, S., Agniva, M., Rama, K.N., Gayatri, V. (2021) Improving soil micronutrient availability under organic farming. Science Direct. Available from https://www.sciencedirect.com/science/article/ pii/B9780 12822358100002X [accessed 04 January 2022].
- Sarah, K. C., Laura, R. D., Frances, P., Lynn, V. T., Angel, H., Sonia, N., Chloe, W., Charlotte, W., David, T., Helen, H., Patricia, E. T., Denis, C. B., Jim, S., Pamela, C. (2019) Weed control options and opportunities for UK crops. AHDB. Available from https://projectblue.blob.core.windows.net/media/Default/ Research%20Papers /Cereals%20and%20Oilseed/rr-cp182-1807258-weed-review-april-2019-.pdf [accessed 10 January 2022]

❖❖

ISSN No. 2583-3146

Banana Value Added Products, Solution for the Unsold Raw Bananas

K.P. Sivakumar[1] and K.C. Siva Balan[2*]

[1]Department of Food Science and Nutrition, Krishi Vigyan Kendra TNAU, Ramanathapuram

[2]Centre for Research in Environment and Agriculture CREA, Trichy

Corresponding Author: sivasubafsn@gmail.com

Introduction

Banana is one among the three fruits like Mango, Jack and Banana. It is known as the 'common man's fruit'. India is the largest producer of banana next to mango. The major banana producing states are Maharashtra, Kerala, Tamil Nadu, Gujarat, Bihar, West Bengal, Assam, Andhra Pradesh and Karnataka. It is highly nutritive and very delicious. Banana is a rich source of carbohydrates, minerals like calcium, phosphorous, iron and also contains appreciable amounts of vitamins, especially B and A and proteins. Thus, it can be called a complete food. About 90% of banana consumed domestically as fresh fruit. Merely 5% is consumed in processed form providing a good potential for future processing. About 2.5% is only processed purely as banana products and the rest as an ingredient in other foods.

Unripe banana as well as the inner core of the pseudostem is commonly consumed as vegetables by the consumers of this region. The lower end of the inflorescence is also cooked as a vegetable while chopped banana stems are used as cattle feed. Its leaves are used as plates for serving meals in social functions in various parts of India including this region.

Strong wind and storm that accompanied the brief spell of rain made twisted and lodging of banana trees in some places. Wind damage leads to lodging of banana tree and wastage of banana bunches, fetches no market value and huge economic loss to the farmers. Most of the banana bunches are affected due to this strong wind before it attains maturity. The wind damaged unriped, immature banana bunches are not been utilized for any purpose in turn it is thrown in the dump yard or dustbin. This serves no purpose to the farmer and cause huge money loss. Being a scientific organization, the Krishi Vigyan Kendra, Ramanathapuram has taken an attempt for the preparation of value added products from the raw immature banana waste.

In some instances, due to more market arrival of banana, the market prices are also not at profitable for the growers. Instead of selling at low margins, there is ample scope to value add those raw banana, which can be sold all through the year with high margin. One banana matured bunch cost about Rs.250/- per 12 months and damaged young banana bunch fetches no value. But by value addition the same bunches fetches the value is Rs.1500/- for 8 months as pickle.

Banana Pickle Preparation

Ingredients

Immature Banana	:	1 Kg
Chilly powder	:	50 g
Mustard	:	10 g
Fenugreek powder	:	20 g
Asafoetida	:	10 g
Gingelly oil	:	400 ml
Salt	:	As desired
Tamarind paste	:	As desired

Method of Preparation

- The immature raw banana skin was peeled, cut into small pieces and steam blanching the banana for 20 to 25 minutes.
- The balanced banana take in to separate pan and add chilly powder and mix well.
- Add oil and boil it well.
- Add mustard seeds, fenugreek powder and asafoetida. Pour over the mixture.
- Remove from flame and allow to cool.
- Store it in bottle and serve after 1 day.

Table 1.Chemical components of banana pickle

Name of the Nutrients	Composition
Moisture	23.54%
Protein	1g
Fat	8 g
Calcium	1.5mg
Phosphorus	31mg
Vitamin C	5.1mg
Thiamin	0.045 mg
Niacin	0.109 mg
Pantothenic Acid	0.201 mg

Banana Powder preparation

Banana powder has a great potential for commercialization. It rich in starch content and can be used as a substitute for supplementary foods and bakery products.

Ingredients

Immature Banana	: 1 Kg
Potassium meta bi sulphite	: 6g
Water	: 500 ml

Method of Preparation

- The immature raw banana skin was peeled, cut into thin slices and blanching the banana for 15 minutes.
- Drain the water and blanched banana should dip into Potassium metabi sulphite solution for 5 minutes.
- After 5 minutes the solution was drained and banana slices dried and make into powdered and packed in air tight container.


Banana Chips

Ingredients

Immature Banana	: 1 Kg
Potassium meta bi sulphite	: 6g
Water	: 500 ml

Method of Preparation

- The immature raw banana skin was peeled, cut into small slices and blanching the banana for 15 minutes.
- Drain the water and blanched banana should dip into Potassium meta bi sulphite solution for 5 minutes.
- After 5 minutes the solution was drained and banana slices dried and make into chips and by using oil fry and packed in air tight container.

ISSN No. 2583-3146

Effect of Nano-Fertilizer's in Soil Health

Ashutosh Shukla[1], Opendra Kumar Singh[2*], Ashutosh Mishra[3], U.S. Mishra[4], and Kartikey Tiwari[5]

[1, 2, 3 & 4]Department of Natural Resource Management Faculty of Agriculture, M.G.C.G.V.V. Chitrakoot

[5]Department of Horticulture, SHUATS, Prayagraj

Corresponding Author: singhopendra8@gmail.com

Introduction

Nano-fertilizer technology is quite innovative and the literature in this field is very scanty. Nano-technology in agriculture has gained momentum in the last decade with an abundance of public funding, but the pace of development is modest, even though many disciplines come under the umbrella of agriculture (De Rosa *et al*., 2010). Nano particles have extensive surface area and are capable of holding an abundance of nutrients and releasing it slowly and steadily such that it facilitates uptake of nutrients matching the crop requirement without any associated ill-effects of customized fertilizer inputs.

Agriculture has evolved in parallel with human evolution. Conventional agriculture demands the regular use of fertilizers, along with traditional agricultural practices, which can tremendously boost the crop growth, the yield, the productivity and the nutritional value. Hence, chemical fertilizers have played an indispensable role in the growth of modern agricultural practices since the era of the green revolution. In the early years of the previous century, rapid mechanization occurred in the field of agriculture whereas new technologies, such as marker-assisted breeding and transgenic crop production, were developed in the later years.

Although these advancements have helped to increase crop production phenomenally, they exert several harmful effects like diminishing the nutritional quality of soils, decreasing the resistance to pathogens and pests and exert adverse effects on the environment.

Out of the total amount of chemical fertilizers and pesticides applied, more than 50% has been estimated to remain unused as they accumulate in the soil and water bodies through leaching and mineralization. Owing to the growing awareness of the harmful effects of fertilizers, the last decade has witnessed extensive research into bio-fertilizers, micro biomes and soil health.

In addition to the other advantages, these need to be provided to the soil in a relatively lesser quantity, thus enhancing the ease of application and reducing the transportation costs. However, similar to all other fertilizers, the use of Nano-fertilizers has certain limitations and disadvantages. In this review, we attempt to highlight the need for and the application of, Nano-fertilizers for sustainable and smart agriculture.

Synthesis of Nano fertilizers

Nanotechnology involves the synthesis and application of devices by managing and controlling their shape and size at the nanometer scale. It has paved the way and enabled the use of nano-structured materials as fertilizers, termed "smart fertilizer". Additionally, the composition of Nano fertilizers can facilitate the efficient nutrient uptake, soil fertility restoration, ultra-high absorption, increased photosynthesis, increased production, reduced soil toxicity, decreased frequency of application, increased plant health and reduced environmental pollution. Nano material components include silica, Fe, Ze, titanium dioxide, cerium oxide, aluminum oxide, gold nanorods, Zincides/ZnS core-shell, ln/ZnS core-shell and Mn/ZnS quantum dots. The size, the content, the concentration and the chemical properties of the nano materials, in addition to the type of crop, have a significant impact on their effectiveness as Nano fertilizers for plant growth. The release of nutrients into the soil occurs when Nano Particle (NP) suspensions containing the Nano fertilizers react with water. In order to avoid unfavorable nutrient losses, the Nano fertilizers can be coated with polymers or thin coatings in order to encapsulate the NPs.

The efficiency of nutrient use can be improved by applying Nano fertilizers that utilize the unique properties of NPs. Nano fertilizers can be produced by adding nutrients individually or in combination to the adsorbents with nano-dimensions. In the case of cationic nutrients, the target nutrients are loaded as is, whereas the anionic nutrients are loaded after surface adjustment to create the Nano materials using physical and chemical methods.

Mechanistic Approach to How Nano fertilizers Enhance Soil Fertility

Traditional fertilizers need to be applied in large amounts, as they have low uptake efficiencies. The two main challenges for phosphorus- and nitrogen-based fertilizers are low nutrient uptake efficiency and rapid change into chemical forms that cannot be utilized by plants. It has a negative impact on the soil and the environment, as the emission of dangerous greenhouse gases and eutrophication have increased. Nano fertilizers gradually release nutrients, which may aid in improving nutrient use efficiency without any related adverse effects. These Nano fertilizers are constructed in order to deliver nutrients slowly over an extended time period and to reduce nutrient loss considerably, thereby ensuring environmental safety. Traditional fertilizers are not only costly but may also be harmful to humans and the environment, whereas Nano fertilizers play a significant role in maintaining the soil fertility and improving the crop yield. Nano fertilizers enhance plant growth by direct as well as by foliar application methods.

The organic and inorganic components of the soil can modify the effects of the applied Nano fertilizers, depending on their nature and their interactions with the soil. When Nano fertilizers are applied to the soil, aggregation occurs first, which reduces the area of action, and the aggregates become less mobile in porous materials as their size increases. Hence, the amount of organic matter in the soil, the surrounding environment and the chemical properties of the Nano fertilizers can enhance or reduce the mobility of the NPs. Moreover, Nano fertilizers can influence the activity of the soil microorganisms in many ways. Nano fertilizers can increase the nutrient use efficiency, thus being beneficial for nutrition management. These nutrients are bound to the nano- absorbents that are applied either alone or in combination and release the nutrients at a slower rate than that of conventional fertilizers. This approach would minimize nutrient leaching into groundwater and increase the nutrient use efficiency. In order to achieve considerable efficiency in food security, both the agriculture and horticulture sectors are under pressure to utilize alternative fertilizers rather than chemical fertilizers.

