Volume 3 : Issue 1 : April 2023

ISSN No: 2583-3146

Krishi Udyan Darpan

Innovative Sustainable Farming

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

ISSN No. 2583-3146

Krishi Udyan Darpan

(Innovative Sustainable Farming)

In This Issue

ISSN No. 2583-3146

ISSN No. 2583-3146

Sericulture Mulberry Cultivation

Jaya Sai Deepika Konda

Department of Entomology, SHUATS, Prayagraj

Corresponding Author: jayasaideepika1998@gmail.com

Introduction

Sericulture is an agro-based industry. It involves rearing of silkworms for the production of raw silk, which is the yarn obtained out of cocoons spun by certain species of insects. The major activities of sericulture comprises of food-plant cultivation to feed the silkworms which spin silk cocoons and reeling the cocoons for unwinding the silk filament for value added benefits such as processing and weaving.

Although there are several commercial species of silkworms, Bombyx mori is the most widely used and intensively studied. According to Confucian texts, the discovery of silk production by B. mori dates to about 2700 BC, although archaeological records point to silk cultivation as early as the Yangshao period (5000 – 10,000 BC). By the first half of the 1st century AD it had reached ancient Khotan and by AD 140 the practice had been established in India. Later it was introduced to Europe, the Mediterranean and other Asiatic countries. Sericulture has become one of the most important cottage industries in a number of countries like China, Japan, India, Korea, Brazil, Russia, Italy and France. Today, China and India are the two main producers, together manufacturing more 90% the world production each year.

The major benefit of sericulture, especially Tasar, is the employment generation to the people, especially in forest areas like tribal areas. Income from the forests leads to a sense of protection and conservation of areas.

Importance of Sericulture

a. High employment potential: About 60-100 lakhs persons are engaged in various sericulture activities in the country It is estimated that Sericulture can generate employment @ 11 man days per kg of raw silk production (in on-farm and off-farm activities) throughout the year. This potential is par-excellence and no other industry generates this kind of employment, especially in rural areas, hence, sericulture is used as a tool for rural economy upliftment. Provides vibrancy to village economies about 57 % of the gross value of silk fabrics flows back to the cocoon growers with share of income to different groups. 56.8 % to cocoon grower 6.8% to the reeler 9.1% to the twister 10.7% to the weaver 16.6% to the trade Thus a large chunk of income goes back to the villages from the cities.

b. Low Gestation: High Returns Mulberry takes only six months to grow for commencement of silkworm rearing. Mulberry once planted will go on supporting silkworm

rearing year after year for 15-20 years depending on inputs and management provided.

c. Five crops can be taken in one year under tropical conditions: By adopting a stipulated package of practices, a farmer can attain net income levels up to Rs. 50,000 per acre per annum. Hardworking farmers with proper maintenance and inputs can reach up to an income of 2 lakh per year from one acre.

d. Women friendly Occupation: Women constitute over 60% of those employed in down-stream activities of sericulture in the country. This is possible because sericulture activities starting from mulberry garden management, leaf harvesting and silkworm rearing is more effectively taken up by the women folk. Even the silk reeling industry, including, weaving, is 100% supported by them.

e. Ideal Program for Weaker Sections of the Society

f. Sericulture can be practiced even with very low land holding : One acre of mulberry garden and silkworm rearing can support a family of five without hiring labour.

g. Features such as low gestation: High returns make sericulture an ideal program for weaker sections of the society.

h. Vast tracts of forest based tasar food plantations available in the country, if judiciously exploited for rearing tasar silkworms, can offer supplementary gainful employment for tribal's.

i. Eco-friendly Activity

j. As a perennial crop with good foliage and root-spread, mulberry contributes to soil conservation and provides green cover. Waste from silkworm rearing can be recycled as inputs to the garden. Dried mulberry twigs and branches are used as fuel in place of firewood and therefore reduce the pressure on vegetation/forest.

k. Being a labour intensive and predominantly agro-based activity, involvement of smoke-emitting machinery is minimum.

l. Developmental programs, initiated for mulberry plantation are mainly in upland areas where un-used cultivable land is made productive.

m. Mulberry can also be cultivated as intercrop with numerous plantations.

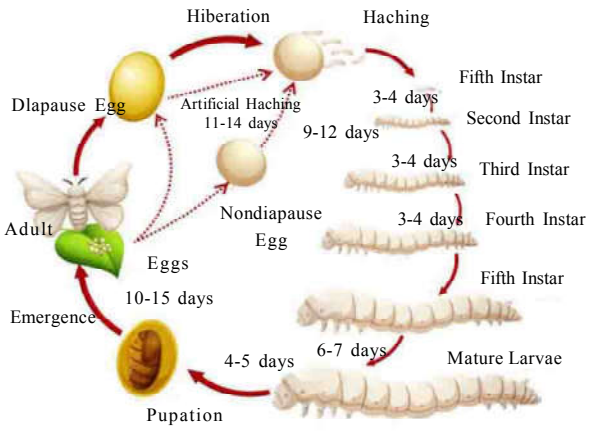
n. Mulberry being a deep-rooted perennial plant can be raised in vacant lands, hill slopes and watershed areas.

o. Currently, only about 0.1 % of the airable land in the country is under mulberry cultivation.

p. Satisfies Equity Concerns

Benefits of sectoral value-addition primarily accrue to rural households. As the end-product users are mostly from the higher economic groups, the money flows from high end groups to low end groups. Cases of landless families engaged in cocoon production using mulberry contracted from local farmers are common in some states. Mulberry farming is also done on community, government lands where the landless are given limited rights to cultivate mulberry.

Lifecycle of Silkworm



The life cycle of mulberry silkworm completes in 45-55 days consists of stages of egg, larva, pupa and moth. Egg stage is lasts for 9-10 days, the larval stage is 24-28 days, pupal stage 8-10 days and moth stages 3-4 days.

Silk Sericulture involves two steps

Step 1: Rearing the silkworm right from when it is in the egg and turns into a cocoon.

Step 2: Producing Mulberry trees to feed silkworms. Mulberry trees' leaves provide minerals, vitamins, amino acids, hydration and other nutrients a silkworm would need to produce larvae.

Silkworm and its types

There are various commercial species of silkworms; Bombyx mori (the caterpillar of the domestic silk moth) is a widely used and studied silkworm. Here are a few types of silk from commonly used silkworms

- Mulberry Silk from Bombyx Mori silk worm
- Tasar Silk from *Antheraea roylet* silkworm
- Eri or Arundi Silk from *Attacus ricini*
- Mina Silk from *Antheraea assama*

Types of Silk

- **Mulberry Silk from Bombyx Mori silkworm:** feeds on Mulberry and results in Mulberry Silk.
- **Tasar Silk from Antheraea Roylet silkworm:** which is feeds on oak and results in Tasar Silk.
- **Eri or Arundi Silk from Attacus Ricini:** feeds on castor and results in Eri Silk.
- **Mina Silk from Antheraea Assama:** Feeds on oak and other forest trees and results in Muga Silk.

Sericulture Industry in India: Silk Production in India

The Indian Sericulture market is expected to reach INR 1,032.8 Billion by 2027, showing a growth rate at a CAGR of 18.4% during 2022-2027. Also, the Sericulture market was evaluated at INR 376 Billion in 2021.

India claims to be the second largest producer of silk. India holds a market share of-

- 71.8% for the Mulberry Silk
- 9.9% for the Tasar Silk
- 17.8% for the Eri Silk
- 0.6% for the Muga Silk

Step-3: Process of Sericulture Farming

Sericulture is an agro-based industry that involves breeding, growing, and managing silkworms to get pure raw silk. Moreover, silk farming in India requires optical environment conditions and protection from pests, insects and diseases. Sericulture involves 3 dedicated steps as follows:

Moriculture

Moriculture is a process of growing and planting Mulberry trees that provides feed to silkworms. Also, these plants can be growing through cultivation from seeds, root or stem grafting. Stem grafting is a highly use method where the stem of a mature mulberry tree is extracted of about a length of approx 22 cm. Also, it is further planted or transplanted to the final location. Mulberry leaves are harvested either through picking manually, removing the entire branch or just shooting tops.

Silkworm Rearing

In this stage, the female silk moth lays the eggs. Silkworm farmers first rear the moths and store their eggs in a clean place under suitable conditions of warmth and humidity. A formalin solution is used to disinfect these eggs. Mulberry leaves are laid on a tray to feed hatched larvae through a process called brushing. Also, twigs are placed in the tray for which the caterpillars spin their cocoons over the next 3-7 days to obtain the silk fibre. When silkworms reach their maturity age, they appear translucent and shrunk. Also, to begin pupation, they wrap themselves in a cocoon via saliva released through their own saliva glands. When this saliva comes in contact with air, it becomes solidified and turns into silk.

Silk Reeling

The larvae inside a cocoon undergo metamorphosis and convert into pupae. Moreover, the pupae inside the cocoon are killed through dry heat and steam to disentangle the threads.

Once the insect inside the cocoons is killed during this process. Finally, the threads unwound from the cocoons by special machines during a process called reeling.

Silk rearing is the final stage when the silk is harvested by removing silk filaments from the dead cocoon. The resulting fibre is raw silk, which is then spun into silk threads woven into silk cloth and further colour.

Government Initiated Policies for Sericulture in India

The Ministry of Textile offers various initiatives that promote and support Sericulture in the Indian landscape. Also, here are a few of them regulate by the textile ministry:

Rashtriya Krishi Vikas Yojna (RKVY) provides benefits to improve the sericulture ecosystem, soil conditions, pest management, and silkworm seed base to boost sericulture cultivation.

The Central Silk Board Amendment Act 2006 releases rules and regulations that oversee the quality production of silkworm seeds or eggs.

Catalytic Development Programme on Sericulture (CDP) is a flagship program of the Central Silk Board. The program ensures the setting up of enterprises for seed production until processing. The programs also help create mulberry clusters, extend credit flow, and scale businesses in tribal and rural areas.

Forest Conservation Act allows farmers

to undertake Vanya rearing in their host plantation in forests.

Mulberry Cultivation

Mulberry (Morus spp., Moraceae) The important character of the members of the family Moraceae (especially Morus spp.) is the presence of idioblast, an enlarged epidermal cell in the leaf.

Ecological requirements

Climate

Mulberry can be grown upto 800 m MSL. For the optimum growth of mulberry and good sprouting of the buds, the mean atmospheric temperature should be in the range of 13°C to 37.7°C. The ideal temperature should be between 24 and 28°C with relative humidity of 65 to 80 percent and sun-shine duration of 5 to 12 hours per day.

Mulberry can be grown in a rainfall range of 600mm to 2500mm. Under low rainfall conditions, the growth is limited and requires supplemental irrigation. On an average, 50mm once in 10 days is considered ideal for mulberry.

Soil : Slightly acidic soils (6.2 to 6.8 pH) free from injurious salts are ideal for good growth of mulberry plants. Saline and alkaline soils are not preferred.

Mulberry varieties

Irrigated	:	Kanva 2, MR 2, S 30, S 36, S 54, DD (Viswa), V1
Semi irrigated	:	Kanva 2, MR 2
Rain fed	:	S 13, S 34, RFS 135, RFS 175, S 1635

Propagation of mulberry

- Mulberry is mostly propagated through cuttings.
- Cuttings may be planted straight away in the main field itself or nursery may be raised and the sprouted and rooted seedling may be planted in the main field.
- The latter method is advisable because of its easy establishment in the main field.

Selection of planting material

- Generally, the mulberry plants are raised from semi-hardwood cuttings.
- Cuttings are selected from a well established garden of 8-12 months old.
- Only full grown thick main stems, free from insect and disease damages having a diameter of 10-12mm are chosen for preparation of cuttings.
- The cuttings should be of 15-20 cm with 3-4 active buds and should have 45o slanting cut at the bottom end.
- Care should be taken to make a sharp clean cut at both the ends of cuttings without splitting the bark.
- Manually/power operated mulberry cutter (stem cutting machine) is available for quick cutting of propagation material.

Nursery

- Nursery bed preparation
- Select 800 sq m. area of red loamy soil

near water source for raising saplings for planting one hectare of main field.

- Apply 1600 kg of Farm Yard Manure (FYM) @ 20 t/ha and mix well with the soil.
- Raise nursery beds of 4m x 1.5m size.
- The length may be of convenient size depending upon the slope, irrigation source, etc.
- Provide a drainage channel and avoid shady area.

Pre-treatment of cuttings

- Mix one kilogram of Azospirillum culture in 40 liters of water.
- Keep the bottom end of the cuttings for 30 minutes in it before planting. Azospirillum is applied for inducement of early rooting.

Nursery planting

- Apply VAM @ 100 g/m^2 the of nursery area.
- Irrigate the nursery bed. Plant the cuttings in the nursery at 15 cm x 7 cm spacing at an angle of 45o.
- Ensure exposure of one active bud in each cutting.

Nursery management

- Irrigate the nursery once in three days.
- Dust one kg of any one of the following chemicals around the nursery bed to avoid termite attack.

a. Malathion 5 D

b. Quinalphos 1.5 D

To avoid root rot and collar rot, drench the soil with carbendazim 50 WP (2 g/l) or apply *Trichodermaviride* 0.5 g/m^2 using rose can.

After weeding, apply 100 g of urea/m^2 between 55 and 60 days after planting at the time of weeding.

Age of sapling

- The saplings are ready for transplanting in the main field after 90-120 days of planting.

Planting Methods

Paired row system: Plant the cuttings/ saplings at a spacing of 75 / 105 cm x 90 cm. Raise intercrops in the wider inter row space (amenable for mechanization also).

Planting method	Spacing (cm)	
	Irrigated	Rainfed
Ridges and furrows	60 x 60 / 90 x 90	90 x 90
Pit system	90 x 90	90 x 90

No. of cuttings / ha. - 27,780 (60 x 60 cm) ; 12,345 (90 x 90 cm)

Time of planting

- Plant during rainy season.
- Avoid planting during winter and summer months.

Planting of saplings

Plant the well rooted and sprouted saplings at a depth of 15-20 cm

- Earth up and level the area around the saplings
- Gap fill during monsoon months.

Nutrient management

a) Irrigated/semi irrigated (kg/ha)

	Row system			Pit system		
	N	P	K	N	P	K
Recommendation	300	120	120	280	120	120
Split doses						
First crop	60	60	60	60	60	60
Second crop	60	-	-	40	-	-
Third crop	60	60	60	40	-	-
Fourth crop	60	-	-	60	60	60
Fifth crop	60	-	-	40	-	-
Sixth crop	-	-	-	40	-	-

- For V1, fertilizer schedule is 375: 140: 140 kg NPK/ha.
- Apply fertilizers as per soil recommendation wherever possible.
- Apply the first dose of fertilizers three months after planting.
- Follow subsequent fertilizer application after each leaf harvest and pruning.
- Apply straight fertilizers to minimize the cost.

b) Rainfed (Kg/ha)

	N	P	K
Recommendation	100	50	50
First dose	50	50	50
Second dose	50	-	-

- Apply the first and second doses coinciding with South West and North East monsoons respectively.

Bio-fertilizers

- Apply *Azospirillum* @ 20 kg/ha in five split doses. Apply phosphobacteria@ 10 kg/h in two equal splits.
- Mix the bio-fertilizers with 50 kg of FYM for uniform distribution.
- Ensure irrigation after application.
- Do not mix bio-fertilizers with inorganic fertilizers.
- Growing and in situ incorporation of sunn hemp.

Micro nutrients

- Apply recommended major/secondary nutrients based on the deficiency symptoms.
- For micro nutrients according to the deficiency symptom expressed, apply micronutrients as foliar spray @ Zinc sulphate 5g, Ferrous sulphate 10 g, Borax 2.5g, Copper sulphate 2.5g, Manganese 2.5g or Sodium molybdate 100 mg/lit of water using high volume sprayer (spray fluid 500 lit/ha).
- Add wetting agent, Teepol @ 0.5 ml/lit. for better adherence on the foliage.

Methods of irrigation

Ridges and furrows method.

- Most efficient method of irrigation.
- Comparatively requires less amount of water.
- The furrows serve as drainage channels during heavy rainfall.

Flat bed method

- Rectangular beds and channels are formed.
- Water run off is relatively low.
- More land is wasted and requires more labour for field preparation.
- Most efficient in water use.
- Substantial saving in irrigation water.
- Better crop growth.
- Suitable for undulating terrains.
- Fertilizers can also be applied along with irrigation water.
- Clogging of emitters by physical, chemical and biological impurities.

ISSN No. 2583-3146

Weed Flora

The common weed flora in the mulberry garden is given below.

Botanical name	Tamil name	English name
A. MONOCOTYLEDONOUS WEEDS (Grassy weeds)		
Cyperus rotundus	Korai	Nut grass
Cynodondactylon	Arugampull	Bermuda grass
B. DICOTYLEDONOUS WEEDS (Broad leaves)		
Abutilon indicum	Thuthi	Velvet leaf
Amaranthus viridis	Kuppaikeerai	Pig weed
Acalypha indica	Kuppaimeni	Copper leaf
Boerhaevia diffusa	Mookirattai	Hog weed
Croton sparsiflorus	Milakai poondu	Croton
Parthenium hysterophorus	Vizhachedi	Carrot grass
Trianthema portulacastrum	Saranai	Carpet grass
Tridax procumbens	Manjapoo	Tridax

Integrated Weed Management of Cultural method

- Remove the stubbles and roots of weeds while preparing the land.
- Use well decomposed manure to avoid dissemination of weeds.
- Clean the implements before use.

Mechanical method

- Operate country plough after pruning in the interspace.
- Remove the weeds by hand hoe.

Chemical method

- As a post-emergence application, use Paraquat (Gramoxone) @ 2-3 lit/ha.
- Spray Glycel 7.5 ml with 10 grams of ammonium sulphate per litre of water as post-emergence application. A total of 600 litres of spray fluid is required/ ha.
- Use flooding / deflector / fan type nozzle for spraying weedicide. Apply the weedicide immediately after pruning or within 2-3 days after pruning.

Intercropping

Intercropping with short duration pulse crop enriches the soil, gives additional revenue and also controls the weed growth. Grow any one of the following crops / varieties as intercrop

Black gram	-	Co 5, VBN 1, VBN 3, VBN 4
Green gram	-	Co 5, Paiyur 1, Pusa bold, VBN 2, VRM 1, Co 6
Cowpea	-	Co 4, Co 5, Pusa 152

- Seed rate : 10 kg/ha
- Sow the intercrop after pruning and earthing up

Mulching

Mulching with pruned mulberry twigs and other materials like straw and dried leaves will have the following advantages

- Controls weed growth.
- Conserves soil moisture by reducing run-off.
- Increases the infiltration of water.
- Reduces the soil temperature.

Pruning Methods

i) Bottom pruning: The plants are cut at ground level leaving 10-15 cm stump above the ground. This type of pruning is done once in a year.

ii) Middle pruning: The branches are cut at 40-60 cm above the ground level. After bottom pruning, subsequent cuts are made at 45-50 cm height.

iii) Kolar or Strip system: In a closely planted area, this type of pruning is done. The branches are cut at ground level every time. Thus, it receives five prunings every year. This type of severe pruning requires heavy fertilization and irrigation.

Harvesting

The method of leaf harvest depends on the type of rearing practiced. It is preferable to harvest the leaves during morning hours. There are three methods of harvesting mulberry leaves.

Leaf picking

Individual leaves are harvested with or without petiole. Leaf picking starts 10 weeks after bottom pruning and subsequent pickings are done at an interval of 7 - 8 weeks.

Branch cutting

The entire branches are cut and fed to the worms. Before that, topping is done to ensure uniform maturity of the lower leaves. Whole shoot harvest

The branches are cut at ground level by bottom pruning. Shoots are harvested at an interval of 10-12 weeks and thus 5 to 6 harvests are made in a year.

Time of harvest: It is preferable to harvest the leaves during morning hours.

Preservation of leaves

Use leaf preservation chamber or wet gunny bags to store the leaves or cover the bamboo basket with wet gunny bags to keep it cool and fresh.

Conclusion

Rearing of silkworms is a commercially practicable activity and is dominating the industry worldwide. Due to the increasing lifestyle and income of individuals, Silk has great demand that is not going to be repressed soon. In addition, the Sericulture process is quite easy to approach by any individual looking to rearing Silkworms for commercial purposes or just for a hobby. The best thing about Sericulture or silk cultivation is the number of employment opportunities it brings, which is greater than any other farming type. And the process of sericulture is easy for anyone to start with, given initial knowledge and training.

References

- Altman, G. H., and Farrell, B. D. (2022). Sericulture as a sustainable agro industry. *Cleaner and Circular Bioeconomy*, 100011.
- Babu, K. M. (2018). Introduction to silk and sericulture. *Silk 2nd Edition, processing, properties, and applications. Cambridge: Woodhead Publishing*, 1-29.

- Bhat, M. A., Buhroo, Z. I., Aziz, A., Qadir, J., and Azam, M. (2020). An Overview of Current Scenario of Sericulture Industry in Jammu and Kashmir, India. *Int. J. Curr. Microbiol. App. Sci*, *9*(6), 3813-3824.
- Chanotra, S., Bali, K., and Bali, R. K. (2019). Sericulture: An opportunity for the up liftment of rural livelihood. *Journal of Entomology and Zoology Studies*, *7*(6), 1100-1103.
- Chauhan, T. P. S., and Tayal, M. K. (2017). Mulberry sericulture. In *Industrial entomology* (pp. 197-263). Springer, Singapore.
- Dewangan, S. K., Sahu, K. R., and Achari, K. V. (2011). Sericulture-A tool of eco-system checking through tribal. *Journal of Environmental Research and Development*, *6*(1), 165-173.
- Dhyani, S. K., Chauhan, D. S., Kumar, D., Kushwaha, V., andLepcha, S. T. (1996). Sericulture-based agro forestry systems for hilly areas of north-east India. *Agroforestry systems*, *34*(3), 247-258.
- Eswarappa, K. (2011). Developmental initiatives and sericulture in a South Indian village. *South Asia Research*, *31*(3), 213-229.
- Gangopadhyay, D. (2008). Sericulture industry in India–A review. *India Science and Technology (Online)*.
- Grzecœkowiak, J., £ochyñska, M., and Frankowski, J. (2022). Sericulture in Terms of Sustainable Development in Agriculture. *Problemy Ekorozwoju*, *17*(2).
- Horie, Y., and Watanabe, H. (1980). Recent advances in sericulture. *Annual Review of Entomology*, *25*(1), 49-71.
- Jalba, H. C. (2016). Scenario of sericulture industry in Maharashtra State, India. *Journal of Entomology and Zoology Studies*, *4*(1), 601-605.
- Kakoti, R. K. (2012). Sericulture as well as Ericulture as a Source of Employment and Income. *IJCAES Special Issue on Basic, Applied & Social Sciences, II*, 370-372.
- Klose, N. (1963). Sericulture in the United States. *Agricultural History*, *37*(4), 225-234.
- Prakasam, K., & Ravi, G. (1930). Sericulture–An Ideal Enterprise for Sustainable Income in Erode District of Tamil Nadu. *Language in India www. language inindia. com ISSN*, *2940*(14), 9.
- Qaxxorovich, N. Q., Juraevich, Y. N., Nozimjonovna, O. I., and Baxtiyorovna, N. B. (2021). The Perspective Directions for The Development Of Sericulture. *The American Journal of Engineering and Technology*, *3*(09), 24-27.
- Raina, S. K. (2001). *The economics of apiculture and sericulture modules for income generation in Africa*. Icipe Science Press.
- Sharma, K., and Kapoor, B. (2020). Sericulture as a profit-based industry—a review. *Indian Journal of Pure and Applied Biosciences*, *8*(4), 550-562.
- Shekar, P., and Hardingham, M. (1995). *Sericulture and silk production: A handbook*. Intermediate Technology Publications.
- Singh, R. N., and Saratchandra, B. (2002). An integrated approach in the pest management in sericulture. *International Journal of Industrial Entomology*, *5*(2), 141-151.
- Srinivasa, G., Rahmathulla, V. K., Vindhya, G. S., and Rajan, R. K. (2007). Training programmes in sericulture: their evaluation and impact on extension personnel and sericulturists. *Indian Journal of Sericulture*, *46*(1), 26-31.
- Srivastav, P. K., Thangavelu, K., andBaghel, S. S. (2005). *Sericulture and Seri-biodiversity* (Vol. 41). Associated Publishing.
- Ssemugenze, B., Esimu, J., Nagasha, J., and WanduiMasiga, C. (2021). Sericulture: Agro-Based Industry For Sustainable Socio-Economic Development: A Review.
- Takeda, S. (2009). Sericulture. In *Encyclopedia of Insects* (pp. 912-914). Academic Press.

❖❖

ISSN No. 2583-3146

Role of Seed Bio-priming in Plant Health Management

Valenta Kangjam

School of Agricultural Sciences and Rural Development (SASRD)

Nagaland University, Medziphema

Corresponding Author: kangjam.valenta59@gmail.com

Introduction

Seed bio-priming is a process of biological seed treatment that refers to a combination of seed hydration and inoculation of the seeds with beneficial micro-organisms. In most of the cases microbial inoculants such as plant growth-promoting rhizo-microorganisms (bacteria or fungi) are used for the purpose of bio-priming of seeds (Prabha *et al*., 2019).

Why seed bio-priming required : Crop productivity in India suffers heavy loss due to diseases under field and storage conditions and a majority of them are seed-borne and soil-borne in nature. Seed bio-priming is a suitable alternative to seed treatment because the microbes multiply continuously, occupy the growing root surfaces, form a bio-film around the roots and protect the plants from soil-borne plant pathogens throughout the crop-growing stages. It also improves seed viability, germination, vigour indices, plant growth and subsequent protection against diseases and finally enhances crop yield.

Advantages of seed bio-priming

Seed treatment has some advantages over other pest control or crop enhancement measures such as:

- More alternatives available to chemicals in an effective manner.
- Protection of seed during storage and after planting in soil.
- Reduction in initial inoculum.
- Minimize the environmental side effects *viz.* reduce risk to non-target organisms, no problem of drift and reduction in land surface exposed to active ingredients with maximum efficacy reduce the rate of application per hectare, thus decrease the cost of disease control per ha while achieving exceptional control of seed borne, soil borne and foliar diseases.
- Increase seed vigour which is the key of successful field emergence and establishment.
- Breaking of seed dormancy and improving emergence and plant stand.

Mechanisms of seed bio-priming

Bio-priming is directly involved in the enrichment of plant development by the excretion of compounds and mineral solubilisation (Sukanya *et al*., 2018). Phosphorus solubilising microorganism like *Bacillus, Beijerinckia, Enterobacter, Microbacterium*, *Pseudomonas* and *Serratia* release rock crystal dissolving compounds like organic anions, protons, hydroxyl ions, carbon dioxide or liberation of extracellular enzymes namely phosphatase leads to solubilisation of the phosphorus and make it obtainable to plant. Some PGPR used in bio-priming have the capacity to mobilize potassium from potassium-

bearing minerals (Mica, illite and Orthoclase) by emission of organic acids (citric acid, tartaric acid and oxalic acid) which directly dissolves the rock potassium or chelate the silicon ion. Siderophore production by bio control agents in primed seeds has inhibited the disease and improved the plant growth (Deshmukh *et al.,* 2020).

Types of Bio-inoculants used for bio-priming

a. Potential fungal bio-inoculants for bio-priming: Wide range of fungal bioagents through its novel interactions with plants has made it beneficial for alleviating biotic and abiotic stresses. *T.harzianum*is most widely used for bio-priming for its vast range of antagonism against plant pathogens, mainly fungi and nematode; increased plant growth especially roots particularly under stress; systemic resistance to abiotic plant stresses including drought, salt and temperature (Mansouri *et al*., 2010); decomposition of organic matter thereby increasing humic acid in soil; solubilisation and mobilization phosphorus; and increased nitrogen use efficiency and nutrient availability per cent. Symbiotic fungi, vesicular- arbuscular mycorrhiza (VAM), *viz*., *Acaulospora* sp., *Ambispora* sp., *Gigaspora* sp., *Glomus* sp., *Pacispora* sp., and *Paraglomus* sp., have shown significant influence on plant nutrient uptake, growth and colossal capacity to resist abiotic stress, especially drought situations; however, the success of establishing symbiotic interaction was limited through bio- priming,but recent reports suggest that inclusion of some bio stimulants has made it successful by increasing the occurrence of viable colonies and *percent* infection at early seedling growth stages.

b. Potential bacterial bioinoculants for bio-priming: Bacteria are the most abundant soil microbes and integral part in nutrient cycling for maintaining soil fertility. Beneficial bacteria in the rhizosphere are of two types: (a) bacteria forming symbiotic relationship through specialised structures and (b) free-living bacteria present in the vicinity of plant domain which are often known as Plant Growth-Promoting Rhizobacteria (PGPR). PGPR include a wide range of bacteria belonging to genera *Azotobacter*, *Arthrobacter*, *Agrobacterium*, *Azospirillum*, *Enterobacter*, *Streptomyces*, *Bacillus*, *Burkholderia*, *Klebsiella*, *Pseudomonas* and *Serratia*. Co-application of PGPR to seed via bio-priming improves plant performance under stress environments and consequently enhances yield both directly and indirectly. Some PGPR may exert a direct stimulation on plant growth and development by providing plants with fixed nutrients and phytohormones that have been sequestered by bacterial siderophores. Strains of *Rhizobium leguminosarum* by *viciae* confer tolerance to abiotic stress factors like drought and salinity by maintaining its capacity to nodulate and fix nitrogen in faba beans. In the rhizosphere the synergism between various bacterial genera such as *Bacillus, Pseudomonas* and *Rhizobium* are well demonstrated to promote plant growth and development. Compared to single inoculation, co-inoculation improved the absorption of nitrogen, phosphorus and other mineral nutrients by seed crop.

Application methods

Regardless of the organism used one of the important criteria for successful biological seed treatment is the method for their application. Biologically active bacteria are applied as cells to seeds, fungi as mycelial fragments, sexual or asexual spores to the seeds. Application methods are varied extend from bacterially inoculated peats for the introduction of Rhizobia onto seeds to simple slurry application containing biocontrol inoculum.

The method commonly recommended for bio-priming is to soak the seeds in water for 12 h. Selected formulated product of the micro-

Table- 1: Commercial formulations of biocontrol agents available in India.

Product	Bioagent	Use
Antagaon-TV	*T. viride*	As seed and soil treatment for control of *Rhizoctoniasolani* and *M. phaseolina*in pulses and vegetables.
Biocon	*T. viride*	Available in broth and dust used for control of root and stem disease in tea.
Bioderma	*T. viride*+ *T. harzianum*	Seed treatment against the fungal pathogens in vegetables and pulses.
BioGuard	*T. viride*	As seed and soil treatment of seed-borne diseases in vegetables and pulses.
Bioshield	*Pseudomonas fluorescens*	As seed, soil and seedling dip against fungal pathogens of cereals and pulses.
Biotak	*Bacillus subtilis*	Available in broth formulation and used for the control of black rot disease of tea.
Defence-SF *T. viride*	*T. viride*	As seed and soil treatment for control for different diseases in crops.

organism is added to pre-soaked seeds at the rate of 10 g/kg of seed and mixed well. The treated seeds can be taken in polythene bags, heaped and covered with a moist jute sack to maintain high humidity and maintained for 48 h at approximately 25–32 °C. During this period, the bioagent adhering to the seed grows on the seed surface to form a protective layer all around the seed coat. These bio-primed seeds can be sown in the nursery bed. Some studies have shown that bio-primed seeds can be safely stored for up to 2 months. Similarly, some workers have brought out that bio-priming along with osmo-priming (with NaCl) is more effective in improving seed invigoration and seedling growth.

Conclusion

Use of varied seed enhancement technologies are being developed and deployed for seed invigoration and biotic as well as abiotic stress management. Therefore, research programmes comprising of identification and genetic manipulations of novel biocontrol agents (fungal and bacterial strains) along with its commercial application needs to be devised. Additionally, various fungi have also been studied for their beneficial effects on plant.

References

- Deshmukh, A. J, Jaiman, R. S., Bambharolia, R. P. and Vijay A. Patil, 2020. Seed Bio-priming– A Review *International Journal of Economic Plants*, 7(1):038-043
- Harman, G. E. (2011). Multifunctional fungal plant synbionts: new tools to enhance plant growth and productivity. *New Phythopathology*. 189: 647-649.
- Prabha, R., Singh, D.P., Yadav, S.K., 2019. Seed bio-priming with potential microbial inoculants as sustainable options for stress management in crops. In: Singh, D., Prabha, R. (eds). Microbial Interventions in Agriculture and Environment. Springer, Singapore.
- Sukanya, V., Patel, R.M., Suthar, K.P., Singh, D., 2018. An Overview: Mechanism Involved in Bio-Priming Mediated Plant Growth Promotion. International Journal of Pure and Applied Bioscience 6, 771-783.

❖❖

ISSN No. 2583-3146

Medicinal Importance of Butter fly Pea (*Clitoria Ternatea*) in Human Health

Amit Lohar* and Abid Hayat

Department of Horticulture, Seacom Skills University

Corresponding Author : amitflori350@gmail.com

Introduction

Clitoria ternatea, commonly known as butterfly pea or blue pea, is a perennial herbaceous plant from the Fabaceae family. It probably originated in tropical Asia and spread all over the world like India, Sri Lanka, Malaysia, Philippine Islands, Australia, Indonesia, South Africa, Australia, and around countries in the Indian ocean. Due to its potential use in agriculture, modern medicine and as a source of natural food colourants and antioxidants, it has recently gained a lot of attention. It thrives in damp, neutral soil as a vine or creeper. The flowers of this plant have a striking deep blue colour that is solitary and marked with light yellow markings, up to around 4cm in length. Flowers showed a wide range of pharmacological activities including antimicrobial, antioxidant, anticancer, hypolipidemic, cardiovascular, central nervous, respiratory, immunological, anti-inflammatory, analgesic antipyretic and many other pharmacological effects. As long as human civilization has existed, many illnesses have been treated with medications and cosmetics made from plants. *Clitoria ternatea* is used for curing and infinite number of diseases in human being (Chauhan *et al*., 2012). The extracts of different parts of flower butterfly tea showed different efficacy against the tested microorganisms. These discrepancies could be attributed to the kind and concentration of antimicrobial compounds present in the extracts, as well as their mechanism of action on the various test bacteria. (Barbour *et al*., 2004).

Clitoria ternatea

Plant profile

Aparajita's botanical name is Clitoria ternatea and Fabaceae (*Pipilionaceae*) family

Common names: Blue ternate, Butterfly pea, Blue ternate, Bluebelvine, Cordofan pea

Biological uses of *Clitoria ternatea*

Plant parts used: Leaves, seeds, bark, fruits, sprouts and stems were used medicinally.

Traditional uses

Clitoria ternatea, also referred to as Aparajita in Bengali, is a popular Ayurvedic drug. The herb's leaf, root and shoot are all

used medicinally. In traditional Ayurvedic medicine, it has been used for centuries as a memory enhancer, nootropic, antistress, anxiolytic, antidepressant, anticonvulsant, tranquilizing and sedative agent (Mukherjee *et al*., 2008). These medicinal plants are gift of God, to cure various numbers of diseases in human beings and other living organism. They have been the major source of drugs in all system of medicine and other ancient systems in the world and especially it is prevent in the diseases such as chronic bronchitis, dropsy, goiter, leprosy, mucous disorders, sight weakness, skin diseases, sore throat and tumors (Ramaswamy *et al.,* 2011). Ascetics, abdominal visceral expansion, sore throats, and skin conditions were all treated with root. Children were given root as a general tonic for boosting mental abilities, physical stamina, and complexion tonics along with honey and ghee. And the roots were also used in epilepsy and insanity diseases. It was common practice to utilise seeds and leaves as a brain tonic and to enhance memory and intelligence. Snake bites were treated with juice and flowers. For sore joints, seeds were applied topically. For urinary issues, crushed seeds were ingested with cold or boiling water.

Chemical constituents

Importance chemical constituents are highly presence such as Taraxerol and taraxerone, pentacyclic triterpenoids and flavonol glycoside, 3,5,4'-trihydroxy-7-methoxyflavonol-3-O-β-d-xylopyranosyl-O-β-d-galactopyranosyl O-β-d-glucopyranoside are present in the root of CT. Kelemu *et al*., (2005) reported the presence of antimicrobial and insecticidal protein finotin in the seeds of CT. Ternatins A1-3, B1-4, C1-5 and D1-3 are found in CT flowers. Additionally, kaempferol, kaempferol 3-neohesperidoside, kaempferol 3-2G-rhamnosyl rutinoside and kaempferol 3-rutinoside are present in CT flowers.

Butterfly Pea Benefits

Butterfly pea flower has several health benefits. It has been consumed for centuries as memory enhancer, brain booster, anti-stress and calming agent. (Gupta *et al*., 2010)

Due to the excellent health benefits it offers, like aiding weight loss, cleansing the body, calming the mind, enhancing skin texture, and enhancing hair development, blue tea has been a hot culinary trend in recent years. Other benefits of butterfly pea are as below:

- **Fights against cancers:** Butterfly pea plants contain substances that have anticancer properties. Drinking blue butterfly pea tea might help prevent cancer. It enters the cancer cells and stops them from expanding.
- **Anti-inflammatory properties:** Consumption of blue butterfly pea tea can reduce swelling in the body. It can lessen headaches, migraines, and swelling brought on by cuts.
- **Lowers blood pressure:** Consumption of butterfly pea flower tea can help reduce blood pressure. This can be consumed by people who have hypertension, or high blood pressure.
- **It improves skin health:** Blue butterfly pea is rich in antioxidants. It can delay skin ageing, stop premature ageing, and enhance the overall tone and texture of the skin.
- **It improves hair health:** Butterfly pea nourishes hair follicles, promotes hair growth, reduces hair fall and slows down the greying of hair. Several shampoos, conditioners and other hair treatments use butterfly pea as a component.
- Blue butterfly pea tea's antioxidants can help relax stomach muscles, thereby improving digestion. Additionally, it has anthelmintic properties, which assist

stop the development of intestinal worms.

- **It helps to regulate the blood sugar levels:** Butterfly pea flower tea can help regulate the absorption of sugar into the bloodstream, thus regulating blood sugar levels. If taken along with the meds, the tea can help diabetic people.

Conclusion

Clitoria ternatea is both a wild herb and a medicinal plant. It has a wide range of medicinal uses in addition to its numerous traditional uses. Even certain incurable conditions including cancer, neurological disorders, nephrological disorders, hyperglycemia, urinary disorders, goitres, respiratory disorders, etc. can be treated with it. Therefore, it can be evaluated clinically for the efficacy and safety of *Clitoria ternatea* in various types of dementia.

