

# Production Management of Citrus Fruits under Arid Region of Rajasthan

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## Introduction

Citrus is an important fruit crop worldwide. The global production of citrus is 121.27 MT (Anonymous, 2015). It is mainly grown in China, Brazil, USA, Spain, Mexico, India and Argentina. The genus citrus includes more than 162 species belonging to the order Geraniales of Rutaceae family and sub family Aurantoideae (Webber and Batchelor 1948; Scora 1975). Citrus fruits have long been used as nutritious and tasty diet. The citrus flavors are most preferred bio-compound in the world. It is well-known that citrus is rich source of vitamins, minerals and dietary fiber which are essential for growth and development, overall nutritional fulfillment and to reduce the risk of many chronic diseases of human (Economos and Clay 1998). It is expected that demand for citrus fruits would increase by 50 per cent with increasing of the population and nutritionality of fruits by 2030 (CCRI 2015).

In India, citrus is the third largest fruit crop which is grown commercially in Maharashtra, Andhra Pradesh, Karnataka, West Bengal, Sikkim, Punjab, Rajasthan and Assam from arid & semi arid region to humid tropical regions. The present area under citrus is 1.06 mha with a production of 12.51 million tones and average productivity of 11.8 tons ha<sup>-1</sup>. The most important commercial citrus species in India are the mandarin orange (*C. reticulata* Blanco), sweet orange (*C. sinensis* L. Osbeck) and acid lime (*C. aurantifolia* Swingle)/ lemon (*C. limon* Burm) sharing 39.82, 26.93 and 20.00 percent, respectively (Anonymous, 2018). In Rajasthan, kinnow mandarin cultivation accounts to 12.84 thousand ha area with 267340 ton production and 20.82 tons ha<sup>-1</sup> productivity followed by sweet orange having 0.19 thousand ha area with 2350 tons production and 12.36 tons ha<sup>-1</sup> productivity. Lime/ lemon occupy area of 2.89 thousand ha with 16360 tons production and 5.66 tons ha<sup>-1</sup> productivity (Anonymous, 2016). The annual growth rate in area and production from last eight years was 17.21% and 43.88% respectively, (Anonymous, 2018).

## Commercial basket of citrus based on climate and soil requirement in Rajasthan

Citrus is grown throughout the Rajasthan which varied in soil and climatic condition due to rich in biodiversity of citrus germplasm (species and varieties). The Rajasthan state is covering basically three type of climate based on temperature and rainfall e.g. sub tropical, semi arid and arid as well as different type of soils are black, red, sandy loam sand and rocky soils. The north - western part of Rajasthan is under arid and central part in semi arid whereas south part of state is considered as sub tropical. The Nagpur mandarin is commercially grown in hadati region because it required high humidity and black cotton soil for its successful condition while Kinnow mandarin is covering north western part of the state. Kinnow mandarin is temperature response fruit crops so it is grown only where distinct season and day night temperature fluctuation for fruit colour

development, sweetness and blending of juice etc. In despite, acid lime is having huge scope for its cultivation in east and central part of the state like Bharatpur, Dholpur, Swai –Madhopur, Alwar, Dausa, Jaipur and Ajmer etc.

Overall citrus tree is required neutral or slightly low pH soil and water, sufficient soil profile upto one meter no hardpan, well water holding capacity, and good rainfall 400-800 or plenty of ground water because it is required more water throughout the year due to shallow and fiber roots. Hot and cold wave free environment is required during flowering and fruit setting period.

### **Selection of scion and rootstocks varieties**

A large numbers of species and cultivars in genus citrus are being cultivated throughout India. The selection of species, varieties and rootstocks are key component and play a vital role for better orchard development and profitability of the farmer based on soil and climatic locations. Therefore, some commercial cultivars for arid region are described in the tables 1.

