

## Frequently Asked Questions

### Biotechnology

**1. What is gene?**

**Ans:** Functionally, gene is the unit of inheritance which controls the expression of a character, Structurally, gene is the segment of DNA, located in affixed place on the chromosome, which codes for one polypeptide, ribosomal or transfer RNA.

**2. What is gene bank?**

**Ans:** Gene bank is a storage facility where germplasm is stored in the form of seeds, pollen or in vitro culture, or in the case of a field gene bank, as plants growing in the field.

**3. What is tissue culture?**

**Ans:** Tissue culture is a general term used for the cultivation of plant parts under aseptic condition in artificial media in vitro. It is a technique of vegetative propagation.

**4. What is transgenic plant?**

**Ans:** A plant that contain foreign or introduced genes (DNA) is called a transgenic plant.

**5. What is Shoot tip?**

**Ans:** The meristematic dome together with leaf primordial and adjacent stem tissue is called shoot tip.

**6. What is Shoot Tip Grafting?**

**Ans:** STG is in vitro grafting of excised shoot tip having meristem and 3 leaf primordial (0.1 to 0.3 mm) on to a decapitated rootstock. It is the most effective procedure for the elimination of pathogens in primary budwood of citrus.

### Nursery management

**7. What is the best time for budding?**

**Ans:** Under central India condition from November last week to December end is the best time for budding. This is the time when the plant has active sap flow which favours high percentage of bud take. Such a conducive weather in North-Eastern States is found in March-April months, hence in that area the best time for budding is March-April.

**8. How citrus seeds are prepared for sowing?**

**Ans:** Seeds should be obtained from healthy, virus – free, old trees, which have a pedigree performance of desirable characters. Seeds are taken out of mature fruits obtained from healthy and vigorous trees. The fruits are cut into two halves and seeds are squeezed into a sieve to allow the juice to pass out. All the floating seed is discarded for being immature. After extraction, the seeds are washed thoroughly in water for removing the shiny layer and then mixed with ash and dried in

shade. Bold and well filled seeds should be selected and immature light seeds floating on water should be discarded.

**9. What is polyembryony? How is it exploited in citrus propagation?**

**Ans:** Polyembryony is a rule in most of the species of citrus. More than one seedlings emerge out of a seed, of which one is sexual from embryo and others from nucellar embryos. The sexual seedlings do not perform uniformly when used either as a seedling tree or as rootstock, as they are heterozygous genetically. On the other hand, nucellar seedlings breed true to mother and perform uniformly. As such it becomes imperative to discard the sexual seedlings at the initial stage itself.

**10. At what stage the seedling are transplanted in secondary nursery?**

**Ans:** Six to nine months, at times, one year after sowing, the seedlings are transplanted into a nursery bed. The seedlings of uniform vigour and height are selected for transplanting.

**11. What care should be taken to control *Phytophthora* in the nursery?**

**Ans:** To control *Phytophthora* in nursery Ridomil MZ 72 @ 2.75 g or Aliette @ 2.5 g in 1 liter of water should be sprayed at the interval of 40 days. Similarly *Phytophthora* affected plants should be reported from the nursery and destroyed.

**12. What are the nursery pests of citrus? How to control them?**

**Ans:** Citrus leaf miner and mealy bug are the major nursery pests of citrus and it can be controlled by spraying monocrotophos @ 0.5 ml or quinolphos @ 1 ml/l of water.

**13. When are the rootstock seedlings considered ready for budding?**

**Ans:** The rootstock seedlings are ready for budding when they attain the girth of pencil thickness at the base of the seedlings. Generally it takes 12-14 months to attain thickness.

**14. Can the budding operation be undertaken during rainy and summer seasons?**

**Ans:** No, the budding is avoided in rainy season as water enters the operated parts and causes rotting of bud due to fungal infection. In summer season also excessive dry and hot weather causes injury to young sprouts by desiccation. However, under controlled conditions budding is possible with desired success even in summer months.

**15. How to cut the bud from budstick?**

**Ans:** Using a sharp budding knife having a blade of excellent quality steel with a rounded end, the bud is cut from below the petiole with a slice of thin wood. It has been observed that the buds cut with an extremely sharp knife give a higher percentage of success than those cut with a blunt knife.

**16. What are the methods of budding commonly followed?**

**Ans :** Shield or T-budding or patch budding method is commonly followed. Patch budding consists of four incisions on the stock at a height of about 20 cm, two vertical (1.8 cm long, 0.6 cm apart) and two horizontal incision enabling to take off a rectangle patch. Patch of similar

dimensions is removed from the budstick with a healthy bud in its centre, which is placed immediately over the patch on the stock and covered by wrapping with polyethylene tape.

However, most commonly followed method is shield or inverted T- budding. In this a shield shaped patch containing a bud at its centre is removed from the budwood and a vertical inverted T shaped cut is given on the rootstock. The shield shaped bud is inserted through the inverted T shaped cut and wrapped with polythene tape.

**17. How to Store budstick?**

**Ans:** In fact, budsticks should be cut just prior to use. Care must be taken not to allow budwood to dry. To protect from drying it should be kept in sphagnum or peat moss or damp saw dust. If more than one variety is used, the budstick should be labelled.