Advantages of Nano fertilizers over Conventional Chemical Fertilizers

Nano fertilizers are non-toxic and are less harmful to humans and the environment than the conventional fertilizers. In addition, they increase the soil fertility, the yield and the crop quality; minimize the costs; and optimize the profit. Carmona *et al*., recently reported that the functionalization of amorphous calcium phosphate Nano fertilizers post- synthesis (instead of its single-pot synthesis) has substantially reduced the manufacturing costs, and this new method is now being utilized for the large-scale production of Nano fertilizers in order to help small-scale farmers and plant breeders. Chemical fertilizers are employed by farmers in large quantities in order to promote crop output because they are synthetic, meaning that they are made of non-organic cultivated ingredients. Chemical fertilizers function more quickly than organic fertilizers because they instantly dissolve in water, they can be found in granular or liquid forms and they are less expensive. However, because some insoluble chemicals are present in P fertilizers, including mono- ammonium phosphate, diammonium phosphate and triple superphosphate, they do not readily dissolve in water. Organic substances, including animal dung, bird droppings, food waste and sewage sludge, are broken down by soil microorganisms, thus releasing the vital nutrients. Because it enhances the soil texture, increases the activity of the soil bacteria and fungi and stored water for longer periods, this natural fertilizer is more environmentally friendly. N, K and P, which shield plants from pests and diseases, comprise the majority of the nutrients that are released from this material. The biggest drawback of this type of fertilizer, compared with chemical fertilizers, is the slower release of nutrients. Biofertilizers are excellent substitutes for synthetic fertilizers because they improve the soil quality and contain the vital nutrients that are necessary for plant fertility and productivity. They are also inexpensive, renewable and environmentally friendly. Several microorganisms, such as Azotobacter, Anabaena, and Rhizobium, that are involved in N fixation and *Pseudomonas* spp., which serves as phosphate-solubilizing bacteria, act as biofertilizers by assisting plants in nutrient uptake and absorption. These microorganisms generate several kinds of bioactive compounds, organic acids, vitamins, growth hormones, and antagonistic compounds, thus protecting plants from diseases, in addition to fixing nitrogen and increasing the availability of nutrients to the plants.

Limitations and Drawbacks of Nano fertilizer Use

Although the use of NPs as fertilizers to promote agricultural production and to increase the availability of plant nutrients is gaining interest, there are some toxicity-related risks. In addition, gaps exist in the research, the legislation and sufficient monitoring, which hamper the large-scale application of Nano fertilizers. These small particles can penetrate biological systems more deeply and pose great potential dangers; hence, the toxicity, the safety, and the effects of NPs on the environment are still unknown. Chemical and physical procedures yield NPs that are more dangerous than those that are produced by biological approaches. Moreover, the organic NPs are less toxic to the soil microorganisms than the metal and metal oxide NPs. Although NPs are being utilized to deliver nutrients to plants, the nano-toxicity remains a matter of concern for both humans and the environment; hence, extensive research is required on the toxicity of biologically manufactured NPs. Currently, there is no suitable legislation or risk management system to monitor the use of Nano fertilizers for sustainable crop production. Notably, Nano fertilizers are not being produced or made available in quantities that are required to meet the demands of their wide-scale application in plant nutrition. The higher cost of Nano fertilizers, compared to that of the conventional fertilizers, is a concern when it comes to their wide application under different pedo-climatic conditions across the earth, which is a big hurdle, coupled with the fact that there is a lack of standardization and recognized formulation of these fertilizers, resulting in contrasting effects on the same plants across different areas.

Most importantly, a bitter truth is that many products are currently marketed that are not actually "nano"-fertilizers and are of "micron" size, which further suggests a lack of monitoring of Nano fertilizers. These particles have severe toxic effects on the long-term persistence in plant systems.

Conclusion

As an innovation in material design and consumer product development, a customized nano fertilizer was created. Although the application of these approaches in agriculture is still in its infancy, it can change agricultural systems, especially with regard to the problems with manure application. By minimizing fertilizer expenses and emission hazards, the use of diverse Nano fertilizers can have a remarkable effect on crop productivity. Owing to their increased solubility, reactivity and ability to penetrate the cuticle, Nano fertilizers provide targeted distribution and controlled release. Moreover, by reducing abiotic stress and heavy metal toxicity, Nano fertilizers can enhance the crop growth, the yield, the quality, and the nutrient use efficiency. However, attention is being drawn to the risks that are associated with consuming and using the technology in limited ways, rather than its benefits and efficacy.

With recent developments in nanotechnology, unique NPs and nano materials have been developed that can boost crop growth and production while also acting as carriers for macro- and micronutrients. According to the evidence that has been gathered, the impact of NPs varies with the type of plant and is influenced by their manner of application, size, shape and concentration. Once the optimal dosage and plant requirements for Nano fertilizers are established, the crop production can be greatly increased. Future crop plants could benefit greatly from greener nano nutrition, especially in light of the known nano toxicological effects of nano materials and NPs. Therefore, green nano materials/NPs may potentially be used as a nutrient source for crops, which would significantly contribute to more environmentally friendly nano nutrition.

❖ ❖

ISSN No. 2583-3146

Impact of Leaf Colour Chart (LCC) on Site Specific Nutrient Management for rice cultivation in Cauvery delta zone of Tamil Nadu

Ranjith R*[1], Arun A[2] and Surya Mithra Nair J[3]

[1& 3] Department of Agronomy, Tamil Nadu Rice Research Institute, Aduthurai

[2]Department of Agronomy, Sethu Bhaskara Agricultural College and Research Foundation, Karaikudi

Corresponding Author: ranjithagronttnau@gmail.com

Introduction

Rice (*Oryza sativa* L.) is being one of the principal food crops and utilized by one third of world population. Nitrogen (N) fertilizer is important in rice production. Apply N fertilizer several times during the growing season to ensure that the crop's nitrogen need is supplied, particularly at critical growth stages. Precise application of nitrogen needs for plant to improves fertilizer use efficiency in rice crop. The recently introduced nitrogen management approach was estimating the leaf nitrogen concentration by the measurement of leaf greenness. Leaf color is generally used as a visual and subjective indicator of the rice crop need for nitrogen (N) fertilizer. Leaf color intensity is directly related to leaf chlorophyll content and leaf N status. LCC technique is a tool that can help farmers to improve their decision-making process in N management. The leaf color chart (LCC) is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status. Inexpensive leaf color chart (LCC) has proved quick and reliable tool to decide the time when fertilizer needs to be applied to the crop. SSNM is a plant-based approach for feeding in rice with nutrients as needed. It includes the following features likes early P and K adjusted to plant need, early N adjusted to plant need and use of organic materials, Top dressing N to match plant need as determined by leaf color chart (LCC), Top dressing K at panicle initiation (PI) based on plant need and Use of micronutrients, such as zinc and sulfur, based on local recommendation.

Use of LCC for N management

What is the LCC?

- The LCC is an inexpensive tool which is more efficiently manage N fertilizer in rice. The Leaf Color Chart (LCC) is used to determine the N fertilizer needs of rice crops. It determines the greenness of the rice leaf, which indicates its N content. How to use the LCC
- Randomly select at least 10 disease free plants or hills in a field with uniform plant population.
- Select the top most fully expanded leaf from each hill or plant. Observe the leaf colour in the fully opened third leaf from the top as index leaf. Match the leaf color with the colours in the chart during morning hours (8-10 am).
- Place the middle part of the leaf on a chart and compare the leaf color with LCC shades and do not destroy the leaf. Measure the leaf color under the shade of your body. Direct sunlight affects leaf color readings.

- If possible, the same person should read the LCC at the same time of the day, every time. If the color of a rice leaf is in between two shades, take the average of the two values as the reading.
- Take observations from 14 DAT in transplanted rice or 21 DAS in direct seeded rice. Repeat the observations at weekly intervals up to heading. LCC critical value is 3.0 in low N response cultures like White Ponni and 4.0 in other cultivars and hybrids
- When 6/10 observations show less than the critical colour value, for aged seedlings: Basal application of 35 kg N per ha is recommended to avoid yield loss when seedlings aged 35 - 45 days are used for transplanting and the LCC based N management can be followed from 14 DAT.

Use of SSNM

Recommendations are provided for the kuruvai (dry season) and thaladi (wet season) assuming a growth duration of rice (from seed to seed) of 110-115 days in kuruvai and 125-135 days in the thaladi. The recommendation rates of fertilizer are sufficient under conditions of favorable climate and sufficient water to achieve maximum yields. The rates of P and K suggested in this leaflet are based on omission plot technique which can be modified further to accommodate local conditions. In relatively low fertility soils, apply the first (early) application of N (20 to 30 kg N per hectare) within 7 to14 days after transplanting (DAT). Do not use the LCC with this early N application. Reduce the application of early N when high quality organic materials and composts are applied. In Old Delta, N fertilizer application can typically be delayed until 14 to 21 days DAT. Apply N at about 14 DAT for relatively low fertility soils. N fertilizer is typically not required before 21 DAT for relatively high fertility soils or fields previously grown and incorporated with a green manure crop.

(a) Apply all required P_2O_5 fertilizer and 50% of K_2O fertilizer as basal dose.

(b) Take LCC readings for every 7 days (Short duration varieties/ kuruvai) and at 10 days interval (medium and long duration varieties/ thaladi) starting at 21 DAT and continue until booting (about 55 DAT in kuruvai and 75 DAT in thaladi).

(c) Out of ten readings, if six or more leaves read below the critical value of 4 (or 3 for transplanted White Ponni variety and direct seeded rice)

- Apply 40 kg N per hectare in the kuruvai
- Apply 30 kg N per hectare in the thaladi

(d) Apply about 50 % of the total required K_2O fertilizer at panicle initiation.

Either compound (NPK) or single element fertilizers can be used in the early application to obtain the desired amounts of N, P_2O_5 and K_2O at lowest cost.

Merits of LCC

LCC is an uncomplicated and effortless tool for the farmers to measure nitrogen status of the leaf and to identify the instance for top dressing of N to paddy. Here are some of the merits or benefits of using a leaf color chart: plant health assessment, nutrient management, precision agriculture, research and data collection on plant health, used for education and training purpose and cost-effective tool. LCC is cheap and portable thus, making it easy to carry to field for estimating N status of the leaf. It is a non-destructive method and doesn't involve any laboratory analysis. Any specific knowledge or skill is not required for using LCC because it depends only in comparing the colour and computing the scale of the leaf with standard chart.

