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A CASE STUDY

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Insect pests of citrus and their management

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ABSTRACT

Citrus is one of the most important fruits and one of the largest fruit industries in the world, grown in more than 52 countries around the world. In India, 250 species of insects and mites have been reported infesting different species of citrus. Trunk borer, Leaf miner, citrus psylla, red scale, mealy bugs and aphids were recorded as major pests of khasi mandarin oranges in NEH region of India. These pests significantly contribute towards the citrus decline in the region. For management of these pests, diagnosis of the causes of decline, the rejuvenation schedule may be formulated with multi-disciplinary approach. More information is needed on some of the key elements required for environmentally friendly management Biological control through augmentation and conservation of parasitoids integrated with other non-pesticide measures need to be tested with holistic approach in citrus. More attention should be given to the knowledge of the biology and ecology of parasitoid species. Bio-pesticides, including botanicals, can offer a safe and effective alternative to conventional insecticides for controlling the pest within an integrated pest management programme.

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INTRODUCTION

Citrus is one of the most important fruits and one of the largest fruit industries in the world, grown in more than 52 countries around the world. Brazil and China are the largest producers of citrus worldwide producing about 45 million tons (MT) of citrus fruit together, followed by USA, India, Mexico and Spain with a production of 10.7, 8.6, 7.2 and 5.5 MT, respectively (Mahmood *et al.*, 2014).

India ranks fourth in the production of citrus fruit in the world. Citrus fruits originated in the tropical and sub tropical regions of South East Asia, particularly India and China.

In India, citrus is commercially grown in about 10.42 lakh ha with an annual production of 100.90 lakh tonnes and productivity of 9.7 t/ha (NHB, 2013) and are primarily grown in Maharastra, Andhra Pradesh, Punjab, Karnataka, Uttaranchal, Bihar, Orissa, Assam and Gujarat It is of Particular interest because of its high content of Vitamin C and refreshing juice. Of the various types of

citrus fruits grown in India, orange (mandarin or santra), sweet orange (mosambi) and lime/ lemon are of commercial importance.

North Eastern Region is one of the richest reservoirs of genetic diversity of Citrus as the primary as well as the secondary centre of origin of numerous citrus species and has been described as one of the major centre of diversity for citrus in both wild and cultivated forms (Singh *et al.,* 2006).

North Eastern Region Systematic exploratory survey of mandarin orange showed that *Citrus indica* is one of the most primitive species of citrus available in the region. Other promising natives so far identified and commercialized are cytron (*C. medica*), sweet lime (*C. lamittoides*), sour orange (*C. aurantium*), sweet pumalo (*C. grandis*), sour pumelo (*C. megaloxycarpa*), Khasi paida (*C. latipes*), rough lemon (*C. jambhiri*), etc. High rain fall, prolong high humid conditions with favourable temperature regime and cultivation and / or occurrence of a number of wild and cultivated species of citrus harbour largest number of pest and diseases of Citrus in this region. In India, 250 species of insects and mites have been reported infesting different species of citrus (Wadhi and Batra, 1964).

The trunk borer, *Anoplophora versteegi*, Citrus psylla, *Diaphorina citri* and black aphids (*Toxoptera aurantii* and *T. citricidus*) are major pests of citrus. In NE region. Leaf miner, *Phyllocnistis citrella* is also equally important and damages at nursery and plants during each new flush. Other pests of economic importance includes lemon butterfly, leaf mining beetles, tobacco caterpillars, leaf folder, looper, mealy bugs, scales, orange shoot borer, bark eating caterpillar, fruit sucking moths and fruit flies etc. (Azad Thakur *et al*., 2012).

Major insect pests of citrus:

Around 250 species of insects are reported.

Regular pests	**Incidence**
Trunk borer (*Anoplophora versteegi*)	4.4–48.65%
Bark eating Caterpillar (*Inderbella* spp.)	10.80–43.76%
Leaf miner (*Phyllocnistis citrella*)	8.70–42.01%
Lemon butterfly (*Papilo domelis*)	3.10–27.89%
Citrus psylla (*Diaphornia citrii*)	3.12–8.36%
Citrus aphid (*Toxoptera citricida*)	9.18–11.30%

Emerging pests:

Citrus looper (*Anacamptodes fragilaria*)2.10–26.68%
Citrus mealy bug (*Planococcus citri)* 2.04–5.56%
Citrus Black fly (*Aleurocanthus woglumi*)
Fruit Sucking Moth (*Ophederes* sp. *Achaea janata*)

Table 1 : Seasonal incidence of major insect pests of citrus

Pests	Emergence	Peak Season	Disappear
Trunk Borer	March	May - June	October
Bark eating caterpillar	October	April - May	June
Leaf miner	March	May - June	December
Citrus butterfly	March	May - June	December
Citrus Psylla	Whole year		
Citrus looper	March	June - July	November
Citrus Aphid	November	Dec. – Jan.	May

Leaf miner, citrus psylla, red scale, mealy bugs and aphids were recorded as major pests of khasi mandarin oranges in NEH region of India. These pests significantly contribute towards the citrus decline in the region Peak period of activities were observed from July to January for lea miner, March to October for psylla, November to December for red scale, July to October for mealy bugs and April for aphids with infestation on tree basis being 83, 375, 8, 125, 54, 0, 24, 375 and 10.25 per cent, respectively for these pests (Anoop *et al.,* 1982).

Ecology:

The adults of citrus trunk borer first appeared in the 3rd week of March to 2nd week of April. Female beetle appeared earlier than male. The beetle population reached the peak on 1st to 3rd week of May, after which the population declined and completely disappeared from the orchards from the 4th week of July to 2nd week of August. Adult beetle population is negatively correlated with minimum temperature and positively correlated with BSSH and wind speed (Saikia *et al*., 2011).

Population dynamics of citrus black fly, psylla and leaf miner:

Black fly- peak population- 1st week of April and August and 2nd fortnight of November

Psylla- 2nd week of September and last week of November

Leaf miner- last week of September and 2nd week of June.

Temperature favoured psylla population whereas leaf miner favoured most of the weather factors except sunshine hours (Patel and Patel, 2006).

Three population peaks were observed, First in April (spring flush), small second peak in July and third peak in September (autumn flush). These peaks so obtained coincided with the availability of new flush and the percentage infestation was correlated significantly and positively with maximum and minimum temperatures and average rainfall in Jammu region (Chhetry *et al.*, 2012).

Nature of damage of major insect pest of citrus:

Citrus Trunk Borer (*Anoplophora versteegi*):

- Grub bores into the pith making round holes generally at the base of the trunk.
- Accumulation of coarse saw dust in tree base.
- Grub destroys the xylem and phloem during their long development period causing the deterioration of the tree resulting in serious economic losses.
- About 15- 60 per cent damage caused in citrus of Assam and even as high as 68 per cent damage in Khasi mandarin.

Bark eating caterpillar:

- Infest bark of young and matured citrus plant.
- Larvae make tunnel at the joints of trunk or branches and feed on the bark during night.
- Heavy infestation leads to slowly drying of plant due to nutrient deficiency.
- Attacked tree gradually declines.

Citrus butterfly:

- Citrus butterfly is a pest of nurseries and young plantations.
- Caterpillar feeds on foliage causing defoliation. At times young plants are completely defoliated.
- Most destructive stage is larva. Young larval stage looks like bird excreta

Leaf miner (*Phyllocnistis citrella*):

- Mostly important in nursery and young orchard.
- Larval stage is more destructive. Newly emerged larva mines the under surface of the leaf in a zigzag way.
- Appearance of silvery serpentine mines on the underside of leaf which leads to wrinkling and curling up.
- Leaf miner attacks helps in spreading mealy bug infestation and predisposes to Canker infection.

Citrus Psylla *(Diaphornia citrii)*:

- Peak period for multiplication is in May.
- Both nymph and adult sucks the cell sap from newly emerged leaves, tender shoots and flowers causing curling of leaves and defoliation leading to deblossoming and dieback.
- Secretes whitish crystalline honeydew which attracts the growth of fungus, adversely affecting the photosynthesis.
- Psylla is also known to inject toxin in plant due to which die-back of shoot occurs.
- It acts as vector of citrus greening virus disease.

Citrus looper (*Anacamptodes fragilaria*):

- Drooping and hanging from trees/ upper branch through silken threads.
- Looper larva voraciously consume new growth flushes resulting in severe defoliation, but also feed on blossoms and young fruits.
- Very young larvae typically feed on lower leaf surfaces along the leaf margin.
- Mature larvae eat the leaves making holes on it or consume them entirely. It is an emerging pest.

