



CITRUS



all about
Citrus

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Himachal Pradesh Subtropical Horticulture, Irrigation & Value Addition (HPSHIVA) Project, was conceived to harness the potential of horticulture in the subtropical climate area of the state.

The main objective of HPSHIVA project is development of sub-tropical horticulture on commercial lines in cluster approach besides providing sustainable livelihood opportunities to the farmers, who have abandoned their cultivable land because of menace of stray animals, monkeys & wild animals and to the youth population migrating to urban areas to seek wages employment.

The project is being implemented by Department of Horticulture (DoH) and Jal Shakti Vibhag (JSV) as implementing agency with the financial assistance from Asian Development Bank (ADB).

As part of consultancy services under the project, “Package of Practices” for the mandated fruit crops of HPSHIVA Project was developed by a team of experts from Dr. YSP University of Horticulture & Forestry ,COHF- Neri, Hamirpur.

The booklet is an abridged version of PoP developed specifically for Citrus.

Climate

Citrus fruits in subtropical area of state are cultivated under varied agro-climatic situations right from Kangra to Paunta valley of Sirmaur district. The optimum temperature range for growth and production of citrus is 130 C to 370 C. Soil temperature around 250C seems to be optimum for root growth. The sub-tropical climate of state is best suited for growth and fruit production of citrus.

Topography and soil

The ideal soil for citrus cultivation is deep, sandy loam or alluvial soils rich in organic matter, although, it can be grown on wide range of soils. Citrus orchards flourish well in light soils with good drainage properties. Deep soils with pH range of 5.5 to 7.5 are considered ideal.

Recommended cultivars

Velencia Late, Mosambi, Jaffa and Malta Blood Red. Westin, Pera, Hamlin and Natal varieties are also recommended for commercial cultivation

Layout and Planting

Spacing

- Citrus should be planted at 3.0 m x 3.0 m accommodating 1111 plants/ha.
Layout
- Square or rectangular planting systems should be adopted in citrus planting. The orientation of planting should be North–South direction. However under the condition with undulating topography, planting should be done by mulching contour terraces.

Preparation of field, bed, planting pit and filling

- Deep ploughing should be done and raised bed (2 meter wide at bottom x 1.5 meter wide at top x 45 cm height) should be prepared one month before planting.
- Planting should be done in pits of 60 x 60 x 60 cm size and pits are dug about a month prior to planting and disinfect by intense solar radiation. Each pit should be filled with top soil mixed with farmyard manure (20kg), neem cake (1kg), and single super phosphate (500g). After filling the pit, watering is done to allow soil to settle down.

Planting

- Place the tree in the hole so that the potting mix mark is slightly higher than ground level to allow for some sink. Fill the hole up to half level with soil and press it gently towards the root.



High density plantation

- Fill the hole with water and allow it to drain before completely filling the hole with soil. Do not place fertilizer in the planting hole as this can burn sensitive roots.
- Apply a layer of organic mulch in 1 m diameter around the trees.
- Planting should be done during early spring or rainy season depending on availability of irrigation water.
- Polybag raised plants can be planted without disturbing their roots.
- Staking should be provided to young plants to keep the plant straight and avoiding breakage of shoots by winds. Use 50-80 cm long wooden sticks and tie the main branches with strings. Wooden sticks should be treated with chloropyriphos 2 ml/litre for termite protection.



High density planting in 4th year

Canopy Management

- Citrus produces 3-5 growth flushes each year according to the growing environment. Each new growth flush is added onto the previous flush, resulting in a drift of young bearing wood to outside of tree canopy. Over the time, this produces larger trees with increased shading inside the canopy, restricting the fruit development to top and side of the trees.
- Growth rates are highly variable depending on climate, cultural practices, tree spacing, scion and rootstock. Younger trees have higher growth rate in relation to tree size. Once the tree reaches desired height, annual pruning may be required to maintain the height, thin the growth, and promote prolific fruiting.
- Maximum fruits are set on wood that is less than 2 years old. Pruning should be least damaging to tree yields when done on a regular basis to wood on the outside of the canopy.