References

- Chauhan N, Rajvaidhya S and Dudey BK (2012). Pharmacognostical, phytochemical and pharmacological review on *Clitoria ternatea* for antiasthmatic activity. *International Journal of Pharmaceutical and Sciences and Researches*, 3: 398-404.
- Barbour E, Sharif MA, Sagherian VK, Habre AN, Talhouk RS and Talhouk SN (2004). Screening of selected indigenous plants of Lebanon for antimicrobial activity. *Journal of Ethno pharmacology*, 93: 1-7.
- Gupta GK, Chahal J and Bhatia M (2010). *Clitoria ternatea* (L.): Old and new aspect
- Kelemu, S., Cardona, C and Segura, G (2005) Antimicrobial and insecticidal protein isolated from seeds of Clitoria ternatea, a tropical forage legume. *Plant Physiology and Biochemistry*, 42: 867-73
- More, P. M. and Hake, K. R (2019) Medicinal importance of *Clitoria ternatea*. *International Journal of Applied Research*. 5: 222-225
- Mukherjee PK, Kumar V, Kumar N S and Heinrich M (2008). The Ayurvedic medicine *Clitoria ternatea*-from traditional use to scientific assessment. *Journal of Ethnopharmacology*, 120: 291-301
- Ramaswamy V, Varghese N and Simon A (2011). An investigation on cytotoxic and antioxidant properties of *Clitoria ternatea*. *Journal of Drug Discovery*, 3: 74-77

❖❖

ISSN No. 2583-3146

Implement IPM Strategies to Manage Insect-Pests of Wheat in Punjab

Mandeep Pathania and Urvi Sharma*

Department of Entomology

PAU, Regional Research Station, Ballowal Saunkhri, Punjab

Corresponding Author: urvisharma01@pau.edu

Introduction

Wheat (*Triticum aestivum* L.) is a major cereal crop throughout the world, including India. The productivity of wheat is hampered by a variety of biotic and abiotic factors (Hussain *et al.,* 2021). Wheat crop is generally thought to have fewer insect-pest problems under the Indian field conditions. However, since the introduction of the rice-wheat cropping system insects such as aphids (*Rhopalosiphum maidis* (Fitch), *R. padi* (L.), *Sitobion avenae* (Fab.) and *S. miscanthi* (Takahashi)), pink stem borer *(Sesamia inferens* (Walker), and armyworm (*Mythimna separata* Walker), which were previously considered as minor pests of wheat, have been reported to cause serious crop damage. The other insect-pest that ravage wheat crop includes termites, *Odontotermes obesus* (Ramb); shoot fly, *Atherigona naqvii* (Steyskal); brown wheat mite, *Petrobia latens* (Muller) (Farooq *et al.,* 2019). These insect pests attack the wheat crop at various stages of crop development, thus causing damage and ultimately, yield reduction.

In Punjab, wheat constitutes to be the major *rabi* season crop. During 2020-21 the crop was cultivated on 35.30 lakh hectares with the production and productivity of 171.85 lakh tonnes and 19.70 quintals per acre, respectively (Anonymous, 2022). This article aims to identify important insect pest fauna of wheat and their crop damage, so that sustainable Integrated Pest Management (IPM) strategies can be implemented to reduce pest infestation and yield losses in the wheat crop.

The different insect pests infesting wheat crop in Punjab include pink stem borer, termites, aphids, armyworm, gram pod borer and brown mite. Out of these, pink stem borer and termites are the major insects which infest the wheat crop in seedling stage and are remain active at different stages of crop, thus a proper monitoring of the crop and adoption of Economic Threshold Levels (ETL) for the management of these insects is must for sustainable crop production.

Pink stem borer: The larva of the pink stem borer is damaging. After hatching it feeds in groups behind the leaf sheath by scrapping the epidermal layer which results in secretion of gummy substance and development of water soaked lesions on the affected leaf sheaths. After that it reaches the central growing point and starts feeding on unopened leaves in the whorl which results in formation of oblong holes of 2-3 mm size in parallel rows in the unfolded leaves. Infestation of the growing point of the shoot resulting in drying up and the formation of “dead heart” at seedling stage and “white ears” at ear head stage was observed.

Termites: The incidence of the termites in wheat fields appeared especially at seedling stage and also near maturity. The pest can

generally be observed feeding on roots or near the root zone of the damaged plants resulting in yellowing of leaves by withering and drying of plants which can be pulled out easily. During ear head stage, the damage of termites can be characterized by the appearance of chaffy ear heads with little or no grain formation. The damage is generally low in clay and black soils, high in sandy loam soils and severe in red soils.

Aphids: Aphids feed by sucking juices from the leaf and developing grains. A few aphids per plant do not cause a problem, but under severe circumstances, ample water and nutrients can be removed to effect yield. Wheat aphids generally feed on leaves and earhead and while feeding, these aphids' secrets a toxin known as honey dew that causes leaf discoloration and plant distortion. Heavily infested plants show head stunting and poorly formed grains or no grains at all.

Army worm

The damaging stage of the insect is larvae which usually attack wheat during March-April, however it is also observed in the month of December in fields having large loads of paddy straw. It damages leaves and earheads. Though it is designated as a minor pest in Punjab but under favourable conditions it may cause economic losses to wheat growers.

The other minor insects infesting wheat crop in Punjab are gram pod borer and brown mite. The larva of gram pod borer feeds on developing grains in wheat and the incidence can be seen in places where cotton-wheat cropping rotation is followed, whereas, the incidence of brown mite can be seen in wheat as discoloration of wheat leaves and the incidence can be more prominent in crop grown under rainfed conditions.

Integrated Pest Management

Management of insect-pests need focused integrated approach around the year. Keeping in consideration the biology and nature of damage of these insects the following points may be considered for implementing IPM strategies:

Field sanitation and clean cultivation: Following points should be kept in consideration while practicing wheat cultivation:

a. Proper management/ destruction of residue after harvesting of paddy crop and field sanitation will help in reducing the inoculum/carryover of pink stem borer to wheat crop.

b. The farmers are advised to avoid early sowing of wheat where paddy fields are severely infested with pink stem borer.

c. Control of weeds in/ near the farm all year round helps in delaying the initial infestation of insects.

d. Surveillance and monitoring of the crop for insect-pest infestation at weekly intervals should be practised.

e. Irrigation of the fields should be done during day time to maximize predation of insects by the birds.

f. Termites cause more damage in sandy soil thus irrigating the affected field's result in suppressing termite infestation to some extent.

g. Avoid higher doses of nitrogenous fertilizers to avoid damage by aphids.

h. A coordinated approach for the effective management of insect-pests should be followed at community level. The approach may include tight planting windows, weed management, conservation of natural enemies, delay in use of disruptive insecticides and stress on botanicals to control the initial build-up of insects.

Management of insects using pesticides: Follow up of Economic Threshold Levels (ETL) for application of insecticide against different insects and use of

recommended insecticides at prescribed dosages in alternation will be extremely beneficial while planning management strategies. By following ETLs we are able to minimize the number of sprays/chemicals as well as it helps in delaying the development of resistance. Do not repeat applications of the same insecticides or the products with the same mode of action.

The economic threshold level of 5 aphids per earheads (recorded from 10 randomly selected ear heads in each of the 4 quarters of one acre field) should be followed for spraying of insecticides. Insecticides should be applied only if the aphid attack appears on ear head stage. Since the aphids appear first on borders of the crop, spray only the infested strip to check their further spread. For better effectiveness of the insecticide, spraying should be done in the evening when armyworm larvae are more active.

For proper coverage the spray application of insecticides in wheat should be done by using 80- 100 litres of water per acre with knap sack sprayer or 30 litres of water per acre with power sprayer. Always follow directions given in the pesticide labels. Knowledge of the registered products against these insects will help to improve the management decisions.

Insecticides recommended by PAU, Ludhiana for the management of different insect-pests in wheat

Insecticide	Dosage	Brands
Seed treatment for termites		
Thiamethoxam	40 g/40 kg seed	Cruiser 70 WS
Chlorpyriphos	160 ml/40 kg seed	Dursban/Ruban/Durmet 20 EC
Imidacloprid + Hexaconazole	80 ml/40 kg seed	Neonix 20 FS
Broadcasting of insecticides by mixing with 20 kg of moist sand before first irrigation for the management of termites, pink stem borer and army worm		
Fipronil	7 kg/acre	Mortel 0.3 G
Chlorpyriphos	1.2 litre/acre	Dursban 20 EC
Spray application of insecticides:		
Aphids		
Thiamethoxam	40 g/acre	Actara/Taiyo 25 WG
*PAU homemade neem extract	2 litre/acre	2 sprays at weekly interval
Pink stem borer		
Chlorantraniliprole	50 ml/acre	Coragen 18.5 SC
Army worm		
Chlorantraniliprole	40 ml/acre	Coragen 18.5 SC
Quinalphos	400 ml/acre	Ekalux 50 EC
Gram pod borer		
Quinalphos	800 ml/acre	Ekalux50 EC

***Method of preparation of Neem extract:** Boil 4.0 kg terminal parts of the shoots of Neem trees (including leaves, green branches and fruits) in 10 litres of water for 30 minutes. Then, filter this material through muslin cloth and use the filtrate for spraying at the recommended dose.

Symptoms of termite infestation in wheat

Aphids infestation in wheat earhead

Conclusion

The major insect-pest infestations encountered in wheat under Punjab conditions includes the attack of termites, pink stem borer, aphid and armyworm. Proper field sanitation and timely sowing of wheat is recommended for avoiding the infestation of pink stem borer. Seed treatment with recommended insecticides delays the attack and prevents seedling damage by termites. Also, irrigating the fields under dry conditions especially in sandy soils reduces termite damage. The PAU homemade Neem extract @2litre/acre is advised as foliar spray at weekly intervals as soon as the aphid attack is witnessed. Further, the insect population is scouted regularly for making a vigil on ETL and the spray of recommended insecticides is done at this stage to check the damage caused by various insect-pests.

References

- Annonymous, 2022. Package and Practices for Crops of Punjab, Rabi 2022-23. pp.1
- Farook UB, Khan ZH, Ahad I, Maqbool S, Yaqoob M, Rafieq I, Rehman SA and Sultan N. A review on insect pest complex of wheat (*Triticum aestivum* L.). Journal of Entomology and Zoology Studies 2019; 7(1): 1292-1298.
- Hussain, D., Asrar, M., Khalid, B. et al. Insect pests of economic importance attacking wheat crop (*Triticum aestivum* L.) in Punjab, Pakistan. *Int J Trop Insect Sci* 42, 9–20 (2022). https://doi.org/10.1007/s42690-021-00574-9

❖❖

ISSN No. 2583-3146

Seed Priming: New era for Seed Germination

M. Veeraragavan[1*] and R. Ranjith[2]

[1]Department of Plant Biochemistry, MTCA, TNAU, TN

[2]Department of Agronomy, TRRI, TNAU, Aduthurai

Corresponding Authors: veerabio1981@gmail.com

Introduction

Seed priming is a pre-seeding treatment that advances to the physiological state responsible for more efficient seed germination. It can also be defined as a seed treatment method that regulates germination by managing seed temperature and humidity. Seed priming is a very promising, effective and inexpensive approach to increase germination, growth, as well as crop yield and productivity. Seed primers are used not only to improve the yield and growth properties of plants, but also to increase various stress tolerances.

During subsequent germination, primed seeds exhibit a faster and more synchronized germination and young seedlings are often more vigorous and resistant to abiotic stresses than seedlings obtained from un-primed seeds. Regular crop establishment can be helped by improved and uniform seedling emergence. Priming can improve processes that occur at the start of germination, but the entire process is halted at a specific point, which is the same for all the seeds involved. Priming can also cause structural and ultra-structural changes in the seeds, facilitating subsequent water uptake and reducing initial discrepancies in imbibition, resulting in more uniform germination. Most seed treatments depend on the penetration characteristics of the seed allowing the seed to pass the first reversible germination stage but not allowing radical protrusion through the seed coat. Priming usually involves soaking the seeds in a pre-set amount of water or limiting the soaking time.

Objectives of seed priming

- Priming is planned by focusing on the following objectives.
- To decrease the time of germination.
- To enhance the speed and uniformity of germination.
- To eradicate or greatly reduce the number of seed-borne fungi.
- To improve tolerance towards water and temperature stress.
- To increase the shelf life of seed.
- To enhance the crop yield.

Mechanism of priming

Seed germination is a complicated process involving different metabolic events which result in change from stored food reserve to activation phase where radicle and plumule emerges. In general, the seeds intake water by undergoing three phases. First phase is called as an Imbibition phase, which involves quick water uptake through forces driven by seeds. In this phase, there are changes occurring such as metabolic activities and translation processes taking place whereas DNA and mitochondria are repaired. Second phase is the lag phase where there is less

water uptake resulting in a minor increase in fresh weight of seeds. This phase is also called as Activation phase as this period is highly active physiologically and metabolically. It helps in maturation of mitochondria (causing ATP synthesis), protein synthesis from new mRNAs and mobilizing stored macromolecules into molecules required for radicle outgrowth. The third phase is germination phase. In this phase, germination is completed and seedling growth starts by recommencement of radicle and quick water uptake. In priming, first and second phase occurs, not allowing seeds to enter phase III. Phase II initially occurs for longer time for performing processes and prevents phase III. So, in primed seeds lag phase is reduced as preparation for phase III is not required, which is already done. Due to this, different benefits are imposed in seeds such as synchronisation of radicle emergence, increase in growth rate and enhancing large number of seeds to germinate. During priming, seeds already complete first two phases of germination, so on sowing; these seeds have the ability to complete the process faster (imbibition) once it is provided with water. This reduces the time required for cellular activities to take place. DNA content increases due to activation and/or synthesis of enzymes of nucleic acid, ultimately increasing total RNA amount and proteins. It also heals the damage caused to cell membrane during storage/drying.

Physiological and biochemical changes in seeds on priming

Priming leads to different biochemical and physiological changes in seeds. It synchronizes germination after breaking dormancy, diminishes the lag time required for imbibition, hydrolyses or metabolises inhibitors, activates enzymes, mobilises reserved food and enhances embryonic tissue outgrowth. Starch metabolism is of great importance during seed metabolism which influences seedling vigour under stress. This metabolism is brought about by á-amylases which hydrolyse the starch reserves into metabolisable sugars providing energy to the developing embryo. Seed priming enhances á-amylase and dehydrogenase activity that could hydrolyse the starch macromolecules into smaller and simple sugars with increased ATP production and respiration. Phytase, amylase, and protease also increase during this process. Likewise [2] have shown increased activity of á-amylase in primed barley seeds by 2.8 times, whereas in primed wheat seeds activity was increased by 2.7 times compared to unprimed seeds. This might have led to enhanced germination events in primed seeds. Priming also helps in improving function of malate synthase and isocitrate lyase which converts lipids into carbohydrates whereas antioxidant enzymes (POD, SOD, CAT and GR) that scavenge ROS (Reactive Oxygen Species). Thus, protecting the seeds from lipid peroxidation and oxidative damage of membrane phospholipids rendering seed longevity. There are also reports of proline accumulation and glycine production in primed rice seedlings acting as an osmotic agent, radical scavenger and increasing GSH synthesis respectively, thus protecting the plants from oxidative damage of cold stress. â mannanases activity has been increased on priming which weakens endosperm layer and allows radicle to emerge, therefore breaking thermo dormancy. Priming also maintains cell division and structure (cytoskeleton) by abundant synthesis of alpha and beta tubulin subunits.

Methods of priming

Now a days different priming techniques are developing to provide better seed quality such as hydro-priming, osmo-priming, matrix priming, halopriming, osmo hardening, hormone or growth enhancer priming, micronutrient seed priming (Nutri priming), biopriming or seed treatment with micro-organisms, e.g.,

Pseudomonas aureofaciens, Trichoderma spp. etc., and nanoparticle priming or coating seeds with nanoparticles (NPs). Each crop requires specific and optimised priming technique.

a. Hydro-priming: The simplest method of seed priming, which relies on soaking of seeds in pure water and dry them to their original moisture content before sowing. No additional chemicals are used as a primer, so this method is inexpensive and environmentally friendly. The main disadvantage of hydropriming is uncontrolled water uptake by seeds. This is a consequence of free water availability to seeds during hydropriming, so that the rate of water uptake depends only on seed tissue affinity to water. Moreover, this technique may result in unequal degree of seeds hydration thus leading to lack of simultaneous metabolic activation within seeds followed by unsynchronized emergence. Considering these limiting factors, it is highly important to define accurate treatment duration, temperature and water volume used in hydropriming to ensure desired level of seed hydration and to prevent radicle protrusion. Hydro primed seeds showed maximum results suggesting that ion accumulation in the seed has no toxic effect on the embryo. This treatment thus can be used to increase tolerance in drought conditions and enhance growth leading to environment-friendly techniques for improving crop yield.

b. Osmo-priming: This involves soaking of seeds in an osmotic solution of low water potential instead of pure water. Due to the low water potential of osmotic solution, water slowly penetrates into the seeds, which allows the seeds to gradually soak in and to trigger the early stages of germination, but prevents the radicle protrusion. Various compounds are used in the permeation process, including Polyethylene Glycol (PEG), mannitol, sorbitol, glycerol and inorganic salts such as NaCl, KCl, KNO_3, KH_2PO_4, $MgSO_4$ and $CaCl_2$. PEG being inert in nature and able to maintain uniform water potential may be involved in imbibing water rapidly, reviving seed metabolism, increasing germination rate and reducing inherent physiological heterogeneity in germination.

c. Solid matrix priming: Solid matrix priming is a process in which water uptake by seeds is controlled and has been developed as an alternative method to osmo-priming because of the high cost of osmotic agents and technical problems with aeration. During solid matrix priming, seeds are mixed and incubated with a wet solid water carrier for a certain period. Afterward, seeds are separated from matrix, rinsed and back-dried. The use of solid medium allows the seeds to hydrate slowly and simulates natural imbibition process occurring in the soil. To successfully accomplish SMP, materials utilized as matrices should possess specific physical and chemical features such as low matrix potential, minimal water solubility, high water holding capacity and surface area, no toxicity to seeds, and ability to adhere to seed surface. In fact, vermiculite, peat moss, charcoals and clay and some commercially offered substrate such as Celie or Micro Cell are exemplary solid carries applied in solid matrix priming. In order to obtain the best priming performance, time of treatment and optimal water content must be determined separately for each matrix.

d. Halo-priming: Halo-priming is a technique which involves submerging seeds in solutions of inorganic salts viz. sodium chloride, potassium chloride, potassium nitrate, calcium chloride etc. Some of these salt solutions may exert direct or indirect nutritional effects. Primed seeds increased seed germination, sturdy seedlings and produced a large quantity of plants/unit area. However, there was a decrease in germination percentage and seedling appearance in seeds (both treated and untreated) as NaCl salinity increased, but in

primed seeds, the decrease was less. Priming might have enabled the seeds to absorb water effectively, homogenise germination in less time, lead to earlier metabolic activities in seed germination and could also stimulate enhanced germination via cell division, ultimately enhancing growth in plants. It might have reduced the negative impact of salt stress leading to improved weight of shoots and roots. Its tolerance to salinity by enhancing K+ and Ca_2+ accumulation, reducing Na+ accumulation and efficient osmosis regulation due to organic solutes like proline accumulation in primed seeds.

e. Hormo-priming: During hormo priming, seed imbibition occurs in the presence of plant growth regulators, which have a direct effect on seed metabolism. The following regulators like abscisic acid, auxins, gibberellins, kinetin, ethylene, polyamines and Salicylic Acid (SA) are commonly used for hormo priming.

f. Bio-priming: Bio-priming was first described by Callan and Co-workers in 1990 for the biological management of Pythium pre-emergence in sh2 sweet corn. Bio-priming involves seed imbibition together with bacterial inoculation of seed, increases the rate and uniformity of germination, but additionally protects seeds against the soil and seed-borne pathogens. It was found that bio priming is a much more effective approach to disease management than other techniques such as pelleting and film coating. Now a days, the use of bio-priming with Plant Growth-Promoting Bacteria (PGPB) as an integral component of agricultural practice shows great promise. In pearl millet, bio priming with Pseudomonas fluorescens isolates enhanced plant growth and resistance against downy mildew disease. Bio priming with rhizobacteria improved germination parameters of radish seeds under saline conditions.

g. Chemical-priming: It refers to the treatment of seeds with various chemical solutions used as a primer. This approach includes priming with a variety of natural and synthetic compounds such as antioxidants (ascorbic acid, glutathione, tocopherol, melatonin and proline), hydrogen peroxide, sodium nitroprusside, urea, thiourea, mannose, selenium, chitosan, etc.

h. Nutri-priming: Nutri-priming is a technique in which seeds are soaked with a solution containing limited nutrients instead of purified water. The idea of this method is to obtain nutritional efficiency as well as biochemical benefits from priming to improve seed quality, germination parameters and seedling establishment. Seed priming with Zn improved yield of chick pea and wheat, early germination and growth of rice, development and root growth of maize when exposed to low rhizosphere temperatures, while K priming has a favourable effect on the growth and nutritional status of cotton plans under saline conditions. Several nutrient priming techniques are commonly used by seed companies during seed production and preparation for growers. One such method, Broad Spectrum Nutrient (BSN) seed priming, which is based on immersing seeds in a mixture of minerals, such as zinc, copper, manganese, molybdenum and phosphorus, which has been proved to fertilize the seeds and provide the nutrients for early growth, which positively affects germination, seedling vigour and root system development.

i. Nano-priming: Nano-priming, a technique based on a combination of seed priming and nano particle treatment, has been an effective tool for improving seed quality, seedling establishment and crop productivity as well as increasing tolerance to environmental stresses. It is a new method of seed priming with nano particles (NPs) such as zinc oxide, iron oxide, titanium dioxide, silver nano particles etc., them as they get drained

away or are broken down by exposure to light and water. Nano particulate material/nutrient delivery to plants provide adequate and restricted use of nutrients/ macromolecules at a specific site required for enhancing plant growth.

Beneficial effects of priming

- Priming exhibits uniform and faster germination rate, seedling vigour and crop establishment under adverse conditions.
- Priming overcomes thermodormancy. High temperatures (35°C) inhibit accumulation of free amino acids and esterase activity required for radicle protrusion, which can be reversed by seed priming with kinetin leading to germination.
- Seed priming of different crops can alleviate the adverse effects caused by stress (drought and salt) and enhance crop yield.
- It reduces the soil-borne destructive diseases.
- Priming also enhances viability of low vigour seeds.
- Seed deterioration occurs by the formation of free radicals which are generated on peroxidation of unsaturated membranous fatty acids leading to harmful effects on cell membranes and related subcellular components by accelerated aging.

Limitations of seed priming

However, there are still certain drawbacks of priming technique. The extended seed treatment during priming may result in seed desiccation tolerance loss, which lowers seed viability. Similarly, all priming techniques may not result in considerable germination and growth if the priming circumstances are improper, causing the protective proteins to degrade.

Conclusion

All priming methods lead to relevant changes in crop biomechanics by reducing salinity stress, heavy metal pollution and flood stress and improving tolerance to cold, heat and drought. We strongly recommend that the combination of multiple priming (hybrid) methods provide new technologies and additional beneficial biological approaches to advance knowledge of seed priming and crop plant science. It should be said that seed priming can be used as an important strategy to increase crop yields under stress-tolerant environments and to meet global food demand. Therefore, substantial research is needed to determine the best priming technique for diverse plants in terms of germination and growth under varied climatic circumstances.

❖❖

ISSN No. 2583-3146

Remote Sensing: A Modern Technology in Agriculture

Tushar Kothal[1*] and Garima Kaushik Parashar[2]

[1]Department of Agriculture, GRD-IMT College, Dehradun

[2]Department of Agronomy, Shri Guru Ram Rai University, Dehradun

Corresponding Author: garimakaushik1991@gmail.com

Introduction

Remote sensing is a wireless modern technology; generally this technology is used to obtain information about objects or areas from a distance, typically from satellites. Remote sensing plays an important role to detecting in and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the satellite. In remote sensing systems, special designed cameras are used to collect remotely sensed images, which help scientists and researchers to do deep study about that sensed images. Remote sensing is also counted the fastest technology, because this system gives any geographical data and information within a second.

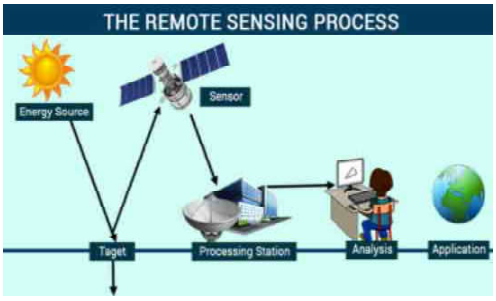
This technology is widely used in agriculture sector, to timely monitoring and providing accurate pictures and data of agriculture sector

Remote sensing and GIS in Agriculture

Remote sensing in Agriculture

Remote sensing systems plays a vital role in the agriculture sector, as this technology is a modern and fastest one, so it saves lots of time for farmers. Remote sensing system help Agronomical researcher as it help to give information about:

- Crop monitoring
- Yield assessment
- Crop classification
- Detect soil moisture
- Detect soil stress condition
- Detection of upcoming natural calamities (Flooding, Earthquake, Heavy rainfall)
- Help to detect upcoming insects, pests, and diseases, so that farmers can take action accordingly.
- Land assessment can also be done by using G.I.S technology.



Types of Sensors used in remote sensing

- RADAR
- Gravimeter
- Spectrometer
- Microwave radiometer
- Special cameras
- Optical mechanical scanner
- Solid scanner
- Later water depth meter
- Satellite sensor
- Laser distance meter

Types of Remote Sensing System

- Visual Remote sensing system
- Optical Remote sensing system
- Infrared Remote sensing system
- Microwave Remote sensing system
- Satellite Remote sensing system
- Airborne Remote sensing system

The Sensors that Enable Precision Agriculture

Application of remote sensing

- Crop Identification
- Weather forecasting
- Used for crop production forecasting
- To detect crop diseases, insects and pests.
- Detecting the crop progress and damaging symptoms.
- Detecting yield assessment.
- Used for preparing soil mapping.
- Used for yield modeling
- Detecting extreme drought and wet conditions.
- Prepare land mapping
- Drone images are used to detect crop damage.
- To analyze of Horticulture cropping system.
- To identify the planting and harvesting time.
- Detection of soil moisture and soil estimation.
- Monitoring and identification of irrigation time and management.
- To prepare mapping of degraded land or barren land.
- Identification of problematic soil and their reclamation.
- Detection of nutrient deficiency in crops.
- Preparing Flood mapping and monitoring.
- To collect past and current data of Farmland and weather.
- To identify crop intensity
- Help in precision farming
- Climate change monitoring
- Detection of air moisture
- Identifying and reporting crop health status.

Disadvantages of Remote sensing system

- Initial investment is high to build and operate.
- It is affected by weather conditions like heavy rainfall.
- Farmers have to be more knowledge-full and attached with technologies to operate Remote sensing systems.
- Data interpretation can be difficult.

- Remote sensing systems need proper electronic gadgets to run this technology.
- It reflects human errors, because the working of this technology is depend on humans.
- Might be a chance of image and data errors, because at a time of image and data mapping it is interfered by other phenomenon in result it give error data and images.
- The information collected by remote sensing, it might be incomplete and temporary.
- Large scale engineering maps cannot be prepared from satellites.

Conclusion

Remote sensing is an important and advanced technology, which gives an accurate data of various biotic and abiotic problems in crops and also gives an idea of management of different crop issues. For the effective utilization of crop information through remote sensing there is a need to start remote sensing at state or district level information system. The government also uses this technology to make decisions about different policies and how to overcome from agricultural related problems. Though application of remote sensing has a huge scope in agriculture science for higher production, crop assessment, yield estimation under the context of climate change.

References

- Das, D. K. and Singh, G. (1989). Estimation of evapotranspiration and scheduling irrigation using remote sensing techniques. Proc. Summer Inst. On agricultural remote sensing in monitoring crop growth and productivity, IARI, New Delhi, pp.113-17.
- Menon, A.R.R. (2012). Remote sensing applications in agriculture and forestry. A paper from the proceedings of the Kerala environment congress, pp. 222-235.
- P. Shanmugapriya*, S. Rathika, T. Ramesh and P. JanakiInternational Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 8 Number 01 (2019) Journal homepage: http://www.ijcmas.com. https://doi.org/10.20546/ijcmas.2019.801.238
- **https://doi.org/10.1111/j.1751-5823.2005.tb00155.x**

❖❖

ISSN No. 2583-3146

Dragon Fruit Cultivation in Different Types of Soil: Problems and their Management

Soumyashree Mansingh[1] and Abhilash Padhan[2*]

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

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

Corresponding Author: fruitbreederabhilash9020@gmail.com

Introduction

Dragon fruit (Order: Caryophyllales; Family: Cactaceae; Genus: Hylocereus and Stenocereus) is an herbaceous perennial climbing cactus, widely known as Red Pitaya/ Strawberry Pear/ Noblewoman/ Queen of the night, throughout the world, has recently drawn much attention among the Indian growers, not only because of its attractive red or pink colour and economic value as fruit, but also valued for its high antioxidant potential, vitamins and minerals content. Being a native of Southern Mexico, Guatemala and Costa Rica, Dragon fruit was introduced in India during the late 90's and still the area under its cultivation is gradually increasing. Farmers in the Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands have already taken up their cultivation and the estimated total area under Dragon fruit cultivation in these regions may be less than 400 ha (G. Karunakaran, 2019). Dragon fruit production is ideally suited in the dry, frost-free agro-climatic zones of Southern, Western and North Eastern India because it's a member of the cactus family and needs lengthy days for flowering. Due to the significant demand for Dragon fruit on both the local and international markets, growing them might be a profitable side business for both small scale home gardeners as well as business owners of medium and large scale plantations. There are numerous success stories of farmers from various regions of India who have already started growing Dragon fruit. For the purpose of raising Dragon fruit planting material, many nurserymen began propagation. The red hue epicarp with white and pink pulped sub-sweet juicy pulp matrix is one of the varieties of dragon fruit that is most frequently cultivated and sold. It is a perennial fruit crop that yields quickly, beginning to produce profitably the first year after planting and reaching its maximum potential in three to five years. Additionally, it was found to produce in its first few years of living there, provided that good cultural management techniques are used. Despite the relatively hefty initial investment, there is a sizable profit after four to five years (G. Karunakaran, 2019). In India, commercial cultivation of this fruit is picking up and the market price of this fruit is 200 to 250 Rs/kg. (Jagdish, 2018). Its cultivation is excellent where less rainfall is expected. The fruit is treated as an ornamental plant as well as fruit producing plant. It is consumed as fresh fruit or processed products such as jam, jelly, ice cream, fruit juice and wine. Dragon fruit contains small amounts of several nutrients. It's also a decent source of iron, magnesium and fibre.

Nutritional Value of Dragon Fruit

The nutritional composition of Dragon fruit is given in the table below:

Nutrient	Amount per 100g	% Daily Value	Comment
Water	87 g	NA	Very high-water content
Protein	1.1 g	2.1	
Fat	0.4 g	NA	Contains practically no fat
Fibre	3 g	3.4	Very good source of dietary fibre
Carbohydrates	11 g	12	
Vitamin B1 (Thiamine)	0.04 mg	2.7	
Vitamin B2 (Riboflavin)	0.05 mg	2.9	
Vitamin B3 (Niacin)	0.16 mg	0.8	
Vitamin C (Ascorbic Acid)	20.5 mg	34.2	Contains more than 3 times the amount of vitamin C found in carrot
Calcium (Ca)	8.5 mg	0.9	
Iron (Fe)	1.9 mg	10.6	A good source of iron
Phosphorus (P)	22.5 mg	2.3	
Zinc (Zn)	NA	NA	

(Source: https://www.healwithfood.org)(Thokchom, 2019)

Varieties

There are four main types of Dragon fruit based on its flesh and skin color.

Sl No.	Skin Color	Flesh Color	Species
1	Pink	White	*Hylocereus undatus*
2	Red	Red	*Hylocereus polyrhizus*
3	Red	Purple	*Hylocereus costaricencis*
4	Yellow	White	*Hylocereus selenicereus*

Pink skin with white flesh

(Hylocereus undatus)

Red skin with red flesh

(Hylocereus polyrhizus)

Red skin with purple flesh
(Hylocereus Costaricensis)

Yellow skin with white flesh
(Hylocereus Selenicereus)

Soil Requirement for Dragon Fruit Cultivation

Dragon fruit plant survives in poor soil condition and temperature variations and it requires a minimum annual rainfall of 50cm. The fruit can be grown on almost any soil however sandy soils that have good irrigation are generally preferred. The pH of the soil should be between 5.5 to 6.5 for better growth and development and the beds should be at least 40-50 cm high (Tripathy, 2021).

Best Soil for Dragon Fruit

The optimal soil for growing Dragon fruit is one that drains well, is nutrient-rich, has a decent percentage of loamy sand and has organic matter for some water and nutrient retention. Because Dragon fruit is a cactus, it completely detests "wet feet" and will suffer in soggy, damp soils; however, very sandy soils dry up too rapidly and are also poor at retaining nutrients. Growing Dragon fruit in very sandy soil will require more frequent watering and fertilizing. Land should be ploughed till soil achieves the fine tilth and weed free. As part of land/ field preparation apply any organic compost in a proportionate ratio (Jagdish, 2018).

Ideal Soil pH for Dragon Fruit

With a pH of 6 to 7, neutral or slightly acidic soil is ideal for Dragon fruit growth. Dragon fruit may grow in a variety of pH conditions, but anything that is too acidic or too alkaline will limit the amount of nutrients that are available in the soil. For instance, calcium and magnesium are better absorbed at a higher pH than trace elements like iron and zinc, whereas the essential macronutrient phosphorus is best absorbed between a pH of 6 and 6.5.

Clay Soil for Dragon Fruit

Although clay soil can support the growth of Dragon fruit, it does so less successfully than sandy or loamy soil. Because clay soil is so dense and holds so much water, it is the cause. Dragon fruit's roots might quickly become soaked in water and drown in clay soil. However, due to clay's abundance of minerals and other micronutrients, modest levels of clay are advantageous (Grow Guide, 2023).

Soil Problems and Their Management

Some soils pose significant physical and chemical obstacles to crop growth. These soils provide a concern. For satisfactory agricultural production, these soils require particular care. Physical restrictions can be controlled by proper soil conservation techniques such as terracing, contouring, mulching, manuring, tillage and cover crops. Due to the possibility

of their degrading, soil use and disturbance should be avoided in wetlands and on steep slopes. They ought to be allowed to live naturally. Saline soils are managed by providing sufficient irrigation, leaching, draining, and producing crops that can withstand the salt. In order to manage sodic soil, it is necessary to apply chemical additions like sulphur and gypsum together with leaching and draining. Liming, leaching and proper disposal of acid-wash water are all part of managing acid soils, as well as growing crops that can withstand the acidity (Osman, 2012).

Saline Soil for Dragon fruit

Problem

Cultivation of Dragon Fruit in saline soil retards water absorption by the plants. In fruit plants, salinity suppresses the plant height and the emergence of new branches and leaves while hastening the senescence. Initially appear as the yellowing, scorching and chlorosis of the leaf margins. If salt stress is not relieved, leaves soon become chlorotic, develop necrotic spots and eventually shed off the plant (Singh, 2018).

Management

Improving the planting techniques such as planting done in the auger-holes and pits containing 5-20 kg gypsum as auger-holes is effective in promoting water and air flux and root growth. Fertigation with water soluble fertilizers should be done wherever possible to save the nutrients and to prevent the groundwater contamination (Singh, 2018) .

Acid Soil for Dragon fruit

Problem

In the uplands, soil acidity is caused mostly by leaching losses of bases and high percolation of water. This creates problems of crust formation particularly in light textured red soils and adversely affects the seed emergence. Fe toxicity leads to necrosis, or death of the fruit leaves. Necrotic spots will appear on the leaves of plants suffering from iron toxicity. Other symptoms include dark green foliage, stunted top growth and root growth, as well as leaf bronzing which causes dark brown to purple spots on the foliage. Aluminium toxicity leads to inhibition of root growth and injured roots. Poor availability of P in acid soil due to P fixation and P precipitation.

Management

Soil should be limed if the pH is less than 5.5, the finer the liming material, the greater the neutralizing activity. Additions of organic residues: The addition of FYM, vermicompost, green manures and animal wastes to acid soils can reduce the total concentration of Al in soil solution and/or the concentration of monomeric Al in solution and thus reduce Al phytotoxicity and increase crop growth. Proposed mechanisms include an increase in soil pH.

Calcareous soils for Dragon fruit

Problem

Due to an unbalanced nutrient supply, Dragon fruit will have reduced nourishment and stunted growth. Fe chlorosis may cause a 32% loss in yield. Soils also can become calcareous through long term irrigation with water containing small amounts of dissolved $CaCO_3$ that can accumulate with time. Calcareous soils can contain from 3% to >25% $CaCO_3$ by weight with pH values in range of 7.6 to 8.3 (Janaki,2019) .

Management

Band placement of P fertilizers is advised over broadcasting. Application of granular or slow-release N fertilisers in the root zone and also the application of phosphate solubilizing bacteria and Vascular arbuscular mycorrhizae @ 2kg/ha enhances P availability (Reddy, 2023). The presence of $CaCO_3$ directly or indirectly affects the chemistry & availability

of nitrogen (N) Phosphorus(P), Magnesium(Mg), Potassium (K), Manganese (Mn), Zinc (Zn) and iron (Fe). The availability of copper (Cu) also is affected. The application of acid forming fertilizers such as ammonium sulphate and urea fertilizers, sulphur compounds, organic manures and green manures are considered as effective measures to reduce the pH of the soil to neutral pH value (Janaki, 2019).

Conclusion

Due to lack of numbers in commercial producers and high demand, the marketability of Dragon fruit in the area is anticipated to be quite high. India has the ability to produce Dragon fruit outside of the peak season, but even then, the market price per kg is still expensive, ranging from INR150.00 to 250.00 per kg. In the future, production is expected to rise; hence, marketing strategies need to be critically examined. Available sources of information on crop management and multiple cropping schemes integrating Dragon fruit to other crop cultivation in location specific areas are still unavailable, so more research is to be carried out for better quality production by proper scientific management of different soil types to increase productivity as well as focus should be on improving the soil fertility status.

Reference

- American Beauty in Kerala: Now playing, a dragon tale like no other! (2021, August 21), The New Indian Express, accessed 17 January 2023, <https://www.newindianexpress.com/specials/2021/aug/29/american-beauty-inkerala-now-playing-adragon-tale-like-no-other-2349699.html>
- Dharmapuri farmer's experiment with dragon fruit pays off. (2021, September 21), The New Indian Express, accessed 17 January 2023, <https://www.newindianexpress.com/states/tamil-nadu/2021/sep/18/dharmapuri-farmers-experiment-with-dragon-fruit-pays-off-2360263.html>
- What Is the Best Soil for Dragon Fruit? Grow Guide. (2023), Bountiful gardener, accessed 12 January 2023, <https://www.bountifulgardener.com/what-is-the-best-soil-for-dragon-fruit/>
- 4 BEST TYPES OF DRAGON FRUIT IN INDIA. (n.d.), India Gardening, accessed 12 January 2023, <https://indiagardening.com/lists/types-of-dragon-fruit-in-india/>
- Thokchom, A., Hazarika, B., & Angami, T. (2019, April), Dragon fruit -An advanced potential crop for Northeast India, Researchgate, accessed 12 January 2023, <https://www.researchgate.net/publication/332180519_Dragon_fruit_-An_advanced_potential_crop_ for_Northeast_India>
- Earning 12 Lakh from Dragon Fruit Cultivation: A Success Story of a Farmer in India. (n.d.), Agrifarming, accessed 17 January 2023, <https://www.agrifarming.in/earning-12-lakh-from-dragon-fruit-cultivation-a-success-story-of-a-farmer-in-india>
- G. Karunakaran, M. A. (2019, October 23), Dragon Fruit Country Report from India, Food and Fertilizer Technology Center for the Asian and Pacific Region, accessed 15 January 2023, <https://ap.fftc.org.tw/article/1603>
- Jagdish. (2018, 5 24), Dragon fruit cultivation guide, Agrifarming, accessed 12 January 2023, <https://www.agrifarming.in/dragon-fruit-cultivation>
- Janaki, M. a. (2019), Problem soils and their management, tnauagritech, accessed 12 January 2023, <https://agritech.tnau.ac.in/pdf/3.pdf>

- Krishnan, A. (2022, June 24), Doctor Uses Organic Dragon Fruit Farming To Earn Rs 1.5 Cr, Helps 5000 Farmers Learn, thebetterindia, accessed 17 January 2023, <https://www.thebetterindia.com/291638/doctor-does-organic-dragon-fruit-farming-helps-farmers-free-training-earns-crores/>
- Osman, K. T. (2012, September 12), Problem Soils and Their Management, Springlerlink, accessed 12 January 2023, <https://link.springer.com/chapter/10.1007/978-94-007-5663-2_11>
- Panday, C. (2020, June 11), How this Tripura farmer got success with dragon fruit plantation, eastmojo, accessed 17 January 2023, <https://www.eastmojo.com/news/2020/06/11/how-this-tripura-farmer-got-success-with-dragon-fruit-plantation/>
- Reddy, K. (n.d.), Calcareous Soils and their Management, krishiicar, accessed 12 January 2023, <https://krishi.icar.gov.in/jspui/bitstream/123456789/28904/2/Untitled-1.pdf>
- Singh, A. (2018), Soil and Water Management Practices for Fruit Cultivation in Salt Affected Soils, krishi icar, accessed 12 January 2023, <https://krishi.icar.gov.in/jspui/bitstream/123456789/8027/1/Soil%20 and %20 Water%20 Management %20 Practices %20 for %20 Fruit %20 Cultivation%20in%20Salt%20 Affected%20Soils.pdf>
- Tripathy, S. d. (2021, July 21), Dragon Fruit Cultivation: A Complete Guide for Beginners, Krishi Jagran, accessed 12 January 2023, <https://krishijagran.com/agripedia/dragon-fruit-cultivation-a-complete-guide-for-beginners/>

❖❖

ISSN No. 2583-3146

Rainwater Harvesting: to Secure the Future

Bipin Kumar[1*] and Garima Kaushik Parashar[2]

[1]Department of Agriculture, GRD-IMT College, Dehradun

[2]Department of Agronomy, Shri Guru Ram Rai University, Dehradun

Corresponding Author: aryabipin906057@gmail.com

Introduction

Rainwater harvesting system can be defined as the collecting of rain water and storing it for extra activities like irrigation, washing, bathing, drinking, etc. In developing countries there is scarcity of water and it becomes a major problem. To remove such problems we apply this technique to fulfil the proper requirement of water. It is a technique in which we arrange the system as roof-like structure on which the rain water is collected from the roof and send it to the water tank, deep pit and reservoir. Rainwater harvesting system is mainly used in those areas where the people are suffering from drought and less rainfall availability. Therefore, the people store water for the future use. This technique is the better way of recharging the ground water and reviving the water table.

