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Lecture-10

Application of precision farming in horticultural crops

Precision Farming is generally defined as an information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource. In this mode of farming, new information technologies can be used to make better decisions about many aspects of crop production. Precision farming involves looking at the increased efficiencies that can be realized by understanding and dealing with the natural variability found within a field. The goal is not to obtain the same yield everywhere, but rather to manage and distribute inputs on a site specific basis to maximize long term cost/benefit.

Banana occupies a prominent position among the fruit crops grown in India. Maharashtra ranks first in productivity (62.9 tones/ha) of banana which excels the national average (33.5 tones/ha) and is one of the few crops in India where precision farming techniques have not just been developed but being successfully implemented with full advantages. Varietal improvement, micro propagation, crop geometry, drip irrigation, fertigation, bunch management, intercropping, mulching, propping and integrated pest and disease management are some of the aspects responsible for the increased productivity in banana..

Varietal Improvement:

Varietal improvement work had focused on developing cultivars for high yields and resistance to major biotic and abiotic stresses. From the Cavendish group various clonal selections had been made. The chief varieties under cultivation in Maharashtra include Basrai, Shrimanti, Ardhapuri, Mahalaxmi (Robusta) and Grand Naine in entire Maharashtra. The average contribution of these cultivars in total area is more than 90 per cent.

These cultivars are grouped under dwarf to semi dwarf types and complete their crop duration between 12 – 15 months depending upon type of soil, planting time and other management aspects. These cultivars are having conical to cylindrical shape of bunch having weight in between 15 to 30 kg. Bunches of these cultivars are having medium to well spaced hands producing slightly curved to curved with green to dark green coloured fruits. The cultural practices for most of these dwarf Cavendish cultivars are similar.

Propagation Techniques:

In vitro Techniques:

In Maharashtra, banana is traditionally propagated through suckers; however it continued to be the cause of diseases and pests necessitating the use of clean material. In this context macro and micro propagation was developed. Tissue cultured plantlets has acquired the commercial significance owing to the uniformity in crops, earliness, free from from diseases and pests and high yield. About 2,000 plantlets can be produced from a single growing point in a year of sub culturing. In India 746 million plantlets are needed in order to bring at least one third of the banana growing area under tissue culture. The journey for production of tissue culture plants started with the production of 2-3 lakh plants in 1990 has reached to production of 120 million plants in 2010-11.The tissue culture protocols have been standardized for the successful in vitro propagation of wide range of cultivars by the NRC for Banana, Trichy and NCL, Pune. The ideal tissue culture plant should be of 45-60 days of hardening age, 30 cm in height with 5 to 7 leaves and should have pseudostem circumference of 5.0-6.0 cm.

In vivo Techniques:

Micro propagation technique though provides large number of planting material in Banana within short period of time. However, the availability of tissue culture plants to the farmers is limited and that to be at higher costs. These tissue culture plants are also exhibiting undesirable variations on farm. Natural regeneration is slow in Banana due to hormone mediated apical dominance of the mother plant. However, repression of apical dominance to stimulate lateral bud development and increase in suckering rate can be accomplished by mechanical means through complete or partial decapitation or by detached corm technique.

Planting system:

The production system for banana has been standardized which includes high density planting. For the Cavendish group cultivars like Basrai, Shrimanti, Grand Naine high density square planting at 1.5 m x 1.5 m is recommended. It accommodates 4,444 plants/ha. In this system, there is severe competition for sunlight however; it helps to cover the all the canopy area and prevents the radiations to reach the soil. It creates the microclimate in the garden by way of reduction in the soil temperature, weed growth and evaporation losses from the soil and increase in relative humidity. It also protects the plant and bunches from hot scorching sun during the summer months where temperature goes upto 48^0C and also lodging during high velocity wind waves. Pair row system of planting at 0.9 X 1.5 X 2.1 m is also recommended in Maharashtra. It also accommodate the 4444 plants/ha. Farmers from western Maharashtra are also adopting 1.5 X 1.8 m, 1.8 X 1.8 m or 1.8 X 2.1 m spacing.