**18. What care should be taken of the citrus plants on arrival from nursery?**

**Ans:** If the distance from the nursery to the orchard is not very long. It would be enough to keep them in shade after sprinkling water on them. However, if the plants are ordered from a far off nursery, they may show some signs of wilting on arrival. Under such conditions, the plants may be removed and washed thoroughly. This will help to make up the loss of water during the journey. These plants should then be placed in shade and water may be frequently sprinkled on them till they are set in orchard.

**19. What is the ideal size of the plastic trays for raising seedlings in a containerized nursery?**

**Ans:** High density polyethylene tray of approximately 560x360x120 mm size tray are ideal for sowing of citrus seeds.

**20. Can the plastic trays be placed on the ground and open to the sky?**

**Ans:** No, the seed trays should be placed on at least one foot height on a suitable platform to avoid contamination from water splash. The area of containerised nursery should preferably be covered by either a shade net or polyhouse or glass house.

**21. What is the ideal size of polythene bags for transplanting the citrus seedlings?**

**Ans:** Citrus seedlings can be transplanted in UV stabilised polythene bags of size 15-20 x 20-25 cm which can sustain the growth of the seedlings at least upto one year.

**22. What is the use of growth regulators in propagation of citrus plants?**

**Ans:** Growth regulators are used for rooting of cuttings, quicker callus formation, better union in grafts and quicker and better seed germination and subsequent seedling growth.

**23. What care should be taken while transporting budlings from one place to the other distant areas?**

**Ans:** During transporting, drying of roots is common. Hence to avoid it, the roots should be packed in water holding material and frequent watering should be given. Partial defoliation of budding may also be done to reduce the transpiration losses of water leading to faster drying of roots. The most ideal conditions for transporting budlings are in the rainy days in the months of June-July

when the weather is overcast and the atmosphere is humid. These days even the bare rooted budlings wrapped in wet gunny cloth sustain a transit period upto 12 hours.

**24. What is the planting season for citrus orchards?**

Ans: When the rains have set in and the weather is sufficiently humid, citrus orchard is commonly planted. This period comes in July-August in Central India.

**25. How planting is done in citrus?**

Ans: Planting of citrus orchard is normally done in square system. While planting care should be taken to keep the bud union portion at least 6” above the ground and the budded portion should be facing the western side of the orchard site. If needed the tap root of the plant may be cut to avoid curving of the tap root to maintain its polarity.

## **Rootstocks**

**26. What is a rootstock?**

Ans: A rootstock is a lower part of a stionic combination which replaces the root system of the scion portion so as to impart resistance to various biotic and abiotic stresses to the scion variety.

**27. What are the commonly used rootstock in India?**

Ans: Most commonly used rootstock throughout India is rough lemon(*Citrus jambhiri Lush*) for most of the citrus fruits followed by Kharna khatta (*Citrus karna*) being more popular in Punjab and UP. In western India, Jamberi (*Citrus jambhiri Lush*) is employed as a rootstock for Mosambi. Rangpur lime proved to be best for Nagpur Santra due to its resistance to gummosis and root rot. Satgudi for Satgudi and Batavian oranges in Andhra Pradesh has given best results over others while Gajnimma (*Citrus pennivesiculata Tanaka*) proved superior for acid limes and lemons. Under Coorg condition, for Coorg mandarin both Rangpur lime and Kodakithuli orange (*Citrus reticulata Blanco*) have shown great promise as rootstocks. Sweet lime, sour orange, Kichilli, Billikichilli (particularly in Andhra Pradesh and Tamil Nadu) are some of the rootstocks which are in a limited use.

**28. What are the characteristics of mandarin as rootstocks?**

Ans: Mandarin(*Citrus reticulata*) is a highly polyembryonic species of Chinese origin, having medium sized upright trees. Fruits medium – sized, globose, sweet in taste, segments easily separable, core open at maturity, loose skinned, orange in color, rind thin, rind and segment easily separable, usually 10-14 segments in each fruit; seeds pointed with light green cotyledons.

**29. What is citranges?**

Ans: Citranges are the hybrid between sweet orange and trifoliate orange.

## Soil and Nutrition

### 30. What is the importance of soil selection for 'Nagpur' mandarin cultivation?

**Ans:** Nagpur mandarin is a perennial crop and remain in the field under productive life for more than 15-20 years. It takes about 5-7 years for a plant to come to bearing. The various soil factors such as physiography, physical characteristics including drainage, clay content, depth, CaCO<sub>3</sub> content, chemical characteristics and management levels have been attributed to a large variation in mandarin performance in terms of growth and hence proper care must be taken regarding soil selection before plantation of the mandarin orchards.

### 31. What is the role of lime in citrus soils?

**Ans:** Presence of lime in moderate amount is good for citrus cultivation. Excess amount of lime in powdery form is toxic and harmful and it is an important contributing factor for deficiencies of zinc, iron and manganese. But if this lime is in nodular form which is not so active is useful in clayey soils as it makes soil friable and improve the soil drainage.