Citrus Aphid (Black Aphid: *Toxoptera aurantii*, Brown Aphid: *Toxoptera citricida*) and Mealy bug (*Planococcus citri*):

- Nymph and adult suck the sap from tender parts of plant and devitalize.
- Nymphs excrete honeydew on which black sooty mould grows wildly resulting in blackening of the twig.
- In severe infestation the flowers do not form fruits.
- Brown citrus aphid (*Toxoptera citricida*) is responsible for vectoring citrus virus disease 'Tristeza'.

Citrus black fly (*Aleurocanthus woglumi*):

- The cell sap is suck from the leaves leading to leaf curling, leaves fall off immaturely.
- Honey dew secretion leads to sooty mould fungus.

- Leaf turns to black in colour and affects photosynthetic activity of the leaves.
- Affected trees produce few blossoms which develop into insipid fruits.

Fruit sucking moth (*Ophederes* sp. *Achaea janata*):

- It is a serious pest of maturing khasi mandarin fruits.
- Adult is the damaging stage.
- The adults puncture the ripening fruits.
- Such fruits drop prematurely, As a result of rottening due to fungal and bacterial infections introduced through punctures causing considerable fruit loss.

Citrus psylla *Diaphorina Citri*:

Among the insects pests, which infest and cause heavy losses to the citrus, citrus psylla *Diaphorina citri* is the most destructive and consequently the most important of all the insect pests of citrus. Citrus psylla is also a vector of a (*Citrus tristeza* colestero virus), which is responsible for the greening disease of citrus (Su *et al*., 1991).

Population of citrus psylla showed two peak times in a year, firstly in the month of August and 2nd time in the month of April. Correlation values showed that environmental factors had almost no effect on the population build up of citrus psylla.

Three insecticides, methamidophos, dimethoate and imidacloprid applied, had almost equal effect on the population reduction of citrus psylla on all the three species of the citrus.

Citrus die back:

The term die back means death of plant from top to down wards. Citrus dieback is not a specific disorder but is culmination of several interacting factors such as pathological infections, pest attack, nutritional disorder, unfavourable environment, faulty cultural practices, poor choice of planting material etc.

- Avoid spraying during strong wind, cloudy days and dizzling
- Spray may be given as soon as the new flush is emerged.
- Destroy the ant colonies.
- Close spacing and water logging conditions should be avoided.
- Avoid pruning during the active growth periods, if necessary, prune only the infected dry shoots after fruit harvest.
- Apply N-ous fertilizer as the need only
- Modify canopy structure in such a way that light interception is maximum below the canopy.

Integrated Pest Management practices for citrus:

- Conditions that lead to stress on plants should be avoided such as close planting and water logging.
- Good orchard sanitation and removal of weed.
- The affected plant parts should be pruned and destroyed.
- Excessive use of nitrogenous fertilizer and irrigation should be avoided.
- Need base application of insecticides) for management of insect pests based on ETL.
- Use and conservation of predators/parasitoids.
- Field release of predatory ladybird beetle, *Cryptoleamus montrouzieri* @ 10 beetles/plant and inoculative release of exotic parasite, *Leptomastrix dactylopii* is very effective.
- For management of bark eating caterpillar, citrus trunk borer and many other diseases, application of Bordeaux paste during March-April and September-October on the tree trunk up to the height of 1m is very effective.

Effect of biopesticides:

Effect of biopesticide from wood vinegar and extracted substances from 3 medicinal plants such as: non taai yak (*Stemona tuberosa* Lour), boraphet (*Tinospora crispa* Mier) and derris (*Derris elliptica* Roxb) were tested on the age five years of pomelo in Thailand (Pangnakorn and Chuenchooklin, 2015). The extracted from plants and wood vinegar were evaluated in 6 treatments: Water as control; wood vinegar; *S. tuberosa* Lour; *T. crispa* Mier; *D. elliptica* Roxb; mixed (wood vinegar + *S. tuberosa* Lour + *T. crispa* Mier + *D. elliptica* Roxb). The results showed that *T. crispa* Mier was the highest effectiveness for reduction population of thrips (*Scirtothrips dorsalis* Hood) and citrus leaf miner (*Phyllocnistis citrella* Stainton) at 14.10 and 15.37, respectively, followed by treatment of mixed, *D. elliptica* Roxb, *S. tuberosa* Lour and wood vinegar with significance different. Additionally, *T. crispa* Mier

promoted the high quality of harvested pomelo in term of thickness of skin at 12.45 mm and *S. tuberosa* Lour gave the high quality of the pomelo in term of firmness (276.5 kg/cm^2) and brix (11.0%).

