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S&T REVIEW

A REVIEW ON INTEGRATED MANAGEMENT OF COTTON AND SUGARCANE PEST

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ABSTRACT

Various insect pests can damage crops to different extents, reducing both their quality and quantity. Cotton and sugarcane are particularly vulnerable to sucking complex pests and borer complex pests, which cause damage in different ways. Complex pest sucking sap from delicate plant components, while borer complex pests bore into the crop. These pests have the potential to cause significant damage to the agricultural sector, leading to a considerable loss in yield and quality. The haphazard use of insecticides and pesticides to manage these pests has become a global problem, resulting in harmful effects on human health, plant systems, and the environment. To regulate pest populations, different integrated pest management techniques are followed, including physical, mechanical, cultural, and biological methods. These strategies, which are both sustainable and environmentally sound, attempt to keep pest populations below the economic threshold level. This paper gives an introduction to the invasive pest, biology, lifecycle, and integrated management of cotton and sugarcane pests.

KEYWORDS

Introductory pathway, sucking complex pest, borer complex pest

1. Introduction

1.1 Background Information

Cotton (Gossypium hirsutum L.) is a valuable cash crop farmed worldwide that is vital to the farming community (Sable and Kadam, 2012). The crop is sensitive to 1326 insect pest species globally (Ghosh, 2001). Cotton crops attract a wide range of insect pests and mites, which includes sucking pest complexes (whitefly, jassids, thrips, and mites) and bollworm pest structures (Spotted, Pink, and American bollworm), which lead to substantial decreases in cotton production quality and quantity (Matthews and Tunstall, 1994). Sugarcane (*Saccharum officinarum* L.) is one of the important cash crops grown in all tropical and subtropical areas around the world. A great variety of the insect attack on sugarcane including the major order such as Lepidoptera, Coleoptera, Hemiptera, Orthoptera and Isoptera (Habebe et al., 2018). About 1300 species of insect pests are known to cause damage to sugarcane crop globally (Paudel et al., 2021).

Integrated pest management is the integrated use of pest control strategies in a way that not only reduces pest population to satisfactory level but is sustainable and non-polluting (Sable and Kadam, 2012). It includes cultural techniques that have been modified, an emphasis on biological control (predators, parasitoids, and entomopathogens), plant extracts, pest monitoring, crop management practices, and careful application of insecticides, among other things (Khatri et al., 2020).

2. Methodology

This paper is based on review of various national and international documents of insect pest of cotton and sugarcane crops. Various articles were used for the gathering of the information.

Ethiopia
Entomol
Acta Scientific Agriculture
Pakistan Sugar Journal
Archives of Agriculture and Environmental Science
International Journal of Current Microbiology and Applied Sciences
Acta Scientific Agriculture
International Journal of Plant Protection
Journal of Agriculture and Natural Resources
International Journal of Environment
The pharma innovation journal
International Journal of Development Research
Entomon
International Journal of Biosciences
Annals of Agricultural Sciences
Annals of Plant Protection Sciences
Southwestern Entomologist
Journal of Entomological Research
Journal of Economic Entomology
Current Science
Biology of Field and Lab Susceptible Population of Red Cotton Bug
Agriculture, Ecosystems and Environment
Crop protection folder series
Pakistan Journal of Agricultural Research,
Advances in Agricultural Entomology
Indian Sugar
African Entomology
Sugar Cane International
Australian Cotton Grower
International Journal of Agronomy and Agricultural Research
Environmental Entomology
Entomol
Acta Scientific Agriculture

3. Literature Review

3.1 Cotton

Various insect pest attack cotton crop throughout the growing season. During the recent period sucking pest complex and bollworm complex evolved as a major headache for cotton growing farmers.

Table 1: Major sucking pest complex of Cotton crop are listed as;				
S.N.	Common name	Scientific name	Family	Order
1	Cotton Jassid	Amrasca biguttula biguttula I.	Cicadellidae	Hemiptera
2	Cotton Aphid	Aphis gossypii G.	Aphididae	Hemiptera
3	Cotton Whitefly	Bemisia tabaci G.	Aleyrodidae	Hemiptera
4	Red cotton Bug	Dysdercus koenigii F.	Pyrrhocoridae	Hemiptera

Source: (Sahu and Samal, 2020)

3.1.1 Cotton Jassid

Amrasca biguttula biguttula is a polyphagus pest that feeds on cotton, brinjal, okra, sunflower, cowpea, china rose, pigeon pea, and other plants (Kamble and Sathe, 2015).