Rainwater harvesting

This technique is therefore used to meet the water demand and it reduces the problem of scarcity of water. Over exploitation of ground water resources has resulted in decline in water levels. We apply this technique to enhance availability of ground water at a specific place and time.

- It is used to improve the vegetation cover.
- To raise the water level in bore wells and dug wells that are drying up.
- To remove the problem of areas with a short duration of rainfall.
- Its also recharge the ground water.
- Its store the rain water on the surface for future use.

Method of Rainwater Harvesting System

Rooftop Rainwater Harvesting: This is the technique in which the rooftop becomes the catchments and the rainwater from the building and houses are collected to the

reservoir for the future use. This method is less expensive and very effective. Rooftop rainwater harvesting can be done at any buildings, large or small. This water can be used as drinking, household needs, agricultural needs or to recharge bore wells and ground water levels.

Surface Runoff Harvesting: Surface rainwater harvesting is the way of collection of rainwater, which flows away as surface runoff. In this method the rainwater is accumulated in a small constricted area like pits, wells, trenches, shafts, etc. This method is also known as recharging ground water aquifers. This method is also used to recharging the bore holes, wells, pits, trenches, etc.

How to Harvest Rainwater?

The process of rainwater harvesting involves the collection and the storage of rainwater with the help of artificially designed systems that run off naturally or man-made catchments areas like the rooftop, ground surface, hill slopes and artificially repaired land surface. It is also harvested through a rain barrel linked to a pipe fitted to collect rainwater from the rooftop of the house.

The rainwater harvesting system has three main stages

(a) Collecting and transporting rainwater: This is done through catchments areas. The catchment of a water harvesting system is the surface which receives rainfall directly.

(b) Filtration: A filter unit is a chamber filled with filtering media to remove the dirt from water before it enters the storage tanks.

(c) Storage in Tanks for Reuse: The harvested water can now be stored in storage tanks for immediate usage, which are designed according to the water requirements of the society.

Components of Rainwater Harvesting System

Rainwater harvesting system consists of the following components:

Catchment: It is an area which is used to collect and store the captured rainwater and also work as the storage.

Conveyance system: It is used to transport the harvested water from the catchment to the reservoir.

Flush: It is used to flush out the first spell of rain.

Filter: Filter is used as the filtering of the collected rainwater and removing all the pollutants present in the water.

Tanks and reservoir: It is used as the store the filtered water which can easily use for any activity.

Advantages of Rainwater Harvesting

- It is the cheapest technique.
- It reduces the problem of shortage of water.

- It helps in reducing the consumption of high energy electricity.
- It improves the quantity of ground water.
- It promotes both water and energy conservation.
- This technique is very simple, easy to use.
- Rain water is good for landscape irrigation as it does not contain any types of chemicals or salts in it.
- Helps to improve the quality of ground water.
- It also helps in reducing soil erosion, flooding etc.
- Rainwater can also be used for different purposes like gardening, washrooms, cleaning homes etc.

Disadvantages of Rainwater Harvesting System

- It requires maintenance.
- Technical skills are necessary for installation.
- Low rainfall affects the system.
- It may attract mosquitoes if not installed properly.
- The storage of water is limited in this technique.

Conclusion

Shortage of water is the main problem in many regions of the country. Recharging of the ground water table is a gradual process, which we cannot increase by constructing recharge structures. Rainwater harvesting is an environmentally friendly approach and has no bad impacts on users. Sustaining and recharging of ground water is very essential process and if sufficient action is not taken up timely then we will face a crisis which is very effective for the survival of humans. Rainwater harvesting is a very effective approach to recharge ground water and also to store water for future use. Rain water can be used for household purposes also.

References

- J.R.Julius1, Dr. R. Angeline Prabhavathy2, Dr. G.Ravikumar3 RAINWATER HARVESTING (RWH) - A REVIEW International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August-2013 276 ISSN 2229-5518.
- Sadia Rahman,1 M. T. R. Khan,2 Shatirah Akib,1 Nazli Bin Che Din,2 S. K. Biswas,3 and S. M. Shirazi4 Hindawi Publishing Corporation ?e Scientific World Journal Volume 2014, Article ID 721357, 10 pages http://dx.doi.org/10.1155/2014/721357.
- https://www.ircwash.org/sites/default/files/Kumar-2006-Rainwater.pdf
- Ranjit Kumar Sharma, 'Rainwater Harvesting at N.I.T. Rourkela ', Department Of Civil.
- Engineering, National Institute of Technology, Rourkela 2010 iv. Rain Water Harvesting, CAMTECH/2004/C/RWH/1.0 , Ministry of Railways, Government of India, August 2004.
- Ranjit Kumar Sharma, 'Rainwater Harvesting at N.I.T. Rourkela', Department Of Civil.
- Engineering, National Institute of Technology, Rourkela 2010.
- iv. Rain Water Harvesting, CAMTECH/2004/C/RWH/1.0 , Ministry of Railways, Government of India, August 2004.
- Ranjit Kumar Sharma, 'Rainwater Harvesting at N.I.T. Rourkela ', Department Of Civil.
- Engineering, National Institute of Technology, Rourkela 2010.
- iv. Rain Water Harvesting, CAMTECH/2004/C/RWH/1.0 , Ministry of Railways, Government of India, August 2004.

❖❖

ISSN No. 2583-3146

Sugarcane Trash Mulch Farming: A Novel Approach

R. Ranjith[1], C. Vengatesan[2] and Paulraj Suryakala[3]

[1]Department of Agronomy, Tamilnadu Rice Research Institute, TNAU, Aduthurai

[2&3]Department of Agronomy, JSA College of Agriculture, Tholudur

Corresponding Author: ranjithagrontnua@gmail.com

Introduction

Sugarcane is crushed for extraction of juice and sugar manufacture or jaggery making only after removing the cane trash and green tops. On an average the cane trash available is 9 to 10 tones ha^{-1}. Generally the trash is burnt in the field itself or used as fuel in jaggery making or for thatching huts. It is estimated that the sugarcane trash contains 0.4% nitrogen, 0.13% phosphorus, 0.12% potassium, 4.65% moisture and 50% organic matter. In the context of shortage of bulky organic manures and need for integrated nutrient management in sugarcane; cane trash management is highly important for soil-moisture conservation, fertility improvement and thus increase cane production. It is well known that trash mulching in rainfed areas/areas with limited irrigation facilities conserves soil moisture, especially during the formative phase which coincides with dry summer period in North Coastal Andhra Pradesh. Though recycling of nutrients present in the trash through incorporation into the soil during grand growth period (in the presence of sufficient moisture during rainy season) is practiced, the wide C: N ratio, high cellulose and lignin contents make the decomposition process very slow.

Sugarcane Trash Mulching

In view of high temperature and extensive weed growth during summer, mulching for moisture conservation and suppression of weeds is highly useful in sugarcane. Besides, it adds to the organic matter content of the soil. Mulching the inter row spaces with 7.5 cm to 10 cm thick layer of dry leaves of sugarcane (trash) or any other organic source is quite effective. About 10 tones of sugarcane trash per hectare are required. Mulching in ratoon is more convenient than in the plant crop. The trash on decomposition release nutrients which improves the fertility of soil. Mulching with sugarcane trash is therefore, advantageous over burning which is usually practiced to reduce the incidence of diseases and insect-pests, as in the case of scale insect.

Trash Mulch on Ratoning Cycle

Trash mulch farming extends the ratooning cycle. A summary of research studies in the Philippines and Vietnam on trash farming systems. It indicates that sugarcane yields increase, on the average 20.1% in the first and 30.0% in the second ratoon crop. These findings have major implications in increasing the profitability of sugar cane production. Extending ratooning cycles is a cost-reducing practice in sugarcane production. Ratooning means savings on land preparation, cane points and planting which account for about 20 to 25% of the total cost of production. Improving soil fertility through trash farming will gradually create a positive feedback system with longer ratoon cycles. Improving cultural practices along with widespread screening of cane trash varieties

for ratooning will enable extended cycles of 4 years or more to be achieved in the Philippines, as is commonplace in Australia and Brazil (Boddey *et al.,* 1995).

Trash Mulch on Chemical fertilizers

Trash mulch farming reduces chemical fertilizer use. The cost of fertilizer used (material + application) accounts for about of 16% in plant cane and 26% in ratoon. When trash is burned, the nitrogen is lost as nitrous oxide (N_2O). Burned cane equals loss of soil N at an average of 44 kg N $ha^{-1}yr^{-1}$. Some of the P and K can also be lost through burning. In trash farming, P uptake appears more efficient as the mulch protects the soil from desiccation and permits root proliferation in the soil surface where P levels are high. In Brazil, gains in soil nitrogen equivalent to 54 kg N ha^{-1} yr^{-1} over 9 years were reported for unburned cane (Boddey *et al.,* 1995). Nitrogen fixation levels of 50kg to 200 kg N ha^{-1} occur in trash farmed sugarcane fields, with the higher range associated with higher trash levels. In Brazil, where trash farming is frequently practiced, only 60 kg N ha^{-1} on average is applied to the crop. About 150-300 kg N ha^{-1} are used in most non-trash farming cane producing countries such as Cuba, Peru, India and the United States (Boddey 1995).

Trash Mulch on Soil properties

Decomposition of sugarcane trash (as organic matter) is transformed into a stable product called humus, which is of agro-ecological importance. Hodge (1998) pointed to the importance of organic matter for long-term sustainability of agriculture. Conserved as mulch, sugarcane trash decomposes into humus, improving soil tilth and decreasing tillage required. By increasing water infiltration into the soil, water retention is improved, thereby decreasing the need for irrigation. Trash-mulched canes can tolerate the normal dry season and El Niño events better than ratoon crops in burned cane fields, which have no trash mulch cover. The effects of mulching on soil fertility have been studied in research stations and on-farm field trials in Vietnam (Mui *et al.,* 1997a, Mui *et al.,* 1996). During a three year experiment, it was consistently shown that mulched fields had higher percentages of carbon, phosphorus, potassium, nitrogen and lower bacteria, actinomycetes and fungi than unmulched fields. The higher percent carbon denotes the unique contribution of mulching in terms of carbon sequestration into the soil, which is important in reducing greenhouse gas emissions (Mendoza 2001).

Trash Mulch on Soil conservation

Trash mulching sugarcane fields helps protect the soil as it minimizes and/or prevents soil erosion which is the principal factor leading to massive land resource base degradation, even on relatively flat to gently sloping lands (Rosario *et al.,* 1992). Without soil conservation, an annual loss of 20 to 200t ha^{-1} of fertile topsoil can occur depending on soil type, slope and rainfall intensity. This rate far exceeds the tolerable rate of soil loss at 10t ha^{-1}. Soil organic matter is also lost through erosion. Between 0.4 and 4.0t ha^{-1} of organic matter is lost in a soil with 2% organic matter. A 200t ha^{-1} soil loss corresponds to a 2.0 cm loss of topsoil, a resource that takes about 100 years to form. Such a reduction can occur over a 1 year period if soil conservation measures such as trash mulching, contour tillage and use of biophysical barriers like buffer strips or hedgerows for steeper slopes are not employed (Rosario *et al*., 1992).

Trash Mulch on Fossil fuel usage

The trash farmed crop had a higher ratoon yield (78 t ha^{-1}) than conventional cane (65 t ha^{-1}). While the increased yield in the trash farmed cane also increased the harvest/ hauling energy usage, it also reduced the overall energy input per ton (mainly due to lower nitrogen fertilizer inputs and the impact

of the increased yield). Fertilizer reduction was estimated to be 99 kg N ha^{-1} to 110 kg N ha^{-1}. The total fossil energy requirement for the fertilizer in the ratoon crop is thereby reduced to 9.1 GJ ha^{-1} (Mendoza *et al.,* 2003). The other apparent way by which sugarcane trash farming reduces fossil fuel energy inputs is through the reduction of tillage.

Increasing the number of ratoons, the frequency of land preparation associated with new plant cane establishment is decreases. The most energy-intensive component is primary tillage or deep plowing (40cm to 50 cm) as sugarcane is deep-rooted. As per the trash farming scheme (Mendoza 1979, Mendoza 1985), the ratio of non-trash and trash mulched rows is 50:50. This represents a 50% reduction in inter-row cultivation.

Trash Mulch on Human health

Sugarcane workers have been observed to have significantly high rates of mortality due to illnesses originating from agricultural operations. A case-control study in the US suggests that people engaged in sugarcane farm-related occupations have significantly higher rates of lung cancer (Mulvey & Rothschild 1983). A recent cancer study involving agricultural workers in India (Amre *et al.,* 1999) also found an increased risk of lung cancer for workers employed in a sugarcane farm. Work involving burning after harvesting and exposure to fibers of biogenic amorphous silica during fieldwork may account for the increased risks of lung cancer and possibly Mesothelioma among sugarcane farmers (Poolchund 1991). By eliminating the field burning of residues, trash farming reduces the health hazards associated with exposure to airborne particulate matter (fly soot and biogenic amorphous silica).

Benefits of Trash mulch farming

These are the benefits of sugarcane trash mulch farming:

- Protects the soil likes Reduces surface heating, water evaporation and prevents splash, run-off and wind erosion.
- Improves soil physical properties *viz.,* Improves soil fertility/decrease tillage intensity, Decrease bulk density/increase soil porosity.
- Improves soil fertility/ promotes N-fixation in litter.
- Increase water infiltration and Conserves water/decreases irrigation expense.
- Reduces fertilizer expense.
- Controls weed growth.
- Reduces inter-row cultivation/use of herbicides.
- Increases sugar yield in both cane and sugar quality.
- Increases the number of ratoons without reducing cane yield.
- Compliance to Clean Air Act (Promotes clean air/minimizes particulate/dust spread).
- Reduces tillage cost in establishing new plant crop.
- Reduces the unit energy cost per ton cane/sugar produced.
- Improves profitability of crop production
- Improves long term sustain-ability of crop farming.
- Promotes CO_2 sequestration in the agricultural landscape.
- Decreases the cost of crop production.

Conclusion

In this sugarcane trash mulch farming is noticed the following benefits. It increases the yields in the ratoon crop. It improves soil properties, e.g., Soil tilth, which decreases need for tillage intensity, improves water

infiltration and water retention. This allows sugarcane to tolerate drought especially during the EI Nino years. It conserves soil and soil organic matter by preventing soil erosion. Eroded soils ranging from 20 to 200t ha^{-1} contains 0.4 to 4.0t ha^{-1} organic matter. It reduces the fossil fuel oil usage of sugarcane production. It's fixing the soil nitrogen and eliminates the health hazards associated with exposure to airborne particulate matter.

References

- Amre DK, C Infante-Rivard, A Dufresne, PM Durgawale and P Ernst. 1999. Case study of lung cancer among sugar cane farmers in India. Occupational and Environmental Medicine. 56(8):548-252.
- Boddey RM, OC de Olivera, S Urquiaga, VM Reis, FFL de Olivera, VLD baldani and J Dobereiner.1995. Biological Nitrogen fixation associated with sugarcane and rice: contributions and prospects for improvement. *Journal of Plant and soil*.174:195-209.
- Boddey RM.1995. Biological Nitrogen fixation in sugarcane: A key to energetically viable biofuel production. *Critical reviews in plant science.* 14 (3): 263-379.
- Hodge R.1998. Soil organic matter: Its central position in organic farming. In Advances in Soil Organic Matter Research. pp 355-363.
- Mendoza TC.1979. Optimum spatial arrangement in sugarcane and legume intercropping. MSc thesis UPLB College, Laguna, Philippines.
- Mendoza TC.1985. Bio productivity and economic evaluation some sugarcane production alternatives. PhD thesis UPLB College, Laguna, Philippines.
- Mendoza TC. 2003. Assessment of Sugar Yield Trends in the Philippines and their Implications. Philippine Agriculturist 76(2): 133-145.
- Mendoza Tc.2001.CO_2 greenhouse gas reducing potentials of some ecological agriculture practices in the Philippine landscape. *Philippine Journal of Crop Science.* 26(3): 31- 44.
- Mui Thi Alguyen, NT Dung, D Van Binhn and TR Preston.1996. On farm evaluation of planning distance and mulching of sugarcane. Livestock Research for Rural Development 9(3):1-6.
- Mui Thi Alguyen, NT Dung, D Van Binhn and TR Preston.1997. Response of four varieties of sugarcane to planting distance and mulching. Livestock Research for Rural Development 9(3):1-10.
- Mulvey JJ and H Rothschild. 1983. Sugarcane farming- Is there a link with cancer. Ecology of Disease 2(4): 267-270.
- Pineda FA.1956. Trash mulching improved the yield of sugarcane. PHILSUTECH proceedings of the 196-198.
- Poolchund HN.1991. Aspects of occupational health in the sugarcane industry. Journal of the society of Occupational Medicine 41(3): 133-136.

❖❖

ISSN No. 2583-3146

Disguised Unemployment in Agricultural Sector and Rural Areas of India: A Potential Problem for the Economy

Sambuddha Mukherjee[1*] and Sanchita Roy[2]

[1]Deptartment of Agricultural Economics, SHUATS, Prayagraj

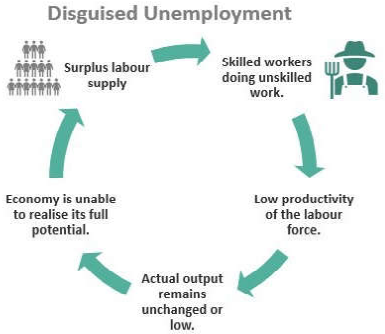
[2]Department of Agriculture Eutention, Doon (P.G.) College of Agricultural Science & Technology, Dehradun

Corresponding Author: sambuddha321@gmail.com

Introduction

Unemployment is a major problem for most of the countries of the world, specially in this Post-Pandemic period. Since the last few years India has been facing a moderately high to high level of unemployment. Agrarian sector, which is an important pillar of the Indian economy, along with the agro-based industry and food industry, has been taking a pioneering role in order to compensate the losses happened in the covid and lockdown situation. Thus, agricultural sector, which is always employing a very high percentage of rural population and manual workers is skilled and unskilled labourers; but here lie the loopholes. In the Agricultural sector, the disguised unemployment is very vividly seen where the no. of employed farmers or employed population is many more than the necessary numbers.

It not only harms the national statistics, but gives wrong data and misinformation regarding the assessment of national economy, gross and net national income, data related to persons employed and persons who did employ. This scenario is neither covid-born nor a recent invention, it prevails since independence and has now been characterized as an integral trait of Indian Agriculture, Indian demography and population distribution of the country.



Nature and Magnitude

Disguised unemployment is considered as the most severe and most difficult to track. The severity is not concerned here, but when it is difficult to track it acts like a fallacy. Neither the data collector has the idea to note the actual intake of that very villages or farming work, nor the farm manager or farmers' community can give cent percent accurate data, because the work might be supervised or carefully undertaken; but it is quite less utilized to take the data in regard to the no. of farmers actually needed to carry out the process.

A good example of this fact is that, in India, agriculture and agri-allied sectors contribute 20% of the GDP of the country[1] whereas agricultural sector employs 51% of the total employment[2] Hence, half of the employed quantity is working here as the input and the output is one-fifth of the Gross.

domestic product of nation.

Disguised Unemployment at its peak; in unorganized sectors more than the necessity peoples are engaged. And Indian Agriculture and rural sectors are prominent examples of this. The persons seem to be employed but in practice he is doing nothing.

Reasons

Firstly, India witnesses a high population growth from time to time. The economy was not effective or workaholic enough to provide them proper employability so they had to choose their own financial way of leading their life and sustaining their family. Secondly, a large proportion of the higher growth is attributable to the rural areas. As per census report of 2011, 69% of the population lives in villages[3] with the commonness of high growth of population, also with a very higher rate of population explosion in some specific states. So in this crucial situation of joblessness the rural population naturally emerges to be involved in agricultural activities, without noticing the labour requirement or waged labourers or wage policies! In the common areas people choose farming, cultivating, fishing, vegetable growing, plantations and a different group of people is also seen various other works like artisan-work, making of bamboo products, crafts etc., MSME works. In both of the cases working peoples are many more than the needed or necessary ones.

Again, In India, from the historical context, a large no. of farmers are poor and don't have the ability to buy lands. They need to work out in others' land and farm, in this unquestionable situation they are asked to work at the owner-determined rate, and don't have any say on the wage policy. This trait from the feudalistic period obliges farmers of a higher no. but in a limited means or resources!

The natural law of demand and supply partakes to keep their wages low and numbers high. Due to higher availability of rural labourers and landless farmers, labour is available at a cheaper cost, accompanied by a higher level of job-seekers. Hence Landowners do employ by a cheaper wage and the no. of labours seems to be higher than actually needed, which can be attached with development of exploitation policies of zamindars showcasing their landlordism.

Apart from that the rural population of India is neither very adoptive nor innovative they are very least adaptable in regards of new technology or methods. Despite proper Extension programmes and Community Development Programmes, Indian farmers are quite distant from adopting new technologies and Govt. prescribed Innovative policies, this kind of psychological barriers discourage them from going to urban areas, finding new jobs, searching for better opportunities, good alternative options. So mosts of the rural farmers like to be attached with the present occupation and farming activities.

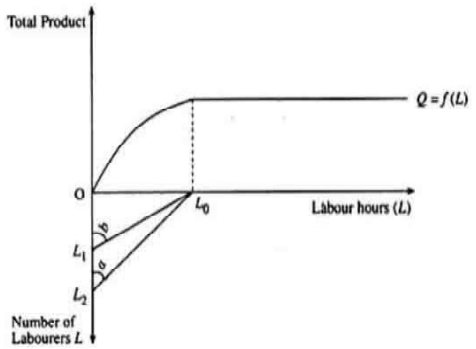


Fig. Disguised unemployment

The graphical representation clearly shows that the total output or product level after a certain phase is constant. That denotes

in spite of using or adding more input the Marginal Physical Product (MPP) is zero and the ultimate Marginal Return (MR) is also zero and after certain level it becomes negative. So, the Total Physical Products before (TPP_1) and after (TPP_2) is same.

now,

$TPP_1 = TPP_2$

So, TP= Constant(K),

MP=0

MR<0 i.e., (-)ve

Possible Approaches

Govt. may provide adequate credit to the farmers for their personal initiations and to fulfil financial requirements, if farmers need money they would no longer require to work on others' farm and in exchange of a minimum wages. The credit can be reached through the Regional Rural Bank operating there or as an Agricultural loan though Agriculture Field Officers, but never through any unorganized creditors like landlord or Mahajan, they show a dazzling amount of loan and charge a very high rate of interest, pen-ultimately leading them in debt trap.

Skill development or entrepreneurial activities can be encouraged in rural areas, so farmers can think to opt for a better income and the procedure of Result Demonstration should be followed, so that farmers or labours can prepare their minds for adopting easily.

The fact is, farmers' tendency to stay in rural area makes the rural zone more stagnant, and that multiplies the resources' unavailability! So a mass migration is friendly to work in such a situation, it would decrease the existing pressure of the rural areas and would help them to get a better wage policy in the urban zones. In this time frame of 21st century, mass mobilization is very important for dealing with such competitive environment, but that too in a scientific way.

Conclusion

In India, Government can be credited for a lot of works in order to create rural employability and for alleviation of rural poverty. The schemes are found to create working days and families from various backgrounds have joined the RDP schemes or programmes, it has another impact [rather than employment generation or poverty alleviation]: most of the workers are being assigned to work out in their own villages or localities, as a result, a local employability grows.

References

- Official website of Ministry of Statistics & Project Implementation, Govt. of India. Released by National Statistical Office (NSO).

  As per the data for 2020-21, the contribution of agriculture to India's GDP was 19.9%, which is higher than the previous season, as it was 17.8% in the 2019-20. In observation with respect to Gross Value Added (GVA), Agriculture contributes 17.2% to the Gross Value Added (GVA) of the country (Subramanian, A. and Felman, 2019). In combination, total 19.48 lakh crores rupees (US$ 276.37 billion) was the GVA by Agriculture, Forestry and Fisheries sector in FY20. In 2022, the percentage of GVA that belongs to the agriculture and related sectors (at current prices) is 18.8% of the total GVA of India (Manida and Nedumaran, 2020).

  Point to be noted that the fisheries sector has a share of 1.07% in the GDP of India. According to the statement by National Fisheries Development Board, fishery sector generates Rs 334.41 billion in export which shows the external demand and Forex reserve earning capability of this sector, which

is a good component of Income from abroad and Gross National Product (GNP).

- NITI Aayog Official website.
- Census report, 2011. The rural-urban distribution of population is 68.84% and 31.16% respectively, as concluded by C. Chandramouli, the Registrar General and Commissioner of 2011 Census. And it got decreased from the previous report as the proportion of rural population was 72.19% in 2001 census. Again, during 2001-'11 decades the growth rate of rural population had been 12.18 %.
- **And other sources**
  - ✓ Economic Survey Reports
  - ✓ Official websites of NABARD, Press Information Bureau (PIB), National Fisheries Development Board and Indian Council of Agricultural Research (ICAR).

❖❖

ISSN No. 2583-3146

Artificial Intelligence in Horticultural crops

Deepshikha

Department of Fruit Science, SKUAST-Jammu

Corresponding Author: maandideepshikha6@gmail.com

Introduction

AI is an emerging technology in the field of agriculture. AI-based equipment and machines has taken today's agriculture system to a different level. This technology has enhanced crop production and improved real-time monitoring, harvesting, processing and marketing (Yang *et al.,* 2007). The latest technologies of automated systems using agricultural robots and drones have made a tremendous contribution in the agro-based sector. Various hi-tech computer-based systems are designed to determine various important *parameters* like weed detection, yield detection and crop quality and many other techniques (Liakos *et al.,* 2018).

Artificial Intelligence (AI) can be applied cross disciplinary and it can also bring a paradigm shift in how we see farming today. AI-powered solutions will not only enable farmers to do more with less, it will also improve quality and ensure faster go-to-market for crops. Today's technological advancement in Artificial Intelligence, Big Data and IoT are becoming the major drivers for providing the Digital IT solution in almost all the fields and business sectors.

Hence, it is proposed to make use of Digital solutions aided with Artificial intelligence to uplift the habitat of the trampled farmer community while providing yet a new opportunity for business and entrepreneurs by enabling smart farm as a service. The technologies which are AI-based help to improve efficiency in all the fields and also manage the challenges faced by various industries including the various fields in the agricultural sector like the crop yield, irrigation, soil content sensing, crop- monitoring, weeding, crop establishment (Kim *et al*., 2008).

Importance of Artificial Intelligence in Horticulture

Growth driven by Internet of Things (IOT): Digital transformation is disrupting the agricultural world. IoT technologies allow correlations of structured and unstructured data to provide insights into food production. Huge volumes of data get generated every day in both structured and unstructured format. These relate to data on historical weather patterns, soil reports, new research, rainfall, pest infestation, images from Drones and cameras and so on. Cognitive IoT solutions can sense all this data and provide strong insights to improve yield. Proximity Sensing and Remote Sensing are two technologies which are primarily used for intelligent data fusion. One use case of this high-resolution data is Soil Testing.

While remote sensing requires sensors to be built into airborne or satellite systems, proximity sensing requires sensors in contact with soil or at a very close range. This helps in soil characterization based on the soil below the surface in a particular place. The IoT enabled sensors need to be installed in the field at the prescribed locations. These sensors are the transducers that collect the data on climatic condition, soil moisture and fertility, root & shoot growth; profused leaf growth, photo-period monitoring, floral & seed setting, grain/fruit bearing, pest and diseases as critical growth factors symptoms and harvest readiness.

The IoT device includes the transducer that probes the various parameters of environment and crop mentioned above. It can be mounted on a protected mini board with Wi-Fi device, microcontroller, low cost VGA image sensor, mini battery powered with micro solar panel. The data can be collected at required time intervals either by installing Wi-Fi active hot spot towers as required for entire field coverage. Alternatively, drones with active Wi-Fi hotspot, can also be used to scan and collect data from IoT devices as well as to capture elevated motion pictures of the entire field.

Data-driven farming: By analyzing and correlating information about weather, types of seeds, soil quality and probability of diseases, historical data, marketplace trends, and prices, farmers will make more informed decisions. Panpatte (2018) said that artificial intelligence makes it possible for farmers to assemble large amounts of data from government as well as public websites, analyze all of it and provide farmers with solutions to many ambiguous issues as well as it provides us with a smarter way of irrigation which results in higher yield to the farmers. Due to artificial intelligence, farming will be found to be a mix of technological as well as biological skills in the near future which will not only serve as a better outcome in the matter of quality for all the farmers but also minimize their losses and workloads. The UN states that, by 2050, 2/3rd of the world's population will be living in urban areas which raises a need to lessen the burden on the farmers. AI in agriculture can be applied which would automate several processes, reduce risks and provide farmers with a comparatively easy and efficient farming.

Image-based insight generation: Precision farming is one of the most discussed areas in farming today. Drone-based images can help in in-depth field analysis, crop monitoring, scanning of fields and so on. Computer vision technology, IOT and drone data can be combined to ensure rapid actions by farmers. Feeds from drone image data can generate alerts in real time to accelerate precision farming. Companies like Aerial tronics have implemented IBM Watson IoT Platform and the Visual Recognition APIs in commercial drones for image analysis in real time. Given below are some areas where computer vision technology can be put to use.

Disease and Pest detection: Pre-processing of images ensures the leaf images are segmented into areas like background, non-diseased part and diseased part. The diseased part is then cropped and sent to remote labs for further diagnosis. It also helps in pest identification, nutrient deficiency recognition and more. Selvaraj *et al.,* (2019) developed an AI-based banana disease and pest detection system at CIAT (International Center for Tropical Agriculture) to support banana farmers.

Crop readiness identification: Images of different crops under white/UV-A light are captured to determine how ripe the green fruits are. Farmers can create different levels of readiness based on the crop/fruit category and add them into separate stacks before sending them to the market.

Field management: Using high-definition images from airborne systems (drone or copters), real-time estimates can be made during the cultivation period by creating a field map and identifying areas where crops require water, fertilizer or pesticides. This helps in resource optimization to a huge extent.

Identification of optimal mix for agronomic products

Based on multiple parameters like soil condition, weather forecast, type of seeds and infestation in a certain area and so on, cognitive solutions make recommendations to farmers on the best choice of crops and hybrid seeds.

The recommendation can be further personalized based on the farm's requirement, local conditions and data about successful farming in the past.

External factors like marketplace trends, prices or consumer needs may also be factored into enabling farmers to make a well-informed decision.

Health monitoring of crops

Remote sensing techniques along with hyper spectral imaging and 3d laser scanning are essential to build crop metrics across thousands of acres. It has the potential to bring in a revolutionary change in terms of how farmlands are monitored by farmers both from time and effort perspective. This technology will also be used to monitor crops along their entire lifecycle including report generation in case of anomalies.

Automation techniques in irrigation

In terms of human intensive processes in farming, irrigation is one such process. Machines trained on historical weather patterns, soil quality and the kind of crops to be grown, can automate irrigation and increase overall yield. With close to 70% of the world's fresh water being used in irrigation, automation can help farmers better manage their water problems.

Drone Based Technology

One of the most promising areas is horticulture, where drones have the potential to address major challenges. Drone technology is giving horticulture a high-tech makeover. Because of their versatility as well as amazing imaging technology which covers from delivery to photography, the ability to be piloted with a remote controller and the devices being dexterous in air which enables us to do a lot with these devices, drones or UAVs are becoming increasingly popular to reach great heights and distances and carrying out several applications. Here are six ways drones will be used throughout the crop cycle:

Soil and field analysis: By producing precise 3-D maps for early soil analysis, drones can play a role in planning seed planting and gathering data for managing irrigation and nitrogen levels.

Planting: Start-ups have created drone-planting systems that decrease planting costs by 85 percent. These systems shoot pods with seeds and nutrients into the soil, providing all the nutrients necessary for growing crops.

Crop spraying: Drones can scan the ground, spraying in real time for even coverage. The result: aerial spraying is five times faster with drones than traditional machinery. The UAVs, otherwise called drones, are chiefly established on the innovations of sensors and microcontrollers which are grown especially with an expectation to make up for the non-attendance of the pilot and accordingly empower the trip of unmanned vehicles and their independent conduct (Spoorthi *et al*., 2017).

Crop monitoring: Inefficient crop monitoring is a huge obstacle. With drones, time-series animations can show the development of a crop and reveal production inefficiencies, enabling better management. The advanced sensors and imaging capabilities have provided the farmers with many new ways to increase yields and reduce crop damage. Unmanned airplanes which are used for practical purposes in recent years have taken a bizarre flight. New sensors mounted on UAV, with high-tech cameras being the eyes of the client on the ground and optimal procedures for survey, data acquisition and analysis are continuously developed and tested. As a matter of fact, the use of aerial surveys is not new to the agricultural world. Satellites have been used for a decade to inspect large croplands and forestry, but a new level of precision and flexibility has been obtained with the use of UAVs. To carry out UAV flights, one does not need to depend on the position of

the satellite or having the correct weather conditions and as UAV pictures are taken 400–500 ft. from the ground level; they result in better quality and provide precision.

Irrigation: Sensor drones can identify which parts of a field are dry or need improvement. Kumar (2014) discusses the different irrigation methods with the primary motive of developing a system with reduced resource usage and increased efficiency. The first technique was the subsurface drip irrigation process, which minimized the amount of water loss due to evaporation and runoff as it is directly buried beneath the crop. Later researchers came with different sensors which were used to detect the need of water supply to the fields as soil moisture sensor and rain drop sensor, which were instructed through wireless broadband network and powered by solar panels. The rain drop sensor and soil moisture sensor informs the farmer about the moisture content in the soil through SMS in their cell phone using GSM module. Accordingly, the farmer can give commands using SMS to ON and OFF the water supply. Thus, we can consider that this system will detect part or area in the fields which require more water and could hold off the farmer from watering when it's raining.

Health assessment: By scanning a crop using both visible and near-infrared light, drone-carried devices can help track changes in plants and indicate their health and alert farmers to disease. UAVs may one day consist of autonomous swarms of drones, collecting data and performing tasks. The biggest obstacle to that becoming a reality is sensors capable of collecting high-quality data and number crunching software that can make that high-tech dream a reality.

Models for Farmers Services

The beneficiary of this service can be offered with following service models. (a) Chatbot (b) Agri-E-calculator for suitable crop selection along with resource estimation (c) Crop care service. (d) Price prediction and market guidance (e) Crop loan and insurance service.

Chatbot: Currently, AI-powered chatbots (virtual assistants) are used in retail, travel, media and insurance sectors. But horticulture could also leverage this technology by assisting farmers with answers and recommendations on specific problems. This service lets the farmer get their queries answered via interactive voice chat in their native languages. The chatbot engine is driven with both supervised and reinforced machine learning techniques for continuous and context sensitive learning. Thereby the chatbot answers to most of the generic queries before it lets human operator intervention for any queries that are unique in nature.

Agri-E-Calculator: The *agri-e-calculator* as a smart application help the smart farmer to choose the most suitable crop and affordability based on several dependency factors. The farmer can use the smart calculator and just choose the desired crop to be cultivated over his preferred coverage area of the farm. Then all other required inputs based on various dependency factors are automatically identified and taken by the e-calculator and provide the estimation results. This output result provide useful data on estimation of fertilizers cost/quantity, water, seeds, cultivation equipment cost and Labour Day efforts/cost with Labour Day effort distribution on calendar chart of crop life cycle, crop yield along with extrapolated market price at the harvest time and its profitability. All the required inputs which are both linear and non-linear in nature are taken by farmer's data base, external information sources mentioned earlier. The inputs get processed by machine learning techniques and generate the estimation with feasibility study so that the farmer can choose the desired crop for cultivation.

Crop care service: The crop care service guidance spans right from the sowing of seeds as start point till the time of harvesting as endpoint. The complex structured data sampled from IoT sensors from the fields are analyzed along with the data collected from sources of information sites along with domain expert inputs wherever needed through Artificial Intelligence techniques. After the analysis of complete data, the overall corrective action item is derived out of PID (*Proportional Integral & Differential*) controller mechanism. Accordingly, the corrective measures are alerted to the farmer on their smartphone to prioritize the action based on severity and urgency to act upon.

Price prediction and market guidance: This service helps to safeguard the farmers from market fluctuation and mitigates the risk of price loss. Based on the statistical data collected from various sources a predictive price and demand information is shared with the farmers during the complete crop life cycle. And hence the farmers can plan better for releasing their commodities to market.

Crop loan and insurance service: This service helps the farmers in facilitating feasibility of getting crop loans, processing support, eligibility criteria and loan limit as per the smart estimation made for the proposed crop. Also, it helps to get the crop insured as a mitigation plan for crop failures due to any uncertainties or calamities.

Currently used AI technologies in Agriculture

Blue River technology: Founded in 2011. This California-based start-up combines artificial intelligence, computer vision and robotics to build next-generation agriculture equipment that reduces chemicals and saves costs. Computer vision identifies each individual plant, decides how to treat each individual plant and robotics enables the smart machines to take action. The use of sensors that detect weeds, the type of weeds and the right herbicides to apply within the right buffer around the plant. The cameras and sensors use machine learning where the images are captured, and the machines can be taught in different weeds. Then also the right herbicides are sprayed precisely as per encroachment area. Blue River Technology has developed a robot called See & Spray which reportedly leverages computer vision to monitor and precisely spray weeds on cotton plants. Precision spraying can help prevent herbicide resistance. The short video below demonstrates how the robot works in action.

Farm Bot: Founded in 2011. This company has taken precision farming to a different level by enabling environment conscious people with precision farming technology to grow crops at their own place. The product, Farm Bot comes at a price of $4000 and helps the owner to do end-to-end farming all by himself. Ranging from seed planting to weed detection and soil testing to watering of plants, everything is taken care of by this physical bot using an open source software system.

