Entomology

Insect pests of important fruit crops and their recent management strategies in emerging horticulture hub of Andhra Pradesh-Ananthapuramu

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Abstract

The 'Mission Horticulture Hub' envisaged by Andhra Pradesh government to develop the Ananthapuramu district with a semi-arid climate registering an annual rainfall of less than 500 mm is catching up among the farmers despite the adverse climatic conditions and groundnut being its principal crop. Farmers keen on shifting from groundnut cultivation to raising fruit gardens as it is proving remunerative. Mango plantations are spread over 40,000 hectares, sweet oranges 40,000 hectares, banana 10,000 hectares, pomegranate 10,000 hectares, grape 500 hectares and vegetables in 30,000 hectares apart from sapota, guava and papaya in considerable extent. For efficient fruit production, the insect-pest poses a major challenge. Citrus, Pomegranate, Guava and Banana receive more attention.

Keywords: horticulture, fruits, insect-pests, semi-arid

Introduction

The 'Mission Horticulture Hub' envisaged by Andhra Pradesh government to develop the district with a semi-arid climate registering an annual rainfall of less than 500 mm is catching up among the farmers despite the adverse climatic conditions and groundnut being its principal crop. Farmers keen on shifting from groundnut cultivation to raising fruit gardens as it is proving remunerative. Horticulture crops was raised in 1.5 lakh hectares in Anantapur during 2015-16. The fruits grown in the district are said to be the best, tastier and sweeter than fruits produced at other places. The district's extent of horticulture crops is nearly 1.50 lakh hectares (3.75 lakh acres) in the year 2015-16. Mango plantations are spread over 40,000 hectares, sweet oranges 40,000 hectares, banana 10,000 hectares, pomegranate 10,000 hectares, grape 500 hectares and vegetables in 30,000 hectares apart from sapota, guava and papaya in considerable extent (www.thehansindia.com). The district officials from the departments of horticulture, minor irrigation, DWAMA and other stakeholders under the leadership of Collector are racing against time to pull the district out of the clutches of drought and to banish drought conditions permanently from the district by developing horticulture crops. The gross value addition (GVA) of horticulture produce from the district is around Rs 4,067 crore every year. The Department of Horticulture is promoting horticulture in the district under the 'Mission for Integrated Development of Horticulture' funded by the Union government. It is also doing a great deal in rejuvenation of old orchards through micro-irrigation projects. Promotion of protected horticulture in the form of poly houses, green houses and digging of nearly 1.50,000 farm ponds both by DWAMA and horticulture departments is also contributing to recharging of groundwater and also in developing the district as a horticulture hub. This paper provides an up-to-date illustrated account of the various pests of fruit crops throughout Ananthapuramu, many of which (or their close relatives) are also present in other regions. In fact, several pose problems on fruit crops worldwide. This authoritative book focuses on insect and mite pests affecting fruits in subtropical climates. Citrus, Pomegranate, Guava and Banana receive more attention (David, 2017) [6].

Citrus

1. Citrus psylla, *Diaphorina citri* Kuwayana (Aphalaridae: Hemiptera)

Distribution

India, China, Formosa, Japan, Myanmar, Sri Lanka, and New Guinea

Host range

In India, it has been recorded on all species of citrus and a number of other plants of the family Rutaceae.

Morphology

The adult rests on the leaf surface with closet wings, the tail end of the body being turned upwards. The wings are membraneous, semi-transparent, with a brown band in the apical half of the fore wings. The hind wings are shorter and thinner than the fore wings. The nymphs are flat, louse-like and orange yellow creatures, and are seen congregated in large numbers on young leaves and has Almond-shaped, orange and stalked eggs.

Biology

Site of oviposition is on tender leaves and shoots of citrus trees. The eggs are laid either singly or in groups of two or three and are arranged in straight line. Eggs are orange to yellow initially turned darker as they are ready to hatch. On emerging, the light-yellow nymphs have a tendency to stick close to the egg shell. The egg and nymphal periods are 4-6 and 10-11 days respectively. There are five nymphal stages. Full-grown nymphs migrate to the lower surface of leaves, where they change into adults. The adults copulate 4-8 days after emergence and the females start laying eggs immediately afterwards. The females live longer than males, and the duration may be as long as 190 days in winter and only 12-26 days in the summer. In summer, the life-cycle is completed in 14-17 days. There are 8-9 overlapping generations in a year.