Suggested ITK for citrus pest management:

Smoking in the field	Control of fruit fly	Smoke often act as repellent
Application of fish water at the base of the citrus plant	Control of citrus trunk borer	The fish water attract predatory red tree ant (*Oecophylla* sp.)
Smoking below the citrus plant before flowering	Control of citrus pests	Smoke repel insect pests
Placing of red tree ant (*Oecophylla smoragina*) nest on the citrus plant	Control of citrus pests	Red tree ant is a predator of citrus pest

(Deka *et al.*, 2005)

Technology for rejuvenation of declining orange orchards:

Causal factors:

The intensity of factors responsible for citrus decline may vary from orchard to orchards and region to region in the state but the main factors responsible for the decline were found as follows:

- No effective control against insect pests, especially against the rampant attack of Trunk borer and Bark eating caterpillar.
- Insufficient control of diseases, especially against Twig blight, Phytophthora foot rot and Stem end rot.
- No control against parasitic plants like Loranthus etc., and epiphytic plants like Mosses, Lichens, Orchids etc.
- No use on amendments in acidic soils.
- Malnutrition of major and minor elements specially P, Ca, Mg, Zn, B, and Mo.
- Long and heavy spells of rainfall (upto 6 to 7 months).
- Heavy soil erosion due to cultivation upto 60 – 70^0 slopes in the hills region and also deforestation.
- Water logging in the plain region due to lake of proper drainage system and also in some orchards due to rise of river bed present near to orchards.
- Plantation of non descript seedlings of unknown yield potential and tolerance to pests and diseases attack.
- Plantation without cultivation and no control of weeds.
- Rain fed cultivation, as a result there is long spell of water stress condition during winter.
- General neglect due to causes of ledge system of marketing.
- In certain cases, over bearing during 'on' year that often set the initial stage of decline.
- Cultivation in unsuitable soils.
- Excess shade and also keeping tree inside the orchards having allolopathic effect may sometime cause citrus decline

Rejuvenation schedule:

Based on diagnosis of the causes of decline, the rejuvenation schedule was formulated with multi-disciplinary approach. Rejuvenation programme should be started after harvesting the fruit during winter season and before new flush emergence. The following operations should be carried in declining orchards:

Pruning and training:

Unwanted, diseased and pest infected branches and twigs is to be removed by pruning and training in the month of December and January after harvest of the fruits. At the same time, all the parasitic and non-parasitic plants *viz.*, loranthus, mosses, orchid etc. are to be removed properly.

Correction of soil pH :

Agricultural lime @ 1 kg per plant is to be applied to the soil surrounding the plant and is to be mixed with soil by light hoeing in the month of January and February.

Integrated nutrient management:

Apply 450 g N + 225 g P_2O_5 + 450 g K_2O + 5.625 kg *Neem* oil cake along with VAM (500g), PSB (100g), Azospyrillum (100g) and *T. harzianum* (100g) per plant per year in two splits *i.e.*, in March-April and September-October was found to best. The required amount of biofertilizers is to be mixed together with 10 kg FYM and applied 15 days before the application of inorganic NPK. Two foliar sprays of micronutrient consisting of 0.2% Zn, 0.05% B and 0.05% Mo are to be applied; first spray in the month of March- April and second spray during September- October. Integrated management of

trunk borer and bark eating caterpillar:

Prophylactic smearing of 50 ml Dimethoate + 1 kg lime in 10 liters water along with gum at the tree trunk up to 1 metre height from the ground level during March – April prevents early infestation of both trunk borer and bark eating caterpillar. Cleaning of infected holes and insertion of cotton soaked in Petrol followed by mud plastering will have to be done where and when the trunk borer attack is noticed.

Integrated management of diseases:

- **Phytophthora foot rot:** For control of Phytophthora foot rot, soil drenching and spraying of tree trunk with Ridomil @ 0.2% followed by Bordeaux mixture (2:2:250) during February March and July August is to be done. The affected spots should be scraped with a knife before application of Bordeaux mixture.
- **Twig blight:** Prune out the affected branches in the month of December- January and then spray immediately carbendazim (0.1%) two spray and there after two spray of copper-oxy-chloride (0.3%) at monthly interval.
- **Stem-end-rot:** To control Stem-end-rot, spray carbendazim (0.1%) at bi-monthly interval starting from May for three rounds.

