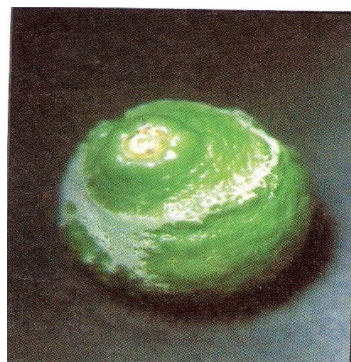
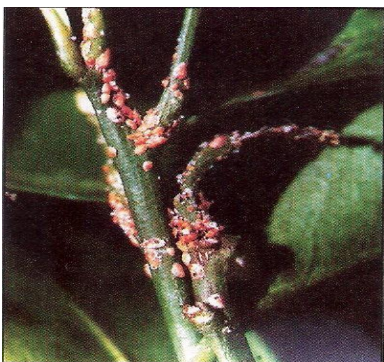
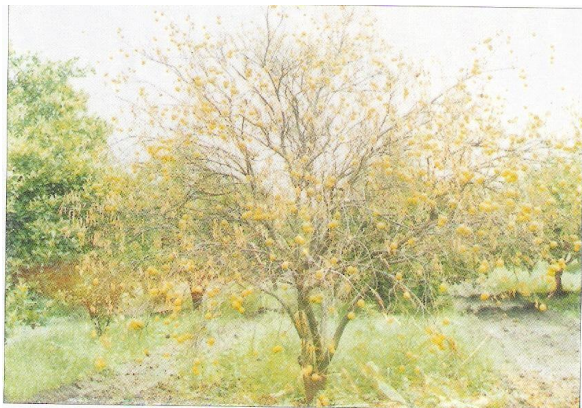




IPM SCHEDULE FOR CITRUS PESTS



Horticulture Year, 2012

National Horticulture Mission

Ministry of Agriculture

Department of Agriculture & Cooperation

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IPM SCHEDULE FOR CITRUS PESTS

Citrus is the most important fruit crop of Central India. It suffers heavily on account of the serious damage caused by insect pests. About a dozen of them attack this crop regularly right from nursery stage to the harvest with cognizable damage. But only a few are quiet serious of which effective control at appropriate time is must to ensure the quantity and quality of the produce.

DISEASES

VIRUS AND VIRUS-LIKE DISEASES

1. Tristeza (CTV): It is caused by a phloem limited, 2000 nm long filamentous virus.

Symptoms: Tristeza virus can cause diverse field symptoms based on citrus cultivars, environmental conditions and virus strain involved. Five different strains of tristeza are known to exist viz. mild, seedling yellows, decline on sour orange, stem pitting on grapefruit and stem pitting on sweet orange. Sudden collapse or abrupt wilting that justifies the name 'quick decline' followed by defoliation in sweet orange, grape fruit and mandarin, on sour orange rootstocks are indicative of tristeza infection.(Fig 1).

CTV is more damaging to sweet orange than other cultivars. Leaves lose their dark green lusture, become dull and later they develop chlorosis along midrib and lateral veins (Fig. 2). Soon after discolouration, the leaves begin to fall until many of the twigs are defoliated and the limb of the tree becomes exposed and gradually begin to show die-back symptom (Fig. 3). Certain CTV isolate develops vein corking symptom (Fig 4). Abnormally heavy crops of prematurely coloured fruits are sometimes the first visible indication of disease. Typical symptom on kagzi lime develops vein flecking of leaves, leaf cupping and stem pitting (Fig.5 & Fig 6). In general, mandarins are tolerant but some strain of CTV can cause even stem pitting to Coorg mandarin, upright branches with leaf yellowing, falling of leaves, twig decline and sickly appearance on Nagpur mandarin. Strains of tristeza also induce stem pitting on trunk and branches of grape fruit, pummelo, tangelo and sweet orange.

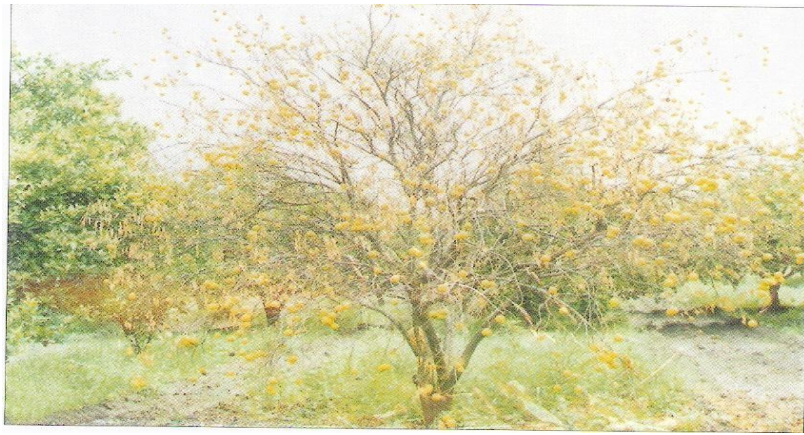


Fig. 1. CTV induced quick decline of sweet orange



**Fig. 2 . CTV induced mosambi leaves showing chlorosis of mid veins
and lateral veins and leaf yellowing**

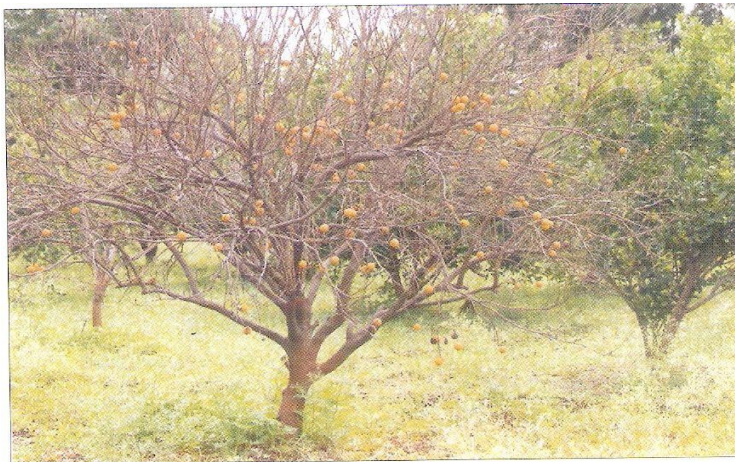


Fig. 3. CTV induced declined mosambi plant



Fig. 4. Vein corking in mosambi

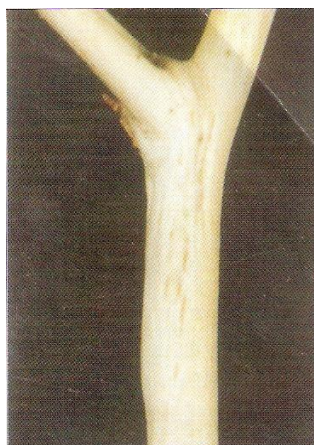
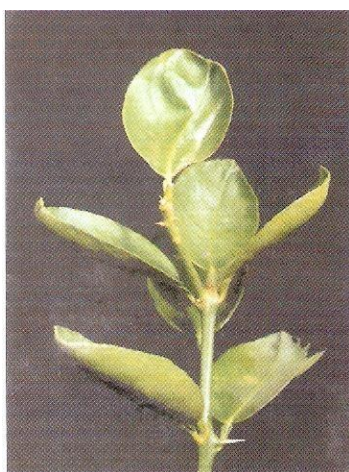


Fig 5. Leaf cupping in acidlime Fig. 6 Stem pitting

Fig. 7 Black and brown

Aphid-vector of CTV

Host range: CTV infected nearly all species, cultivars, and intergeneric hybrids of citrus and some citrus relatives. The only known *nonrutaceous* host is *Passiflora*.

Transmission: Tristeza can be transmitted by grafting, budding, dodder and by aphid vectors. *Toxoptera citricidus*, *T. aurantii*, *Myzus persicae* and *Aphis craccivora* are the common aphid vectors and the most efficient among these is *T. citricidus*(Fig 7).

Detection/ Identification:

- Mexican lime or kagzi lime is the best indicator plant for CTV detection that develops vein clearing, vein darkening, leaf cupping, stem pitting or vein corking symptom.
- For detection of stem pitting strain of CTV seedlings of grapefruit and Madame Vinous or Pera sweet orange to be used.
- For detection of seedling yellow strain of CTV seedlings of grapefruit or sour orange should be used that develops small yellow leaves, compact and stunted growth.
- All shoots to be allowed to develop fast for the first three growth flushes, then prune and train as a single shoot. Eight to ten months old plants become ready for graft inoculation of test samples.
- Minimum of 3-5 indicator plants are needed for a single test.
- Temperature requirement: 24-27 C maximum days /18-21⁰ C min. night.

