Status of *Conogethes punctiferalis* (Guenée) in South of Vietnam

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Abstract

Currently over a dozen species of *Conogethes* have been recognized. Of which, *Conogethes punctiferalis* is prevalent on several plants and well distributed in South of Vietnam. Species of *Conogethes* infesting ginger and other Zingiberaceae belong to another species. Durian, soursop, longan, and rambutan are the major fruit crops infested by *C. punctiferalis* in Vietnam. Integration of cultural, mechanical, biological, and chemical methods has proven effective against this borer pest. Augmentation and supplement releases of parasites and encouragement and conservation of predators and natural enemies is necessary for suppressing *Conogethes* borer populations in fruit orchards and plantations.

Keywords

Durian · Ginger · Integrated pest management · Vietnam

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6.1 Introduction

Fruit borer, *Conogethes punctiferalis* (Guenée), is a highly polyphagous pest; the larvae bore into fruits, seeds, and stems of plants of many different families. It has been reported from various parts of the world, mainly because larvae are imported alongside fruits. Records include Hawaii, Great Britain, and the Netherlands. This is a species complex and incomplete information on their separation has been published to date. *C. punctiferalis* is found in Asia (from India eastward) and Australasia. *C. punctiferalis* species complex has been recorded from Australia, Brunei, Darussalam, Burma, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, North Korea, Papua New Guinea, the Philippines, South Korea, Sri Lanka, Taiwan, Thailand, and Vietnam (CABI 2011).

6.2 Characteristics of *C. punctiferalis* (Guenée) in South of Vietnam

6.2.1 Species of Genus *Conogethes* in South of Vietnam

Among 12 species of genus *Conogethes, Conogethes clioalis* (Walker, 1859), *C. diminutiva* (Warren, 1896), *C. ersealis* (Walker, 1859), *C. haemactalis* (Snellen, 1890), *C. minimastis* (Meyrick, 1897), *C. parvipunctalis* (Inoue & Yamanaka, 2006), *C. pinicolalis* (Inoue & Yamanaka, 2006), *C. pluto* (Butler, 1887), *C. punctiferalis* (Guenée, 1854), *C. semifascialis* (Walker, 1866), *C. tharsalea* (Meyrick, 1887), and *C. umbrosa* (Meyrick, 1886). There is one species present in South of Vietnam, i.e., *C. punctiferalis* (Guenée, 1854).

6.2.2 Synonyms

Astura punctiferalis (Guenée), *Dichocrocis punctiferalis* (Guenée), *Deiopeia detracta* (Walker), *Botys nicippealis* (Walker), and *Astura guttatalis* (Walker)

6.2.3 Host Range

Major host range: Durian (*Durio zibethinus*), guava (*Psidium guajava*), longan (*Dimocarpus longan*), rambutan (*Nephelium lappaceum*), and soursop (*Annona muricata*)

Minor host range: Ginger (*Zingiber officinale*), macadamia (*Macadamia ternifolia*), white mulberry (*Morus alba*), cotton (*Gossypium* spp.), starfruit (*Averrhoa carambola*), corn (*Zea mays*), and sunflower (*Helianthus annuus*). The species of *Conogethes* infesting Zingiberaceae is not *C. punctiferalis*. It has now been identified as *C. sahyadriensis* (Shashank et al. 2018).

6.2.4 Morphological Characteristics

The size of the larvae and adults, the numbers of black dots, as well as the distribution of the number of black dots on the wings are depending on the food as well as the host plant. The largest size of *C. punctiferalis* is obtained when reared on guava. The smallest size is seen when it is reared on soursop. Eggs of *C. punctiferalis* are oval shaped, 2–2.5 mm in length. Freshly laid eggs are creamy white and then become yellowish.

Fully grown larva is 22–28 mm in length. The head of the larva is brown, the body is white blush, prothoracic and mesothoracic segments and two ends of abdominal segments are usually pinkish white, and another one segment is pink. There are four light brown dots with spin hair on every segment of the body, two top dots are large, and two lower dots are narrow and long in shape. Each body segment has small brown dots on the side of the body, beside the black spiracle. The ventral side of the body has light brown dots on every segment with small spin hair (Fig. 6.2).

Adult wingspan is 25–30 mm in length; the body is 12–14 mm in length. The body and wings are yellow with black spots scattered (Fig. 6.1). Pupa is brownish yellow turning brown when ready to emerge, 13–15 mm in length and 4–5 mm in width.