**Table: 01. Description of citrus mandarin, sweet orange, lemon, lime and inter-specific hybrid varieties**

| <b>Species</b>                             | <b>Varieties and their characters</b>  |
|--|--|
| Mandarin<br>( <i>Citrus reticulata</i> )   | <p><b>Kinnow-</b> Cold resistant, attractive golden-orange colour, easily peeled, abundant juice, excellent aroma and taste, special flavour, rich source of vitamin C and high yielding which make good export quality.</p> <p><b>Daisy-</b> It is crossed between Fortune mandarin and Fremont mandarin. Daisy is produces medium-large fruit with attractive dark orange rind, moderately seedy, excellent in flavor and tangy taste.</p> <p><b>Michal-</b> It is a natural hybrid of 'Clementine' and 'Dancy'. It has good fruit quality, earliness, small fruit size and easy peels ability but with tendency to alternate bearing. The crown is compact or dense, not weeping.</p>   |
| Sweet orange<br>( <i>Citrus sinensis</i> ) | <p><b>Sathgudi-</b> Fruits are smooth and have attractive orange colour, shape spherical, size variable, rind medium thick, segments 10 to 12, pulp orange coloured abundant juice, good flavour.</p> <p><b>Mosambi-</b> Fruit light yellowish orange in colour, surface rough with prominent streaks on the rind, oblate to spherical, apex broad, rind thick, well-defined segments numbering 9 to 12, peeling difficult, pulp light yellow; juice sweet.</p> <p><b>Malta (Common)-</b> Fruit orange-yellow, surface smooth; shape spherical; medium to large in size; thickness of the rind medium, segments 10, well-defined; pulp orange, abundant juice, good flavour.</p> <p><b>Malta (Blood Red)-</b> Skin yellow with scarlet blush. Rind is relatively thin, tight and glossy. Pulp corn coloured and red streaked, early ripening; pulp sweet, abundant juice, red coloured, pleasant flavour etc.</p> <p><b>Valencia-</b> Thinner skins, harder to peel, much juicier, ideal for orange juice.</p> |

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|-------------------------------------|---|
|                                     | <p><b>Pusa Round-</b> Plants are dense foliage, attractive round and uniform fruit, granulation free. Its yields 3.5-fold higher than Jaffa and 2.4-fold higher than Valencia.</p> <p><b>Newhall Navel-</b> It is a limb sport of a Washington navel orange selected by Paul Hackney .Fruit are slightly smaller in size with deeper rind color and flesh color than Washington navel orange with good flavor.</p> <p><b>Jaffa-</b> It is clone of Palestine beledi tree, tree vigorous, upright, medium-large, dense foliage, cold-resistant, moderately productive, but with alternate bearing tendency. Fruit is content less seed and Mid-season maturity.</p> <p><b>Hamlin-</b> Most widely grown, cold tolerant and early in maturity. Small fruit in size and susceptible to splitting and creasing.</p> <p><b>Pineapple-</b> Tree moderately vigorous, medium-large, thornless, highly productive but more sensitive to frost. Fruit is medium in sized, moderately seedy and excellent for processing.</p> |
| Lemon<br>( <i>Citrus limon</i> )    | <p><b>Eureka-</b> Heavy yielder, fruit medium , ovate to oblong, rind pitted medium and thin, lemon yellow colour, juice abundant, very acidic quality and flavour excellent</p> <p><b>Lisbon-</b> Fruit medium, oblong to elliptical segment 7-10, juice abundant, very acidic with excellent quality</p> <p><b>Pant lemon-</b> Tree dwarf, spiny tolerant to canker, scab and gummosis , fruit rind yellow and smooth, fruit juicy and seedless</p>   |
| Lime ( <i>Citrus aurantifolia</i> ) | <p><b>Vikram-</b> Cluster bearing, high yielding and off season</p> <p><b>Pramlini-</b> Cluster bearing, juice 30-55 % and high yield</p> <p><b>Chakradhar-</b> Seedless, erect and compact plant habit, rind papery fruit round and juice-60-65 %</p> <p><b>PKM- 1-</b> Fruit Round and medium to large size, yellow colour, juice above 52 % and high yield</p>   |
| Inter-specific hybrids              | <p><b>Fremont-</b> Clementin mandarin x Ponkan Tangelo by P. C. Reece at USDA. Tree moderately vigorous, upright growing, almost thornless, precocious, resistant to <i>A. alternata</i>, fruit high quality, early-ripening variety, medium size, rind medium to thick, color bright reddish-orange.</p> <p><b>Fairchild-</b> It is crossed between ‘Clementine’ mandarin and ‘Orlando’ tangelo, made by J. R. Furr at the U.S Date and Citrus Station at Indio, California, and the variety was released in 1964. It is well-suited deserts of Arid zone, early fruit maturity, rich flavored, juicy and sweet especially when very ripe.</p> <p><b>Pearl Tangelo-</b> It a hybrid of ‘Imperial’ Grape fruit x ‘Willow’ leaf Mandarin made by Howard Frost in 1940. Tree vigorous, spreading, drooping and</p>  |