3.2 Life Cycle

3.2.1 Egg

Females lay eggs in sensitive petioles and succulent leaves, with the bulk of eggs placed in the midrib tissue's undersurface. Eggs are bright and translucent, with a somewhat oval form. Egg incubation time ranged from 3 to 7 days (Singh et al., 2018).

3.2.2 Nymph

They have transparent body which are green yellow in color and are very delicate. They have four nymphal instars with period varied from 5-16 days. They walk diagonally (Nagrare et al., 2012).

3.2.3 Adult

Adults are green, yellow with black spots on both sides of the median line at the vertex of the head and another on the apical portion of the forewing. They walk with respect to diagonal. Average duration of adult is 13.37 days (Nagrare et al., 2012).

3.2.4 Damage caused by cotton Jassid

Adults and nymphs ingest plant sap, releasing salivary toxins that inhibit photosynthesis. Before drying and shedding, the leaves curl downwards, turn yellowish, then brownish (Patel and Radadia, 2018).

3.3 Cotton Aphid

Over 320 plant species from 46 families have been identified as appropriate hosts for Aphis gossypii globally, with cotton (*Gossypium hirsutum*) being one of the most commercially important cash crops and being extremely vulnerable (Blackman and Eastop, 2000).

3.3.1 Lifecycle

There is evidence of parthenogenetic reproduction. A. gossypii reproduces asexually with females that are either alate or apterous. Aphids, on the other hand, frequently alternate between sexual and parthenogenetic reproduction (cyclic parthenogenesis) (Slosser et al., 2001).

3.3.2 Damage caused by Cotton Aphid

Aphids sucking fluid from phloem tissue reduces plant vigour, resulting in wrinkled, malformed leaves and buds, slowing plant development, hindering growth, and lowering lint output. Cotton has been found to have black sooty mould (Hafez et al., 1996).

3.4 Cotton whitefly

Bemisia tabaci is a polyphagous species with a global distribution; yet, certain locations in Europe, such as Finland, Sweden, the Republic of Ireland, and the United Kingdom, remain Bemisia-free (Gangwar and Gangwar, 2018).

3.4.1 Lifecycle

3.4.1.1 Eggs

During her lifetime, a female can oviposit around 300 eggs. Eggs are placed singly on the abaxial surface of leaves and are held in place by a pedicel. They are white, translucent, and spindly (Kedar et al., 2014).

3.4.1.2 Nymph

They have four instars of nymphs. Nymphs in their first instar are oval in shape and whitish golden in color. Fourth instar (Puparium) is yellowish white in hue, oval in shape, and has well developed reddish brown compound eyes (Kedar et al., 2014).

3.4.1.3 Adult

They have dark brown compound eyes, smoky white wings, and a pale yellow wider abdomen with an ovipositor. *B. tabaci* life cycle was completed in 14-107 days. The body and both pairs of wings are covered in a powdery, waxy secretion that ranges in color from white to slightly yellowish (Kedar et al., 2014).

3.4.1.4 Damage

Whiteflies consume sap and emit honey dew, on which sooty mould forms. Branch dieback is possible. Whiteflies spread about a hundred virus infections, including African cassava mosaic virus, Cotton leaf curl virus, and Tomato yellow leaf curl virus (Gangwar and Gangwar, 2018).

3.5 Red cotton Bug

It is found all over the world and is a major pest of cotton in South East Asia. Okra, sorghum, millet, hollyhock, hibiscus, milky weed, Silk cotton tree, and jute are all severely affected.

3.5.1 Life cycle

3.5.1.1 Eggs

Soft to the touch, whitish in color, with oval or round shape that later turned buff golden before incubation. The eggs are laid in large numbers on the ground (Parwaiz et al., 2019).

3.5.1.2 Nymph

The nymph goes through five instars. Dysdergus koenigii's newly moulted fifth instar nymph is cylindrical in shape and scarlet red in color. The antennae and legs are black (Parwaiz et al., 2019).

3.5.1.3 Adult

Scarlet crimson in color as an adult. The form of the head is triangular. The forewings are narrower and longer than the hind wings. The hind wings are clear, membranous, and larger than the forewing (Parwaiz et al., 2019).