Damage

Damage is caused by both nymphs and adults damage are so long-lasting that the trees may look sickly even when the population is not high. They suck the cell-sap & vitality of the plants deteriorates, and the young leaves and twigs stop growing further. The leaf-buds, flower buds and leaves may wilt and die. Nymphs secrete honeydew which acts as a medium for sooty mold fungus that adversely affects photosynthesis. It is also thought that the insect produces a toxic substance in the plants as a result of which the fruits remain undersized and poor in juice and insipid in taste. Psyllid feeding also results in reduction of shoot length giving a witches' broom effect. It acts as vector for the greening virus or 'Huang Long Bing' or yellow dragon disease, caused by *Candidatus liberobacter* Sp.

Management

Collect and destroy the infested plant parts. Pest population may be reduced to a great extent by conserving the natural enemies which are quite abundant in citrus ecosystem. *Tetrastichus radiatus* (Eulophidae) is an important parasitoid of nymphs and is distributed in all the citrus grooves. Conserve parasitoids such as *Tamarixia radiata, Diaphorencyrtus aligarhensis* and predators viz *Coccinella septempunctata, C. transversalis, Menochilus sexmaculatus, Chilocorus nigrita* and *Brumoides suturalis* (Coccinellidae), and *Chrysoperla carnea* (Chrysopidae) larvae also feed on nymphs during March with the appearance of the pest and again in the first week of September. Protection equipment used are very effective at controlling both the nymphs and the adults. Foliar spray of Systemic insecticides like imidacloprid 17.8% SL @ 50 ml depending on size of tree & thiamethoxam 25% WG @ 40 g in 400 L of water/acre.

2. Citrus Blackfly, *Aleurocanthus woglumi* Ashby (Aleyrodidae: Hemiptera)

Distribution

India, Sri Lanka, the Philippines, Jamaica, Kingston, Cuba and Bahamas. Punjab, Maharashtra, Karnataka, West Bengal and Madhya Pradesh. It is a serious citrus pest of Asian origin (Dietz and Zetek 1920) [7].

Host range

Citrus fruits, especially the sweet orange, Indian mulberry *Morinda tinctoria* and malta, *Murraya koenigii*, avocado, grapevine, mango, guava, pear, plum, etc.

Morphology

The adult fly is dark orange with smoky wings and fore wings having four whitish area of irregular shape. The female flies are bigger than males. Yellowish brown oval shaped eggs which are arranged in a spiral on broad leaves. The nymphs are scale-like, shiny black and spiny, and are bearded by a white-fringe of wax. The pupa is oval, black in colour and its dorsum is arched with long black spines, and the margins have rounded black teeth. At emergence, the head is pale yellow, legs are whitish, and eyes are reddish-brown. Within 24 hours after emergence, the insect is covered with a fine wax powder which gives it a slate blue appearance.

Biology

The adult's females lay 15-22 eggs in cluster. Site of oviposition spiral pattern on the underside of the leaf. Each female lays two to three egg-spirals. They pass through four nymphal instars. The first instar is elongate-oval, brown in colour, with two glassy filaments curving over the body. The second instar is more ovate and convex than the first instar and is dark brown in colour with numerous spines covering the body. The third instar is more convex and much longer than the second. The body is shiny black with spines stouter and more numerous than those in the second instar. The sex is readily distinguishable based on size at pupal stage. Site of pupation is on the leaf surface. The egg, nymphal and pupal periods are 7-14, 38-60 and 100-131 days respectively.

Damage

Both adults and the nymphs suck plant sap, reducing the vitality of trees. It results in the curling of leaves and also the premature fall of flower buds and the developing fruits. The pest attack 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. Honeydew secretion and sooty mould growth, locally called as 'Kolshi', covering entire plant affecting photosynthesis.

Management

Collect and destroy the damaged plant parts along with nymphs, pupa and adults. Use light trap (wavelength of 550 nm)**.** Yellow sticky traps or cards reduce the density of black flies. The hymenopterous parasites recorded on this pest are *Encarsia divergens*, *E. merceti* and *Eretmocerus serius* (Aphelinidae).

3. Citrus Caterpillar; Lemon butterfly, *Papilio demoleus* Linnaeus (Papilionidae: Lepidoptera)

Distribution

Africa, greater part of Asia as far as Formosa and Japan. All over India and causes very severe damage.

Host range

All varieties of cultivated or wild citrus and various other species of the Rutaceae, curry leaf, *Aegle marmelos* and *Psoralea corylifolia*.