Training

- To develop structural framework training operation should start after 6 months of planting when the plants have attained a height of 45-60 cm.
- All branches up to 30 cm height should be removed and first ring of branches should start 30 cm above the ground.
- During the second phase, select 3-5 primary branches above 30 cm height in all directions. The selection of primary, secondary and tertiary branches should remain continuous during next year.
- The orientation of primary branches should be toward peripheral canopy at about 60° angle with stem and upright growing branches should be thinned out.
- During development of framework structure, training should be done continuously for first two years.
- The maximum height of grown tree should not exceed 2.5 m and canopy should be developed in round dome shape.

Pruning

The best time for pruning the bearing trees is immediately after the harvest of the fruits. For getting better yield of high quality fruit, pruning of such branches is necessary to open up the tree for proper ventilation and provide more chances for inner wood to bear fruit. Removal of dead and dried wood is necessary to check the further spread of diseases.

- Hard pruning of thick shoots should be discouraged.
- Removal of water sprouts and water shoots should be continuous except in May-July.
- Pruning of dried, intermingled and diseased branches should be done during winter months.
- Apply Bordeaux Paste to the cut ends having diameter more than 10 mm or spray.
- Copper oxychloride 3g/L. to the plants after pruning.

Operations to be done during pre-pruning & pruning

- Sterilize the secateurs or pruning tool with sodium hypochlorite (2 to 3 ml/l) while pruning.
- Remove weeds and suckers.
- Collect and burn fallen leaves/debris from the orchard.

Orchard Management

Mulching

The bed should be covered with mulching (plastic or organic mulching) to check the weed population, conserve the soil moisture and regulate soil temperature. Preferably organic mulching having 15-20 cm thick layer of uprooted weeds and dry grass from the field is considered economic and better for production and quality of the produce. Apply mulch to cover the root zone in accordance to the spacing of plantation around the tree; Keep mulch 30 cm away from the trunk. Mulching should be done in the month of February, which helps in conserving moisture and reducing weed growth. In case of plastic mulch bed should be covered from one corner to another corner completely.

Intercropping

During the initial two years, the intercropping of different annual crops can be undertaken as secondary crop as mentioned in the table below to get additional income. Inter- cropping should be avoided during rainy season

Sr.No.	Name of Crop	Inter Crops	Not be grown as Intercrops
1.	Vegetable	Cabbage, Cauliflower, Pea, Broccoli, Radish	Potato, Tomato, Brinjal, Okra, Cucumber, Pumpkin, Bottleguard, Bittergourd, Parval, Colocasia, Chilli, Capsicum
2.	Spices	Turmeric, Ginger, Onion, Garlic, Coriander, Fennel, Fenugreek	
3.	Legumes	Lentil, Chickpea, Horse Gram (Kulth)	Beans, Soybean, Blackgram (Urd), Greengram (Moong), Kidneybean (Rajmash)
4.	Leafy Vegetable	Mustard, Spinach (Palak), Chinopodium, Coriander, Fennel, Fenugreek	
5.	Fodder crops	Barley, Oat	Barseem, Jawar, Bajara
6.	Cereals Crops/Oilseeds	Wheat, Barley, Linseed, Mustard	Maize, Sugarcane, Ragi
7.	Flowers	Marigold, Gladiolus	
8.	Fruit Crops	Strawberry,	

Integrated management of fruit drop in Orange

- Prune citrus trees to remove diseased and dead twigs during January to February after the fruit harvest and spray Bordeaux Mixture or Copper oxychloride (3g/litre of water).
- Repeat spray in March, July and September to reduce die-back of twigs.
- Collect and burn all the pruned wood.
- Spray GA3 (10 mg/litre of water) in mid April, August and September.
- Collect and destroy the mummified fruits on the trees as well as the fallen fruits by deep burying.
- Avoid flood irrigation in orchards, as it increases the attack and spread of Phytophthora disease.

Quality Improvement

To improve fruit size and increase yield in orange, three foliar sprays of 1.0% potassium nitrate (13:0:45) 10g/litre at the end of June, July and August should be done.



Irrigation Management

Irrigation is one of the most important factors in producing a good quality yield of citrus. Citrus requires uniform and optimum moisture regime in rhizosphere. The annual water requirement varies from 900 to 1100 mm per year depending upon the location.

Irrigation Scheduling

Quantity of water and frequency of irrigation depends on the soil texture and growth stage. Micro irrigation systems ensure good retention of fruits during crucial stages of crop growth and cropping. The drip line should be laid out at the time of planting of orchard with two drip lines having two inline drippers at 50 cm apart in plant basin with 4.5 lph discharge. There should be a control unit/valve for each land holdings.

