Sustainable Coffee Cultivation in India: Challenges and Management

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Abstract

Coffee is one of the major plantation crops mainly grown in southern India. Two commercially important species of coffee viz., arabica coffee (Coffea arabica) and robusta coffee (Coffea canephora) are grown almost in equal ratio in about 292,000 ha. India produces about 282,000 tonne of coffee annually. Coffee is an important export commodity earns about $200 million of foreign exchange annually. Though coffee cultivation is a large-scale monoculture system, the trained perennial coffee plant is mainly grown under canopy of various species of wild trees and thus an environment-friendly crop. Hence, coffee grown under shade can be regarded as a kind of forest that is almost similar to natural forests, which support rich biodiversity. Coffee plantations provide a congenial habitat to various valuable species of soil fauna, insects, birds and mammals. In addition to this, the mixture of vegetation prevents soil erosion and fallen leaves decompose to rich humus and thereby retain the precious forest ecosystem. Like every plants in nature, coffee plants are attacked by different species of insect pests and diseases. Of the more than hundred species of insect pests recorded on coffee, only a few namely, coffee white stem borer Xylotrechus quadripes (Coleoptera: Cerambycidae) on arabica, shot-hole borer Xylosandrus compactus (Coleoptera: Scolytidae) on robusta, and coffee berry borer Hypothenemus hampei (Coleoptera: Scolytidae), mealybugs Planococcus citri (Homoptera: Pseudococcidae), and green scale Coccus viridis (Homoptera: Coccidae) on both arabica and robusta coffee are economically important. Similarly, of the various diseases coffee leaf rust Hemileia vastatrix is a major disease on arabica coffee. These major pests of coffee are managed by adopting integrated management methods. However, the most of the coffee farmers are not aware of various ecofriendly management methods. In the case of enlightened farmers who are aware of various management practices are facing severe constraints in adopting the methods. Detailed aspects of awareness and constraints of farmers in adopting various management methods in coffee plantations are discussed.

Key words: Coffee cultivation, management, insect pests, disease

Introduction

Coffee is one of the major plantation crops mainly grown in southern states (Karnataka, Kerala and Tamil Nadu) and to a small extent in northeastern states of India. Two commercially important species of coffee viz., arabica coffee Coffea arabica and robusta coffee Coffea canephora are grown almost in equal ratio in about 292,000 ha in India. India produces about 282,000 tonnes of coffee annually and southern states of India contribute about 98% of the total production. Coffee is an important export commodity earns about US$200 million foreign exchange annually (Anonymous, 1997).

Coffee cultivation is confined mostly to hilly tracts of Western and Eastern Ghats in India. Though coffee cultivation is a large-scale monoculture system, the coffee plant is by itself a trained perennial bush grown under the canopy of various species of wild trees and thus an environment-friendly crop, which supports rich biodiversity. Coffee plantations
provide a congenial habitat for various species of soil fauna, insects, birds and mammals. Like every plants, coffee is also attacked by more than 50 species of insect pests. Of them, Coffee white stem borer *Xylotrechus quadripes* (Coleoptera: Cerambycidae) on arabica coffee, coffee berry borer *Hypothenemus hampei* (Coleoptera: Scolytidae) on arabica and robusta, sho-hole borer *Xylosandrus compactus* (Scolytidae) on robusta, mealy bugs *Planococcus citri* and *P. lilacinus* (Homoptera: Pseudococcidae) mainly on robusta and green scale *Coccus viridis* (Green) (Hemiptera: Coccidae) on young plants of both species of coffee are major pests in India (Anonymous, 1997). In addition to these pests, leaf rust *Hemileia vestatrix* is a major disease on arabica coffee. Concurrently, the stable coffee ecosystem in India also harbours diverse species of potential indigenous natural enemies of coffee pests (Le Pelley, 1968; Venkatesha and Seetharama, 1998) with exception of *H. hampei*, which is a newly introduced pest. The management of various coffee pests and problem associated with the pest suppression practices are discussed.

**Materials and Methods**

Practice of integrated management methods (IPM) for the control of major pests of coffee was studied. Mind-set of growers in pest control methods was analyzed. Awareness and constraints of farmers in adopting pest management methods in coffee plantations was also assessed.

**Results and Discussion**

The major pests of coffee and their peak incidence periods in India are given in Table 1. The various major insect pests and diseases are managed by adoption of IPM.

