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Coffee Borer Complex and their Integrated Pest Management

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The coffee borer complex refers to the borer pests of coffee and primarily they are coffee berry borer (*Hypothenemus hampei*), a beetle that is considered the most serious pest of coffee worldwide. Other coffee borer pests include coffee white stem borer (*Xylotrechus quadripes*), coffee shot hole borer (*Xylosandrus compactus*) and the coffee red borer (*Zeuzera coffeae*). All these borers can cause significant damage to coffee plantations. Integrated pest management strategies, which integrate cultural, mechanical, biological, and chemical control measures, are effectively used in managing these borer pests of coffee.

Keywords: Coffee, borer complex, white stem borer, coffee berry borer, coffee shot hole borer, coffee red borer, Integrated pest Management.

Introduction

Coffee is an important commodity in India that is grown by smallholder farmers and large-scale coffee producers. The coffee borer complex viz., white stem borer, coffee berry borer, coffee shot hole borer (major pests) and coffee red borer (minor pest) of coffee and they originates from south east Asia, tropical Africa and has invaded all coffee producing regions. With climate change, the problems that these borers pose to coffee production are expected to increase. Controlling this borer pests is a true challenge, along with chemical control, other practices like cultural, mechanical, biological control altogether as integrated pest management can manage the infestations of borer pests of coffee.

1. Coffee white stem borer: *Xvlotrechus quardripes* (Cerambycidae: Coleoptera)

White stem borer is the most significant pest of coffee plantations across the country. The majority of growers see the stem borer as a significant danger to coffee arabica. It is recorded in India, South Africa, Thailand, Sri Lanka, China, Brazil, and Vietnam. It is distributed throughout Karnataka, Tamil Nadu, Kerala, and Andhra Pradesh, where coffee arabica is grown. It also reported in Assam and Bengal. It causes 2.3 to 12.5% loss in well-managed gardens and 17.8 to 20% loss in neglected gardens. It attacks *coffea arabica*, which grown with inadequate shade.

Adult identifying characters: Adults are elongate, blackish-brown longicorn beetles with numerous white patterns on the elytra and thorax. Beetles are roughly 8mm long, and males are typically smaller than females. The head of a male beetle has distinctively pronounced black ridges. These ridges are not noticeable in females. The posterior tip of the abdomen is rectangular in males and semi-circular in females. Adults emerge between April and May, while females lay eggs from October to November.

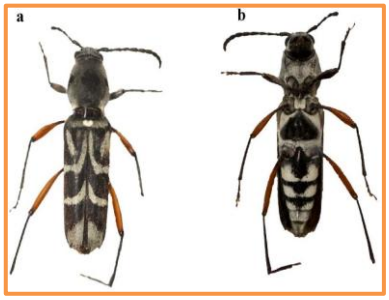

Fig. 1: The female of Xylotrechus quadripes a: dorsal and b: ventral view (Source: Kariyanna et al., 2023)

Biology and Life cycle

- **Eggs:** Female beetle laid her eggs in small groups in cracks and crevices on the loose bark of the main stem and thick primaries, with a preference for plants that receive sunlight. A single female lays approximately 100 eggs in groups of 1 to 10 during a life span of 9 to 30 days. I. P: 9 to 15 days.
- **Grubs:** They bores into the bark and tunnels in all direction with in the stem feeding on the internal tissues for about 9 months. Full grown grub is about 2.5 to 3cm long, white to yellow in color slightly boarder anteriorly. L. P: 9 months.