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|  | sometime alternate bearing. Fruit is medium to small, yellow color, seedy, rind thin and tightly adherent, solid axis, medium-early in maturity. |
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The rootstock is a key component of successful and sustainable citrus orchard. Development of genetically uniform and superior rootstock is an important task in citrus. In citrus, a lot of species and hybrids are being used as rootstocks for various purposes and objectives. A single rootstock is not effectively suitable for testing all the scions under different soil and climatic conditions. In citrus, diploid rootstocks have been utilized since past time, even though, these rootstock are suffering to a lot of biotic and abiotic stresses throughout citriculture in the world. The diploid rootstocks are vigorous in nature thus grafted plants on it acquire giant shape after 10-13 years. To maintain size and shape in such circumstances, the growers have to start severe pruning. However, citrus plants do not like severe training and pruning as it resulted into decline due to contamination of various biotic factors and prone to abiotic stresses. As the consequence, the cost of cultivation is affected adversely and citrus growers are getting heavy loss. To address these problems, polyploids have been selected throughout evolution because of their genome plasticity leading to selective advantages over diploid, and in most cases an enhanced vigor. Adaptation of polyploid populations to novel environments was evaluated and the evolutionary consequences of exposure to these environments were analyzed. Among these polyploids rootstock, tetraploid rootstocks are found more tolerance to biotic and abiotic stress during evaluations. Numerous tetraploid somatic hybrids have been produced by protoplast fusion for rootstock breeding. The findings suggested that increased tolerance in tetraploid rootstocks could be related to more effective regulation of the transpiration stream and that it is related to increased ABA synthesis in root among rootstocks. The tetraploid rootstocks have highly responded to drought, salinity, chilling, nutrient and heavy metals stresses than their diploid parents. However, allotetraploid are found more superior than autotetraploid regarding multi-stresses because they are produced from two differently superior autotetraploids. Thus, allotetraploids can be recommended to establish citrus orchards where environmental problems occurred more.

**Table: 2 Different rootstocks identified for special traits and environmental condition**

| Rootstocks  | Characters  |
|---|---|
| <b>Diploid Rootstocks</b>   |   |
| Alemow  | Highly resistant to drought, salinity, cold, decline, tristeza and three times more yield (22 ton ha <sup>-1</sup> ) than conventional rootstock of citrus (Sonkar <i>et al.</i> , 2013)  |
| Swingle   | Highly productive dwarfing, resistant to salinity, drought, tristeza, nematode and phytophthora, suitable to hot region (Janick <i>et al.</i> , 1996)   |
| Flying Dragon<br>( <i>Poncirus trifoliata</i> Var. <i>monstrosa</i> ) | True dwarfing rootstock which may be used effectively in high density planting due to young plant has a slow growth rate and the size of a bearing tree is usually small, resistance to gummosis, tristeza, cold hardiness and high quality (Haddou <i>et al.</i> , 2000, Gheshlagh <i>et al.</i> , 2012) |
| Trifoliolate orange   | Cold hardy and fairly resistant to nematode (Batchelor <i>et al.</i> , 1952)  |

