ANIM5506

Integrated Pest Management of *Helicoverpa armigera* in Cotton in India

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Abstract

The Integrated Pest Management approach adopted in India helped to reduce the insecticide applications on the cotton crop, reduced the total input cost and reduced the protection of cotton plants. The growth of conventional cotton crops has been replaced by the growth of transgenic and genetically modified crops of cotton in India which has significantly reduced the incidence of diseases in cotton plants. The Integrated management of pest Helicoverpa armigera in cotton crop in india ranges from the traditional mechanical measures like handpicking and collecting the pest infected plants in the bags to the modern sustainable methods based on the principles of making the plants infection free since the beginning of the sowing. The practices involve identification of the crop, plants, for the potential presence of pest larvae and the quality of soil to identify the quality of the plants.

Aim

The aim of the study is to identify the various integrated pest management practices adopted in India to prevent the infestation of cotton plants from the pathogen *Helicoverpa armigera*.

General Background

Cotton is one of the most profound crop grown in India contributing to more than 16% of the total agricultural crops in India (Agarwal,2007). More than 9% of the cultivation land area in India is used to grow the cotton crop which is the largest fraction of area used by any country in the world. Currently the country produces 4.59 million tonnes of cotton every year which makes up

the 18% of the cotton produced internationally. In 2018 the crop perceived 15% increase in the land area cultivated for cotton (BusinessLine,2018).

The main insect pests of the conventional cotton in india are Helicoverpa punctigera and armigera species. H.armigera, commonly known as American bollworm, is a dominant pest of the cotton crop in India and has high resistance to the pesticides and other drugs sprayed to eradicate them. The adults produce numerous eggs which lead to the development of high populations infesting the majority of cotton crops in favorable conditions. Though all the plant stages are infested by the pathogen, the seedlings are most vulnerable, the pathogen eating out their terminal buds. The chewing damage harnesses the usual normal growth of the plants encouraging the fungal infestations like boll rot. It is important to observe and monitor the crop regularly to take early decisions for the control and prevention of larvae.

Multiple approaches are used to control the growth and development of Helicoverpa armigera in India to improve the quantity and quality of cotton growth in different parts of the world however the use of synthetic insecticides such as Pyrethroids, Organophosphates and Biorational compounds are the most commonly used methods adopted to control the pest. Vast application of insecticides is a concern for the ecological balance as well, and leads to the development of resistance in Helicoverpa armigera species. Additionally the pesticides also influence the non target populations of the fields such as natural predators and enemies of the pest. Therefore it is highly recommended to develop a strategic plan of action to mitigate the pest population and minimize the exposure to harmful synthetic insecticides.

The Integrated Pest Management not only reduces the dependence on the the harmful synthetic insecticides but also contributes to the healthier

agricultural practices and balancing the pest population below the achievable Economic Injury level (EIL).

The commercial growth and development fo the cotton plants in India is conducted in the North, Central and South Zone. Since 2002, the conventional crops of cotton have been replaced by the growth of transgenic varieties. Since 2002, the area, productivity and production of the crops have increased hugely from 116 lakh hectares to 489 hectares. The issues like changing rainfall, weather and temperature conditions during the development and growth of the cotton plants pose considerable problems for the cotton growing farmers. The IPM aims to decrease the production cost encouraging the yield at the level of farms.

Introduction

The Integrated Pest Management (IPM) is an integrated pest control methodology to manage the crop while solving the ecological issues in agriculture. It includes the prevention of pests and associated diseases in plants, observation and monitoring of crops to facilitate healthier growth and interventions to manage the population of pests at an acceptable level while minimizing the risk to the human health and the environment. The holistic pest management approach monitors the pests keeping track of the potential damage caused by the pests and facilitates the breeding of pest resistant crop varieties. The integrations refers to the holistic implementation of different methods and approaches to control the pests, pests refer to the vertebrate and invertebrate organisms, weeds and the pathogens affecting the crop. Management refers to the multidisciplinary approach of monitoring the crop based on decision making principles and other social and economical considerations. The IPM involves selection of appropriate pest control approach, the financial benefits to the farmers growing the cotton,

the decision regulations and rules guiding the appropriate selection of the controlling methods and relevant benefits to the environment. The method also considers the impact of other insects and pests on the cotton produce. Few of the proposed definitions of the integrated Pest Management are as follows:

IPM is a sustainable methodology to implement the avoidance, prevention, suppression and monitoring strategies to reduce the environmental, economical health related risks (Brier, Quade, & Wessels,2010).

IPM is an integrated approach where the pest control measures interact together to enhance the benefits and reduce the disadvantages like risks (Fathipour & Sedaratian, 2013).

Pest (Helicoverpa armigera)

The pest Helicoverpa armigera is mainly a pest of pulse crops and chickpea. The pest has a stout morphology with brown color with grayish wavy color lines at the wings. The female moth lays eggs over the leaves at an average rate of 185 eggs per day. The eggs of H.armigera are round and yellowish, hatched in 2-4 days. The young larvae feed on the leaves and bore in the buds, balls and flowers of cotton. The larvae may transmit in different bolls, emerging from the bolls and developing into pupae in the soil. The pupae of H.armigera are brown . The larvae bore into the fruits of the cotton plant leading to vigorous shredding. The grown up larvae eat up the big sized bolls, destroying and consuming them (Arora, Jindal, RAthore & Singh, 2017).