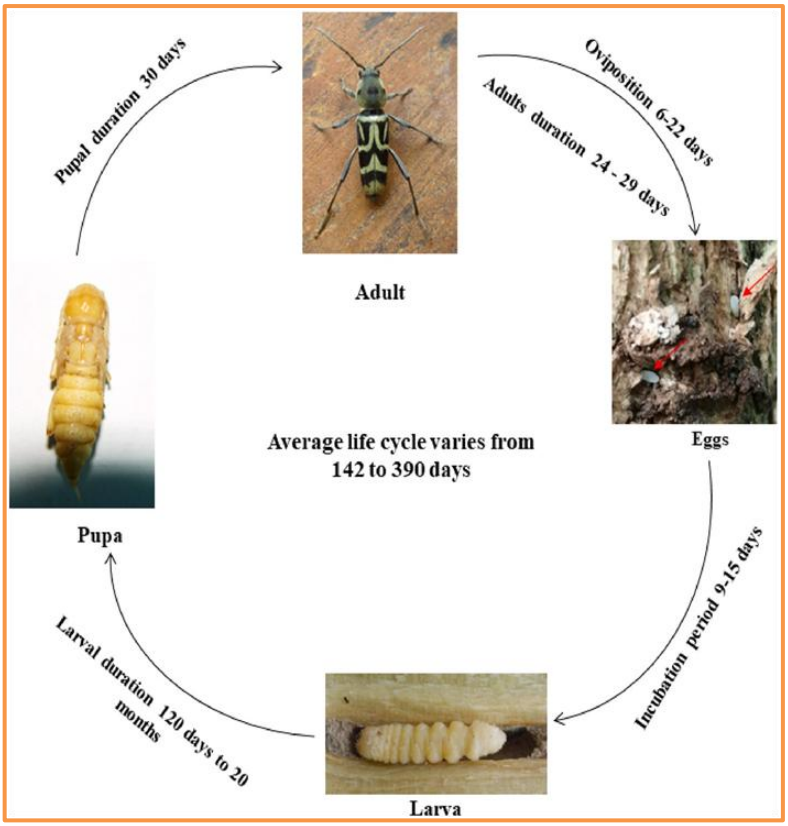

Fig. 2: Life cycle of white stem borer, Xvlotrechus quardripes

- **Pupa:** Pupation takes place with in a chamber close to the periphery of the stem. Pupal Period: 3 to 4 weeks.
- **Adult** remains in the tunnel for 3 to 7 days and emerge out by cutting an exit hole in the bark. Exit hole indicates that borer has completed its life cycle and emerged as an adult.

Nature of damage

- On hatching grubs feeds on corky portion under the bark for two months.
- Later they enter in to hard wood feed on internal tissues and make tunnels in all direction with in the stem.
- The stem and branches are killed as a result of grub tunnelling. Tunnels are filled with excreta. Galleries in the main stem and primary branches.
- Young plants suffer the most and older plants lose their vigour and the yield gets reduced.
- Adult feed on foliage, conifer needles, tender bark of stems and shoots and pupation chamber near to the bark.

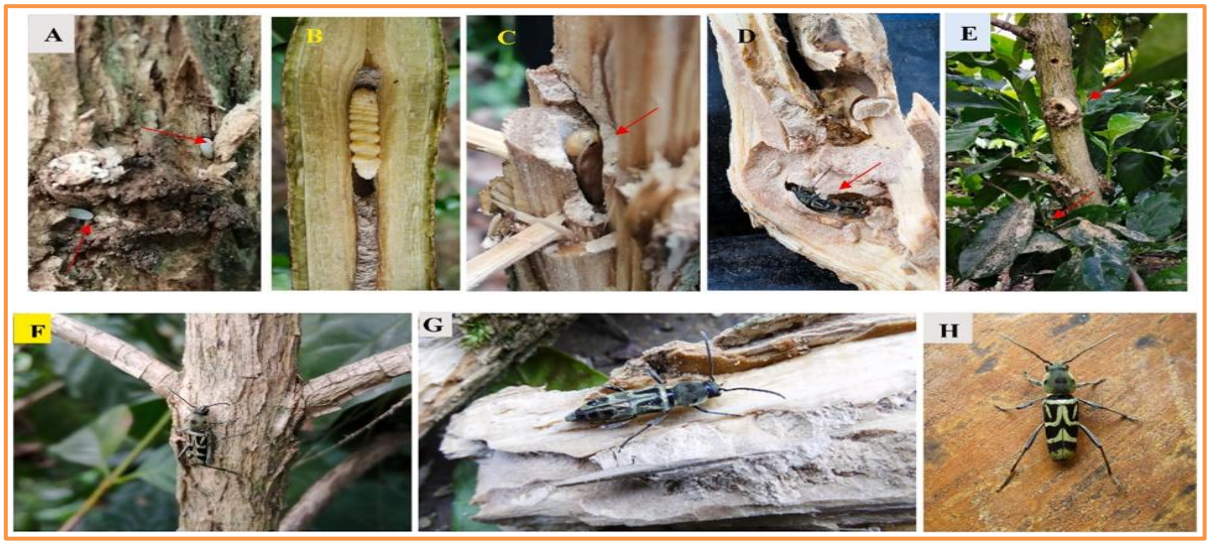

Fig. 3: Boring activity of the coffee white stem borer on the stem, A: Egg laid on the bark, B: Larva inside the stem C: Pupa inside the stem D: Adults inside the bored stem, E: Stem with holes and powdery dust on the leaves caused by borer, F,G,H: adult spotted on the different location. (Source: Kariyanna *et al.*, 2023)