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| Cleopatra                    | Tolerant to quick decline and gummosis (Batchelor <i>et al.</i> , 1952)  |
| Troyer Citrange              | Highly resistant to gummosis, cold and produces superior quality fruit (Batchelor <i>et al.</i> , 1952)  |
| Volkameriana                 | Tolerant tristeza virus or exocortis and xyloporosis viroids. Susceptible to citrus nematodes and phytophthora root rot but lesser than rough lemon (Lacey, 2012)  |
| Rangpur lime                 | Tolerant to CTV, drought, salt, precocious and prolific with quality produce. Good union with mandarin and mosambi (Singh <i>et al.</i> , 2004)  |
| C-35                         | Tolerant to root rot, gummosis, nematode, tristeza, dwarf in nature and high fruit quality (Cameron <i>et al.</i> , 1986)  |
| Rough lemon                  | Extremely vigorous and moderately tolerant to high salinity. (Bevington, 2002). Scions on rough lemon are susceptible to freeze because of higher root conductivity at lower root temperature than found in Carrizo. (Robert <i>et al.</i> , 1990). The fruit retention capacity is shorter on rough lemon as compared to other certain rootstocks. The fruits are poor quality which is thick skinned puffy due to granulation with low T.S.S. and acidity. (Castle <i>et al.</i> , 2004). Fruit produced on rough lemon have thick skin, rough texture with low juice content, also more prone to root diseases, nematodes and water logging. (Hardy, 2012). |
| <b>Polyploidy rootstocks</b> |  |
| Carrizo citrange             | The tetraploid Carrizo citrange showed more drought stress, boron and chloride toxicity, and chilling tolerance (Allario <i>et al.</i> 2013; Ruiz <i>et al.</i> 2016; Oustric <i>et al.</i> 2017).   |
| Rangpur lime                 | It is more tolerant to chromium (Cr-) toxicity as compare to diploid counterpart and more powerful tolerance to exiting diploid characters (Balal <i>et al.</i> 2016).   |
| Flhorag 1                    | Flhorag 1 is an allotetraploid (4x) somatic intergeneric hybrid of [Willow Leaf Mandarin ( <i>C. paradisi</i> -4x) + Pomyroy Poncirus ( <i>Poncirus trifoliata</i> -4x) and suitable where chilling and high light intensity stress (Oustric <i>et al.</i> 2018).  |
| Cleopatra Mandarin           | The roots of tetraploid Cleopatra accumulating more concentration of Cr- than the roots of its diploid without any observable deformities (Balal <i>et al.</i> 2017).  |
| Poncirus trifoliata          | Tetraploid <i>Poncirus trifoliata</i> was more tolerant to salinity, cold hardiness, resistant to foot rot, tristeza virus and nematode than their respective diploid counterpart (Saleh <i>et al.</i> 2008; Ruiz <i>et al.</i> 2016; Balal <i>et al.</i> 2017).   |

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|--------|---|
| Alemow | The tetraploid Alemow plants show a higher capacity of Cl <sup>-</sup> exclusion, probably led by reduced transpiration rate that delays the salt stress-induced leaf damage (Ruiz <i>et al.</i> 2016) and uptake of K <sup>+</sup> ion is higher than Na <sup>+</sup> ion as a result it showed salinity tolerance compared to its diploid plants (Martinez-Alcantara <i>et al.</i> 2015). |
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### **Planting and spacing**

Pits of box 1x1x1 m size are dug at 6 meters apart each way and filled with 30 to 40 kg farm yard manure or compost and top soil along with 2 kg superphosphate and Bavistin or formaldehyde. It should be kept one month as such as during hot summer and filled with water just one day before planting to avoid the logging of plants. One year old, healthy seedlings are recommended of budded/grafted plants for planting. Most ideal season for planting is the onset of monsoon (July- September).