**Table 1. Major pests of coffee and their peak incidence period in India**

<table>
<thead>
<tr>
<th>Pests</th>
<th>Host coffee plant</th>
<th>Peak period</th>
</tr>
</thead>
<tbody>
<tr>
<td>White stem borer (<em>Xylotrechus quadripes</em>)</td>
<td>Arabica</td>
<td>April-May and October-December</td>
</tr>
<tr>
<td>Coffee berry borer (<em>Hypothenemus hampei</em>)</td>
<td>Arabica &amp; robusta</td>
<td>October-January</td>
</tr>
<tr>
<td>Shot-hole borer (<em>Xylosandrus compactus</em>)</td>
<td>Robusta</td>
<td>September-January</td>
</tr>
<tr>
<td>Mealybugs (<em>Planococcus citri</em> &amp; <em>P. lilacinus</em>)</td>
<td>Robusta &amp; arabica</td>
<td>December-June</td>
</tr>
<tr>
<td>Green scale (<em>Coccus viridis</em>)</td>
<td>Arabica &amp; robusta</td>
<td>December-June</td>
</tr>
<tr>
<td>Coffee leaf rust (<em>Hemileia vestatrix</em>)</td>
<td>Arabica</td>
<td>Sepember-October</td>
</tr>
</tbody>
</table>

White stem borer is the most serious pest on arabica coffee. The borer infests the plants twice a year (October-December and March-April). It causes significant loss amounts to $17.5-26 million to Indian coffee industry annually. The female stem borer beetles deposit eggs in the canneries of the main stem and thick primaries of plants exposed to sunlight. Hatched out young grubs feed in the corky portion just under the bark for about two months. Consequently, bark splits and appears as ridges on the stem. Later the grubs enter the hardwood and make tunnels in all directions and severely damage the plant. The borer completes its life cycle in about a year. IPM practices such as maintenance of optimum shade to reduce the adult borer mating and egg laying activities, uprooting and burning of infested plants, spraying or sponging of Chlorpyrifos 20EC prior to two flight periods, bark scrubbing of main stem and thick primaries, and sex pheromone in sticky traps are adopted against the stem borer (Venkatesha and Seetharama, 1998). About 90% of planters are aware of the stem borer flight periods and nature of damage and IPM methods to be adopted for control of the stem borer. However, non-availability of skilled workers who can lop the canopy of shade trees is a major constraint. Moreover, farmers are tempted to open the
canopy to harvest more crops, which increase the borer incidence (Venkatesha, 2002). Tracing and uprooting of the borer infested plants is done based on the presence of ridges on the main stem and thick primaries of arabica coffee plants. Again skilled workers who can identify the symptom of attack are scarcely available for tracing of the plants. Several planters store uprooted stems in the estates to use them as firewood, from which adult stem borer develop quickly and emerge, and infest the plants. Chlorpyrifos is applied on the main stem and thick primaries of arabica plants during emergence period of the borer, i.e. October-December and April-May. The applied insecticide usually washed off in post- and pre monsoon rains, which coincides with emergence period of the borer. Moreover, the insecticide kills natural enemies of the borer as well as other pests of coffee. The stem borer female sex pheromone, 2-hydroxy-3-decanone in white sticky traps act as aggregation pheromone and traps both sexes of the borer (Venkatesha, 2001). About 30 pheromone traps are required per hectare. Cumbersome handling of sticky traps and low trap catches discourage its usage in the plantations. As the trap is not target specific, affects insect biodiversity in the plantations and imbalance the coffee ecosystem. Bark scrubbing of main stem and thick primaries against the stem borer is highly effective as it deters egg deposition (Venkatesha). However, sometimes sharp objects are used to remove the bark will expose green tissues and such plants die in summer. Furthermore, improper scrubbing retains canners in which eggs are laid and the borer infestation continues.

Coffee berry borer is another serious pest attacks both robusta and arabica coffee. It attacks mature berries. The female beetle (2.5mm) bores into the berry through navel region and makes a tunnel in the hard bean, and lays about 15 eggs in the tunnel. Hatched out grubs feed on the bean. The berry borer completes its life cycle in about 30 days. The Adult females of berry borer survive more than five months, and thus the pest is carried over from one season crop to next. IPM of berry borer is timely harvesting of crops; no berries should be left over on the plant or on the ground. Endosulfan 35 EC is used as pesticide of choice. Fungal pathogen *Beauveria bassiana* is used as biocontrol agent. Volatile traps with 1:1 ethanol and methanol mixture lure is used for trapping of adult berry borer (Coffee berry, book). Constraints in the berry borer management are timely harvest in not possible due to non-availability of workers. No berries should be left over on the plant or on the ground is a difficult task to practice as large number of small berries to be harvested from coffee bushes. Endosulfan and *Beauveria bassiana* should be sprayed when beetles are in the pulp region. It is difficult to take up the spray when beetles are just boring at the pulp region. However, volatile traps are highly effective, but availability of lure is a constraint as it is an alcohol mixture, which may be misused by common man.

