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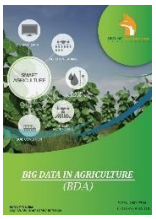

REVIEW ARTICLE

A REVIEW ON MANAGEMENT OPTIONS FOR LITCHI FRUIT AND SHOOT BORER, *CONOPOMORPHA SINENSIS*

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ABSTRACT

Under changing climatic condition, litchi fruit and shoot borer is becoming a major threat to quality litchi production and leading to more than 70% borer infested fruit in unmanaged orchard. Different management methods viz., physical, mechanical, cultural, biological, innovative, chemical and integrated pest management approach have been adopted to manage fruit and shoot borer. Based on various management strategies, integrated pest management approach with the use of green label insecticides and pheromones traps has huge potential for pest management and preservation of non-targeted species. Therefore, an attempt has been made to review management options for litchi fruit & shoot borer, Conopomorpha sinensis.

KEYWORDS

Bio-pesticides, Borer, Insecticides, IPM, Pheromones

1. INTRODUCTION

Litchi (*Litchi chinensis* Sonn) is a popular subtropical evergreen fruit crop in the Sapindaceae family. Due to its gorgeous deep pink/red coloring and flavored juicy aril, it is nicknamed as the 'Queen of the Fruits.' It has a good nutritional value and a pleasant flavor. Litchi is eaten as a fresh fruit, a pulp, and a variety of processed products like as squash, RTS, and wine (Singh et al., 2012). Litchi appears to be a native of the area, which is located near China's Southern Province and northern Vietnam. China, India, Brazil, Malaysia, Thailand, Vietnam, Myanmar, Mauritius, South Africa, Australia, New Zealand, Madagascar, and Taiwan are the biggest litchi producing countries (Kumar, 2014). Due to its high demand, strong economic return, and export potential to other countries, cultivation of this crop is gaining traction in a number of countries. Given the importance of this fruit crop in various parts of the world, efforts are being made to give technological support through research, production, post-harvest management, and marketing.

However, while the area under this crop has increased, the productivity trend has not been steady through time (Fashi and Alam, 2019). Insect pest infestation is a serious restraint in the successful and lucrative development of this fruit crop, among other things. Fruit borer, litchi mite, shoot borer, bark borer, leaf minor, leaf webber, and other insect pests are causing major problems for litchi growers, reducing production and decreasing marketability (Kumar et al., 2011). Litchi fruit and shoot borer, *Conopomorpha sinensis* (Lepidoptera: Gracillariidae), is a substantial danger to litchi production, inflicting severe losses to fruit and young shoots of 24-48 percent and 7-70 percent, respectively, among the many insect pests (Srivastava et al., 2016). According to a study this bug is the primary cause of reduced litchi yields (Bhatia et al., 2000).

Litchi fruits and foliage are severely damaged by the litchi fruit borer and shoot borer. Litchi fruit and shoot borer larvae mine into newly born litchi leaves as leaf miners, then create a tunnel inside vulnerable shoots, and when fruits arrive in April and May, the larvae bore into the fruits and feed on their pulp. Fruits that have been infested become unfit for both home and export consumption, resulting in significant losses (Hameed et al., 1999; Lall et al., 1978).

2. OBJECTIVE

The main objective of this review is to present scenario of the pest in Nepal and Asian countries, its habit, nature of damage and management options through different ways such as physical, mechanical, cultural, biological, innovative, chemical and IPM.

3. METHODOLOGY

This review paper uses secondary data of different literature reviews, books, journals, publications, and case studies about different management options for litchi fruit and shoot borer.

4. RESULTS AND DISCUSSIONS

Various options for management of litchi fruit and shoot borer are found to be effective which are discussed and presented in this review.