Morphology

Eggs are pale or greenish yellow, when freshly laid, but later

turn brown, becoming dark grey just before hatching. The full gown caterpillar is yellowish green, cylindrical with a horn-like structure on the dorsal side of the last body segment. The adult butterfly head and thorax are black, there being creamy-yellow coloration on the underside of the abdomen. The butterfly has black and yellow markings on its large wings. Its wings are dull-black, ornamented with yellow markings. The general coloration on the underside of the wings is slightly paler and the markings are also larger. The antennae are black and have club like structures at their ends. The chrysalis is fastened to the plant by a girdle of fine silken threads.

Biology

This pest is active throughout the year. The butterflies appear in March. Eggs laid singly on tender shoots and fresh leaves, mostly on the undersurface. The eggs are placed singly or in groups of 2-5. The larvae show preference for young and shiny leaves of citrus. The black or brown and white markings make the early instar larvae look like bird droppings. Larvae rarely pupate on which they had been feeding. The pest is tri/tetra voltine in nature.

Damage

Serious pest in nursery. The young larvae feed only on fresh leaves and terminal shoots. Habitually, they feed from the margin inwards to the midrib. In later stages, they feed even on mature leaves and sometimes the entire plant may be defoliated. The pest is particularly devastating in nurseries and its damage to foliage seems to synchronize with fresh growth of citrus plants in April and August-September. Heavily attacked plants bear no fruits.

Management

Hand picking of various stages of the pest and their destruction especially in nurseries and new orchards helps to suppress the population of the pest Spraying *Bacillus thuringiensis*, or nematode DD-136 strain or neem seed extract (3%) is effective at larval stage. The egg parasitoids are *Trichogramima evanescens, Pieromalus luzonensis* (Pleromalidae) and *Telenomus sp*. (Scelionidae), while larvae are parasitized by *Erycia mymphalidaephaga, Charops* sp. (Ichneumonidae) and *Brachymeria sp.* (Chalcididae). In severe infestation, spray quinalphos 25 EC or 2.0 litres of carbaryl 50 WP in 1250 litres of water per ha during April (after fruit set) and October (after rainy season) Spray application of profenofos 0.05% or cypennethrin 0.025% controls the pest.

4. Citrus Leaf-miner, *Phyllocnistis citrella* Stainton (Gracillariidae: Lepidoptera)

Distribution

Australia and India. Serious and common pest of citrus nurseries. The citrus leafminer (CLM), *Phyllocnistis citrella* Stainton, is a potentially serious pest of citrus andrelated Rutaceae and some related ornamental plants (Beattie 1989, Clausen 1933, Kalshoven 1981) [4, 5, 10].

Host range

Citrus pomelo, willow, cinnamon, *Loranthus* spp. etc

Morphology

Eggs are minute, flattened, spherical and transparent. The full-grown larva is pale yellow or pale green with light-brown well developed mandibles and apodous. In body form, the pupa is not much different from the larva, but turns slightly brownish. The adult is a tiny moth. On the front wings there are brown stripes and prominent black spots along the tips. The hind wings are pure white and both pairs are fringed with hairs.

Biology

Eggs laid on young leaves or tender shoots, on the lower surface, near the midrib. Soon after emerging, the apodous larvae mine into the leaf tissue and form galleries within which they remain confined their immature life. By the time they spin cocoons for pupation, the leaves get twisted or folded over. Site of pupation inside the leaf mine. It is partly exposed through the gallery wall and has a spine on its head with the help of which it pierces through the wall as it emerges as a moth. The egg, larval and pupal periods is 2-10, 5-30 and 5-25 days respectively. Total duration is 12-55 days depending upon the temperature. Several overlapping generations per year.

Damage

The larva mines in between the epidermal layers of the leaf in a zig-zag manner which results in distortion of the leaf lamina. Serious infestation causes retardation in growth. The injured epidermis takes the shape of twisted silvery galleries. On older leaves, brownish patches are formed which serve as foci of infection for citrus canker. Orange, mandarins, lemons, limes, grape-fruit are highly susceptible. Mature citrus trees (more than 4 years old) generally tolerate leaf damage without any effect on tree growth or fruit yield. Citrus leaf-miner is likely to cause damage in nurseries and new plantings because the growth of young trees is retarded by leaf-miner infestations.

Management

Use pheromone trap (@5/acre. Pruning of affected parts during winter and burning. Spray of 2% neem seed extract has been found quite effective and safe. Conserve larval parasitoids - *Cirrospiloideus phyllocnistoides, Scotolinx quadristriata* and *Eurytoma* sp. Spray 1.25 litres of fenvalerate 20EC or 2.5 litres of cypermethrin 10 EC or 3.125 litres of triazophos 40EC or 4.5 litres of chlorpyriphos 20EC in 1250 litres of water per ha during April. May and August-September. Synthetic pyrethroids should be avoided on full grown trees. Carbofuran 3% CG @ 20000 g/acre; Foliar spray with imidacloprid 17.8% SL @ 50 ml and use spray volume depending on size of tree & protection equipment used; Foliar spray with phorate 10% CG @ 6000 g/acre.