The shot-hole borer, which attack green succulent branches of robusta and green scales, which is a sucking pest of both arabica and robusta are major pests of coffee. Although they are major pets, they are not in serious nature except in some endemic areas. However, of late their incidence is in rise as insecticides like Endosulfan against coffee berry borer and Chlorpyrifos against white stem borer are killing the large number of active predators and parasitoids of shot-hole borer and green scales.

Mealybugs, *Planococcus citri* and *P. lilacinus*, which are sucking pests attack nodes, spikes, berries, tender branches and roots of robusta coffee. In the early stage of infestation mealybugs hide in the spikes, flowers and fruits. The exotic predator of mealybugs *Cryptolaemus montrozieri* and a wasp, *Leptomastix dactylopii* are moderately effective in the management of mealybugs. These biocontrol agents are mass multiplied by Coffee Research Institute and supplied to farmers. However, the farmers are unable to notice the early
incidence of mealybugs as they hide in the spikes, flowers and fruits. Planters will come to know the pest incidence only after the flower buds and small berries are severely damaged. Moreover, the biocontrol agents are not available to the farmers in required numbers to initiate control in the appropriate time.

Coffee leaf rust, *Hemileia vestatrix* is a serious disease on arabica coffee. The disease results in defoliation, die-back, and debility and crop loss up to 70% if timely control measures are not adopted. Leaf rust infected plants show yellow to orange spots on the lower surface of leaves with powdery mass of uredospores. Fungicides such as Bordeaux mixture 0.5% or Plantvax 0.03% a.i. or Bayleton 0.02% a.i. sprayed during September-October is highly effective in containing the disease. However, sometimes leaf rust damage is severe as fungicide sprays are not carried out in time due to non availability of workers or sometimes the diseases is not controlled as spray coverage in not properly done as it should be sprayed on lower surface of leaves.

**Conclusions**

Most of the planters are aware of various pest management methods. As many coffee holdings are large areas it is difficult to manage the incidences of various pests regularly. As coffee culture is mainly depend on large number of skilled workers there is a problem in implementing various pest management methods meticulously as skilled men are not available of late. Hence, mechanization of several cultivation practices is only an alternative for management of various pests in coffee in near future. The proper shade management and cultural operations itself can keep various coffee pests below economic injury level. These practices will automatically conserve and augment the native natural enemy complex in the field. Once natural enemies are established in the least disturbed perennial coffee ecosystem, natural regulation of pests will go a long way in coffee cultivation. It is advisable to discourage use of large-scale toxic insecticides and promote already evolved integrated pest management practices in coffee plantations, allowing natural enemies to exert maximum control. The need of the hour in coffee pest management is that scientists, extension workers and enlightened growers should jointly work together on war footing to promote biological control and IPM of coffee pests, which will help to save precious Western and Eastern Ghats environment from deathly pesticides and produce coffee sustainably.

**Literature cited**


Cultivation of coffee was started by the Dutch East India Company in Java using seeds obtained from Mocha in Yemen in the 1690s. From Java, plants were taken to the Amsterdam Botanical Garden in 1706, from which a plant was taken to France in 1713; this plant was used by Antoine de Jussieu in first describing coffee. Natural or artificial shade is provided to coffee plants in cultivation to recreate their original forest environment, although sunlight-tolerant varieties have been developed for increased productivity. However, shade still remains useful, especially to mitigate the effects of extreme high and low temperatures (Descroix & Snoeck, 2009). The Coffee Growing Challenge. Global agricultural operations are increasingly impacted by erratic weather patterns attributed to climate change. Although there are increasing efforts to move towards sustainable production methods, coffee, like many crops, can have a substantial carbon footprint due to input requirements of fertilizer, energy, and water from cultivation to cup. In some coffee cultivation regions, there is a growing use of pesticides to control the coffee berry borer (Hypothenemus hamperi) and coffee leaf rust. At the same time many growers have increased the use of fertilizers (United Nations, 2004) to boost yields in nutrient-poor soils, which can have negative environmental and human health impacts if used in excess. The road to sustainable cultivation involves managing and balancing several different challenges. Learn more about some of the most important challenges—the impact and how different cultivation methods can move us in the right direction. Lantmännen takes an active role in the development of a more sustainable farming where we can make a big difference for the climate and nature. Lantmännen works together with other players to drive the development of cultivation in a sustainable direction. We do this by offering advisory services to farmers and developing technology and methods. We conduct plant breeding with a focus on sustainable cultivation and we are at the forefront of non-chemical seed treatment.