2. Ring Spot (CRSV)

The incidence of ring spot disease was observed upto 100% in most of the kinnow mandarin orchards of North India. The field symptoms appear on mature leaves that include loss of pigmentation in the form of distinct rings of diameter ranging from 2.1 to 24.2 mm with green tissue in the middle. The number varies from one to several per leaf. These symptoms are prominent on Kinnow mandarin, Malta orange and Kagzi lime (Fig. 8 & Fig. 9 &10). The leaf lamina of infected plants exhibits epinasty, chlorotic flecks and leaf mottling. Latter on the infected leaves drop prematurely. Severely affected

plants show dieback and decline symptom. Blisters on twigs and leaves are also associated with the disease. In Kinnow mandarin, the quality of fruits is adversely affected due to reduction in fruit size, juice, total soluble solids and vitamin C contents.



Fig. 8. Ring spot on kinnow

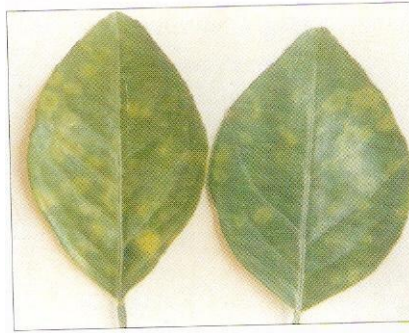


Fig. 9. Malta orange



Fig. 10. Kagzilime

Transmission: Except bud transmission no other mode of natural spread of the disease could be established so far. There is report of pollen transmission of the virus

Detection/ Identification

- Mechanical transmission to *Chenopodium quinoa* which develops well distributed chlorotic lesions within 4 to 8 days.
- Sweet orange and grapefruits when used as indicator plants show shock and young leaf pattern within 4-6 weeks after graft inoculation with positive samples.
- Cool screen house temperature viz., 24-27⁰C max. day/ 18-21⁰C min. night is needed for symptom expression in indicator plant.

3. Mosaic

Yellow mosaic disease of citrus is common especially on sweet orange. The causal virus has been named as citrus yellow mosaic badnavirus group. The incidence of the disease varies from 10-70% in acidlime, Sathgudi and Chinni sweet orange of South India.

Symptoms: Bright yellow mottling or mosaics on the leaves of sweet orange are characteristic symptoms of infection under field conditions (Fig 11 & Fig. 13). Similar type of symptoms was also found in pummelo (Fig. 13). In acid lime, citrus mosaic virus infected leaves show light green irregular areas. Severely infected leaves showed yellow areas with green areas throughout the leaf lamina. Light green and yellow colour variegation areas were seen in some of the fruits. There is moderate reduction in leaf and fruit size.



Fig. 11. Mosaic on
Mosambi



Fig. 12 Yellow mottling
on sathgudi orange



Fig. 13. Mosaic/ golden yellowing

Transmission: Mosaic is transmissible by graft and mechanical inoculation from among citrus species and is also dodder transmissible. Mealy bug (*Planococcus sp.*) is reported to be the possible vector of the virus.

Detection/ Identification: Sweet orange and Rangppur lime are the preferred indicator plants which show varying degree of bright yellow mosaic along with chlorotic spots.

4. Exocortis:

Citrus trees are known to be naturally infected by 5 distinct groups of viroids. Among these, citrus exocortis viroid (CEVd) is economically the most important viroid disease and present in almost all the citrus growing regions.

Symptoms: Field symptoms range from mild bark cracking to very severe bark scaling/splitting on trifoliolate and Rangpur lime rootstock accompanied by various degrees of stunting and mild to moderate decline of the tree (Fig. 14). Twigs and branches of CEVd infected trifoliolate or Rangpur lime may show yellow streak like blotches especially on younger greenish twigs. Rough lemon is comparatively resistant, however, it may also develop mild bark cracking symptom with apparently no decline symptom. Although many of the commercial citrus cultivars are symptom less carriers, trees may be stunted to some degree on rootstocks normally considered tolerant.



Fig. 13 Exocortis induced severe bank splitting on Rangpur lime rootstock

Transmission: Citrus viroids are distributed primarily by the introduction and propagation of infected budwood and subsequently by mechanical transmission through contaminated hedging equipments, tools, knives etc. Neither CEVd nor other citrus viroids are known to be vector transmitted.

5. Witches' broom

It is one of the most recent diseases of acid lime which is seen in isolated pockets and caused by *Candidatus Phytoplasma aurantifolia*. Blastomania/ multiple sprouting is somewhat identical phytoplasma disease and reported to infect *C. aurantifolia*, *C. limonia* and *C. reticulata*.

Symptoms: Symptoms include small chlorotic leaves with highly proliferated shoots, and shortened internodes. Leaves drop prematurely and infected branches show distorted twigs resembling characteristic witches' broom symptoms on the canopy of the infected lime or mandarin tree. (Fig 14) In advance stages, infected plant showed dieback symptom. (Fig. 15) Not all the branches of the affected trees exhibited witches' broom symptoms. Infected twigs did not bear any flowers or fruits.



Fig. 14 Symptom on canopy of acidlime Fig. 15 Dried broom like symptom on mandarin

Transmission: Graft and dodder (*Cuscuta reflexa*) transmitted. Natural transmission takes place probably by leaf hopper vector *Hishimonus phycitis*.

Detection/ Identification:

- Mexican lime indicator plant
- Immunofluorescence, electron microscopy, DAPI staining.

6. Other diseases:

- **Yellow corky vein disease in kagzi lime (CYCV):** It is known to occur in India for a long time but its etiology was not known. The disease is characterized by yellowing of the main vein and formation of corky tissue on the lower surface of the leaf (Fig. 16). The disease is mechanically transmissible and found to have a viroid etiology.
- **Rubbery wood:** It is another phytoplasmal diseases and more common on mandarin. It develops thin and linear shoots with unusual flexibility or elasticity of branches. Plant gets stunted with small chlorotic leaves and affected tree produce no flowers or fruits
- **Woody gall/vein enation:** It causes galls particularly on rough lemon or volkamer lemon.(Fig. 17) However, galls may be induced by insect damage or other causes. Presence of typical enations or protuberance on veins on underside of leaves is diagnostic of the disease.

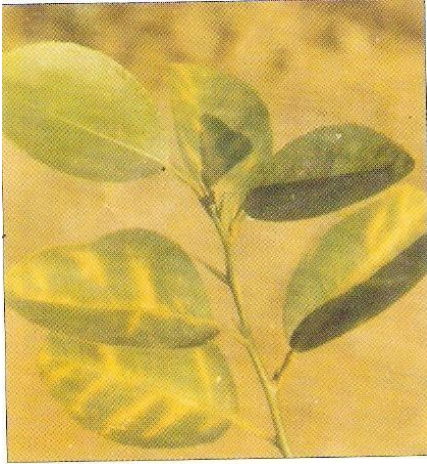


Fig. 16. Ykellow corky vein symptom
on Kagzi lime



Fig. 17. Woody gall on rough lemon
rootstock

on Kagzi lime

Diagnosis

Sensitive and reliable diagnostic methods are essential for developing strategies to avoid pathogens in propagated material. Brief description of different diagnostic techniques is given below.

Guidelines for Biodiagnosis

A. Seed collection and raising seedlings of indicator plants

- Collect sound fruit from healthy looking plants and form branches which is more than 1 m above the ground
- Extract seeds and washed thoroughly with soapy water to free seed from pulp.
- Surfaces sterilize seed with 0.5% sodium hypochlorite with 0.1% wetting agent for 10 minute and then rinsed thoroughly with water.
- Surface dry seed under shaded conditions. The seed may be treated with a 3 min dip in a 1% solution of 8-hydroxyquinoline or after drying with a powdered fungicide such as thiram.
- Germinate the seeds especially in sterile soil mixture.
- Once seed has germinated may be transplanted into sterilized soil mix in an insect free containment facility.
- When the seedling has reached sufficient size it should be used for biodiagnosis.

B. Seedling indexing

- Collecting tools like knives, secateurs etc. to be sterilized by dipping in 1-2% sodium hypochlorite solution.

- Bud wood samples should be collected from a minimum of four quadrants of each tree.
- Remove leaves and thorns, but leave petioles attached, label, pack in a plastic bag and maintain at 25⁰ C or lower, preferably in an ice chest.
- Collected bud wood should be thoroughly washed with a mild detergent and water using a soft brush and then air or towel dried.
- Most commonly indicator seedlings are bud, chip, blind bud or side graft or wedge graft inoculated. Inoculation by two buds is a recommended standard except for detection of greening and stubborn where multiple side grafts or leaf grafts are preferred. Adequate positive and negative controls must be included for each test.
- Post inoculation care of plants is very important eg. for CTV detection, the developing young side shoots on Mexican lime seedlings should not be trimmed for first three flushes of growth in order to obtain the maximum number of leaves to examine for vein clearing. However, after third growth flush, the side shoot should be trimmed and most vigorous terminal shoots tied to a stake and trained to grow as a single shoot for later examination of stem pitting.
- Cool screen house temperature is highly essential for symptom expression for pathogen like CTV, ringspot, greening, mosaic etc whereas higher screen house temperature is essential for symptom expression of viroids, phytoplasma on respective indicator plants.