Table: Fertilizer application schedule through soil

SN	Time of fertilizer application	N	P_2O_5	K_2O
		(Urea)	**(SSP)**	**(MOP)**
1.	Within 30 days after planting	37.5 (82)	40 (250)	50 (83)
2.	75 days after planting	37.5 (82)	--	--

3.	120 days after planting	37.5 (82)	--	--
4.	165 days after planting	37.5 (82)	--	50 (83)
5.	210 days after planting	16.7 (36)	--	--
6.	255 days after planting	16.7 (36)	--	50 (83)
7.	300 days after planting	16.7 (36)	--	50 (83)
	Total	**200 (435)**	**40 (250)**	**200 (332)**

Table: Fertigation schedule (g/Plant/Week):

SN	Period of application	No. of weeks	N (Urea)	K_2O (MOP)
1.	1 – 16 weeks	16	3.0 (6.52)	2.0 (3.15)
2.	17 – 28 weeks	12	6.0 (13.0)	5.0 (8.35)
3.	29 – 40 weeks	12	2.5 (5.45)	4.0 (6.70)
4.	41 – 44 weeks	4	--	3.0 (5.0)

Water management:

Being a succulent plant, banana requires high amount of water ranging from 1,800- 2,500 mm water annually which shall be met by well distributed rainfall and through irrigation. Traditionally farmers are applying irrigation at an interval of 4 – 7 days as per the season and crop growth by the traditional method of flow irrigation.

Now a days, majority of banana growers are using drip irrigation system which is an innovative method of irrigation by providing precise and measured quantities of water directly to the root zone. Principle involves supply of water drop by drop through plastic emitters or drippers through a low pressure delivery system. The drip irrigation schedule for banana is as below:

Sl. No	Crop growth stage	Duration (weeks)	Quantity of Water (Lit/Plant)
1.	After planting	1-4	4
2.	Juvenile phase	5-9	8-10
3.	Critical growth stage	10-19	12
4.	Flower bud differentiation stage	20-32	16-20
5.	Shooting stage	33-37	20 and above
6.	Bunch development stage	38-50	20 and above

Bunch Management:

Removal of male bud after the completion of the female phase is done. It serves the dual purpose of saving of movement of food into unwanted sink and to avoid the thrips attack on fruits which remain underneath the male bud. Dehanding at 6^{th} or 8^{th} hands improved the fruit quality parameters to meet the export standards.

Banana Research Station, Jalgaon has recommended the two sprays of Potassium di hydrogen phosphate (0.5 %) + Urea (1%) on banana bunch at 5 and 20 days after last hand opening which helps in improving the overall quality of bunch, enhancing maturity and yield of banana.

The bunches are then covered with perforated (2 to 6% vent), 100 gauge

polyethylene bags which protects the bunch from thrips, beetles, dust, rains and from low temperature during winter, scorching sun in summer and enhances the maturity with increased yields.

Intercropping:

Intercropping is a common practice in banana orchards to check the weed growth and to increase the soil fertility and augment the income. In the initial stage, in interspaces different short durational intercrops can be grown.

In the one experiment conducted at Banana Research Station, Jalgaon intercropping of banana cv. Basrai with ground nut (var. Phule Pragati) in Kharif season proved beneficialby obtaining additional bonus yield of groundnut without any adverse effect on yield of banana. In another experiment sowing of four rows of, semi-spreading var. Phule Pandhari of cow pea gave better results as an intercrop for higher yield and monetary returns in Mrig Baugh planting of banana cv. Grand Naine. Raising the intercrops like marigold and Sunhemp reduced significantly the nematode population.

The Integrated weed management by cross hoeing + weeding + growing double crop of cowpea and its incorporation in soil is also recommended by Banana Research Station, Jalgaon for effective control of weeds.

Mulching :

Mulching has major implication for conserving soil moisture with ancillary benefits like suppression of weeds and regulation of plant micro climate. Polythene is an effective mulch but sugarcane trash, paddy straw and dried banana leaves and sheaths are cost effective apart from addition of organic manure to the soil.

In an experiment use of wheat straw and banana leaves as a mulch material (@ 12.5 kg per plant) in banana orchards found to increases the bunch weight and conserves the soil moisture where the mulch was applied at the start of summer season (February). Same results have been obtained by using kaolin 8% spray on banana leaves as anti-transpirant in summer months (from February onwards) at an interval of 15 days till the onset of monsoon.