### 32. What is pH requirement of citrus crop?

**Ans:** A pH value of 5.5 to 6.0 is considered to be an optimum for citrus cultivation But citrus orchards continue to flourish on soils with pH value of 4.0 to 8.5 and even higher.

### 33. What is drainage?

**Ans:** Drainage is the natural or artificial removal of excess water on the soil. Water is in excess when the amount present adversely affects the crop production and hence it is necessary to decide the quality of water which is in excess and has to be removed.

### 34. What is the effect of drainage on physical properties of soil?

**Ans:** Drainage has a favourable effect on physical soil conditions like structure, aeration, organic matter and temperature. Poor drainage condition deteriorate the soil structure leading to more compact and sticky subsoil. On the surface many large clods are found after ploughing, whereas in well drained soils, small crumbs predominate, it increases the water stable aggregates, large pore spaces, lateral and vertical hydraulic conductivity, moisture distribution and O<sub>2</sub> and CO<sub>2</sub> diffusion throughout the profile.

### 35. What is the role of surface drainage?

**Ans:** Surface drainage is necessary to remove excess surface water rapidly during and after heavy rains. Water that soaks into the soil and raises the water table must be removed by subsurface drainage.

### 36. What type of surface drainage system is suitable for shallow soils?

**Ans:** In case as shallow soils, "Breeding" surface drainage system is suitable as it increases the rooting depth of plants. It provides well-drained condition during high rainfall and also acts as a water harvesting structure during low rainfall period.

**37. What is the difference between soil and leaf analysis?**

**Ans:** Leaf analysis is used as a primary indicator of nutrient status of orchard while the soil analysis as a nutrient sources available to the plant. The leaf analysis values were observed better correlated with fruit yield than soil analysis except Ca and Mg and hence it is necessary to do both type of analysis for deciding the nutrient status.

**38. What should be the optimum leaf nutrient level for Nagpur mandarin?**

**Ans:** The optimum leaf macro and micro nutrient level for Nagpur mandarin is as below.

Nitrogen	-	2.2 to 2.4 %
Phosphorus	-	0.07 to 0.10%
Potassium	-	1.18 to 1.56%
Calcium	-	1.32 to 1.51%
Maganesium	-	0.48 to 0.67%
Iron	-	110 to 132 ppm
Copper	-	8 to 15 ppm
Zinc	-	18 to 29 ppm

**39. What is the nutrient status of Nagpur mandarin orchards of central India?**

**Ans:** The fertilizer schedule in an orchard is required to be adopted based on the presence of nutrient constraints in order to meet the objective of balanced fertilization. The nutrient status of Nagpur mandarin orchards of central India shows that among macronutrients, Nitrogen was most limiting nutrient followed by phosphorus. The calcium and magnesium content was enough to meet their requirement by crop while zinc was most limiting micronutrient.

**40. What is nutrients antagonism?**

**Ans:** Antagonism exist among the nutrients means an increase in the supply of any one of the nutrient would raise its content in the leaf, but decrease the content of one or both of the other elements or vice-versa . And hence, balance simply is the relative proportion among the essential elements.

**41. What are the advantages of fertilizers as compared to manures?**

**Ans:** Unlike the manures, the nutrient element in fertilizers are present in higher concentration and in forms which can be readily utilized by plants directly or after rapid transformation. Being concentrated in nutrient

Elements, the fertilizer have the advantage of smaller bulk, economy and ease of transport, storage and handling. Moreover their dose can be adjusted to suit the requirement as determined by soil fertility evaluation.

**42. What are the methods of soil fertilizer application in citrus?**

**Ans:** Fertilizer are applied in the soil in two ways.

- 1) First of all the soil around the tree having a circle of 30-45 cm diameter near the trunk should be given a hoeing, then finely powered manure or fertilizer is evenly broadcast and mixed well into the soil by giving a second hoeing. This is followed by adequate irrigation.

- 2) It can be applied in trench. Usually a trench of 15 to 25 cm wide and 15 cm depth around and below the drip of the tree is dug, fertilizer and manures are added and finally covered with the dugout soils.

**43. What is organic farming?**

**Ans:** This is a age old farming practice popularly known as natural farming. It is defined as 'Production system' that avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators, and rely upon crop rotations, crop residues, animal manures, green manures, of-farm organic wastes, mechanical cultivation, mineral bearing rocks and aspects of biological pest control to maintain soil productivity and health, to supply plant nutrients and to control insects, weeds and other pests.

## **Water management and nutrition**

**44. What is irrigation and its role in citrus cultivations?**

**Ans:** Irrigation is an artificial application of water to the plant root-zone in absence of rainfall to meet water requirement of the crop. Irrigation plays a vital role in citrus cultivation because excess of water through conventional methods may pose drainage and disease problems. Citrus is sensitive to excess of water because water logging results in various diseases such as root rot, foot rot, collar rot caused by *Phytophthora* spp. Deficit of irrigation water can affect critical growth stages, yield and fruit quality.

**45. What are the advanced method of irrigation?**

**Ans:** Advance methods of irrigations are:

- 1) Drip Irrigation.
- 2) Sprinkler irrigation.

Drip irrigation method is suitable in citrus orchards.