3.5.1.4 Red Cotton Bug Caused Damage

Cotton's market value suffers as a result of a severe lint staining problem. Adults and nymphs both feed on developing fruits, affecting crop productivity and fruit quality as they drain sap from the plant. The red cotton bug attack results in decreased germination and less oil content in the seed, as well as secondary infection with the bacterium Nematospora gossypii, which enters the injury site and colors the fiber (Parwaiz et al., 2019).

3.5.1.5 Bollworm complex of Cotton

The bollworm complex, which feeds on the reproductive plant parts of the cotton plant, is the most serious lepidopteron pest of cotton. Bollworm larvae feeding on buds and bolls cause significant harm. (Morse et al., 2006).

Table 2: The major bollworm complex pest of cotton				
S.N.	Common name	Scientific name	Family	Order
1	Pink Bollworm	*Pectinophora gossypiella* S	Gelechiidae	Lepidoptera
2	Spotted Bollworm	*Earias vitella* F.	Noctuidae	Lepidoptera
3	American Bollworm	*Helicoverpa armigera*	Noctuidae	Lepidoptera

3.6 Pink Bollworm

3.6.1 Lifecycle

3.6.1.1 Eggs

Eggs are laid either alone or in small clusters. The eggs are tiny and slightly elongated, and they are deposited between the boll and the bracts that surround it. When eggs are originally laid, they are white but soon turn orange. Eggs hatch within three to four days of being laid (Vennila et al., 2007).

3.6.1.2 Larvae

Mature larvae are 10-12 mm long and have broad horizontal red or pink bands. Because of the sclerotized prothoracic shield, young larvae are tiny white caterpillars with dark brown heads (Vennila et al., 2007). The larval phase lasts roughly 10 to 14 days.

3.6.1.3 Pupae

The majority of pupation takes place in the top layer of soil beneath cotton plants. The pupa is light brown in color and around 7 mm length.

3.6.1.4 Moth

The adult is characterized by small grayish brown coloured. The wing have the slender appearance when their wings have been folded each other.

3.6.1.5 Damage caused by Pink bollworm

Pink bollworms only eat cotton seeds. It enters the cotton bud/boll shortly after hatching and kills the seeds to feed on. A damaged boll may not exhibit any external damage indicators.

3.7 Spotted bollworm

3.7.1 Lifecycle

3.7.1.1 Eggs

When first laid, eggs are quite little and white blue, then change light blue-green and finally brownish soon before hatching. The single 0.5 cm eggs are placed on the leaf lamina, young shoots, peduncles, or flower buds (Shah et al., 2014).

3.7.1.2 Larvae

Spiny bollworm larvae are light yellowish brown in color with black markings on their bodies and are between 1.3 - 2.5 mm in length. The larval stage lasts 8 to 16 days (Shah et al., 2014).

3.7.1.3 Pupae

Pupa is a brown creature. The cocoon may also be clinging to a withered leaf or twig, or it may be found among surface debris on the soil's surface. The pupal stage can span between 8 and 16 days.

3.7.1.4 Moth

The forewings range in color from silvery green to straw yellow. In the middle, there is a broad green band. The spiny bollworm's life cycle lasts 30 to 53 days, depending on temperature.

3.7.1.5 Damage caused by Spotted bollworm

Spiny bollworms have an impact on cotton plants during the vegetative, blooming, and fruiting stages. Hollow out shoot and flower buds by boring into them. It can bore into the plant's growth point, which is known as tip boring. The bolls are attacked, however they are usually immature (Rahman, 2012).

3.8 American Bollworm

3.8.1 Geographical distribution

Africa, central and south-eastern Asia, Australia, southern Europe, India, New Zealand, and several eastern Pacific islands are all represented.

3.8.2 Main host plants

Cotton, peanuts, maize, pulses, rapeseed, safflower, sorghum, soybean, sunflower, tobacco, tomato, and other crops are examples (Deguine et al., 2008).

3.8.3 Lifecycle

3.8.3.1 Eggs

Freshly placed eggs are whitish yellow in color with 28 longitudinal ridges and are typically laid on the plant's upper half. The eggs are nearly spherical and placed in single layers on the upper surface of the leaves.

3.8.3.2 Larvae

Fully grown larvae have a distinctive pale stripe running longitudinally along the back and on either side of their body. It comes in a variety of colors, but is most commonly green or brown; it is around 30 - 40 mm long (CABI, 2014).

3.8.3.3 Pupae

When feeding stops, larvae burrow into the soil around plants and pupate for 12 to 18 days. The pupa is brown in color and makes tiny movements when disturbed.