Propping :

Due to heavy bunch, bearing plants may lodge and up root. Therefore, the plants are traditionally staked with bamboo, eucalyptus, shevari or casuarina poles. As the supports are placed against the stems on leaning side of the bunch emergence; it has a disadvantage of causing bruising injury to the bunch. These are now replaced with the use of polypropylene strips for supporting the pseudostem. In this method, the stripe is fastened to the neck of the bearing plant and the two ends of the stripe are tied to the base of neighbouring plants on the side opposite to the leaned direction. This reduces the cost of propping as well as the bruising injury to the bunch.

Integrated Pest Management:

Corm weevil, pseudstem borer, red rust thrips and nematodes are the major insect pests causing losses in banana production.

Cut pseudostem of one feet length is used as the delivery system for the biocontrol agents

(*Beauveria basiana*) and entomopathgenic nematodes for the monitoring and management of pests. Polythene sleeves impregnated with 0.1 per cent chlorpyriphos + paraffin oil + adjuvant controlled the thrips attack by 25 – 30 per cent. Bell injection (flower bud injection) immediately after shooting with Imidachloprid 0001% has controlled red rust thrips attack to a great extent.

Use of neem based formulations like Nimbicidin and Econeem @30 ml/plant or *Pseudomonas flurescence, Pacilmyces lilacines Verticillium chlamydospermum* and *Trichiderma harzianum* has been effectively used for nematode management in banana. Use of VAM (*Glomus Fasciculatum* and *Glomus mossaeae*) at planting and after 3 months effectively reduced the infestation of nematodes.

Disease Management:

Among fungal diseases Yellow sigatoka, and Cigar end rot are important one while among bacterial diseases Erwinia rot is the major constraint in the banana production of Cavendish group. Among viral diseases Banana Bunchy Top, Infectious chlorosis and Banana streak viruses are still playing hurdles in the successful production of banana.

A Wireless sensor based forecasting for Sigatoka leaf pot disease was developed at TNAU, Coimbatore (Anonymous, 2012) in which the relative humidity was found to be the most reliable variable.

The cultural practices play significant role in the management of Sigatoka disease. It includes weed free clean and well drained garden, removal and destruction of disease plant part away from the garden and one preventive spray of fungicide in the month of May. The Sigatoka leaf spot can be controlled by using chemical fungicides however the effective management can be possible only when mineral oil (1.0 %) with or without fungicides is used.

Guava:

GUAVA is one of the most important fruit and it is considered as apple of the tropics

. In India ,it's position is forth after mango, banana, and citrus so far as area and production of major fruits are considered. One of the most gregarious of fruit trees, the guava, *Psidium guajava* L., of the myrtle family (Myrtaceae),

Selected species

- *Psidium amplexicaule*
- *Psidium araao*
- *Psidium araca*
- *Psidium australe*
- *Psidium cinereum*
- *Psidium dumetorum*
- *Psidium firmum*

Formerly, round and pear-shaped guavas were considered separate species–*P. pomiferum* L. and *P. pyriferum* L.–but they are now recognized as mere variations. Small, sour guavas predominate in the wild and are valued for processing.

Cultivars: In India much attention is given the characteristics of local and introduced guava cultivars and their suitability for various purposes. Among common white-fleshed cultivars are:

'Apple Colour'–of medium size, slightly oblate; deep-pink skin, creamy-white flesh, moderate amount of seeds, very sweet flavor (0.34-2.12% acid, 9 to 11.36% sugar); heavy bearer; good keeping quality; good for canning.

'Behat Coconut'–large, with thick white flesh, few seeds; poor for canning. **'Chittidar'**–medium to large, round-ovate, white-fleshed, mild acid-sweet flavor; bears moderately well; keeps well; good for canning.

'Habshi'–of medium size with thick, white flesh, few seeds; halves good for canning. **'Lucknow 42'**–of medium size, roundish, with creamy-white, soft flesh; sweet, pleasant flavor; very few seeds; good quality; bears heavily; keeps fairly well; not suitable for canning.

'Lucknow 49'–medium-large with cream-white, thick flesh, few seeds; acid-sweet; good quality; heavy bearer; high in pectin and good for jelly; halves good for canning.

'Safeda'–of medium size, with very thin skin, thick, white flesh, few seeds. Outstanding quality for canning. A famous guava, widely planted, but susceptible to wilt and branches are brittle and break readily.