5. Fruit-sucking Moths, *Otheris* spp., *Elygea materna* (L.) and *Rhytia hypermenestra* Stoll (Noctuidae: Lepidoptera)

Distribution

Throughout India *O. materna* Cramer, *O. fullonica* (Clerck), *O. homoen* Hbr., and *O. ancilla* Cramer are the commonest species. *Achaea janata* is also fruit sucking moth. adult lepidopterans cause damage to fruits, when a French botanist Thozet observed for the first time *Eudocima (=Othreis) fullonia* (Clerck) moths sucking juice from ripe orange fruits at Rockhampton in Australia (Baptist, 1944) [3]. Later this was confirmed by the observation of Kunckel in 1875 in Australia.

Host range
Citrus, mango, grapes, pomegranate and apple.

Morphology
The eggs are round and translucent. These moths are large and stoutly built and their prominent palpi are turned upwards. The forewings in *O materna* are pale greenish-grey with palish-white markings and the hind wings are orange brown, having marginal dark bands mixed with white spots. The larvae are typical semiloopers and have a stout appearance. Their velvety dark brown background along with other patterns makes them cryptic. They have distinct eye-spots on the head, yellow or red lateral spots and a dorsal hump on the last segment of the body. A full-grown larva when disturbed, it poses a threatening posture by curving round the head and raising the hind part of its body. The full grown larva is a semi looper, with orange, blue and yellow spots on its velvetty dark speckled body. The pupa is thick-set and is dark reddish brown.

Biology
The moths are nocturnal. The moths emerge in large numbers soon after rains. Eggs laid on wild plants and weeds of Minospermaceae, namely *Tinospora cardifolia, T. smilacina, Cocculus hirsutus, Cirsampelos pareira, Convolvulus aruentis, Trichisia pattens* and *Pericampylus glancus*. They hatch in about two weeks and within 24 hours of emergence, the young larvae start feeding on the foliage of host plants. A larva passes through five instars in four weeks. Pupal case by webbing together pieces of leaves and soil particles or in leaf fold. This stage lasts about two weeks. The moths, on emergence, fly to nearby orchards for feeding on fruit-juice. Moths emerge in spring, when they start breeding & the second brood in July. They damage citrus plants up to October. The pupae of the third brood hibernate. The egg. larval and pupal periods are 3, 20 and 9 days respectively.

Damage
It is a serious pest of maturing mandarin fruits. Unlike most moths and butterflies, the fruit-piercing moths cause damage in the adult stage. With the help of its strong, piercing mouthparts, moth punctures the fruit for sucking juice. Characteristic pin-hole damage in citrus and other fruits. Bacterial and fungal infections take place at the site of attack, as a result the brownish mouth of the puncture becomes pale and eventually the whole fruit turns yellow. It drops off the tree and apparently looks like a premature fruit. If the damaged fruit is squeezed, the juice spurts from the hole. In severe cases of infestation, almost all the fruits are lost.

Management
Systematic destruction of alternate host plants in the vicinity of the orchard**.** Dispose off fallen fruits which attract the moths. Installation of one fluorescent light trap/acre before 7.00 PM and 11.00 PM. Trap crop-tomato**.** Bagging of fruits with polythene or paper covers is effective but very laborious and expensive**.** Creating smoke in the orchards after sunset ward off the pest. The moths can be caught with light torches and killed. Spray trees with 2.5 kg of carbary1 50WP in 500 litres of water per ha at the time of maturity of fruits. Kill moths with a bait containing gur 1 kg + vinegar 60 g insecticides water 10 litres. Wide mouthed bottles (1 bottle per 10 trees) containing bait solution should be tied to the plants when the fruits are in unripe condition.

Guava

1. Tea mosquito bug *Helopeltis antonii* Signoret (Miridae: Hemiptera)

Distribution
All over India. It is serious on tea in Kerala.

Host range
Tea, neem, cashewnut, guava etc.

Morphology
Eggs are elongate and slightly curved or sausage shaped with a pair of long filaments like processes which remain jutting out from the tender plant tissue in which the eggs are bedded by the female. The newly hatched nymphs resemble spider in general appearance with elongate appendages. Adults are reddish brown bug with black head, red thorax, black and white abdomen.

Biology
Egg and nymphal period are 7-8 and 14-16 days respectively. Life cycle completed in 22-25 a knob like process on mid-dorsal thorax. They undergo five moults and complete one generation in two weeks in June and eight weeks or more in cold weather.