Integrated Management of Viral Diseases

The virus disease of crop plants, particularly of perennial horticultural plants, can be best managed through an integrated approach of using virus-free planting material, use of host resistance, sanitation, cultural practices, vector control and regulatory measures.

a) Use of virus-free certified planting material/Bud wood certification: For vegetative propagated crops, like citrus, use of virus-free planting material is imperative. It requires careful testing as the bud wood collected even from apparently healthy looking plants may not be virus free due to latent infection. This can be best achieved by a strong healthy bud wood certification programme armed with sensitive diagnostic techniques. *In vitro* 'shoot-tip grafting' is also very useful in producing virus-free plants, but these also need to be certified.

b) Sanitation: Use of virus-free plants will not be of much use unless the orchards using virus-free plants are also free from other sources of infection like the old diseased plants and collateral hosts since the infected plant may act as foci for secondary virus spread. The most obvious alternative host of citrus pathogens is the citrus relatives. But quite unrelated genera can also host citrus pathogens. Lily and pome fruits are host of apple stem grooving virus, which is very similar to citrus tatter leaf virus with respect to particle, biological properties and host range. Viroids which infect citrus also have quite a wide host range outside the Rutaceae. The recent finding of CEVd variants in vegetable crop in a citrus free area suggest viroids may be more widespread than previously assumed. *Murraya koenigii*, *Ruta graveolens*, *Evodia hupelensis* are reported to be symptomless carriers of tristeza, similarly periwinkle is also reported to be an

additional host of greening organism. It is therefore essential to have special programme for eradicating diseased plants and other sources of infection and replanting with certified healthy planting material.

c) Vector control

- Collecting tools like knives, secateurs etc. to be sterilized by dipping in 1-2% sodium hypochlorite solution.
- Different virus/virus like pathogens of citrus are being transmitted by various insect vector. These insect vectors should be controlled by using biological and non biological methods in order to prevent the spread of virus diseases. The non –biological methods include the use of suitable insecticidal sprays, insect traps, reflective mulches etc.
- For controlling aphids, psylla, mealybug and leaf hopper acephate @ 1.5 g/litre or monocrotophos @ 1.5 ml/litre or dimethoate @ 2 ml/litre of water should be sprayed.
- Time of application of these insecticides is also very important. For aphids spraying should be done during January-February. For psylla during March-April and for leaf hopper and mealybug spraying should be done as and when these insects are seen.
- Different biocontrol agents include parasitoids, predators and microbes. Parasitoids are host (insect) specific. The genera *Aphelinus*, *Mesidia* and *Mesidiopsis* of Aphelinidae (superfamily: Chalcidoidea) are of parasitoids of aphids, and *Tamarixia radiata* is an effective parasitoid of citrus psylla.
- Similarly different coccinellids are useful predators of aphids. Entopathogenic fungi like *verticillium lecanii* and *Paecilomyces farinosus* etc are being used commercially against *T. citricidus*, *Aphis gossypii*.

d) Cultural Practices

- Crop hygiene is a neglected area which is a major cause of mechanically transmitted disease like ring spot, mosaic and exocortis through field implements during intercultural operations, harvesting etc.
- All pruning and grafting tools should be adequately disinfected with 1-2% sodium hypochlorite, prior to any fruit picking, grafting or cutting of any tree or nursery plant to avoid spread of mechanically transmitted diseases.

e) Cross Protection

- Cross protection is the phenomenon of development of resistance against severe strain of a virus when a particular plant is previously inoculated with mild strain of the same virus.
- The most extensive use of cross protection has been in the citrus industry.
- Efforts may be taken to identify effective stable mild strain virus that can protect trees under field condition.

f) Quarantine / Regulation

- Quarantine remains the most important means of preventing the introduction of new, exotic and potentially destructive viral pathogens.
- One of the main problems of quarantine is the introduction of diseases for which indexing methods do not exist or can not be taken up due to infrastructural deficiencies.
- Importation of bud wood should be restricted to the bare minimum essential and multiple steps of therapy be undertaken before introduction.
- Strict quarantine measures and restricted movement of citrus bud wood will limit the spread of viral diseases.

BACTERIAL DISEASES

7. Greening

Symptoms: The range and severity of symptoms vary with season, type and extent of infection, age and nutritional status of the trees. Greening infected citrus leaves are generally small, upright and frequently have symptoms with green veins and chlorotic interveinal areas (Fig 18). Diseased leaves also show various types of chlorotic mottling. Leaf mottle is one of the best diagnostic symptoms of greening. In severe cases leaves become almost chlorotic with scattered dark green islands (Fig.19). The internodes become shorter, plants are very stunted and many of them never yield any fruit. Symptoms are often seen on part of the canopy or even only in a branch or a twig. Chronically infected trees are sparsely foliated and show extensive twig die-back and soon decline to an unproductive state. Infected fruits are small and mis-shapen, many fall prematurely, while those that remain on the tree do not colour properly, remaining green on the shaded side and hence the origin of the name "greening".



Fig. 18 Greening symptoms in Nagpur Mandarin

Fig. 19. Leaf chlorosis

Fig. 20. Citrus psylla, vector of greening

Casual Agent: It is now known to be caused by a phloem-limited, uncultured bacterium with a cell wall of the Gram-negative type.

Detection/Transmission: Greening disease is transmitted by infected budwoods and in the orchards through citrus psylla (Fig. 20). Psylla picks the pathogen in nymphal stage and transmits it when adult. Greening can also be spread, especially long distances and internationally by import and its propagation in nurseries.

Identification: Diagnosis of citrus greening is very important for disease management. Correct identification of the disease under field condition is often very difficult because it can be confused with mineral deficiency, root rot or other stress-related leaf symptoms. Also the irregular distribution of the disease within the tree and slow disease development make both visual detection and bioassays difficult. As of today, biological indexing using indicator plants is the most easy and cheapest way to detect greening infection.

Management

- The control of greening disease involves removal of affected unproductive trees and their replacement by disease-free budded plants developed on improved rootstock.
- Through proper indexing programme, greening-free parent trees should be selected for bud wood.
- Regulatory (quarantine) measures should be strengthened to limit movement, sale and use of infected bud wood or nursery stock.
- Strict control of nurseries through registered disease-free certification scheme is essential to prevent the spread of disease.
- Since the disease also spreads through the vector, citrus psylla, suitable insecticides e.g., monocrotophos @ 0.7 ml/litre or quinalphos @ 1.0 ml/litre of water should be sprayed to control its spread.
- Spraying should be done at bud burst stage of when infestation is noticed on sprouts in June-July, January-February and October-November.
- Although tetracyclines have been reported to suppress greening symptoms when applied as trunk injection, complete elimination of the pathogen is not possible by this method.
- In brief, an intensive and integrated management approach is most effective against greening disease. This includes quarantine measures, use of disease-free planting material, and reduction of inoculums by pruning of infected branches, removal of heavily infected trees and control of psylla.

8. Canker- *Xanthomonas campestris* pv. *citri* (Hasse) Dye

Symptoms: Canker lesions start as pinpoint spots and attain a diameter of 2-10 mm. Their eventual size depends mainly on the cultivar and the age of the host tissue at infection. The lesions are initially circular but later may develop irregularly often aggregated at the leaf margin or the leaf tips or in a restricted area of the leaf (Fig. 21). Lesion is become visible on the underside of leaves about 7 days after infection and on the upper surface soon after. The characteristic symptom of the disease on leaves is the yellow halo that surrounds lesion. Young lessons are raised or pustular, particularly on the lower leaf surface. The pustules later became corky and crateriform, with a raised margin and a sunken centre. Lesions on fruit and stems extend 1-3 mm in depth and are superficially similar to those on leaves (Fig. 22 & 23).



Fig. 21. Canker on leaves



Fig. 22. Canker on twig

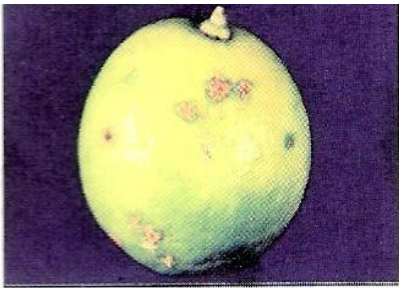


Fig. 23. Canker on fruit



Fig. 24. Canker spread through leaf minor

Management:

- Prevention is the only affective means of reducing the canker disease.
- Avoid leaf injury form wind blown soil.
- Reduce wind speeds by planting of wind breaks.
- Avoid working in infected orchard when the trees are wet from dew or rain.
- Control leaf miner caused injury facilitates infection (Fig. 24).
- Thorough inspection of nursery and orchards quarantines and on-site burning of infected / pruned debris before monsoon.
- Three to four sprays of copper oxychloride (COC) 0.3% in combination with streptocycline 100 ppm at monthly interval just after the onset of monsoon.