**46. What is Drip irrigation?**

**Ans:** Drip irrigation is a method of applying water directly to the rootzone of crop through network of pipes and emitters. It provides the watering close to the consumptive use of the crop.

**47. How much water is saved in drip irrigation? How?**

**Ans:** In drip irrigation system, a network of pipes is used to convey the water and only required amount of water is applied reducing deep percolation losses. Thus, water is saved by increasing conveyance and application efficiencies. In citrus, about 50-55% of water is saved by using drip irrigation as compared with the conventional basin method of irrigation.

**48. What are the different type of filters are used in drip irrigation method?**

**Ans:** The filters used in drip irrigation may be classified as:

- 1) Sand or Gravel filters
- 2) Disc filters
- 3) Screen filters
- 4) Hydrocyclone filters.

**49. Why screen filters are used in drip system?**

**Ans:** Screen filters are used to remove suspended particles in the irrigation water.

**50. What is the use of sand or gravel filters?**

**Ans:** When the source of water like lake, tank or river water, it may contain algae or organic matter. In this situation, sand or gravel filter is required in addition to screen filters.

**51. What do you mean by fertigation?**

**Ans:** Application of required fertilizers within the root zone through micro-irrigation system is called as fertigation.

**52. Which are the chemicals applied through drip irrigation system besides fertilizers?**

**Ans:** Most of the plant nutrient requirements as well as substantial proportion of the fungicides fumigants, insecticides and nematicides can be applied through drip irrigation system. This method requires appreciably smaller quantities of the chemicals concerned and the risk of phyto-toxic reaction in the plant is normally also much reduced, due to very dilute conditions of the chemicals.

**53. What is mulching?**

**Ans:** Mulching is one of the soil moisture conservation technique in which the ground area around the fruit tree is covered with organic or synthetic materials. This reduces evaporation of water from the rootzone, reduces weed growth and there by improves productivity of the plants.

**54. What are the advantages of mulching in citrus?**

**Ans:** Mulching under citrus trees with paddy husk or dry leaves to a depth of 8 cm reduces the weed growth and number of irrigation. It also provides organic manure after decomposition of organic matter and improves the yield and fruit quality. Mulches have been observed to save moisture by 10% and increase citrus yield by 30% in clayey soil.

## **Inter-cropping**

**55. What is inter-cropping?**

**Ans:** The growing of short term crops in the vacant spaces between the young trees, in the early years of an orchards is called as inter-cropping.

**56. What are the principals of inter-cropping?**

**Ans:** The principles of inter-cropping are in line with the ecological systems in nature, where the vacant space created by the long duration and wide spread crops is successively and suitable utilized by the short duration and closely spaced crops. In order to get maximum output from a unit area in the shortest possible time it is imperative to practice intensive cultivation in suitable areas where other facilities are easily available.

**57. What care needs to be taken while selecting inter-crops?**

**Ans:** While selecting of inter-crops the care needs to be taken as follows:

1. Inter-crops should not be injurious to main crop.
2. First crops as inter-crop should be provided with separate irrigation system.
3. Cropping type of vegetables should be avoided as inter-crops.
4. Manuring of inter-crops be done regularly and adequately.
5. Preferably short duration inter crops should be taken into consideration.
6. Monoculturable crops can be selected.

**58. What are the inter-crops suitable for summer seasons?**

**Ans:** For summer season vegetable like round gourd (Tinda), bitter gourd, pumpkin (kaddu), onion, chillies and crop like soyabean, black gram, ground nut, mung bean, rajmah, cow-pea, cotton (upto 3-4 years) and cluster bean etc. are suitable.

**59. What are the inter crop suitable in winter season?**

**Ans.** For winter season vegetable like peas, turnip, carrot, radish, cauliflower and crops like-senji, gram etc. are found suitable.

**60. Which crops are grown as green manure crop?**

**Ans:** Legumes are raised as green manure crops. They includes sunhemp, dhaincha, cowpea, horsegram, pillipesara (*Phaseolus trilobus*) etc.

## **Weed Management**

**61. What are the methods of weed control?**

**Ans:** The methods of weed control are hand and mechanical tillage, removing, burning, grazing, competitive intercropping, smothering with mulches, flooding, use of biological agents and chemical control.

**62. How to control the weeds in nursery?**

**Ans:** Weeds compete for nutrition hence adversely affect growth of the seedling. Hence, manual weeding is generally recommended due to closeness of seedling and their delicate nature. However, to avoid the damage to the roots and shoots of young seedling reduce the production cost, chemical weed control measures can be adopted.

**63. What the weedicides used in nursery? When are they applied? What are the precautions to be taken?**

**Ans:** As a pre-emergence herbicide, Bromacil@5 kg/ha can be sprayed as it effectively controls weeds including harali(*Cynodon dactylon*) and lavalala (*Cyperus rotundus*), Diuron @ 2 kg/ha is also used effectively as pere-emergence weedicide in citrus nurseries. [Terbacil@2.5](#) kg/ha and Krovar II (Diuron + Bromacil)@ 3 kg/ha sprayed in nursery give almost complete control of all seedling weeds and most grasses including nutgrass (*Cyperus* spp.)for 5-6 months. The weedicide is applied just before the arrival of monsoon in the last week of May.