4.1 Scenario in Case of Nepal and Asian Countries

The Litchi fruit borer belongs to the Gracillariidae family of moths. It can be found in China, India, Nepal, Taiwan, Thailand, and Vietnam, among other places. Litchi fruit borer was previously known in China as the litchi stem-end borer and in Thailand and India as the litchi fruit borer (Srivastava et al., 2021). In Nepal, there hasn't been enough research done on the litchi fruit borer. It was quite serious in India, especially during the fruit development stage when the weather was humid. In untreated orchards in Taiwan, 96.1-100 percent of litchi fruit is ruined. A closely similar species has caused damage in Punjab and Himanchal Pradesh, ranging from 13.6 to 64.9 percent. In Bihar, nearly 70% of the fruit had been damaged the previous year (Srivastava et al., 2017).

Although the bug prefers litchi to longan, damaged fruit from both crops may fall from the tree. *Acrocercops cramerella* (now *Conopomorpha cramerella* Snellen, Lepidoptera: Gracillariidae) was previously recorded as a borer species, but *C. cramerella* was only found in ambutan and cocoa.

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Only *Conopomorpha sinensis* Bradley and *Conopomorpha litchiella* Bradley have been found connected with litchi fruits, leaves, and shoots throughout Southeast Asia, according to literature and records. However, it has recently been verified that *Conopomorpha sinensis* Bradley is a major litchi fruit and shoot borer species (Reddy et al., 2016; Srivastava et al., 2018). *Acrocercops cramerella* (now *Conopomorpha cramerella* Snellen, Lepidoptera: Gracillariidae) was previously recorded as a borer species, but C. cramerella was only found in ambutan and cocoa.

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4.2 Insect Habit and Nature of Damage

Conopomorpha sinensis adults are smaller than microlepidoptera, with a wingspan of 12.0-15.0 mm and a greyish brown coloration. The body measures 6.0-7.0 mm in length and has a zigzag-colored pattern. The apex of the wings is golden brown, the hind wing is silver, grey, and the silvery antennae are longer than the wings. The larvae have a yellowish color with a brownish head. The pupa is greenish on the dorsal side and greenish yellow on the ventral side (Srivastava et al., 2021). Adults are nocturnal, usually mating at twilight, and lay their scale-like eggs (0.4 0.2 mm length) individually on new shoots, under the surface of the leaf, or under the calyx of litchi fruits shortly after mating. Leaf buds are favored for oviposition throughout the winter months. A single female's total egg production ranges from 30 to 49 eggs per day, with an average of 5-6 eggs per day. The incubation phase lasts 4 to 5 days. There are five larval instars in all. Larvae in the first instar are milky white with a prominent light brown head. The fully grown larva is yellowish in color and is 8.00.1 mm in length and 0.80.01 mm in width. The pupal and larval periods were 8-9 days and 6-7 days, respectively. Fully grown larvae emerge from the fruit and pupate behind an oval cocoon on the litchi surface. Adults have a lifespan ranging from 4 to 7 days. During the fruiting season, the pest normally completes three generations that overlap (Srivastava et al., 2019).