Integrated weed management:

Weeds from the orchards are to be removed first by light hoeing before application of fertilizer in the month of February-March, then spray Glyphosate 41 SL @ 1 liter per hectare in the month of May. After two months of Glyphosate spray, again remove the weeds manually. Rejuvenation programme should be started after harvesting the fruit during winter season and before new flush emergence. The following operations should be carried in declining orchards:

Management of major insect pests of Citrus:

Citrus psylla:

– Monitoring using yellow sticky trap.

– Chemical control using dimethoate @ 1.25 ml or imidachloprid @ 0.3 ml or quinalphos @ 1.0 ml or acephate @ 1g or thiometan 0.8 ml at bud burst stage. Second spray should follow after 10-15 days.

– Extracts of botanicals like *Vitex nigundo*, *Acorus calamus*, etc. can also be used.

– Biological control: Predators like *Mallada boninensis* Okamoto and *Cheilomenes sexmaculata* (Fabricius) and host specific parasitoid, *Tamarixia radiata* (Waterston) are effective in bringing down the psylla population.

Lemon butterfly:

– Collection of infested leaves and destroying by burning or burying under the soil.

– Hand-picking and destruction of the various stages of the butterflies,

– Severe infestations can be controlled by spraying leaves with Malathion 57 EC or Dimethoate 40 EC at the rate of 2.0 ml/litre of water.

Citrus leaf miner:

– For effective control, prune heavily the affected parts during winter and burn the same

– Plants with new flushes of leaves should be sprayed with Dimethoate 40 EC or Carbosulfan 20 EC or Malathion 57 EC @ 2.0 ml/litre of water. A second spraying should be given after 15 days of the first spraying.

Citrus mealy bug:

– Collection and destruction of affected leaves and twigs, severely infested plants may be sprayed with Malathion 57 EC or Diazinon 60 EC @ 1.0 ml/litre of water.

Orange fruit fly:

Regular removal and destruction of fallen and infested fruits can reduce the pest population, Male annihilation, utilizing the attraction of males to methyl eugenol may be used to eradicate the pest, Application of bait spray containing Malathion 57 EC and sugar in water will also reduce fruit fly infestation, After harvest dipping of fruits in 5 per cent sodium chloride solution for 60 minutes will destroy the eggs.

Thrips:

Spraying of the affected leaves with plain water, in case of severe infestation 2-3 times spraying of Malathion 57 EC or Tafgor 40 EC @ 2.0 ml/litre of water at 10-15 days interval.

Red mite:

– Collection and destruction of the infested leaves along with mites by burning,

– In case of severe infestation, spraying of Omite 57 EC or Neoron 500 EC @ 2ml/litre of water at 10 days interval.

Citrus greening diseases:

Citrus greening disease was first detected in the United States in Florida in 2005. It was found throughout Asia, the Indian subcontinent and neighboring Islands, the Soudi Arabian Peninsula and since 2004 in the Sao Paulo State of Brazil. The citrus greening pathogen is transmitted by psyllid vectors, grafting and possibly by citrus seed. The Chinese name, Huanglongbing, meaning yellow shoot or yellow dragon refers to the leaf yellowing that may appear on a single shoot or branch.

The asian citrus psyllid directly damages citrus and closely related ornamentals (Halbert and Manjunath, 2004). The honey dew coats the leaves of the tree, encouraging sooty mould to grow. The most serious damage caused by asian citrus psyllid is due to its ability to efficiently vector the phloem inhabiting bacterium *Candidates liberibacter asiaticus* that causes citrus greening disease. In recent years however, DNA probes, electron microscopy and ELISA tests have been developed that have improved detection (Bove *et al*., 1996). Symptoms of citrus greening include yellow shoots and moulting and clorosis of the leaves. The moulting superficially resembles zinc deficiency. Infected trees are stunted, sparsely foliated and may bloom off season. In addition there is twig die back, leaf and fruit drop, aborted seeds. The juice of the infected fruit has a bitter test. Fruit do not colour properly leading to the name greening.