Amount of water to be applied to sweet orange through drip irrigation

Months	Irrigation (litres per tree biweekly*)				
	1st year	2nd year	3rd year	4th year	5th year onwards
Jan.	0.75	2.0	4.0	7.0	9.0
Feb.	1.0	4.0	6.0	15.0	16.5
Mar.	1.3	5.0	12.0	15.0	16.5
Apr .	1.5	6.5	14.0	25.0	28.0
May	2.0	7.0	16.0	28.0	30.0
June	3.5	8.0	18.0	30.0	34.0
July **	1.2	4.5	10.0	19.0	22.0
Aug. **	1.2	4.5	10.0	19.0	22.0
Sept.**	0.75	2.5	5.0	8.0	12.0
Oct.	0.75	2.5	5.0	6.0	8.0
Nov.	0.75	2.5	5.0	6.0	8.0
Dec.	0.75	2.5	5.0	6.0	8.0

*Approx. Amount of irrigation water may vary by 10-15 percent depending upon soil, climate and prevailing weather conditions.

**During Rainy season from July to Sept sufficient rainfall occurs in the subtropics of the state. Therefore, under such situations there is no need of irrigating the crops except during failure of the monsoon. Irrigation should be stopped/restricted one month before harvesting.

Nutrient Management

Manure

Well rotten farmyard manure should be applied along with 50% P through single super phosphate (SSP) in the basin by band placement during winter months during January- mid February.

Age of Plant (year)	1 st	2 nd	3 rd	4 th	5 th year onwards
FYM (kg plant-1)	10	15	20	25	30

Nutrient recommendation

The amount of nutrients to be applied through fertilizers in high density orchard of citrus depends on the age of tree, condition of plant and type of soil. The nutrient dose (g/ tree) should be divided equally among the number of splits and applied at weekly intervals. For proper growth and higher yield, following nutrient doses should be applied:

Age of theTree (year)	Nutrient (g tree-1)		
	N	P	K
1	80	40	80
2	160	80	160
3	240	120	240
4 year onwards	320	160	320

Percent nutrient supplied through fertigation (minimum number of fertigation dose for all stages are four)

Stage - I (Jan –Feb.)			Stage - II (Mar-April)			Stage - III (May- June)			Stage – IV (July – Aug.)			Stage V (Sept – Oct.)			Stage VI (Nov - Dec)		
N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
0	0	0	30	40	10	30	35	10	20	25	30	10	0	25	10	0	25

Cropping

The inadequate fertilization is one of the reasons of citrus decline. Nutrition has become very costly input for fruit crops. Judicious use of manures and fertilizers helps to maintain productivity of citrus orchards. Right choice of fertilizers in an appropriate doses in split applications at critical growth stages of the crop results into maximum advantage.

- Soil application of chelated micronutrients 20g borax, 20g copper sulphate, 20g manganese sulphate, 20g iron sulphate, 20g zinc sulphate and 40g magnesium sulphate per tree per year in the month of January-February along with FYM application should be given.
- For better fruit set and cropping, micronutrients should be applied as foliar spray of 0.2% solution of the needed nutrient (fruit set and pea stage).

Harvesting

Maturity indices

Sweet orange fruits should be harvested when they have attained adequate size and 12:1 (TSS : Acid ratio) in juice. The best time for picking different cultivars varies from end of October to 1st week of February.

Harvesting

Harvesting season within the state also varies with locality and the cultivars. Harvesting is done with a clipper retaining a non-protruding short fruit stalk on the branch. Harvesting during early hours of the day when there is dew on fruits and harvesting immediately after rains should be avoided.

The harvesting should be done at a stage considering the growing area and the duration of transport, so that light green colour should not exceed one fifth of the total surface area of the fruit.

Grading

For local markets, the citrus fruits are graded as per the size into small, medium and large grades. The difference between categories will depend on the size of fruit.

Packaging

Citrus fruits are packed in stacks, bags, bamboo baskets and wooden boxes for sending to local markets. Corrugated trays are equally effective as packaging material while transporting the fruits.

Storage

After the fruits are harvested treatment of fruits with Bavistin 100 ppm reduces post harvest losses and extends the shelf life to 25-30 days even at room temperature.