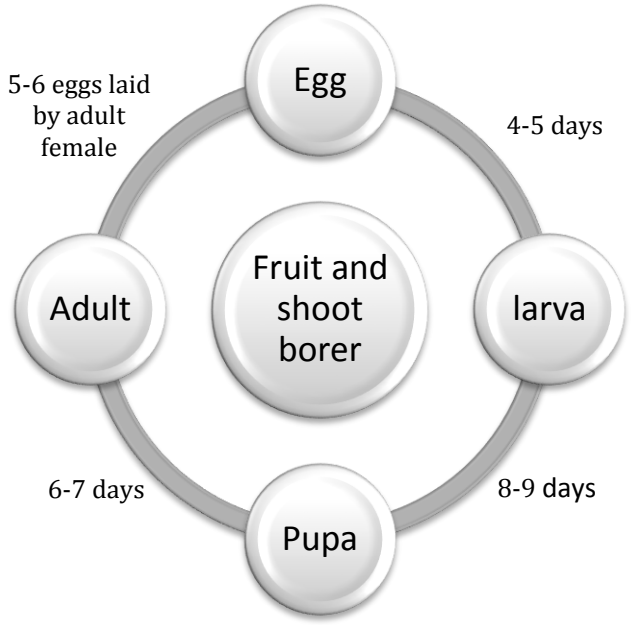

Figure 1: Lifecycle of Fruit and shoot borer

During the months of September and October, the insects (larvae) attack the freshly developed shoot, causing it to fail to blossom. Furthermore, around April-May, it punctures the peduncles of developing and mature fruits, resulting in severe loss due to early fruit drop and the emergence of excreta/larvae when the fruit is cut/opened after ripening (Kumar et al., 2014; Srivastava et al., 2016). Eggs are usually laid on top of fruits near the pedicel during the color break stage. The newly hatched larvae begin by digging into the fruits until they reach the pulp-seed junction, where they may eat. The afflicted fruits have a black mark on the pedicel and are modest in size. Infested fruits usually fall off before they reach maturity. This borer's larvae cause direct harm to litchi fruits in this way. During the monsoon season, larvae cause indirect damage by burying mines in young leaves and branches. Branches wither and drop as a result of mines. This insect has been predicted to cause 25-60 percent fruit loss and 9-70 percent leaf infestation, respectively (Srivastava et al., 2017).

4.3 Management Strategy

Understanding the seasonal incidence, nature of damage, life cycle, and associated natural enemies of the pest are all part of the litchi fruit and shoot borer control strategy. Growers should be knowledgeable enough to select the available pest management methods to lower total pest load and that are effective, economical, and environmentally sound when using pest management systems (Srivastava et al., 2021).

4.3.1 Physical and Mechanical Method

The manipulation of temperature, humidity, and the employment of radiant energy are all examples of physical approaches. Mechanical approaches, on the other hand, entail the use of mechanical devices or manual operations to manage pests. This approach for managing litchi fruit and shoot borer includes hand picking, shaking, fruit wrapping, pest collecting devices, bagging and plugging the bore hole. Fruit and shoot borer infestations can be controlled using this method, which involves blocking the tunnel's opening with cotton wool and mud. Likewise, other fruit crops, bagging has been found very effective technology in litchi to improve fruit quality, reduce fruit borer damage, sun burning and cracking in litchi. The litchi fruit bunches of cv. Shahi is bagged with white butter paper bag/ Nonwoven PP bags (30 g) of 500-650 mm X 350-500 mm (L X W) at 40 days after bloom (40 DAB) which was during 3rd fortnight of April, when the average fruit weight is approximately 3-5 g. Bagging has been found very effective in reducing fruit borer infestation (71-77%) and cracking (55-80%) through creating a physical barrier and modifying fruit microenvironment year (Srivastava et al., 2016).

4.3.2 Cultural Method

Orchard sanitation, collection and destruction of crop residues, pruning of infested twigs in June as well as crop rotation in the alleys help in minimizing pest build-up. Application of 4 kg castor cake and 1 kg neem cake at root zone after the first shower of monsoon have been proved effective in reducing the pest population viz., fruit & shoot borer infestation, mites, leaf roller, litchi looper and weevils. The pest which harbored on alternate host such as kaith, jamun, amaltash during off season should be collected and destroyed in order to minimize the chance of heavy infestation of the pest in subsequent (Srivastava et al., 2021). Attacked shoots should be clipped off and destroyed. The hole should be cleaned and kerosene/petrol/crude oil or formalin is poured into the stem borer hole.