Fertilizer application for transplanted rice in the kuruvai season

Condition	Time of application	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
Old delta	Initial	20 to 30 (E)	35 (B)	25 (B)
	21 to 55 DAT	40 (If LCC < 4)	-	-
	35 to 40 DAT (PI)	40 (If LCC < 4)	-	25
New delta	Initial	20 to 30 (E)	35 (B)	40 (B)
	21 to 55 DAT	40 (If LCC < 4)	-	-
	35 to 40 DAT (PI)	40 (If LCC < 4)	-	40

B-Basal; E-Early stage within 14 DAT for old delta and within 7 to 10 DAT for new delta. For N application take LCC readings every 7 days.

Fertilizer application for transplanted rice in the thaladi season

Condition	Time of application	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
Old delta	Initial	20 to 30 (E)	35 (B)	25 (B)
	21 to 75 DAT		30 (If LCC < 4)	- -
	55 to 60 DAT (PI)	30 (If LCC < 4)	-	25
New delta	Initial	20 to 30 (E)	35 (B)	40 (B)
	21 to 75 DAT	30 (If LCC < 4)	-	-
	55 to 60 DAT (PI)	30 (If LCC < 4)	-	40

B-Basal; E-Early stage within 14 DAT for old delta and within 7 to 10 DAT for new delta. For N application take LCC readings every 10 days.

Conclusions

It was concluded that leaf color chart (LCC) is an easy to use and cost-effective technique for monitoring chlorophyll of leaf and effective in improving nitrogen fertilizer management in transplanted rice. LCC helped farmers to estimate plant nitrogen demand, without compromising their yield. The critical leaf color has to be maintained for optimal growth. LCC provides guidance when to apply nitrogen fertilizer and how much quantity of "N" is to be applied for getting better yield.

References

- Balasubramanian, V., Morales, A. C., Cruz, R. T., and Abdulrachman, S. 1999. On-farm adaptation of knowledge-intensive nitrogen management technologies for rice systems. *Nutr. Cycling Agroecosyst*, 53:93-101.
- Furuya, S. 1987. Growth diagnosis of rice plants by means of leaf color. *Jpn Agr Res* Q, 2
- Kropff, M. J., Cassman, K. G., Van Laar, H. H., Peng, S. 1993 Nitrogen and yield potential of irrigated rice. *Plant and Soil* 155/156: 391-394.
- http://www.knowledgebank.irri.org/step-by-step-production/growth/soil-fertility/leaf-color-chart https://pdf.usaid.gov/pdf_docs/PA00K938.pdf

❖❖

ISSN No. 2583-3146

Karonda: Delicious Under-utilized Fruit Crop

P A Sable*, M K Sharma, K Z Vaghela, G S Patel and Piyush Verma

Department of Vegetable Science

College of Horticulture, Sardar krushinagar Dantiwada Agricultural University, Jagudan

Corresponding Author: sable.pating@gmail.com

Introduction

Karonda (*Carissa carandas*) is a thorny shrub of the family Apocynaceae. It is a very famous protective hedge and thrives well in tropical, subtropical, arid climatic conditions. It is also drought tolerant and can be grown with minimal care and management. Besides the use of plants in bio-fencing, its berry shaped fruit having nutraceutical values can be used in chutneys, pickles and candy making.

Soil and Climate

Karonda is a handy crop. It can be grown successfully on a wide range of soil types, viz., sandy loam, laterite, alluvial and calcareous even it is found growing well in fallow land, light soil, saline, stony, rocky and less fertile soils. All over India, it can be grown in dry, arid, tropical and subtropical climatic conditions. It is tolerant to high temperature, drought and saline soil.

Varieties

Konkan Bold

It is an improved, high yielding, round shape variety of karonda developed through a selection method by Dr. Balasaheb Sawant Konkan Krishi Vidhyapeeth, Dapoli (MS). Its fruit weight is 12-16 g, pulp 92 %, shelf life 4 days. Alcohol content 14.50 – 15.00% has been found in the wine prepared from this variety. This fruit becomes dark black at ripening, contains vitamin C 361 mg/100 g pulp, having soft seeds which can be consumed with fruit.

Thar Komal

It is a regular bearer variety developed through selection from existing germplasm by ICAR-CIAH, Bikaner (Raj). Flowering and fruiting start from 3rd year, ripens 55-56 days from fruit set in the month of June. Its average fruit weight is 4.97 g, pulp 93.64%, TSS 9.540 Brix, acidity 0.64%, vitamin C 30.41 mg/ 100 g. Nine year onwards it gives fruit yield 13.00 kg/ plant.

Maru Gaurav

It is an improved high yielding variety developed through selection from seedling population after long term evaluation (2006-17). Seed propagated plants start flowering and fruiting from 4th year, while, air layered or budded plants can starts flowering and fruiting in just second year of planting. The peak flowering occurs during March-April and fruit matures during August-September. The average fruit weight is 3.71, number of seeds 6.3 per fruit, pulp 88.5%, TSS 9.40 Brix, acidity 2.8, vitamin C 35.88 mg/100 g. Eight year onwards it gives fruit yield 40.00 kg/ plant or even more.

Pant Manohar

This variety is developed from GBPUA&T, Pantnagar in 2007. The plants of this varieties are medium, dense bushes, fruits are dark pink blush on white background, weighing 3.49 g., seeds 3.94/ fruit, pulp 88.27% and yield 27 kg/ plant.

Pant Sudarshan

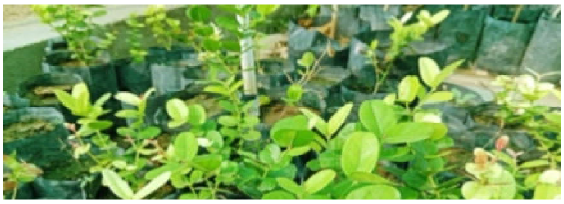
This variety is developed from GBPUA&T, Pantnagar in 2007. The plants of these varieties are medium– sized dense bushes. Fruits shows pink blush on white background. On ripening fruits become dark brown. Average fruit weigh 3.46 g, seeds 4.68 / fruit, pulp 88.47% and yield 29 kg/ plant.

Pant Swarna

This variety is developed from GBPUA&T, Pantnagar in 2007. Plants are upright growing and sparse. Fruits shows dark brown blush on green background. Average fruit weight 3.62 g, seeds 5.89/ fruit, pulp 88.27% and yield 22 kg/ plant.

Propagation

Though karonda can be propagated though sexual and asexual (vegetative) methods, vegetative i.e., hard wood stem cutting and layering ensured for fruit production or for perpetuating any other quality traits. No dormancy is found in karonda seed so the seeds are to be extracted from fully matured ripened fruit which are available in August. At full maturity and ripening fruits turn black and drop off. Such fruits can be collected for extraction of seeds. Karonda seeds are recalcitrant type and loose viability upon storage, therefore, they should be sown fresh, immediately after extraction. Seeds pulp is to be cleared off and washed in water and allow for drying under shade. The seeds can be treated with carbendazim @ 4 g /kg before sowing. Then seeds are to be sown in the polybags or raised bed during August-September. The seedlings become ready for transplanting after one year. In vegetative method, hard wood cuttings are to be treated with 500 ppm IBA (quick dip method) for early and maximum rooting. The cutting should be taken from mature shoots about one-year old, 25-30 cm in length. Air layering is quite successful in Karonda using growth regulators. In July-August months, a ring of bark of about 5 cm is to be removed from the branch and treated with 2500-5000 ppm IBA and NAA for early and maximum rooting. The cut portion is to be wrapped with moist sphagnum moss and wrapped with plastic sheet and tied at both the ends. Frequent water is to be injected in the layers to keep it moist. The rooted layers can be separated from mother plant after 3 months of layering.



Karonda Seedlings

Planting

Karonda can be planted on farm boundary as live fence as well as hedge row plantation. For live fencing 0.90 m plant to plant distance can be kept and for hedge planting 3-4 m. The pits of 1.5 x 1.5 x 1.5 feet size are to be dug in May and filled with a mixture of soil, well rotten FYM @ 2 kg and single super phosphate (SSP) @ 200 g. At onset of monsoon seedlings are to be planted. One year's old seed propagated seedlings and three month's age old propagated by vegetative mean to be preferred for planting.

Karonda lantation as live fence

Karonda plantation as hedge row

Karonda naturally found in jungle

Water Management

In first year of plantation, seedlings are to be irrigated at intervals of 15 days during winter and 8 days intervals during summer. In first year of plantation, around 20 lit of water per plant are to be given per irrigation. After second year of plantation, plant do not requires more water but life saving water is to be applied.

Nutrient Management

At the time of planting, per plant 2 kg FYM and 200 g single super phosphate is to be applied. In first year of plantation, 20:10:10 g NPK/ plant are to be applied. It can be increased every year in same proportion. After 4 years of plantation, 10 kg FYM and 100:100:50 g NPK/ plant are to be applied. The full quantity of FYM, P and K and half dose of N is to be applied during July, while, remaining N may be applied at the end of August. The manures and fertilizers should be thoroughly mixed in the entire canopy area.

Pruning

Initially 3-4 well spaced branches are to be allowed to develop into main scaffold structure of the plants. The bearing plants usually do not require much of the pruning, however, shoots coming from basal portions should be pruned during March-April. After 5th year of plantation light shoot pruning is to be done every year after fruit harvesting (May-June).

Harvesting and Yield

Seed propagated plants starts fruiting after 4-5 years, while, 2-3 years in vegetative propagated plants. In karonda flowering starts in February and fruit matures and harvested in April-June.

Flowering and fruiting in Karonda

The fully mature fruits are dark black shiny and maroon coloured.

The matured fruits may be harvested for chutney, pickle and candy preparation, while, ripened fruits may be used for juice extraction for beverages, seed extraction and consumption. About 3.5 – 5 kg fruit yield per plant can be obtained even it can be obtained up to 12 – 14 kg per plant under proper management.

Green immature fruit

Ripened Fruit

Conclusion

Karonda is a dry land fruit crop which requires less amount of water. Very less research work has been done on this crop so scientific information on this crop is lacking. However, this hardy, spiny and underutilized indigenous crop is widely grown in India have the richest iron content among the fruit crops. It can be cultivated on wide range of soils. Cultivation of improved varieties as a live fence or hedge row plantation with adequate nutrient management, water management and pruning gives benefit to the farmers in dry land and arid region.

References

- http://www.ciah.ernet.in
- Jadhav S D, Nangare D D and Kakade V S (2022). Karonda: Under-Exploited Fruit Crop for Dry Land Condition. *Just Agriculture* (e-ISSN:2582-8223: multidisciplinary e-Newsletter), 2 (9), May, 2022: 1-8.
- Meghwal P R, Singh Akoth and (2019). Maru Gaurav: New karonda variety. *Indian Horticulture*, March-April, 2019: 29-31.
- Tripathi, P. C. and Karunakaran. G. (2013). Production technologies of minor fruits with special emphasis on Kodagu. Souvenir and Abstracts, SYMSAC-VII, Madikeri , Karnataka, November 27- 29: 97-105.
- POP, Dr. Balasaheb Sawant Konkan Krishi Vidhyapeeth, Dapoli (MS).