6.2.5 Biological Characteristics

The larvae have five instars. Larvae need 12–13 days to fully develop and then go to pupal stage. The pupal stage lasts for 7–9 days.

Adults are nocturnal. They are active during 20–22 pm until 5 am. During daytime moths hide in the leaves of the trees. Both male and female often live on nectar of host plants in the orchard. After emerging, females often release sex pheromone to attract males (CABI 2005). Two to three days after mating, the females start laying eggs. Each female lays 20–30 eggs. The eggs hatch in the morning. The incubation period is 4–6 days. The life cycle of *C. punctiferalis* completes in 29–32 days. Surprisingly, the number of eggs laid/female is less.

Fig. 6.1 Adults of *Conogethes punctiferalis*

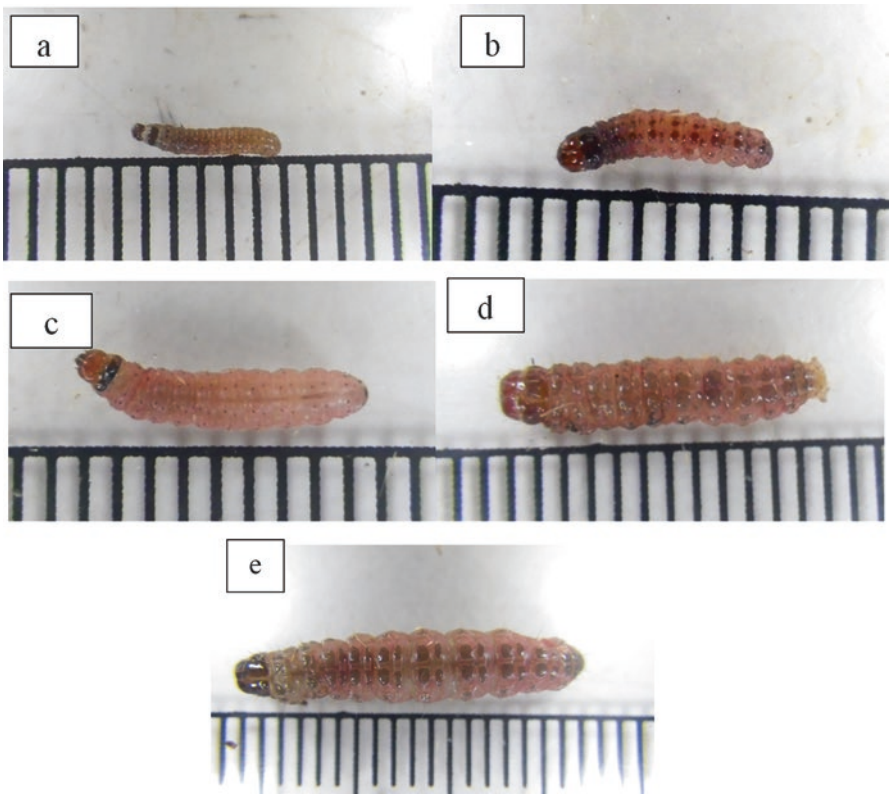

Fig. 6.2 Larvae of *Conogethes punctiferalis* (**a**) first instar, (**b**) second instar, (**c**) third instar, (**d**) fourth instar, (**e**) fifth instar

6.2.6 Natural Enemies

C. punctiferalis has many natural enemies such as larval predators (adult ant lions, Myrmeleontidae, and birds), moth predators (mantis and spiders), and larval parasitic nematodes (*Steinernema glaseri*). In castor fields, several natural enemies of *C. punctiferalis* were recorded such as wasps, *Trathala flavoorbitalis*, *Brachymeria atteviae*, *Chelonus blackburni, Anthocephalus decipiens, Epitranus erythrogaster*, and Phorid flies (Maruthi et al. 2009).

In Australia, flies *Argyrophylax proclinata* parasitized *C. punctiferalis* larvae, and the parasitization rate goes up to 40% (Pena et al. 2002). According to Evangelista (1995), natural enemies of *C. punctiferalis* include larval and pupal parasitic wasp *Suallonius* sp. and larval predator springtails *Euborellia annulata*. There may also be other parasitoids (Fig. 6.2).