Damage
Nymphs and adults make punctures on petiole, tender shoots and fruits. The blisters are formed due to the toxic substance injected by the bugs on the foliage. Elongate streaks and patches develop on shoots. Corky out growth or scab formation on fruits and drying of shoots that reduces marketability. Maintain proper sunlight in the plant canopy by adequate pruning. Collect and destroy the damaged plant parts.

Management
Do not interplant guava with alternate crops such as cotton, tea, sweet potato, cashew, mango etc. Conserve predators such as *Mallada sp.*, *Oxyopes sp.*, Reduviid bug. Periodical spray application of malathion 0.1% has been reported to minimize damage.

2. Fruit fly - *Bactrocera correcta* (Bezzi), *Bactrocera dorsalis* (Hendel)

Guava fruits are attacked by five species of fruit flies, *viz. B. dorsalis, B diversus* (Coquillett), *B. cucurbitae* (Coquillett), *B. nigrotibialis* (Perkins) and *B. zonata* (Saunders). However, among these, the former two (Tephritidae: Diptera) are most common and serious pests of guava.

Damage
Presence of dark green sunken patches. Adults and maggots attack semi-ripe fruits Oviposition punctures on fruits. Maggots destroy and convert pulp into a bad smelling Discoloured semi liquid mass.

Management
Orchard sanitation is essential. Remove regularly the fallen infested fruits and bury them in at least 60 cm deep pit. The pit

may be covered with clay after every 2-3 days and should not be allowed uncovered for a longer period. Tillage of tree basin helps in checking the pest population as the pupae and hibernating larvae are destroyed by natural enemies. Avoid taking rainy season crop which may get heavily infested by the pest Plough and stir the soil well before June-July to expose and kill pupae. Harvest the fruits when slightly hard and green in colour. Bait application technique (BAT). Conserve parasitoids such as *Opius compensates*, *Spalangia philippinensis*, *Diachasmimorpha kraussi* etc. Spray 3.125 litres of fenvalerate 20EC in 1250 litres of water per ha at weekly intervals on ripening fruits commencing from July onwards till the rainy season crop is over. Harvest fruits 3rd day after spray.

3. Whitefly

Spiralling whitefly is a serious insect pest. Wooly whitefly *Aleurothritus floccosus* was found recently infesting guava. Strict quarantine measure required to restrict its spread.

Morphology

Eggs are smooth, sub elliptical, stalked at broader basal end. Its colour is light yellow, when freshly laid, turn dark brown later on. Nymph is louse like, sluggish creature having pale-yellow body. Convex in shape and possesses deep yellow patches on the abdomen. Adult fly is small winged insect having light yellow body o dusted with a white waxy powder. Wings are pure white and have prominent long legs.

Biology

Eggs singly laid on the underside of the leaves. The eggs, nymphal and pupal periods are 5-17. 14 to 81 and 2-8 days respectively. The life cycle is completed in 14-122 days. It is multivaltine pest Temperature of 28-36°C and 62-92% relative humidity and scanty rainfall during August to January are quite favorable.

Damage

Chlorotic spots, yellowing, downward curling and drying of leaves. Vector of potato leaf curl disease.

Management

Collect and destroy the infested plant parts. Remove other hosts. Deep ploughing of the field. Overlapping and overcrowding branches should be pruned. Conserve natural enemies Predators: *Chrysoperla carneu*, *Scymmus coccivora*, *Cryptolaemus montrouzieri*, and *Spalgis epius* and Parasitoids: *Aenasius advena*, *Blepyrus Coccophagus* and *C. bogoriensis* (Aphelinidae). Release *Cryptolaemous montro*uzieri beetles @ 10/tree. In case of severe attack, spray 2.5 litres of diazinon 20 EC or 1.25 litres of monocrotophos 40EC in 1250 litres of water per ha.

4. Guava mealy scale, *Chloropulvinaria psidii* (Maskell) (Coccidae: Hemiptera)

Distribution

Punjab, Uttar Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu.

Host range

Guava, coffee, tea, citrus, mango, gular, jack-fruit, jamun, litchi, loquat, sapota, many other shrubs and trees etc.

Morphology

The adult scales are shield-shaped, oval, yellowish green. Eggs are laid beneath the body of mature female in a conspicuous egg-sac and later the female dies. The first instar nymphs or crawlers are the active dispersive phase responsible for starting new infestation. Yellow to pale white in colour. Adult females apterous, long, slender covered with white waxy secretions Biology Egg, nymphal and adult periods are 28-32, 21-29 and 23-28 days respectively. The total life span of female and male 46-49 and 23-29 days. The reproduction occurs both sexually as well as parthenogenetically. Three to four nymphal instars.