❖❖

ISSN No. 2583-3146

Preservation and Processing of Fruits

Kirandeep Kaur

Department of Horticulture, Khalsa College Amritsar, Punjab

Corresponding Author: kirandeepkaur.kdk97@gmail.com

Introduction

Sharma *et al*., (2016) reported that India has been considered as the second largest producer of fruits, with the production of 134 million tonnes per year. Out of the roughly 130 million tonnes of fruit and vegetable produce, nearly 30-40% gets wasted or damaged during harvest, storage, grading, transport, packaging and distribution because of the challenges involved in the industry. Due to deficiency of skilled manpower, poor cold storage facilities, inefficient post-harvest management, India contributes only 1% to the global market of the fruit processing industry. Fruits compromise many nutrients like vitamins, carbohydrates, proteins, minerals and dietary fibers. Fruits are perishable in nature and there is no need to process fruits in order to increase their storage or shelf life. Fruit processing is done to add value to the fresh fruits. According to the research study of Dwivedi *et al.*, (2017), various chemical, enzymatic or microbial activities from the food itself cause spoilage to food products. The fruits have limited shelf life and in order to increase it, certain preservatives are added to fruit products.

Fruit Preservation

Preservation is the branch of science which deals with the methods of prevention of decay or spoilage of food, thus allowing it to be stored in a fit condition for future use. Dwivedi *et al*., (2017) reported that preservative is a chemical that is added to different kind of products to prevent their decomposition by microbial growth or by unwated chemicalk changes. These are sustances which inhibit the microbial growth, prolong the shelf life, maintain the nutritional value, improve wholesome and palatability, enhance flavor, control pH and provide colour by preventing the food spoilage.

Principles of preservation

Prevention or delay of microbial decomposition

- By keeping out microorganisms (asepsis).
- By removal of microorganisms through filtration.
- By hindering the growth and activity of microorganisms by low temperature, drying, chemicals.
- By killing the organisms with the help of heat or radiation.

Prevention or delay of self- decomposition of the food

- By destruction or inactivation of enzymes through blanching.
- By prevention or delay of chemical reactions like prevention of oxidation by means of an oxidant.

Prevention of damage from insects, animals, mechanical causes, etc.

Fruit and Vegetable preservation methods

According to research findings of Rahman (2007), various preservation methods are proposed to prevent the food spoilage from occurring.

A. Physical method

Asepsis: Asepsis means preventing the entry of microorganisms. Maintaining of general cleaniness while picking, grading, packing and transporting of fruits and vegetables increases their keeping quality and the products prepared from them will be of superior quality. Washing or wiping of the fruits and vegetables before processing should be strictly followed as dust particles adhering to the raw material contain microorganisms and by doing so a large number of organisms can be reduced.

a. By addition of heat

Pasteurization: It is the process of heating at boiling temperature or slightly below it for a sufficient length of time to kill the microorganism which causes spoilage. It causes partial destruction of organisms below 100°C. It is normally used for fruits.

Sterilization: It is the process of heating at above 100°C for particular period of time. It causes complete destruction of microorganisms at 121°C for 30 minutes. It is normally used for vegetables.

b. By removal of heat

Cellar storage: The temperature in cellars (underground rooms) where surplus food is stored in villages is lower than 15°C. Root crops, potatoes, onion, apples can be stored for limiting period during the winter months.

Refrigeration or chilling: The best storage temperature is slightly above 0°C. The fruits and vegetables can be preserved for few days to many weeks when kept at this temperature. Commercial cold storages with proper ventilation are now used for the storage of semi- perishable foods such as potatoes and apples.

Freezing: Leistner (2,000) noticed that at temperatures below freezing point of water (-18 to -40°C), the growth of microorganisms and enzymatic activity are reduced to minimum. Most perishable products can be preserves for several months if kept or stored at this temperature.

c. By removal of water

Drying: Moisture can be removed by the application of heat. Microorganisms need moisture to grow, so when the concentration of water in the food is brought down, they are unable to grow.

B. Chemical Method

a. Preservation by Sugar: Sugar absorbs most of the available water, with the result there is very little water for the growth of microorganisms, hence their multiplication is inhibited. Fruit syrups, jam, jelly, candy are preserved by sugar.

b. Preservation by Salt : Salt at the concentration of 15 to 25 % is sufficient to preserve most of the products. Salt in the form of brine is used for canning and pickling of vegetables (Sharif *et al*., 2017). It exerts preservative action by :

- Causing high osmotic pressure
- Dehydrating food by drawing out moisture
- Reducing the solubility of oxygen in water

c. Preservation by Acids: Highly acidic environment inhibits the growth of food spoilage micro-organisms, hence organic acids are added in foods to preserve them.

- Vinegar (Acetic acid) is added to pickles, chutneys, sauces, ketchups, etc. About 2% acetic acid prevents the spoilage of many products.
- Citric acid is added to many fruit squashes, jams and jellies to increase the acidity and prevent mould growth.

d. Preservation by Oil and Spices: Oil on the surface of food produces anaerobic conditions which prevent the growth of mould and yeast. Thus the pickles in which enough oil is added to form a layer at the top can be preserved for long periods. Spices like turmeric, pepper have bacteriostatic effect and have ability to prevent the growth of other micro-organisms. Their primary function is to impart their characteristics flavour to the food.

e. Preservation by Chemical Preservatives: A "preservative" is any chemical substance which is capable of inhibiting, retarding or arresting the process of fermentation, acidification or decomposition of food. The inhibitory action of preservatives is due to their interference with the mechanism of cell divisions, permeability of cell membrane and activity of enzymes.

Potassium Metabisulphite

It is fairly stable in neutral or alkaline media but decomposed by weak acids like carbonic, citric, tartaric and malic acid.

Advantages

- It has better preservative action against bacteria and mould.
- It helps to retain the colour of the beverage for a longer period of time.
- It prevents the discolouration of the product.
- It also retards the development of non-enzymatic browning.

Disadvantages

- It cannot be used in naturally coloured juices like phalsa, jamun, pomegranate, strawberry, plum, etc.
- It cannot be used for juices which are to be packed in tin containers because it not only corrodes the tin but also forms the hydrogen sulphide.

Sodium benzoate

Advantages

- It is more effective against yeasts.
- It is mostly used in colored products of tomato, phalsa, jamun, pomegranate, plum, strawberry, etc.

Disadvantages

- It should never be added in the solid form as the solid may settle undissolved at the bottom of container with the result that fermentation may start before the action of preservative can begin.

f. Preservation by Fermentation: Decomposition of carbohydrates by microorganisms or enzymes is called fermentation. The foods are preserved by alcohol or organic acids formed by microbial action. The keeping quality of alcoholic beverages, vinegar, fermented pickles depends upon the presence of alcohol, acetic acid and lactic acid respectively. 14% alcohol acts as preservative in wines because yeasts cannot grow at that concentration.

g. Preservation by Carbonation: Carbonation is the process of dissolving sufficient carbon dioxide in water or beverage so that the product when served gives off the gas as fine bubbles and has a characteristics taste. Fruit juice beverages are generally bottled with carbon dioxide content varying from 1 to 8 gram per liter. Another advantage of carbonation is the removal of air thus creating an oxidation of ascorbic acid and prevents browning. Moulds and yeasts require oxygen for their growth and become inactive in the presence of carbon dioxide.

h. Preservation by Filtration: The juices are clarified by using ordinary filters and then passed through special filters which are capable of retaining yeasts and bacteria. Various types of germ proof filters are used for this purpose. It is not used in India.

i. Preservation by Antibiotics: The metabolitic products of microorganisms have germicidal effect and are termed as antibiotics. Nisin is an antibiotic produced by Streptococcus lactis. It is widely used in the food industry for the preservation of acidic foods. Subtilin is an antibiotic produced from strains of Bacillus subtilis. It is used in preservation of asparagus, corn, peas, tomatoes, etc.

j. Preservation by Irradiation: It is recently developed method of preservation which has not yet gained general acceptance. When gamma rays pass through foods, there are collisions between ionizing radiation and food particle at the atomic and molecular levels, resulting in the production of ion pairs and free radicals. The reactions result in the physical and chemical phenomenon which inactivate the microorganisms found in the food.

Fruit Processing

According to the research findings of Sabir (2016), fruit processing is the conversion of fruit into convenient product, to increase the shelf life and value addition of fruit. The fruits and vegetables can be processed into jams, jellies, marmalades, candies, crystallized and glazed fruits, preserves, chutneys, pickles, ketchup, sauce, puree, syrup, juices, squashes and cordials, etc.

Apple Jam

Thakur *et al*., (2022) stated that jam is a product made by boiling fruit pulp with the sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position.

Ingredients

- Apple pulp = 2 kg
- Sugar = 0.75 kg
- Citric acid = 1-3 g

Preparation of Apple Jam

Receiving of raw material

↓

Sorting or grading

↓

Washing

↓

Peeling

↓

Cutting

↓

Cooking till softening

↓

Pulping

↓

Addition of sugar

↓

Addition of citric acid

↓

Addition of colour and flavor

↓

Judging of end point

↓

Hot filling (88°C)

↓

Cooling (29°C)

↓

Waxing

↓

Lidding

↓

Sealing

↓

Storage

Tomato Ketchup

According to the research findings of Okafor (2019), there is no major difference between sauce and ketchup. However, sauces are generally thinner and contain more total solids than ketchup.

Ingredients

- Tomato = 4 kg
- Salt = 40 g
- Sugar = 75 g
- Onion = 50 g
- Ginger = 10 g
- Garlic = 5 g
- Red chilli powder = 5 g
- Cinnamon, Cardamom, Cumin = 7 g
- Black pepper = 3 g
- Vinegar = 150 ml

Preparation of Tomato Ketchup

Tomatoes (Fully ripe, red)

↓

Washing and Sorting

↓

Cutting and Chopping

↓

Pre-heating at 70-90°C for 3-5 minutes (to soften)

↓

Straining tomato pulp/ juice

↓

Pulping

↓

Cooking pulp with one-third quantity of sugar

↓

Putting spice bag

↓

Cooking to one-third of original volume of pulp

↓

Removal of spice bag (after squeezing in pulp)

↓

Addition of remaining sugar and salt

↓

Judging of end-point (by hand refractometer/ cold plate test/ sheet test)

↓

Addition of vinegar/ acetic acid

↓

Addition of preservative (40 ppm KMS)

↓

Hot filling

(to kill all the micro-organisms)

↓

Pasteurization (85-90°C)

↓

Crown corking

↓

Cooling

(to room temperature, 29°C)

↓

Storage at ambient temperature (4°C) (in cool and dry place)

Lemon Pickle

Kuna *et al.*, (2018) observed that the preservation of food in common salt or in vinegar is known as pickling. It is one of the ancient methods of preserving fruits and vegetables. Pickles are good appetizers and add to the palatability of a meal.