The ideal storage temperature for sweet orange is 6-8°C at 85-90% relative humidity.

Yield

The sweet orange tree starts bearing fruits at 3rd year onwards after planting with 8-10 kg yield per plant. The plants can bear 20-25 kg fruit in 4th year which will stabilize in 5-6th year onwards at 50-55 kg per plant yield under good management practices.

Diseases

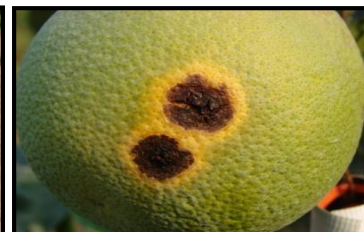
Important diseases prevalent in sub tropical zone of Himachal Pradesh affecting citrus are listed below:

Anthracnose

Causal organism: *Colletotrichum gloeosporoides*

Symptoms

- The disease leads to defoliation and tip drying of twigs, it is called whither tip.
- Symptoms appear on leaves as black sunken spots which causes shedding of leaves and dieback of twigs leading to defoliation which ultimately leads to drying of tips.
- On the dead twigs acervuli appear as black dots.
- On fruits, light green spots appear which turn brown after some time.
- Pathogen also infects, stem-end of immature fruits which leads to fruit drop.
- Die back type symptom is observed in severe cases.
- Black spots appearing on skin of the affected fruits gradually become sunken and coalesce showing typical anthracnose symptoms on the ripening fruits.



Disease cycle and Epidemiology

- Primary source of inoculum in the spread of the diseases is in the form of mycelia in infected leaves, dried twigs and fallen debris. The pathogen can survive saprophytically for a long duration in dead tree parts. Conidia produced in acervulus serve as secondary source in the spread of the disease.
- Prolonged period of rainfall during flowering helps in severe outbreak of the disease.
- The temperature range of 30-32 °C, free water or relative humidity 80-95% is conducive for infection.

Disease Management

Cultural Methods

- Affected leaves should be collected and burnt.
- Infected branches should be pruned and Bordeaux paste applied on cut ends.
- Avoid N application in excess.
- Summer irrigation is effective.

Chemical Methods

- Spray 1% Bordeaux mixture (10g each of copper sulphate and lime / litre of water) or mancozeb (2.5 g / liter) twice at the interval of 15 days on leaves.
- Spraying of carbendazim (1ml/liter) at 15 days interval four times before harvest.

Citrus Canker

Causal organism: *Xanthomonas campestris* pv. *citri*

Symptoms

- Initially small, round, watery translucent raised spots appear on leaves which later become yellowish brown.
- Symptoms appear on the lower leaf surface first and then on both the surfaces.
- With the disease progress, the surface of the spot becomes white or greyish and finally ruptures in the centre giving a rough, corky or crater like appearance.
- Yellowish brown to green raised margin and watery yellow halo surround the rough lesions.
- On petiole and midrib, spots cause premature defoliation.



- On fruits, symptoms same as that of leaves occur but yellow halo is not visible and the crater like depression in the centre is more prominent.
- There is only skin-deep injury and no effect on juice or pulp is noticed.
- Symptoms are same as leaves on stem, except that no yellow halo, bark eruption takes place, from cracks bacterial ooze is seen during warm rainy season.

Disease cycle and Epidemiology

- Temperature range of 20-35°C, high relative humidity and moisture on the host surface favour the disease development.
- Twigs bearing old lesions on the standing trees are the main source of perennation of the pathogen.
- Bacterial cells spread through irrigation water, agricultural operations, pruning shears etc.
- The bacterium enters the host by means of stomata or wounds. Canker pustules harbour and exude bacteria in the form of gummy substance. Dispersal is through wind and by rains. Citrus leaf-miner has a role in dissemination and infection of the disease.

Disease Management

Quarantine: If area is disease free, restrict the entry of planting material from infected to healthy area.

Cultural Methods

- Destroy the affected leaves, stem and fruits by burning
- Pruned portion of stem should be pasted with Bordeaux mixture

Chemical Methods

- Alternate spray of COC (3g/litre) + streptocyclin (1g/10litre) and neem seed kernel extract (50g/litre) starting from second fortnight of June up to second fortnight of October at 30 days' interval.