4.3.3 Biological/Bio-Rational Methods (Predators, Parasitoids and Botanicals)

Some predators used for the management of litchi fruit and shoot borer are Mirid bug (*Campyloneura* sp.), lady bird beetles (*Cheilomenes sexmaculata*, *Coccinella septumpunctata*, *Brumoides suturalis*), lacewing, King crow, common mynah, wasp, dragonfly, spider, robber fly, reduviid bug, praying mantis, red ants, big eyed bugs (*Geocoris* sp), pentatomid bug (*Eocanthecona furcellata*), earwigs, ground beetles, rove beetles etc. To control the population of fruit borers, parasitoids such as *Trichogramma* are used at a rate of 20,000 adults per acre. As an alternative to pesticides, an environmentally friendly bio-pesticide made from various organic ingredients can be sprayed. To avoid insect egg laying, two sprays of neem oil (4 ml/l) should be applied, the first before flowering and the second soon after fruit set. Further, two sprays with panchgavya (30 ml/l) made up of cow ghee, urine, dung, curd milk along with banana and sugarcane juice should be done at clove stage and color break stage and two spray with biodynamic pesticide (50ml/l) made up with cow urine, cow dung, chopped leaves of Neem/Calotropis (madar) decomposed in water should be done at aril (pulp) development stage and about 10 days before expected fruit harvest.

4.3.4 Innovative Methods/Use of Sex Pheromone

Genetic modification, insect repellents, anti-feedants, hormones, and analogues are all examples of innovative control. Rather than simply eradicating insect pests, its application aims to change, manage, and regulate them. Insect growth regulators (IGRs) are an excellent fit for an integrated pest control program since they are less toxic and do not pollute the food chain in the environment due to their selective action (Kuldeep and Shri Ram 2004; Kuldeep et al., 2004). Pheromone traps should be placed at a rate of 4-5 traps per acre. Research conducted under the subtropics of Bihar shows IGRs significantly influenced the borer infestation and fruit yield of litchi. Weight of infested litchi fruits showed

that application of IGRs reduced the damage of litchi fruits done by borer that contributed towards more marketable fruit yield as compared to control. The highest healthy fruit (16.38 kg/tree) was recorded with diflubenzuron followed by lufenuron (14.99 kg/tree), emamectin benzoate (14.46 kg/tree) and novaluron (13.99 kg/tree) against lowest (4.14 kg/tree) in control. Similarly, reduction in fruit infestation over control calculated on weight basis was also highest in diflubenzuron (78.77%) followed by lufenuron (75.79%), emamectin benzoate (73.85%) and novaluron (73.33%) (Srivastava et al., 2017).

4.3.5 Resistant Varieties

Resistant varieties are plants within a certain group that are less vulnerable to attack by plant pests or diseases. It is the safest and best method for reducing the damage and loss caused by the pest. In case of Nepal and other Asian countries, there has not been sufficient study and report of resistant varieties of Litchi.

4.3.6 Chemical Method

To control litchi pests, newer/safer compounds with selective action, low toxicity to non-target organisms, and low environmental impact (avermectins, spinosyns, diamides) have been advocated (Srivastava et al., 2004; Srivastava et al., 2005; Srivastava et al., 2007). Novaluron 10 EC @ 1.5 ml/l, flubendiamide 39.35 SC @ 1.5 ml/5l, emamectin benzoate 5 percent SG @ 2ml/l, and spinosad 45 SC @1.75ml/5l have all been proven to be highly effective against litchi fruit and shoot borer. After three spraying of any of the above compounds at 10-15 days intervals after the fruit reached pea size, the infestation was kept below the threshold level. In the event of good weather circumstances (rainy and humid), the first and second sprays with thiocloprid 21.7 SC @ 0.7-1.0 ml/l may be used for improved outcomes (Srivastava et al., 2021).

Chlorantraniliprole (18.5 percent w/w SG) or flubendiamide (39.3 percent m/m) could be used to control the litchi fruit borer, a serious pest of litchi. Both pesticides might be used at a rate of one milliliter per three liters of water. It should be used at least three times with a 10-day break between each application. Because these insecticides have a higher selectivity for insect receptors than mammalian receptors, they may pose a lower danger to human and cattle health (Upadhyay et al., 2020). For the control of shoot borer infestation on developing shoots, two sprays of systemic insecticide thiacloprid 21.7 SC or imidacloprid 17.8 SL @ 0.5-0.7 ml/l at 15-day intervals were used in September. To prevent egg laying, spray neem oil (4 ml/l) on the plant before flowering.