**64. What care should be taken during spraying of herbicide in nursery?**

**Ans:** In nursery the seedling are in close proximity unlike the main orchard. Hence while spraying, the young nursery seedling should be guarded against the spray drift of herbicide so that it does not have any phytotoxic effect.

**65. How to control weeds in the main citrus orchard?**

**Ans:** Diuron @3-4 kg/ha (Plate 12.1) or simazine @4-5 kg/ha (Plate 12.2) as pre-emergence herbicides are the best controlling monocot and dicot weeds, except a few resistant ones. Glyphosate @ 4 l/ha (Plate 12.3) also has been reported to control broad leaf weeds, annual grasses and a few perennial grasses for 60-100 days. For effective control of weeds in citrus orchards sometimes more than one weedicides in combination can be used due to their selective nature.

**66. What is a weed? What are characteristics of a weed?**

**Ans:** Any plant not sown in the field by the farmer and is out of place is called as weed. The important characteristics of weeds are as under:

1. The weed seeds germinate early and seedlings grow faster, they being hardy, compete with the crop plants and deprive them of light, moisture and nutrients
2. They flower earlier, mature ahead of the crop. They are therefore difficult to control
3. They are non-useful, unwanted and undesirable, harmful to crops, cattle and human beings
4. Viability of weed seeds remains intact, even if they are buried deep in the soil
5. Weeds can be easily disseminated over long distances

**67. What the common weeds found In citrus orchards?**

**Ans:** The most commonly found weeds in citrus orchards are: Monocots: *Cyperus rotundus*, *Cynodon dactylon*, *Sorghum halepense*, *Dicanthium annulatum*, *Eragrostis minor*, *Andropogon*, spop etc.

Dicots: *Euphorbia thubiflora*, *E. hirta*, *E. microphylla*, *Convolvulus arvensis*, *Tribulus terrestris*, *Fumaria purvifolia*, *Sonchus arvensis*, *Cromophus didimus*, *Oxales corniculata*, *Amaranthus viridis* etc.

**68. What are the harmful effects of weeds in citrus orchard?**

**Ans:** Weed competition with young trees can be severe and reduces growth significantly. Weeds can reduce fruit production by competing for nutrients and water. Near about 46.60 Kg N, 4.12 Kg P and 75-06 Kg K is removed by the weeds in Nagpur mandarin orchards in an area of one hectare if they are not removed. Weeds also interfere with agricultural operations, increase the cost of labour and tillage and ultimately adversely affect the yield and quality of the produce.

## **Crop regulation**

**69. What are the main flowering/fruiting seasons in citrus?**

**Ans:** Citrus trees are subtropical in nature and exhibit continuous cyclic growth throughout year. Under typical subtropical conditions as exist in north India, the trees are exposed to low

temperature stress during the months of December and January. With the onset of spring, there is a rise in atmospheric temperatures, the growth of the plants resumes and flowering takes place by the end of February. The fruits are available in the months of October-November. In central and southern India in the absence of sufficient low temperatures, flowering is not restricted to spring season only. If left to nature, the trees flower and fruit sparsely throughout the year, thus, rendering the orchard management uneconomical. Therefore, in order to induce a concentrated bloom in citrus orchards, withholding of water is practiced. This can be done either in December for inducing flowering in January which is called as *Ambia bahar* (spring flowering) or in April and May for inducing flowering in June with the arrival of monsoon which is called as *Mrig bahar* (monsoon flowering). The fruits of *Ambia* crop mature in October-November and that of *Mrig* crop in March-April.

**70. What is *Bahar* treatment in citrus?**

**Ans.** Citrus plants need some kind of stress for flower bud differentiation. Under typical subtropical conditions this is achieved by the occurrence of low temperatures (0-6<sup>0</sup>C) during peak winter season. In the tropical and semitropical areas, in the absence of sufficient low temperatures, withholding of water is done to induce a concentrated bloom. This treatment of providing artificial stress through withholding of water is called as *Bahar* (bloom) treatment. If left to nature, the trees may bloom and fruit irregularly throughout the year.

**71. What are the growth regulators used to improve fruit set in citrus?**

**Ans:** Gibberellins have been found to be most effective in increasing the fruit set in citrus when sprayed at full bloom at about 10-50 ppm conc. Along with 1% urea. Similarly 2,4-D or 2,4,5-T@ 10-15 ppm are also effective.

**72. What are the growth regulators used to increase the fruit size in citrus?**

**Ans:** 2,4-d, 2,4,5-T and GA3 are used to increase fruit size and quality in citrus they can be used at 10-20 ppm concentrations as foliar spray.

**73. What is the flowering behaviour of limes and lemons?**

**Ans:** If left to nature, limes and lemons tend to flower and fruit throughout the year responding to slightest of environmental stresses such as short spells of low temperature or drought giving out vegetative and reproductive flushes in all the citrus growing areas of the world. In order to induce these plants in to a concentrated bloom, crop regulation is done.