Citrus Gummosis / Root and Collar Rot

Causal organism: *Phytophthora citrophthora*, *P. parasitica*, *P. palmivora*

Symptoms

- Yellowing of leaves, followed by cracking of bark and profuse gumming occur on the surface.
- Rotting of the bark and drying of tree leads to girdling effect.
- There is heavy blossom prior to death, but fruits die prematurely.
- Foot rot or collar-rot occurs.

Disease cycle and Epidemiology

- Temperature range of 18-22°C and relative humidity of 90-95%, high soil moisture and pH 6-7 are conducive for development of the disease.
- Primary source of inoculums is in the form of dormant mycelia and oospore present in infected debris and infested soil.



- Disease is further spread by zoospore produced in sporangia borne on sporangiophores asexually and spread through soil, irrigation water.
- Sexual reproduction takes place by gametangial contact as antheridia and oogonia are formed in the mycelium and results in the production of oospores to continue the disease cycle in the next season.

Disease Management

Cultural Methods

- Provide good drainage, as it creates adverse conditions for the pathogen thus reducing the asexual reproduction and secondary inoculum
- Uproot severely infected plants and replant with tolerant varieties.
- Avoid low lying areas for citrus.
- Avoid excess N application, apply recommended K Application

Biological Methods

- Application of Trichoderma (100 g per plant) or Trichoderma harzianum + Trichoderma viride + Pseudomonas fluorescens (100 g tree⁻¹) is effective

Chemical Methods

- Chemical soil drenching and foliar spray of Bordeaux mixture (10g copper sulphate + 10 g lime per litre of water) or Copper oxychloride (3g/litre), Ridomil MZ 72 @ 0.25 % (2.5g/ litre of water) is effective in controlling the disease.
- Applying Bordeaux paste on trunk pre- and post monsoon

Sooty Mould

Pathogen: *Capnodium citris*

Symptoms

- The pathogen produces superficial and dark mycelium. They grow on sugary substances i.e. honeydew secreted by plant hoppers. Black encrustation covers the leaves which affect the photosynthetic activity.
- On the leaf surface, disease appears as black velvety growth.
- The leaf surface or portion of the leaf may be covered with fungal growth and in severe cases the whole plants are affected.
- The thin layer formed on the leaf surface can be rubbed off easily.
- Under the dry conditions this may be blown off as small fragments by the wind.
- The disease causing fungi in true sense are non-pathogenic, however, photosynthetic activity of the plant is impaired due to covering of the leaves.



Disease cycle and Epidemiology

- The disease causing fungi are non pathogenic. Insects secreting honeydew favour development of fungus.

Disease Management

- Management should be done for both insects and sooty moulds simultaneously. Controlling of insect by spraying systemic insecticides
- Spraying starch solution (1kg Starch or Maida in 5 litres of water, boil and dilute to 20 litres) is effective. Starch dries and forms flake which are removed along with the fungus.

Citrus Tristeza

Causal organism: *Citrus tristeza Virus*

Symptoms

Citrus tristeza virus (CTV) causes different symptoms on citrus plants depending on the virus strain, the variety of citrus, and the scion-rootstock combination.

- Quick Decline (QD) or Tristeza is the most notorious symptom and is associated with the name Tristeza. When a sweet orange variety used as a scion grafted onto sour orange rootstock and infected with a quick decline strain of CTV, infection occurs.
- Virus affects the cambium layer right below the bud union and prevents the normal development of cambium.
- Severe strains of CTV cause symptoms such as stem pitting (SP) and seedling yellows (SY).
- Pits in the wood can be observed ranging from short and narrow to elongated and deep when the bark is peeled away; sometimes gum is associated with the pits.
- Trunks may be so severely impacted that they have a ropey appearance.
- Severely affected trees are chlorotic, stunted, and generally have a low yield of poor quality fruit.
- Seedling yellows (SY) is typically not seen in field situations with the exception of top working of SY-infected trees with grapefruit or lemon budwood.
- It affects primarily young seedlings.



Disease cycle and Epidemiology

- 20°C - 25°C is the optimum temperatures for virus infection and multiplication.
- The infected plants and cuscutea vines are primary source of infection and from where the virus gets transmitted through aphid vectors
- CTV is transmitted by aphid species, out of which citrus brown aphid, *Toxoptera citricida* is the most effective vector.