FUNGAL DISEASES:

9. Phytophthora Diseases (*P. citrophthora*, *P.nicotianae* (= *P. parasitica*), and *P. palmivora*)

Symptoms: *Phytophthora* causes foot rot, root rot, crown rot, gummosis, leaf fall and brown rot disease in well grown orchards. Foot rot lesions develop as high as 60 cm from the ground level on the trunk and may extend below the soil on crown roots as

crown rot. On scraping the dead bark of the lesion, a brown, discolored, 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 (Fig. 25).

In dry season, the dead bark becomes firm, breaks away from healthy bark, curls and splits (Fig 26). Usually the disease is confined to feeder roots and remains unnoticed by the growers (Fig. 27). Dull chlorotic foliage is the first symptom of such affected plants where mid rib, main lateral veins and bands of leaf tissue bordering them becomes yellow leaving rest of the leaf normal in colour.

In severe cases, where regeneration of feeder root does not cope with the rate of destruction, the affected plant will show starvation, less canopy volume with naked branches, die back and slow decline symptoms.

In continuously wet weather conditions for about 24 hrs or more, *Phytophthora* splashes along with rain drops to low hanging fruits and causes a typical brown rot of fruits and leaf fall (Fig. 28). Foot and root rot cause severe moisture stress in the plants and result either in erratic bearing and yield loss or such plants bear heavily and collapse when fruits are still on the plant.(Fig. 29)



Fig. 25. Gummosis

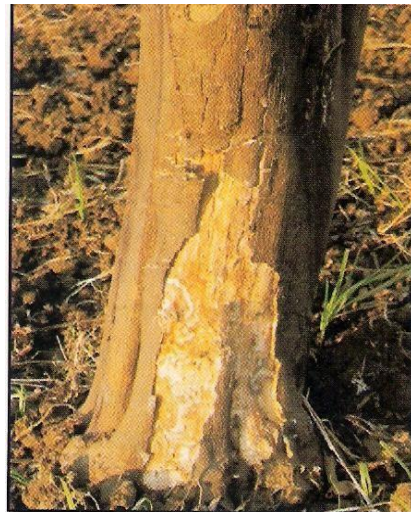


Fig. 26. Foot rot

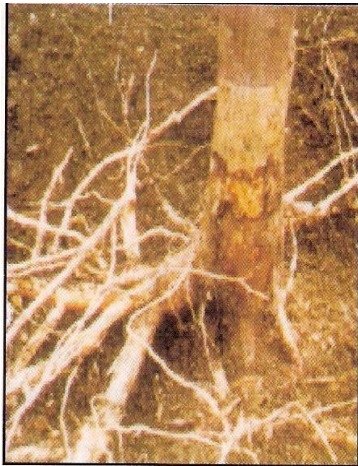


Fig. 27. Root & Collar Rot

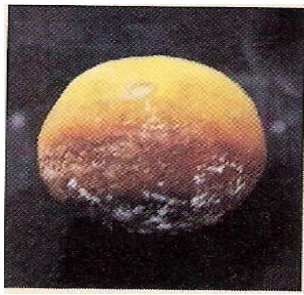


Fig. 28. Brown Rot

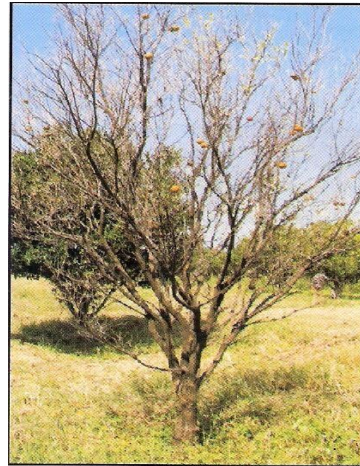


Fig. 29. Decline due to foot
& root rot

Reason for Severity:

- *P. nicotianae* and *P. palmivora* can tolerate temperature up to 35 ° C and thus are most active in summer (28-32° C) for its activity and ceases its activity with the increase of temperature.
- Phytophthora remains active throughout the year in nurseries and in irrigated orchards.
- Heavy and poor drained soil, excessive irrigation, use of susceptible rootstock and prolonged contact of water with tree trunk exacerbate the diseases and buildup of inoculums.

Mode of disease spread

- Use of susceptible root stock,
- Flood irrigation and flat bed system
- Retention of water for longer period in beds,
- Prolonged period of wet weather
- Low budding,
- Repeated use of same land for nursery raising,
- Location of nurseries near old orchards
- Regular contaminating through soil and irrigation water are the predisposing factors for Phytophthora diseases.
- Through wound or injury on hanging foliage or root tips
- Through organic matter having Chlamydo spores or oospores.

Management

(i) **Use of resistant rootstocks:** Rough lemon, though highly vigorous in growth but is susceptible to *Phytophthora*. Much variability exists among the strains of rough lemon and Rangpur lime. Sour orange and Trifoliate orange are highly tolerant. However, sour orange is susceptible to tristeza virus and can be used where tristeza is not a problem.

(ii) Cultural practices: Since the pathogen is soil-borne, its complete eradication becomes difficult in field nurseries but modified cultural practices can keep disease under control as given below:

- Seeds should be treated with fungicides before sowing.
- Seeds should be sown in trays or in raised nursery beds where water can not stand for longer period.
- Nursery site should be away from the citrus orchards and soil must be well drained.
- To avoid contamination, nursery operation equipments should be separate from the orchards equipments.
- Introduction of soil and other material infested with the pathogens should not be allowed.
- Preferably containerized nursery system should be adopted.
- Plant should be selected from *Phytophthora*-free certified nurseries and with high budding (above 9” ht.).
- The nursery soil beds should be either solarized in summer months and / or fumigated with soil fumigant like Dazomet to eliminate the chances of pathogen in it.
- While planting, care should be taken to keep bud union as high as possible so that irrigation water should not touch the scion.
- Soil should be kept well drained and flood irrigation and stagnation of water for longer period in the basin should be avoided.
- Injuries to trunk and root system by farm operation should also be avoided.
- Irrigation emitters should be placed so that the trunk is not wetted for prolonged period.
- In orchards, if old budlines or elite mother plants got infection and a considerable portion of root and collar has been destroyed by *Phytophthora*, inarching or bridge grafting with resistant rootstock can effectively rescue the affected plants. Such infected plants in the orchard can be rejuvenated for longer productive life.

(iii) Chemical control

- Copper fungicides are used as foliar spray, drenching of basins and as trunk paste to control *Phytophthora* diseases. Two sprays with drenching either by Aliette (2.5 g/l) or Ridomil MZ-72 (2.75 g/l) covering the whole plant canopy and basin of affected plant at 40 days interval after the onset of monsoon.
- Copper fungicides are effective in controlling foot and root rot and gummosis of citrus provided they should be used at correct time.
- Bordeaux paste should always be applied before onset of monsoon on tree trunk as prophylactic measure. Foot rot or gummosis affected portions should be scraped out with sharp knife taking care not to damage the wood before application of Bordeaux paste.
- Apply matalaxyl (or its isomer, mefenoxam) and fosetyl-A1
- Alternating use of both fungicides should be practiced to minimize the risk of the development of fungicide resistance.

Precautions

- Disease-free planting material should be selected for planting.
- Flood irrigation in order to check water logging and water stagnation for longer period should be avoided.
- Tree trunk should not be allowed to come in contact with irrigation water.
- Regular monitoring for the disease symptoms as described should be done to control the disease at its initial stages.
- In doubt of the disease, soil and infected plant samples should be got checked in laboratory for *Phytophthora*.

INSECTS

10. Black Fly -*Aleurocanthus woglumi* Ashby (*Aleurodidae*, *Homoptera*)

Damage: Citrus black fly is an endemic pest. The pest attacks the crop during all the three flushing periods viz., Ambia (Jan.-Feb.), Mrig (Jun.- July) and Hasta (Oct.-Nov.) bahar and completes three generations in a year. Both nymphs and adults suck cell sap and secrete voluminous honeydew on which sooty mould grows wildly that leads to fungal manifestation (*Capnodium* sp.) locally called as 'Kolshi', covering entire plant due to which photosynthesis is affected. Plants are devitalized due to excessive desapping and in severe cases fruit bearing capacity of the tree is also affected. Fruits are rendered insipid in taste and blackened due to black sooty mould. Such fruits fetch low price in the market.