Alternatively, throughout April-May, three sprays of appropriate insecticides might be sprayed at varied intervals. The first spray should be applied when the fruit is the size of a clove, the second spray should be applied when the fruit is the size of a large cardamom (after 15 days of the first spray), and the third spray should be applied 10 days after the second spray (approximately 15 days before harvest). Recommended insecticides for litchi fruit & shoot borer are lufenuron 5 EC (0.7ml/ l), novaluron 10 EC (1.5 ml/l), cypermethrin 25 EC (0.5 ml/l), emamectin benzoate 5% SG (0.4 ml/l), deltamethrin 2.8EC (1ml/l), lambda cyhalothrin (0.5ml/l), flubendiamide 39.35 SC (1ml/5 l) and spinosad 1ml/4 liters of water.

4.3.7 Integrated Pest Management (IPM) Technique

Some of the strategies used under this method of management of fruit and shoot borer are as follows (Patel and Srivastava, 2015):

- Orchard should be weekly inspected before initiation of flowering with pheromone trap to observe the abundance of fruit borer.
- If incidence observed, release of *Trichogramma chilonis* @50000 eggs/ha should be made immediately.
- After fruit setting bunch of fruits may be bagged to exclude the pest. Bagging also improved fruit colour and quality.
- Trees should be pruned after harvest to remove harbour pupae of the pest.
- If needed, spray the orchard with Deltamethrin 2.8EC (0.0028 per cent) 1ml/l or Fipronil 5 SC (0.01 per cent) 2 ml/l or Flubendiamide 39.35 SC (0.008 per cent) 1ml/5 l of water after fruit set and second spray may be given before 15 days harvest.

5. Way Forward

Understanding the seasonal incidence, nature of damage, life cycle, and associated natural enemies of the pest are all part of the litchi fruit and shoot borer control strategy. Growers should be knowledgeable enough to select the available pest management methods to lower total pest load and that are effective, economical, and environmentally sound when using pest management systems. (Srivastava et al., 2021). Chemical management is the quickest of all the management strategies. Insecticide resistance develops as a result of the insecticide's persistence and specificity, as well as the pace, timing, and quantity of treatments made. Other factors that influence resistance development include the initial frequency of resistance alleles in the population, the rate at which insects reproduce, the level of resistance of the insects, the migratory and host range of the insects. Insect pests that live in large numbers and reproduce quickly, for example, profit from pesticide development, especially when insecticides are abused or overused.

Preventing and integrating pesticide resistance management strategies as part of an integrated pest management approach is the best way to avoid and control insecticide resistance in litchi fruit and shoot borer. The economic threshold level (ETL) was the basis for several decades, but in modern IPM, the emphasis is on AESA, in which farmers make decisions based on a larger range of field observations in the orchard (Food and Agriculture Organization of the United Nations., 2002). The environment has an impact on a plant's health, which includes both physical (soil, rain, daylight hours, wind, etc.) and biological elements (i.e., pests, diseases and weeds). All of these factors have the potential to disrupt the normal balance between herbivorous insects and their natural predators. Pest control, such as the control of the litchi fruit and shoot borer, and other pests, can benefit from a greater understanding of the many interactions that take place in an ecosystem.

6. Conclusion

Accounting all the data and facts, litchi fruit and shoot borer has pulled a lot of attention as a major pest in litchi orchard. To manage this pest, various techniques/methods such as physical, mechanical, cultural, biological, innovative, chemical and integrated approach have been developed. But with the rise in globalization, various harmful insecticides and pesticides have come upon use which may endanger the existence of numerous species. Therefore, eco-friendly management of the borer should be prioritized with the use of green label insecticides and pheromone traps to ensure the future of various flora and fauna. Hence, these efforts of pest management should be focused to produce safe and economical litchi.




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