Disease Management

- Use the seedlings obtained from seeds.
- Use a rough lemon root stock and other scion, protecting plants from phloem necrosis.
- As the disease severity increases cut and burn the affected parts.
- Phased manner replanting with resistant plants.
- Hot water treatment of rootstocks at 45°C for 10-25 min is effective.
- Removal of *Cuscuta* and spraying of systemic insecticide controls the aphid vector population.
- Apply recommended dose of N P K and FYM.

Greening in Sweet Orange

Causal organism: *Candidatus liberobacter* spp. (*L.asiaticus*, *L.africanus*, *L.americanus*)

Symptoms

- Citrus greening is characterized by yellows type of symptoms which are highly variable.
- Leaf chlorosis is the main symptom which resembles the zinc deficiency.
- In the yellow tissues of the leaf lamina, scattered green islands are seen.
- Leaf veins are also yellow.
- A characteristic feature of greening is that the yellow areas are surrounded on one side by the mid rib and on the other side by lateral veins. The yellow expands towards the margins.
- The size of leaves is also reduced.
- The leaves are thicker than normal and usually remain erect.
- Internodes of the branches are shortened giving a bushy appearance to the branch (Witches broom).
- Such branches produce excess of buds and later show die back.
- Poor crop of predominantly green and worthless fruits in seen and only a portion of tree is affected.
- The affected trees produce small, irregularly shaped fruit with a thick, pale peel that remains green at the bottom. Such fruits taste bitter.



Disease cycle and Epidemiology

- The Asian form (*L.asiaticus*) is heat tolerant and thus can produce greening symptoms even upto a temperature of 35°C.
- The African forms (*L. africanus*) are heat sensitive and in this case the symptoms can develop only upto a temperature of 20-25°C.
- The bacteria are transmitted by psyllid vectors and also by graft transmission.
- *Trioza erytreae* (African) and *Diaphorina citri* (Asian) are the two psyllids responsible for bacterial transmission.

Disease Management

- Chlorosis can be caused by nutritional disorders, many workers have claimed the control of greening with micronutrient spray which only temporarily masks the symptoms of greening.
- Use disease free planting materials.
- Destroy the infected plantations.
- Spray the crops with insecticides regularly to reduce the vector population.

Insect Pest Management

There are number of insect-pests infesting citrus. Important insect-pests prevalent in sub tropical zone of Himachal Pradesh are listed below:

Citrus Butterfly *Papilio demoleus*, *Papilio polytes*, *Papilio helenus* *Papilionidae: Lepidoptera*

Host

It infests almost all citrus varieties though Malta (*Citrus sinensis*) is its preferred host. It can feed and breed on all varieties of cultivated or wild citrus and various other species of family Rutaceae. Besides citrus, it also attacks ber, wood apple, curry leaf.

- *P. demoleus* is a big beautiful butterfly with yellow and black markings on all the four wings, having wing expanse of about 50-60 mm. Its hind wings have a brick red oval patch near the anal margin and there is no tail like extension behind though common in *Papilionidae*.
- *P. polytes* males are black and females vary in form.
- *P. helenus* has black wings with three white distal spots.

Symptoms and Damage

Leaves fed up to midribs.

Life Cyle

- Yellowish white, round, smooth eggs are laid singly on tender leaves and shoots by *P. demoleus*.
- Egg hatches in about 3 – 8 days.



Citrus butterfly



Citrus butterfly infestation



Leaves fed up to midribs



Pupa

Larvae

Adult

- Freshly hatched caterpillars are dark brown and soon develop irregular white markings on their body resembling bird's drop.
- The caterpillars feed voraciously on tender leaves right up to the mid ribs and defoliate the entire seedlings or the tree leaving behind only the midribs.
- The full grown caterpillar is deep green and cylindrical in form and measures about 40- 50 mm in length with a hump in front and has a horn like structure on the dorsal side of the last body segment. When the caterpillar is disturbed, it pushes out from the top of its prothorax a bifid, purple structure called osmeterium which emits a distinct smell.
- Larval duration varies between 11 – 40 days.
- Pupation takes place on plant parts. Pupa which is a chrysalis is seen girdled by a fine silken thread on a twig of the plant. Adult emerges in a week in summer and in 12 – 20 weeks in winter.
- Hibernation is in pupal stage and there are 2-4 overlapping generations per year.