Fig. 30. Infested leaves

Management:

- Spray monocrotophos @ 1.5 ml or phosalone @ 1.5 ml @ of water on the lower side of leaves covering the entire tree canopy.

- After 15 days second spray should be given with any of the above insecticides or neem oil @ 10 ml/L of water.
- Avoid close planting, water logging and excessive nitrogen.
- The affected shoots should be clipped off and destroyed.

Time of application: Timing of spray is very vital as only first nymphal instar of the pest is vulnerable to insecticides. The stage of 50% eggs hatching is the most ideal timing for spray application (Fig. 30). This needs regular watch on the pest population in the field. Following timings were found most suitable to initiate control measures.

Precaution: For successful fruit set a minimum of 2.2% organic nitrogen in leaf is must. Five to ten black flies/cm² area or 50 to 100 nymphs/ leaf are sufficient to reduce the leaf nitrogen level below 2.2%.

11. Psylla (*Diaphorina citri* Kuwayama (Psyllidae; Homoptera)

Damage: Nymphs and adults in flocks of tens and hundreds suck the cell sap from young twigs, leaf and flower buds that results into heavy drop of young flush and fruits and drying of twigs. Nymph secretes honeydew on which sooty mould grows (Fig. 31). Psylla is also known to inject toxin in plant due to which die-back of shoot occurs. More importantly the pest is an active vector of the deadly “Greening” disease caused by phytoplasma like organism.



Fig. 31 Infestation of psylla nymphs

Management:

- Control of psylla during March-April and June-July flush is must as the pest causes severe damage.

- Collateral host like Curry leaf (*Murraya koengi*) plant should not be grown in the vicinity of citrus orchards as it may act as a breeding ground for psylla. However, the possibility of using this plant as a “trap crop” may be used.
- Spray Dimethoate 2ml/l or Imidacloprid 0.05% or quinalphos 1 ml/l of water at bud burst stage or when infestation is noticed on sprouts in Jun-Jul, Jan-Feb and Oct-Nov. If required, second spray of any of the above insecticides should be given after 15 days.
- A hymenopteran nymphal parasitoid *Tamarixia radiate* has been quite effective causing as high as 30 to 40% and even upto 90% parasitism at certain locations particularly during March-April.
- Among predators, the chrysopid *Apertochrysa crassinervis*, *Brumus suturalis* and the *Coccinellids*, *Coccinella rependox* prey upon nymphal psylla to be used for biological control.
- Release of *Mallada boninensis* in the month of February and Oct.-November.

12. Leaf Miner (*Phyllocnistis citrella* Stainton (Phyllocnistidae, Lepidoptera)

Damage: Newly emerged larva mines the under surface of the leaf in a zigzag way. Serpentine mines on the underside of leaf which are silvery in colour due to entrapped air are the characteristic symptoms (Fig. 32). Attacked leaves curl-up from the margins towards inner side, eventually dry up and fall down. Since new flush is attacked, growth is severely hampered. In case of twig attack in young plants ‘die-back’ also occurs (Fig. 33). Ventral leaf surface is preferred by the pest but due to high population pressure dorsal infestation is also seen. Citrus leaf miner helps in spreading mealy bug infestation and also acts as foci of citrus canker.

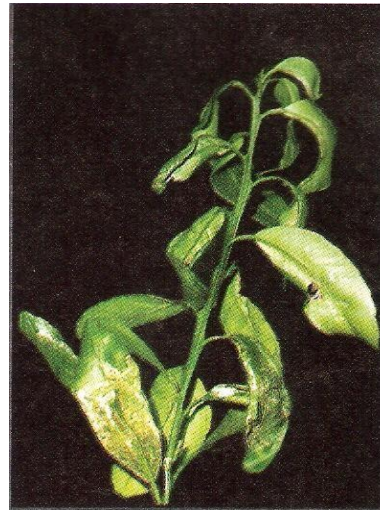


Fig. 32. Mandarin leaf having larval mines Fig. 33. Shoot affected by citrus leaf miner

Occurrence: The pest attacks the crop through out the year except during severe cold and hot summer having peaks in March and September.

Management

- Spray NSKE 4% if infestation is moderate during new flush emergence, under heavy infestation give alternate sprays involving monocrotophos @ 1.5 ml or quinalphos 2 ml/l.
- Prune heavily infested branches destroy them and spray should be aimed at young flush only.
- Parasitoids such as *Tetrastichus phyllocnistoides*, *Cirrospillus quadristriatus*, *Simpieses purpurea* and black chalcid, *Ageniaspis* sp. larvae cause about 30 to 45 and even upto 80% parasitism.

13. Lemon Butterfly (*Papilio demoleus* Linn. (Papilionidae, Lepidoptera))

Damage: The pest attacks mandarin and acid lime plantations almost throughout the year but is serious during July-August. Larvae being the voracious feeder cause severe defoliation of plants (Fig. 34 & 35).



Fig. 34 Defoliation of shoots



Fig. 35. Egg and larval instars

Management:

- Collect and destroy larvae, which look like bird dropping in the early stage.
- The pest can be controlled by foliar spray of any of the contact or systemic insecticides viz., dimethoate @ 1.5 ml, fenitrothion 1ml, or quinalphas 2ml/l at an early larval stage.
- Dipel (*Bacillus thuringiensis* Berl.) spray at 0.05% gives good control of the pest. Entomopathogens like bacterium *Serratia marcescens* and fungus *Fusarium* sp. also kill the pest population substantially.
- A braconid *Apanteles flavipes* and ichneumonid *Melalophacharops* sp. are the predominant larval parasitoids and a chalcid *Pteromalus puparium* and a ichneumonid *Holcojoppa coelopyga* are the major pupal parasitoids which could be utilized for effective control of the pest biologically.
- Release *Trichogramma chilonis* @ 500 adults per tree.

14. Bark Eating Caterpillar (*Inderbela quadrinotata*, *T. tetraonis* Moore (Melarbelidae, Lepidoptera))

Damage: Infestation is seen in neglected orchards. Grubs feed on the bark portion during evenings and nights by coming out of tunnels bored at the joints of two branches. Infested plants have shortened life span and low productivity. As many as 17 tunnels

were recorded on a single 8 year old tree. Such orchards give the declining look (Fig. 36).



Fig. 36. Larvae feeding on bark

Management: Inserting a cotton wad soaked in petrol or kerosene or monocrotophos or 3-5 ml dichlorvos (1%) in tunnel and plugging it by mud and also spraying the affected portion with the same solution after clearing the larval excreta and wooden frass.

15. Mealy Bug (*Planococcus citri* Risso (Pseudococcidae, Homoptera))

Damage: The pest causes heavy damage to nursery and grown up plants. Damage is severe in spring and autumn. The leaves and tender shoots get deformed and twisted into knots and loops. The leaves become curled up. It feeds at stem ends of fruits and often causes heavy fruit drop. Clusters of white formations of bug are found at the joints of twigs (Fig. 37). It extracts plant sap and reduces tree vigour. It also excretes honeydew which invites sooty mould.

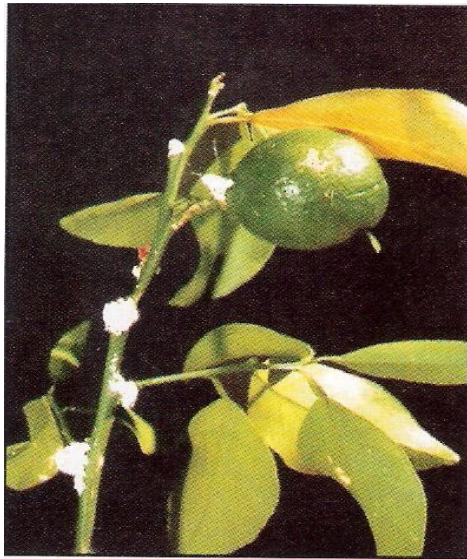


Fig. 39 Twig and fruit infested by mealy bug

Management:

- Chemical control of the pest includes spraying of dimethoate 150 ml+ kerosene oil 250 ml in 100 litres of water or malathion 20 ml in 10 litres of water.
- Use of nymphal and adult parasitoid *Leptomastrix dactylopii* and the predators the coccinellid *Cryptolaemus montrouzieri* and the chrysopid *Mallada boninensis*.

16. Aphids (*Toxoptera citricida* Kirkaldy and *T. aurantii* (B.d.F) Aphididae, Homoptera).

There are two species of aphids, viz. brown citrus aphid (*T. citricida*) and black citrus aphid (*T. aurantii*). It is a pest of young flushes of plants of all ages. They multiply in hundred in a short time.

Damage: Adults and nymphs suck the sap from tender leaves and shoots devitalizing the plants. The pest secretes copious sugary solution on which sooty mould grows (Fig.34 & 35). Brown citrus aphid, *Toxoptera citricida*, is responsible for vectoring citrus virus disease 'Tristeza (Fig. 36).