**74. What is the nature of fruit drop in citrus**

**Ans:** A heavy shedding of flowers and fruits, right from the flowering stage up to the time of harvest is serious problem in citrus cultivation. However, all the fruits that fail to mature do not drop at one time but at different times. There are more or less definite periods or stages when extensive dropping occurs. The loss comes in a series of waves varying with the different fruits in number and length of time between them.

## Nematodes

### 75. When was the nematode reported for the first time as pest of citrus?

**Ans:** The first report of a nematode associated with citrus was recorded in 1889. That was root knot nematode (*Meloidogyne* sp.) attacking citrus roots.

### List out different types of citrus nematodes

- |                         |   |                                  |
|-------------------------|---|----------------------------------|
| 1. Citrus root nematode | - | <i>Tylenchulus semipenetrans</i> |
| 2. Reniform nematode    | - | <i>Rotylenchulus reniformis</i>  |
| 3. Burrowing nematode   | - | <i>Radopholus similis</i>        |
| 4. The lesion nematode  | - | <i>Pratylenchus coffeae</i>      |
| 5. Root knot nematode   | - | <i>Meloidogyne africanae</i>     |
| 6. Lance nematode       | - | <i>Hoplolaimus indicus</i>       |

## Integrated Pest Management (IPM) Principles of IPM

### 76. What is Integrated Pest Management?

**Ans:** Integrated pest management (IPM) system is defined as a pest management system that in the context of the associated environment and the population dynamics of pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at a level below those causing 'economic injury' (F.A.O.)

### 77. What are the key pests?

**Ans:** Key pests are the most severe and damaging pests with general equilibrium position well above the economic injury level, e.g. citrus blackfly, trunk borer, fruits sucking moth.

### 78. What are the IPM Practices for citrus leaf miner?

**Ans:**

- (i) Avoid pruning during active growth periods as it may induce further new flush and thereby allow the pest to have more number of generations. It necessary, prune only the infested shoots during winter from the inner canopy.
- (ii) Application of frequent dosages of nitrogen fertilizers may be avoided.
- (iii) Regulate drip irrigation intervals which otherwise promotes several new flushes and thereby provide continuous food to the pest.
- (iv) Insecticidal spray should be initiated as soon as the new flush is emerged and should be continued at weekly intervals. Application of synthetic pyrethoid, fenvalerate (0.01%) may be made once in 45 days to bring the population to the below threshold limits.
- (v) Sprays may be directed at the new flush only

### 79. What is the waiting period for pesticides?

**Ans:** 'Waiting period' is the time required for degradation of the pesticide below permissible limit so as to be acceptable for consumption of plants/fruits after the spray. For example waiting period

of 15-18 days is recommended for mandarin and acid lime after spraying of monocrotophos 0.1 per cent.

**80. What are semio-chemicals/**

**Ans:** Semio-chemicals are *chemical signals* that are released externally by organisms with information content for other organisms.

**81. What are pheromones?**

**Ans:** Semio-chemicals are called as pheromones if the communication is effected/improved between members of same species.

**82. What are insect growth regulators (IGRs)?**

**Ans:** Insect growth regulators are the chemicals interfering with the process of growth and development of insects usually by their close relationship to an insects own internal hormone or by acting as antagonist of the latter.

**83. What are insect attractants?**

**Ans:** Insect attractants are chemical substances which cause oriented movement of insect towards their source.

**84. What are antifeedants?**

**Ans:** Antifeedants or feeding deterrents are chemical compounds which prevent the feeding of phytophagous and other insects without killing or repelling them.

**85. What are phytochemicals?**

**Ans:** Plant synthesized chemicals used by insects, which have been molded during the course of evolution. These chemicals generally termed phytochemicals are often distasteful and toxic to many insects and even may be growth regulators, inhibitors, repellents oviposition inhibitors against a variety of insect species.

**86. What do you know about “Kolshi”?**

**Ans:** Citrus blackfly nymphs excrete voluminous honeydew on which black sooty mould (*Capnodium* sp.) grows wildy. This fungal manifestation is called as ‘Kolshi’ as it forms black continuous layer on each and every part of the plant adversely affecting the photosynthetic rate of plant. Market value of thus blackened fruit is also severely affected.

**87. What is the seasonal incidence of citrus blackfly?**

**Ans:** Incidence of citrus blackfly coincides with the flushing seasons viz., ‘*Ambia*’ or spring (Feb-March), ‘*Mrig*’ or summer (June-July) and ‘*Hasta*’ or autumn (Oct-Nov). Thus, there are three overlapping generations in a year. The adult emergence and engg laying commence with the appearance of new flush.

**88. Name the collateral hosts of blackfly.**

**Ans:** Mango, guava, sapota (Chicku) and pomegranate are the collateral hosts of blackfly which should not be grown in the vicinity of citrus orchards.

**89. What is pseudopupa in case of whitefly?**

**Ans:** Whitefly adults develop within the fourth instar, thus fourth instar is known as pupal case and is called pseudopupae.

**90. How does whitefly damage the crop?**

**Ans:** Larval and adult stages suck the cell sap from leaves. The honeydew excreted by the nymphs is a very good medium for the growth of sooty mould, which forms black layer on the plant surface that interferes the process of photosynthesis.