Harvest CROO Robotics: Crop Harvesting: Harvest CROO Robotics has developed a robot to help strawberry farmers pick and pack their crops. Lack of labourers has reportedly led to millions of dollars of revenue losses in key farming regions such as California and Arizona. The robot picks up strawberries, helping farmers reduce the cost of harvest labour. Strawberries need to be picked in a certain time period and hence qualified pickers are needed. Harvests CROO Robotics believes that their invention will save money, increase yields, reduce energy usage and improve quality. Watch this short vision and learn more. Xiong *et al.,* (2018) developed an autonomous strawberry harvesting robot Norwegian University of Life sciences. The robot is equipped with an image recognition

system and a low-cost dual arm system which is optimized for maximum efficiency and minimum risk of collision.

Plant diseases diagnosis app - Plantix: The Berlin-based agricultural tech start-up, PEAT, developed the Plantix app that identifies potential defects and nutrient deficiencies in soil. The app uses images to detect plant diseases, a smart phone collects an image which is matched with a server image and then a diagnosis of the plant health is provided. In this way the application uses AI and machine learning to solve the plant diseases.

Sky- Squirrel Technologies: Sky Squirrel Technologies Inc. is one of the companies using drone technology in vineyards based in Canada. It aims to help users improve their crop yield and to reduce costs. Users pre-program the drones' route and once deployed the device will record images which will be used for analysis. Sky Squirrel uses algorithms to integrate and analyze the captured images and data to provide a detailed report on the health of the vineyard, specifically the condition of grapevine leaves.

Farm Shots: Based in Raleigh, North Carolina, it is focused on analyzing agricultural data derived from images captured by satellites and drones. The company claims that its software can inform users exactly where fertilizer is needed and can reduce the amount of fertilizer used by nearly 40 %. Specifically, it aims to detect diseases, pests and poor plant nutrition on farms. Hyperspectral imaging and 3D Laser Scanning are capable of providing enhanced information across thousands of acres.

Sweeper Project: It is the world's first fully automated sweet pepper harvesting robot developed by Wageningen University and Research, Netherland. The ultimate goal of the Sweeper project is to put the first working sweet pepper harvesting robot on the market. Using the camera system mounted on the end-effector, the SWEEPER scans plants looking slightly upwards for detecting mature fruits (the robot observe the bottom part of the peppers to determine the fruit maturity). In general, SWEEPER has a success rate of 49% in harvesting ripe fruits (Shamshiri *et al.*, 2018). The main aim behind its development was to reduce labor dependency and to provide a platform for further advancement in AI in greenhouses.

Prospera: Founded in 2014. This Israeli start-up has revolutionized the way farming is done. It has developed a cloud-based solution that aggregates all existing data that farmers have like soil/water sensors, aerial images and so on. It then combines it with an in-field device that makes sense of it all. The Prospera device which can be used in greenhouses or in the field, is powered by a variety of sensors and technologies like computer vision. The inputs from these sensors are used to find a correlation between different data labels and make predictions.

Advantages of AI

High accuracy with less errors: AI machines or systems are less prone to errors and can achieve results with high accuracy.

High Speed: AI machines can work with very high speed and make decisions very fast.

High Reliability: AI machines are highly reliable and can perform the same action multiple times with high accuracy.

Digital assistant: AI technologies can be very useful to provide digital assistance to users like in farming, healthcare, industries etc.

AI operates 24 x 7 without interruption or breaks and has no downtime.F

Disadvantages of AI

High cost of implementation: Setting up AI- based machines, computers, etc., entails huge costs given the complexity of engineering that goes into building one.

Can't replace humans: Machines perform much more efficiently as compared to a human being, but we cannot build human intelligence into a machine as it is a gift from nature.

Doesn't improve with experience: One of the most amazing characteristics of a human being is the ability to develop with age and experience. However, the same can't be said about AI.

Lacks creativity: Although AI can help humans to develop and design something special, but their ability is limited to what they have been programmed to do.

Risk of unemployment: AIs will result in a less human intervention which may cause major disruption in the employment status.

Challenges with Artificial Intelligence in Horticulture

Though Artificial Intelligence offers vast opportunities for application in horticulture, there still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world. Exposure of farming to external factors like weather conditions, soil conditions and presence of pests is quite a lot. So what might look like a good solution while planning during the start of harvesting may not be an optimal one because of changes in external parameters.

AI systems also need a lot of data to train machines and to make precise predictions. In the case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. For example, most of the crop-specific data can be obtained only once in a year when the crops are growing. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model. This is one reason why AI sees a lot of use in agronomic products such as seeds, fertilizer, pesticides and so on rather than in-field precision solutions. While large scale research is still in progress and some applications are already available in the market, the industry is still highly underserved (Shobila and Mood, 2014).

Conclusion

AI technologies help farmers to analyse land/soil/health of crops etc., and save time and allow farmers to grow the right crop in each season that has the best yield. Vertical cropping can reduce water usage, make efficient land usage, can be cultivated in urban areas in buildings. It can reduce the problems with labour unavailability. AI allows prediction of next year crop seasons/weather/climate/ rainfall etc. AI based predictions enable suggesting appropriate pesticides/crops/place at right time before large scale incidence of disease. In conclusion the future of farming in the times to come is largely reliant on adapting cognitive solutions. Though a vast amount of research is still on and many applications are already available, the farming industry is still not having sufficient service and remains to be underserved. While it comes down in dealing with realistic challenges and demands faced by the farmers, using AI decision making systems and predictive solutions in solving them, farming with AI is only in a nascent stage. AI solutions have to become more viable to assure that this technology reaches the farming community. If the AI cognitive solutions are offered in an open source platform that would make the solutions more affordable, which eventually will result in faster adoption and greater insight among the farmers.

References

- Dharmaraj, V. and Vijayanand, C. 2018. Artificial Intelligence (AI) in Agriculture. International Journal of Current Microbiology and applied Science. 7(12):2122-2128.
- FAO. Food and Agriculture Organization

of the United Nations, 2017, 2017. The State of Food And Agriculture Leveraging Food Systems for Inclusive Rural Transformation. 978-92-5-109873-8pp. 1–181.

- Kim, Y. J., Evans, R. G., Iversen,W. M., 2008. Remote sensing and control of an irrigation system using a distributed wireless sensor network. IEEE Trans. Instrum. Meas. 57 (7), 1379–1387.
- Kumar, G., 2014. Research paper on water irrigation by using wireless sensor network. International Journal of Scientific Engineering and Technology, IEERT conference Paper, pp. 123–125.
- Liakos, K., Busato, P., Moshou, D., Pearson, S., Bochtis, D., 2018. Machine Learning in Agriculture: A Review. Sensors 18 (8), 2674. https://doi.org/10.3390/s18082674.
- Panpatte, D.G., 2018. Artificial Intelligence in Agriculture: An Emerging Era of Research.
- Intuitional Science, Canada, pp. 1–8.
- Selvaraj *et al.*, 2019. AI- powered banana disease and pest detection. Plant Methods.15:92.
- Shakya, S. 2020. Analysis of Artificial Intelligence based Image Classification Techniques. Journal of Innovative Image Processing. 2 (1): 44-54.
- Shamshiri R. R., Weltzien C., Hameed I. A., Yule I. J., Grift T. E., Balasundram S. K., *et al.*, 2018. Research and development in agricultural robotics: A perspective of digital farming. Int J Agric & Biol Eng. 11(4): 1–14.
- Shobila, P., Mood, V., 2014. Automated irrigation system using robotics and sensors. Int.
- J. Sci. Eng. Res. 3 (8), 9–13.
- Spoorthi S., Shadaksharappa B., Suraj S., Manasa V.K. 2017. Freyr drone: pesticide/ fertilizers spraying drone - an agricultural approach. 2017 2nd International Conference on Computing and Communications Technologies (ICCCT). https://doi.org/10.1109/iccct2.2017.7972289.
- Xiong et al., (2018). An autonomous strawberry-harvesting robot: Design, development, integration and field evaluation. J Field Robotics. 2019;1–23.
- Yang, H., Liusheng,W., Junmin, X. Hongli, Jan. 2007. Wireless Sensor Networks for Intensive Irrigated Agriculture, Consumer Communications and Networking Conference, 2007. CCNC 2007. 4th IEEE. pp. 197–201 Las Vegas, Nevada.
- Zixing C. and Guangyou X. 2004. Artificial Intelligence and Its Applications, The 3rd Edition, Tsinghua University Press, Beijing.

❖❖

ISSN No. 2583-3146

Important Diseases of Pearl Millet and their Control

Vijay Kumar Kashyap[1*], Vivek Kumar Viswakarma[2] and Pramod Kumar Fatehpuriya[3]

[1& 3] Department of Plant Pathology, RVSKVV, Gwalior

[2]Department of Plant Pathology, SHUATS, Prayagraj

Corresponding Author: vijaykumarkashyap2@gmail.com

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the most important cereal crop subsequent to rice, wheat, maize and sorghum. It is staple food of millions of people and widely grown in about 30 million ha. in the arid and semi-arid tropical regions of Africa (>18 million ha) and Asia (>10 million ha.) accounting for half of the global millet production. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. It is used as a staple food for human consumption, as fodder and feed in livestock sector. It is also used in industries such as - alcohol and fuel, starch and processed food sectors. Being a climate-resilient crop, pearl millet is very important in mitigating the adverse effects of climate change facilitating income and food security among farming communities of arid regions.

It is usually grown under the most adverse agro-climatic conditions where other staple cereal crop like rice and wheat fail to survive. It can survive in the harshest conditions including low soil fertility, high soil pH, high soil Al^{3+} saturation, low soil moisture, high temperature, high soil salinity and scanty rainfall. During 2020-21, Pearl millet was grown in 7.41 million ha with a productivity of 1391 kg/ha, (Anonymous 2021). The major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat, Haryana and Madhya Pradesh contributing to 90% of total production in the country. Most of pearl millet in India is grown in rainy (kharif) season (June/July-September/October). Pearl millet is also cultivated during summer season (February-May) in parts of Gujarat, Rajasthan and Uttar Pradesh; and during the post-rainy (Rabi) season (November-February) at a small scale in Maharashtra and Gujarat. Madhya Pradesh ranks 7th in area 0.33 million hectares with 0.74 million tonnes production and 2256 kg/ha. productivity (Anonymous 2021). Morena, Bhind, Gwalior, Sheopur and Datia jointly contribute more than 80% production of bajra In Madhya Pradesh.

The discussion of important pearl millet diseases and their management strategies is the focus of this article. Pearl millet is infected by a large number of diseases caused by fungal, bacterial and viral pathogens, and nematodes. However, only a few are considered economically important, namely downy mildew (*Sclerospora graminicola*), blast (*Pyricularia grisea*), rust (*Puccinia substriata* var. *indica*), ergot (*Claviceps fusiformis*) and smut (*Moesiziomyces penicillariae*).

Downy mildew (*Sclerospora graminicola*): Downy mildew is a highly destructive and widespread disease in most pearl millet growing areas of Asia and Africa (Williams 1984; Andrews *et al.,* 1985a) and causes 20-40% grain yield losses annually worldwide (Singh 1995; Hash *et al*., 1999), and sometimes it could be much higher where

a susceptible cultivar is repeatedly grown in the same field. Primary infection occurs at the seedling stage from the infection caused by soil-borne oospores and systemic symptoms generally appear as chlorosis on the second leaf and on all the subsequent leaves. Whitish growth of the pathogen in the form of spornagiophores and sporangia appear more on the abaxial leaf surface particularly during the morning hours. These spores get blown off by wind and rain splash and cause secondary infection in the field. Young seedlings die under severe infection and panicles produced on the infected plants develop green-ear symptoms (Fig.1 and 2).Sporangia produced on the foliage of infected plants serve as the source of primary or secondary inoculum for nearby plants. Oospores are produced in the infected necrotic leaf tissues, which fall in the soil and serve as a source of primary inoculum for the next crop.

Fig: 1

Fig: 2

Management

- Downy mildew resistant varieties CO7, WCC 75, CO(Cu)9, TNAU-Cumbu Hybrid-CO9.
- Transplanting reduces disease incidence. At the time of planting infected seedlings should be removed.
- In the direct sown crop, infested plants should be removed up to 45 days of sowing as and when the symptoms are noticed.
- Spray any one of the fungicides Metalaxyl + Mancozeb @500 g or Mancozeb 1000g/ha.

Blast (*Pyricularia grisea*): Pyricularia leaf spot, also known as blast disease, is particularly important in pearl millet forage cultivars. It is an important disease in the southern United States and more recently it has emerged as a serious disease of dual purpose (grain and fodder) pearl millet hybrids in India (Lukose *et al.,* 2007; Anonymous 2009). In India, the disease was first reported from Kanpur, Uttar Pradesh (Mehta *et al*., 1953) and remained as a minor disease for a long time. The disease causes chronic yield losses of grain (Timper *et al*., 2002) and forage (Wilson and Gates 1993). The disease appears as grayish, water-soaked lesions on foliage that enlarge and become necrotic, resulting in extensive chlorosis and premature drying of young leaves. Depending on the resistance level of the host cultivar, the lesion size varies from small, roundish, elliptical, diamond shaped to elongated, measuring 1-2 mm to 20 mm (Fig.3).

Lesions are often surrounded by a chlorotic halo, which turns necrotic, giving the appearance of concentric rings. The lesions are usually confined to interveinal spaces on the foliage. Lesions grow and coalesce to cover large surface areas and cause necrosis of tissues. In case of a susceptible cultivar the entire foliage gives a burnt appearance. Severely infected plants produce no grain or few shriveled grains in blasted florets.

(a) (b)

(c)

Fig: 3 Blast symptoms on: (a and b) foliage; (c) sheath

Management

a. Pre-emergence application

- It applied after sowing but before emergence of seedling. - Atrazine (0.5-1.0) - Pendimethalin (1.0-1.5) - Tebutryn (1.0-2.0) for light soils - Norea (1.0-2.0) for heavy soils.

b. Post-emergence application

- In case of severe infestation.
- Low rates of 2,4-D(0.5-1.0 kg/ha) may be applied when the plants are about 10 to 30 cm tall.

Rust (*Puccinia substriata* var. *indica*): Rust on pearl millet has been reported from many countries of Asia, Africa also from the US and Brazil. Substantial losses in grain yield and fodder quality may occur when infection occurs before flowering (Wilson *et al*., 1996). Rust is of greater importance on multi cut forage hybrids where even low severity can result in substantial losses of digestible dry matter yield (Wilson *et al.,* 1991). The disease has become wide spread due to large-scale seed production in the summer season and overlapping cropping in certain states of India. Infected leaves initially show pinhead chlorotic flecks, which later turn into reddish-orange, round to elliptical pustules on both surfaces (Fig.4). Individual pustules (uredinia) are small and erumpent and as the disease progresses they coalesce to occupy larger leaf surface. The infection generally begins from the distal end of the leaf and progresses towards the basal part. In severe cases, rust pustules appear on the entire leaf blade, leaf sheath, stem and culm. These pustules contain numerous urediniospores that become airborne as pustules burst. As the pustules age, teliospores also appear, although with low frequency.

Fig: 4

Management

- Sowing during December - May result in less incidence.
- Adopt control measures when there is rust incidence in the early stages as spread of infection to top leaves results in poor grain filling.
- Spray any one of the following fungicides when the initial symptoms of the diseases are noticed. Wettable sulphur 2,500g / ha Mancozeb 1,000g/ha.
- Repeat application 10 days after if necessary.

Ergot (*Claviceps fusiformis*): Ergot is prevalent in most pearl millet growing areas of Asia and Africa. In India, the disease is more severe in genetically uniform single-cross F1 hybrids than in open pollinated varieties. Ergot susceptibility is related to the Cytoplasmic Male-Sterility (CMS) system and lack of pollen at protogyny (Thakur and Williams 1980; Thakur and King 1988a; Thakur and Rai 2002). The disease is highly weather sensitive and causes substantial losses of both grain yield and quality under favorable weather conditions. The first symptom of ergot appears as cream to pink mucilaginous droplets called 'honeydew' oozing out from infected florets of the pearl millet panicle (Fig. 5). These droplets contain numerous asexual spores called conidia. Both macro- and microconidia are produced in the honeydew. These droplets dry out within 10-15 days and are replaced by hard, dark brown to black structures with a pointed apex called 'sclerotia', which protrude from the florets in place of grains. During harvesting and threshing these sclerotia fall to the ground and get mixed with the grain and serve as a source of primary inoculum for the next crop.

Fig: 5 - Ergot symptoms: honeydew and sclerotic

Management

Spray any one of the fungicides like Carbendazim 500g or Mancozeb 1,000g /ha when 5 - 10% flowers have opened and again at 50% flowering stage.

Smut (*Moesiziomyces penicillariae*): Smut is an important disease of pearl millet in India, western Africa and USA. Although, present in almost all countries where pearl millet is grown, no epidemics have been reported so far and the extent of losses caused by the disease is quite variable (Thakur and King 1988b). Like ergot, it is a panicle disease that is more severe in CMS-based single-cross hybrids than in open-pollinated varieties (Thakur 1989). The estimated grain yield loss due to smut is 5-20%, although it can be higher under conditions favorable for disease development. Smut symptoms appear on the panicle as green, shining smut sori in place of grains two weeks after inoculation; the sori mature within the next two weeks (Fig. 20). Matured sori turn brown and rupture to release dark-brown to black spore balls of numerous teleutospores (Fig. 6).

Fig :6-Smut symptoms: green and mature sori

Management

- Removal and destruction of affected ear head will help in controlling the disease.
- Pearl millet was intercropped with Mung bean, Moth bean, Cowpea and Cluster bean and lowest smut severity (4.5%) was observed with Mung bean followed by intercropping with Moth bean (7.4%) and Cowpea (8.4%).
- In case of fungicides all the fungitoxicants i.e., Carboxin, Carbandazim, Copper oxychloride, Mancozeb, Hexaconazole and Propiconazole reduced smut significantly as compared to control. In the past Carboxin has been recommended for the control of smut but in the present studies Hexaconazole and Propiconazole have expressed their superiority over Carboxin giving 97.63 and 97.43 percent disease control respectively.

References

- Andrews DJ, King SB, Witcomb JR, Singh SD, Rai KN, Thakur RP, Talukdar BS, Chavan SB and Singh P.1985a. Breeding for disease resistance and yield in pearl millet. Field Crops Research 11:241-258.
- Anonymous. 2009. Annual Report, All India Coordinated Pearl Millet Improvement Program, Indian Council of Agricultural Research, Mandore, Jodhpur.
- Anonymous, (2021). Agricultural statistics at a glance, Ministry of agriculture, GOI (New Delhi) pp-57.
- Hash CT, Thakur RP, Rao VP and Bhaskar RAG. 2006. Evidence for enhanced resistance to diverse isolates of pearl millet downy mildew through gene pyramiding. International Sorghum and Millets Newsletter 47:134 -138.
- Lukose CM, Kadvani DL and Dangaria CJ. 2007. Efficacy of fungicides in controlling blast disease of pearl millet. *Indian Phytopathology* 60:68-71.
- Mehta PR, Singh B, and Mathur SC. 1953. A new leaf spot disease of bajra (*Pennisetum typhoides* Staph and Hubbard) caused by a species of *Pyricularia*. *Indian Phytopathology* 5:140-143.
- Singh SD. 1995. Downy mildew of pearl millet. Plant Disease 79:545-550
- Thakur RP and King SB 1988b. Smut disease of pearl millet. Information Bulletin No. 25., Andhra Pradesh 502324, India: International Crops Research Institute for the Semi-Arid Tropics. 17 pp.
- Thakur RP. 1989. Flowering events in relation to smut susceptibility in pearl millet. Plant Pathology 38:557-563.
- Thakur RP and Williams RJ. 1980. Pollination effects on pearl millet ergot. Phytopathology 70:80-84.
- Thakur RP, King SB, Rai KN and Rao VP. 1992a. Identification and utilization of smutresistance in pearl millet. Research Bulletin no.16. Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 36 pp.
- Thakur RP and Rai KN. 2002. Pearl millet ergot research: advances and implications.

❖❖

ISSN No. 2583-3146

Low-Cost Plastic Rain-Shelter and Poly-Tunnel for Protected Vegetables Cultivation

Raghuveer Singh and T. Angami
ICAR Research Complex for NEH region
Arunachal Pradesh Centre, Basar
Corresponding Author: singhraghuver@gmail.com

Introduction

In Arunachal Pradesh, the high rainfall during pre-monsoon and South West monsoon period is one of the major limiting factors for low production of high value vegetable crops like king chilly, tomato, etc. The average annual rainfall is very high around 2,500 mm and the seasonal rainfall distribution indicates that 20.80 % and 63.20% rainfall occurred in pre-monsoon and South West monsoon period, respectively. The number of rainy days is 142 days, so in the rainy season, it is difficult to get rain free days. Indigenous farmers normally face major problems for production of vegetables in open field conditions due to heavy rainfall.

Hence, looking into aforesaid difficulties, ICAR Research complex for NEH region, Arunachal Pradesh centre, Basar has designed a low-cost rain-shelter along with rain water harvesting system to fulfil the water requirement for irrigation of the crops inside the structure. With the total amount of rainfall received, the structure has potential to harvest 2.8 lakhs liters of water in a year which is far beyond the requirement of the crops. This shelter is made up of the locally available bamboo and UV stabilized polythene (200 micron). Simultaneously, this centre organizes trainings, conducts awareness among the farmers to adopt low-cost protected cultivation technology and similarly structures were set up at the adopted villages of Tribal Sub-Plan (TSP) project. With these efforts, many farmers are ensuring better yields, greater price and are saving their input resources year after year that helped them to uplift their socio-economic livelihood in the state.

Seedlings of tomato (Arka Samrat F_1) were transplanted in the spacing of 90 x 60 cm on raised bed (1.8 x 1.8 m) and a total 144 plants were accommodated. To utilize the inter-bed space and side space, 50 king chilli plants were also accommodated. The king chilli plants were transplanted in 20 kg capacity of plastic bags. Tomato and was cultivated in two times (May-Aug. & Nov.-March). Regular monitoring and standard intercultural operations were done.

In the 1st year Rs. 15,184.00 was generated as income but from this small structure one can easily generate income of Rs. 1,41,312.00 within 3 years. The CB ratio of rain-shelter is 1.81. So, it may be a suitable option for protected cultivation of tomato and king chilly in such high rainfall areas. It is economically viable and also enables the farmers to grow high value low volume crops like king chilly, tomato, etc., for livelihood improvement of resource poor farmers through income generation.

Economy of Plastic rain-shelter

Items	Quantity	Amount (Rs.)	Items	Quantity	Amount (Rs.)
Expenditure for establishment of unit in the size: Length- 20 m, Width- 8 m & Height (One side-2.5 m & another side-2 m)					
UV stabilized polythene, 200-micron thickness	216 m^2	14,000.00	Bamboos (Post)	15 nos	2,250.00
Green agro-shed net -75%	80 m^2	3,500.00	Labours	15 nos.	5,250.00
Bamboos (medium)	100nos	6,000.00	Water tank 500 L cap.	2 nos	11,000.00
Steel raiser for water harvesting	7 nos	3,500.00	Plastic rassi (rope)	25 rolls	3,750.00
Binding wire	1.5 kg	450.00	Rose/watering cane	2 nos	700.00
				Sub-total	**50,400.00**
Operational cost (FYM-3900.00, labours-35000.00, lime-400.00, plastic rope-300.00)					39,600.00.
				Total	90,000.00

Total yield of tomato was 1108.80 kg and get return of Rs. 60,984.00 @ Rs.55 per kg, total fruit production of king chilli were 6800 nos. and get return of Rs. 44,200.00 @ Rs. 6.50 per fruit. Total return from tomato and king chilli was Rs.1,05,184.00. In 1st year net income was Rs. 15,184.00.

The life-span of the structure is minimum 3 years. The expected return from above structure during 2nd& 3rd year will be Rs.2,10,368.00 and the subsequently expected income will be Rs. 1,26,128.00 (2,10,368.00 - Operational expenditure of Rs. 79,200.00) - Maintenance cost of Rs. 5,040.00). Total benefit will be Rs.1,41,312.00 (Rs.15184.00 + 1,26,128.00).The cost: benefit ratio will be 1.81.

View of rain-shelter with water harvesting system

Tomato in vegetative stage

ISSN No. 2583-3146

Tomato in fruiting stage

Harvested tomatoes

Tomato + king chilli

King chilli in ripening stage

Harvested king chilli

Low-cost plastic tunnel for vegetables nursery

Growing of off-season vegetable nurseries under poly-tunnel structure has become profitable to the farmers. The cost of king chilly seeds is very high so, it is necessary that every seed must be germinated with maximum germination and it required controlled conditions. The main purpose of raising nursery inside the poly-tunnel is to get higher profit and disease-free seedlings in off-season to bring the early crop.

Similar to rain-shelter this structure also made up of the locally available bamboo and UV stabilized polythene (200 micron). Seeds of fully matured fruits of king chilly were sown inside poly-tunnel in lines with 8-10 cm spacing & 1 cm depth. After 45 days after sowing (DAS), seedlings were ready for transplanting. Seeds were sown staggered manner thrice a year (Nov.-Dec., Feb.-March & April-May). Regular monitoring and standard intercultural operations were done.

In the 1st year Rs.1,01,830.00 was generated as income. The CB ratio of plastic tunnel is 26.18. So, it may be a suitable option for protected vegetables nursery of king chilli in such high rainfall area.

Economy of plastic tunnel

Items	Quantity	Amount (Rs)
Expenditure for establishment of unit in the size: Length- 5.50 m, Width-1.50 m and Height -1.50 m		
UV stabilized polythene, 200-micron thickness	24 m^2	1,680.00
Bamboos (medium)	12 nos.	720.00
Labors	2 nos.	700.00
Plastic rassi (rope)	2 rolls	300.00
Sub-total	3400.00	
Operational cost (FYM-100.00, Neem cake-350.00 and lime-40.00)	490.00.	
Total	3890.00	

Total production of king chilly seedlings were 5286 numbers and get return of Rs. 1,05,720.00 @ Rs. 20 per seedling. In 1st year net income was Rs. 1,01,830.00. The cost: benefit ratio will be 26.18.

View of low-cost poly-tunnel

Healthy king chilli seedlings inside poly-tunnel

Advantages of low-cost plastic rain-shelter and poly-tunnel

- It provides conducive micro-climatic conditions for production of high-quality vegetables and allows growing multiple crops on the same piece of land in a year.
- It gives opportunity to fetch a better price of the produce by growing them in off-season.
- It supports well to easily raise nurseries of different vegetable crops and also protects them.
- Raising of vegetable nursery in poly-tunnel structure has manifold benefits such as easy management, early nursery and protected from biotic and abiotic stresses.
- It increases the yield productivity with better quality and attracts enhanced return per unit resource invested.
- It provides alternative venture to cultivate the vegetables in high rainfall areas.
- It also fulfils the demand of producing nutritionally rich and hygienically healthy vegetables due to lesser use of pesticides.
- It facilitates effective control to pests and diseases and becomes easier to produce disease and insect' free seeds of king chilli.
- Low-cost protected structures are ideally suited for progressive farmers having small holdings.

Constraints/Limitations of low-cost plastic rain-shelter and poly-tunnel

- High price fluctuations and lack of market information was the major of marketing constraints in the way of protected cultivation.
- In marketing channel of produce, the major constraints faced by the farmers include the bad road conditions and high cost of transportation.
- Frequent occurrence of windstorms, hailstorms is the serious constraints.

Conclusions

ICAR Research complex for NEH region, Arunachal Pradesh centre, Basar has designed a low-cost rain-shelter along with rain water harvesting system. The rain-shelter is made up of the locally available bamboo and UV stabilized polythene (200 micron). Inside rain-shelter tomato (Arka Samrat F_1) and king chilli plants were grown and income of Rs. 1,41,312/- was generated with recorded CB ratio of 1.81.Similar to rain-shelter poly-tunnel was also set up with locally available bamboo and UV stabilized polythene (200 micron). Under this structure seeds of fully matured fruits of king chilly were sown in staggered manner thrice a year (Nov.-Dec., Feb.-March & April-May) and From this structure, the recorded CB ratio was 26.18. So, it may be a suitable option for protected vegetables nursery of king chilli in such high rainfall area.

Future prospects

Revalidating the developed agro-techniques under harsh climatic condition and refining the technologies developed as per need and demand.

❖❖

ISSN No. 2583-3146

Factor Associated with the Fruit Drop and their Management

Devi Darshan[1], Kuldeep Kumar Shukla[2], Komal Preet Kaur[3], Kriti Gupta[4] and Deeksha Gautam[5]

[1, 2&4]Department of Fruit Science Punjab Agricultural University, Ludhiana

[3&4]Department of Fruit Science and Horticulture Tecyhnology, O.U.A.T., Bhubaneswar

Corresponding Author: devidarshantiwari@gmail.com

Introduction

Fruit crops play a significant role in the food and nutritional security of the country because it's necessary to increase both the production and quality of these crops. In the world, fruit crops cover an area of 65.20 million hectares and produce 883.4 million metric tonnes with a productivity of 13.5 t/ha. Among the countries, China has the largest area and production of fruit crops, followed by India. Fruit drop is the premature abscission of fruits before it is fully ripe. Early drops of flowers and fruits are not a great matter of concern, the problem for orchardists is abnormal fruit drop. A cries cross review on the causes of fruit drop reveals that dropping of fruit occurs due to non-fertilization, embryo abortion, nutritional deficiency, hormonal imbalances, formation of abscission layer, drought or lack of irrigation, unfavourable climatic conditions during fruit development period, cracking, insect-pest attack and diseases. Nutrients and plant growth regulators have been reported to be useful in overcoming this problem in many fruit crops. But, more research should be carried out to control the fruit drop which may be due to biotic and abiotic stresses.

Fruit drop in mango

Fruit drop in citres

Causes of fruit drop

Internal factors

Conditions of pollination and fertilization

The extraordinary significance of floral pollination and fertilization is particularly evident in walnuts. When a significant amount of viable pollen is recognized as being harmful, the rare instance of "over pollination" leading to the abortion of female flowers is observed. Insufficient pollen production appears to be even more advantageous because it may lead to the creation of apomictic seeds, which could compensate for the absence. The timing of pollination and fertilization has little bearing on when the fruit will eventually fall. According to Ortega *et al.,* (2004), fruit drop is more common in almonds if pollination is done on the fourth or sixth day following the emasculation of flower buds, which is close to the end of the effective pollination period. Late-maturing sweet cherries generally exhibited greater rates of fruit drop, which is linked to the abortion of the embryo. The remaining cherries are kept until because embryo abortion frequently happens in super-early cherries during the second stage of pericarp growth.

Seed content of fruits

Fruit species including apple, pear, quince and currants, which produce fruits with more than one seed, preferentially drop the fruits with the fewest seeds. As a result, types that produce fewer seeds are actually more vulnerable to environmental challenges, such as water stress, inadequate nutrition, etc. and are more likely to lose fruit. The presence of seeds in the fruit is the primary need for keeping it on the tree. The crucial fruit seed content mostly depends on the species or variety. According to Teskey & Shoemaker (1972), when the fruit set was plentiful, apple fruits with less than three seeds were shed first. Murneek (1987) estimated the fruit drop of pears containing less than 3 seeds per fruit.

Competition between the organs of plants

Competition between the vegetative and generative organs

The fruits will drop if the source and subsequently the movement are reduced (such as when the leaves of the short branches were eliminated) (Roper *et al.,* 1987).Atkinson *et al.,* (2001) reported a decline in fruit size rather than fruit drop. Only during the two-week period leading up to harvest time did fruits diminish due to the poor ratio of leaf area to quantity of fruits. One apple fruit set requires 1-4 leaves around the time of petal loss, 10-15 leaves around the time of June drop, and 40 leaves at the end of fruit development. For fruits to establish more than one per inflorescence and for fruit drop to not occur, a relative greater leaf area is required.

Competition between the generative organs

It is widely acknowledged that the buildup of organic matter in a big mass of flowers or fruit primordia is not optimum, resulting in a vigorous drop of fruit. The rate of fruit set was often low after a supernumerary bloom. The flower or fruit set that began growing earlier becomes dominant in comparison to other flower or fruit sets that delayed significantly, according to the physiological explanation presented forward.

External factors

Climatic and meteorological conditions

Premature fruit drop is typically brought on by a variety of circumstances, including highly likely unfavourable environmental conditions. Meteorological events preceding, during and following floral development and vigour, bloom, fertilization and flower subsequently fruit drop are extremely

important. Late frosts that occur in April and May in the moderate climate significantly harm blooming buds, flowers and early fruit primordia, mostly by destroying crucial conducting tissues and causing fruit drop before and after fruits are set. Temperatures experienced during bloom are already affecting the embryo sac's viability and longevity, which lowers the probability of fruit set. Each degree of increase will shorten the embryo sac's life span by one day as long as the mean temperature stays below 17° C. Low temperatures above freezing also reduce the embryo sac's viability. The damage could go undetected, render the flower partially or completely sterile, and speed up floral wilting. Damages are also anticipated as a result of the unusually high temperatures.

The influence of phytotechnical interventions on fruit drop

Fruit thinning

It is intended to lessen conflict between the fruit's competing generative and vegetative organs, which is one of the main reasons of fruit drop.

Irrigation, water supply

One of the explanations why fruit falls off is because of the limited water supply. Watering plays a crucial function in growing environments that are dry or arid. It is also known that watering can prevent fruit from dropping off prematurely. In addition to raising the air humidity in the canopy, the above-crown water spray also effectively lowers the temperature of the leaves and fruits.

Nutrition

An overload of fruits is often considered to induce drop of young fruit because of the relative scarcity of nutrients. Martinez*et al* (1973) based their attempts on data raised by leaf analysis as to predict the imminence of fruit drop. Papp (2003) accentuated the role of nitrogen being essential for a normal fruit set and later in avoiding the threatening June drop. Tarita *et al.,*(1979) stated the same in relation of sour cherry, which could be saved from the first fruit drop by nitrogen.

Harvest

In order to control fruit drop, the timing of harvest is crucial, especially for types that are prone to preharvest fruit drop. Harvest equipment is also crucial, particularly for mechanical harvest.

The role of biotic factors

Diseases

A *Xanthomonas* infection causes walnuts to drop their blossoms (or catkins).Fruit drop is typically attributed to the fungus *Monilinia fructicola*, which causes fruit rot. It causes significant preharvest fruit drop and is polyphagous, occurring in many different fruit species. The peach leaf-curl disease (*Taphrina deformans*) can also cause protuberances and discolorations on the fruit. Premature fruit drop in apricot and peach trees carried on by scab (*Venturia carpophyla*) is particularly dangerous during an extended drought, especially when water stress is present.

Pests

One of the most common causes of fruit drop is animal pests. *Omophlus proteus*, the beetle, prefers to live on delicious cherries. The stamens and stigmata of flowers are the primary food sources for the images, though they may also eat the pistil or immature fruit primordium. In the past, the fruit was drilled randomly. The damaged fruit or flower primordium is withering and will soon disappear. After feeding on green stone fruits during the preharvest phase, the peach moth (*Anarsia lineatella*) causes fruit drop.

Table 1: List of fruit crops which are highly prone to fruit drop and its control measure

S.N	Name of fruit crops	Control measure
1	Mango	Spraying of 2,4 D @ 10 ppm or NAA @ 50 ppm at marble stage helps in preventing fruit drop Providing pollinizers for self-incompatible variety Maintain soil moisture Provide wind breaks
2	Citrus	Prune citrus trees to remove diseased dead twigs during January to February after the fruit set and spray Bordeaux Mixture (2:2:250) or Copper oxychloride 50 WP (3g/liter of water) Repeat spray in March, July and September to reduce die-back of twigs, Collect and destroy all the pruned wood by burning Spray GA3 (10 mg/liter of water) in mid-April, August and September Apply the recommended fertilizers to maintain the health of the trees Give irrigation according to the requirement Avoid stagnation of water for longer period in tree basin
3	Grape	Cultural practices, maintain C: N ratio Balance use of fertilizers and minerals Planofix @ 100 ppm is most effective in reducing post-harvest berry drop (spray at 1-2 week before harvest NAA@ 20-50 ppm for controlling post-harvest berry drop
4	Jamun	GA_3 @ 20 ppm or 2, 4-D @ 5 mg/l reduced the bud drop and fruit drop in jamun NAA@ 5 ppm or 5 mg/l reduced the bud drop and fruit drop in jamun Girdling practices also reduced the fruit drop in jamun
5	Apple	NAA @ 10 ppm to prevent the preharvest fruit drop 2,4, 5-T @ 20 ppm 2,4, 5-TCPA @ 15
6	Litchi	Two foliar sprays of 0.2% Boron to improve pollen germination Fruit growth and development and for enhancement of fruit retention When fruits reach peanut size, two foliar treatments of Plano Fix @ 4 ml/5 litres of water may be made at intervals of 15 days When sprayed on panicles, plant growth regulators such NAA at 20-30 ppm, GA at 20-25 ppm, and 2,4-D at 10-20 ppm are helpful at reducing fruit drop. Sprays of $ZnSO_4$ @ 0.2% and synthetic auxins like 3, 5, 6-TPA can lessen fruit drop before the bloom opens

10	Ber	To manage physiological fruit drop in ber, use two sprays of 15 g NAA (Naphthalene Acetic Acid) in 67 500 litres of water per acre once in the second fortnight of October and once in the second fortnight of November.
13	Plum	Two sprays of NAA 10 ppm (Dissolve 1 gram NAA in 10-15 ml alcohol and then make a 100 liter solution with water) in the second and fourth weeks of April or one spray of Ethrel 100 ppm (25 ml Ethrel in 100 liters of water) in the fourth week of March (after pit hardening) reduced pre-harvest fruit drop in the plum *cv.* Satluj Purple.

Conclusion

Preharvest fruit drop has been a rcognized as severe problem in fruit production and a big challenge for horitultural industry, in which fruit abscise from the tree prior to horticultural maturity. The pre harvest drop is affected by various horiticultural and climatic factors, but the role of these factors has not been fully investigated. The control measures have been only relied upon the use of PBR,s Inspite of efficient control measures available for controlling this problem a well-organized research is needed to invetigate the affect of various factors, new PBR's management strategies and breeding solutions to reduce the incidence of fruit drop, which may improve the profitability of drop prone cultivars and ultimately reduce crop loss.

References

- Anonymous (2020) FAOSTAT agricultural data base. http:// faostat.fao.org/faostat/.
- Racskó, J., Leite, G. B., Petri, J. L., Zhongfu, S., Wang, Y., Szabó, Z & Nyéki, J. (2007). Fruit drop: The role of inner agents and environmental factors in the drop of flowers and fruits. *International Journal of Horticultural Science*, *13*(3), 13-23.
- Pór, Á. – Pór, J. (1990): The effect of the excess of pollen on the fruitset of walnuts in Balatonboglár. Acta Hort. 284: 253–256.
- Singh, Z. – Malik, A.U. – Davenport, T.L. (2005): Fruit drop in mango. Horticultural Reviews. 31: 111–153.
- Szentiványi, P. (1990a): Effect of fertility auto-regulation on productivity of walnut. Acta Hort. 284: 251.
- Szentiványi, P. (1990b): Effect of fertility-autoregulation on variety-combinations of walnut. Acta Hort. 284: 257–260.
- Timmer, L.W. – Brown, G.E. (2000): Biology and control of anthracnose diseases of citrus, p. 300–316. In: Prusky, D. – Freeman, S. – Dickman, M.B. (ed.) (2000): Colletotrichum: Host specificity, pathology, and host-pathogen interaction. APS Press, St. Paul, Minn.