3.8.3.4 Moth

The moth emerges after 18 days to six months (winter diapause). On each wing, it features brown forewings with a fine darker tracery around a single dark spot describe the hind wings as buff with a dark border and a pale spot (Deguine et al. 2008).

3.8.4 Damage caused by American Bollworm

They annihilate leaves, buds, blooms, and bolls. Only the biggest larvae will attack fully grown bolls. During peak infestation, extensive damage to young fruiting bodies can occur quickly. A broken boll may have a clear circular hole and be just partially eaten (Rahman, 2012).

3.8.5 IPM related research and findings on Cotton insect pest:

a) Helicoverpa spp. have been reported infesting cotton from nearby crops such as sunflower, tomato, and pigeon pea. When cotton is not accessible, the interplanted vegetation should not provide an extra food supply for insect pests (Sharma et al., 2000).

b) Oviposition by American bollworm was less on Deltapine Smooth Leaf (least number of trichomes) than on Deltapine 16 (pilose). Selection of an oviposition site is determined by the ease with which the tarsi could grip the surface. Bollworm larval movement, however, is retarded by higher trichome density (Hassan et al., 1990).

c) The American bollworm's economic threshold level is 12 eggs/24 plants scouted and 4 larvae/24 plants scouted. Scouting allows chemical control to coexist with biological control. It avoids the use of pesticides when pest numbers are below the economic threshold, allowing natural enemies to develop (Mapuranga et al., 2015).

d) Broad-spectrum synthetic pyrethroids are used in rotation with conventional insecticides (non-pyrethroid insecticides) primarily of the carbamate group to control bollworms and other pests. In Zimbabwe, the rotation of bollworm pesticides is known as "the pyrethroid window." Australia, like Zimbabwe, maintains a similar regulatory control over pyrethroids, with pyrethroids restricted to specific periods of cotton growth (CABI, 2014).

e) Sorghum, maize, and cowpeas are the most favoured hosts for American bollworm oviposition and larval development. This avoids the majority of the harm to these crops while saving the cotton plant (Mapuranga et al., 2015).

f) Deep ploughing exposes bollworm pupa to birds and hot sun. Ploughing cotton stubble diminishes African bollworm overwintering populations. Synchronous planting in the same location prevents bollworms from moving from older to younger plants (Fitt and Forrester, 1987).

g) A group researchers conducted an experiment on cotton jassid population management using a biological control agent and discovered Arescon enocki as a dominant parasitoid that is successful in regulating the jassid population (Hakim ali et al., 2018). Not only was jassid under control in unsprayed cotton, but the mealy bug, whose resurgences were prevalent in sprayed cotton, was completely under control in unsprayed cotton, with parasitism reaching up to 25.52%.

h) Cotton cultivars with trichomes/hairiness on leaves and stems are a significant source of resistance to numerous insects, particularly jassids, thrips, weevils, and mites.Insect movement, egg laying, attachment, shelter, feeding, ingestion, and digestion are all disrupted by trichomes. Cotton sucking insect complex resistance is heavily influenced by hairiness (Rahman et al., 2013).

i) Excess nitrogen fertilizer increases the severity of jassid and whitefly assaults while also extending the period of insect control (Kumar, 1984).

j) Jat and Jayakumar found a 20% reduction in leafhopper population in green chilli garlic extract at 10% (23.14%) and neem oil at 5% (20.81%) treated plots, while neem oil reduced the leafhopper population by up to 40% (Jat and Jayakumar, 2006).

k) Intercropping maize with cotton resulted in significantly lower jassid, Amrasca bigutulla bigutulla (0.96 and 0.89/leaf), thrips (7.44 and 6.20/leaf), and whitefly, Bemisia tabaci (0.42 and 0.36/leaf) infestations. Cotton intercropped with millet and sunflower as trap crops scored second and third for all of the above insect pests (Siddiqui et al., 2018).

l) The number of eggs and nymphs/adults of B. tabaci was 45-69% and 22-36% lower in weekly irrigated cotton than in bi-weekly irrigated cotton, respectively. Thus, higher watering rates can be incorporated into an IPM program to manage B. tabaci (Flint et al., 1996).

m) Pink bollworms have limited host ranges, hence crop rotation is helpful. Because the pink bollworm can only live on cotton squares and bolls, large-scale cotton rotation has a significant impact on this pest. Maize, wheat, and soyabeans are among the crops grown in rotation (Blasingane et al., 1991).