6.3 Status of *Conogethes punctiferalis* (Guenée) on Crops in South Vietnam

6.3.1 Durian

Durian (*Durio zibethinus* Murray) is the fruit of tree species belonging to the genus *Durio*. There are 30 recognized *Durio* species, at least nine of which produce edible fruit. There are over 300 named varieties in Thailand. *Durio zibethinus* is the only species available in the international market: other species are sold only locally. There are hundreds of durian cultivars; many consumers express preferences for specific cultivars, which fetch higher price in the market.

In the world, durian is a specialty of Malaysia. In the Far East, durian is popular in this region. Particularly in Thailand, the durian is one of the fruits of the country's strengths, especially variety Monthong, which is of good quality. In Vietnam, durian can be grown from the plains to the 1000 m as in Bao Loc, Di Linh. Durian is one of the fruit trees grown quite popularly in provinces in the Mekong Delta and the Southeast of Vietnam.

Common insect pests attacking durian are the fruit borers (*Tonica lagaropis* and *C. punctiferalis*), shot-hole borer, and psyllids. Although it is only the fruit borer that has a significant contribution in directly reducing durian yield, the other insect pests can play an indirect role in increasing the incidence of *Phytophthora* infection either by creating entry ways for the fungal pathogen or by decreasing the resistance of the trees against the disease. The shot-hole borer (*Xyleborus* sp.) is a tiny black or brown beetle which bore holes in the bark and feed on the cambium layer. It is of particular significance to the subject of disease control in durian because it is associated with *Phytophthora*. The psyllids (*Allocarsidara incognita*) lay eggs on the unopened leaves. The nymphs have body coverings that appear cottony white. They suck the young leaves causing yellowish spots and, if not controlled, severe infestation may cause dying of the tree.

6.3.1.1 Damage Symptoms

Eggs are laid scattered on the young fruit. After hatching, larvae move on the surface of fruit and then bore into the fruit. *C. punctiferalis* attacks durian fruit from young to mature fruits. They attack more on bunch of fruit than lonely fruit. Damaged young fruits will be deforming or falling. Damaged mature fruits affect commercial value of fruit. The boring of caterpillars inside the fruit causes secondary infections of fungi and bacteria. This results in fruit rot and fruits drop-off. Larvae pupate between the spines of the fruits by making cocoons from their silk and frass.

C. punctiferalis attack the durian flower clusters also. Moth lays eggs on the flower clusters. After hatching, larvae feed on the stalk of flowers and then bore into stalk and bud of flowers for feeding. Damaged flowers dry and then fall off. The damage of *C. punctiferalis* on the durian flower is easily recognized through the perforated holes and clusters of dark brown frass on the surface of flower stalk clusters. Pupation was recorded in the damaged flower cluster (Fig. 6.3).

Fig. 6.3 Damage symptoms of *C. punctiferalis* on durian fruit and flowers

6.3.1.2 Management

Cultural Control

- Monitoring the orchard regularly in flowering stage, fruiting to detect early damage of *C. punctiferalis* on flowers and fruits
- Collection and destruction of the damaged flowers and fruits
- Removing fruits which are deformed from bunches
- Using a piece of carton to wedge inside bunches of fruits to limit the damage by fruit borer

Chemical Control

When necessary, chemical insecticides can be used in heavily infected areas. The chemicals can be sprayed at 10–15 days intervals during the flowering and fruit setting to prevent attack of *C. punctiferalis* on flowers and fruits. Insecticides can be used to control *C. punctiferalis* such as *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC, Crymax 35 WP, WP 3.2 Dipel) or spinosad (Success 25 SC) or emamectin benzoate (Acplant 1.9EC) or abamectin (Abatin 5.4 EC) according to the recommended dosage and safety on the label.

Huynh Thanh Loc et al. (2006) showed that *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC), spinosad (Success 25 SC), and Lambda-cyhalothrin (Karate 2.5 EC) were effective against *C. punctiferalis* on durian. Fruits infested by *C. punctiferalis* at 10 days after second treatment were 0.87, 0.00, and 1.59%, respectively, compared to 27.24% in control (water treatment).