Symptoms of affected coffee plants by white stem borer:

- Yellowing and wilting of plants.
- Sawdust like residues (frass) on the ground.
- Exit holes of adults clearly seen in the stem.
- Development of ridge's on the surface of the stem.
- Infested stem had borer tunnels.
- Affected branches are easily broken off.

Vulnerability to diseases and termite damage may increase. Tunnelling of stem affecting translocation and development of the plant. Damage is more serious on *Coffea arabica* with inadequate shade. Young plants (7 to 8 years old) attack by the borer may die in a year while older plants withstand the attack for a few seasons.

Management practices

- Destruction of affected plant parts during March-April and September-October.
- Maintain optimum shade on the coffee estates build up good shade as the adult prefer coffee exposed to sunlight for egg laying i.e., shade regulation.
- Scrubbing to remove loose scaly bark of the main stem and thick primaries using coir glove or coconut husk to get rid of cracks and crevices, where in eggs are deposited
- Scrubbing is done in October and April helps in destroying the eggs and grubs in the bark region and also prevents beetle from egg laying due to smooth surface of the stem.
- Deep Scrubbing with any sharp implement may injure the green wood and eventually kills the plant.
- Scrubbing can be easily done during monsoon period when the bark is moist, but not to be done during summer period.
- Integrate Scrubbing with shade management can effectively check the incidence of the stem borer.
- Avoid highly susceptible variety like Cauvery 1, 2, 3, Hemavathi, Selection 795 and Sandraman.
- Chandragiri, shows a good yield potential and a high tolerance to the ***Xvlotrechus quardripes***.
- The grubs are parasitised by *Metapelma* sp. and *Campyloneurus* sp.
- Predators: Red ants, Ground beetles and Anthocorid bugs, Birds: Small green barbet (*Megalaima viridis*) and Blue barbet (*Megalaima* sp.)
- *Beauveria bassiana* was effective when the fungus was applied to young larvae located under the bark.
- Chlorpyriphos 20 EC @ 600 ml / 200 lit. of water along with 200 ml of any wetting agent is more effective and less hazardous, and it is recommended for stem application during the peak emergence periods of *Xvlotrechus quardripes*
- Spraying the main stem and thick primaries with 5% Neem Seed Kernel Extract gave good control. However, repeated applications are necessary as the persistence of neem derivatives is only for a short period.

2. Coffee berry borer: *Hypothenemus hampei* (Scolytidae: Coleoptera)

The coffee berry borer is the most significant pest of coffee in the world. It was reported in 58 coffee growing countries. It is a monophagous species that feeds and breeds only on coffee berries. The pest originated in central Africa but was later spread into coffee growing regions such as Central America and Asia. This pest was recently observed in a few plantations in the Gudalur area of Niligiris district of Tamil Nadu, in early 1990. In 1990, it reaches Karnataka via the Wayanad district of Kerala. In Karnataka, this pest was originally discovered in 1991 in Kutta, Kodagu district, affecting 29,700 acres of coffee palntations. This pest attacks all of the planted coffee types. Under Indian conditions, *Coffea robusta* suffers badly than *Coffea arabica* because it is harvested early, and pest buildup is greater when *Coffea robusta* ripens.

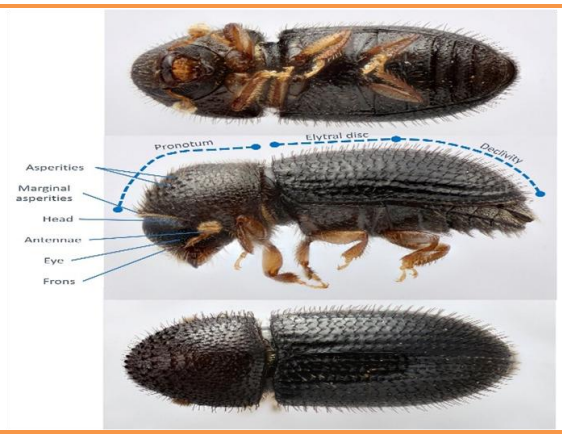

Fig.4: Adult coffee berry borer (photo credit: Andrew Johnson, UF/IFAS)