Mode of transmission:

- Can be transmitted by bud grafting but not at high rates due to necrosis in sieve tubes and uneven distribution of the bacteria
- Dodder (*Cuscuta* spp.)
- Citrus Psyllid is the primary vector
  - Occurs with high psyllid populations when the host is flushing which is when the psyllid migrations are highest
  - The fourth and fifth instar nymphs can acquire citrus greening bacteria and transmit the disease as nymphs or adults

Insect vector:

2 species of Citrus psyllid are vectors

- The African Citrus Psyllid, *Trioza erytreae* occurs in Africa, Reunion, Yemen and vectors the African strain of greening. It survives well in cool upland areas
- The Asian Citrus Psyllid, *Diaphorina citri* is in Asia, India, Saudi Arabia, Reunion, and North, South and Central America. It is more resistant to high temperatures and survives in hot lower

Table 1 : Flowering plants that attract natural enemies/repel pests

Natural enemies	Attractant / Repellent / Trap Plants
Citrus aphid	
Predators: Lacewings, hover files, coccinellids, birds, earwigs, some ground beetles and rove beetles, and spiders	**Attractant plant:** Carrot family, sunflower family, marigold, buckwheat, (syrphid, predatory mite, lacewing, minute pirate bug, samsel bug and ladybird beetle) • Nectar rich plants with small flowers *i.e.* dill and mustard (Aphid parasite and Braconid wasp) • Sunflower, buckwheat and cowpea (Braconid wasp)
Citrus black fl y **Parasitoids:** *Encarsia formosa, Eretmocerus* spp.(Pupal) **Predators:** *Chrysoperla zastrowi sillemi*,coccinellids, spiders	**Attractant plant:** French bean (Predatory thrips)
Citrus psylla **Parasitoids:** *Tamarixia radiata, Diaphorencyrtus aligarhensis* (nymphal and adult) **Predators:** *Chrysoperla zastrowi sillemi,* coccinellids, syrphids	**Attractant plants:** Carrot family, sunflower family, buckwheat, alfalfa, (minute pirate bug, lacewing, syrphids)
Mealy bug **Predators:** Parasitic wasps, hover flies, ladybugs or mealy bug destroyers (*Cryptolaemus montrouzieri*)	**Attractant plants:** Coriander attracts wasps
Citrus butterfly **Parasitoids:***Trichogramma evanescens,Telenomus* spp., (egg), *Brachymeria* sp (larval), *Pterolus* sp. (pupal)	**Attractant plants:** Carrot family, sunflower family, buckwheat, alfalfa, shrubs (Lace wing) • Nectar rich plants with small flowers *i.e.* dill, mustard, sunflower, buckwheat and cowpea (Braconid wasp)

(NIPHM report, 2014)

altitudes.

Control of vectors:

– Systemic pesticides used for psyllid control on young non-producing trees and contact pesticides used on older trees.

Control of the greening pathogen:

– Thermotherapy
  - Treatment of bud wood, seedlings or other plant material at high temperature (*i.e*. 47^0 C for 2 hr)
– Shoot-tip grafting
– Chemotherapy
  - Injection or treatment with antibiotics
– Breeding for resistance

Other suggested control measure:

– Produce greening-free trees
– Use shoot-tip grafted material
– Use sticky yellow traps to identify nursery and groves that have psyllids
– Remove abandoned trees/groves and alternate host (Table 1).

Conclusion:

Insect pests on citrus have rich natural enemy complexes and mostly are under natural control. Some of the pests such as mealy bug *Drosicha stebbinji*, fruit flies *Bactrocera* spp., butterfly, leaf miner, scale insects *Aoinidiella* spp. and citrus psylla need to be addressed on priority. All these pests too have good natural enemies complexes, however some of the agricultural practices impact on natural enemies that need to be identified. There is need to develop techniques which encourage natural control. Biological control through augmentation and conservation of parasitoids integrated with other non pesticide measures need to be tested with holistic approach in citrus.

Citrus is a perennial crop therefore all negative approaches of applying insecticides should be avoided. The pest control should be integrated rather than depending only on chemical control as most of the farmers do. Therefore pests should be monitored regularly to know their abundance and time of activity. This aids in making timely decisions and maintaining farmer's economic and environmental balances. More attention should be given to the knowledge of the biology and ecology of parasitoid species, both to better use them in biological control programmes and to enhance natural bio-control.

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