Damage

The scale insects are found in large numbers sticking to leaves on ventral side, tender twigs and shoots. They suck sap from ventral side of leaves, petioles, tender shoots and occasionally from fruits. They cause leaf distortion and growth disturbance. The females feed voraciously and also exude copious quantity of honeydew which encourages the development of sooty mould on foliage and interferes with photosynthetic activity of plants and spoils the market value of fruits. Severe infestation could kill the branches. Infested fruits will have uneven shapes, poor quality, and are susceptible to secondary infections by pathogens.

Management

Collect and destroy the infested plant parts. Remove other hosts. Deep ploughing of the field. Overlapping and overcrowding branches should be pruned**.** Conserve natural enemies Predators: *Chrysoperla carneu*, *Scymmus coccivora*, *Cryptolaemus montrouzieri*, and *Spalgis epius* and Parasitoids: *Aenasius advena*, *Blepyrus Coccophagus* and *C. bogoriensis* (Aphelinidae). Release *Cryptolaemous montro*uzieri beetles @ 10/tree. In case of severe attack, spray 2.5 litres of diazinon 20 EC or 1.25 litres of monocrotophos 40EC in 1250 litres of water per ha.

Banana

1. Banana weevil or banana beetle or banana borer *Cosmopolites sordidus* (Germar) (Curculionidae: Coleoptera)

Distribution

Native to South-east Asia. One of the most serious insect pests of banana all over the world, found distributed in South Asia, Africa, many pacific islands, Australia, Northern South America, Central America, West Indies and some parts of North America. In India reported as serious pest in Kerala, Tamil Nadu, Andhra Pradesh and other banana growing areas. Banana production has declined due to the banana corm weevil *Cosmopolites sordidus* Germar and it is considered as a major pest (Waterhouse and Norris 1987; Gold *et al.,* 2001) [15, 8].

Host range

Attacks only members of the genus Musa.

Morphology

Grub is apodous, yellowish white with red head. Pupa is white in colour, occur in inside the tunnels of corm. Adult is dark weevil, newly emerged weevil is red brown.

Biology

It oviposits in root stock/leaf sheath just above ground level. A female can lay 10-50 eggs. The egg, larval and pupal stages are completed in 5-7, 15-20 and 6-8 days, respectively. The larvae after emergence bore into the corm, where they feed, making a tunnel. Site of pupation in the same tunnel. The adults, on emergence, remain in the soil for some time, feeding on the underground parts of the plants before going for oviposition. Adults can live over two years without food. Weevils are nocturnal in habit & during day they hide in debris or in soil.

Damage

Grubs bore into the rhizome, tunnels in it and cause death of the plant. Withering of outer leaves & finally the plant blow-down by even slight winds. Presence of dark coloured tunnels, blackened mass of rotten tissues on rhizomes. The seedlings are killed as a result of the borer attack when the larvae approach the growing point. If the infestation occurs on a mature rhizome, damage symptoms appear through the reduction in the leaf number, bunch size and the fruit number. Since the weevils do not attack the roots, they do not cause toppling over.

Management

Pheromone lure ("cosmolure") @ 2/acre can be used for monitoring as well as trapping. Avoid growing varieties like Robusta, Karpooruvally, Malbhog, Champa and Adukkar. Grow less susceptible varieties like Poovan, Kadali, Kunnan, Poomkalli. Use of cover crop Calopogonium. Drenching with chlorpyriphos 0.1% emulsion in the soil before planting may afford some relief. Treatment of banana sucker with insecticide before planting is called pralinage. Suckers should be dipped in 0.1% quinalphos emulsion before planting. In case of attack, spray 315 ml of phosphamidon, 100 or 625 ml of dimethoate 30EC or fenitrothion 50 EC in 625 litres of water per ha around the base of the plants or clumps. Before planting, the suckers should be dipped in carbofuran 3% CG @ 33g/ sucker then shade dry for 72 hrs then go for planting for rhizome weevil.

2. Banana pseudo stem borer *Odoiporus longicollis* (Olivier) (Curculionidae: Coleoptera)

Distribution

Serious pest in North-east India the distribution of the BPW is reviewed by Krishnan *et al.* (2015; 2020) [13, 12].

Morphology

The adult is a robust reddish-brown weevil. Eggs are yellowish-white, cylindrical in shape. The grub is apodous, yellowish with reddish head. Pupa is pale yellow color, fibrous cocoon formed inside the tunneling on the periphery.