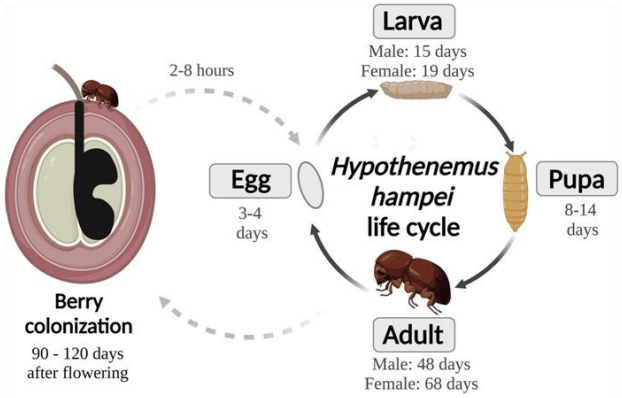

Fig. 5: Life cycle of coffee berry borer, *Hypothenemus hampei* (source: N. Moreno-Ramirez *et al.*, 2024)

Biology and Life cycle

- **Eggs:** female beetle prefer to lay eggs only when the beans get hardened Female lays about 20-60 eggs in the tunnel, I. P. – 3 to 4 days.
- **Grubs:** the apodous larva with a brownish head feed on the beans making small galleries of main tunnel bored by the adult. L. P. – 15 to 19 days.
- **Pupation** takes place in the berries, P. P. – 8 to 14 days.
- **Adult:** The adult berry borer is a black coloured beetle with a sub cylindrical body and covered with thick hairs and morphologically similar to the shot hole borer on robusta coffee. The female beetle is 1.5-2 mm long and male 1 mm long.

Its head is also deflexed under the thorax and its mouth parts occur closer to the front legs. The female beetle enter the berry by making a small circular hole, generally at the tip of the berry i.e. naval region, generally one beetle enter the berry. The adult live for about 5 months. The female to male ratio is 10:1. The males are not able to fly. The attacked berry could be easily identified by the presence of holes, at the naval region (tip of the berry)

Nature and symptoms of damage

- The pest damages to young as well as ripe berries.
- The beetle does not breed in tender berries.
- Generally most of the affected berries fall due to the injury / secondary infection by fungi.
- Breeding occurs in developed berries from the time when the endosperm first become hard, up to the time the berries ripe either in the tree or on the ground.
- In case of severe infestation, 30-80 % of the berries are damaged resulting in heavy crop losses.

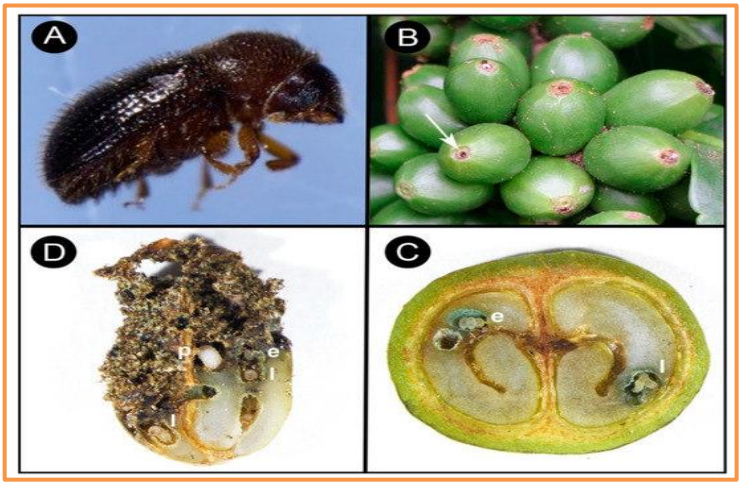

Fig.6: Damage symptoms, A: Adult female, B: Infested berry showing borer hole, C: Damaged berry with galleries containing eggs, D: Severe bean damage due to larval feeding (source: Johnson et al., 2020)

- The infested berries can be easily identified by the presence of small round hole at tip of the berries
- Generally one and sometimes two or three beetles in the naval region.
- All the cultivated coffee varieties are susceptible to the attack of this pest.