Fig. 34. Aphid infested citrus
Twig / leaves

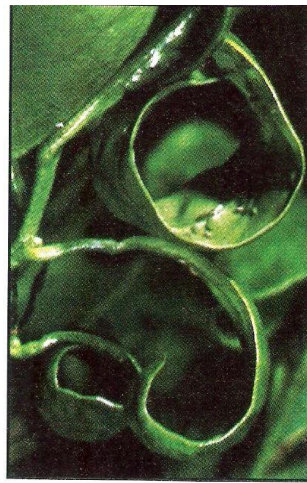


Fig. 35. Leaves affected by
Aphid feeding

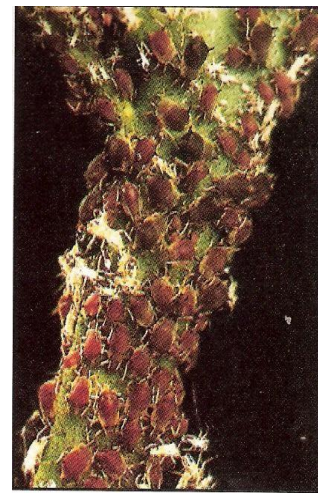


Fig. 36. Brown citrus aphid

Management:

- Spray quinalphos or dimethoate 0.05% at weekly intervals. In case of severe outbreak, spray imidacloprid 200SL @ 0.25 ml/l.
- An ichneumonid parasitoid *lipolexis scutellaris* and the predators like chrysopids, coccinellids, syrphids feed on this pest.
- Release *Chilomenes sexmaculata* @ 50 per plant in the absence of natural enemies.

17. Thrips (*Scirtothrips spp. Heliothrips haemorrhaeodalis* Bouche (Thripidae, Thysanoptera)

Damage: The nymphs and adults suck the sap from fully developed flower and leaf buds, young and grown-up fruits and also the leaves (Fig. 37 & 38) The leaves become cup shape and leathery. Two white line parallel to leaf midrib and a whitish silvery ring around the fruit neck are characteristics of thrip infestation.

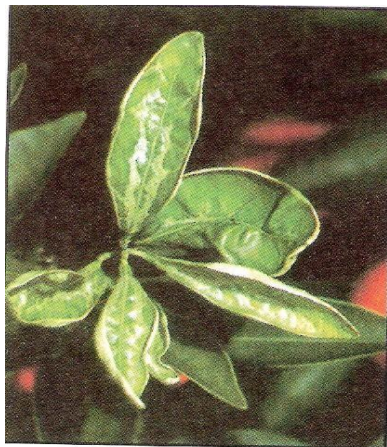


Fig. 37. Leaves damaged by citrus thrips

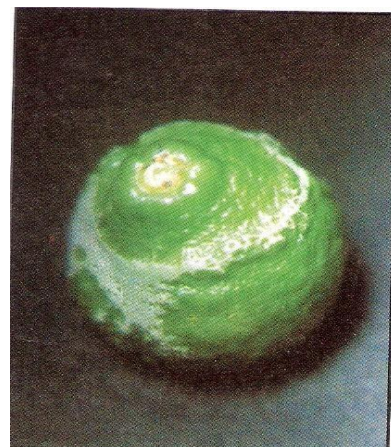


Fig. 38. Fruit damaged by citrus thrips

Management:

- Dimethoate or quinalphos or monocrotophos @ 1ml/l of water should be sprayed at bud burst stage & on berries and the surrounding vegetation should also be sprayed as the pest thrives on it.

18. Fruit Sucking Moth (*Ophederes* sp. *Achaea janata* L. (Noctuidae, Lepidoptera)

Damage: It is a serious pest of maturing mandarin fruits. The adults puncture the ripening fruits. Such fruits drop prematurely as a result of rotting due to fungal and bacterial infections introduced through punctures causing considerable fruit loss.

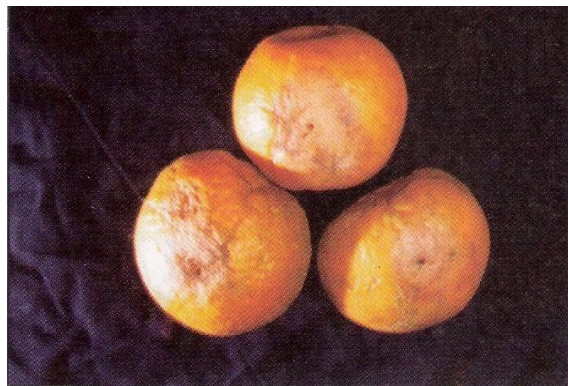


Fig. 39 Punctured fruits by sucking moth

Management:

- Poison baiting with 20 g malathion (W.P) + 200 g gur with some vinegar or fruit juice in 2 litres of water (two bottles containing poison bait per 25-30 trees) has been found quite effective.
- Use light traps to collect moths.
- Sprays of malathion or dimethoate (1ml/l) should also be given on the weeds around the orchard where the young stages of the pest survive.
- Destroy fallen fruits by burying in the ground.
- Clean cultivation of the orchard is must to avoid the pest development.

19. Fruit fly (*Dacus dorsalis* Handel (Trypetidae, Diptera)

Damage: The adult fly punctures the ripening fruits by penetrating its ovipositor and lays the eggs inside. Larva on hatching feed on the pulp inside. Fungal and bacterial infection takes place through puncture hole due to which rotting of fruit occurs. The fruit ultimately drops down.

Life cycle: The female inserts 2 to 15 eggs into the rind of the ripening fruit about 200 eggs are laid in a month's periods which hatch in about 2 to 3 days during summer and 10

days in winter. The maggots take 16 to 29 days for its full growth in the pulp and then undergo pupation in 3 to 7 inches deep in the soil. The adults emerge out after 6 to 14 days depending upon the climatic condition

Management:

- Keeps bait containing malathion or trichlorofon 0.05% +1 % crude sugar, about two months before fruit ripening followed by 10 days interval.
- Use male attracting fly trap baited with 0.1% methyl eugenol and 0.05% malathion @ 25 traps / ha starting from 60 days before fruit harvest and fresh solution after every 7 days.
- Fallen fruits should be collected and buried deep in the ground.

20. MITES (*Eutetranychus orientalis* Klien (Tetranychidae, Acarina)

Damage: Citrus mite extracts cell sap from leaves and fruits. Mite feeding causes pale stripping on the upper surface of leaves which are not seen on the lower surface. In severe infestation the stripping enlarges to dry necrotic areas. But the stripping / silvering of green fruit disappear when the fruit changes colour (Fig. 40 & 41). When large population feeds on maturing fruits the silvering may persist. Generally leaves drop and die-back of twigs starts.



Fig. 40 Affected fruits



Fig. 41. Infested leaves

Management:

- Foliar spray of dicofol @ 1.5 ml, monocrotophos 1 ml or oxydemeton methyl 1.5 ml or wettable sulphur 3 g/l of water. Second spray, if required, may be given after a week. New sprouting on grown up trees creates the favourable conditions for rapid and continuous multiplication of the pest leading to its outbreak.
- The most important natural enemies of citrus mite are a predacious mite *Euseius hibisci* and the predators *Agistemus* sp. and *Ambylesisus hibisci*.
- Water stress often aggravates mite problem. Make sure that trees are well irrigated, particularly during the stress in late summer.

21. Trunk borer

Damage: Grub bores the trunk at ground level horizontally up to the pith and then tunnels vertically and again horizontally for exit. Attacked trees gradually dry up (Fig. 42 & 43).

Management

Swabbing of tunnel either with Dichlorvos (0.1%) or Monocrotophos (0.02%) kills the grub effectively.



Fig. 42 Infested trunk



Fig. 43. Adult

Calendar of Operations (Guidelines) of Citrus Growers

January

- In case there is infestation of Bark eating caterpillar then remove the wooden frass present in between the joints of the tree trunk and inject Dichlorovos (DDVP) 76 EC 0.1 percent @ 5 ml in the larval tunnel with the help of disposable syringe and push the cotton swab soaked in Dichlorovos solution in the larval tunnel.
- Prune dead wood from the trees. While pruning dip the pruning instruments in one percent sodium hypochlorite solution.
- Spray gibberallic acid 10 ppm + urea 1% at the time of initiation of *Ambia* flush.
- Scrap out Gum oozing portion by sharp knife from the infected tree trunk and apply metalaxyl or Fosetyl-AI paste.