❖❖

ISSN No. 2583-3146

Importance of Forages in Livestock Nutrition

Sowmiya S.* and R. Ranjith

Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore

Corresponding Author: kokisowmani97@gmail.com

Introduction

Forages are vegetative parts, fresh or preserved, utilized as feed for animal. Forage crops provide bedrock to sustainable agriculture. Forage is defined as the edible parts of plants, other than separated grain, that provide feed for grazing animals or that can be harvested for feeding. Forage crop mainly consist of family Fabaceae (Leguminosae) and Poaceae (Gramineae) and used in the form of hay, pasture, fodder and silage. Forages play an important role in cattle industry, enhancing crop diversity wildlife habitat and soil ecosystem.

Crops grown for animal feed

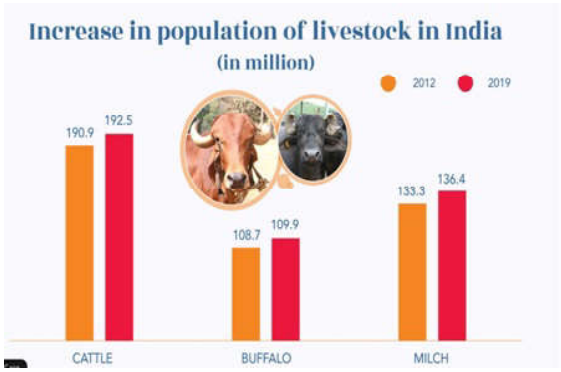
Crops name	Scientific name
Cumbu napier	*Pennisetum glaucum*
Guinea grass	*Panicum maximum*
Blou buffel grass	*Cenchrus glaucus*
Fodder maize	*Zea mays*
Berseem	*Trifolium alexandrinum*
Muyal masal Lucerne / Alfalfa Subabul	*Stylosanthes hamata* *Medicago sativa* *Leucaena leucocephala*

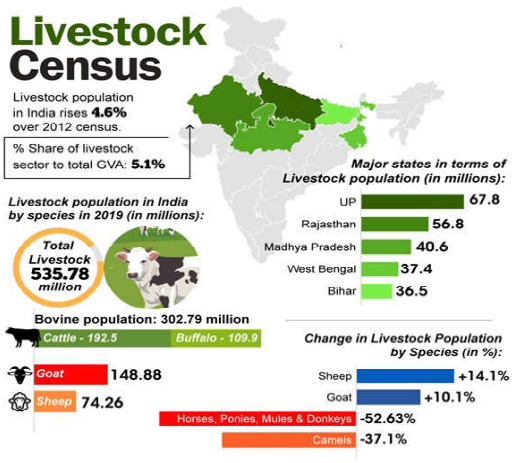
Keywords: Forages, Hay, Silage

Importance of Forage crop

Livestock population

- India has the largest livestock wealth while the animal performance is one of the lowest in the world.
- India has highest animal wealth in the World with 535.78 million in 2019.
- The current feed and fodder resources in India can meet only less than 50% of the requirement of its livestock population of 535.78 millions.
- Only 6.9 million ha. or 4.4% of the countries cropped area is under fodder





crops because of pressure on agricultural land for food and cash crops.

Grazing resources

- The forest grazing resources are reducing roughly 1.5 millions/ ha. /every year. There is lack of sufficient good quality fodder.

Grazing Resources in India

Resources	Area (Million ha)	Percentage
Forest	69.41	22.70
Permanent pastures, grazing lands	10.90	3.60
Cultivable wasteland	13.66	4.50
Fallow land	24.99	8.10
Barren uncultivable wastelands	19.26	6.30
Total common property resources other than forests	54.01	17.70

Source: vision 2050, www.igfri.res.in

- The main reason for poor performance of cattle and buffalos in India are inadequate supply of nutritious forage and feeds (malnutrition, under-nutrition or both) and lower production potential of the animal.

Nutritive Value of Fodder Crops

- Livestock need fiber for rumen health. Forage dry matter consumption should be near 2% of the body weight.
- Provide at least 2 Kg of fibre a day. We are highly deficient in various livestock products, though we have about one-fourth of the total cattle population of the world.
- The success of an efficient diary, sheep, goat, piggery, poultry and other livestock industry revolves around the supply of nutritious forage and feeds.
- Green fodder is the primary only source of vit A for lactation, vit 'A' is present in the form of precursor.

Carotene Content of some fodder	
Agathi	18.3 mg / 100 dry matter
Lucerne	15.6 mg / 100 dry matter
Guinea grass	14.2 mg / 100 dry matter
Desmodium	7.09 mg / 100 dry matter

Forages are highly digestible (55 – 65%) mostly when harvested at a proper time. The crude protein may range from as little as 3% in very mature forages to over 30% in young heavily fertilized grass (on DM basis).

Source: vision 2050, www.igfri.res.in

Table : Projected requirement, availability and deficit of CP and TDN (million tonnes)

Year	Requirement		Availability		%Deficit	
	CP	TDN	CP	TDN	CP	TDN
2010	60.04	347.8	42.95	271.3	28.47	21.99
2020	62.58	372.5	47.18	290.5	24.60	19.87
2030	67.01	388.2	53.09	320.2	20.78	17.52
2040	70.19	406.6	57.61	342.8	17.92	15.69
2050	74.44	431.2	61.92	364.5	16.81	15.47

Estimations are based on following assumptions

Concentrate feed avaiability data were taken from different sources nd projected. Factors for conversion of DM from each source into TDN were taken as 0.53 for given forage,0.40 for dry forage and 0.70 for concentrate feed:Factors for conversion of DM from each source into CP were 0.04, 0.15 and 0.18 for dry forage, green forage and concentrate feed, respectively.

The soluble carbohydrate of grasses ranges in the dry matter from 4-30%. The cellulose and hemicellulose are generally within the range of 20-30% and 10-30% of the dry matter respectively. Grass proteins are particularly rich in arginine, glutamic acid and lysine. Green forages are excellent source of carotene 250mg/kg), the precursor of vitamin A.

Generally leguminous fodder contains 8-12% DCP and 45-60% TDN. The phosphorus content of leguminous fodder is poor. It is advisable to supplement a ration containing a large amount of leguminous fodder with a limited quantity of wheat or rice bran, which is rich in phosphorus.

The non-leguminous fodder is having 2.5% DCP and 45-60% TDN on dry matter basis. Green fodder is the primary source of vitamin A. Vit. A is present in the form of precursor. Green fodder contains 100 mg carotenes /Kg when compared with about 20 mg /Kg in silage. Carotene requirement of milch animals is 60 mg for production; 30 mg for pregnancy, for growth requirement is 11 mg carotene per 100 Kg live weight. Vit. A is directly related to vision, maintenance and function of mucous membrane, essential for reproduction (for conception, maintenance of pregnancy, shedding of placenta), deficiency leads to diarrhoea, mal absorbtion of nutrients, incidence of stone in the kidney, ureter & bladder. During lactation 2000 I.U. of Vit. A is eliminated in milk

Green forages have

- Cooling effect on the animal body
- More palatable contain easily digestible nutrients
- Provide fresh effectively utilizable nutrients in natural form
- Slightly laxative.
- The use of concentrates give the greatest animal production per unit feed intake, but this may not be economical in countries like India where grains and concentrates are costly and in short supply.
- The grazing intensity is very high in monsoonal grasslands of India viz., 2.6 adult ha^{-1} against 0.8 adult ha^{-1} in developed countries. This underlines the need to rejuvenate the natural grass lands, pastures and also to increase the productivity of forage crops.
- There is tremendous pressure of livestock on fodder, as land available for fodder production has been decreasing.
- Scenario of fodder availability till 2050 is as below.

Table: Demand and supply estimates of dry and green forages (million tonnes)

Year	Demand		Supply		Deficit		Dficit as %	
	Dry	Geen	Dry	Green	Dry	Green	Dry	Green
2010	508.9	816.8	453.2	525.5	55.72	29.13	10.95	36.55
2020	530.5	851.3	467.6	590.4	62.85	260.9	11.85	30.65
2030	568.1	911.6	500.0	687.4	68.07	224.2	11.98	24.59
2040	594.9	954.8	524.4	761.7	70.57	193.0	11.86	20.22
2050	631.0	1012.7	547.7	826.0	83.27	186.6	13.20	18.43

*Assumptions

For calculation of demand of dry and green forages, concentrate feed's data were adopted from article 'India's livestock feed demand. Estimates and projections. Dikshil, AK. and PS Birthal. 2010 Agricultural Economics Research Review. 23(1), 15-28. Green forage, dry forage and concentrate feed were converted into Dry Matter (DM) applying a factor of 0.25,0,90 and 0.90 respectively. Area under fodder crop and pastures were extrapolated and divided into irrigated and un-irrigated areas. Supply of green folder was calcuated using a factor of 50 and 70 i/ha for arrigulated and irrigated areas. For poature sources. A factor of 1.2 to 1.5 t/ha was used for green forage supply.

Source: vision 2050, www.igfri.res.in

Environmental effect

- Forages play an important role in maintaining a good natural environment.
- Communities of forage plants .
- produce oxygen for clean air.
- Reduce soil erosion.

- Keeping sediment out of waterways.
- provide food and shelter for wildlife.
- Beautifly our surroundings with a variety of foliage and flowers.

Important forage-based products

Products	Source
Milk, Cheese, Butter, Cream	Milk from dairy cows that eat FORAGES
Wool	Shearing from sheep that eat FORAGES
Leather	Hides from animals that eat FORAGES
Beef, Mutton, Lamb, Venison	Meat from beef cows, sheep, and other FORAGES
Biomass Fuels	Fiber from switch grass, alfalfa, corn and other FORAGES.
Medicinal Products	Biochemical intermediates from FORAGES

- Forage crops having grass root systems can improve organic matter content of the soil and reduces soil erosion.
- Forage crops contain rich in vitamins, fiber and proteins that enhance metabolic activity of the animals.
- Forage crops are rich in minerals which helps poultry for bone, eggshell formation, fluid balance and in hormone production.
- Forage crops reduce weed development.

Conclusion

The gap of demand and supply of forages needs to be bridged by maximizing forage production by space and time (intensification), identifying new avenues of forage production, integration of forage crops in existing cropping and utilization of marginal, sub-marginal degraded and problem land. Revitalizing fodder production through agronomic management of forage crops, scientific cultivation of fodder crops, adoption of Silvi-pastoral System, Agri-silvi-pastoral system, Agri-horti-silvi-cultural system and Horti-pastoral system.

References

- www.nddb.coop
- vision 2050, www.igfri.res.in

❖❖

ISSN No. 2583-3146

A Traditional Method of Soil Nutrient Management Using the Tank Silt Amendments

R. Ranjith[1], A. Arun[2] and C. Vengatesan[3]

[1]Department of Agronomy, Tamil Nadu Rise Research Institute, TNAU, Aduthurai

[2]Department of Agronomy, Sethu Bhaskara Agriculture College & Research, Karaikud

[3]Department of Agronomy, JSA College of Agriculture, Tholudur

Corresponding Author: ranjithagrontnua@gmail.com

Introduction

In India, food crops is the most important and extensively grown field crop occupied an area of 272.8 million hectare with a production of 310.74 million tones and has average productivity of 3.6 t ha^{-1}. The existing mostly sandy loamy soil and various higher proportion sand in other major soil types noticed for less productivity in India. Delayed monsoon rainfall and also inadequate quantity of water leads to low soil moisture content which in turn affects fertilizer use efficiency. However, there were several constraints noticed in the above said area. Of the constraints, delayed monsoon rainfall with inadequate quantity seems to be the major ones. In addition, more sandy with low clay content of the above soil type having low organic carbon content cause less moisture retentivity that in-turn lead to nutrient loss due to leaching resulting in poor nutrient use efficiency. As a result, there was poor growth and development of crop finally less yield. In order to manage the above constraints particularly the low clay, loamy and high sandy nature of the soils, having tank silt like amendments would make the soil more ideal for better crop growth by improving physical properties of the soil, which can be made possible by application of tank silt with high clay. When the tank silt is applied to the above high sand proportion soil, it could reduce not only the moisture loss but also the nutrient loss as well.

What is tank silt?

Valuable nutrient-rich top soil from the catchments area comprising undulated wastelands and rainfed agricultural lands, which is carried along. Rainfall runoff with eroded top soil from surrounding lands filling the tanks.

Tank Silt Application

Tank silt is a fine soil brought from surface runoff during rainfall from catchments area along with crop debris and is deposited as sediment in the tank water spread area and decomposed over a period time. Upto 2-3 feet sediment (tank silt) was excavated and transported and spread in agricultural field and incorporated during ploughing. It provides the potential for enhancing crop productivity.

Impact of tank silt on Soil

Silty soil is usually more fertile than other types of soil, meaning it is good for growing crops. Silt promotes water retention and air circulation. Too much clay can make soil too stiff for plants to thrive. So, using the tank silt it overcomes those problems. It has proven for multiple benefits on climate resilient farming that can be promoted in large scale. This silt is considered to be rich in organic matter. It is mainly applied to improve soil and moisture conservation, enhancement of water holding

capacity as well as increase the aeration, porosity and nutrient status of the soil for a good crop growth. Application of tank silt in sandy clay loam soil will effectively improve the bulk density, particle density and porosity of the soil. As the tank silt amendment improves the physical properties of soil *viz.,* bulk density, particle density and water retentive capacity of soil.

Application of tank silt in sandy clay loam soil would improve the clay and organic carbon content, which has direct influence on EC and pH of soil. Tank silt have higher amount of organic carbon content than cultivated field soil. Application of amendments in sandy clay loam soil may increase the organic carbon content. Further more, this may enhance the microbial population and soil activity.

The poor physical, chemical and biological property of the soil heightens the ill effects of climate change, which significantly affects the rainfed cropping. Tank silt applied in poor structured soil slightly hybridizes the normal soil. Further more favourably enhance the physical, chemical and biological properties of soil.

Impact of tank silt on Crop Production

Tank silt is a locally available organic amendment and low cost substitute for chemical fertilizers. Application of tank silt amendments, it will be reduce the leaching losses of nutrients that would improve the soil nutrient availability which is most essential for increasing the yield of crop. Application of tank silt on agricultural field once in three years is one of the indigenous technical knowledge, it followed by farmers. As the tank silt has higher amount of available nitrogen and potassium, it could enhance the crop growth and development in poor structured soil. The application of tank silt @ 20 t ha^{-1} recorded highest yield in groundnut (Binitha, 2006). Tank silt application is significantly increased the yield of groundnut, maize, rainfed ragi, tomato, mulberry and irrigated finger millet is 60%, 77%, 80%, 80%, 80% and 80% respectively compared with unamended field (Krishnappa *et al.*,1998). Soil amended with tank sediment at the rate of 20 t ha^{-1} was significantly increased the Bengal gram yield (Ramesh, 2001). Groundnut yield was attained to higher with the combined application of farm yard manure and tank silt in each at the rate of 12.5 t ha^{-1} (Jeyamangalam and Fathima, 2019).

Conclusion

From the previous discussion, it can be concluded that, organic amendments *i.e.,* tank silt not only reduce the rate of nutrient losses but alongside they played an immense role in improving the physical, chemical and biological properties which is improve qualitative characters and most importantly tremendously enhanced the yield and yield contributing traits in crops.

References

- Binitha, N. K. 2006. "Characterization of tank silt on northern Karnataka and evaluation of the effect of tank silt on growth and yield of groundnut."
- Jeyamangalam. F., and Fathima N.M. Rasool. 2019.''Short term effect of manure on the physicochemical properties of the soil and yield of groundnut''. Indian journal of Agricultural Science. 11(1):20-23.
- Krishnappa, A. M., Ranganna, B. Raman gouda, P. and Arun Kumar, Y. S,. 1998. "Karnataka Rajyada Dakshnina Jillcgalalli kerehoolettuva karyakramada upayuktate mattu artliikathe; Kolar Jilleya Anubhava".
- Ramesh. N. R. 2001. "Characterization of tank silts of Dharwad district. M.Sc. (Agri.) Thesis. Univ. of Agric. Sci., Dharwad."

❖❖

ISSN No. 2583-3146

Post Harvest Management and Value Addition in Fruit Crops

N. R. Rangare*, Anay Rawat and D. P. Sharma

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

Corresponding Author: nrrangare@gmail.com

Introduction

India is the second largest producer of fruits in the world after China. The area and production of fruits is 69.82 lakh ha., and 812.85 lakh MT (Source: National Horticultural Board 2012-13. As per the estimates, by Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana, the wastage of fresh horticultural produce is upto 18 percent due to poor post harvest management practices. Hardly 2 percent of perishable horticultural produce is processed to value added products. Hence, there is huge scope for processing of fruits and vegetables. This wastage can be easily prevented by adopting various methods of preservations. At the same time, there is market glut during harvesting season and farmers are forced to sell their produce at throw away prices. Therefore, food processing industries can help farmers to get sure income for their produce and also avoid market glut. Processing is the exceptional manner of making use of surplus manufacturing of culmination at some point of seasonal gluts.

Advantages of processing

- Helps in changing perishable culmination in to long lasting form.
- Fruits, which can be very tough to devour out of hand may be processed in to more than a few incredibly suited fruit product.
- Helps in decreasing wastage.
- Value addition. Methods of processing of culmination into products.
- Preservation with the aid of using warmth treatment.
- Asecptic packaging.
- Preservation of with the aid of using elimination of warmth.
- Quick freezing.

Table: Recommended temperature, relative humidity and storage life of fruits

Fruit	Temperature (ºC)	Relative humidity (%)	Approx. storage live (weeks)
Custard apple	7-10	85-90	1-2
Guava	5-10	90	2-3
Jackfruit	11-12.8	85-90	3-5
Mango	13	95-90	2-3
Pineapple	7-13	85-90	2-4
Pomegranate	0-5	90-95	2-3 months

Mango (*Mangifera indica*)

It is belongs to the Family Anacardiaceae. Approximately 50% of all tropical fruits produced worldwide are mangoes. Mango is an important fruit crop in India and popularly

Table: Composition of some tropical fruits (per 100g if edible portion)

Fruits	Edible portion (%)	Moisture (%)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbohy-drates (g)	Carot-ene(g)	Vita-min (mg)
Aonla	89	81.8	0.5	0.1	0.5	3.4	13.7	9	600
Bael	64	61.5	1.8	0.3	1.7	2.9	31.8	55	8
Custard apple	45	70.5	1.6	0.4	0.9	3.1	23.5	-	37
Jackfruit	30	76.2	1.9	0.1	0.9	1.1	19.8	175	7
Guava	100	81.7	0.9	0.3	0.7	5.2	11.2	0	212
Jamun	75	83.7	0.7	0.3	0.4	0.9	14.0	48	18
Mango	74	81.0	0.6	0.4	0.4	0.7	16.9	2743	16
Phalsa	69	80.8	1.3	0.9	1.1	1.2	14.7	419	22
Pomegranate	68	78.0	1.6	0.1	0.7	5.1	14.5	0	16
Sapota	83	73.7	0.7	1.1	0.5	2.6	21.4	97	6
Tamarind*	-	20.9	3.1	0.1	2.9	5.6	67.4	60	3
Wood apple	53	64.2	7.1	3.7	1.9	5.0	18.1	61	3

called the 'king of fruits'. Mango is the most widely cultivated fruit in India. India is the major Mango growing country. It is a rich source of vitamin A and C. Raw fruits are used for preparing various traditional products like raw slices in brine, amchur (mango) powder, pickle, murabba, jam, chutney, panhe (sharabat) etc. Mangoes are harvested with the aid of using hand if the pickers can attain them. Fruits on excessive branches are harvested with a choosing pole having a material bag and reducing knife on the top. Fruits are to be harvested with little stalk to save you latex trickling which ends up in stem quit rot.

Mangoes are normally harvested at physiological mature stage and it takes 6-14 days to ripen below ambient conditions. The ripening phenomenon is related to conversion of starch to sugars and lack of firmness of fruit. Mango is one such fruit, which may be processed at nearly each degree of growth, development, adulthood and ripening. Raw mango end result is applied for mango powder, pickle, chutney etc. A first-rate drink also can be crafted from inexperienced mangoes. Ripe mangoes are applied for making slab, toffee numerous liquids together with nectar, squash etc. Drying after exposing to sulphur fumes additionally preserves ripe mango slices. Methods have additionally been standardized to provide cryogenically (liquid N) frozen mango slices.

Guava (*Psidium guajava*)

Guava end result re maximum typically harvested with the aid of using hand. Firm yellow to half-yellow mature end result are harvested. Over ripe end result are without difficulty broken in delivery and handling. Fruits which might be immature while harvested do now no longer change into excellent ripe end result. Guava end result may be saved in ventilated polyethylene luggage for 10 days at ambient temperature 18-20°C. Guava could be very famous as a sparkling fruit due to its first-rate taste, excessive nutrition content material and 100% edibility. This fruit is similarly important for the processing industry. A massive range of processed products are made from guava. Because of presence of wealthy quantity of pectin, a excessive excellent herbal jelly is acquired from guava. Processed guava pulp is a first-rate uncooked fabric for guidance of diverse different guava products inclusive of nectars, beverages, jams, toffee, cheese, ice cream topping etc. Guava pulp may be preserved correctly in bulk both with the aid of using utility of heat (asceptic packaging)

or addition of chemical preservation (SO_2). Cannel guavas with sugar syrup (40° Brix), dehydrated guavas, and guava powder are the other important products.

Pomegranate (*Punica granatum*)

Pomegranate is highly famous as a sparkling fruit; it isn't always used for processing to a amazing extent. Pomegranate juice is fairly appropriate drink. The steps in making of juice drink include, extraction of juice, rationalization in a flash pasturizer, cooling, settling for twenty-four hours, racking up, filtering warmth preservation. Anardana is crafted from pomegranate seeds, in particular of the bitter type, after drying that we're used as acidulant for culinary purpose.

Custard apple (*Annona squamosa*)

Custard apple is harvested in numerous instalments, however the satisfactory harvesting level is while the corporation fruit starts off evolved to expand colour. It is commonly picked while it turns into creamy yellow among the segments and starts off evolved to crack slightly. The fruit has the tendency to burst open if saved at the tree for a protracted time. Custard apple is incredibly perishable and cannot be saved for lengthy time. It may be saved efficaciously for nine weeks at 7-10oC with 85% to 95% RH. Lower garage temperature induces chilling injury. Custard apple may be saved for nine days after treating with 50 ppm Bavistin and setting in a polythene bag containing $KMnO_4$ in comparison to untreated culmination for five days. Custard apple isn't always used for processing reason to an exceptional extent. On heating the pulp at develops bitterness. To pulp may be frozen efficaciously to be used within side the ice cream industry. Ready to serve beverages are prepared from custard apple. Bitterness of the pulp may be eliminated via way of means of treating with peptic enzyme.

The pulp may be frozen efficiently to be used in ice-cream industry. At CRIDA, a easy approach has been evolved for guide extraction of custard apple pulp via way of means of rotatory movement of a spherical hair comb within side the scooped fruit held in stainless-steel sieve. This pulp may be provided to the ice-cream industries.

Jackfruit (*Artocarpus heterophyllus*)

The fruit is used each with inside the unripe and ripe stage. Raw jackfruit is popularly used as a vegetable. Fully mature however unripe culmination is harvested and look and a stupid sound upon tapping decide fruit maturity. Ripe jackfruit is ate up as a dessert fruit. Jackfruit leather-based is likewise prepared from the ripe or semi-ripe fruit. A palatable beverage pay attention may be crafted from jackfruit pulp via way of means of including sugar, citric acid and water. In addition excessive elegance canned, frozen and dried Products together with nectar, preserves confections and so forth may be organized from the ripe culmination. The raw jackfruit applied for making pickle, canned and curried vegetables. The wastes (skins, peels and cores), which represent approximately 45% of the full fruit weight, had been observed to be a reasonably properly supply of pectin.

Bael fruit *(Aegle marmelos)*

The Bael fruit is thought for its medicinal properties. The Bael fruit is one of the maximum nutritious. It consists of 61.5 g of water, 1.8 g of protein, 1.7 g of minerals, 31.8 g of carbohydrates and 1.19 mg of riboflavin/ a hundred g safe to eat portion. It can be cited that no different end result has this sort of excessive content material of riboflavin. Bael fruit has been used from time immemorial for processing within side the mature green shape to put together preserves. The trouble within side the extraction of ripe Bael fruit pulp is triumph over with the aid of using addition of water identical in weight to the pulp, adjusting the pH to 4.3 with citric acid and heating at 80°C for one minute, earlier than passing via

the extractor/pulper. Addition of water dilutes the mucilage and the software of warmth rot most effective inactivates the enzymes however additionally facilitates in dissolving the mucilage uniformly at some stage in the pulp. The fruit pulp hence received has nearly the identical consistency and shade as mango pulp. Ripe Bael fruit pulp, if extracted nicely may be used for the coaching of diverse fruit Products viz., nectar squash/leather/slab, powder etc., which may be commercially exploited.

Aonla *(Phyllanthus emblica)*

The fruit is distinctly nutritious and is a rich source of pectin and polyphenols other than ascorbic acid. Aonla culmination is widely recognized for his or her medicinal properties. The culmination is used for curing persistent dysentery, bronchitis and diabetes. The garage of Aonla relies upon on adulthood at harvest. The fruit maintains properly in cool chamber for 17-18 days in comparison to 8-nine days at ambient temperature. Aonla fruit is seldom consumed fresh but the fruit is valued highly in the Ayurvedic system of medicine. In Ayurvedic preparation like 'Chyavanprash' and triphala, Aonla is one of the main ingredients. Fruit products like pickle, preserve, candy, jam, syrup and dried shreds are made from Aonla. Aonla preserve is very important article of commerce and is in great demand. Streaming or blanching the fruit prior to processing can minimize ascorbic acid loss in the products. It is also used in tanning and dyeing industries.

An approach has been advanced at CRIDA for separation of segments of aonla and cast off nut with the aid of using steaming. These segments had been used for instruction of various Products. In a examine at the suitability of various types for processing into sweet, murabba and pickle, the sweet of range Chakkiya ranked first in recognize of rankings for colour, flavour, texture and general rating and typical ranking. The range Banarasi ranked first for texture and range, Francis ranked first for color. After garage duration of four months at room temperature, the range Chakkiya once more ranked first in all characteristic besides flavour. The sweet of Banarasi ranked 2nd over all. In case of murabba the range Krishna ranked first in all characteristic accompanied with the aid of using Chakkiya, which ranked 2nd in all characteristic besides texture, in which it ranked first.

Squash was prepared by blending Aonla juice with other juices viz., ginger, roselle, pineapple and lime. Organoleptic evaluation of squash revealed that score for color, flavour and consistency increased with addition of ginger and Roselle. The blend of aonla, ginger, roselle (80:15:5) ranked first in all attributes including overall ranking, this was followed by blend of aonla, lime, ginger (75:20:5). Roselle helps in improving the color and ginger helps in improving the flavour of squash.

Ber *(Zizyphus mauritiana)*

Ber fruit are use on as such or may be processed into unique fruit products. Juicy types are higher ideal for pulp and juice extraction. The completely ripe, well-evolved end results are washed de-stoned and juicer extracts juice. Ber juice may be used for the prepration of RTS beverage. Carbonated beverage of ber is notably applicable and has superb retaining quality. Dehydrated for is ready through treating ber end result with sulphur dioxide at three. 5-10 g/kg for three hours observed through solar drying, or carbinet drying underneath 15% moisture. Ber may be applied for sweet and ber pulp may be processed into wine. The steps encompass diluting the pulp, including pectinase enzymes adjusting right Brix with sugar, addition of yeast, fermentation, stabilization and clarification.

Jamun *(Syzygium cumini)*

Jamun fruits are used for making Products consisting of jam, jelly beverages, wine and vinegar. It has been discovered that

most yield of Jamun juice with a excessive degree of anthocyanins and different soluble parts may be acquired through grating the fruit, heating to 70°C and passing thru basket press. The Jamun juice as a result acquired is once more heated to 85°C after which cooled to room temperature. Sodium benzoate (500 pm) is introduced to the juice earlier than it's far saved. Pure Jamun juice also can be saved through warmth pasteurization. The juice being notably acidic isn't always ate up as such. A prepared to serve beverage (nectar) is ready with 25% juice, 18° Brix and 0.6% acidity. Jamun seeds also are recognised for his or her residences which assist to remedy diabetes, diarrhea and dysentery.

Guava *(Guavajawa)*

Value addition favours the availability of guava beyond the seasons, geographic areas and provides consumers with innovative and convenient products. Guava is very popular as a fresh fruit because of its excellent taste, high vitamin content and 100% edibility. This fruit is equally important for the processing industry. Several advanced technologies have been developed in guava for value addition and there is immense scope for diversified value-added products of guava. Due to presence of rich amount of pectin, a high-quality natural jelly is obtained from guava. Processed guava pulp is an excellent raw material for preparation of various other guava products. Guava juice blended RTS beverages, Guava wine, Guava powder, jam and toffee. Cheese, ice cream topping, nectar are some important products of guava

Conclusion

On the basis of above content it may be concluded that its help to pay more attention on value addition through fruit processing and nutrition sciences to develop a newer and better technology that can be used for various processed and applications at both industrial as well as commercial levels with focus on food safety.

References

- NR Rangare, PK Jain, SK Pandey, BP Bisen and Bharat Kumar, International Journal of Chemical Studies 2017; 5(4): 1748-1752
- National Horticultural Board 2012-13
- Gopalan *et al.,* (1978) * Tamarind is the richest source of Tartaric acid (8-18%).
- T.K.Bose *et al.,* (1999)

❖❖

ISSN No. 2583-3146

Recent Approaches in Mango Breeding

Atul Kumar Singh*, Saket Mishra, Akhilesh Kushwaha and Gaurav Singh Vishen

Department of Horticulture, SHUATS, Prayagraj

Corresponding Author: atul123321123@gmail.com

Introduction

The family Anacardiaceae in order Sapindales, is amongst the most important tropical fruits of the world. It is also called the king of the fruits. It originated in the South East Asian or Indo-Burma Region having 41 recognised species of mango originating as forest trees with fibrous and resinous fruits. Mango has been cultivated for thousands of years in India and its cultivation is as old as Indian civilization. Its development and culture in the subcontinent is mainly contributed by the Mughal Emperors, especially Akbar who planted Lakhibag, amateur gardeners, nurserymen and farmers by means of selection and subsequent cloning. Now, it is an integral part of the history and culture of the Indian subcontinent. Though soil and climatic conditions are highly suitable for mango production, India is still far behind in yield per hectare than the major mango producing countries of the world.

Mango (*Mangifera indica* L.) exhibits a wide variation in flowering and fruiting habits due to varietal differences and diversity in agro climatic conditions. Flowering is a decisive factor in the productivity of mangoes. The process associated with mango involves shoot initiation followed by floral differentiation of apical bud and panicle emergence. All these developmental events occur in most of the mango cultivars sometimes during October to December. The induction of floral bud formation has strong links to prevailing environmental conditions and age of terminal resting shoots as under tropical locations, the flower induction occurs in response to age of previous years shoot, while cool inductive conditions are vital to floral induction under sub-tropical conditions.

Identification of more gene donors for improvement of specific characters has also been made in many mango research centres. In addition, the use of isozymes as genetic markers (Degani *et al*., 1993) and the use of RAPD molecular markers to determine phylogenetic relationship (Schnell and Knight 1993) are all expected to offer valuable information to assist conventional breeding programmes. The objectives of this paper are to present recent information on the results obtained in mango improvement at various research centres in different countries.

The improvement of mango rather than any crop needs to explore new recombinants primarily by means of exploiting the breeding methodologies. Diversity or heterogeneity : the main character desired for breeding is either natural manmade. It is required to have a vast genetic pool to get new combinations of desired nature and develop new hybrids. It has been mentioned earlier that the development of mango in the area (Indian subcontinent) is result selections from the amateur gardeners. Breeding has yet to play its role in the development of this crop as it has been effectively manipulated in the distant past. Now, scientists have developed certain hybrids of mango. To go for such strategies, a comprehensive knowledge of physiology of the reproductive parts, their breeding behaviour and cytological information of the crop is

needed. This will eventually help to improve mango production status.

Breeding objectives

The objectives set for the mango breeding programmes in different countries vary greatly depending on the environment under which the crop is grown and the local market requirements, in addition to the general aims of obtaining high yielding and with better quality hybrids.

The objectives of the mango breeding programme varies from region to region in India since some of the major diseases and physiological disorders are specific to certain climatic zones and cultivars, respectively. Since one of the most damaging diseases of mango, namely, mango malformation is more widespread in the sub-tropical Indo- Gangetic plains this is one of the important aspects that is taken care of while screening hybrids. However, this disease is not widespread in southern and western parts of India. Similarly, 'internal breakdown' is serious only in 'Alphonso', a very popular cultivar in western and southern India and hence hybrids involving 'Alphonso' are to be screened against this malady since Iyer (1991) has shown that this is genetically controlled.

The other major objective in most of the mango breeding programmes is the development of attractive skin colour in the hybrids to make the fruits more attractive and export-worthy. Development of dwarf mango hybrids has also been one of the objectives in many breeding programmes in India since there is a lot of interest for high density planting. In addition, no rootstock has shown a consistent dwarfing effect on the scions in mango.

Achievements of Mango Breeding

Mango hybridization is in progress in various Research centers in India during the last 4-5 decades in an intense way. Many new hybrid cultivars have been released from some

Fig. A student is selecting mango scion for grafting of mango

of these centers. However, the adoption of these new cultivars is fairly slow owing to various reasons. These include

- Apprehension among growers about the marketability of large quantities of new cultivars since consumers are aware only about the old existing cultivars,
- Middlemen hesitant to take risk on marketing new cultivars,
- Unknowingly marketing new cultivars under the brand of 'unknown varieties' and hence fetching less price,
- Susceptibility of some of the new hybrid cultivars to certain diseases and problems in keeping quality owing to inadequate pre-release screening.

At the Indian Institute of Horticultural Research, Bengaluru, India two more hybrids have been released, in addition to the two which were released earlier. The hybrid 'Arka Anmol' ('Alphonso' x Janardhan Pasand') is regular bearing, free from spongy tissue and with a good keeping quality and sugar acid blend. The second hybrid, 'Arka Neelkiran' (Alphonso' x 'Neelum') is regular bearing with medium sized fruits, free from spongy tissue, good pulp colour, excellent skin colour and the tree is semi vigorous and consequently suitable for close planting.

In a programme at the Indian Agricultural Research Institute, New Delhi, designed to transfer the attractive skin colour to the otherwise suitable commercial cultivars, it was found that some hybrids involving 'Sensation' as one the parents had excellent skin colour combined with good fruit quality.

At the Regional Fruit Research Station, Vengurla, Maharashtra, India, a parthenocarpic mango cultivar 'Sindhu' has been evolved as a result of back crossing 'Ratna' (Neelum x Alphonso) with 'Alphonso'. 'Sindhu' has medium sized fruits (215 g) with a high pulp to stone ratio (26:1) and very thin (30mm) and small stones (6.7 g). The non-viable cotyledon-free stone which makes up only 3.1 per cent of the total fruit weight encloses a small degenerated ovule (1.1 g) inside the very soft endocarp (Gunjate and Burondkar 1993, Salvi *et al*., 2012).

Clonal selection

Somatic mutations accumulated over the years get preserved in vegetatively propagated plants since there is no gametic sieve and hence offers scope for selecting desirable clones within a cultivar. Mango has proved to be no exception to this generalisation. Singh and Chadha (1981) assembled some distinct clones of the major commercial cultivar 'Dashehari' and their study for a period of thirteen years showed that Line No. '51' was distinctly superior to all other clones in terms of regularity in bearing, yield and free from 'Malformation'. Singh *et al.,* (1985) isolated two clones in the cultivar 'Langra' based on higher yield and better fruit quality.

Genetic marker

Mango cultivars are currently identified on the basis of distinct morphological characters. However, morphological traits cannot serve as unambiguous markers since they may vary with environmental conditions (Tansley *et al*., 1989) In addition this type of cultivar identification usually requires growing plants to maturity and it often lacks decisiveness and objectivity. Recently, reliable genetic markers have been developed and introduced for mango cultivar identification. These include isozymes, RAPDs (random amplified polymorphic DNAs) and VNTRs (variable number tandem repeats). Even though DNA markers became a very popular tool, only a limited work has been done with this tool in mango. The application of mini satellite probes was documented by Adato *et al*., (1995). This work demonstrated the ability to individualize mango cultivars and rootstocks. Several mini and micro- satellites were used as probes in order to identify 40 various mango trees. The DNA fingerprints (DFP) detected by the mini satellite probe 33.6 were the most polymorphic. On the average, five to seven specific bands and 52-55% Band Sharing were observed pending on the restriction enzyme.

Role of wild species in mango breeding

Fairchild (194 observed that crosses between five stamen and Indian mango could produce hybrids with better pollination quality. Bompard (1993) stated that *M. laurina* could be used to incorporate resistance to anthracnose. There are certain wild cultivars of mango i.e., *M. orophila* and *M. dongnaiensis* both described from Malaysia and Vietnam respectively, that are restricted to mountain forests about sea level. These could help to start mango cultivation even in the Mediterranean areas. Other wild species have certain specific characters like *M. mangifica* is fibreless, *M rufocostat* and *M. swintonioides* have off-season bearing habit, *M. pajang* and *M. foetida* have good quality fruits an *M. casturi* from *S. kalimantan* is prolific bearer with small beak sweet fruit. These species may be helpful to enhance the existing gene pool and to develop new hybrids in mango (Bompard 1993; Kostermans & Bompard 1993). *M. altissima* unaffected by

hoppers, tip and seed borers (Angeles 1991).

Breeding problems

Breeding problems can be minimized by minimizing the high fruit drop, shortening juvenility and polyembryony dilemma for the breeder and asset in rootstock propagation. Isozymes are used to identify the zygotic seedling from the nucellar one's as the nucellar seedling should have the same isozyme alleles as that of the maternal parent.

Conclusion

Cultivars that are quite popular in several Asian countries including India and which are characterized usually by the green peel and relatively sweet taste. On the other hand, the Floridian cultivars (such as 'Tommy Atkins' 'Keitt' and others) are the popular cultivars found in western markets including the US and Europe. Our breeding efforts were aimed towards the selection of new cultivars with high quality, beautiful appearance, good yield and long shelf life. Our preliminary data, suggest that such cultivars could be selected. Quantitative genetic analysis, although not very common in fruit trees, might shed some light on the genetics of the crop. DNA markers are a very common tool for several purposes including identification and improvement of breeding projects.

References

- Adato A., J. Hillel, S. Gazit., D. Sharon and U. Lavi 1995. Application of DNA fingerprints for identification and genetic analysis of mango (*Mangifera indica*) genotypes J. Amer. Soc. Hort. Sci. 120: 259-264.
- Dalvi N. V., Salvi B. R., Chavan S. A. and Kandalkar N. P. 2010. High density planting in mango CV. Alphonso, J. Hort. Sci., 5: 117-119.
- Degani C., Cohen M., El-Batsri R. and Gazit S. 1992. PGI isozyme diversity and its genetic control in mango. Hort. Sci., 27: 252-254.
- Gunjate R. T. and Burondkar M. M. 1993. Parthenocarpic mango developed through hybridisation. Acta Hort., 341: 107-114.
- Iyer C. P. A. 1991. Recent advances in varietal improvement in mango. Acta Hort., 291: 109-32.
- Knight R. J. Jr and Schnell R. J. 1994. Mango introduction in Florida and the Haden cultivars significance to the modern industry. Econ. Botany, 48: 139-145.
- Salvi B. R., Munj A.Y. and Varadkar R. S. 2014. Konkan Samrat – A New Mango Hybrid. International Event Horticulture for Inclusive Growth (6-9 November, 2014) pp. 90.
- Schnell R. J., Ronning C. M. and Knight R. J. Jr. 1995. Identification of cultivars and validation of genetic relationships in *Mangifera indica* L. using RAPD makers. Theor. Appl. Genet. 90: 269-274
- Singh G. and Kapur S. P. 1979. Varietal screening against powdery mildew in Punjab. Mango workers Conference, Goa, tech. Doc., 13: 3132.
- Singh L. B. and Singh R. N. 1956. Variability in mango and its significance to the production of new varieties. Ind. J. Hort., 15: 168-172.
- Tanksley S., Young N., Paterson A. & Bonierbale M. 1989. RFLP mapping in plant breeding: New tools for an old science. Bio Technology, 7: 257:264.