Symptoms:

- A typical pin hole at tip of the berries indicates the presence of the pest.

- Severe infestation: Two or more holes are seen, either in the naval region or on the sides.
- A powdery substance pushed out through the holes, reveals the active tunnelling and feeding with in the beans.
- Minute tunnels, often with a bluish colour are seen in the infested portion.
- Fruit drop of young and green berries.

Favourable conditions for multiplication of the pest:

- Incidence will be more at lower altitudes and less at higher altitudes i.e., altitude range from 500 to 1000 M above sea level.
- Heavy shaded plantations are more prone to attack than dry open areas.
- Chemical stimuli from developing berries and heavy rainfall are believed to trigger the emergence of beetles, Temperature: 26 – 30% and Relative humidity: 90-95%
- The pest comes out and infests fresh berries in the evening hours.

Management practices

Following IPM practices for control of coffee berry borer

Cultural control

- Remove excess shade from the garden i.e., Maintain optimum shade and good drainage
- To maintain optimum relative humidity in the garden i.e., high relative humidity favours pest attack.
- **Gleaning**: spreading gunny bags or polythene sheets on the ground after picking the berries.
- Remove lantana plant from the field. i.e., female take shelter in the seeds of lantana Remove the unseasonal berries.

Mechanical control

- Pick out all mature berries at time of harvesting without leaving berries on the plant. Collect the fallen berries thoroughly leaving none of on the ground to prevent multiplication of the pest.
- Do not move stock from infested area to non-infested area.
- Set up attractant traps with ethyl: methyl alcohol (1:1) to attract and kill the adults.
- Install multiple funnel trap and pitfall trap to collect and kill the adults

Biological control

- Release the Bethylid ectoparasitoids: *Prorops nasuta*, *Cephalonomia stephanodarix* and Braconid larval parasite *Heteropsilla coffecola.*
- Use fungal pathogen *Beauveria bassiana* @ kg/ha kills the borers when the humidity is high.
- Predator: *Crematogaster curvispinosa* is predacious on coffee berry borer.
- Take simultaneous plant protection in all plantations.

Chemical control

- Need based application of chlorpyriphos 20 EC 0.05% at 120-150 days after flowering.

Time of application

- First spray may be given during May to June and second spray during middle of monsoon.
- If it is necessary 2 to 3 sprays may be given at monthly intervals before harvesting to protect developing berries.
- Follow post-harvest precautions and seed quarantine to check the spread by cross infestation.

In storage places

- Pest could be effectively controlled by fumigation with durofume @ 32gm/cu.mt area for 48 hours
- Fumigate all gunny bags both at estate level and at curing level before filling them with berries.

The beetle cannot survive in berries that are dry enough. So dry the berries to the prescribed moisture level while processing at the estate level.

- Arabica/robusta parchment: 10%
- Arabica cherry: 10.5%
- Robusta cherry: 11.05%

3. Coffee shot hole borer*: Xylosandrus compactus* (Scoltidae: Coleoptera)

Sometimes serious pest on *coffea robusta* and also attack *coffea arabica*. Adults are dark brown to black coloured beetles, small sub cylindrical measures about 3 mm in length and body covered with fine hairs. Females are darker and larger (1.5 to 1.8mm) whereas males are dull black in colour and smaller (0.8 to 1.0mm). Pest infests green succulent main branches / tertiary branches in young plants. Female beetle makes a longitudinal tunnel between the nodes. The beetle then lines of the wall of the gallery with *ambrosia* fungus, the spores of which are carried from the tunnel. There are two species of Ambrosia fungi 1. *Ambrosiella macrospora* 2. *Ambrosiella xylebori* have been recorded in India.