**91. List out the predators and parasitoids of whitefly.**

**Ans: Predators:** *Brumus suturalis* (Fabr.), *Cryptognatha flavescens* Motsch, *Veronia cardoni* Weirs, a predatory thrip, *Aleurothrips fasciipennis*, small wasp, *eretmocerus haldemanii* and lacewing, *Chrysopa* spp. Are the predators of whitefly.

**Parasitoids:** *Prospaltella lahorensis* (How.) and *Prospaltella citufila* Silv. Are the major parasitoids of whitefly.

**92. What are the psyllids?**

**Ans:** Psyllids or jumping plant-lice are small sucking bugs found all over the world on a large number of cultivated and wild host plants. More than 30 species have been recorded infesting various fruit trees in India. Of these, only 3 have been reported on citrus trees, *Diaphorina citri* Kuwayama, *D. communis* Mathur and *Euphyllus minuta* (Crawfor;) first one being the most destructive pest. Other psyllids feeding and breedings on citrus trees include, *Psylla citrionga*, *P. citricola* and *Trioza erytreae* from China, *P. murreyi* <athur from Malaysia and *D. auberii* Hollis from Comoro Islands. However, the important psylla species which attack citrus groves are Asian citrus psylla, *D. citri* Kuwayama (Psyllidae) and African citrus psylla. *Trioza erytreae* Del Guerao (Trioziidae).

**93. What is population dynamic of citrus psylla?**

**Ans:** Adult *D. citri* reaches sexual maturity within 2-6 days after emergence. After emergence. Oviposition takes place (singly or in clusters) on the inner surface of the tender parts of the plant immediately after mating. A female lives longer (13.77-80.22 days) than the male (10.41-74.0 days) and lays an average 500-800 and even as many as 900 eggs during its life time of 190 days in winter and 12-26 days in summer. The eggs are elongate and almond shaped with rounded basal portions provided with a slender stalk for thrusting the egg into plant tissue. The eggs are pale yellow immediately after oviposition but gradually change to orange at the time of hatching. Incubation takes 3-6 and 10-20 days and nymphs (5 instars) take 15 and 47 days during summer and winter, respectively. Total life cycle is completed in 8 weeks. The pest completes 9-10 or even up to 16 overlapping generations in a year. Overwintering adults may live over 6 months. Adults can disperse with the prevailing winds and a distance of more than 15 km is well within their reach.

## Fungal Diseases

### Name of the major fungal diseases of citrus prevalent in India.

1. Root rot, foot rot, crown rot, gummosis & brown rot (*Phytophthora spp.*)
2. Twig blight (*Botryodiplodia theobromae*, *Colletotrichum gloeosporioides*)
3. Post-bloom fruit drop (*Fusarium solani*)
4. Dry root rot (*Fusarium fawcettii*)
5. Citrus scab (*Elsinoe fawcettii*)
6. Powdery mildew (*Acrosporium tingitaninum*)

### 94. What are the main species of *Phytophthora* commonly found in the citrus orchards and nurseries in India?

Ans:

- I. *Phytophthora nicotianae*
- II. *P. citrophthora*
- III. *P. Palmivora*

### 95. How *Phytophthora* cause losses in citrus?

Ans: Losses due to *Phytophthora* occur in seed beds due to damping-off of seedlings; in nurseries from root rot; in orchards from foot rot, gummosis, feeder root rot and brown rot; and in packing houses due to brown rot of fruits.

### 96. What is gummosis?

Ans: Gummosis is a pathological condition characterized by excessive formation and exudation of gum. This is caused by *Phytophthora* infection on a citrus tree trunk.

### 97. What are the symptoms of *Phytophthora* diseases?

Ans: *Phytophthora* spp. Causes foot rot, root rot, crown rot, gummosis, leaf fall and brown rot diseases in citrus. Foot rot lesions develop as high as 60 cm from the ground level from the trunk (Plat 16.1) and may extend below the soil on crown roots as crown rot. On scraping the dead bark of the lesion, a brown discoloured slippery area can be seen. Such active lesions start oozing gum which can be seen on the trunk as brownish black oozing known as 'gummosis'. In severe cases, when foot and significant portion of root system is damaged the large branches of the same side of the affected plant are killed due to rot of conducting tissues near the bark. Usually the disease is confined to feeder roots and causes their decay. Dull chlorotic foliage is the first symptom of such affected plants. In continuously wet weather conditions, *Phytophthora* causes a typical brown rot of fruits and leaf fall.

### 98. How *Phytophthora* causes infection in citrus

Ans: *Phytophthora* inhabits in soil and is a water loving fungus. It survives in soil through small thick walled spores (chlamydospores) and oospores which can tolerate dry summer condition. With onset of monsoon and in optimum temperature. Flooding or excessive irrigation, these in water and sare attracted to root tips and wounds to cause infection. A new generation of sporangia are formed within 24 hours of their entrance in tissue and again liberate the zoospores to initiate the new

infection, this cycle repeats so far soil remain saturated and thus reservoir of inoculums accumulates. Thus zoospores are the main propagules responsible for infection and spread of *Phytophthora* between roots of citrus trees.