Ingredients

- Lemon = 1 kg
- Salt = 200 g
- Chilli powder = 15 g
- Cumin, Cardamom, Cinnamon, Black pepper = 10 g

Preparation of lemon pickle

Lemons

↓

Washing

↓

Drying

(by wrapping in cloth or in sun drying)

↓

Cutting into 4 pieces

↓

Squeezing out juice from ¼ amount of fruit

↓

Addition of spices and salt

↓

Mixing with lemon pieces

↓

Filling in jars

↓

Addition of vinegar

↓

Covering with lid

↓

Keeping in sun for 4-6 days (shaking jar at least twice a day)

↓

Pickles get ready

↓

Storage

Lemon Squash

Ramesh *et al*., (2017) stated that squash is a type of fruit beverage containing at least 25 % fruit juice, 45 % TSS, 1.0 % acidity and 350 ppm of KMS or 600 ppm of sodium benzoate. It is diluted before serving. Lime, orange, mango, pineapple, etc., are used for making squash by using KMS as preservative, whereas jamun, passion fruit, raspberry, strawberry, grape fruit etc., with sodium benzoate as preservative.

Ingredients

- Lemons = 1 kg
- Sugar = 1.25 kg
- KMS = 3 g

Preparation of lemon squash

Lemons

↓

Washing

↓

Trimming

↓

Cutting

↓

Juice extraction

↓

Straining

↓

Juice measuring

↓

Preparation of syrup (Sugar + water + acid, heating just to dissolve)

↓

Straining

↓

Mixing with juice

↓

Addition of preservative (1.0 g Sodium Benzoate or

0.6 g KMS per liter of squash)

↓

Bottling

↓

Capping

↓

Storage

Conclusion

Fruit processing industry is considered to be the sunrise sector of the Indian economy. There is a need to process the fruits because of their perishable nature in order to increase their shelf life. The fruit processing industry has employed a large portion of skilled and semi-skilled persons and thus providing employment opportunities to the population. Moreover, the processed fruits which are preserved with the use of preservatives have become popular due to greater consumer awareness. The food preservatives not only reduce the bacterial growth but also enhance the shelf life of products in which it is added. It also allows them to remain fresh or maintain its consistency for a long span of time and causes no toxic effect.

References

- Dwivedi S, Prajapati P, Vyas N, Malviya S, Kharia A (2017) A Review on Food Preservation: Methods, harmful effects and better alternatives. *Asian J Pharmacy and Pharmacol.* 3(6): 193-99
- Kuna A, Sowmya M, Sahoo M R, Mayengbam P D, Dasgupta M and Sreedhar M (2018) Value addition and sensory evaluation of products made from underutilized Kachai lemon (*Citrus jambhiri*) Lush fruits. *J Pharmacognosy*

and *Phytochemistry*. 7(5): 3032-36

- Leistner L (2000) Basic aspects of food preservation by hurdle technology. *Int J Food Microbiol*. 55(1): 181-86
- Okafor O A (2019) Production of Tomatoes Ketchup using two local species: Uziza and Ehuru. *Int J Academic Management Sci Res*. 3(12): 20-36
- Rahman M S (2007) Food Preservation. Overview: Handbook of food preservation. 2nd edition, pp 3-7, London; CRC Press.
- Ramkesh M, Reddy S V R, Sarolia D K, Singh R S and Bhargava R (2017) Formulation and acceptability studies of Rough lemon (*Citrus jambhiri Lush*.) squash. *Indian J of Arid Horti*. 12(1-2): 80- 84
- Sabir M S, Rajendra C D, Amol S, Poournima S S (2016) A Review on: preservatives used in pharmaceuticals and impacts on health. *Pharma Tutor.* 4(5): 25- 32.
- Sharif Z I M, Mustapha F A, Jai J, Yusof N M, Zaki N A M (2017) Review on methods for preservation and natural preservatives for extending the food ongevity. *Chemical Engg Res Bulletin*. 19: 145-53.
- Sharma A, Singh B K, Anand N (2016) Fruit Processing Industry in India: A Short Review. *https://www. Researchgate .net/publication/298855725*
- Thakur V, Mal D and Gharde S K (2022) Preparation of Apple Jam at home. *Indian Farmer.* 9(6): 248-51.

❖❖

ISSN No. 2583-3146

Millet: A Sustainable Food for Future Generation

Kshirod Chandra Sahoo[1*], Jyotirmayee Sahoo[2]

[1]Department of Soil Science and Agricultural Chemistry, School of Agriculture, GIET University, Gunupur

[2]Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur

Corresponding Author: kshirodsahoo@giet.edu

Introduction

Millet's are minor food grains, that grow widely in different soils and climatic conditions. It acts as a source of nutrition for living being. Millets are a type of cereal crops which provide small grains. It provides more protein as compared to cereals. Therefore it is required for the growth & development of human beings. It enhances the immunity of living cells. It also having other properties like disease prevention and other curative measure. Millets are occupying on suitable place throughout the continent i.e. from arid, semi-arid to humid climate. The nutritional value of millets is superior as compared to other food grains. It is also called Nutricereals or Sri Anna. Millets have less water requirement as compared to other food grains (Mahajan *et al.,* 2021). Millet act as a super-food but also as a resilient crop. This crop has been grown in soil with limited fertility, therefore making it eco-friendly than rice, wheat, vegetables, pulses and many other crops which needed various carbon emitting fuel resources for irrigation purposes and fertilizers for enhancing the fertility of soil. Millets remain world friendly crop and so receive attention fron climate change initiatives and sustainable environment practices. Being insect tolerant, millets has been required minimal to no usage of pesticides. There are many health benefits of millets including low glycemic index, gluten free, good source of magnesium, strong antioxidants, keep gut healthy, high dietary fibre, helps in digestion, keep weight under control and prevent diabetes. Millets are C4 plants with high photosynthetic efficiency, more dry matter production capacity, short duration and high degree of tolerance to heat and drought.

Key word: Millet, food grain, health benefit, antioxidant, glycemic index, ecofriendly.

Soil Requirement

Millet can grow a wide range of soil and tolerate alkalinity upto some extent. The best soils are alluvial, loamy and sandy soil. Finger millet is grown in a wide range of soil ranging from loam to shallow upland soil with organic matter content having pH 4.5 – 8.0. Deep, loam and fertile soil suitable for kodo millet. Clay loam soil is suitable for pearl millet. Proso millet prefers sandy loam to black cotton soil.

Food Security for Future Generation

Macronutrients

Millets have comparable or better nutritional value than other main cereal grains. Millets are a perfect health food due to their extra advantages, which include gluten-free proteins, high fibre content, a low glycaemic index and a wealth of bioactive components. Millets range in average carbohydrate content from 56.88 to 72.97 g/100 g. Barnyard millet has been found to have the least amount of carbohydrates. In the case of finger millet, protein in the range of 4.76g to 11.70 g/100 g. Methionine, valine and lysine are among the necessary amino acids found in high concentrations in finger millet. Proso millet has the highest protein content of all millet which is equivalent to wheat. The lipid content of millets as a whole ranges from 1.43 to 6 g/100 g and is equivalent to that of wheat and rice (2.0% in wheat and 2.7% in rice). The highest source of crude fibre, with an average amount of 12.8 g/100 gm, is barnyard millet. Kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*) have the highest recorded dietary fibre contents at 37% and 38% respectively. The dietary fibre that this resistant starch adds to functions as a prebiotic, enhancing the health advantages of millet. In addition, resistant starch aids in the colon's synthesis of beneficial metabolites like butyrate, which controls colonic cell proliferation and acts as a barrier against colon cancer.

Micronutrients

Millets contain vitamins & minerals. So it is called micronutrients. Minerals are essential for the development of bones, the clotting of blood, sending and receiving signals, maintaining a normal heartbeat, producing cellular energy, transporting oxygen, metabolizing and synthesizing fats and proteins, acting as coenzymes, boosting immunity and supporting a healthy nervous system. Millets have a far greater mineral content than common cereals like wheat (1.5%) and rice (0.6%), ranging from 1.7 to 4.3 g/100 g. Calcium concentration in finger millet is eight times greater than wheat's (348 mg/100 g), making it the best food for preventing osteoporosis. Both pearl millet and barnyard millet are excellent sources of iron, and pregnant women with anaemia can get all the iron they need by eating both grains. Zinc concentration (4.1 mg/100 g) is greatest in foxtail millet and it also contains 2.7 mg Fe / 100 g which helps in increasing immunity. Millets are an excellent source of riboflavin, niacin, and folic acid as well as beta-carotene and B vitamins. The amount of riboflavin in millets is significantly greater than that in common cereals, with pearl millet (1.48 mg/100 g) and foxtail millet (1.65 mg/100 g).

Health Benefits of Millets

Most of the study reveals that taking millet in diet decreases the risk of heart disease, improves digestion, guards against diabetes, lowers the risk of cancer, detoxifies the body, boosts immunity in the respiratory system, gives people more energy and strengthens their muscles and nervous systems. It helps in protecting against several degenerative diseases, including Parkinson's disease and metabolic syndrome. Resistant starch, oligosaccharides, lipids, antioxidants such phenolic acids, avenanthramides, flavonoids, lignans and phytosterols, which are thought to be responsible for several health advantages, are among the essential elements found in millets. Millet assists lower blood pressure and the risk of heart attack as it is a source of magnesium.

It decreases cholesterol by decreasing the Low DL and increasing benefits of high DL. The finger millets and proso millets lower the concentrations of serum triglycerides. It also decreases cardiovascular disease by reducing plasma triglycerides in hyperlipidemic rates. The presence of magnesium, fibre, phenolic, vitamin E, compounds and tannins in the diet lowers the chance of developing diabetes as they delay the abrupt rise in blood sugar and insulin levels. Millets contain high fibre which aids in the eradication of constipation, excessive gas, bloating, and cramps. Based on published data, millet grains are high in phenolic acids, tannins, and phytate. In animals, these nutrients lower the incidence of colon and breast cancer.