6.3.2 Guava

Common insect pests attacking guava are the fruit borers (*Conogethes punctiferalis*), red-banded thrips (*Selenothrips rubrocinctus*), chilli thrips or yellow tea thrips (*Scirtothrips dorsalis*), fruit flies (*Bactrocera dorsalis*, *Bactrocera correcta*, *Bactrocera carambolae*), mealybugs (*Planococcus lilacinus*, *Planococcus* sp.,

Fig. 6.4 Damage symptoms of *C. punctiferalis* on guava fruit

Pseudococcus sp.), scales (*Coccus viridis*, *Aonidiella aurantii*, *Lepidosaphes becckii*), *Archips micaceana*, whitefly (*Aleurodicus dispersus*), aphid (*Aphis gossypii*), mosquito bug (*Helopeltis* sp.), and mites.

6.3.2.1 Damage Symptoms

Eggs are laid scattered on the young fruits. After hatching, larvae bore into the fruit. They attack guava fruit from young to mature fruits. On the young fruit, larvae feed inside the fruit; fruit can turn black and dry and falls off, or the growth gets retarded. Fruit borer preferred to lay eggs and damage fruits that are held in bunches. The damage of fruit borer on the guava fruits can be detected through the perforated dark brown frass adhering on the damaged fruits with holes.

Adults are nocturnal. They hide undersides of leaves during the day. Pupa is brown, about 10–13 mm in length. Pupation takes place inside the damaged fruits or at bunches of fruit by making cocoons from their silk and frass (Fig. 6.4).

6.3.2.2 Management

Cultural Control

- Sanitation of the orchard by collecting and destructing the infested fruits.
- Pruning the canopy after harvest.
- Using black light traps to trap moths.
- Fruit bagging is one of the best practices to prevent fruit borer because this method is safe and effective.

Chemical Control

Monitoring the orchard regularly at stage of fruiting to detect early damage of the fruit borer. When the infested fruit rate up to 5%, chemical insecticides could be used to control *C. punctiferalis* such as *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC, Crymax 35 WP, WP 3.2 Dipel) or spinosad (Success 25 SC) or emamectin benzoate (Acplant 1.9EC) or abamectin (Abatin 5.4 EC) according to the recommended dosage and safety on the label.

Fig. 6.5 Damage symptoms of *C. punctiferalis* on longan fruits

6.3.3 Longan

Longan (*Dimocarpus longan* Lour.) is a tropical tree that produces edible fruits. It is one of the better-known tropical members of the soapberry family (Sapindaceae), to which the litchialso belongs. It is native to Southern Asia. In Vietnam, longan is grown in Vung Tau, Dong Nai, Tien Giang, Vinh Long, and Ben Tre province.

The fruit is sweet, juicy, succulent, and superior in quality. Apart from being eaten fresh, it is also often used in Asian soups, snacks, desserts, and sweet-and-sour foods, either fresh or dried, sometimes canned with syrup. The seed and the shell are not consumed. Dried longan is often used in Chinese cuisine and Chinese sweet dessert soups, food therapy, and herbal medicines.

The most important pest is the Longan stink bug, *Tessaratoma javanica*. Other pests include erinose mite, scales, fruit flies, aphids, stem borers, fruit borer, leaf-eating caterpillars, flower-eating caterpillars, mealybug, fruit-spotting bug, elephant beetles, and fruit-piercing moths.

6.3.3.1 Damage Characteristics

Females lay eggs on the fruits, especially at the junction between the two fruits. After hatching, larvae bore into the fruits and feed on the inside of the fruits. *C. punctiferalis* attack the fruits from young to mature ones, especially when the fruit starting flesh setting. Damaged young fruit will be distorted, dry, and fall down. Damaged mature fruits will affect commercial value of the fruits (Fig. 6.5).

6.3.3.2 Management

Cultural Control

- Pruning the canopy after harvest to clear the orchard
- Sanitation of the orchard by collecting and destroying the infested fruits

Chemical Control

Monitoring the orchard regularly on different stages of fruiting to detect early damage of the fruit borer. When the infested fruit rate goes up to 20%, insecticides could be used to control *C. punctiferalis* such as *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC, Crymax 35 WP, WP 3.2 Dipel, etc.) or spinosad (Success 25 SC) or emamectin benzoate (Acplant 1.9EC) or abamectin (Abatin 5.4 EC) according to the recommended dosage and safety on the label.

Nguyen Thi Kim Thoa et al. (2009) showed that *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC), spinosad (Success 25 SC), and abamectin + *Bacillus thuringiensis* var. *kurstaki* (Kuraba WP) were highly effective on *C. punctiferalis* on longan. Fruit infested by *C. punctiferalis* at 14 days after second treatment were 1.74, 1.61, and 1.77%, respectively, compared to 2.98% in control (water treatment).