Management

- In small orchards and nurseries with mild infestation, hand picking and destruction of various stages of the pest.
- Natural enemies enumerated below suppress the pest population Egg parasitoids: *Trichogramma evanescens*; *Telenomus* sp. Larval parasitoid: *Distatrix papilionis*; *Brachymeria* sp.
- Pupal parasitoid: *Pterolus* sp.
- Spraying of chlorantraniliprole (0.3ml/l) or cypermethrin (1ml/l) or flubendiamide (0.5ml/l) Spinosad (0.2ml/l)
- When the caterpillars are small. B. t. formulation HALT (9 g/l) is also recommended.

Citrus leaf miner *Phyllocnistis citrella* **Gracillariidae: Lepidoptera**

Host

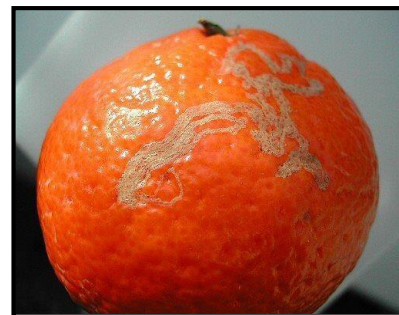
It attacks all species of citrus but prefers sweet oranges. It also infests Ponagamia, jasmine etc.

Symptoms and Damage

- Characteristic silvery white zigzag galleries below the epidermis of tender leaves.
- Serious infestation causes retardation in growth. The infestation predisposes leaves to canker growth.

Life Cycle

- The pest is active all-round the year, except during severe winter (December – February). Maximum damage is caused during May-June and also during August- October, if the temperature is high enough.
- Adult is a silvery white small moth with brown striped forewings having a prominent black spot near the tip and white hindwings.
- Both pairs of wings are fringed with hairs.
- The adult moth measures 6 mm in wing span.
- Minute, flat and greenish yellow eggs are laid singly on tender leaves and young shoots. Egg period is 2-10 days.
- The tiny red, apodous larva mines in between the epidermal layers of the leaf in a zigzag manner and feeds on chlorophyll which results in distortion of the leaf lamina.
- The tunnel appears silvery white. New and tender leaves are preferred.
- Sometimes, the larva mines the outer layer of young green twigs.



Infestation predisposes the leaves to canker growth



Adult Moth



Zigzag galleries below the epidermis of tender leaves



- The full grown caterpillar is slender, yellowish green with brownish mandibles.
- It is found inside the gallery formed in leaf tissue. Larval period is 15-30 days.
- Pupation takes place inside the leaf mine. Pupal period is 5-25 days.
- Total life cycle takes on an average 20-60 days depending on the climate.
- There are 9-13 overlapping generations in a year.

Management

- Pruning of affected parts during winter and burning.
- Spraying of Neem cake solution 3ml/l or neem oil 2ml/l or imidacloprid (0.5ml/l) or cyantraniliprole (0.3ml/l) or chlorantraniliprole (0.25ml/l) twice at 10 days interval at every new flush time i.e. during June – July, Sep – Oct, Dec – Jan.

Citrus psylla *Diaphorina citri* Psyllidae: Hemiptera

Host

Citrus

Symptoms and Damage

- The damage is caused by the nymphs who crowd on the terminal shoots and buds and suck up the juice which results in Curling and cupping of leaves.
- Defoliation and death of young shoot in severe infestation and
- Fruits turning undersized and juice content reduced.

Life Cycle

- The pest is active from February to November and has 16 generations per year.
- Adults are reddish with jumping legs. Eggs are laid in tender shoots and anchored in the tissues by means of short stalks
- and the egg period is 8-35 days depending on the season.
- A single female lays 180 to 860 eggs.
- There are five nymphal instars and the nymphal period is 9-38 days.
- Adult life span is 135 days for males and 145 days for females.

Management

- Spraying of methyl demeton (1ml/l) or imidacloprid (0.25ml/l) at seedling stage on fresh foliage twice at 10 days interval.
- Spraying of Neem cake solution (3ml/l) or neem oil (2ml/l) or imidacloprid (0.25ml/l) or cyantraniliprole (0.3ml/l) or chlorantraniliprole (0.25ml/l)



Citrus whitefly *Dialeurodes citri* **Aleyrodidae : Hemitera**

Host

Persimmon and Darek

Symptoms and Damage

- Damage is caused by both the nymphs and adults.
- It sucks the sap from leaves, which curl and fall off.
- Nymphs excrete honeydew, which promotes the growth of sooty mould.