February

- During this month heavy incidence of citrus leaf miner, citrus psylla and blackfly is observed. Spray Monocrotophos 1.5 ml or Quinalphos 2 ml or Dimethoate 2 ml in one litre water. Repeat application after 10 days in case the infestation of leaf miner and citrus psylla persists. One spray may be given when blackfly attains the peak of adult population.
- In case there is infestation of Bark eating caterpillar then remove the wooden frass present in between the joints of the tree trunk and inject Dichlorovos (DDVP) 76 EC 0.1 percent @ 5 ml in the larval tunnel with the help of disposable syringe and push the cotton swab soaked in Dichlorovos solution in the larval tunnel.
- In case of citrus aphid attack spray Quinalphos or Dimethoate 0.05 percent and repeat it after every 7 days.
- In case leaf eating caterpillar is observed spray Imidachoprid (0.30 ml/l) or Dimethoate 1.5 ml or Fenitrothion 1ml or Carbaryl 2 g in one litre of water.

March

- During this month, there may be *Phytophthora* symptoms on the tree trunk. Spray Metalaxyl MZ 72 @ 2.75 g/litre or fosetyl A1 @ 2.5 g/litre fungicide on the tree covering the whole plant canopy.
- In case of citrus psylla and leaf miner attack spray monocrotophos 36 SL @ 0.7 ml dimethoate 1.5 ml or Quinalphos one ml in one litre water. Repeat the spray after 15 days.
- In case of leaf eating caterpillar infestation spray Dimethoate 30 EC @ 1ml/l of water.
- During this month due to rise in temperature drip irrigation should be given @ 12-53, 78-127, and 145-180 litres per day for trees 1-4, 5-7,8 years old and above respectively. Follow double ring method of irrigation and irrigate orchard 7 to 10 days.
- Spray 2, 4-D 10 ppm + urea 1% to Jan. – Feb. fruits.
- Spray 2, 4-D 10 ppm and Potassium nitrate 1% if there is sudden rise in temperature range 35 to 40 degree C.

April

- During April month, incidence of bark eating caterpillar is commonly seen, more menacing on old orchards. To control the pest, remove the wooden frass and then inject Dichlorovos (0.1%) at the rate of 5 ml with the help of disposable syringe, or push the dichlorovos soaked cotton wad into the larval tunnel.
- About 50% eggs laid by the citrus blackfly (Kolshi) hatch during the 2nd half of April month. The nymphs and adults both suck cell sap from young leaves and twigs. The nymphs secrete honeydew on which black sooty mold develops on entire tree which is called 'Kolshi'. Hence, to control the pest, spray of monocrotophos 10 ml or Acephate 1.25 gm or Dimethoate 20 ml or Quinalphos 15 ml per 10 litres of water is suggested with second spray to be given after 15 days.
- Incidence of mites takes an alarming shape during the month. To combat this pest, spray of Dicofol 1.8 EC at the rate of 15 ml in 10 liters of water is suggested.
- The dead wood on the citrus trees should be kept pruned, about 2 cm, below the dead portion followed by spraying with carbendazim fungicide at the rate of one gm per litre of water.
- To check fruit drop during Ambia bahar, spray of solution containing 1.5 g 2, 4-D or gibberelic acid (GA), 100 g benomyl and 1 kg urea dissolved in 100 liters of water is suggested. The interval spray may be reduced to 15 days if an excessive fruit drop continues.

May

- Irrigation should be continued to maintain the fruit set.
- Give water stress to tree for preparing them for the next crop in June.
- Apply Bordeaux paste on the tree trunk upto the height of 24 inches by brush. For preparation of Bordeaux paste dissolve 1 kg Copper sulphate in 5 liters water in a plastic bucket and 1 kg slaked Lime in 5 litres water in separate bucket leave it for a overnight. Next day mix them together to make a paste. Apply the paste on tree trunk with in 12 hours after mixing.
- If the citrus trees are showing oozing symptoms of gum then scrap the area with a sharp knife and apply Metalaxyl MZ-72 or Fosetyl A1 paste on it.
- Spraying and drenching with metalaxyl MZ-72 @ 2.75 gm or Fosetyl A1, 2.5 gm in one litre water on the tree for controlling *Phytophthora*.
- To check fruit drop in citrus crop spray the solution containing 1.5 gm 2,4-D or Gibberelic Acid (GA), 100 g Carbendazim 50 WP and 1 kg Urea (1%) in 100 litres of water. Repeat the spray after 15 days if fruit drop continues.
- The menace of Bark eating caterpillar can be checked in this month by removing the wooden frass and they injecting Dichlorovos 76 EC 0.1% @ 5 ml in a larval tunnel with the help of disposable syringe or pushing in the Dichlorovos 76 EC 0.1% soaked cotton wool into the larval tunnel.
- For controlling citrus Mealy bugs the basin around the tree trunk should be earth on up. Sticky band by smearing with mobil oil around the tree trunk and destruction of ant's nests should be done. Spraying of Chlorpyrifos 20 EC @ 2 ml/litre of water or Dichlorovos @ 2.5 ml/litre of water should be done on the tree leaves and trunk.
- Snail infestation in certain pockets has been observed recently on citrus. To control snails use metaldehyde pellets. Alternatively take straw of paddy or

wheat, jaggery or sugarcane mollasses, yeast and Methomyl or Thiomethazim. In order to prepare poison bait dissolve 2 kg jaggery, 25 gms yeast in 10 litre water. Now add wheat or paddy husk and mix well and keep for fermentation for 10 to 12 hrs. Thereafter add 100 gm Methomyl or 50 gms Thiomethazim and spread it at the base of citrus tree trunk in the evening through out the entire orchards. Citrus snail will be attracted and will die after feeding on such poison bait.

June

- In case the trees on stress receives water during stress period Cycocel a growth retardant at the rate of one gm per litre of water should be sprayed on the trees. Second spray should be applied after 20 days. For increasing the fruit size of Ambia crop and if there is wide gap of more than a week between two spell of rains spray potassium nitrate at the rate of 1.5 kg + 2, 4, D 1.5 gms per 100 litres of water.
- Apply Bordeaux paste on the tree trunks to control Phytophthora disease on citrus. Prepare the paste by mixing 1 kg lime and 1 kg copper sulphate in 5 liter water separately overnight in a plastic container. Next day mix both the mixtures in equal proportion so that the color of the paste is sky blue. Apply with brush on the tree trunk up to 24 inches from soil level. This paste should be applied within 12 hrs after mixing.
- During this month there is rapid spread of citrus canker hence the affected leaves, branch should be pruned and burnt. Sprays copper oxychloride 200 gm with streptomycin 6 gm in 60 litre of water before the onset of the monsoon. Repeat the sprays 3-4 times at interval of 30 days.
- To check fruit drop spray the citrus tree with 1.5 gms 2,4-D or Gibberelic acid(GA). 100 gms carbendazim 50 WP with 1 kg Urea in 100 litres of water. Repeat the spray after 15 days if the fruit drop continues.
- To control insect pest Monocrotophos 36 SL @7 ml or Dimethoate 30 EC 10 ml or 14 ml or Acephate 7 gms in 10 litres of water should be sprayed.

July

- Avoid water stagnation near the tree trunk. Drain out excess rainwater from the orchard through the drainage channels prepared earlier.
- Remove water shoots and any other shoots below the budded area. Intercrops such as Urad, Moong, Soyabean, Groundnut etc. can be grown in between the interspaces of plants. For green manuring sow seeds of Dhaincha or sun hemp @ 40 kg per hectare.
- To check fruit drop spray the citrus tree with 1.5 gm 2,4-D or Gibberelic Acid (GA) with 100 gms Carbendazim and 1 kg Urea mixed in 100 liters of water.
- Prune all canker affected branches and leaves and burn them. Spray copper oxychloride (180 gms) with Streptomycin (6 gms) per 60 litre water to check citrus canker in acid lime. Repeat the spray after 30 days interval.
- Control citrus psylla and leaf miner by spraying Quinalphos 12.5 ml or Monocrotophos 7.5 ml or Dimethoate 15 ml in 10 litres of water. Apply second spray (Imidacloprid 0.05%/ lit) after 15 days interval if required.

August

- Avoid water stagnation near the tree trunk. Stagnated water should be disposed off through the drain, clean the drains if required.
- Remove water shoots from the trees.
- During this month there is rapid spread of citrus canker in Acid lime hence the affected leaves and branches should be pruned and burnt. Spray copper oxychloride 180 gms with streptocycline 6 gms in 60 liters of water.
- There is 50 percent hatching of egg of black fly in first fortnight of this month which is responsible for spreading “Kolshi” in citrus. To control the pest spray Monocrotophos 10.0 ml or Quinalphos 15.0 ml in 10 liters of water. Repeat second round with Dimethoate 20 ml in 10 lit of water after 10 days of first spray. The above spray will also take care of citrus leaf miner.
- During this month there is attack of fruit sucking moth. To control the pest destroy all the fallen fruits by burying in the pit. Poison baiting with 20 gms Malathion WP or 50 ml Diazinon mixed with 200 gms gur and some orange juice in two litres of water should be placed in a tray. Place a bulb of 60 watts above this tray to kill the moth. Follow clean cultivation and uproot all weeds in the orchard.