References

- Mahajan, P., Bera, M. B.,Panesar, P. S., &Chauhan, A. 2021. Millet starch: A review. *International Journal of Biological Macromolecules*. 180: 61-79.
- Kumar, A., Tripathi, M. K., Joshi, D., & Kumar, V. (Eds.). 2021. *Millets and Millet Technology* .Springer Singapore. 438.
- Platel, K. 2013. Millet flours as a vehicle for fortification with iron and zinc. In: Preedy,. Handbook of food fortification and health, eds. New York: Springer. 115-123.
- Handel, G., Kumar, M., Dubey, M. and Kumar, M. 2014. Nutritional properties of minor millets: neglected cereals with potentials to combat malnutrition. Current Science. 107(7): 1109-1111.
- Kumar, A., Tomer, V., Kaur, A., Kumar, V. and Gupta, K. 2018. Millets: a solution to agrarian and nutritional challenges. *Agriculture & food security*. 7(1): 1-15.

❖❖

ISSN No. 2583-3146

Carbon Farming Technologies in Rice and it's Benefits

Surya Mithra Nair J, S. Elamathi, and R. Ranjith

Department of Agronomy, Tamil Nadu Rice Research Institute, Aduthurai

Corresponding author: mithranair1998@gmail.com

Introduction

Rice production can contribute to greenhouse gas emissions through various processes involved in cultivation, processing, and transportation. The two primary greenhouse gases associated with rice production are methane (CH_4) and carbon dioxide (CO_2). Rice cultivation involves flooding the fields, creating anaerobic conditions that promote the growth of methane-producing microorganisms. Efforts are being made to mitigate greenhouse gas emissions from rice production. Some strategies include:

a. Alternate Wetting and Drying (AWD) method: This technique involves periodically drying the fields between irrigations instead of keeping them continuously flooded. AWD can significantly reduce methane emissions from rice fields while maintaining crop productivity.

b. Improved water management: Implementing more precise and efficient water management practices, such as maintaining optimal water levels and minimizing water losses, can help reduce methane emissions.

c. Nutrient management: Optimizing fertilizer application by using site-specific nutrient management approaches can reduce nitrogen losses and associated greenhouse gas emissions.

d. Conservation agriculture: Practices like direct seeding, residue management and crop rotation can contribute to soil carbon sequestration and overall sustainability.

e. Adoption of new rice varieties: Researchers are developing rice varieties with improved tolerance to flooding and better methane-reducing capabilities, which could help reduce emissions in the future.

It's worth noting that the greenhouse gas emissions associated with rice production can vary depending on local agricultural practices, regional differences and specific management techniques employed. Therefore, the overall emissions from rice cultivation can differ between different geographic areas and farming systems.

Benefits of Low Carbon Farming

Low carbon farming, also known as climate-smart agriculture or sustainable agriculture, offers several benefits. Here are some key advantages of adopting low carbon farming practices.

a. Reduced greenhouse gas emissions: Low carbon farming practices aim to minimize the release of greenhouse gases, such as carbon dioxide, methane and nitrous oxide. By implementing techniques like improved nutrient management, conservation tillage and agro-forestry, farmers can significantly reduce their carbon footprint and contribute to mitigating climate change.

b. Enhanced soil health and fertility: Low carbon farming methods focus on building and maintaining healthy soils. Practices like cover cropping, crop rotation and organic soil amendments improve soil structure, increase organic matter content and enhance nutrient cycling. Healthy soils can store more carbon, improve water retention and support robust crop growth.

c. Conservation of natural resources: Low carbon farming emphasizes efficient use of natural resources, such as water and energy. Precision irrigation systems, water-efficient practices and renewable energy adoption can help reduce water consumption and energy use in agricultural operations. Conserving resources not only benefits the environment but also helps farmers reduce their production costs.

d. Biodiversity preservation: Low carbon farming practices promote biodiversity conservation by providing habitats for beneficial insects, birds and other wildlife. Planting hedgerows, preserving buffer zones, and adopting agro-ecological principles contribute to a more diverse and resilient ecosystem. Preserving biodiversity helps maintain natural pest control, pollination services, and overall ecosystem balance.

e. Improved resilience to climate change: Low carbon farming methods often involve climate adaptation strategies that help farmers cope with the impacts of climate change. Diversifying crops, using drought-tolerant varieties and implementing agro-forestry systems can enhance farm resilience to extreme weather events, such as droughts, floods, and heatwaves.

f. Economic benefits: Low carbon farming practices can lead to cost savings and increased profitability for farmers. By minimizing input use, optimizing resource management and adopting sustainable practices, farmers can reduce their expenses on fertilizers, pesticides and energy. Moreover, sustainable agricultural practices often improve crop yields, enhance product quality, and provide market opportunities for eco-conscious consumers.

g. Water and air quality protection: Low carbon farming techniques promote responsible use of agrochemicals and reduce the risk of water and air pollution. By adopting Integrated Pest Management (IPM), precision application of fertilizers and erosion control measures, farmers can minimize nutrient runoff and pesticide residues, protecting water sources and improving air quality.

Overall, low carbon farming practices offer a more sustainable and resilient approach to agriculture, benefiting the environment, farmers, and local communities.

Conclusion

In conclusion, low carbon farming practices provide a sustainable and climate-smart approach to agriculture that offers numerous benefits. By reducing greenhouse gas emissions, improving soil health, conserving natural resources, preserving biodiversity, enhancing resilience to climate change and providing economic advantages, low carbon farming contributes to mitigating climate change, protecting ecosystems and ensuring long-term agricultural sustainability. Embracing low carbon farming methods is essential for a more resilient and environmentally friendly agricultural sector that can meet the challenges of a changing climate while ensuring food security and promoting the well-being of both farmers and the planet.

References

- Action plan to reduce carbon emission, ministry of environment, forest and climate change (2022)
- Aggarwal p k (2003). Impact of climate change on indian agriculture, journal of plant biology 30: 189-98.
- Aggarwal p k and mall r k, (2002). Climate change and rice yields in diverse agro-environments of India. Ii. Effect of uncertainties in scenarios and crop models on impact assessment. Climate change 52:331-43.

- Agricultural soils of India and their global warming potential. Curr. Sci. 87(3): 317-324.
- Ahuja dr (1990) estimating regional anthropogenic emissions of greenhouse gases, us-epa climate.
- Algas (Asia least-cost greenhouse gas abatement strategy) (1998) national report on Asia least Amended soils under rice-wheat system in the indo-gangetic plains. Atmos. Environ. 39: 6976–
- Bhatia a, aggarwal pk and pathak h (2007) simulating greenhouse gas emissions from Indian rice
- Bhatia a, pathak h and aggarwal pk (2004) inventory of methane and nitrous oxide emissions from
- Bhatia a, pathak h, jain n, singh pk and singhak (2005) global warming potential of manure
- Cao m, gregson k, marshall s, dent jb and heal o (1996) global methane emissions from rice paddies.
- Change technical series, Washington dc, 20 p.
- Chemosphere 55(5): 879-897.
- Cost greenhouse gas abatement strategy, ministry of environment and forest, government of Fields using the info crop model. Int. Rice res. Notes. 32: 38-40.
- Garg a, bhattacharya's, shuklapr and dadhwalvk (2001) regional and sectoral assessment of Greenhouse gas emission in India. Atmos. Environ. 35: 2679–2695.
- If pri (2009) agriculture and climate change: an agenda for negotiation in copenhagen. The international food policy research institute (ifpri).2020 vision for food, agriculture and the environment, 29 p.

❖❖

ISSN No. 2583-3146

Nutritional and Economical Importance of Under Utilized Fruits

Kumari Anuska
Department of Horticulture
Chandra Bhanu Gupta Agriculture Post Graduate College Bakshi Ka Talab, Lucknow
Corresponding Author: anushka56724@gmail.com

Introduction

Minor fruits are a group of fruits that are now growing randomly and unattended on homesteads, wasteland and other surfaces. Minor fruits are generally those that, while edible by humans, are less palatable than other major fruits, have less market demand, are grown to a limited extent only and are not typically cropped in organized plantations with the use of artificial agro-inputs. They have the capacity for extensive exploitation and are generally resilient, growing well even in brittle soil and environment. Many of these crops experience significantly less attacks from harmful pests and diseases. Rather than going extinct, they develop and multiply on their own. Rather than going extinct, they develop and multiply on their own. These fruits are referred to as "minor fruits" in popular culture since the area under each of these fruit trees is small. In India, a vast number of underutilised fruits grow carelessly in homestead, fallow, and forest regions as well as along roadways and railway tracks. These are tailored to the local environment, very nutritious, and help rural residents live in greater poverty and with greater household food security. They also play a vital part in herbal medicine. Although there are many different underutilised fruit crops in different agro-ecological zones of India, nearly none of them have organised orchards or recognised cultivars, and some of those that do have them are being lost to erosion.

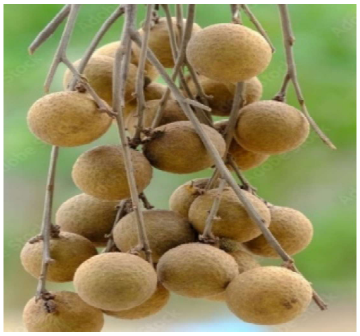
Here are some underutilized fruits that have been always neglected. These fruits are rich source of Vitamins, antioxidant properties.

Rambutan *(Nephelium Lappaceum)*

Rambutan is a tropical fruit native to Indonesia, widely grown in Southeast Asia, India, and Sri Lanka. It belongs to the Sapindaceae family and is an evergreen tree reaching 12 to 20 meters in height. The fruit is a hairy, round to oval drupe with colours ranging from yellow to pink and red, it is normally 3-6 cm tall and 3-4 cm wide .The rambutan fruit is highly valued as a fresh fruit in North America, the Middle East and Europe. With 82 kcal of calories, 20.87g of carbohydrates, 0.9g of dietary fibre, 0.21g of fat and 0.65g of protein per 100g of fresh fruit, it is a nutrient-dense food. Additionally, it contains traces of iron and zinc in addition to minerals such as potassium, calcium, sodium and magnesium. Additionally, it is a good source of ascorbic acid, a form of vitamin C and vitamins B. Rambutan trees produce male, female, or hermaphrodite flowers, and after fruit set, the fruit matures in 15 to 18 weeks. The Indian Institute of Horticultural Research (IIHR) in Bangalore has created a number of important rambutan varieties, including Rongrien (common in Thailand and suitable for canning), Binjai, Azimal, Singapura, Arka

Coorg (red colorline) and Arka Coorg Patib (yellow colourline).

Longan *(Dimocarpus longan Lour)*



Longan, also known as dragon eye fruit, is a sub-tropical fruit belonging to the Sapindaceae family. The fruit is native to southern China, but it is also cultivated in other countries like India, Myanmar, and Thailand. Longan trees are ever green with dense dark green foliage and can grow upto 30 meters in height. The fruit grows in clusters and is round, with a diameter of 1.25-2.5 centimeters. Longans are known for their health benefits, high sugar content and rich source of vitamin C. The fruit is typically propagated by air layering or budding and pests like stink bugs and witche's broom diseases can be a problem. The longan season in Southeast Asia is from July to September and West Bengal is a well-known area in India for growing longans. Some important varieties of longan include Chuliang, dew, Gandaki-.