Life Cycle

- Adults lay eggs singly on the underside of soft young leaves during February.
- The eggs are stalked, oval and yellow.
- A single female during its life span of 7 to 10 days lay more than 200 eggs.
- The young larvae on emergence, crawls about for a few hours and then inserts its proboscis into the succulent portion of a twig.



Sooty mould



Adult causing damage



Leaf Infestation



Eggs



Nymph



Pseudo Pupae



**Aleurotolius Marlatti
(Quaintance)**



Dialeurodes Sp.

Management

- Removal and destruction of affected shoots.
- Spray imidacloprid (0.5ml/l) or acetamiprit (0.5ml/l) or cyantraniliprole (0.3ml/l) or chlorantraniliprole (0.3ml/l) during February, March, May-June and July-August.

Citrus bark eating caterpillar *Indarbela tetraonis*, *Indarbela quadrinotata* Metabelidae: Lepidoptera

Host

Mango, Guava, Litchi, Orange, Pomegranate, Loquat, Mulberry, Moringa, Rose and Eugenia.

Symptoms and Damage

- Young trees succumb to the attack. Caterpillars bore into the trunk or junction of branches make zig zag galleries.
- Presence of gallery made out of silk and frass is the key symptom.
- They remain hidden in the tunnel during day time, come out at night and feed on the bark.
- Under severe infestation, flow of sap is hindered, plant growth arrested and fruit formation is drastically reduced.

Life Cycle

- Adult emerge in summer and lays 15-25 eggs in clusters under loose bark of the trees.
- Eggs hatch in 8-10 days.



Larvae



Caterpillars bore into the trunk or junction of branches
make zig-zag galleries



Adult Moth

- Larvae make webs and feed making zig-zag galleries on the wood filled with frass and excreta and later bores inside the wood.
- Larval period is 9-11 months and then pupates inside the stem.
- Pupal stage is 3-4 months.

Management

- Kill the caterpillars by inserting an iron spike into the tunnels.
- Injecting ethylene glycol and kerosene oil in the ratio of 1:3 into the tunnel by means of a syringe and then the opening of the tunnel with mud.
- Dip a small piece of cotton in any of the fumigants, like chloroform or petrol or kerosene. Introduce into the tunnel and seal the opening with clay or mud.
- Spray cypermethrin (4ml/l) or imidacloprid (0.2ml/l) or cyantraniliprole (0.4ml/l) or chlorantraniliprole (0.4 ml/l) or spinosad (0.8ml/l)

Citrus fruit fly *Bactrocera dorsalis* **Tephritidae : Diptera**



Infestation on fruit fly maggots on ripe fruits



Brectocera Zonata



Brectocera Dorsalis



Brectocera Correcta



Fruit Infestation

Life Cyle

- Adult punctures the ripening fruits
- Infested fruits get rotten due to bacterial/fungal attack

Management

- Collection and destruction of infested fruits
- Light ploughing during winter/summer
- Use of traps (methyleugenol) @10/acre
- Spray spinosad (0.25ml/l+200 g gur/l) or indoxacarb (0.25ml/l) at 15 days interval

Physiological Disorder

Granulation

Sometimes, the juice sac of citrus fruit becomes harder with greyish colour and some enlargement. This causes decrease in juice content, TSS and acidity of fruit. Factors responsible for granulation include high relative humidity, high temperature during spring and delay in time of picking.

Management

- Harvest fruit at proper maturity.
- Continuous moisture regime and suggested nutrient scheduling should be followed.
- The application of fertilizer should be done according to the fertilizer schedule as the high concentration of calcium, manganese and low concentration of phosphorus and boron in plant tissues is responsible for granulation disorder.
- Granulation could be reduced to 50% by applying 2-3 sprays of NAA (300 ppm – 3.0 g in 10 liter of water) in month of August-September and October.

Post-Harvest Management

Citrus fruit can be stored for up to 6-8 weeks under optimum storage (0-80 C temperature and 85-95% RH) which depends upon cultivar, pre-harvest conditions and post- harvest handling. Regular inspection of fruit for checking any type of decay/disorder should be ensured.



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