Fig.7: Adult, *Xylosandrus compactus*

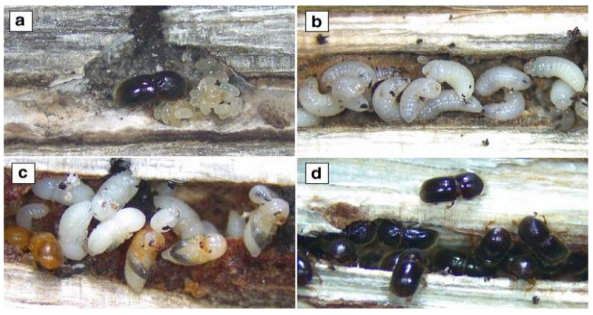

Fig. 8: Life stages of *Xylosandrus compactus*, a: Eggs, b: Larvae, c: Pupae, d. Adults (source: Gugliuzzo *et al.*, 2019)

Biology and life cycle

- **Eggs:** After growing the fungus, female lays 2550 eggs, in group of 5 to 8 The beetle make galleries in infested shoots where they lay eggs, I. P – 2 to 3 days.
- **Grubs:** are small, milky white in colour, feed on fungus cultivated by beetles i.e. Ambrosia fungus. L.P: 13 to 21 days.
- **Pupa:** Pupation takes place inside the gallery. P.P: 10 to 11 days.
- **Adults** drill shot holes and emerge out.
- The life cycle completes in 35-40 days.
- All the life stages of the pest are seen in the same tunnel during the peak period of incidence
- The beetle make galleries in infested shoots where they lay eggs.

Nature of damage

- The attacked branches shows discoloration around the pinholes, drooping of leaves which in turn yellow and fall off and die back symptoms appears.
- Leaves above the point of attack fall of prematurely.
- Adult drill a neat circular hole in the tertiary branches resulting in drying of young shoots, they are encouraged under humid condition.
- Severe infestation results in the loss of productive branches due to loss of primaries.
- The pest thrives better under heavy shaded condition.

Fig. 9: Round tunnel holes on coffee twig.

Fig. 10: Mature (black) and teneral (light brown) females of *X. compactus* inside the tunnel of a coffee branch.

Fig. 11: Entry hole made by *X. compactus* in coffee branches.

Symptoms

- In young plants the main stem may be attacked and presence of shot hole.
- Initial symptom is drooping and drying of leaves.
- Withered (faster in young branches and delayed in older twigs) Or dried branches
- Attacked leaves fall off prematurely.
- Terminal leaves fall and dry.
- Severe infestation causes loss of considerable number of productive branches.

Management practices:

- Maintain optimum or thin shade and good drainage system.
- Pruning of affected branches along with the pest and burn from September onwards.
- The pest prefers to breed in the suckers during dry period. So, remove and destroy all the unwanted or infested suckers during summer (Avoid breeding)
- Spray the crop with contact insecticides i.e., quinalphos @ 2 ml/lit spray twice at monthly interval during November-December.

4. Coffee red borer: *Zeuzera coffeae* (Cossidae: Lepidoptera)

The caterpillar is a stem borer with wide distribution and is a minor pest of *Coffea arabica* and *Coffea robusta* coffee. Adult is a orange-red coloured medium sized moth with white coloured fore wings and many black spots and marginal dots on the hind wings and measures about 28-40 mm across the wings.

Fig. 12: Larvae of coffee red borer

Fig. 13: Adult, *Zeuzera coffeae*

Life cycle

- **Eggs:** Female laid their eggs in rows on the barks of the stem and branches. I. P: 9 to 10 days.
- **Larva:** becomes fully grown in 4-5 months measuring a length of 38 mm with reddish coloured body and brown coloured head hence the name red borer. Larva bores into the bark. They make tunnels down entering the main stem and reaching up to the taproot in young plants
- **Pupa:** Pupation takes place within the tunnel. P. P. – 3 to 4 weeks.
- Life cycle is completed in about 4-5 months and the pest survive under heavy shade.

Nature of damage:

- Larva causes damage by boring the stem or branches to feed on wood.
- The attacked plants show pinkish excreta emerging out of holes at various interval on the stem.
- Affected branches wither and die back symptoms occurs externally.
- Young plants when attacked, killed out rightly.

Management practices:

- Removal and destruction of the affected branches.
- Regulate the shade by pruning the branches.

- Encourage the activity of braconid parasitoid, *Amyvosoma zeuzerae.*
- Use of fungal pathogen, *Beauveria bassiana* @ 1 kg/ha.
- Spray the crop with malathion 50 EC @ 2ml/ litre.

Conclusion

The borers of coffee are significant pests of coffee, crop losses caused by these pests are expected to increase and expand geographically in the near future as a result of increasing temperatures and erratic rainfall patterns. The Integrated Pest Management practices that combine cultural, mechanical, biological, and chemical control methods are effective in managing the populations of coffee borers.

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