'Smooth Green'–of medium size, with thick white flesh, few, small, hard seeds. Halves are firm, good for canning.

'Allahabad'–large, white-fleshed, with few, medium-sized, fairly hard seeds. **'Karela'**–medium-large, pear-shaped, furrowed, rough-skinned, with soft, granular, white flesh; sweet, rich, pleasant flavor. Poor bearer. Not popular.

'Nagpur Seedless'–small to medium, often irregular in shape; white-fleshed.

'Seedless' (from Allahabad)–medium to large, pear-shaped to ovoid; with thick white flesh, firm to soft, sweet. Light bearer; poor keeper.

A seedless type at Poona, India, was found to be a triploid with 33 chromosomes in place of the usual 22.

Other white-fleshed guavas with poor canning qualities are: **'Dharwar', 'Mirzapuri', 'Nasik', 'Sindh',** and **'White Supreme X Ruby'.**

Among red-fleshed cultivars in India there are:

'Anakapalle'–small, with thin, red flesh, many seeds; not suitable for canning.

'Florida Seedling'–small, with thin, red, acid flesh; many seeds; not suitable for canning.

'Hapi'–medium to large, with red flesh.

'Hybrid Red Supreme'–large, with thin, red, acid flesh; moderate amount of seeds; not suitable for canning.

'Kothrud'–of medium size with medium thick, red flesh; moderate amount of seeds; not suitable for canning.

'Red-fleshed'–of medium size with many (about 567) fairly soft seeds; high in pectin and good for jelly; not suitable for canning.

Indian breeders have crossed the guava with its dwarf, small-fruited relative, *P. guineense* Sw., with a view to reducing tree size and enhancing hardiness and yield.

Pollination: The chief pollinator of guavas is the honeybee (*Apis mellifera).* The amount of cross-pollination ranges from 25.7 to 41.3%.

Climate Requirement: Guava are adopted to areas with hot summers and cool winter. In some areas an average monthly maximum temperature higher than 32 o C and minimum temperature 3 o C are regarded as restrictive for the cultivation of guavas. Temperature of up to 45 o C can be tolerated although the highest yield are usually recorded at mean temperatures of 23 to 28 o C .Optimum vegetative growth occurs between 15 and 28 o C

.The quality of the fruits becomes inferior when mean temperatures fall below 15 o C.

during the maturation period. Guavas are more drought resistant than most tropical trees and grow best in areas with an annual rainfall of 1000 to 1500 mm.

Soil Requirement: The guavas grow well in any type of soil conditions, but will produce better in rich soils high in organic matter. They also prefer a well-drained soil in the pH range of 5 to 7. Good drainage is recommended but guavas are seen growing spontaneously on land with a high water table–too wet for most other fruit trees but will not tolerate salty soils.

Irrigation: As compared to other fruit crops guava needs less irrigation. In the early stage plants required 8-10 irrigations a year, while full grown trees require irrigation during April to June at 15 days interval to get good yield. Irrigation during winter was also found effective in improving the fruit quality of winter crop. In south India, irrigation induces fruiting in guava more or less throughout the year.

Pruning: Shaping the tree and removing water shoots and suckers are usually all that is necessary. Guavas can take heavy pruning, however, and can be used as informal hedges or screens. Since the fruit is borne on new growth, pruning does not interfere with next years crop.

Manuring and Fertilization: Guavas are fast growers and heavy feeders, and benefit from regular applications of fertilizer. Mature trees may require as much as 50 to 80 kg of FYM, 1 kg ammonium sulfate or 800g of calcium ammonium nitrate, 3kg of super phosphate and 2 kg of potassium sulphate.

Propagation: Guava seed remain viable for many months. They often germinate in 2 - 3 weeks but may take as long as 8 weeks. Since guavas cannot be depended upon to come true from seed, vegetative propagation is widely practiced. They are not easy to graft, but satisfactory techniques have been worked out for patch-budding by the Forkert Method (probably the most reliable method), side-veneer grafting, approach grafting and marcotting The tree can also be grown from root cuttings.. Trees grown from cuttings or air-layering have no taproot, however, and are apt to be blown down in the first 2 or 3 years. One of the difficulties with budded and grafted guavas is the production of water sprouts and suckers from the rootstocks.