6.3.4 Rambutan

Rambutan (*Nephelium lappaceum* L.) is a tropical tree species in Southeast Asia, family Sapindaceae. Rambutan is native to Malay-Indonesian region and other regions of tropical Southeast Asia. It is closely related to several other edible tropical fruits including the litchi, longan, and mamoncillo. Rambutan fruit contains diverse nutrients but in modest amounts, with only manganese having moderate content at 16% of the daily value per 100 g consumed (right table; note data are for canned fruit in syrup, not as raw which may have different nutrient contents).

As an unpigmented fruit flesh, rambutan does not contain significant polyphenol content, but its colorful rind displays diverse phenolic acids, such as syringic, coumaric, gallic, caffeic, and ellagic acids having antioxidant activity in vitro. Rambutan seeds contain equal proportions of saturated and unsaturated fatty acids, where arachidic (34%) and oleic (42%) acids, respectively, are the highest in fat content. The pleasant fragrance of rambutan fruit derives from numerous volatile organic compounds, including beta-damascenone, vanillin, phenylacetic acid and cinnamic acid. In Vietnam, rambutan is grown in Ben Tre, Dong Nai, and other provinces, with high economic value, can be eaten fresh or canned.

Few insect pests have been reported by rambutan growers: fruit borers (*Conogethes punctiferalis, Acrocercops* sp., *Deudorix epijarbas amatius*, *Tirathaba ruptilinea*) and leaf-eating insects – the mealybug, *Pseudococcus lilacinus,* and the giant bug, *Tessaratoma longicorne* – the oriental fruit fly attack very ripe fruits and may require control measures.

6.3.4.1 Damage Symptoms

Females lay eggs on the fruits. After hatching, larvae feed on the skin of fruit, and then larvae bore and feed into the fruits. Fruit borer can attack the fruit from young to mature fruits, especially when the fruit starts flesh setting. Through these holes, the disease agents such as bacteria and fungi affect the fruit. Larvae often join some fruits together by their silk and then feed on inside. They feed on all seeds of the

Fig. 6.6 Damage symptoms of *C. punctiferalis* on rambutan fruit

young fruit; fruit is deformed, is dry, and falls down. Damaged mature fruits will affect commercial value (Fig. 6.6).

6.3.4.2 Management

Cultural Control

- Pruning unproductive pests and diseases affected old branches aids in reducing the borer population.
- Maintaining field sanitation in the orchards is also important.
- Affected fruits should be collected and destroyed.
- Bagging of fruit saves yields loss.

Chemical Control

Monitoring the orchard regularly for borers on fruits to detect early damage of the fruit borer is important. When the infested fruit rate goes up to 5%, chemical insecticides could be used to control *C. punctiferalis* such as *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC, Crymax 35 WP, WP 3.2 Dipel) or spinosad (Success 25 SC) or emamectin benzoate (Acplant 1.9EC) or abamectin (Abatin 5.4 EC) according to the recommended dosage and safety on the label. Insecticides should be sprayed three to four times/fruiting season at 10–15 days intervals.

6.3.5 Soursop

Soursop (*Annona muricata* L.) belongs to the family Annonaceae. It is generally known in most Spanish-speaking countries as *guanabana*; in Salvador, as *guanaba*; in Guatemala, as *huanaba*; in Mexico, often as *zopotedeviejas* or *cabezade negro*; in Venezuela, as *catoche* or *catuche*; in Argentina, as *anona de puntitas* or *anona de broquel*; in Bolivia, *sinini*; in Brazil, *araticum do grande, graviola* or *jaca do Para*; and in the Netherlands Antilles, *sorsaka* or *zunrzak*; the latter name is also used in Surinam and Java; in French-speaking areas of the West Indies, West Africa, and Southeast Asia, especially North Vietnam, it is known as *corossol*, *grand corossol,*

Fig. 6.7 Damage symptoms of *C. punctiferalis* on soursop fruit

corossol epineux, or *cachiman epineux*. In Malaysia it is called *durian belanda, durian maki*, or *seri kaya belanda*; in Thailand, it is called *thu-rian-khack*.

In Vietnam, soursop is not only used fresh but also used as a beverage processing and for confectionery. At Tet lunar holiday, soursop is also valuable especially in fruit tray on family altar in Vietnam. Soursop is a delicious fruit with high nutritional value.