September

- Undertake necessary tillage operations if there are no rains. Remove the weeds form the tree basin and prepared double ring around the tree for Irrigation. Care should be taken to see that first ring is made one meter away form trunk and second ring meter away from the trunk. In case of drip irrigation system spread the laterals and gives irrigation as per requirement.
- Due to high humidity the problem of citrus canker gets aggravated in acid lime leading to excessive fruit drop. Spray copper oxychloride 180 gms with streptocycline 6 gms in 60 liters of water to control canker.
- Control fruit sucking moth by preparing a poison bait containing 20 gms malathion or 50 ml Diazinon mixed with 200 gms gur and some orange juice in 2 liters of water. Fill it in as bottle and has one bottle between 25 to 30 trees all over the orchard.
- Creating smoke in bearing orchard in the late evening hours i.e. 7.00 to 10.00 pm during the last fortnight before the harvest.
- To control fruit fly use male attracting traps containing 0.1 percent methyl eugenol and 0.05 percent malathion. Use 25 traps per hectare from 60 days before fruit harvest and change the bait after every 7 days.
- Follow clean cultivation in orchard and bury fallen fruits in a deep pit everyday.

October

- Control Fruit sucking moth by preparing a poison bait containing 20 ml malathion or 50 ml Diazinon mixed with 200 gms gur (jaggery) or orange juice in 2 litre of water. Fill it in a broad mouth bottle and hang one bottle between 25 to 30 trees all over the orchard.
- Create smoke in orchard with grass (wet) cow dung cakes and neem leaves in the late evening hours i.e. 7.00 to 10.00 pm during this month.

- To control fruit fly use sex traps (methyl eugenol traps) for trapping the fruit flies containing 0.05 percent malathion mixed with orange juice one litre. Use 25 traps per hectare from 60 days before fruit harvest and change the bait after every 7 days.
- Follow clean cultivation in orchard and bury fallen fruit in a pit and cover it with soil every day.
- In case of incidence of citrus mite spray Dicofol at the rate of 1.5 ml or wettable sulphur at the rate of 3 gm per litre of water. After 15 days second application should be given with either of the two above miticides (Do not repeat the miticide as for as possible)
- Apply post monsoon Bordeaux paste on the tree trunk.
- For *Phytophthora* infected trees, spray and drench with metaxyl MZ @ 2.75 gm per liter covering the tree canopy.
- Weeding and harrowing operation should be done in the orchard. Prepare double ring system for irrigation.
- Spray carbendazim @ 1 gm per liter at 15 days interval. Spray 2,4-D or gibberlic acid @ 1 g in combination with either monopotassium phosphate, diammonium phosphate, potassium nitrate @ 2% at 15-20 days interval depending on the crop load.
- Harvesting of matured santra fruit should be started.

November

- In case of citrus psylla attack spray Monocrotophos @ 0.7 ml or dimethoate 1.5 ml or Quinalphos one ml per litre of water. Second application should be done with any one of the insecticides not applied earlier at 15 days interval.
- In case of incidence of citrus mite spray Dicofol at the rate of 1.5 ml or wettable sulphur at the rate of 3 gm per litre of water. After 15 days second application should be given with either of the two above miticides (Do not repeat the miticide as for as possible)
- Apply Bordeaux paste on tree trunk if not applied earlier.
- For *Phytophthora* / gummosis disease control scrap out the oozing portion by a sharp knife and apply metalxyl MZ or fosetyl AI paste.
- After harvesting of fruits, prune dead wood and water shoots followed by spray of fungicide, carbendazim @ 1 gm/liter water.
- Harvest the fruits; if delay is anticipated in harvesting of fruits, two sprays of Gibberellic acid 15 ppm + urea 1% may be given at 15 days interval.
- Uproot and destroy all weeds.
- Breakdown the soil collected around the tree trunk.

December

- In case of incidence of citrus mite spray Dicofol at the rate of 1.5 ml or wettable sulphur at the rate of 3 gm per litre of water. After 15 days second application should be given with either of the two above miticides (Do not repeat the miticide as for as possible).
- During the first fortnight of this month 50 percent egg hatching of citrus blackfly is observed. Spray Monocrotophos one ml or Acephate 0.8 gm or Quinalphos 1.5 ml or Dimethoate 2 ml per litre water directing the spray nozzle on the underside

- of the leaves. Repeat application with any one of the insecticides not sprayed earlier after 15 days interval.
- For citrus leaf miner attack particularly in nursery pluck and destroy the affected leaves and sprays spinosad 45 SC @ 0.25 ml or Quinalphos 1.5 ml or Dimethoate 2.0 ml in one litre water.
 - Dead wood pruning may be done after harvest of crop followed by spraying of fungicide, Carbendazim @ 1 gm/litre water.
 - Nurseryman should start budding on rootstock. Take care to do budding 20 to 25 cm above ground level.
 - If there is incidence of *Phytophthora* gummosis on trunk of tree, scrap out the oozed Gum portion and apply fosetyl AI or metalaxyl paste.

Tips for Control Measures

- As precautionary measure first spray may be given as soon as the new flush is emerged.
- Destroy the ant colonies in the orchards as they are the carriers of certain pests to their feeding sites and also protect them from other harmful agencies.
- Close spacing and water logging conditions should be avoided in the orchards which help in creating micro-niche favouring the pest population.
- Avoid pruning during active growth periods as it induces irregular and frequent flushes which lead to the perpetuation of pest. If necessary, prune only the infested dry shoots after fruit harvest.
- Apply nitrogenous fertilizers as per need only as excessive and frequent applications promote new flushes which provide favourable conditions for insect pests infestation.
- Modify canopy structure in such a way that light interception is maximum below the canopy.
- Preparations of spray solution, spraying operations, insecticide residue and compatibility in mixtures are important aspects to keep in mind before undertaking the sprays.

Spraying operation

- The time of insecticide application should be decided after monitoring the pest incidence meticulously viz., only young and vulnerable life stages of the pest should be sprayed upon.
- The spray should be targeted on the lower surface of the leaves and the new flush. Canopy should be covered till the run off stage.
- Avoid the repeat application of a particular pesticide and do not use expired pesticide.
- Prepare spray solution first in small quantity and then increase the volume to desired level by adding water. In case of wettable power take required quantity of pesticide, add a little quantity of water, mix it thoroughly to prepare the paste and then add remaining quantity of water to this paste with constant stirring.
- Avoid spraying during strong winds, cloudy days and drizzling.

Preparation of Bordeaux mixture

Bordeaux Mixture and its preparation

The application of the Bordeaux mixture has been recommended for the control of a range of fungal and bacterial diseases such as leaf spots, blights, anthracnose, downy mildew and cankers etc. It, however, causes burning of foliage or russetting of fruits such as apple when applied under extreme weather conditions. The phytotoxicity of the Bordeaux mixture is reduced by increasing the ratio of lime to pathogens, and sometimes to plants, while lime primarily acts as a neutralizer.

Bordeaux Mixture (1%) preparation

- Dissolve one kilogram of Copper Sulphate in fifty litres of water.
- Dissolve one kilogram of Quick Lime in fifty litres of water separately.
- Pour Copper Sulphate solution into the Lime water slowly with constant stirring.
- To check the quality of the mixture, dip a polished knife in the solution for two minutes. If the knife gets a reddish stain, then the mixture is acidic and harmful to the plant, if sprayed. To neutralize the mixture, add more limewater, till the non-deposition of the reddish stain on the knife.

Bordeaux past (10%) preparation

- Dissolve one kilogram of copper sulphate in five litres of water.
- Dissolve one kilogram of Quick lime in another five litres of water separately.
- Mix the above two solutions to get the Bordeaux paste.

Care to be taken

- Always spray freshly prepared mixture for effective management. Therefore prepare only the required quantity for the day.
- Use only wooden, earthen or plastic vessels, to avoid the corrosion of the metal vessels by the mixture.
- Do not use the Bordeaux mixture in combination with any other chemical or pesticide e.g. in citrus, zinc sulphate spray should be given, keeping a gap of at least one week from that of the Bordeaux mixture.
- To avoid choking of the nozzle, it is advisable to strain the Bordeaux mixture through a cloth or a sieve before putting it into the spray tank.
- The Bordeaux mixture tends to sediment easily. Therefore, its stirring while using is desirable.
- In exceptionally hot days, when the plants are showing signs of temporary wilting or when it is raining, the Bordeaux mixture should not be sprayed, particularly on newly emerged tender foliage. Exercise this caution particularly on nursery plants.
- After carrying out spray operations the appliances should be thoroughly washed with plenty of water to remove any copper deposits.
- The left over Bordeaux mixture should not be dumped in the field as this may prove toxic to the subsequent sowings.