In India, air-layering and inarching have been practiced for many years. However, trees grown from cuttings or air-layers have no taproot and are apt to be blown down in the first

2 or 3 years. For this reason, budding and grafting are preferred. Approach grafting yields 85 to 95% success. At the Horticultural Experiment and Training Center, Basti, India, a system of patch budding has been demonstrated as commercially feasible. Tongue layering is a common practice in Maharashtra. In case of grafting using root stock wedge grafting is done.

Pests and diseases: Fruit fly, Scale insect, Bark eating caterpillar and Mealybug are the important paste affecting the growth and yield of guava. And major diseases are wilt of guava, fruit canker, Anthracnose and Cercospora leaf spot occurring in northen and eastern India as well as other guava growing areas.

Cartap hydrochloride was found most effective in managing guava fruit borer.

Inoculation technique (stem hole inoculation) for reproduction of wilt in guava has been standardized.

Gliocladium roseum has been found most potent causal pathogen for guava wilt, as it produces symptoms in grown up plants in field within 2 months of inoculation.

Bio-control agents, *Aspergillus niger* (AN 17) and *Penicillium citrinum* have been identified for the control of guava wilt.

Co-cultivation with *Curcuma domestica*, *Allium sativum* and *Tagetis erecta* were found effective in reducing the incidence of wilt in guava.

Corn meal medium was found best for multiplication of guava wilt antagonists, *Trichoderma harzianum, and Aspergillus niger*and *Penicillium citrinum*.Ninety-five isolates of *Fusarium* sp. from wilted plants of guava were collected from different parts of India. Population of spiral nematode was found high in wilt affected guava plant(s).

Harvesting and Yield: Guava fruits mature for harvesting after 4-5 months of anthesis (Pande and Mishra,1984) Tripathi and Gangvar (1971)recorded 0.960-0.950 specific gravity, 12 to 12.6 per cent TSS and 0.36 to 0.41 per cent acidity at the time of fruit maturity. In warmer regions guavas will ripen all year. There is a distinctive change in the color and aroma of the guava that has ripened. For the best flavor, allow fruit to ripen on the tree. Fruit that has changed color cannot be stored for any extended periods. It bruises easily and will quickly deteriorate or rot. Economic yields are obtained from 7 to 8 years onward. I t varies in different cultivars , management of orchid and season of cropping. The average yield per tree was estimated to be 350 kg from the grafted trees (Singh, 1980).

Mitra et al. (1981) recorded maximum yield was recorded in L-49 followed by Allahabad Safeda and Chittidar in rainy season.

Post Harvest Management:

Guava fruits of cv. Allahabad Safeda could be stored for 28 days in 0.25 per cent ventilated LDPE bags at 50C.

The storage study of nectar prepared from 5 pink fleshed varieties of guava revealed that nectar prepared from HPS-I-35 was best after 6 months of storage.

Among 5 pink fleshed guava varieties, HPSI-16 was found best for processing. Guava slices from cv. Lalit could be stored in 400Brix sugar syrup for 9 months.

CFB boxes (190X300X80mm) of 2 kg capacity with 0.5 per cent ventilation were designed and fabricated for extending the shelf-life of guava fruits (cv. Sardar).

Crop Regulation -It is recommended to give application of 100 ppm GA in first week of January and June and that of 1000 ppm CCC in first week of October every year; plus 600 ppm Ethrel in first week of February and July in the first year and only in first week of July in subsequent years for higher hasta bahar and more monetary returns from guava under Plain Zone conditions of Western Maharashtra.

Old Orchard Rejuvenation - The unproductive old (up to 35 years) guava orchard planted in medium black soil can be rejuvenated by deheading the trees at 60-75 cm height from ground level giving clean cut and keeping the straight stump as far as possible. The pruned infected branches be destroyed. The cut surface of trunk be pasted with bordeaux paste. The orchard be ploughed. Basins of 3 x 3 m size be prepared and recommended dose of manures and fertilizers (50 kg F.Y.M. and 900:300:600 g NPK/plant) be applied and the orchard immediately irrigated. When the sprouts appear on the deheaded trunk, 3-4 upright growing well- spaced sprouts be maintained as future branches and the other sprouts be removed.