ISSN No. 2583-3146

Augmenting Yield through Crop Nutrient Management

S. Nithila[1], R. Siva Kumar[2] and K. C. Siva Balan[3]*

[1]Krishi Vigyan Kendra, Sirugamani, Trichy, Tamil Nadu

[2]Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu

[3]Centre for Research in Environment and Agriculture (CREA), Trichy, Tamil Nadu

Corresponding Author: shiv-balan@yahoo.com

Introduction

Crops need some nutrients in large quantities called macronutrients while some in smaller quantities known as micronutrients. Soil supplies thirteen additional micronutrients (Iron, copper, zinc, chlorine, boron, manganese) and macronutrients (calcium, magnesium, potassium, nitrogen, phosphorous).The deficiency of these nutrients impedes the growth of plants, affects their life cycle, processes and declines their immunity against diseases. Soil's fertility can be increased by providing nutrients in the form of manure and fertilizers. Growing plants act as integrators of all growth factors and are the products in which the grower is interested. Therefore, careful inspection of the growing plant can help identify a specific nutrient stress. if a plant is lacking in a particular nutrient, characteristic symptoms may appear. The deficiency of a nutrient does not directly produce symptoms. Rather, the normal plant processes are thrown out of balance, with an accumulation of certain intermediate organic compounds and a shortage of others. This leads to the abnormal conditions recognized as symptoms. Visual evaluation of nutrient stress should be used only as a supplement to other diagnostic techniques (i.e., soil and plant analysis). Each symptom must be related to some function of the nutrient in the plant.

Plant nutritional elements

At present chemical elements such as N, P, K, Ca, Mg, S, B, Cl, Cu, Fe, Mn, Mo and Zn along with C, H, O are considered as essential elements and each of these essential elements performs one or more specific internal roles in plants. A less than adequate supply of any one of these essential elements will lead to the metabolic disruptions, including changes in activities of enzymes, rate of metabolic reactions and concentration of metabolites. In addition to alterations in metabolic patterns, severe deficiencies of individual essential elements also produce a set of characteristic effects in the external appearance of leaves, stems, roots, blossoms, and fruits.

- Visual symptoms of nutritional deficiency include
- Stunted growth
- Chlorosis (failure of leaves to produce normal amount of chlorophyll)
- Mottling of leaves
- Abnormal curling of leaves
- Development of abnormal leaf discoloration
- Development of regions of necrosis (blackening and decay of tissues)
- Premature drying and withering of leaves

- Premature senescence of leaves and blossoms.

As a general rule, symptoms of deficiencies are first noticeable in older or in lower leaves for elements that are able to move readily form one region to another within the plants. Among the essential elements, N, P, K and Mg are highly mobile. When the supply of one of them to the plant is less than adequate, the element is translocated away from older tissues to younger,more metabolically active tissues. Therefore, the deficiency symptoms of these elements appear in older leaves initially.

On the other hand, deficiencies of some elements such as iron, boron, manganese and calcium are noticeable first in younger leaves and growing tips because they are not mobile within the plants. These tissues are first to suffer when the supply of one of these elements is less than adequate because these elements tend to remain in older leaves. A given nutrient may have several functions, which makes it difficult to explain the physiological reason for a particular deficiency symptom. For example, when N is deficient, the leaves of most plants become pale green or light yellow. When the quantity of N is limiting, chlorophyll production is reduced, and the yellow pigments, carotene and xanthophylls are shown through a number of nutrient deficiencies produced such as pale green or yellow leaves, and the deficiency must be further related to a particular leaf pattern or location on the plant. Nutrient deficiency symptoms appear only after the nutrient supply is so low that the plants can no longer function properly. In such cases, it would have been profitable to have applied fertilizer long before the symptoms appeared. If the symptoms are observed early, it might be corrected during the growing season. Since the objective is to get the limiting nutrient into the plant as quickly as possible, with some nutrients and under some conditions this may be accomplished with foliar applications or side dressings. Usually the yield is reduced below the quantity that would have been obtained if adequate nutrients had been available at the beginning. The soil characteristics also in constant change while adding external inputs and organic inputs (Kumar, S Dahiya, R and Phogat, V.K. 2012).

Nitrogen: The young plants show stunted growth with yellowish green leaves. Older leaves become light green, followed by yellowing and drying or shedding, often with abundant anthocyanin in veins. Shoot becomes short, thin, growth upright, flowering reduced.

Phosphorus: Young plants show stunted growth, leaves dark-blue green sometimes purplish; often anthocyanin in veins and may become necrotic, stems slender.

Potassium: Leaves of monocotyledons become pale green or streaked with yellow, with marginal chlorosis and necrosis, appearing first in old leaves; usually wrinkled.

Calcium: Leaves chlorotic, rolled and curled; breakdown of meristematic tissues in stem and roots. Roots are poorly developed. Symptoms appear near growing points of stem and roots.

Magnesium: Mottled chlorosis with veins green and leaf tissue yellow or white, appearing first on old leaves; severely affected leaves may wilt and shed or may abscise. Necrosis often occurs.

Manganese: Mottled chlorosis with vein green and leaf tissue yellow or white, appearing first on young leaves; may spread to old leaves. Stems are yellowish green, often hard and woody.

Molybdenum: Light yellow chlorosis of leaves; leaf blade may fail to expand.

Boron: Terminal leaves necrotic, shed prematurely; internodes of terminal shoots shortened, apical meristems blacken and die, general breakdown of meristematic tissues,

roots short, stubby. Plants dwarfed, stunted. Flower development and seed production usually impaired.

Copper: Wilting of terminal shoots; frequently followed by death. Leaf color often faded.

Carotene and other pigments reduced.

Iron: Interveinal white chlorosis appearing first on young leaves; tendency of chlorosis of all aerial parts, often becoming necrotic; in some cases leaves may be completely bleached; margins and tips scorched.

Zinc: Leaves chlorotic and necrotic, young leaves growth first affected; rosetting; premature shedding; whitish chlorotic streaks between veins in older leaves and withering of upper leaves in monocotyledons; chlorosis of lower leaves in dicotyledons.

Sulphur: Leaves light green to yellow, appearing first along veins of young leaves; stems often slender.

Chlorine: Wilting of leaf tips followed by chlorosis, bronzing and necrosis

Crop Nutrient Management

The use of green manures plays an important role in crop production. At the same time, it is difficult to supply all the nutrient requirements of crops only through organic manures due to the limited supply potential Thus the incorporation of the organic manures and bio- fertilizers/PGPRs as source of nutrient is gaining momentum (Wu and Ma 2015). If the nutrients are applied at the right time and in adequate quantities, optimum crop yield is obtained. Thus, the Nutrient management refers to the efficient use of nutrients to improve crop productivity.

Crop plant yield can be improved by increasing photosynthates, sink potential and control of distribution in plants. The role of various hormones like auxins, gibberellins, cytokinins and ethrel in flowering agriculture and horticulture is well documented. Various growth retardants also used for reducing vegetative growth and improving productivity. Tissue culture is the technique used to make successful *in vitro* growing of plant parts under controlled aseptic medium which contains different hormones.

TNAU Crop boosters

In view of the importance of nutrient management in augmenting the crop yields, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu launched crop boosters for Agricultural and Horticultural crops.

TNAU Rice Reap Benefits

- Improves tolerance against drought and high temperature
- Decreases spikelet sterility
- Improves seed setting
- Improves grain yield up to 15% Application

Dose: 3 kg/acre/stage

- Stages of spray: Booting & 10 days after first spray

TNAU Rice Bloom

For the benefit of paddy growers, so as to increase the paddy yield, TNAU Rice Bloom has been introduced.

Benefits & Dose

- Increase translocation efficiency
- Improves grain yield up to 15% Dose : 8 kg / acre
- Stages of spray: Heading and grain filling

TNAU Coconut Tonic

It is the tonic with nutrients and growth regulators for Coconut. Common nutritional disorders in Coconut include Pencil point disorder, Button shedding, Small nuts and nut splitting. Above nutritional disorder can be corrected by the application TNAU coconut tonic.

Benefits

- Decreases button shedding
- Increases number and size of nuts
- Increases nut yield up to 20 per cent
- Increases longevity and vigour of the palm
- Imparts tolerance to pests, diseases and Environmental stresses

Application

Root feeding of the tonic @ 200 ml / palm twice a year at six months interval

TNAU Pulse Wonder

It is the booster with nutrients and growth regulators for Pulses. Common nutritional disorders in pulses include flower shedding, premature leaf shedding, chlorosis and poor yield. Above nutritional disorder can be corrected by the application of TNAU pulse wonder.

Benefits

- Decreases flower shedding
- Increases yield up to 20 percent
- Increases drought tolerance

Application

Dose: 2 kg/acre

Stage of spray: Peak flowering

TNAU Groundnut Rich

It is a booster with nutrients and growth regulators for groundnuts. Common nutritional disorder in ground nuts include Hollow heart, Heart rot and Chlorosis in younger leaves. Above nutritional disorder can be corrected by the application of TNAU groundnut rich.

Benefits

- More flower retention
- Improves pod filling

- Increases pod yield up to 15 percent
- Improves drought tolerance

Application

Dose: 2 kg/acre

Stage of spray: Peak flowering and pod development

TNAU Cotton Plus

A tonic with nutrients and growth regulators for Cotton. Common nutritional disorders in cotton include Reddening, Square and boll shedding, Small bolls, Poor bursting of bolls. Above nutritional disorder can be corrected by the application of TNAU cotton plus.

- Reduces flower and square shedding
- Improves boll bursting
- Increases cotton yield up to 18 percent
- Increases drought tolerance

Application

Dose : 2.5 kg/acre

Stages of spray: Flowering and boll formation

TNAU Maize Maxim

A tonic with nutrients and growth regulators for Maize. Common nutritional disorder in maize includes white bud, multi-nutritional deficiency and Irregular grain filling. Above nutritional disorder can be corrected by the application of TNAU maize maxim.

Benefits

- Improves grain filling
- Increases grain yield up to 20 percent
- Improves drought tolerance

Application

Dose: 3 kg/acre

Stages of spray: Tassel initiation and grain filling stages

TNAU Sugarcane Booster

A tonic with nutrients and growth regulators for sugarcane. A common nutrient disorder in Sugarcane includes Iron deficiency, Shortened internodes and phala blight. Above nutritional disorder can be corrected by the application of TNAU sugarcane booster.

Benefits

- Improves internodal length
- Improves cane yield up to 20 percent
- Improves sugar content
- Increases drought tolerance

Application

Dose : 1, 1.5 and 2 kg/acre

Stages of spray : 45, 60 and 75 DAP

TNAU Castor Gold Benefits

- Increases pistillate flowers
- Increases seed setting
- Increases yield up to 29 percent

Application

Dose: 0.5 ml/litre (100 ml/acre)

Stage of spray: 25 & 60 DAS TNAU Horse gram Wonder Benefits

- Decreases tendril numbers
- Increases number of flowers
- Increases yield up to 20%

Application

Dose : 2 kg/acre

Stage of spray: Flowering

Conclusion

With the incessant increase in the country's population, demand for crop production is also constantly increasing. At the same time, sustainability of the farming is also requiring considerable attention. For achieving the twin goals of production enhancement and sustainability, Integrated Nutrient Management is a vital solution (Najeebul Tarfeen,Khair-Ul-Nisa, Shahnawaz Hassan, Auqib Manzoor Humaira and Zahara Sultan, 2023). Earlier studies demonstrated the role of INM in increasing the production of crops by 8%–150% when compared to the conventional methods, enhancing the soil health, improvement in the quality of grains and economic returns to farmers. Many evidence suggests that INM methods could be environmental affirmative and innovative strategy for sustainable agriculture. The less external inputs and lesser intensity of land use, Nitrogen use, reactive N losses and GHG emissions were achieved under advanced INM practices (Yadav, Rajni, Goyal, Visha, Bhardwaj, K.K. and Sangwan, Omender, 2023) .Hence various approaches INM in farming should be given due importance in farming research and extension in near future.

References

- Kumar, S Dahiya,R and Phogat, V.K. 2012. Long term effect of organic materials and fertilizers on soil properties in pearl millet- wheat cropping system. Indian J. Agrl.Res.46:161- 66.
- NajeebulTarfeen, Khair-Ul-Nisa, Shahnawaz Hassan, Auqib Manzoor Humaira and ZaharaSultan.2023. Integrated nutrient management strategies for improving crop yield. Sustainable Plant Nutrition. Molecular Interventions and Advancements for Crop Improvement. Pages 283-297.
- Wu, Wei and Baoluo Ma, Integrated nutrient management (INM) for sustaining crop productivity and reducing environmental impact: A review. Science of The Total Environment. 2015.
- Yadav, Rajni, Goyal, Visha, Bhardwaj, K.K. and Sangwan, Omender. 2023. Nutrient content and post-harvest soil fertility as influenced by methods of planting and nutrient management techniques in cotton based cropping system. J. cotton Res.Dev. 37(1), 63-74.

❖❖

ISSN No. 2583-3146

Management of Insects, Pests in Pigeon Pea

Ashok S. Chandar[1*] and Anoorag R. Tayde[2]

Department of Agricultural Entomology SHUATS, Prayagraj

Corresponding Author: aschandar1313@gmail.com

Introduction

Pigeon pea (*Cajanus cajan* L.,) is an important legume crop belonging to the Fabaceae family. In India, it is mostly cultivated during the rainy (kharif) season as sole or intercrop for green vegetable and dry seed purposes. Major pigeon pea growing states of our country are Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Bihar. Among the various constraints limiting Pigeon pea production, insect pests are the major ones. The important insect's pests' causes' economic loss by attacking the crop at vegetative and reproductive stage are Pod borer, *Helicoverpaarmigera*, Legume pod borer, *Maruca testulalis*, Pod fly, *Melanagromyza* spp., Blister beetle, *Mylabris* spp. Pod bug, *Clavigrallaspp*, Plume moth, *Exelastisatomosa* and blue butterflies. Details of these insect pests are as follows:

a. Pod borer, *Helicoverpaarmigera* Hubner (Noctuidae; Lepidoptera)

It is most damaging insect of Pigeon pea. A single female lay up to 2,000 small white eggs usually single eggs are laid on flower buds and young pods. Larval colour is varied-yellow, green, pink, orange, brown or black with dark and light stripes on either side of the body. Full-grown larvae are 30 to 40 mm long and may have various body colour and banding patterns. Young larvae are small and found feeding on tender leaflets. Grown up larvae feed on developing seeds by making an entry hole on pods that is cut with clear round margins. Half portion of larval body remains outside the pod while feeding is also important. Pupation occurs in the soil or in plant debris. It is the single most important constraint to pulses. High level of insecticide resistance, make this species one of the most difficult pests to manage. Adult *H. armigera* have a wing span of about 40 mm with dull brown forewings. The *Helicoverpa* spp., destroys buds, flowers and pods. If flowers and pods are not available, larvae will feed upon foliage. There is no resistant variety for pod borers. Planting date is having influence on the incidence of pod borers.

b. Spotted pod borer or Legume pod borer, *Maruca vitrata* (Geyer) (Pyralidae: Lepidoptera)

The larvae cause extensive damage to floral buds and flowers. The characteristic symptom is webbing together of flowers, pods, and leaves with frass often on pods and shoot tips. This is a serious pest in early maturing varieties. They damage flowers causing discoloration and shedding. Damaged pods have small darkened entry holes on the surface and borers inside. Many time, leaves and pods are stuck together by webbing with signs of surface feeding. The immature larvae are dull to yellow-white and often reach a length of 18 mm. Each segment has dark spots which form a distinct series along the length of the body. This pattern is quite obvious on the upper surface. The larval head is dark brown to black. The adult moth has three white spotted brown forewings and greyish–white hindwing with distal brown markings. The eggs are laid singly in the sepals or petals of the flower or buds or on the pods. The caterpillar, upon hatching, feeds on the tender leaves, flower buds and developing seeds in the pods for about 3 weeks. Thereafter, it emerges from the pod during night and crawls to descend to the soil and pupates beneath leaf debris. The hidden nature of the larval stage (the damaging stage) and pupal stage makes it difficult to manage by chemicals or other conventional means. The adults can be monitored through light traps though there are variations in the catches of different months in various regions of the country.

c. Pod fly, *Melanagromyzaobtusa* (Malloch) (Agromyzidae: Diptera)

The small black fly lays eggs through the wall of the developing pod and the white legless larva, three mm long, feeds inside the green seed. Generally, only one maggot develops in one seed. The brown puparium is formed inside the pod but outside the seed. One generation takes about 3 weeks under optimum conditions. Partially matured pods are preferred for egg laying than the tender or fully matured pods. The fly inserts the eggs while lying on the developing pod. A single fly is reported to lay 80-100 eggs which, incubate for 3 days and hatching maggot bores into the pod and feeds on developing seed. Usually, one seed is sufficient for the development of one maggot. The maggot pupates inside the pod after making a small hole on the pod covering it with a thin membranous stricture.

d. Plume moth: *Exelastisatomosa* (Pterophoridae: Lepidoptera)

Adult is a brown coloured moth with fringed or plume like wings. Larvae are green to yellowish brown, spindle shaped and covered with hairs (Fig). Eggs are small, round and laid singly on buds, flowers and pods. Larva damages the developing grains by boring into pods.

e. Blue butterfly, *Lampidesboeticus* (Linnaeus) (Lycaenidae: Lepidoptera)

It causes damage to buds, flowers and tender pods. It is less significant in comparison to other pod borers. Cowpea, pea and beans are also important hosts for this pest. Small, blue beautifully sculpted eggs are laid singly on buds. The larvae, which are 12 mm long, are green, oval and flat. Pupation occurs in soil or in plant debris. One generation is completed in about 5 weeks.

f. Pod bug, *Clavigralla* spp.(Coreidae: Hemiptera)

Both adults and nymphs suck the plant sap from the flower buds and develop seeds by piercing through the pod wall (Fig.). The attacked pods show dark patches outside and grains inside become shrivelled and small in size resulting in considerable yield losses. The affected grains are often, do not germinate and unfit for human consumption. Adult is a brown coloured hemipteran bug, lays eggs in clusters of 2-60, mainly on pods and leaves. It has five nymphal instars and the whole life cycle completes in an average of 60-70 days.

g. Blister beetles, *Mylabris* spp. (Meloidae: Coleoptera)

Blister beetles are widespread in pigeon pea in Asia. *Mylabrispustulata* adults measure about 25 mm in length and have red and black alternating bands on the elytra. Other species may vary in size but all are brightly coloured. Eggs are usually laid in the soil and the diet of the larvae consists of other soil insects, including major pests. Adult beetles feed on flowers and tender pods, and may have a significant impact on yields, especially of short-duration genotypes. Adults are black in colour with large yellow spots and a red band across the abdomen. Number of spots varies with species. Adult beetles feed on flowers and tender pods, and may have a significant impact on yields, especially of short-duration genotypes.

Integrated Pest Management Practices in Pigeon Pea

Deep ploughing during summer to expose the hibernating pupae to adverse weather conditions and natural enemies.

- Mixing of sorghum/maize seeds (250 g/ha) to function as live bird perches. These plants also help in conserving natural enemies.
- Install pheromone traps at a distance of 50m @ 5traps/ha.
- Installation of bird perches @ 50/ha for rigorous feeding of insects.
- Hand collection and destruction of fully

grown larvae. Mechanical collection of grown-up larva and blister beetle is effective.

- Practice crop rotation, planting non-leguminous crops every cropping season breaks the life cycle of bean pod borers.
- Application of HaNPV @ 250 LE/ha.
- Spraying Neem Seed Kernel Extract (NSKE) 5 percent at 50% flowering stage to manage the insect's populations.
- Spraying of botanical insecticide - Neem 1500 ppm @ 2000 ml/ha.
- Manual picking/ collection of blister beetles using insect nets and destroying them.
- Spraying of synthetic pyrethroids, Cypermethrin @ 1ml/litre protects the crop from Beetle damage.
- Application of Spinosad or imidacloprid gives control upon pod bug damage.
- Spraying of ovicide - Profenophos 50 EC @ 2000 ml/ ha.
- Spraying of effective molecule like Indoxacarb 14.5 SC % @ 300 ml/ha or Emamectin benzoate 5% SG @ 11 a.i gm/ha or Spinosad 45 SC @ 56-73 a.i gm/ha is effective against Pod borer complex.

References

- Balikai, R. A. and Yelshetty, S. (2008). Insect pest scenario of pigeon pea in Northern Karnataka. *Legume Research*, 31(2): 149-151.
- Bommesha, B., Naik, M. I., Mutthuraju, G. P., Arati, P., Syed, I. and Prashantha, C. (2012). Effect of organic manures on biochemical components of pigeon pea, *Cajanus cajan* (L.) Millsp. and their impact on the incidence of insect pests. *Current Biotica*, 6(2): 171-180.
- Dasbak, M. A., Echezona, B. C. and Asiegbu, J. E. (2012). Field insect pests and crop damage assessment of pigeon pea (*Cajanus cajan* [L.] Huth) grown under ratoon and in mixture with maize. *Chilean Journal of Agricultural Research*, 72(1): 45-52.
- Dialoke, S. A., Agu, C. M., Ojiako, F. O., Onweremadu, E., Onyishi, G. O., Ozor, N. and Ugwoke, F. O. (2010). Survey of insect pests on pigeon pea in Nigeria. *Journal of SAT Agricultural Research*, 8: 1-8.
- Haldar, B., Srivastava, C. P. and Joshi, N. (2006). Comparative performance of some newer insecticides against the major insect pests of short duration pigeon pea. *Pestology*, 30(9): 32-35.
- Khamoriya, J., Keval, R., Chakravarty, S. and Mishra, V. K. (2017). Evaluation of sequential application of insecticides against major insect pests on long duration pigeon pea [*Cajanus cajan* (L.) Millsp.]. *Journal of Entomology and Zoology Studies*, 5(3): 1891-1894.
- Latif, H., Srivastava, C. P., Rath, S. and Singh, K. N. (1996). Comparative performance of chemical insecticides, neem derivatives and microbial insecticides against insect pests of pigeon pea. *Pestology*, 20: 5-7.
- Meena, R. S., Srivastava, C. P. and Joshi, N. (2006).Bioefficacy of some newer insecticides against the major insect pests of short duration pigeonpea. *Pestology*, 30(9): 13-16.
- Nebapure, S. M., Sagar, D. and Chander, S. (2018). Population dynamics of insect pests on short duration pigeon pea in relation to weather parameters. *Journal of Agrometeorology*, 20(3): 234-237.
- Pawar, U. A., Chintkuntalawar, P. S. and

Ugale, T. B. (2014). Studies on succession of insect pest complex and their natural enemies in pigeon pea [*Cajanus cajan* (L.) Millsp.]. *International Journal of Plant Protection*, 7(2): 318-324.

- Rachappa, V., Yelshetty, S., Shekhara, C. and Pampapathi, G. (2014). Management of insect pests of pigeonpea using a novel anthranilic diamide molecule. *Journal of Experimental Zoology India*, 17(2): 621-626.
- Ramar, M., Kamalakannan, S. and Claver, A. (2012). A survey of insect pests of pigeon pea and their predators in Eastern Uttar Pradesh, India. *International Journal of Agricultural Sciences*, 2(1): 90-93.
- Shanower, T. G., Romeis, J. M. E. M. and Minja, E. M. (1999). Insect pests of pigeonpea and their management. *Annual Review of Entomology*, 44: 77-96.
- Singh, N. K., Anuradha, T. and Srivastava, O. P. (2008). Evaluation of certain newer insecticides against insect pest complex on Pigeon pea (*Cajanus cajan* (L) Millsp.). *Journal of Applied Zoological Researches*, 19(1): 46-49.
- Snehel, C. and Meena, A. (2016). Evaluation of certain novel insecticides along with bio-pesticides for the management of major insect pests of pigeon pea. *Journal of Experimental Zoology, India*, 19(2): 843-850.
- Srivastava, C. P. and Joshi, N. (2011). Insect pest management in pigeon pea in Indian scenario: a critical review. *Indian Journal of Entomology*, 73(1): 63-75.

❖❖

ISSN No. 2583-3146

Cultivation of Red Mushroom: A Healtheir Approach

Garima Kaushik Parashar

Department of Agronomy, School of Agricultural Sciences

Shri Guru Ram Rai University, Dehradun

Corresponding Author: garimakaushik1991@gmail.com

Introduction

Ganoderma or Reishi mushroom is a large red mushroom with woody texture and glossy from exterior. The word Lucidus is derived from Latin word meaning shiny it is also called Lingzhi in china or in Japan the Ganodermataceae family is Reishi or mannendake. It is a bitter taste fungus with many health benefits. It is a native to East Asia, it is a kidney shape cap which gives a fan like appearance. It is very soft and cork like and flat when it is fresh. The lower surface is porous pale white and on maturity produces red color spores, it grows at the base and stump of deciduous trees of spp. like oak, poplar, acacia, eucalyptus, maple, Tectona etc. It is considered as important mushroom as it constitutes many medicinal properties, it is also called mushroom of immortality and globally called red Reishi mushroom. IT is use to heal many diseases like cancer, diabetes, ulcer, skin infection and bacterial diseases. It contains many chemical constituents like polysaccharides, alkaloids, amino acids, phenol, fatty acids, nucleotides etc., and shows medicinal properties like antioxidants, anti-tumor, anti HIV, antimalaria and many other properties.

History

Ganoderma recognized as medicinal mushroom for 2,000 about years. The first book devoted to description of herbs was Shennong Ben Cao Jing which was written in china, and this book is also known as Classic of the Materia Medica or Shennongs herbal classics during 25 to 220 AD. In ancient time, red mushroom was collected in wild form but now from 1937 artificial red mushrooms cultivation was initiated. In 1969, first successful cultivation of mushroom was done by Chinese technician at Institute of Microbiology, Chinese academy of science at Beijing by the use of spore separation cultivation method. In ancient far east countries included the medicinal use of ganoderma in the treatment of neurasthenia insomnia, chronic hepatitis, hypertension etc. Ganoderma continue to be traditional medicine in Asia and its uses growing throughout the world.

Types of Reishi Mushroom

Aoshiba mushroom: It is blue in colour and having sour taste. It can improve eye sight and improve the function og liver.

Akashiva mushroom: It is red in colour and having bitter taste. It help in improving memory, Aids internal organs and also enhance vitality.

Kishiva mushroom: It is yellow in colour and having sweet taste. It may strengthen spleen functioning.

Shirosheba mushroom: It is white in colour and having pungent in taste. It can improve lungs functioning and also gives courage.

Kuro shiba mushroom: It is black in colour and having salty taste. Can cure kidney related problem.

Murasaki shiba mushroom : It is purple in colour and sweet in taste. It can help in enhancing proper functioning of muscles, joints and ears.

Nutritional value

It contain 2 to 7 % fats, 26 to 28% carbs , 3 to 5 % crude fat 59% crude fibre, and 7 to 8% crude protein, some vitamins, minerals and also contain magnesium, iron, zinc, copper, calcium, potassium. It also contains bioactive molecules like steroids, phenols, nucleotides, polysaccharides. It is especially rich in lysine and leucine and all the essential amino acids.

Benefits

There are lots of benefits of using red mushroom

- It can strengthen the immune system by affecting the genes present in white blood cells. In cancer patients Ganoderma increases the activity of WBC by protecting the body against cancer agents.
- It has an anti cancer property as it can kill many cancer cells such as colon cancer, prostate cancer, Breast cancer. It can help to increase the activity of WBC and also prepare the body to fight against cancer.
- It can help to fight against fatigue and depression.
- It has an Anti diabetic activity as GLSP (Ganoderma lucidum spore powder) helps to decrease blood glucose and promotes glycogen synthesis.
- Reduces the risk of heart disease.
- Helps in treating the clogged arteries and veins.
- It helps in treating altitude sickness.
- It can prevent kidney disorders.
- Helps in treating viral infections.
- Also prevent Hepatitis B.
- It can prevent cardiovascular problems.
- It helps in lowering the cholesterol level.
- Useful in the treatment of gastritis.

- Treatment of asthma and bronchitis.

Dosage

Indiscriminate use of any of the medicine is not safe because dosage of any medicine depends on the human body. Intake of red

mushrooms depends on the health of the person, his/her age and also on the form of the mushroom. Usually it is dried and taken as an extract in liquid powder and capsules form. Red mushrooms can be taken in three forms and dosage like if a person takes it as oral daily dose of crude dried mushroom then dose is 1.59gms is enough. If it is taken in powdered form then dose of 1-1.5gms is suggested. If it is taken in solution form than 1ml is sufficient.

Side effect

Some of the people reported many side effects of red mushrooms such as skin rashes, damaging of lever and upset stomach. It is not recommended as the first response to cancer. It may also cause bloody stool, bleeding nose, itching, sudden dryness in the body diarrhea and nausea. Sometimes due to liver toxicity it may lead to death. It is observed that if a person takes ganoderma extract orally for up to one year it is safe but if the person takes it in powdered form for more than one month it may be toxic to the liver.

Cultivation process

Red mushroom has been cultivated worldwide and its cultivation has been increasing day by day due to its medicinal values. There are two methods of its cultivation a) Liquid State Cultivation (LSC) and b) Solid State Cultivation (SSC). SSC includes two methods i.e., log or basswood and substrate cultivation. The cultivation of red mushroom it's easy and can be done by following process:

- First step is substrate preparation which includes a mixture of rice bran and wet sawdust.
- Fill this wet substrate which contains 65-70% of moisture in a polypropylene bag, and plug it with cotton.
- Now at 121^0C temperature with 15lb pressure sterilize the substrate for about 60-90 minutes in an autoclave.
- Cool the bags to room temperature.
- Now spawning is done and it requires a dark room with 28-30^0C temperature.
- Spawn running requires around 25-30 days.
- After spawn running, immediately open the mouth of the bags and shift it to the cropping room with proper light, cross ventilation and require a temperature of about 28-35^0C with relative humidity of about 80-90%.
- Within 10-15 days pinheads initiation starts and it grows to kidney shaped red brown fruit body.
- Harvesting should be done when white color of the growing edges disappears.

Products

Red mushrooms are used in making tea, coffee, many cosmetic products like talc, soaps, shampoo, body wash etc.

Conclusion

Red mushrooms have been cultivated for about more than 50 years. Due to its high medicinal value and high market demand its production will surely increase in future. It is also referred to as "the lucky fungus" due to its high nutritive and medicinal value. The bioactive substances which are extracted from red mushrooms help in the treatment of many harmful diseases diabetes, hepatitis, cancer,

blood pressure etc. Modern biotechnology also help in quality and quantity of red mushrooms by the development of strains which makes it resistant to disease, increasing yield and productivity and also reduces the dependency on chemicals. There is a great role of modern engineering in red mushroom production as it helps to introduce new methods of spawn making, substrate sterilization and ultimately helps in increasing the productivity of mushroom culture. Cultivation of red mushroom is also helpful to protect environment pollution as it can convert forest and agricultural waste into useful material. It can generate a large amount of substrate which can be used in bioremediation, as animal feed, soil conditioner etc.

References

- https://www.iihr.res.in/Reishi-mushroom-ganoderma-lucidum
- Sissi Wachtel-Galor, John Yuen, John A. Buswell, and Iris F. F. Benzie Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition.https://www.ncbi.nlm.nih.gov/books/NBK92757/
- https://www.frontiersin.org/articles/10.3389/fmicb.2018.01557/full
- https://www.iihr.res.in/cultivation-technology-Reishi-mushroom
- https://dmrsolan.icar.gov.in/Folder_Ganoderma.pdf
- https://www.downtoearth.org.in/blog/agriculture/magical-mushroom-scaling-up-ganoderma-lucidum-cultivation-will-benefit-farmers-users-82223

❖❖

ISSN No. 2583-3146

Role of Poultry Industry in Indian Economic

Bhupendra Singh* and Ngangkham James Singh

Department of Animal Husbandry and Dairying, SHUATS, Prayagraj

Corresponding Author: nggamessingh@gmail.com

Introduction

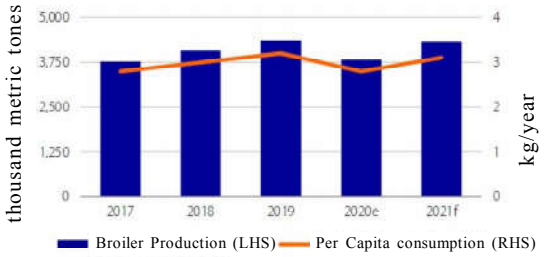
Poultry farming is the form of animal husbandry which raises domesticated birds such as chickens, ducks, turkeys and geese to produce meat or eggs for food. Poultry mostly chickens are farmed in great numbers. Chickens raised for eggs are known as layers, while chickens raised for meat are called broilers. The main purpose of Poultry Farming is the production of eggs, meat, etc. Numerous chickens were grown in poultry farms for the production of eggs and meat. Animal husbandry usually includes animals such as cattle, pig, sheep, poultry, and fish which are useful for humans in various ways. These animals are managed for the production of commercially important products such as milk, meat, wool, egg, honey, silk, etc.

Change in the poultry population

Tamil Nadu, Andhra Pradesh and Telangana states are first, second and third in poultry population whereas Assam (71.63%) and West Bengal (46.34%) have maximum growth in poultry population during the year 2012 to 2019.

Poultry is one of the fastest growing segments of the agricultural sector in India today. While the production of agricultural crops has been rising at a rate of 1.5 to 2 percent per annum that's of eggs and a broiler has been rising at a rate of 8 to 10 percent per annum. As a result, India is now the world's fifth largest egg producer and the eighteenth largest producer of broilers. The Potential in the sector is due to a combination of factors - growth in per capita income, a growing urban

Poultry production in 2011 expected to be at year-2019 levels



Category	Population (In Million) 2012	Population (In Million) 2019	% Change
Total poultry	729.21	851.81	(+)16.81
Backyard poultry	217.49	317.07	(+)45.48
Commercial poultry	511.72	534.74	(+)4.50

Source: 20th Livestock Census (2019), Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India.

population and falling real poultry prices. Poultry meat is the fastest growing component of global meat demand and India, the world's second largest developing country, is experiencing rapid growth in its poultry sector. In India, poultry sector growth is being driven by rising incomes and a rapidly expanding middle class, together with the emergence of vertically integrated poultry producers that have reduced consumer prices by lowering production and marketing costs. Integrated production, market transition from live birds to chilled and frozen products, and policies that ensure supplies of competitively priced corn and soybeans are keys to future poultry industry growth in India. There are number of small poultry dressing plants in the country. These plants are producing dressed chickens. In addition to these plants, there are five modern integrated poultry processing plants producing dressed chicken, chicken cut parts and other chicken products. These plants will manufacture egg powder and frozen egg-yolk for export.

Areas of Production: Over all, Tamil Nadu counts for maximum egg production. In Andhra Pradesh, Hyderabad is the city with maximum poultry and hatcheries. Besides the state of Andhra Pradesh, Visakhapatnam, Chittoor, Karnataka, Tamil Nadu, Maharashtra, Gujarat, Madhya Pradesh, Orissa and North Eastern States are the major egg contributors.

India Facts and Figures: The country has exported 5,44,985.06 MT of Poultry products to the world for the worth of Rs. 687.31 Crores/ 98.42 USD Millions during the year 2018-19.

Major Export Destinations (2018-19): Oman, Maldives, Japan, Vietnam Soc Rep & Indonesia.

The importance of the India poultry industry

- Supply of nutritive food.
- Eggs are a good source of protein, minerals and vitamins.
- Eggs make an ideal diet because of low sugar and source of iron.
- Poultry meat has no religious taboo.
- Market of poultry products is well established.
- Income in poultry farming is round the year.
- Provides self employment to unemployed educated youth.
- Infertile egg produced on poultry farms have been accepted as vegetarian food.
- Provides more food at low cost for e.g. 1 kg body weight of broiler is obtained from 2 kg. Feed and similarly 1 dozen egg can be obtained from 2.2 kg feed.

Limitations of poultry industry

- Rising cost of poultry feeds and its quality.
- Adulteration of poultry feeds.
- Instability in prices of poultry products in the market.
- Lack of selection and quality of chicks
- Lack of cooperation in the poultry sector.
- Lack of disease diagnostic facilities.

Conclusion

Poultry farming is beneficial for the production of eggs and meat for commercial purposes. Millions of chickens are raised across the world as a good source of food in the form of eggs and meat. Poultry is one of the most important and fastest-growing sectors of agriculture sectors today in India. The poultry sector majorly maintains the requirements of protein and nutrition. India today is one of the largest manufacturers of eggs and broiler meat. Poultry farming raising of birds domestically or commercially, primarily

for meat and eggs but also for feathers. Birds can easily be sold for cash (poultry is often described as farmers' "petty cash") and serve as a buffer against shocks such as bad harvests. As the poultry flock grows, surplus birds may be bartered for goats, thus further improving a poor family's livelihood and food security. Since then, we have seen the industry grow, as apparent from the recent 2020 study that shows the poultry industry providing 2.1 million jobs, $121.1 billion in wages, $41.9 billion in government revenue, and $576.6 billion in economic activity. It generates employment for the world and increases the income level of the people and eradicate poverty. It provides meat and eggs to the world population which is the rich source of the vitamins and proteins which play a great role in health development. These enterprises present various economies of scale of operation and, thus, are able to absorb the fluctuations in demand and supply and in input cost. The growth of this sector has remained highly significant over the years.

References

- Asic Animal Husbandry Statistics. Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, Government of India; 2012.
- Bhardwaj SP, Nirman KPS, Pandey RK, Kaushik MS. Study of Marketingof Broilers in Haryana. Indian Journal of Agricultural Marketing1996;10(2):118.
- Bhardwaj SP, Mahajan VK, Pandey RK. Study of cost Behaviour and Marketing Margins in Poultry Production - A case study of Broilers, Indian Journal of Agricultural Marketing Conference special p.72-73.
- Iqbaluddin (1996) Poultry development policies and planning for higher production environmental production income and employment. Proceedings of the 20th World Poultry Congress; 1996 Sept 25; NewDelhi. India. v.111, p.333-342.
- Business News. National Agricultural Cooperative Marketing Federation of India. New Delhi; 2010 Apr.
- Pandey RK, Bhardwaj SP, Mahajan VK, Nirman KPS. Economic Study of Poultry Production in India. Proceedings of the 20 th World Poultry Congress; 1996 Sept 2-5; New Delhi. India. v.3, p.527-34.

❖❖

ISSN No. 2583-3146

Scope of Organic Kinnow Cultivation under Praygraj Agro-Climatic Condition

Mandeep Rawat[1] and Abhilash Padhan[2*]

[1]Department of Horticulture, G.B Pant University of Agriculture and Technology, Pantnagar

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

Corresponding Author: fruitbreederabhilash9020@gmail.com

Introduction

Kinnow belongs to the citrus group of fruits. It is botanically known as *Citrus reticulata Blanco* with a chromosome number 2n=18. It is also known as King's willow mandarin, an interspecific hybrid between *Citrus nobilis* x *Citrus deliciosa*. It was first developed by H.B Frost in the year 1915 at the University of California Research Center, Riverside. In India, kinnow mandarin came in acquaintance during 1954 when it was first introduced by J.C Bakshiat the Punjab Agricultural University, Regional Fruit Research Station, Abohar. Kinnow gained its popularity in India mainly due to its high yielding attribute as well as of its flavour also. The tree grows vigorously and has an upright form, with a strong tendency of bearing heavy fruit yield. The fruit is a rich source of vitamin C and their daily consumption protects mankind from scurvy. The rind of the citrus fruit contains a number of alkaloids, out of which is limonene which have the potential to act as an insect repellent.