**99. How *Phytophthora* spreads in citrus orchards?**

**Ans:** The primary means by which *Phytophthora* spp. are spread in citrus orchards is by use of infected nursery stock. The pathogen may be present in soil or infected roots even though disease symptoms are not readily apparent. The fungus is also introduced in soil by farm equipments and vehicles. Irrigation water also carry the pathogen from place to place, especially where furrow or flood irrigation is practiced.

**100. What is Brown rot?**

**Ans:** In continuously wet weather conditions for about 24 hrs. or more *Phytophthora* splashes along with the rain drops to low hanging fruits and causes a typical brown rot of fruits.

**101. What is the role of lime in Bordeaux mixture? What is 1% Bordeaux mixture?**

**Ans:** Copper is the only ingredient in the Bordeaux mixture that is toxic to pathogen and sometimes even to plants. Lime is added to neutralize the phytotoxicity of copper.

Bordeaux mixture (1%) comprises of 1 kg copper sulfate, 1 kg lime added in 100 lit of water.

**102. What is Bordeaux paste?**

**Ans:** Bordeaux paste consists of the same ingredients as that of Bordeaux mixture, but it is in the form of a paste. The paste should always be applied before and after onset of monsoon on citrus tree trunk as prophylactic measure against *Phytophthora*.

**103. What is the economic importance of citrus diseases?**

**Ans:** Diseases in citrus may reduce yield directly by attacking the fruit. Or indirectly by causing defoliation or stem injury the affects fruit development and yield. Some diseases cause superficial blemished that do not affect yield or juice quality but may affect consumer appeal.

**POST-HARVEST TECHNOLOGY OF FRESH CITRUS**

**104. What are the different ways the citrus fruits are utilized?**

**Ans:** Different citrus fruits are utilized in different ways. The sweet oranges or tight jacket oranges and mandarins or loose oranges are used as fresh fruits or dessert fruits for table purpose and also in processing for extracting juice and preparing beverages and concentrates. Limes and lemons are used for culinary purpose and for garnishing salads and dishes of food. Various refreshing beverages and drinks are also prepared from limes and lemon. Similarly, grapefruits and pummelo are used for preparation of juice and concentrates.

**105. Why are the post harvest losses of citrus fruits more in tropical condition?**

**Ans:** In tropical conditions, temperatures are higher (30-45<sup>0</sup> C) and relative humidity is either too low or too high. These conditions lead to either rapid decay or quick wilting/ shrivelling or both.

**106. Which group do citrus fruits belong to-climacteric or non climacteric? Why?**

**Ans.** Citrus fruit belong to non-climacteric group of fruits due to their lower rate of respiration and ethylene production after harvest.

## **HARVESTING AND MATURITY**

**107. What care should we take while harvesting?**

**Ans.** Since citrus fruits do not ripen after harvest, we have to wait till they mature/ripen on the tree itself. If we harvest early, there will be less juice, less sugar content and more acid. Secondly, fruit should not get injured while harvesting. Injuries during harvest result in to water loss from those areas and development of blemished. Fruits dropped on the ground during harvesting should never be packed. Such fruits are bound to rot.

## **DEGREENING**

**108. What are the pigments responsible for colour in citrus fruits/**

**Ans.** The green colour of citrus fruit is due to chlorophyll. The yellow and orange colour is due to carotenoids. The major carotenoids are b-carotene, Xanthophyll, Cryptoxanthin and Violaxanthin. B-carotene is a precursor of vitamin A and can be converted to retinol in the human body which is active as vitamin A. some varieties of blood red oranges contain anthocyanin pigments which cause the red colour and blush in grapefruits and oranges. The flesh colour is also blood red in these fruits.

## **TRANSPORTATION**

**109. What are the means of transportation of citru fruits?**

**Ans.** From orchard to wholesale markets, citrus fruits are transported in bullock carts, small trucks and tractor trollies. In hilly area, animals are also used. For long distance transportation, trains and big trucks are used.

## **PRECOOLING AND STORAGE**

**110. What is pre-cooling? How does it help to extend storage life of citrus?**

**Ans.** Pre-cooling refers to cooling prior to refrigerated storage or transportation in cooled reefer container during export. Pre-cooling removes the field heat very rapidly and thus helps in retaining freshness of citrus. It slows down respiration rate, water loss, microbial spoilage and ethylene evolution from the fruits.

**111. What is chilling injury? How does it develop?**

**Ans.** All citrus fruits are sensitive to low temperature below normal optimal range and chilling injury symptoms in the form of brown sunken areas or pitting develop on the fruit peel. Nagpur

mandarin and Mosambi sweet orange grown in central India cannot be stored below 4°C temperature. Acid lime cannot be stored at 6°C or lower temperature.

## **PHYSIOLOGICAL DISORDERS**

### **112. What is granulation?**

**Ans.** It is a physiological disorder of mandarins, tangerine, tangerine hybrids, and sweet oranges that develop in case harvesting is delayed. The juice content of the fruit is severely reduced due to gel formation within the vesicles (Plat 18.5). Freezing of the fruits on the trees also causes dryness and symptoms are similar to those of granulation.

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