Mangosteen (*Garcina Mangostana*)

Mangosteen, is native to Southeast Asia and belongs to the Clusiaceae family. It requires a warm, humid and equatorial climate

to grow and is commonly found in tropical countries such as Thailand, India, Malaysia, Vietnam and the Philippines. In India, mangosteen is grown in Nilgiri hills, Chennai and Maharashtra. The mangosteen season occurs twice a year, from April to June and during the monsoon season from July to October. The tree can grow from 6 to 25 meters (19.7 to 82.0 feet) tall and is a never green tree. The fruits are sweet and tangy, juicy, somewhat fibrous, and have fluid-filled vesicles (like the flesh of citrus fruits) with an inedible, deep reddish-purple color edrind (exocarp) when ripe. The seeds are almond-shaped and sized. Mangosteen fruit contains antioxidant, antibacterial, and antifungal properties. Fruit is ideal for treatment of cancer, liver cancer and leukemia. It contains tannin upto13%.

Passion fruit (*Passiflora* spp.)

Passion fruit belongs to the family of passifloraceae . The passion fruit originated from Brazil and is widely cultivated in South Africa, Kenya, East Africa, Australia, New Zealand and Indonesia. In India, it grows wildly in Nilgiri Hills, Waynad, Punjab, Mizoram, Malabar, Kerala and Himachal Pradesh. It is commonly cultivated in warm and tropical regions. The juice is a good source of vitamin 'A' and 'C', and used to flavour ice cream, making jam and refreshing drinks. Its cultivation is extended to South India and NE region. Passion fruit is commercially propagated by cuttings and seeds. Passiflora is a genus that includes at least ten fruit-bearing species, but only two are widely cultivated: purple passion fruit (Passiflora edulis Sims) and yellow passion fruit (Passiflora edulis f. flavicarpa Degener). In India, commercial cultivation mainly focuses on Purple, Yellow and Hybrid (Kaveri) cultivars.

Durian *(Durio Zibethinus)*

The durian is a fruit tree belonging to the

Bombacaceae family, originally from Borneo. It is commercially grown in Indonesia, Malaysia, and Thailand. In India, durian trees can be found in Nilgiris and the West Coast, but there are no large orchards or commercial plantings. In grafted orchards, durian trees typically grow to a height of 12 metres, however they can grow up to 30 metres in woods. It is a huge, up to 5 kg, thorny fruit with a rough exterior. It is known for its unique flavour and potent aroma, which is either adored or despised due to its extremely offensive smell. The pulp of the durian fruit is rich in sugars, protein, carbohydrates, iron and B vitamins, including vitamin E. The roots and leaves of the tree are used in traditional medicine to treat fever, inflammation, infections. Propagation of durian is typically done through seeds, but vegetative propagation of elite trees is recommended. Grafted trees can start producing crops in 4-5 years, while seedlings can take up to 10 years. Fruiting is seasonal and occurs twice a year, with fruits taking about three and a half months to reach maturity. Yields of durian vary depending on the age of the tree, variety and agro-climate. A good yield is considered to be100-120 fruits.

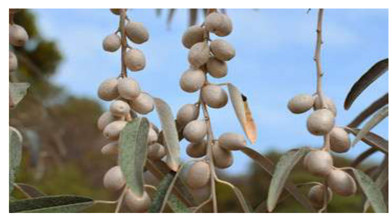
Carambola (*Averrhoa Carambola* L.)

It is a member of the Oxalidaceae family. Carambola, is a fruit tree that is native to the Philippines and is also found in Southeast Asia, South America, and Florida. Common name of carambola is star fruit , Kamrakh, five corner fruit. Vitamin "C" and antioxidants are abundant in the fruit.

Fruit is tart because the flesh contains calcium oxalate crystals that break down in saliva to produce oxalic acid. It is an evergreen tree, densey branched canopy. The flesh is translucent, pale yellow to golden, crisp, highly juicy, and fiberless. Within a few days of being removed from fruit, seeds lose viability. Fresh, uncooked, processed fruits like squash and as a cooling beverage are all common ways to consume ripe fruits. When ripe, the fruit has a bright yellow colour, a waxy skin, and is tasty throughout, being both juicy and crunchy. It is spread through seed.

Silvera berry (Elaeagnus Latifolia)

Silver berry belongs to Elaeagnaceae family grown in NE and Himalayan region. It is grown in the Khasi and Jaintia hills of Meghalaya, part of Uttarakhand, and South India, as well as Sibsagar (Assam). It is alarge, woody, evergreen shrub with rusty-shiny, usually prickly scales. Bees are responsible for pollinating flowers since they are hermaphrodite. The oblong-shaped, dark pink, ripening fruits of E. latifolia have a smooth surface. Flowers appear between September and December, while the light pink fruits are picked between March and April. Fruit can be preserved by being pickled or eaten fresh with salt.



Lutqua (Baccaurea Sapida)

Lutqua belongs the family Euphorbiaceae. Unusual species found in the sub-Himalayan region, primarily on the eastern side, from Nepal through Sikkim, the Darjeeling Hills and Arunachal Pradesh to Assam, Tripura and Meghalaya. Small to medium-sized and semi-evergreen, it may attain heights of up to 10 m. Eating-quality fruits that are yellowish in colour when ripe turn ivory to yellowish, pinkish-buff, or occasionally bright red.

Tree tomato *(Cyphomandra Betacea)*

It is a perennial shrub having red, tomato-like fruit that is native to South America and is a member of the Solanaceae family. Chutney is made from its fruit. In India, it is cultivated

as a backyard hobby crop, particularly in Meghalaya, Mizoram, Manipur, and other regions of South India. It is a little, delicate tree that grows to a height of 2 to 3 metres and bears masses of egg-shaped berries with pointy ends close to the new branches. The smooth, egg-shaped, long-stalked, hanging fruit has a persistent conical calyx on top and is borne alone or in clusters of three to twelve. Its dimensions are 5 to 10 cm long and 4-5 cm wide. In addition to having a subtle dark, longitudinal pattern, skin colour can be solid deep purple, blood red, orange, or yellow, or red and yellow.

Conclusion

Due to their significant medicinal and nutritional value, underutilised fruit crops are important for their therapeutic properties. They can be thought of as future horticultural assets to support nations in ensuring nutrition and food security, as well as providing recreational, social, and environmental significance. Due to their hardiness and adaptation to the local environment, these species may be used to increase sustainable farm income in harsh arid and semi-arid environments, such as wastelands (jharber, kair, pilu), marginal or saline soil and water conditions (ber, aonla, bael, karonda, etc.), rocky terrains (custard apple, timroo, jamun, etc.), as well as in backyard or kitchen gardening (Some fruit crops, such as aonla, bael, karonda, and tamarind, are very important to the food processing industry.

References

- Meena, Vijay Singh, et al. "Underutilized fruit crops of Indian arid and semi-arid regions: Importance, conservation and utilization strategies." Horticulturae 8.2 (2022): 171.
- Murthy, Hosakatte Niranjana, and Vishwas Anant Bapat. "Importance of underutilized fruits and nuts." Bioactive compounds in underutilized fruits and nuts (2020): 3-19.
- www.wikipedia.com

❖❖

ISSN No. 2583-3146

Effect of Sulphur on Soil Health

Ashutosh Shukla[1], Ashutosh Mishra[2], Opendra Kumar Singh[3*], Kartikey Tiwari[4]

[1,2&3]Department of Natural Resource Management Faculty of Agriculture M.G.C.G.V. Chitrakoot, Satna

[4]Department of Horticulture, SHUATS, Prayagraj

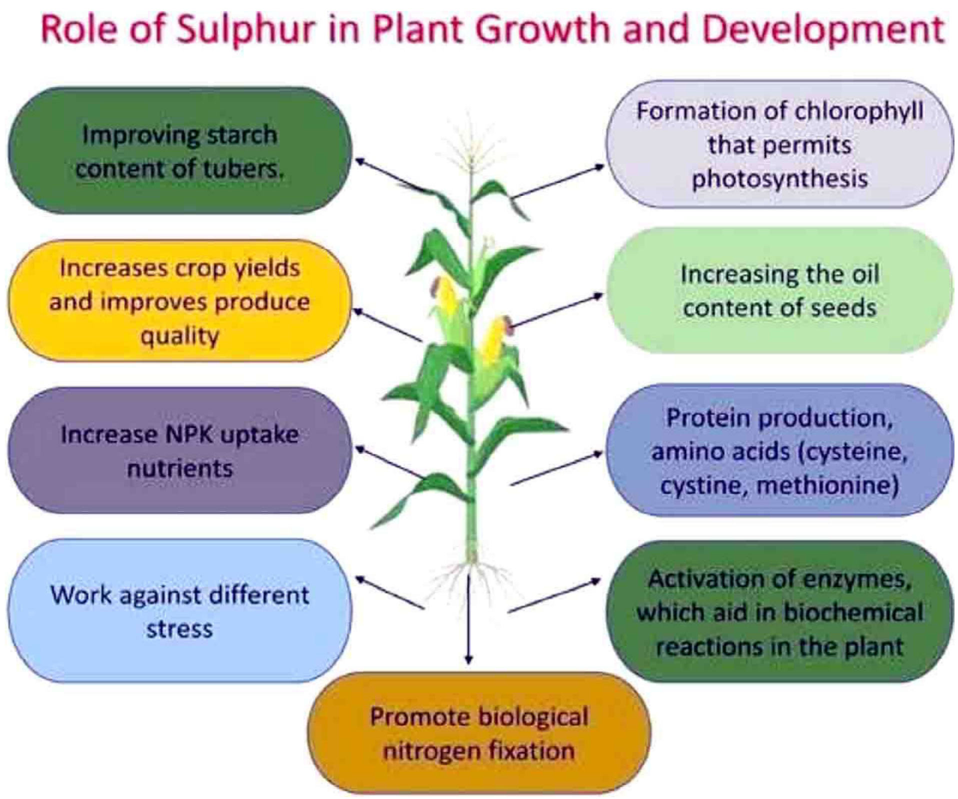
Corresponding Author: singoopendra8@gmail.com

Introduction

Sulphur is one of the essential elements required by all living organisms, including plants. Sulphur is a constituent of the protein aceous amino acids such as methionine and cysteine, glutathione, vitamins (biotin and thiamine), Phyto-chelating, chlorophyll, coenzyme A and *S*-adenosyl-methionine. Sulphur is also involved in disulphide bond formation in proteins andenzymes' regulation, particularly in redox control. It offers protection from oxidative damage through glutathione and its derivatives. Sulphur is also a component of several secondary meta bolites (SMs) of plants and is required for the plant's physiological functions, grow the and development. The Sulphur demand in plants is dependent on the types of species and stages of development. For instance, during seed development and vegetative growth, a higher amount of Sulphuris required. Sulphur-containing compounds such as Fe–Sclusters-containing proteins are required in multiple biological processes, such as photo synthesis, energy generation, photoprotection and metabolic reactions.The primary and dominant Sulphur source is inorganic sulphate (SO_4^{2-}) for the plants. Multiple transporters are involved in SO_4^{2-} uptake and its transportation from source to sink. Chloroplasts of young leaves are the prominent organelle where as similation of SO_4^{2-} to cysteine occurs; however, synthesis of methionine and cysteine can also happen in seeds and roots. Moreover in plants, Sulphur, and Sulphur-containing compounds are directly or indirectly take part in biotic and abiotic stress management, metabolism and signalling.