### **Intercultural operations and care of young orchard**

Plants should be supported with bamboo stick soon after planting and irrigated thoroughly. The main stem of the young sapling be topped to allowed side branches at sufficient space and in all directions. Water sprout and root suckers should be removed immediately from base of arising with the help of secateur. If the bark of stem is opened then immediately paste of Blitox or any copper based fungicides. Otherwise open space or wounds invite the contamination of diseases and leads to decline in the early age of the orchards. Plants or its nearby should be clean by weeding and hoeing regularly. Plants should be protected against pests and diseases by spraying with pesticides and fungicides regularly. Low growing vegetables, leguminous or green manure crops may be grown as inter crops between young trees upto 4 to 5 years of their age.

### **Water and nutrients management**

Irrigation plays an important role in raising and stabilizing yield and maintaining quality of citrus fruit, which is more precious than other fruit crops grown in arid and sub tropical climate. Trees suffer water deficit during crucial fruit development period lead to reduce productivity as well as quality of fruit. Thus effective scheduling of irrigation is very important in decisions related to maximizing yields and improving fruit size and juice quality. Therefore, the irrigation should be applied through drip irrigation to supply the water directly in the root zone of the tree. The irrigation water should be stopped during flowering and fruit setting thereafter once fruit setting is over, the best fruit yield and quality is achieved though well watering. Similarly, younger plants (1-3 years old) are highly sensitive to drought. They require frequent irrigations particularly in hot summer months. Otherwise, mortality rate of younger plants is higher in arid region. Irrigation requirement of citrus is higher than other fruit trees because of their evergreen nature, active growth and development throughout the year. The quantity of irrigation water is depends on water holding capacity, climatic condition and age of the plant. But the ideal amount of water in such arid condition of full grown plant is 40-60 l/day. Furthermore, the citrus is highly susceptible to water logging; consequently, stagnation of water around tree trunk should be avoided. Therefore,

in advance the underground drip irrigation can be install which will help in more water and nutrient shaving; fertilizers and water use efficiency beside, no interfere with intercultural operations & no attack of rats and squirrel as well as increase 3 to 4 time more life of laterals, dripper and others part of drip etc. The underground drip irrigation also helps to direct fertilizers application in the root zone and improve the plants growth and productivity of citrus plant. On another hands, citrus is the micro nutrients loving plants so optimum supply of Zinc, manganese, iron, sulphur, boron etc. at regular period through spaying or drip and as basal dose along with application of manures and macro fertilizers.

### **Canopy management of citrus plants**

Citrus plants are evergreen in growth nature so it is not like excess training and pruning otherwise plants become weak and decline rapidly due to adversely disturbance in metabolism and physiology of plants and severe infestation of pest and disease. Therefore selective training and pruning should be adopted in the citrus orchard. Water sprout, root suckers, lanky or over growth branches, dry shoots, disease and pest infested branches should be remove regularly and immediate application of insecticide, copper based fungicides and nutrient application. Acid lime flowers and produces fruits round the year, but there are three major flushes in February- March, June-July and October- November. These are known as amba bahar, mrig bahar and hast bahar respectively. The haste bahar flowering fruits harvested during summer months are most remunerative among the bahars. To achieve this, irrigation should be suspended for 30-45 days before actual flowering and apply ethephon @ 1000-1500 ppm to accelerated shading of leave. During this period field may be deep ploughed and applied with manure and fertilizers towards the end and irrigation be resumed. Plants can be sprayed with 1000 ppm cycocil twice during fruit growth time which is found to increase the fruit yield twice than the normal yield.

Similarly, it can be done in Nagpur Mandarin of hadoti region during the mrig bahar. This flowering can be induced in June-July, coinciding with the outbreak of monsoon; this treatment is taken in the areas where, water is scarce during the hot weather to obtain off season fruiting and fetch higher price in the market.