n) In Egypt, the best time to plant to avoid Pectinophora gossypiella is about 15 March. Pink bollworm emergence peaks in the first part of May, when cotton plants are too small to sustain strong infestations (Brader, 1979).

o) A group researchers discovered higher cotton aphid numbers in irrigated plots than in non-irrigated plots (Slosser et al., 2001).

p) Compared to potassium fertilizer alone, combined treatments of 120 kg/ha potassium with 108 kg/ha and 144 kg/ha nitrogen levels resulted in the same or significantly lower aphid populations in both years (Ai et al., 2011).

q) Plots with low plant densities supported larger aphid numbers on individual plants due to increased plant moisture concentrations, according to (Slosser et al., 2001).

r) Weathersbee and Hardee studied Mississippi cotton fields and identified many mirids, including the big-eyed bug and the minute pirate bug, as well as several coccinellids, chrysopids/hemerobids, and nabids, as prominent cotton aphid predators (Weathersbee and Hardee, 1994).

s) Mensah and Young reported that several species of *Bemisia tabaci* parasitoids(*Encarsia* sp and *Eretmocerus* spp.) and predatory insects have been observed in Australia, which are effective in controlling *B. tabaci* at low population (Mensah and Young, 2017).

Table 3: Minor pest of cotton

S.N	Common name	Scientific name	Family	Oder
1	Cotton leaf roller	*Syllepte derogate* F.	Pyralidae	Lepidoptera
2	Dusky cotton Bug	*Oxycarenus laetus* K.	Lygaidae	Hemiptera
3	Cotton mealy bug	*Phenacoccus solenopsis* T.	Pseudococcidae	Homoptera

3.8.6 Sugarcane

3.8.6.1 Major insects attacking Sugarcane crop

Table 4: The major insects of sugarcane crop

S.N.	Common name	Scientific name	Family	Order
1	Plassey borer	*Chilo tumidiscostalis*	Pyralidae	Lepidoptera
2	Top borer	*Scirpophaga nivella*	Pyralidae	Lepidoptera
3	Early shoot borer	*Chilo infuscatellus*	Pyralidae	Lepidoptera
4	Sugarcane leaf hopper	*Pyrilla perpusilla*	Lophopidae	Homoptera

3.9 Plassey borer

There have been several species of chilo found globally that attack many crops in the Gramineae family. Chilo tumidicostalis H. (Family:Crambidae) is a species native to Asia. Humans most likely introduced populations to Madagascar, Malaysia, Mauritius, and Reunion in the mid 1800s. Sugarcane is the only food source for Chilo tumidicostalis, which is found in Bangladesh, India, Myanmar, Nepal, and Thailand (Rahman et al., 2013).

3.10 Life Cycle

3.10.1 Egg

Egg stage lasts for 7 days.

3.10.2 Larvae

In the larval stage, the pest exhibits polymorphism, with four unique types of caterpillars seen. A typical larva, on the other hand, can be characterized by the presence of four pinkish-brown stripes on its back and a complete circle of crochet on its prolegs (Gupta and Sharma; 2007a).

3.10.3 Pupa

Pupal duration last for 10-12 days.

3.10.4 Adult

Adults are straw colored (Gupta and Sharma; 2007a).

3.10.5 Damage caused by Plassey borer

Larvae tunnel gregariously into the top three to five internodes, creating the primary infestation, which is distinguished by the formation of set-roots and lateral buds, as well as the dryness of top leaves. Larvae bore independently in different internodes in secondary infestations, although cane tops do not dry.

3.11 Top borer

3.11.1 Life cycle

3.11.1.1 Eggs

Eggs are oval in shape and flattish in the group of 35-40. Eggs are lying on under surface of the leaves and are covered with crimson colored hairs (Kumar and Pal, 2019).

3.11.1.2 Larvae

Larvae hatch in 6-11 days. Caterpillar is creamy yellowish white in color which are slender and soft. Larval period last for 25-41 days (Kumar and Pal, 2019).

3.11.1.3 Pupa

They pupate inside stem and emerge after 12-21 days (Kumar and Pal, 2019).

3.11.1.4 Adult

The adult makes the hole before going through pupation and came out. They are similar creamy white in color and female have crimson hairy tuft at anal end.

3.11.1.5 Damage caused by Top borer

The typical signs are tunneling of the midrib in a leaf, a reddish brown dead heart in a young crop (2-4 months old), and a bunchy top in a mature crop.