Organic Bio-fertilizers for Kinnow Orchard

Kinnow is a nutrient loving plant and requires an adequate amount of nutrients in order to produce a good quality yield. It also requires a fair quantity of micronutrients in order to enhance its juice quality. Use of organic farming as well as bio-fertilizer is reported to increase the quality of fruits as well as it helps in restoring the soil nutrients in a natural way. It not only provides a good quantity of nutrients to plants also helps in saving the soil fauna. One can use bio-fertilizers like Azotobacter, PSB (Phosphorus Solubilizing Bacteria), Azospirillum as a replacement for chemical fertilizer. These bio-fertilizers require substrate to grow, so using FYM as a substrate is very effective. FYM not only serves as a good substrate for these eco-friendly bacteria but also acts as a chelate and makes other micronutrients available to plants. Phosphorus Solubilizing Bacteria (PSB) under acidic or calcareous, fixes large amounts of phosphorus in the soil but are unavailable to the plants. Phospho-bacterins are mainly bacteria and fungi which can make insoluble phosphorus available to the plants. The solubilization effect of phosphor-bacterins is generally due to the production of organic acids that lower the soil pH and bring about the dissolution of bound forms of phosphate and hence making the soil available with the phosphorus. *Azospirillum* is the associative symbiotic nitrogen fixer, aerobic bacteria, which have the ability to associate with the growing root system of a variety of crop plants. This nitrogen-fixing Azospirillum when applied to the soil undergoes multiplication and fixes atmospheric nitrogen in the soil for utilization of various crops. *Azospirillum* is a gram-negative bacterium that fixes atmospheric

nitrogen and makes it available to plants in a non symbiotic manner.

Azotobacter, aerobic, a free-living bacterium, acts as plant growth promoting rhizobacteria (PGPR) in the rhizosphere of almost all crops. Azotobacter are abundant in well-drained, neutral soil. They can fix 15-20kg/ha N per year. Azotobacter spp. can also produce antifungal compounds to fight against many plant pathogens. In order to ensure the maximum benefit of these bio-fertilizers; it is very important to apply them in the right way. These fertilizers are mainly applied along with compost, mix the recommended amount of bio-fertilizer with the compost and leave it overnight in order to multiply the bacteria in compost and then apply it. In this may the bio-fertilizers give the best result.

IPM strategy for pest management

Kinnow is also heavily attacked by insects and pests, of which one of the most damaging pests of kinnow is fruit sucking moth (*Eudocima fullonia*). They mainly puncture the fruit and suck out the juice from them, a heavy infestation resulting in yield loss of up to 80-90% was reported. As they are nocturnal in nature it is hard to control them, setting light traps or poison bait is effective for their control. Bagging of fruits with buter paper prevents the contact of files with fruits. Dilute suspension of fermented molasses or jaggery and malathion 0.05%(50 EC at 1ml/l) as poison bait is effective, or bagging of fruits with 500-gauge polythene bags also prevent the adult moth attack.

Scope of Organic Kinnow Farming at Prayagraj, Uttar Pradesh

Plant nutrients are the key factor in order to increase the fruit yield. Adopting organic means of farming practices a not immediate result giving but it improves the quality of fruits in the successive years. Organic farming improves the soil physical properties such as aeration, texture, water holding capacity, infiltration as well as chemical properties such as pH, CEC, etc. Apart from this the price of organic produce is fetching a good price in the market. So, this is the time that we should slowly move towards organic farming and make our food a little healthier and freer from chemicals. Prayagraj comes under the sub-tropical region of India, due to its climatic conditions it experiences only one bahar in a year i.e., mrig bahar (winter flowering). The Kinnow orchard of SHUATS was first established by W.B Hayes in the late 90's who was the British Agriculture scientist also the first HOD (Head of Department) of Department of Horticulture, SHUATS. The soil of the Prayagraj is clay loam which is enriched with nutrients and also good for the cultivation of most of the fruit crops.

The sandy loam soil type provides a suitable environment for the growth of micro-organisms and suitable for the use of bio-fertilizers. Being a sub-tropical region, it experiences a hot dry summer with a maximum temperature of 48°C. Due to this, Kinnow cultivation at Prayagraj region need more frequent irrigation in order to prevent the June drop. It experiences an annual rainfall of 981mm (approx.) which leads to the heavy infestation of flies and moth in the Kinnow plants and causes a huge pre-harvest loss (upto 80-90% yield losses).

Recommended doses of fertilizers and organic manures for Kinnow growers

S.No.	Recommended doses	References
1.	60 kg FYM, 750 gm of Nitrogen	Garhwal *et al.*, 2014
2.	Azotobacter + 25% N as vermicompost and 75% N as urea	Bakshi *et al.*, 2017

3.	50% NPK + 55 kg farmyard manure + biofertilizers	Ennab, 2016
4.	Nitrogen @ 350 g/plant + vermin compost 20 kg/plant	Pareek *et al.*, 2017

Market Prospective of Kinnow

Kinnow mandarins are medium sized with thin, tight and orange colored skin. It is rich in vitamin-C, sugars and in addition to this it also contains vitamin-A, vitamin-B and vitamin-K and contains a sweet-sour taste. Due to this it fetches a high price in the market and is also utilized by the processing industry. India earns a sizable amount of foreign exchange by exporting Kinnow to various countries of the world like Iran, Singapore, Qatar, Nepal, Switzerland etc. In India, the best quality of kinnow was obtained from the Nagpur region of Maharashtra where these fruits got its characteristic flavour due to the climatic conditions of that region.

Conclusion

Thus, keeping in mind the climatic and the soil conditions of the Prayagraj region, adoption of organic farming techniques in Kinnow mandarin can help us in enhancing the fruit quality and yield as well as in maintaining and restoring the soil fertility.

References

- Bakshi, M., Bakshi, P., Wali, V. K., Rai, P. K., & Jasrotia, A. (2017). Effect of inorganic and organic fertilizers along with Azotobacter on growth, yield and quality of Kinnow mandarin. *Indian Journal of Horticulture*, *74*(2), 281-284.
- Ennab, H. (2016). Effect of Organic Manures, Biofertilizers and NPK on Vegetative Growth, Yield, Fruit Quality and Soil Fertility of Eureka Lemon Trees (Citrus limon (L.) Burm). *Journal of Soil Sciences and Agricultural Engineering*, *7*(10), 767-774.
- Garhwal, P. C., Yadav, P. K., Sharma, B. D., Singh, R. S., & Ramniw, A. S. (2014). Effect of organic manure and nitrogen on growth yield and quality of kinnow mandarin in sandy soils of hot arid region. *African Journal of Agricultural Research*, *9*(34), 2638-2647.
- Pareek, P. K., Bhatnagar, P., & Chander, S. (2017). Effect of nitrogen and vermicompost interaction on growth and development of Kinnow Mandarin in vertisols of Jhalawar district. *Chem Sci Rev Lett*, *6*(23), 1555-1560.

Fig 1. Poison bait to kill fruit sucking moth in kinnow

Fig 2. A healthy bearing Kinnow plant at the Central Field of Department of Horticulture, SHUATS, Prayagraj, Uttar Pradesh India

ISSN No. 2583-3146

Weed Management using Electromagnetic Radiation: An Eco Friendly Approach

P. Kishore Kumar[1]* and R. Ranjith[2]

[1]Department of Agronomy, RVS Agricultural College, Tamil Nadu Agricultural University, TN

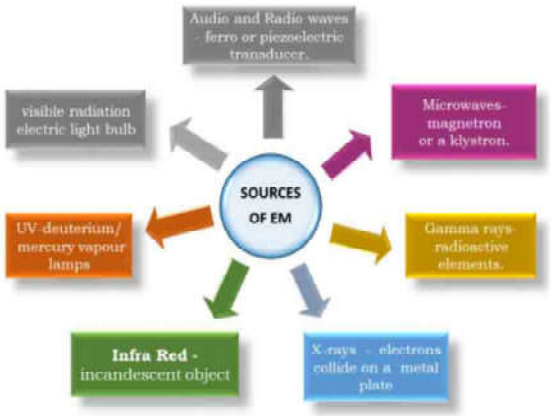
[2]Department of Agronomy TNAU, Coimbatore

Corresponding Author: pkishorekumar95@gmail.com

Introduction

The frequency region from 300MHz to 300 GHz of the electromagnetic spectrum corresponds to the microwave region. These waves propagate through the space as time varying electric and magnetic fields. Microwaves are unique as they can travel through lossy mediums, resulting in an increase in temperature of the medium. This uniqueness has led to the application of microwaves in agricultural and food industries. The microwave energy is usually dissipated in the form of heat throughout the medium (Hao *et al*., 2012).

This volumetric heat generation causes rapid heating and is a highly energy efficient method. The microwave heating has many industrial applications like the pest control, metal casting, and oil extraction from tar, increasing crop production, drying and enhancing the quality of crop and controlling weeds in cropping system. The microwave radiations are being readily used in agriculture as these radiations enable fast, continuous and non-destructive monitoring without cont-aminating the material. These radiations are much safer as compared to the ionizing radiations and are relatively insensitive to dust, wind, water vapour and other degrading environmental conditions. Microwaves can be used for drying of products. It is advantageous as it causes internal vapour pressure which brings the moisture out resulting in an improved quality of food products. The conventional methods for controlling weeds in a cropping system include the chemical and mechanical processes. The use of insecticides, herbicides, and pesticides can cause various health related issues as well as can hamper the soil quality. These environmental concerns have led to an increasing interest for the non-chemical weed control mechanisms. The efficient interaction between microwave and agriculture can result in higher and better agricultural produce. Efforts are being made to understand the underlying physics to employ microwaves efficiently in agriculture (Zielonka and Dolowy, 1998).



Sources of Em (Electromagnetic) Radiation

The General Principle of Microwave Heating

The interaction between the microwave and the medium results in heat generation. The generated heat is dependent on both the moisture content and the dielectric constant of the medium. Microwave heating is because of the simultaneous moisture and heat diffusion in the material. A rapid moisture and heat diffusion through biological material yields faster heating as compared to the conventional heating system. The microwave applications are dominated by the fastest diffusing waves whereas the conventional heating techniques are characterized by the slower waves. The effect of heating the seeds using microwave frequencies was first studied by Davis *et al,*. (1971). The applications of transmitted microwaves to the seeds are listed below.

Promoting germination

Microwaves can be used to simulate growth and seed germination. This dry method is being used for unfolding the seed coating and has far beneficial results as compared to the conventional boiling water mechanism. Plants like Acacia have a waterproof coating which impedes germination. After being microwaved the resulting seeds can be stored for a longer period of time and even remain more viable.

Increasing length of stems and roots

An increase in the length of stems root in some plant species can be obtained by employing microwave techniques. Microwaving of seeds as shown a dramatic increase in both the stem and root length. Some research shows that microwaving the lentil seeds at 450 W for a time period of 30 secs resulted in about 10 percent longer stems and about 7 percent longer roots. When the application time was increased to about 60 seconds, it resulted in seeds having 9 percent longer stems and about 6.5 percent longer roots. A further increase in the heating time for about 90 seconds showed severely negative results.

Enhancing seedling mass

Microwave treatment can be used to enhance the total mass of the seedling. When the seedling was exposed to 450 W of microwave treatment for about 30 seconds and was measured on the 14th day the total mass was found to be 16 percent higher than the usual mass. An exposure time of 60 seconds boosted the seedling mass by 36 percent. Considering the later stages of growth, it was found that treating the seed for about 30 seconds with 450 Watt of microwave energy gives the best result.

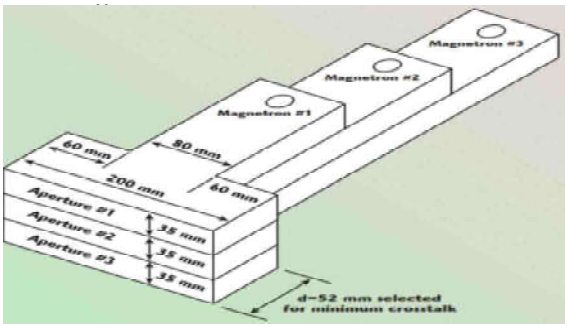
Microwave Treatment of Weeds, Insects and Pests

The interactive relation among several branches of science and technology has brought about improvements in interdisciplinary fields like agriculture. This principle is extensively used in activities relating to spot-weed control.

The cost constraint both in form of the equipment cost as well as the energy requirement cost, limits the use of microwave heating. The presence of glossy unwanted targets in an open environment leads to energy losses. The microwave applications can be made cost effective by improving the polarization field of microwave such that it functions only for some particular targets. When the non-polarized microwave radiations are induced in the weeds, they may not induce current in sensitive parts of the weed plant in order to kill them. Hence polarization of microwave radiation is important to carry out the desired operation. The standing wave patterns will have deep minima if we use a single microwave source to feed a single antenna or a small number of antennas. The weed located in the field minima will survive

these radiations as the heating effect in these minima is too low for rupturing the weed plants.

The following Fig. corresponds to a prototype of a stacked horn antenna which can be employed for weed killing. Here the standard magnetron is operating at 2.45 GHz and the waveguide dimensions are chosen to be 80× 85 cm. The length of the wider section was taken to be 52 cm for achieving minimum



This design can be implemented to develop a stacked horn antenna which uses microwave frequencies to kill weeds.

Species of weeds like Marshmellow seedlings (*Malva Parviflora*), paddy melon and flea bean (*Conyza bonariensis*) were observed under microwave treatment by Brodie *et al*., (2007) and their probability of survival under microwave radiation was found to follow a simple logistic response function given as:

$$S_{survival} = \frac{1.0}{1+(\gamma+/a)^{n}}$$

where a and n are the response parameters and ψ is the applied microwave energy in Jcm^{-2}

$S_{survival}$ represents the probability of survival of species.

Microwave weed treatment

Microwave weed management is an alternative method of weed control in modern agriculture systems. The efficacious application of microwave heating in agricultural systems can substitute for the sometimes hazardous, toxic and environmentally unsafe chemicals that are used to kill weeds. Interest in the use of microwave energy as a tool to weeds control is mainly because of herbicide resistance of various weed species and their long-lasting persistence in the environment. Microwave heating is not influenced by wind direction and speed, therefore prolonging the application periods compared to traditional methods of herbicides spraying (Diprose *et al*., 1984).

Ayappa *et al.,* (1991) reported that the most important features of microwave heating are its accurate control, diminutive start-up time and volumetric heating. Microwave energy density is the most important factor in plant mortality rather than exposure time; therefore, two options for weed management, using microwave energy, become evident: long exposure to diffuse microwave energy; or deliberate application of a strongly focused microwave pulse to quickly debilitate the plants. Microwave radiation, which triggers dielectric heating in plant tissues, is induced by the microwave's electric field. This internal heating ultimately kills or debilitates the plant. Bigu-Del- Blanco *et al.,* (1997) treated 2-day-old seedling of maize with microwave energy at a frequency of 9 GHz for 22–24 h. The authors revealed that more exposure time to microwaves even at very low energy densities significantly dehydrated the maize plants and retarded their growth. In contrast, the recent research on fleabane and paddy melon has concluded that a short exposure ($\leq$ 5 s) of high-intensity microwave heating was enough to hinder plant growth. The plant tissues, which were subjected to microwaves, rapidly dehydrated. Whatley *et al*., (1973) stated that low moisture levels in soil attenuated the microwave transmission less than high moisture content. The authors suggested that pre-emergence microwave treatment for weed control should be worked out when the top soil layer (1 to 2 cm) contains relatively low moisture.

Van Wambeke *et al*., (1983) reported that seeds, fungi and nematodes could be effectively controlled with a short exposure to microwave treatment; however, the efficacy of this short exposure was highly influenced by soil texture, exposure time (sec), soil depth and soil moisture content. Davis *et al*., (1971) conducted an experiment to evaluate the effects of microwave on the seedling survival percentage of twelve species. They described that the seedling (48 h germination) exhibited no survival after short exposure of microwave energy and concluded that susceptibility of young seedlings to microwave heating was highly correlated with moisture content and absorption of energy. Davis *et al*. (1984) proposed that the specific mass and volume of crop seeds were positively correlated to seed mortality during microwave heating. This might be due to the "radar cross-section" attainable by seeds to transmit microwave. More radar cross-section enables the seed to interrupt, and thus absorbs more microwave energy.

The use of electromagnetic radiations for post-emergence control of broad leaves and grasses is the least energy-consuming process available for microwave weed control. Brodie *et al*., (2007) stated that, based on microwave energy calculation for seeds and plants on the sandy soil surface, far more energy was required to kill dry seeds as compared to the previously emerged plants. The actual energy requirement on a large scale would depend on plant density and three-dimensional microwave distribution. Hence, the total energy required for weed management might be significantly reduced if weed seeker systems are employed to control the activation of the microwave unit.

Microwave Based Weed Management Strategies

Microwave Frequency	Energy level	Irradiation duration (s)	Treatment scenario	Target species	Percent weed seed destruction
2.45 GHz	600 W	60 s	Pre-emergence (Dry, 4 hoaked and 46 h germinated seeds)	*Prosopis juliflora,* Cucumis sativus, *Brassica* sp., *Rumex crispus, Echinochloacolonum, Amaranthus* sp., and *Triticum vulgare*	17% reduction in germination in dry seeds but 100% in case of moist seeds at 10 s of exposure
2.45 GHz	600 W	8 s	Post emergence	Duck weed	50 %
2.45 GHz	500 W	30 s	Pre emergence	*Avena fatua*	60 %
2.45 GHz	800 W	120, 240 s	Pre emergence	Parthenium	67 %
2.45 GHz	500 W	30 s	Pre and post emergence	*Malva parviflora*	100% destruction of tested speciesat 0.65 kWh m^{-2}
2.45 GHz	700 W	120, 240 and 320 s	Pre emergence treatment of soil	*Lolium perennis* and *Lolium rigidum*	100% seed mortality was achieved at 240 s of MW Irradiation
2.45 GHz	750 W	5, 15 and 30 s	Pre and post emergence	Prickly paddy Melon	100% debilitation of plants
2.45 GHz	2 kW	5, 10, 15s	Postemergence	Wild radish	100 %

Conclusion

The potential use of microwave energy as a weed management tool has been explored for some time. Experimental evidence demonstrates its effectiveness at killing weeds and their seeds, yet the technology has not been fully commercialised. The main reason for this is the energy requirements needed to treat broad acre cropping enterprises. Chemical weed control is still the cheapest option for weed management on most farming systems. Unfortunately there is a growing population of chemical resistant weed biotypes and chemical weed management may become ineffective in the future. For this reason, microwave weed control systems should be explored as part of an integrated weed management strategy.

Most microwave weed control experiments have focused on managing seed banks. Some experiments have been done on weed plants, but they have been conducted using microwave systems which broadcast their energy over a relatively large area rather than concentrating the energy into a small space on the weed plants. This reduces the efficacy of microwave treatment, prolongs the exposure time need to kill the plants and precludes the onset of thermal runaway in the plant tissue. Thermal runaway, if it can be induced in the plant stems, could vastly reduce treatment time for a given microwave power level, thus reducing the energy needed to treat weeds by an order of magnitude. This would make microwave weed control comparable in energy terms with conventional chemical weed treatment. The integration of microwave treatment systems with weed sensing technologies would also reduce treatment energy.

In conclusion, microwave energy can be used to manage weeds and their seeds. Energy requirements are an important consideration, but these may be addressed by using novel micro wave applicators to focus the microwave energy into a very narrow strip to induce thermal runaway in the plant tissue. Further energy savings may be achieved by integrating microwave treatment systems with weed sensing technology.

Soil pasteurization is more effective in moist soils.

References

- Ayappa. K. G., Davis. H. T., Crapiste. G., Davis. E. J. and J. Gordon. 1991. Microwave heating: An evaluation of power formulations. Chemical Engineering Science. 46: 1005-1016.
- Bigu-Del-Blanco. J., Bristow. J. M. and C. Romero-Sierra. 1977. Effects of low level microwave radiation on germination and growth rate in corn seeds," *Proceedings of the IEEE*, vol. 65, no.7, pp. 1086–1088.
- Brodie. G., Hamilton. S. and J. Woodworth. 2007. An assessment of microwave soil pasteurization for killing seeds and weeds. Plant Protection Quarterly ;22:143-149
- Davis. F. S., Wayland. J. R. and M. G. Merkle. 1971. Ultra high frequency electromagnetic fields for weed control: phytotoxicity and selectivity, *Science*, vol. 173, no. 3996, pp. 535–537.
- Davis. F. S., Wayland. J. R. and M. G. Merkle. 1971. Ultra high frequency electromagnetic fields for weed control: phytotoxicity and selectivity, *Science*, vol. 173, no. 3996, pp. 535–537.
- M. F., Benson. F. A. and A. J. Willis. 1984. The effect of externally applied electrostatic fields, microwave radiation and electric currents on plants and other organisms, with special reference to weed control," *The Botanical Review*, vol. 50, no. 2, pp. 171–223.
- Hao Feng, Yun Yin, Juming Tang. 2012. Microwave drying of Food and Agricultural Materials: Basic Heat and Mass Transfer Modelling.
- Van Wambeke. E., Wijsmans. J., and P. d'Hertefelt. 1983. Possibilities in microwave application for growing substrate disinfestation In proceedings of II International Symposium on Soil Disinfestation. 209-218.
- Whatley. T. L., Davis. F.S. and M.G. Merkle. 1973. Effects of soil moisture on phytotoxicity of microwave fields. In: proceedings of Southern Weed Science Society.
- Zielonka. P and K. Dolowy. 1998. Microwave Drying of Spruce: Moisture Content, Temperature and Heat Energy Distribution. Forest Products Journal. 48: 77-80.

❖❖

ISSN No. 2583-3146

Advanced Production Technology for Rabi Fennel

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

College of Horticulture, Sardar krushinagar Dantiwada Agricultural University, Jagudan

Corresponding Author: sable.pating@gmail.com

Introduction

Fennel (*Foeniculum vulgare* Mill.) is a seed spices crop of the family Apiaceae is a native of Southern Europe and Mediterranean region and one of the popular seed spice in India mainly grown in *rabi* season. It is widely cultivated in countries like India, Syria, Egypt, Turkey, Germany, Spain and Pakistan. Major fennel producing states in India are Gujarat, Rajasthan, Madhya Pradesh, West Bengal and Uttar Pradesh. Gujarat and Rajasthan are major fennel producing states, contributing nearly 96 percent of national fennel area and production both. In Gujarat, the major fennel growing areas are Mehsana, Morbi, Banaskantha, Sabarkantha and Aravalli, while, in Rajasthan, it is mainly cultivated in Nagaur, Sirohi, Jodhpur, Pali and Swai Madhopur districts. During 2019-20 (Adv. Est.) production of 1,27,790 t of fennel was achieved from 75,260 ha area which is 7.61 and 4.3 percent of total seed spice production and area, respectively. The productivity of fennel is 16.98 q/ha (Mehta, *et al*., 2021). Fennel has been ordinarily used as a conventional food and medicine. A significant increase in quantity and quality yield through the suitable practices could build a necessary contribution to farm and pharmaceutical trade. To achieve these goals with reference to sustainable production, we tend to review an outline of cultivation of *rabi* fennel in this article.

Varieties

There are many varieties released commercially for cultivation in different areas of the country. Suitability of variety for any agro climatic zones depends on adaptability of variety to the particular soil and climate.

Ajmer Fennel-1 (AF-1)

This variety is developed by ICAR-NRCSS, Ajmer (Rajasthan) through mass selection method and released in 2005 for growing both for early sowing and as *rabi* crop. This variety is erect and tall growing, bearing large size umbels. It gives an average yield of 20-22 q/ha during *rabi* season and 25.10 q/ha when grown as an early transplanted crop. This variety matures in 170-180 days after sowing. This variety has tolerance to *Ramularia* and *Alternaria* blight.

Ajmer Fennel-2 (AF-2)

This variety is developed by ICAR-NRCSS, Ajmer (Rajasthan) through recurrent selection method and released in 2017 for growing both for early sowing and as *rabi* crop. This variety is erect and tall growing, bearing large size umbels. It gives an average yield of 17.90 q/ ha. during *rabi* season. This variety matures in 175-180 days after sowing. This variety has tolerance to *Ramularia* and *Alternaria* blight.

Ajmer Fennel-3 (AF-3)

This variety is developed by ICAR-NRCSS, Ajmer (Rajasthan) through recurrent selection method and released in 2018 for

growing both for early sowing and as *rabi* crop. This variety is erect and tall growing, bearing large size umbels. It gives an average yield of 21.40 q/ha during *rabi* season. This variety matures in 175-180 days after sowing. This variety has tolerance to *Ramularia* blight.

Fennel CV. Ajmer Fennel-1

Fennel CV. Ajmer Fennel-2

Fennel CV. Ajmer Fennel-3

RF-125

This variety is developed by Sri Karan Narendra Agriculture University, Jobner (Rajasthan) through recurrent half sib selection method from exotic collection, EC-243380 from Italy and released in 1997 (Dheebisha C and Vishwanath Y C, 2020). This variety is early, short stature type with compact umbels and long bold seed. It gives an average seed yield of 17.30 q/ha. This variety matures in 110-130 days after sowing.

RF-205

This variety gives an average seed yield of 18-20 q/ha.

This variety matures in 110-130 days after sowing.

Gujarat Fennel-11 (GF 11)

It is a high yielding variety developed at Seed Spices Research Station, Sardar-krushinagar Dantiwada Agricultural University, Jagudan, Gujarat for *rabi* season. Plants are mature within 157 days. It gives a seed yield of 25-25.90 q/ha.

Gujarat Fennel-12 (GF 12)

It is a high yielding and lodging resistant variety developed at Seed Spices Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Gujarat for *rabi* season. Plants are mature within 151-160 days. It gives a seed yield of 24 q/ha.

Fennel CV. RF-125

Fennel CV. RF-205

Fennel CV. GF 12

Climate and Soil

It is a cool season crop, mainly grown during *rabi* season in North India and does not thrive in South India except at a higher elevation. A cool and dry weather favours higher seed yield. A temperature of 15-30^{O} C is optimum and above 25^{O} C for extended period usually retards development of fennel and in early growth may result in premature flowering and very low seed yield. The optimum temperature for seed germination is 20-29 ^{O} C (Mehta, *et al*., 2021). Fennel thrives well on sandy loam to loam soil, which is rich in organic matter and nutrients and having the pH range 6.5 to 8.5. Fennel is low accumulator of heavy metals and thus can be grown on polluted soil.

Cultivation

The land should be well prepared for ensuring better germination and growth of crops. First ploughing should be done by soil turning plough and after ploughing 2 to 3 crosswise harrowing should be done. The ploughed field should be made fine and leveled by planking. Time of sowing is an important factor for growth and development of fennel crop. Fennel, being a cool season crop is sown from last week of October to first week of November month is an ideal period for *rabi* season for North Gujarat (Sable *et al*., 2022). Seed rate recommended 4-5 kg/ha with a spacing of 45 cm x 22.5 cm. The seeds are to be sown at 2 cm depth. The farmers of Sabarkantha district of North Gujarat region adapted line sowing with a distance of 120 cm x 10-12.5 cm between rows and plants for easy intercultural operations.

Line sowing method in fennel

As per ICAR-NRCSS, Ajmer 08 to 10 kg seed rate is recommended per hectare for direct sowing at spacing of 50-60 cm x 25-30 cm (https://nrcss.icar.gov.in). Seeds should be treated with carbendezim or captan (2.5 g / kg seed). No seed treatment is required for already treated and packed seed.

Nutrient Management

Fertilizer requirement varies from region to region depending upon type and fertility status of the soil, targeted yield of crop and variety to be sown. Therefore manures and fertilizers should be applied based on soil testing reports. When the nutrient content of soil is average, 15t/ ha. organic manure (FYM) is to be applied at the time of land preparation. The farmers of North Gujarat growing *rabi* fennel are recommended to apply 90 kg N, 30 kg P_2O_5 , 40 kg K_2O and S 20 kg/ha (Recommendation, SSRS, SDAU, Jagudan, 2021). Total dose of P, K, S and half dose of nitrogen is to be applied as basal dose and remaining half dose of nitrogen is to be top-dressed at 30 and 60 days after sowing equally as split dose. The proper soil moisture should be maintained before broadcasting of fertilizers for realizing higher nutrient use efficiency.

Recommended Practice: Fennel field with application of FYM 15t and 90:30:40:20 kg NPKS/ha

Farmers Practice: Application of FYM 15t and 90:30:00 kg NPK/ha

Bio-fertilizers like *Azotobacter* and *PSB* (2.5 kg/ha each) can be applied with vermicompost or well decomposed FYM (one week enriched) which enhances yield with 25 per cent saving of Recommended Dose of Fertilizers (RDF). Bio-fertilizers in liquid form can be preferred for easy application through drip irrigation after one week of recommended dose of fertilizers application. Bio-agents should not be used with chemical fertilizers or any agrochemicals.

Aftercare

Irrigation should be adjusted in accordance with prevailing weather and soil conditions. The crop must be irrigated during its critical stages. Special care to be needed till germination; the soil should have sufficient moisture for germination.

Protective irrigation for germination

Crop (*rabi*) is to be irrigated immediately after sowing, at 8th and 33rd days after sowing and remaining 7 irrigations at an interval of 12 to 15 days. Drip irrigation can be followed for efficient water use efficiency, fertilizer use efficiency, to reduce physiological disorders and more yield. Distance between to laterals is to be kept 90 cm and distance between emitters 60 cm. Farmers of North Gujarat region are advised to provide irrigation during September 30 minutes, October to November 75 minutes and December to February 60 minutes at an alternate day by drip irrigation system with discharge 4 l/hr (pressure 1.2 kg/ cm$^{2)}$ (Sable *et al*., 2022). Weeds compete with crop for space, water and nutrients. Hence, the weed free condition in the fennel crop must be ensured. Intercultural practices like weeding, gap filling, thinning are to be done as per the need. Before fennel seed germination, the pre-emergence herbicide pendimethalin 30 EC 1 litre is to be mixed with 500 litre of water and can be sprayed in 1 ha at sufficient soil moisture condition for effective weed control. After 30-45 days the crop is to be earthed up.

Thinning in fennel

ISSN No. 2583-3146

Earthing up in fennel

Harvesting and Yield

Time of harvesting depends upon the products in which we are interested. In order to get green fennel seed which is used for chewing purpose, umbels are to be harvested about 30-40 days after flowering when these are still green and have attained half-length size. While, in order to get seeds for spice purpose umbels are to be plucked, when seeds have changed their colour from green to yellow and are fully mature. All the seed does not mature at a time, therefore harvesting of umbels is to be done 4-5 times as and when they become ready.

After harvesting, umbels are to be dried in sunlight for 1-2 days and then in shade for 8-10 days under well aerated conditions. Longer exposure to sunlight changes the colour and luster of seeds, reducing their quality. The dried umbels are separated and cleaned by winnowing.

Seed setting of fennel CV. GF-12

Shade drying of fennel umbels

Yield per unit area differs as per variety, type of soil and climate. The productivity of fennel is 16.98 q/ha. The farmer's of Sabarkantha area of North Gujarat received seed yield 22.50-25.00 q/ ha. from fennel CV. GF-12 under scientific management conditions of the crop with spacing 120 cm x 10-12.5 cm.

Conclusion

Advanced production technology of *rabi* fennel including use of improved varieties, recent sowing technology, Micro Irrigation System (MIS), Integrated Nutrient Management (INM) and harvesting technology has been found to be more productive.

References

- Dheebisha C and Vishwanath Y C (2020). Advances in cultivation of fennel. *Journal of Pharmacognosy and Phytochemistr*y, 2020: 9 (2): 1295-1300.
- Mehta R S, Meena S S, Anwer M M, Gopal Lal and Krishna Kant (Revised 2021). Advance production technology of fennel. *The Director, ICAR- National Research Centre on Seed Spices*, Tabiji, Ajmer, 305 206 (Rajasthan), November, 2009: 3.
- Mehta R S, Meena S S, Anwer M M, Gopal Lal and Krishna Kant (Revised 2021). Advance production technology of fennel. *The Director, ICAR- National Research Centre on Seed Spices*, Tabiji, Ajmer, 305 206 (Rajasthan), November, 2009: 4.
- ICAR-NRCSS (National Research Centre on Seed Spices): Website: nrcss.icar.gov.in
- P A Sable, A U Amin and J J Mistry (2022). Rabi fennel pays dividend to the farmers of North Gujarat region. *Indian Horticulture*, July- August, 2022: 16.
- P A Sable, A U Amin and J J Mistry (2022). Rabi fennel pays dividend to the farmers of North Gujarat region. *Indian Horticulture*, July- August, 2022: 15.

❖❖

ISSN No. 2583-3146

Black Wheat: A Nutritional Approach

Garima Kaushik Parashar[1*] and Tushar Kothal[2]

[1]Department of Agronomy, School of Agricultural Sciences

Shri Guru Ram Rai University, Dehradun Uttrakhand

[2]Department of Agriculture, GRD-IMT College, Dehradun

Corresponding Author: garimakaushik1991@gmail.com

Introduction

Wheat is the second most important cereal crop of India and plays a vital role in food and nutritional security of the country. At world level among all the cereal wheat ranks 1st in production, major population of India are only depend on wheat as their staple food. As wheat is a major crop of the country, NABI develops a new wheat variety i.e. black wheat by crossing the two variants of wheat. Black wheat is a super food or a pigmented variety of wheat. It is developed by crossing blue and purple wheat. Black wheat is superior to normal wheat. The anthocyanin pigment present in the outer surface of the wheat is responsible for the black colour of wheat grain. The variety is originated from Punjab & Haryana of India. The variety consists of numerous nutritional and bioactive components including anthocyanin, carotenoids, phytic acid, phenolic compounds, essential amino acids, dietary fibres, minerals and vitamins.

How it is different from normal wheat?

Black wheat is different from normal wheat due to the presence of the pigment called Anthocyanin which is responsible for black colour of wheat grains. Anthocyanin is also responsible for different colour of fruits and vegetables. Normally wheat contains only 5ppm concentration of anthocyanin but black wheat is reported to have 100-200ppm of anthocyanin i.e., extremely greater than the normal wheat. It is scientifically a healthier approach.

Normal Wheat	Black Wheat
Anthocyanin content- 5 ppm	Anthocyanin content 100-200 ppm
28% Zinc	35% Zinc
25% Iron	60% Iron

Health Benefits

a. It helps to cure cancer.
b. Helps to relief from stress.
c. Control Cholesterol level.
d. Good for diabetic patients.
e. Good for heart patients.
f. Prevents skin infections and allergies.
g. Helps to boost immunity.
h. It is good for eyes.

Origin

Black wheat was developed at NABI (National- Agro food Biotechnology Institute) Mohali Punjab in 2017. Two other variants of black wheat are blue and purple wheat. NABI patented black wheat variety now. Punjab, Haryana, Madhya Pradesh and Himachal Pradesh are also familiar with black wheat variety and its production.

Advantages

- Black wheat is much healthier than normal wheat.
- Generate income
- High content of Anthocyanin 100-200 ppm.
- It contains a high amount of magnesium which helps to control the cholesterol level in our body.
- It is also rich in fiber which helps to cure stomach issues.
- Good for blood pressure and heart patients.
- Contains a good amount of Vitamin –K and total flavonoids.
- It can also prevent obesity.
- Good for anemic patients.
- Presence of Anthocyanin makes the grain antioxidant rich which helps in delaying ageing.

Disadvantages

- Research on black wheat is still undergoing.
- Price and production is not yet clear.
- Due to inadequate amount of seeds and limited knowledge farmers are unable to cultivate properly.
- Normally wheat market price is approx. 1700-2000 Rs. per quintals but black wheat price is 7000-8000 Rs. per quintals.
- Demand is higher but supply is limited.

Conclusion

Black wheat has a very high nutritional status when compared to white wheat and making it good choice for human consumption. Poshan Abhiyan (NNM) National Nutrition Mission also include black wheat to improve the nutritional status of women, children and adolescents as it contains higher amount of antioxidants that make it more superior source of proteins, iron, zinc, manganese, vitamin K, phyto chemicals. Due to its high demand farmers easily make more money by cultivating it and sold it at a higher price. As it is gluten free so it has more health benefits like to controling diabetes, blood pressure, heart attack and stress release super food. Our overall immunity and health is determined by the food we consume on a daily routine, so it is very important to boost up our immune system and health by consuming nutritional rich , protein rich and low carbohydrate diets.

References

- https://naturessoulshop.com/benefits-of-using-black-wheat-flour/#:~:text=Black%20 wheat%20flour%20is%20a,of%20the%20Government%20of%20India.
- https://hindi.krishijagran.com/farm-activities/black-wheat-farming-black-wheat-in-india-and-health-benefits-black-wheat-seed-online/
- https://www.sciencedirect.com/science/article/abs/pii/S0924224421002983 © 2021

❖❖

ISSN No. 2583-3146

Mushroom Cultivation: A Lucrative Occupation

Kirandeep Kaur

Department of Horticulture, Khalsa College Amritsar, Punjab

Corresponding Author: kirandeepkaur.kdk97@gmail.com

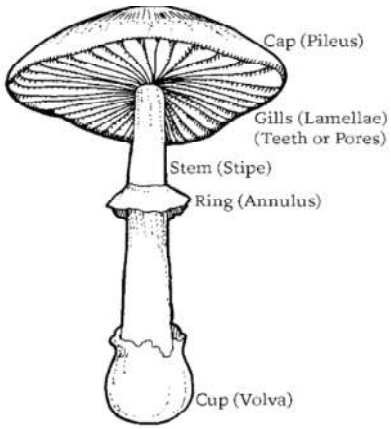
Introduction

Mushrooms are macroscopic basidiomycetous or ascomycetous fungus species. They are a fleshy fungi with spores embedded in fruiting bodies that are valued as food in the marketplace. They are achlorophyllous (lack the green matter content-chlorophyll) and grow saprophytically on dead decomposed matter. They derive their nutrition with the help of the mycelium (many interwoven septate hyphae) that penetrate into the substratum. When the mycelium has grown profusely by absorbing sufficient food materials, it develops the spore bearing reproductive structure or fruiting body that is generally referred to as Mushroom. Ramamurthi and Geethalakshmi (2015) stated that the basic structure of mushroom consists of an umbrella like cap that is known as pileus, bear gills and a stalk or stipe. A number of radiating gills underneath the cap are pink when young and becomes purple brown when mature.

Difference between edible and poisonous mushrooms

According to research findings of Beach and Strom (1989), mushrooms can be both edible and poisonous. To distinguish from the delicious mushrooms, the poisonous mushrooms are known as toadstools. The word toadstool is a distortion of the original German word to destuchl, which means death chair. Some prominent distinctions between edible and poisonous mushrooms are enumerated as follows:

a. A ring or annulus in the middle of stipe of mushroom and a cup or saucer like structure known as volva at the base of stipe are present together generally in poisonous mushrooms. However, in the edible mushrooms, these structures are absent.



b. Poisonous mushrooms are comparatively soft and skin of the cap cannot be easily peeled off.

c. Poisonous mushrooms are generally colourful and quite attractive (having brightly coloured fruit bodies, greenish tinge on gills and pink coloured spores in gills).

d. Milk like exudation oozes out from the damaged fruit bodies in some poisonous mushroom species.

e. Poisonous mushrooms are generally bitter or sour in taste and bear unpleasant smell.

Types of edible mushrooms

The most commonly cultivated edible mushrooms in India are:-

A. Button Mushroom (*Agaricus bisporus*)

Button mushrooms belong to class Basidiomycetes and Family Agaricaceae. It is native to Europe and North America. It is the most popular mushroom variety grown and consumed all over the world. It is of two types white and brown, out of which white button mushroom is commonly grown in India. According to ICAR -Directorate of Mushroom Research, this variety contributes more than 85% to mushroom production was demonstrated by Rai and Arumuganathan (2008). It is the most relished variety used in eateries and households.