### **Harvesting of fruits and post harvest management**

Maturity of citrus fruits is depends upon the species, climatic conditions, nutrition, heat units and moisture availability. The period of maturity is shortest in acid lime and lemon (4-5 months) and sweet orange (7-8) and longest in mandarin (10-11 months) and other maturity indices are fruit size and colour according to varieties, juice content and TSS especially in sweet groups. The fruit yield is completely depends on the seasons, cultivars and orchard management etc. but the average yield is acid lime (60-90 kg), sweet orange (50-70 kg) and mandarin (70-120 kg) per plants of full grown plants. Harvested fruits are graded according to size and colour and packed in bamboo baskets or wooden crates lined with neem foliage and CFB boxes to long distance transport.

## **Plant protection management in citrus**

### **Leaf miner**

Citrus leaf miner larvae feed by creating shallow tunnels, or mines, in young leaves of citrus trees during the rainy season or new flushing time of the plants. Its severe infestation is occurred in the nursery sapling. Its symptoms look like as leaves with serpentine mines, usually on ventral surfaces, curling of leaves and epidermis appearing as a silvery film over leaf mines, and finally the plant growth stunt. It can be controlled by spraying of Dichlorvos 76 WSC @ 1 ml/lit or Dimethoate 30 EC @ 2 ml/lit or Monocrotophos 36 WSC @ 1.5 ml/lit or neem seed kernel extract (NSKE) @ 50g/lit or 3 % neem cake extract or neem oil.

### **Lemon Butterfly**

The beautifully coloured flies are seen in the orchard. It is one of the most destructive pests of citrus whose larval forms cause serious damage by devouring large quantity of foliage of citrus plants. The main attacks of this insect on the newly emerging leaf and it completely ate the leaves. The caterpillar attacks three to four times in year when plants sprout new shoots. Therefore, spray with Monocrotophos 36 WSC @ 1.5 ml/lit or Rogor 30% EC @ 1.5 ml/lit two times at 10 days interval.

### **Fruit Sucking Moth**

Two species of fruit sucking moths (*Eudocima fullonia* and *Eudocima materna*) are cause enormous damage at the time of ripening during rainy season and resulting heavy losses. The moths pierce the ripening fruits and suck the juice, resulting in premature fruit fall, rotting and quality deterioration. Usually a circular spot appears at the site of feeding which gives a frothy jet of fermented juice which oozes out when squeezed. Systematic destruction of the breeding sites such as wild weeds and creepers around the orchards helps to check the pest population, dispose all fallen and decaying fruits, create smoke by burning dry grasses and leaves, and a bait containing gur 1kg + vinegar 60g + malathion 50ml + water 10 litres and wide mouthed bottles containing the bait solution should be tied to the trees at the rate of 1 bottle/10 trees when the fruits are in unripe conditions.

### **Termite**

Termite is the economically pest under arid ecology where the soil moisture is less. During the summer or when low soil moisture and high evapotranspiration, the termite reach in the root zone and start the biting of roots and stem in the end. In such condition the termite cause 100 percent loss of the plants. The watering should be keep proper at regular interval, deep ploughing in summer and timely application of Chlorpyrifos 50% EC @ 1.5 ml per liter or Imidacloprid 21.4% @ 1 ml per 3 liter of water or neem seed kernel extract (NSKE) @ 50g/lit or 3 % neem cake extract or neem oil.

### **Citrus Psylla**

Both nymphs and adults of psylla are sucking the cell sap from leaves, buds and young shoots throughout the year. As a result the terminal shoots is wilted and dried. It also acts as a vector of greening disease, which is main cause for citrus decline. For its control, spray Rogor 30



EC (Dimethoate) @ 2.5 ml/l or Nuvacron 36 SL (Monocrotophos) @ 2 ml/l of water or Imidacloprid @ 5 ml/l.