3.12 Early shoot borer

3.12.1 Lifecycle

3.12.1.1 Eggs

They are white and flat and are arranged in groups of three or more rows beneath the surface of the leaves. They lay around 200 eggs at a time, which hatch in 3 to 4 days (Kumar and Pal, 2019).

3.12.1.2 Larvae

Larvae are white with five violet stripes on the dorsal side of their bodies and a brownish head. Larvae can live for up to 35 days (Kumar and Pal, 2019).

3.12.1.3 Pupa

They develop within the stem. Pupae are light brown in color and live for around 10 days (Kumar and Pal, 2019).

3.12.1.4 Adults

Adults are pale grayish brown with darker edges, especially at the outer edge, and whitish hind wings.

3.12.1.5 Damage caused by Early shoot borer

Borer infiltrates young shoots and tunnels downward. A number of bore holes are located around the base of the shot, close above ground level. If the attack occurs early, the mother shoot dies completely, whereas a late attack causes profuse tillering (Kumar and Pal, 2019).

3.13 Sugarcane Leaf Hopper

3.13.1 Eggs

Greenish yellow eggs are seen in clusters on the underside of the leaves. White cottony waxy filaments wrap the eggs. A cluster of 10-15 eggs is discovered and hatches in about a week (Kumar and Pal, 2019).

3.13.2 Nymph

They develop into adult in 50-60 days. Nymphs pale yellow/brown.

3.13.3 Adult

Yellowish feather like filaments at the tail.

3.13.4 Damage caused by sugarcane leaf hopper

Sugarcane's most damaging foliage-sucking pest. They feed on the cell sap of the leaves and exude honey dew, which attracts the black fungus. Cane yield losses due to pyrilla have been estimated to be around 28% (Kumar et al., 2019).

3.12 IPM related research and findings of Sugarcane insect pest

a) Cotesia flavipes (Hymenoptera: Braconidae) and Trichogramma spp. (Hymenoptera: Trichogrammatidae) are among the most efficient stemborer parasitoids (Goebel et al., 2010).

b) A group researchers discovered that irrigation reduced the occurrence of drilled internodes by 2.5 times and moth borer exit holes/stalks by 2.5 times in sugarcane cultivars (Reay-Jones et al., 2005). Irrigation reduced the likelihood of pierced internodes and moth borer escape holes. Drought stress can impair sugarcane and make cultivars more susceptible to stalk borers' damage.

c) While nitrogen fertilizers increase cane output, they also increase insect and disease outbreaks (Scriber, 1984).

d) Silicon exerts both direct and indirect impacts on the larvae of stem borers. Direct benefits include decreased larval weight, decreased stalk damage, decreased internode borer tunnel length, and eventually decreased moth borers exit holes (Keeping, 2013).

e) Shakarganj Mills Limited, Jhang, established highly significant control of borers infestation with periodic discharge of Trichogramma chilonis in cane growing areas. Borer infestation was 11.65% in the unreleased region and 2.75% in the released area during 1999-2000, according to the results. In the area, the acreage of Trichogramma chilonis treatments was increased on a regular basis. Borer infestations were 6.05% in the unreleased region after five years and 1.73% in the released area. According to the findings, the use of Trichogramma is beneficial, efficient, and environmentally friendly (Hussnain et al., 1997).

Table 5: Minor insects of sugarcane crop

S.N.	Common name	Scientific name	Family	Order
1	Sugarcane white fly	*Aleurilobus barodensis* C.	Aleyrodidae	Homoptera
2	Sugarcane scale insect	*Aulacaspis tegalensis*	Diaspididae	Diaspididae
3	Black bug	*Cavelerius excavates*	Lygaeidae	Hemiptera
4	Sugarcane beetle	*Heteronychus robustus* LeC.	Scarabaeidae	Coleoptera
5	Wolly aphid	*Ceratovacuna lanigera*	Aphididae	Homoptera

4. Conclusion

Sugarcane and cotton crops are vulnerable to various insect pests that damage different parts of the crop by sucking and feeding on it, reducing the quality and quantity of the produce. To control these pests, different integrated management technologies have been adopted and researched worldwide, including mechanical, cultural, biological, and monitoring methods. Farmer education and training related to IPM approaches are essential. In order to control insect pest different integrated management technology have been adopted and researched in the crop in different parts of the world which turn out to be sustainable and environmentally friendly. These include mechanical, cultural, biological, monitoring methods etc. Farmer should be well trained and should be given education and trainings related to integrated pest management approaches.

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