Biology

Site of oviposition in small burrow in the rhizome or within leaf sheaths just above the ground or at random on cut ends of pseudostem. Site of pupation in tunnel towards the periphery. The pupal period lasts 20 24 days in summer and 37-44 days in winter. Egg, grub and pupal periods are 3-5, 26 and 20-24 days respectively. The adult lives for a period of upto two years. Infestation of the weevil normally starts in 5 month old plants.

Damage

Both the grubs and adults cause the damage. Grubs bore into the rhizome and pseudo stem and make tunnels within it leading to wilting of the plant and exudation of a gummy substance from the holes on the pseudo stem. Early symptoms of the infestation are the presence of small pinhead sized holes on the stem, fibrous extrusions from bases of leaf petiole. In advanced stages of infestation, the stem when split open will show extensive tunneling both in the leaf sheath and in the true stem. Rotting occurs and foul odour is emitted due to secondary infection of pathogens. Adults also tunnel within the stem, feeding on its internal tissues as a result of which the internal shoot is killed. Infested plants show premature withering, leaves become scarce, fruits become undersized and their suckers are killed outright. Tunneled part decomposes and pseudostem becomes weak. The estimated yield loss due to this pest is between 10-90% depending on the growth stage in which the infestation occurs and it is the highest in 5 months old crop.

Management

Use longitudinally split pseudo stem trap at 26/acre for monitoring as well as mass trapping purposes. Field sanitation by removing and destroying the affected plants along with rhizome and also the destruction of pseudo stem and rhizome of harvested plants is the most important method. Prune the side suckers every month. Use healthy and pest free suckers to check the pest incidence. Do not dump infested materials into manure pit. Uproot infested trees, chop into pieces and burn. Suckers should be dipped in a solution of Malathion (0.2%) to kill eggs inside. Spray 2.5 kg of carbaryl 50WP in 1250 litres of water/ha. Application of carbofuran 3g @ 30g/plant at planting and @ 15g/plant at 60th and 90th day after planting. Spray application of quinalphos 0.05% or chlorpyriphos 0.03% or carbary) 0.2% at planting. In case of severe infestation spraying may be repeated after 3 weeks.

3. Banana aphid *Pentalonia nigronervosa* (Coquerel) (Aphididae: Hemiptera)

Distribution

It is present everywhere in the world where banana is grown.

Host range

Banana, cardamom, large cardamom (*Amomum subulatum*), *Colocasia untiquorum*, Heliconia, ginger, pink ginger etc.,

Morphology

Nymphs are oval or slightly elongated, reddish brown with six segmented antennae. Adults are small to medium sized, shiny, reddish to dark brown or almost black. They have six segmented antennae and prominent dark veins.

Biology

The aphid lives in colonies within the leaf-axils, or central whorls of leaves and at base of the culm at the ground level. Young ones produced parthenogenetically. An aphid is capable of producing 30-50 nymphs in its life time of 27-37 days. Adults start producing young one day after reaching maturity. They can give birth to 4 aphids per day with an average production of 14 off spring per female. The nymph undergoes four instars of 2-3 days duration each. Total life-cycle is completed in 8-9 days. From 30 to 40 generations are completed during a year under South Indian conditions.

Damage

The aphid is however important not as pest but as a vector of a very serious disease called bunchy top of banana. It also transmits cardamom mosaic ('katte' disease). Both nymphs and adults suck the sap from the tender leaves. Leaves are bunched into a rosette appearance. Leaf margins are wavy and upward rolling. Infected plants don't produce bunches. Feeding also results in honey dew secretion on which the sooty mould grows resulting in decrease of photosynthetic activity and vigour of the plant. BBTV is transmitted by vegetative propagation and the aphid vector, *Pentalonia nigronervosa* (Hu *et al.*, 1996) [9].

Management

Use yellow sticky trap @ 4-5/acre. Remove weeds which are attractant to aphids. Select tolerant varieties such as Poovan, Pachanadan. Encourage activity of predator coccinellids such as *Scymms*, *Chilomenes sexmaculatus*, and lacewing, *Chrysoperla zastrowi*. Apply carbofuran 3% CG @ 166g/sucker or dimethoate 30% EC @ 594-792 ml in 600-800 1 of water/acre or oxydemeten-methyl 25% EC @1200-1600 ml in 600-800 I of water/acre, direct the spray towards the crown and pseudostem base upto ground level. Application of 25 g of phorate 10G or 20 g of carbofuran 30 plant 20 days after planting around the rhizome in the soil. Application of 12 g phorate 10G or 10g of carbofuran 3G /plant in the leaf axils or 25 g phorate 10G or 20 g carbofuran 3G/plant in the soil 75 days after planting which may be repeated 165 days after planting.