## **Diseases**

### ***Citrus Canker***

It is a very serious disease of citrus caused by bacteria named *Xanthomonas citri* particularly in acid limes. Its symptoms appear on leaves, twigs and fruits as yellowish spots which gradually enlarge, turn rough and brownish and become raised on both sides of the leaf. These lesions become rough and corky. It does not affect the internal quality of the fruits but the outer appearance looks very ugly that why fruit price in the market is reduced highly. Spray 10 gm streptomycin in 100 litres of water and also add pure copper sulphate @ 2g/l. of water or three sprays of Bordeaux mixture can also be effective in the control of canker in February, October and December.

### ***Die back***

It is also called wither tip (anthracnose). It is caused by a fungus *Colletotrichum gloeosporioides* or may be due to physiological causes by copper deficiency. Symptoms of die back appear on leaves, young and shoots. The necrotic spots appear as acervuli arranged in concentric rings on leaves and twigs are started drying from tip of the shoot and gradually reached to base of the twigs or branches and death of the plants. Leaves shedding and twig die back are characteristic symptoms of wither tip. For its control, prune the diseased wood, leaves and fruits and destroy, spray the affected trees with Bavistin 1.0 gm/l of water in February and Bordeaux mixture 2:2:250 in March and repeat the same in July-August.

### **Scab**

It is caused by *Elsinoe fawcetti* and produces symptoms as small dark, brown, rough, irregular raised lesions mostly on the underside of the leaves and twigs and fruits also may be infected in advance stage. Spray Bordeaux mixture 2:2:250 or 50% copper oxychloride @ 3g/l of water or Ziram 27 SC or Dithane M-45 @ 2.5 gm/l thrice from June to August at 20 days interval.

### **Gummosis**

Foot rot or citrus plethora is a fungal disease caused by *Phytophthora palmivora*. This disease is normally occurred where orchards with poor soil drainage, or flood irrigated. Fungus causes rotting of rootlets, dropping of the blighted leaves, heavily infected plants profuse gumming from the stem and branches and finally plants are died. These control measures should be followed: Collect and bury deep in soil the diseased leaves or fruits, use Cleopatra as a rootstock, avoid flood irrigation, paint the trunk portions with Bordeaux paint up to 20 cm of height, spray Bordeaux mixture 2:2:250 thrice, i.e. in February before flowering, June and end July or give two applications of Ridomil MZ as paint (2g/100 ml of Linseed oil) to the infected portion of the trunk and drench (25g/10 litre of water/tree) the soil at the base of the tree in February-March and July-August.

## **Virus and Virus like Diseases**

### **Greening (Huanglongbing)**

It is caused by bacterium *Candidatus liberibacter* spp. and manifests as stiff upright multiple twigs and buds. The leaves become small and mottled. Premature defoliation and branches show die back. Control measure of greening as use disease free bud wood, control citrus psylla (*Diaphorina citri*) as it is a vector for greening disease, use tolerant rootstocks and remove immediately infected plants and brunt.

### **Tristeza**

It is caused by a virus and vectored by aphid. The infected trees appear as their roots have been damaged and clearing vein in young leaves. Sieve tube are necrotic at the bud union and cause crease formation, which check carbohydrate translocation from top to roots resulting in starvation of roots. Therefore, use tolerant rootstock as Cleopatra and Jatti khatti, control the insect vector (aphid) which causes its spread.

### **Citrus Decline**

Citrus decline is the only major problem which dispirits the citrus growers. All citrus species are prone to decline, but mandarins are most one susceptible. Plants performance in early years of bearing is excellent. Later on shoots start drying, the scaffolds show oozing of gum, finally leading to bark splitting and drying of scaffold. Slowly –slowly whole of the tree is dead. Factors associated with citrus decline are susceptibility rootstock, nutritional deficiency, faulty irrigation and intercropping, pests and diseases as well as other orchards condition like soil characters, drainage, salt concentrations, water logging, frost injuries etc. Therefore, Citrus decline can be said as a syndrome because there is not a single cause but is the effect of many causes, which may vary from field to field or area to area. Growers should be care off all the factors, which are associated with the decline.

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