B. Shiitake Mushroom (*Lentinula edodes*)

Shiitake Mushrooms are native to East Asia and are highly consumed in Asian countries. They readily grow on wood of deciduous and hard wood trees such as Oak, Chestnut, and Maple etc. Agarwal (2017) noticed that they require moist and warm climate. However, they may cause allergic reaction like itching in some rare cases, but can be eliminated by cooking. It is used in Asian cuisines and traditional medicines.

C. Oyster Mushroom (*Pleurotus ostreatus*)

Among the different types of mushroom, oyster mushroom is also one of the most cultivated species. Oyster mushroom (white-rot fungi) belongs to the family Agaricaceae and class Basidiomycetes. It is also commonly known as 'Dhingri' in India. Ahlawat *et al* (2008) reported that it has fan or oyster shaped cap. They grow easily on decaying wood or straw. It is an edible mushroom having excellent flavour and taste. It is well known for its rich content in vitamin C and vitamin B complex and its protein content along with mineral salt which is essential for human body (Randive, 2012). It was observed by Park *et al* (2014) that mushrooms has received an increasing attention for applications in bio-bleaching and the catalysis of difficult chemical conversions in the paper industry, textile dye decolorization, and detoxification of environmental pollutants.

D. Paddy Straw Mushroom (*Volvariella volvacea*)

Paddy Straw Mushroom belongs to division Basidiomycota. Sharma (2015) found that it is usually grown on Rice straw bed. It is used extensively in Asian Cuisine.

Nutritional value of mushrooms

Due to their delicious flavour, enticing aroma, unique colour and nutritious value , edible mushrooms are a favourite food in many nations and have been cultivated since ancient times (Thatoi and Singdevsachan, 2014). The

protein found in mushrooms is less than in animals but much more than in most plants. They have low calories, fat and carbohydrate content, high fibre and all essential amino acids and with the exception of iron, contain all important minerals and vitamins (Sadler, 2003).

According to Das and Prakash (2022), the nutrients found in edible mushrooms include sugars (sucrose, xylose, rhamnose, mannose, and fructose), amino acids (glutamic, aspartic, glutamate, methionine, and cysteine), proteins, fatty acids (linoleic, stearic, palmitic, adrenic, and nervonic acid), vitamins (folate, riboflavin, ascorbic acid niacin, thiamine, ergocalciferol, and cyanocobalamin) mineral contents (Ca, Mg, K, P, Na, Fe, Cu, Zn, Cd and Mo) and Phenolic compounds (gallic acid, caffeic acid, protocatechuic acid, pcoumaric acid, p-hydroxybenzoic acid and pyrogallol).

Nutritional Value of Mushrooms per 100 g

Nutrient	Value per 100 gram
Energy	113 kJ (27 kcal)
Water	92.45 g
Carbohydrates	4.1 g
Fat	0.1 g
Protein	2.5 g
Thiamine (Vit B1)	0.1 mg (9%)
Riboflavin (Vit B2)	0.5 mg (42%)
Niacin (Vit B2)	3.8 mg (25%)
Pantothenic Acid (B5)	1.5 mg (30%)
Vitamin C	0 mg (0%)
Calcium	18 mg (2%)
Phosphorous	120 mg (17%)
Potassium	448 mg (10%)
Sodium	6 mg (0%)
Zinc	1.1 mg (12%)
Vitamin D (D2 + D3)	0.2 µg
Sugar	1.98 g

Uses of Mushrooms

According to the research study of Sharma (2015), mushrooms can be consumed in various forms like fresh, pickled, dried, powdered, canned etc. It can be mixed into any food preparations or can be processed to give a new product. A lot of mushroom products are currently available in market such as mushroom pickle, seasonings, beverages, extracts, dried and canned mushrooms, mushroom supplements, cosmetics etc. Dried mushrooms can be rehydrated and are used in soups, stews, pickles etc. Mushroom can be eaten as mushroom tomato soup, mushroom pakodas, mushroom kofta, etc.

Medicinal benefits of mushrooms

Apart from its nutritional value, mushrooms are also well known for its medicinal value. There are various chemical compounds found in mushrooms that have medicinal benefits. Chang (2007) observed that mushroom species are known to have a wide range of metabolites such as antitumor, antioxidant, antigen toxic, anti platelet aggregating, anti hyperglycaemic, antimicrobial and antiviral activities. The lipid component of Agaricus contain a compound with anti- tumour activity which was later identified as ergosterol that inhibit tumorigenesis (Takaku *et al.*, 2001). Similarly the lipid fraction of Grifola exhibits antioxidant activity and inhibits enzymes that cause many chronic diseases including cancer (Inoue *et al.*, 2002). They help in fighting for diabetics and cancer. It was found by Sharma *et al* (2013) that due to its high potassium to sodium ratio it is ideal for people suffering from heart disease and hypertension. Oei (2005) noticed that it has no cholesterol content and it is easily digestible. It can also cure anaemia because of the folic acid (blood building vitamin B) (Randive, 2012).

Agro-climatic requirements for cultivation of mushrooms

During the last few decades, mushroom cultivation has grown up in almost all the parts

of the world. In India, owing to varied agro-climate and abundance of farm waste, different types of temperate, tropical and sub-tropical mushrooms are cultivated throughout the country (Shah *et al.*, 2004). Mushroom production requires multiple steps and is grown in favourable conditions which are found in a well- controlled growth chamber.

Bellettini *et al.,* (2019) found that mushroom cultivation depends on many factors such as temperature, humidity and sterility of the substrates which act individually or its interaction between them. While studying the mushrooms cultivation and processing, Sharma (2015) reported that the basic requirements for mushroom cultivation are compost, spawns, right temperature and humidity. The favourable growing conditions involve 80-90 % of relative humidity, ample ventilation, light of 1000 lux, a suitable temperature range of 20-28^{o} C during spawn run and 12-18^{o} C for reproductive growth. The temperature must be maintained at 23 ± 2^{o} C initially for a week and then it can be reduced to 16 ± 2^{o} C for subsequent weeks. The optimum pH for mushroom cultivation is 6-7. The CO_2 concentration should be 0.08-0.15 %.

General steps for production of Mushrooms are discussed below:

Compost Preparation

Gbolagade and Jonathan (2006) reported that mushrooms are grown mostly on waste materials like sawdust, composting materials, straw and garbages. It was noticed by Khare *et al.,* (2018) that the substrates used include manures, sawdust, rice bran, rice straw, wheat bran and wheat straw. The preparation of substrate is known to be the most critical stage in the production process to make sure that the occurrence of diseases is less with better yield (Jongman *et al.*, 2010). The substrate on which mushroom grows is mainly prepared from a mixture of plant wastes wheat straw and supplements like wheat bran and water. The compost can be prepared by two methods, viz. Long method and short method. The compost prepared by short method is relatively more expensive. The long method of compost preparation is most suitable for seasonal growers.

The following materials are required for long method preparation of compost:

Wheat straw or	300 Kg or
Paddy straw	400 Kg
Wheat Bran	15 Kg
Calcium Ammonium Nitrate	9 Kg
DAP	3 Kg
Single Super Phosphate	3 Kg
Muriate of potash	3 Kg
Urea	3 Kg
Gypsum	30 Kg
Furadan	150 g
Lindane dust or BHC	250 g

Before making compost, wheat straw is spread on cemented floor and is turned many times at regular intervals.

Day 0: At the stage, there should be around 75 % humidity content in the wheat straw, to which wheat bran, calcium ammonium nitrate, urea, muriate of potash, and super phosphate are mixed thoroughly and evenly. The material is then piled 1.5 m thick x 1.25 m high with the help of wooden rectangular block. Once the entire material has been stacked up, the blocks are removed. Water is sprayed twice or thrice to keep the substrate moist. Temperature should be in the range of 70- 75^{o}C.

1st turning (Day 6): On the sixth day first turning is given to the stack. The purpose of turning is that every portion of the pile should get equal amount of aeration and water. If the turnings are not given, then anaerobic condition may prevail which may lead to the formation of non-selective compost. In the stack, the

central zone is fermenting at its peak and has maximum temperature, while rest of the portion ferments improperly. The correct method of turning is removing about 15cm of compost from the top and spread it on one side of the floor and rest part of compost on the other side of the floor. Now turning is done by shaking the outer (top most) part and the inner part of the compost, first separately and then mixing them altogether thoroughly with the help of wooden buckets.

2nd turning (Day 10): On the tenth day, again the top most part and the inner part of the compost is separated, water is sprayed on the top part. Again the two parts are piled up together in such a way that now the top part is inside and the inner part is on the top of the stack.

The subsequent turnings 3rd, 4th, 5th, 6th and 7th should be done in the same way on day 13, 16, 19, 22 and 25 respectively. Gypsum and furadan are mixed on day 13. Beyer (2016) found that gypsum is added to the compost to reduce the greasiness and allow more aeration. The lindane dust is mixed with compost during 5th turning. If no ammonia persists in the compost, then spawning is done on day 25.

What are spawns?

Spawns refers to the vegetative mycelium from a selected mushroom strain that is carefully propagated on agars or grains under sterile conditions. Spawn is the planting material which is used as a seed in propagation for mushroom production (Jo *et al.*, 2009). Spawn can be prepared from different carriers of grains such as wheat, sorghum, barley and rice. A research study carried out by Khonga *et al.,* (2013) reported that grains of sorghum are better mycelium carrier as compared to grains of wheat and barley. Although mushroom produces spores which acts as a seed for further propagation but are not used generally due to uncertain germination and growth.

Qualities of a good spawn

- The spawn should be of good quality in terms of flavour, texture and size.
- The spawn should be fast growing in the compost.
- It should give early cropping after casing.
- It should have longer shelf life.
- It should be high yielding
- It should produce better quality of mushrooms.

Spawning

The process of mixing spawn with compost is called spawning. An experiment conducted by Mohan (2009) noticed that the spawns are thoroughly mixed with the compost and then they are covered with newspaper and are watered sufficiently to maintain the

moisture. Humidity is kept high to avoid the loss of moisture throughout the cultivation period. Gradually they grow into white cottony mycelium growth. There are various methods of spawning as given below-

1. Spot spawning: Lumps of spawn are planted in 5 cm deep holes made in the compost at a distance of 20-25 cm. The holes are later covered with compost.

2. Surface spawning: Spawns are evenly spread in the top layer of the compost and then mixed to a depth of 3-5 cm in top and covered with a layer of compost.

3. Layer spawning: About 3-4 layers of spawn mixed with compost are prepared which is again covered with a thin layer of compost.

Spawn Running

After spawning process is over, the compost is filled in a polythene bag accommodating 20-30 kg compost. The fungal

bodies grow out from the spawn and take two weeks to form colonies. The temperature should be maintained at 23 to 28° C in the cropping room. Higher temperature is detrimental for the growth of spawn and temperature below than that range results in slower spawn run. The relative humidity should be around 90 % and a higher CO_2 concentration would be beneficial for better spawn run.

Casing of Soil

Casing is a kind of sterilized soil or dressing containing cow manure which is spread onto the spawn mixed with compost (Beyer, 2016). The significance of casing soil is to maintain the moisture content and exchange of gases within the surface of the compost which helps in the proper growth of the mycelium. The pH of the casing soil should be 7.5-7.8 and must be free from any infection or disease. The casing soil before application should be pasteurized and treated with formaldehyde. After casing is done, the temperature of room is again maintained at 23-28° C and relative humidity of 85-90 % for another 8-10 days.

Watering

Watering should be done regularly as it will help in mycelium development. The house is kept moist by spraying water. Watering is done as and when necessary with the help of sprayer preferably in the morning and evening hours.

Fruiting

Under the favourable environmental conditions namely, temperature, moisture, humidity, CO_2 concentration, the fruiting body initially appears in the form of pin heads and

gradually develop into button stage. While studying the growth and cultivation of mushrooms, Nongthomban *et al.,* (2021) observed that at the time of fruiting, the Relative Humidity should be maintained @ 70-85 % by sprinkling water to the polythene bags or on the compost spread on the floor. At least 8-12 hours of sunlight is required at the time of fruiting.

Harvesting

It was noticed by Reyes *et al.,* (2021) that mushrooms have a very short shelf life due to their rapid respiratory rate, high water content and lack of cuticular structure. All horticulture goods, including fruits, vegetables, and mushrooms, continue to breathe, lose water and soften their cells during the postharvest period (Imahori, 2014). This has a great effect on the quality of the product.

Weijn *et al.,* (2011) noticed that colour is the most crucial factor because it is the first thing people notice and discoloration lessens its appeal to consumers. The other important indices for harvesting of mushrooms include texture, cleanliness, maturity and flush number. The mushrooms are harvested by holding the stipe between thumb and forefingers and by gently twisting the fruiting body clockwise or cutting it using sterilized blade or scissor. The best time of harvesting mushroom is early in the morning before sunrise because sunlight or high temperature during harvesting may increase transpiration loss which results in low quality mushrooms. The harvested mushrooms are then packed in perforated polythene bags for marketing.

Yield

Nongthomban *et al.,* (2021) reported that in a period of one and a half months to two months, from 1 tonne of paddy straw around 500-700 kg of fresh mushrooms can be harvested. The flushes of mushroom fruit bodies appear at 15-20 days interval and the harvest from first three flushes is considered as economic harvest in commercial cultivation.

Diseases of mushrooms

Even though the mushroom itself is a fungus, but it can in turn be affected by a wide range of fungal pathogens. According to the research findings on mushrooms by Nongthomban *et al.,* (2021), the major problems that occur in cultivation of mushrooms are the outbreak of bacterial as

well as fungal diseases and insect pests attack. Due to these problems, there are high losses like shortening of shelf life, low productivity and lower quality. Some of the most common diseases of mushrooms are as follows:

a. Cobweb, mildew (*Dactylium spp.*)

Symptoms: White to pink, cobweb-like, fluffy mould.

Causes: High humidity and contaminated casing soil.

b. Wet bubble/white mould (*Mycogone perniciosa*)

Symptoms: Dense white growth on gills.

Causes: Airborne dust and contaminated casing.

c. Dry bubble/brown spot (*Verticillium fungicola*)

Symptoms: Brown irregular pitted areas on stems and caps. Distortion and splitting.

Causes: Debris and dust on floors of growing house.

d. Ink cap (*Coprinus* spp.)

Symptoms: Turns the bed from black to deep blue.

Causes: Excessive spore production of weed fungus and due to excess moisture in the straw used for mushroom bed preparation.

e. Green mould (*Trichoderma* spp.)

Symptoms: Dark green velvety patches on casing spreading to leisons on stems.

Causes: Improper boiling of the straw or due to contaminated spawn.

f. Browning (*Pseudomonas* spp.)

Symptoms: Yellow to light brown colour on the margin of fruit bodies and the stalk.

Causes: Accumulation of water on the fruit bodies.

Pests of mushrooms

a. Sciarid and Phorid fly: The adults of flies lay eggs on the gills but do not cause damage. The maggots emerging from eggs eat away the soft tissues of fruit bodies.

b. Staphylinid, Scaphisoma and Pleasant beetles: The adults of the beetles feed on the fruit bodies and also on the mycelium during mycelia run.

Management

Maintaining high levels of hygiene will assist any pest management program by reducing the number of problems that are likely to occur. The growing room needs to be in a proper sterilized condition in order to avoid contamination.

Conclusion

Mushroom farming has picked up a fast pack among entrepreneurs because of its nutritional and medicinal benefits and low cost input with high output. The demand for mushrooms is increasing fastly in international markets and a big gap exists between supply and demand. So, there is needed to take advantage of this situation by encouraging its cultivation to increase its productivity which is a highly viable venture. Mushrooms are one of the most popular and versatile gift of nature. Mushrooms are easy to cultivate, have quick growth and nil carbon emission and waste generation. The fungi are a good source of income generation for the growers and also provide additional benefits through its processing.

For the cultivation of mushroom, it is necessary to understand its cultivation practices, its favourable environment such as room temperature, relative humidity, dark period and appropriate aeration. As growing process of mushroom can be affected by various bacterial and fungal diseases as well as insects pests, which often cause a great loss of product at harvesting. These occurred commonly due to unfavourable temperature, relative humidity and inappropriate aeration.

Thus it can be concluded that proper knowledge about the major diseases prone to mushroom cultivation and proper understanding of the symptoms and causes of mushroom diseases is the only way to avoid the risk and loss. All the cultivation practices need to be done in proper hygienic condition. Hence, mushrooms hold a bright future in every aspect due to its diverse properties.

References

- Agarwal S (2017) Know all about Mushrooms. Available from: https://timesofindia.indiatimes.com/Know- all aboutmushrooms/articleshow/47514152.c ms?
- Ahlawat O P, Kumar S, Arumuganathan T and Tewari R P (2008) All India Coordinated Research Project on Mushroom. Available from: http://www.nrcmushroom.org/25_Years_of_Mushroom AIC RIP_.pdf
- Beach L R and Strom E (1989) A toadstool among the mushrooms: screening decisions and image theory's compatibility test. *Acta Psychol*. 72 (1): 1–12.
- Bellettini M B, Fiorda F A, Maieves H A, Teixeira G L, Avila S, Hornung P S, Júnior A M, Ribani R H (2019) Factors affecting mushroom *Pleurotus spp*. *Saudi J Biol Sci*. 26(4): 633-46.
- Beyer D M (2016) Six Steps to Mushroom Farming. Available from: https://extension.psu.edu/six-steps-to-mushroomfarming
- Chang S T (2007) Mushroom cultivation using the ZERI principle: Potential for application. *Micologia Aplicada Int*. 19(2): 33-34.
- Das S and Prakash B (2022) Edible mushrooms: nutritional composition and medicinal benefits for improvement in quality life. In: *Res Technol Adv Food Sci*. 269-300.
- Gbolagade and Jonathan S (2006) Bacteria associated with compost used for cultivation of Nigerian edible mushrooms *Pleurotus tuber-regium* (Fr.) Singer and *Lentinus squarrosulus* (Berk.). *Afr J Biotechnol*. 5(4): 338-42.
- Imahori Y (2014) Role of ascorbate peroxidase in postharvest treatments of horticultural crops. In: Oxidative Damage to Plants. 425-51.
- Inoue A, Kodama N and Nanba H (2002) Effect of maitake (*Grifola frondosa*) D- fraction on the control of the T lymph Node Th-1/Th-2 proportion. *Biol Pharm Bull*. 25: 536-40.
- Jo W S, Cho Y J, Cho D H, Park S D, Yoo Y B and Seok S J (2009) Culture Conditions for the Mycelial Growth of *Ganoderma applanatum*. *Mycobiol*. 37(2): 94-102.
- Jongman M, Khonga E B, Khare K B and Mubyana-John T (2010) Effect of seasonal variation and supplementation on yield of oyster mushrooms cultivated on indigenous grasses in Botswana, Mushroom Research. 19(2): 54-61.
- Khare, Behari K, Jongman M, Loeto D (2018) Oyster mushrrom cultivation at different production systems: A review.
- Khonga E B, Khare K B and Jongman M (2013) Effect of different grain spawns and substrate sterilization methods on yield of oyster mushroom in Botswana.
- Mohan D (2009) Mushroom cultivating Methods, Technology for Mushroom cultivation. Available from : http://cultivatemushrooms.blogspot.com/2 009/04/technologyfor-mushroom-cultivation.html

- Nongthombam J, Kumar A, Manikanta L B, Madhuskekhar M and Patidar S (2021) A Review on study of growth and cultivation of oyster mushroom. *Plant Cell Biotechnol Mol Biol*. 22(5&6): 55-65.
- Oei P (2005) Small-scale mushroom cultivation: oyster, shiitake and wood ear mushrooms. Of Digigrafi, Wageningen, The Netherlands. ISBN Agromisa. 90: 8573-038.
- Park C H, Lim J, Lee Y, Lee B, Kim S, Lee J and Kim S (2007) Optimization and morphology for decolorization of reactive black 5 by Funalia trogii. *Enzy Microb Technol*. 40: 1758-64.
- Rai R D and Arumuganathan T (2008) Post Harvest Technology of Mushrooms. ICAR – Directorate of Mushroom Research, National Research Centre for Mushroom. Available from: http://nrcmushroom.org/Bull_PHT.pdf
- Ramamurthi K and Geetha lakshmi R. Food: Nutritive Value; Health Benefits of Mushroom: TNAU Agritech Portal Nutri. Available from: http://agritech.tnau.ac.in/nutrition/nutri_health_mushroom.html
- Randive S D (2012) Cultivation and Study of growth of oyster mushroom on different agricultural waste substrate and its nutrient analysis. *Adv App Sci Res*. 3(4):1938-49.
- Reyes K C, Carvajal R V and Iznaga T I B (2021) Fresh mushrooms preservation techniques. *Foods*. 10(9): 2126.
- Sadler M (2003) Nutritional properties of edible fungi. *Brit Nutr Found Bull*. 28: 305-08.
- Shah Z A, Ashraf M and Ishtiaq M (2004) Comparative study on cultivation and yield performance of oyster mushroom (*Pleurotus ostreatus*) on different substrates (wheat straw, leaves, saw dust). *Pak J Nutri*. 3(3): 158-60.
- Sharma K (2015) Mushroom: Cultivation and Processing. *Int J Food Pro Tech*. 5: 9- 12
- Sharma S, Yadav K R P and Chandra P (2013) Growth and yield of oyster mushroom (Pleurotus ostreatus) on different substrates. *J New Biol Reports*. 2(1): 03-08.
- Takaku T, Kimura Y and Okuda H (2001) Isolation of an anti tumour compound from *Agaricus blazei Murill* and its mechanism of action. *J Nutr*. 131: 1409-13.
- Thatoi H and Sing dev sachan S K (2014) Diversity, nutritional composition and medicinal potential of Indian mushrooms: A Review. *Afr J Biotechnol*. 13 (4).
- Weijn A M R A H, Tomas sen M M M, Bastiaan-Net Sl, Hendrix E A H J, Baars J J P, Sonnen berg A S M, Wichers H J and Mes J J (2011) Browning sensitivity of button mushrooms. In: Proceedings of the 7th international conference on mushrooms biology and mushrooms products. 203-11.

❖❖

ISSN No. 2583-3146

Detection, Identification and Management of Pulse Beetle (*Callosobruchus maculatus*) during Quarantine Processing

Subham Kumar[1] and Kavita Gupta[2]

[1]Department of Agriculture, JBIT College of Applied Sciences, Dehradun

[2]NBPGR, New Delhi

Corresponding Author: subhamkumarpp12@gmail.com

Introduction

The members of the family Bruchidae have long been reported to destroy the seed of the leguminous plants but a number of them are now known to attack the seed or are associated with the flowers or leaves of plants belonging to other families such as Compositae, Malvaceae, Convolvulaceae, Anacardiaceae, Rosaceae, Umbelliferae, Papaveraceae and Arecaceae. They are not only serious pests of the edible pulses, beans, lentils and peas but also attack the pods and the seeds of the wild forest, medicinal and ornamental plants. The available literature on bruchidae shows that over 1,500 species have so far been recorded from different parts of the world. The bruchidae fauna of India, however, has not been properly explored and very few species are represented in the collections of the Indian Agricultural Research Institute, New Delhi and Forest Research Institute, Dehradun, and even these are neither properly identified nor adequately described. At NBPGR, the world bruchid literature was compiled and a database on bruchids developed. It also included digitized keys for their identification Research work has accordingly been carried out and collections have been made of bruchids from different parts of North-West India with a view to study and establish the identity of the various species, listing their host plants, determining their specific ranges and assigning them to their appropriate systematic positions. The present study was undertaken to detect the presence of bruchid infestation in mungbean, cowpea and gram seeds through X-ray image analysis and to identify the retrieved.

Collection of infested seed materials: Four infested seed samples namely: mungbean, cowpea, gram and pigeon pea were collected from the division of germplasm conservation, NBPGR, New Delhi. The seed samples were brought to the Entomology laboratory of division of plant quarantine at NBPGR, New Delhi for further study.

i. Mechanical cleaning: All the seed lots were cleaned mechanically (hand picking) by removing the insects, stages thereof, infested, discoloured, deformed and shriveled seeds.

ii. Grain material for standardization of X-ray radiography: Experiments for standardization of radiography were undertaken on mungbean, cowpea, gram and pigeon pea.

iii. X-ray machine: The X-ray machine available at National Bureau of Plant Genetic Resources is standard cabinet X-ray machine of Faxitron series. The machine gives soft X-ray radiation enough for studying seed in smaller quantities. The machine has all built in safety features protecting those working in the

vicinity from exposure to the radiation (Fig.1).

Fig.1. Faxitron SR MX 200 real-time X-ray machine for detection of hidden infestation of bruchids in seeds. The seeds are spread in a small plastic tray and exposed to soft X-rays generated at 19-26 kv. For 19-25 second depending on the seed size using the real time X-ray machine, Model No. Faxitron SR MX-200. As the machine is real-time, it automatically gives the X-ray radiograph on the monitor (Fig.2).

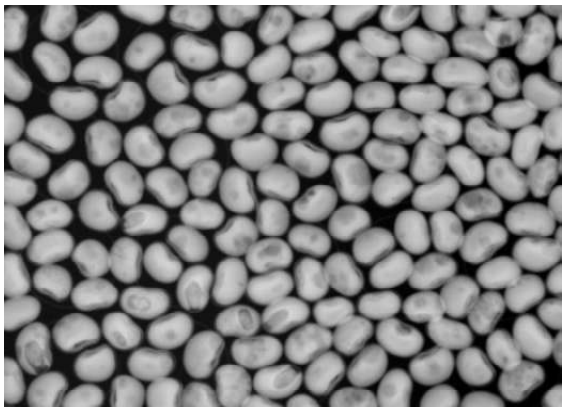


Fig. 2. Image of seed plate after X-ray exposure.

Infested seeds are clearly distinguishable from healthy ones on the monitor. The exposed plate is gently removed from the X-ray machine without disturbing the seed geometry. The infested seeds (as seen in the X-ray radiograph) are then handpicked from the seed sample with original geometry retained an X-ray tray/ plate.

iv. Identification of interceptions: The infested seeds separated by handpicking after X ray radiography are soaked overnight, the seed teased open and the insect removed from inside (Fig.3).

(a). Mung bean **(b). Cow pea**

(c) Gram **(d) Pigeon pea**

Fig.3. Infected seed collected through X-ray Radiography machine and after soak in water

Examined the insect stage by binocular microscope to identify the taxonomic and morphological characters with the help of identification key (Fig.4).

Fig.4. Examined the insect stage by binocular microscope

Taxonomic characters of *Callosobruchus maculatus* (F.)

Head: Black, elongate, frons carinate, eyes emarginated, canthus broad and covered with pale setae. Antennae testaceous, dark brown or black, subserrate in female, longer

and serrate in male.

Pronotum: Subconical, usually black, sometimes dark brown and with a pair of posterior median callosities covered with dense pale setae on the rest of the surface thinly scattered with a pair of prominent lateral white spots in female.

Scutellum: Quadrangular and bearing white setae.

Elytra: Elongate, about twice as long as broad, with 4th and 5thstriae stopping short of other striae; their ground colour in the female commonly testaceous having well defined median and apical black and occasionally with an additional humeral black spot but may be entirely testaceous or entirely black, white pubescence on each elytron disposed along the median black spot but may be entirely testaceous or entirely black, white pubescence on each elytron disposed along the median black spot as a longitudinal band of white setae on the third interstria making the mesal border, a narrow transverse band on the 4th - 9thintersteriae forming the anterior edge and a broader band across the same interstriae comprising the posterior edge, the white pubescence thus assuming the form of two C-shaped areas with their bases facing each other; the ground colour of elytra in the male usually testaceous with median or apical black naked areas or both sometimes entirely testaceous, the testaceous parts covered over by golden setae.

Legs: Testaceous, hind legs sometimes dark brown, hind femur bicarinate below, inner carina with a narrow pointed tooth near apex, outer carina with a short comparatively blunt process.

Pygidium: In the female oblique, either entirely testaceous or black interrupted by a median testaceous stripe, the latter covered over by white pubescence which may spread laterally along the anterior border for varying extent, rest of the surface carrying sparse golden setae (Fig. 13d), pygidium in the male vertical, either entirely testaceous or testaceous with black posterolateral spots, its surface uniformly clothed with golden setae which may aggregate densely to from median line (Fig.6).

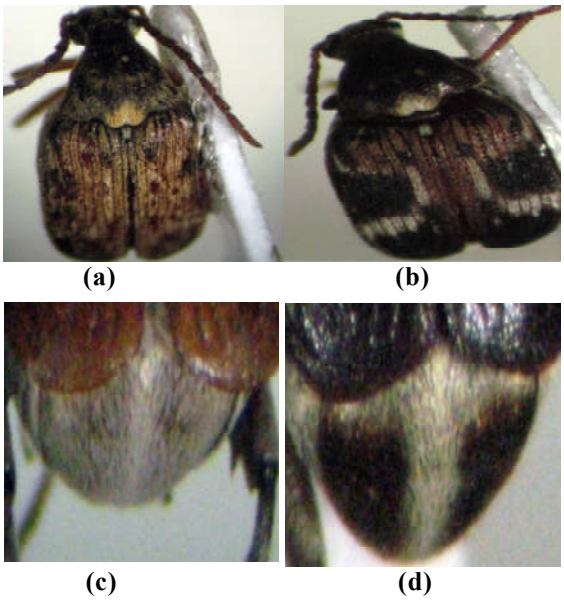


Fig.6. *Callosobruchus maculatus* identified in infested cowpea seed through stereobinocular microscopic observation (a). Male, (b). Female, (c). Male pygidium, and (d). Female pygidium

Phallus: short, broad, 1.57 mm long, parameres elongated, free and flattened at tips which reach beyond the tip of exophallic valve, success region of endophallus beset with numerous thickly set lateral spines, its two lobes of the spermatheca almost sub-equal and the proximal slightly broader than the distal.

Size: moderate, length 3.29 mm to 4.95 mm in male and 4.01 mm to 4.81 mm in female.

Host: *Acacia arabica, Arachis hypogea, Cajanus cajan, C. indicus, Cercis Canadensis, Cicer arietinum, Dolichus biflorus, D. Cyprus, D. lablab, D. monocalis, D. sesquipedalis, D. sudanensis, Dolichussp., Glycine hispida, G. max, Gossypium sp., Lathyrus clymenum, L. sativus, Lens esculenta, Medicago ciliaris, Phaseolus aconitifolius, P. acutifolius, P. angularis, P. articulatus, P.*

aureus, P. Lunatus, p. mungo, P. radiatus, P. vulgaris, Pisumsativum, Pisum sp., Vicia ervilia, V. faba, Vigna catjang, V. unguiculata, Voandzeia subterranea.

Distribution: Widely distributed in plains and hills all over India

4. Life cycle of brunched: Adult beetle is 3-4 mm long, female being larger, brownish in colour, broader at shoulders and rounded posteriorly. There are dark patches on elytra and thorax. Adults show sexual dimorphism. Males possess deeply emarginated or indented eyes and prominently serrate antennae, while in female these characters are not distinctly marked. Tip of abdomen in females is exposed while in males it is covered by elytra. They are active beetles and readily fly when disturbed. Fecundity is about 100 eggs per female. Eggs are whitish, elongated and stuck on the grains or on pods and sometimes on the surface of the container. Incubation period is 3-6 days. Grubs are scarabeiform or cruciform, plump and with short legs and yellowish in colour. First instar larvae bear functional legs and a pair of thoracic plates to facilitate boring into the seeds. They feed on the inner contents of the grain and may damage several grains during development. Larval period may vary between 12 and 20 days. Pupation takes place inside the grain and pupa is dark brown in colour. Occasionally, pupation may take place outside the grain in a cocoon made of excretory matter. Completion of life cycle takes 4-5 weeks and there may be 6-7 overlapping generations in a year (Fig. 6).

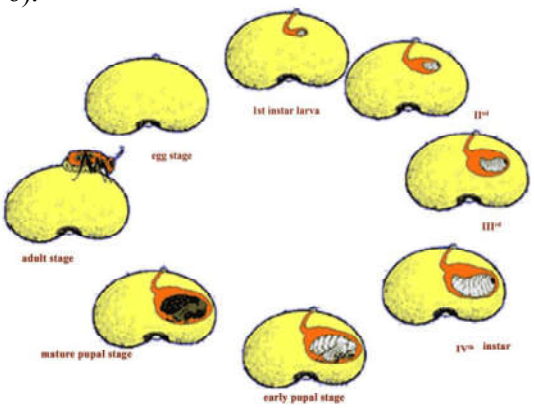


Fig.6. Life cycle of bruchid

5. Management of common storage grain insect pests during quarantine processing

The dose as per the schedule is calculated on the basis of the volume of the space containing the commodity and not the volume of the commodity. The volume of the fumigant (when dose is represented in grams) is calculated as below.

$$\text{Volume of fumigant} = \frac{\text{Required dose (grams) x Volume of container (litres)}}{\text{Specific gravity of fumigant}}$$

Methodology

A. Atmospheric fumigation: Atmospheric fumigation of seeds with ethylene dichloride-carbon tetrachloride against stored grain insect- pests:

- Preparation of the fumigant e.g. ethylene dichloride-carbon tetrachloride (EDCT) which is mixture of two in the ratio of 3:1 (by volume). For the preparation of one litre of the mixture, 250 ml. of ethylene dichloride is put in the bottle. To this, 750 ml. of carbon tetrachloride is added. It is mixed thoroughly and stored in a brown bottle.
- Packets are opened, loaded and properly arranged under normal air pressure (NAP) airtight chamber so as to facilitate the circulation of the gas in the container as well through the material.
- Measured volume of dose is dispensed from a measuring cylinder onto the cotton into small evaporating pan. The cotton easily absorbs the required amount of the fumigant, EDCT (a fumigant in the liquid form), to be released slowly. As EDCT is heavier than air, it is kept on the top of the material as its vapours move downward.
- Atmospheric fumigation is generally done for 48 hrs to facilitate proper penetration of the fumigant and it also saves the

fumigant as the dose depends upon the concentration x time product, i.e. 320mg/ liter for 48 h and 640mg/ lit. For 24 hours.

- Aeration or ventilation of fumigant after treatment is essential so as to remove the fumigant from the space and the material for the safety of the commodity as well as the environment.

B. Vacuum fumigation: The number of fumigant which may be safely used in vacuum fumigation is limited due to various technical considerations. E.g. methyl bromide - a general purpose fumigant in this field can be used for vacuum fumigation. But under no condition phosphine can be used in vacuum fumigation as it is unstable at reduced pressure.

- Air pressure in the loaded chamber is reduced by vacuum pump. Which evacuate the chamber by removing the air in the specially designed fumigation chamber, which helps in hastening the penetration of the fumigant through tightly packed material or internal infestation.
- Fumigant is then introduced causing usually only a small rise in pressure. Treatment may last 1.5 to 4 hours.
- Atmospheric pressure is restored by allowing air to enter.
- Fumigant air mixture is then pumped out
- The cycle of air introduction and evacuation is repeated several times, a process termed as 'air washing' until it is considered safe to open the door for unloading.
- Air washing' until it is considered safe to open the door for unloading.

Safety Precautions: As all fumigants are highly toxic to all living forms, it is imperative to take all the necessary safety precautions while undertaking any fumigation:

- A fumigator must know the threshold limits of the exposure above which it is hazardous; protective clothing including gas masks must always be used.
- Gas leak detectors viz., Riken gas indicators or thermal conductivity meter, concentration monitoring units, first aid, a self-contained breathing apparatus (SCBA) and anti-dotes should always be kept readily available.
- The use of SCBA is mandatory when within 10 m of fumigation site, which should be cordoned off and labeled.

Summary:

The genus *Callosobruchus* has been of concern as the major pests of legumes in field as well as in storage. The *C. maculatus* was taken up for studying their detection, identification and management. Since these insects cause hidden infestation, the detection was done through X-ray radiography using MX 200 Faxitron machine which is for real-time detection of insects inside the grains. After detection, the insects were retrieved and mounted for their identification up to species level. The identification was undertaken based on morphological characters of the four species. The differentiating characters including those of antenna, elytra, hind leg, pygidium and genitalia were studied for all the three species. Management options available such as mechanical cleaning, salvaging through X-ray, fumigation using EDCT (Ethylene Dichloride Carbon Tetrachloride) mixture at normal atmospheric pressure (NAP) and ambient temperature and vacuum fumigation have also been discussed.

References

- Arora, G. L. (1977). Taxonomy of the Bruchidae (Coleoptera) of Northwest India. Part I. *Adults. Orient. Insects Suppl.*,**7**:2-5.
- Singh, S.C. and Kumari, R. (2000). A study of the biology of *Callosobruchus chinensis* (L.) infesting stored pulses in India. *Ind. J. Entomol.*,**62**(4): 319-322.
- Singal, S.K. and Pajni, H.R. (1990). Six new species of *Callosobruchus* pic. from India (Coleoptera: Bruchidae). *Polsk. Pism. Entomol.*,**59**: 761-782.

❖❖

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

For the welfare of the Farmer's, the society "Society for Advancement in Agriculture, Horticulture and Allied Sectors" willing to publish E-magazine in the name of "Krishi Udyan Darpan E-Magazine (Hindi) / **Krishi Udyan Darpan** E-Magazine (English**, Innovative Sustainable Farming**.)**, which covers across India.**

AUTHOR'S GUIDELINE

All authors submitting articles must be annual or Life member of **SAAHAS, Krishi Udyan Darpan** E-Magazine Hindi / **Krishi Udyan Darpan** E-Magazine English**, (Innovative Sustainable Farming**). Articles must satisfy the minimum quality requirement and plagiarism policy. Author's can submit the original articles in Microsoft Word Format through provided email, along with scanned copy of duly signed **Copyright Form**. Without duly signed Copyright Form, submitted manuscript will not processed.

1. The manuscript submitted by the author(s) has the full responsibility of facts and reliable in the content, the published article in **Krishi Udyan Darpan** E-Magazine (Hindi) / **Krishi Udyan Darpan (Innovative Sustainable Farming**) E-Magazine (English)**,** Editor/ Editorial board is not reliable with the manuscript.
2. Must be avoiding recommendation of Banned Chemicals by Govt. Of India.
3. The manuscript submitted by the author(s) should be in Microsoft Word along with the PDF file and the 2-3 (Coloured/Black) pictures should be in high quality resolution in JPEG format, manuscript contains pictures are should be original to the author(s).
4. Articles must be prepared in an editable Microsoft word format and should be submitted in the online manuscript submission system.
5. Write manuscript in **English** should be in **Times New Roman with font size 12 point in single spacing** and line spacing will be 1.0.
6. Write manuscript in **Hind**i should be in **Kurti Dev10 / Mangal with font size 12 point in single spacing** and line spacing will be 1.0.
7. The title should be short and catchy. Must be cantered at top of page in Bold with Capitalize Each Word case.
8. Authors Names, designations and affiliations should be on left below the title. Designations and affiliations should be given below the Authors' Names. Indicate corresponding author by giving asterisk (*) along with Email ID
9. Not more than five authors of one article.
10. It should summarize the content of the article written in simple sentences. (Word limit 100 -150) and the full article should contains (**1600 words maximum or 3 page of A4 Size**)
11. The text should be clear, giving complete details of the article in simple Hindi/English. It should contain a short introduction and a complete methodology and results. **Authors must draw Conclusions and the Reference of their articles at last**. The abbreviation should be written in full for the first time. Scientific names and technical nomenclature must be accurate. Tables, figures, and photographs should be relevant and appropriately placed with captions among the texts.
12. Introduction must present main idea of article. It should be well explained but must be limited to the topic.
13. Avoid the **Repetitions** of word's, sentences and Headings.
14. The main body of an article may include multiple paragraphs relevant to topic. Add brief subheads at appropriate places. It should be informative and completely self-explanatory.
15. Submitted manuscript are only running article and contains the field of Agriculture, Horticulture and Allied sectors.
16. All disputes subject to Prayagraj Jurisdiction only.