Few insect pests have been reported from soursop orchards by Huynh Thanh Loc et al. (2015) through monitoring in Tien Giang province. The pests are mealybugs, scales, aphids, green leafhopper, mosquito bug, fruit borer, trunk borers, fruit flies, and fruit skin-eating caterpillars.

6.3.5.1 Damage Symptoms

Eggs are laid scattered on the young fruit; each female lays about 30 eggs on an average. After hatching, larvae bore into the fruit. Fruit borer attacks soursop fruit from young to mature fruits. The larvae prefer to attack fruits in bunch than single fruit. Usually, there are about two larvae/infested fruit, but the high density can reach to 6–12 larvae/infested fruit. Damaged young fruits will be deformed or fall off. Damaged mature fruits will affect commercial value of fruits. The boring of caterpillars inside the fruit can cause secondary infections of fungi and bacteria. This can result in fruit rot causing fruits to drop off. Pupation takes place in the damaged portion or on the skin of the fruit by making cocoons from their silk and frass (Fig. 6.7).

6.3.5.2 Management

Cultural Control

- Monitoring the orchard regularly at fruiting stage to detect early damaged fruit
- Collection and destruction of the damaged fruits
- Removing fruits which are deformed ones in bunches of fruits
- Using a piece of carton to wedge inside bunches of fruits to limit the damage by the fruit borer
- Fruit bagging with suitable, locally available material

Chemical Control
Monitoring the orchard regularly to detect early damaged fruits. When the infested fruit rate goes up to 1%, chemical insecticides could be used to control *C. punctiferalis* such as *Bacillus thuringiensis* var. *kurstaki* (Biobit 32 B FC, Crymax 35 WP, WP 3.2 Dipel) or spinosad (Success 25 SC) or emamectin benzoate (Acplant 1.9EC) or abamectin (Abatin 5.4 EC.) as per the recommended dosage and safety on the label. One can spray three to four times per season of fruit at 10–15 days intervals, depending on the level of infestation.

6.3.6 Ginger

Ginger (*Zingiber officinale* Roscoe) is a flowering plant whose rhizome, ginger root or simply ginger, is widely used as a spice or a folk medicine. It is a herbaceous perennial which puts forth annual stems about a meter tall-bearing narrow green leaves and yellow flowers. Ginger plant originated in the tropical rainforest in Southern Asia. Although ginger no longer grows in the wild, it is thought to have originated in the Indian subcontinent. The ginger plants found in India show the largest amount of genetic variation. The larger the number of genetic variations, the longer the plant is thought to have grown in that region. Ginger was exported to Europe via India in the first century AD as a result of the lucrative spice trade and was used extensively by the Romans.

Ginger is infested by many species of insects, among which the shoot borer (*Conogethes* sp.) and rhizome scale (*Aspidiella hartii* Sign.) are major pests in the field and during storage of rhizomes, respectively. Other insects that have been reported to affect ginger belong to diverse families and can be classified into sap feeders, leaf feeders, and rhizome feeders. Dry ginger is also infested by many species of insects, most importantly the cigarette beetle (*Lasioderma serricorne* (Fab.), the drug store beetle (*Stegobium paniceum* L.), and the coffee bean weevil (*Araecerus fasciculatus* DeG.).

6.3.6.1 Damage Symptoms
The larvae bore into pseudostems and feed on internal tissues resulting in yellowing and drying of leaves of infested pseudostems. The presence of a bored hole on the pseudostem through which frass is extruded and the withered and yellow central shoot is a characteristic symptom of this pest infestation (Fig. 6.8).

6.3.6.2 Management
Cultural Control

- Use the attractant wild plants for natural biocontrol conservation in the cultivated ecosystems.
- Cut open the shoot, and pick out the caterpillar and destroy. Mulching with green *Vitex negundo* leaves at 2 t/acre at 40 and 90 days after planting is effective in deterring the pest.

Fig. 6.8 Damage symptoms of *Conogethes sp.* on ginger pseudostem

Chemical Control

- Fruit borer usually appears early in the raining season. Neem oil (0.5%) at fortnightly intervals if found necessary can be applied.
- Prevention and treatment: The use of systemic insecticides such as Diazinon (Vibasu 10GR), Fipronil (Regent 0.3 G) is useful. When larvae are seen at 1st–2nd instars in the ginger fields, apply insecticides immediately, if not, control of the pest becomes difficult.

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