Importance of Sulphur in Soil Health

- Sulphur is an anion. In the soil solution, it is very leachable. Sulphur levels on a soil testindicate how much precipitation an area receives, or at least how much water is running through the soil profile. If Sulphur is low, that means it's getting leached out. In those types of soils, the majority of Sulphur is actually supplied through organic matter. 90% of Sulphur in soil is found in organic matter and as biology mineralizes the organic matter, it releases Sulphur for plants. While plants take up about as much Sulphur as phosphate, much more of it leaches every year than phosphorus.
- Sulphur is critical in the creation of aromatic compounds-also termed secondary metabolites-in the onion family. When onions make your eyes burn or when garlic has a strong flavor and aromatic scent, that is Sulphur. Researchers have found that most crops prefer a sulphur to nitrogen ratio of about 15:1. But cruciferous plants, like the cabbage plant family, actually prefer 3:1. The amino acids in alliums and the production of cruciferous plans are maximized with a lot of Sulphur.



- Sulphur and nitrogen are critical in a minoacids and proteins in plants.They are partners in almost every protein in a plant. Optimal Sulphur to nitrogen ratios have been found form any crops. Often times when nitrogen is too high, it makes plants much more susceptible to Sulphur deficiencies.

Sulphur role in plant growth and Soil Nitrogen Fixation

Sources of Sulphur in Soil

There are various sources of Sulphur found in the soil. Organic matter contains around 95% of the total Sulphur content of the soil Break down or decomposition of organic matter resultsin mineralization of organic Sulphur into the SO_4^2, which will be available to plants. A part from the organic matter, various minerals inside the soil also consist of a different sulphur form. Hence, breaking down or weathering these minerals results in transforming a part of sulphur into sulphate. In the atmosphere, a higher concentration of SO_2 is observed around the industrial area. Fuel-burning is also a source of sulphur. It releases sulphur in the form of Sulphur-di-oxide (SO_2).This SO_2 is dissolved in rain water and finally reaches the soil.

Pesticides contribute comparatively small amounts of sulphur to the soil. However, some pesticides contain Sulphur and the use of pesticides adds Sulphur to the soil Chemical fertilizers contain a considerable amount of sulphur along with nitrogen, potassium and phosphorus.

Sulphur deficiency in plants

Sulphur deficiency results in poor quality yield of crops. Mild Sulphur deficiency may have a negligible effect on yield but have a significant impact on quality. Thus, poor or low

Sulphur storage proteins are synthesized in Sulphur limiting soil, such as omega-gliadin and high molecular weight subunits of gluteninat the expense of Sulphur-rich proteins in wheat. It has been reported that sulfate deficiency leads to decreased synthesis of Rubisco (ribulose-1,5-biphosphate carboxylase/ oxygenase) enzyme that affects the assimilation rates of CO_2 which eventually results in retarded synthesis of carbohydrates this resulted in the chlorosis of young leaves. Several studies suggest that Sulphur deficiency affects biomass, overall morphology, yield and nutritional value of the plants. For instance, in *Eruca sativa* L Sulphur deficiencyleads to altered biomass production and chlorophyll synthesis Moreover, the impacts of Sulphur supplementation on grain yield and protein yield of agronomically important traits in wheat were observed in a study. The average protein yield of different cultivars was increased from 0.018 to 0.024/kg/m-2 and the average grain yield of different cultivars was increased from 0.20 to 0.29/kg/m-2. In another study, it has been observed that impact of Sulphur supplementation improves grain yield and protein yield in agronomically important plants like wheat and oilseed rape. Additionally, Sulphur deficiency leads to decreased root hydraulic conductivity as a response probably implicated with signaling nutrient starvation from root to shoot. Moreover, Sulphur deficiency results in the reduction of the internal Sulphur pool and an increase in the soluble nitrogen pool together with amide and nitrate as a consequence of the ratio of nitrogen and Sulphur imbalance.

Factors affecting Sulphurd eficiency in plants

Sulphur deficiency is more prevalent in recent years because of the reduction in atmospheric inputs. Reduced industrial Sulphur emissions because of pollution control regulation resulted in the reduced disposition of Sulphur into the soil from the atmosphere. In addition, extensive use of high purity and Sulphur-free or low percentage Sulphur-containing fertilizers/pesticides and intensivep roduction of higher-yielding crops may also contribute to more Sulphurd eficiency in the soil. It is reported that between 1990 and 2011 the atmospheric concentration of SO_2 has been decreased by 20 tera-gram. It has been reported that soil factors also affect Sulphur deficiency. Organic Sulphur is the primary source of Sulphur utilized by plants. Therefore, the soil's organic content is crucial, and if it is low, it will lead to a Sulphur deficiency in plants. Organic Sulphur becomes available to the plants through mineralization that is carried out by microorganisms This microbial activity is dependent on the temperature of the soil as well as the moisture content. Microbial activity is reduced by cold and excessively wet or dry conditions, thereby decreasing Sulphur availability from soil organic matter to the plants. The lack of Sulphur can be highly variable at the field level because soil Sulphur availability differs significantly from soil organic matter and texture. Sulphur deficiency is frequently seen in sandy soil, lower organic matter and higher elevation areas of a field. However, high organic matter, lower-lying and heavier texture dare a stypically have sufficient Sulphur.

Application of fertilizers to overcome the sulfur deficiency

There are several ways to overcome the sulfur deficiency. Chemical fertilizer, Farmyard Manure (FYM), compost or organic matter can be used to overcome the sulfur deficiency. There are more than 20 different sulfur-containing fertilizers are available commercially which is immediately available for plant uptake Ammoniumthio sulfate is used with either solution of urea-ammonium nitrate or by the mixture of ammonium sulfate and urea. Sulfate of potashmagnesia or potassium sulfate can be added tomuriate of potash to provide sulfur and potassium. But sulfur fertilizers should be applied to crop that requires sulfur to avoid the chances of leaching from the root zone. Since these fertilizers are used before planting, sulfate can be leached from sandy soil before crop requirement. A recent study on wheat showed that the use of sulfur-containing fertilizers accelerated their germination as well as an improved immune response against pathogens.

Conclusion and future perspective

Sulfur nutrition is essential for the growth and development of plants. Sulfur deficiency leads to retarded growth and yield. Sulfate permeases of plants and plant-associated organisms (fungi and bacteria) play a crucial role in sulfur uptake from soil. Plants are able to take up sulfate from the soil over a wide range of concentrations through the use of high-affinity and low-affinity transporters. These sulfate transporters belong to the Major Facilitator Super family(MFS) group of membrane transport proteins. As mentioned in soils withlow sulfur availability, a symbiotic association between plants and an AMF assists with the sulfur acquisition from the soil: plants obtain nutrients from their fungal partner, which in return receives sugars from the plant. In this association, fungal and plant membrane transporters participate in nutrient transfer to the host plant. However, due to the lack of as table transformation system in the case of AMF, the sulfate transporter system of AMF could not be manipulated to improve sulfur uptake in colonized plants. On the other hand, the beneficial endophyte *S. indica* can be cultivated axenically under laboratory conditions and has a well-established transformation system therefore functions of various genes have been studied. Colonization by *S.indica* improves a plant' sability to acquire phosphorus, magnesium, iron and sulfate from a nutrient-deprived soil rhizosphere, due to the presence of dedicated nutrient transporters providing benefits to the host plant such as improved growth and increased resistance to biotic and abiotic stresses. Therefore, *S. indica* has been termed a plant probiotic. The versatile potential of *S. indica* makes it a promising agent in agricultural applications.

Understanding the mechanism that *S. indica* utilizes to improve plant growth opens exciting avenues to further improve the fungal talents. In our opinion, despite all these novel approaches to improve sulfur enrichment in plants, detailed studies on the sulfate permeases and high-affinity sulfate transporters from the plant side as well as from associated partners are highly required to encourage sustainable agriculture and to reduce the load of chemical fertilizers. The cross talk between plant and fungal/bacterial partners at the molecular level is less known. Hence, future studies on inter-organismic nutrient transfer can open new vistas to improve the nutrient exchange and hence plant growth and development. Sulfur and sulfur-containing compounds have been playing important role in the growth and development of plants .They play role in catalyzing several metabolic processes, as well as across mediator in different biotic and abiotic stress tolerance. Sulfur deficiency in the soil became the keyfactor limiting crop growth and yield. So far, as compared to other nutrients, studies on sulfur absorption, metabolism, regulation and its mechanistic under standing is not enough and remain obscure. Thus, in the future, to improve the sulfur utilization efficiency in plants, more effort is required to know the regulatory mechanisms of plant's response toward sulfur deficiency in soil and different stresses.

❖❖

ISSN No. 2583-3146

Krishi Udyan Darpan

(Innovative Sustainable Farming)

In This Issue

Publisher : Snigdha Halder

Editor : Prof. (Dr.) Umesh Thapa

Cover & Layout : Neeraj Gupta

Proof Reading : Prakhar Khare

Type Setting : Mukesh Kumar

Administrative & Production Office

3/2, Drummand Road, Opp. Nathani Hospital, Prayagraj-211001 (U.P)

Mob.-9452254524

Website : saahasindia.org

E-mail - contact.saahas@gmail.com

Subcription : www.saahasindia.org/Magazine.php

•

Corresponding Address

5 Vivekanand Marg, Johnstonganj, Prayagraj- 211003 (U.P.)

E-mail - krishiudyandarpan.en@gmail.com

•

Published by

Society for Advancement in Agriculture, Horticulture & Allied Sectors (SAAHAS), Prayagraj (U.P.)

Printed at

Academy Press, 845/602 Daraganj, Prayagraj - 211006