Pomegranate

1. Anar butterfly, *Virachola isocrates* (Fabricius) (Lycaenidae: Lepidoptera)

Distribution

Widely distributed in India and adjoining countries.

Host range

Aonla, apple, ber, citrus, guava, litchi, loquat, mulberry, peach, pear, plum, pomegranate. sapote, wood apple, tamarind etc.

Morphology

Eggs are oval, shiny white. The full-grown caterpillars are dark brown in colour and have short hair and whitish patches all over the body. The bluish brown butterfly has an orange spot on each of the fore wings and black spots on the hind wings.

Biology

The pest breeds throughout the year on one fruit or the other. Eggs laid singly on the calyx of flowers and on small fruits. The eggs, larval and pupal periods are 7-10, 18-47 and 7-34 days respectively. Site of oviposition inside the fruit but occasionally may pupate outside even, attaching themselves to the stalk of the fruit. There are four overlapping generations in a year. The total life cycle may take 1 to 2 months. Karbre and Mohalkar (1991) [11] reported that the peak activity of *V. isocrates* was started during November when the flowering and fruit setting were noticed.

Damage

The caterpillars cause such a heavy damage by boring the fruits and feed on the pulp and riddling through the seeds just below the rind & that this is major pest. Larva feeds inside the seed and characteristically plugs the bore hole with fecal material. As many as eight caterpillars may be found in a single fruit. The infested fruits are also attacked by bacteria and fungi which cause the fruits to rot. The affected fruits ultimately fall off and give an offensive smell. This pest may cause from 40 to 90 per cent damage to the fruits.

Management

Bagging of fruits with polythene/ paper bags before maturity will help in checking damage. Detect early infestation by periodically looking for drying branches. Clean cultivation and maintenance of health and vigour of the tree should be followed. Collection and destruction of fallen infested fruits prevents buildup of the pest. The larva is parasitized by *Brachymeria cuploeur* (Chalcididae)**.** Release of *Trichogramma chilonis* @ 1:0 lakhs/ acre four times at 10 days interval**.** Five spray applications of fenvalerate 0.01%, fluvalinate 0.01%, carbaryl 0.2% or triazophos 0.05% at intervals of three weeks commencing at initiation of fruit setting may afford control of the pest.

2. Shot hole borer *Xyleborus fornicates* Eichhoff (Scolytidae: Coleoptera)

Morphology

Eggs are oval or round, shiny and iridescent white. Larvae are white and legless. Adul black to reddish-brown, and cigar shaped. They have a short, stubbed head capsule, with chewing mouthparts. Male adults do not fly.

Biology

Egg, grub and pupal periods are 4, 9 and 4 days respectively. Two generations per year Favourable conditions: They survive in temperatures ranging from -26 to 15°C. The flight activity is greatest late afternoon or early evening and the beetles usually fly at or below 15 ft.

Damage symptoms

Adult females bore into the basal part of the stem and roots. Causes small shot holes on roots, main trunk, wilting and finally leads to death of the tree.

Management

Avoid water logging and rake the soil. Infested trees should be uprooted and brunt, especially the root zone. Prune the affected fruits and buds of the plant and destroy. Detect early infestation by periodically looking for drying branches. It is a serious pest of pomegranate in Maharashtra and can be controlled by spray application on stem thrice at 15-day interval with chlorpyrifos 0.25% or carbaryl 0.1%.

3. Thrips *Rhipiphorothrips cruentatus* Hood (Thripidae: Thysanoptera)

Damage

Two species of grapevine thrips *viz.*, *Retithrips syriacus* Mayet and *Rhipiphorothrips cruentatus* Hood have been reported on pomegranate by Ananthakrishnan (1971) [1]. Another species of thrips, *Scirtothrips dorsalis* though recorded as minor pest on pomegranate, is assuming a status of key pest on pomegranate under the semi arid conditions (Bagle, 1993) [2]. Both nymphs and adults feed on the underside of the leaves by rasping the surface and sucking the Leaf tip turn brown and get curled,

drying and shedding of flowers and scab on fruits which will oozing cell-sap. Reduce the market value.

Management

Keep basin clean. Maintain adequate aeration by proper training and pruning. Prune the affected parts of the plant and destroy. Detect early infestation by periodical monitoring for drying branches. Use of blue sticky traps @ 4-10 traps/acre. Conservation and release of defenders like Syrphids and Coccinellids should be done to suppress sucking pests.

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