Threshold and Monitoring

The cotton balls and the plants need to be regularly checked through visual sampling for infection to take appropriate decisions about the control and prevention of the larvae. In addition to monitor the insect numbers it is

necessary to monitor the yield, maturity and fruit load to identify the threshold level where the insect number is below the harmful level. The threshold for the cotton crop relies on the stages of the plant. The seedling to flowering stage may be infested by 1 or 2 larvae, flowring to cut out stage may be infected by 1-2 larvae along with brown eggs. The cut out to open ball stage is infected by the larvae and the eggs.

Majority of the H.armigera species overwinters in March and develops in September onwards time. The survival of the H.armigera adults is affected by numerous mortality factors like temperature extremes, wind and rainfall.

Resistance

The pathogen species Helicoverpa armigera has lot of resistance to the most of the insecticides however the development of genetically modified cotton, the resistance has depreciated considerably. For preventing the resistance in cotton crops, the Insecticide Resistance Management Strategy has been framed which promotes the rotation of different insecticides and the modes of implementation, restricts the time duration of application of the insecticides, and decreases the number of insecticidal applications of same insecticide on the crop.

Pupae Busting is one of the cultural control method performed after harvest cultivation to lower the growth and spread of the pathogen in winters. The plants are grown at a depth of more than 10 com to damage the pupae,trap the developing moths and block the emerging tunnels of the pupae. The cultivation also leaves the pathogens open to predation of the birds, earwigs, wasps and mice.

Many natural enemies of H.armigera such as parasites and predators also influence the different life stages of the adult pathogens. The predators like

red and blue beetles, brown and green lacewing, damsel bug and nightstalking spiders prove harmful to the lifecycle of the Helicoverpa armigera. Other than these, larvae,pupae and moths also affect the species. The parasitoids like eggs of Telenormous and Trichogramma species, larvae of tacinid flies and Microplitis demolitor, and pupae of banded caterpillar parasites are the beneficial insects which influence the different stages of the Helicoverpa armigera (Department of Agriculture and Fisheries, 2018).

Insect Pest Monitoring Methods

Multiple control tactics are implemented to lower down the population density of the H.armigera pest through development of host plant resistance such as development of transgenic Bt plants, interference approaches such as sex pheromones, biological control such as predators and parasites, biopesticides, selective insecticides and the biological control.

A. The Ground Truth Analysis

The Ground Truth Analysis (GTA) can be done to identify the field situations such as humidity, nutrient quality and other climatic factors along with the interrelationship between different factors in the soil. The main parts of the GTA process are analyzing the plant health at all the stages for the potential risk of getting infested, the built in immunity of cotton plants is assessed, evaluating the dynamics of predators and pest population, and analyzing the conditions of soil and climate factors.

B. Survey of Fields

The survey of the cotton plant fields is done to basic infestation level of the soil at initial level. The results of the surveys become the basis of the field scouting initiatives. The Protection measures for the plants are implemented only when the infestation of the plants goes beyond the Economic threshold

Level of the crops. The roving surveys are taken every week and the major diseases and their intensity is recorded.

C. Sticky Traps and Pheromones

The initial development of the pest is monitored by aligning different traps like pheromones, sticky traps and yellow pans. The trapped pests are removed on daily basis.

IPM Practices before sowing the seeds

Deeper ploughing of the soil below 6 inches should be done in summers to expose the pupae residing inside the soil. The excessive heat and temperature makes the pupae die off in the soils. The weeds and the other alternate hosts must be removed and destroyed. The plants like yellow trap marigold flower are done to make sure that the plant achieves flowering soon before the vegetative stage is over. The border crops like maize can be grown in two rows at the border of the fields to provide better environment for the beneficial insects which may protect the inner cotton crop from getting infested easily. The seeds can be delinted with acids such as fumigate and sulfuric acid and the seeds can be dried off completely before sowing them inside the soil. The soil can be treated with Bavistin and Thiomethaxam to save the crop from the infection of the pest (Jambhulkar et al,2012).

IPM Practices after sowing may involve the growth and maintainance of border crops to eliminate the transmission of infestation through air, pheromone traps and sticky traps can also prevent the transmission of the infestation through the plants.

The cultural and mechanical measures to control the H.armigera infestation involved the grazing od sheeps and goats to feed on the burs and unpicked

balls remained in the cotton fields after the major collection of the produce is completed. The cotton sticks which are used in form of fuel wood by the farmers are eliminated from the fields as these sticks often act as a source of carryover of the pest. The seeds of cotton which are to be sown next year are fumigated to destroy the larvae of the American ballworm. The Punjab Agricultural University recommended the irrigation, crop cultivation and practices of fertilizer application to be implemented in the field area. The fields are checked for the mechanical removal of the twigs which are infested with ballworm. The Jassid sprays are used to destroy the larvae.

Economic Threshold Level

The ETL of H.armigera provides effective information to the farmers for initiatingthe pest management control practices. In this pest the ETL includes 5% damage to the fruiting bodies,or 3 damaged square per plant or 1 larva on each plant collected from the 20 plants chosen randomly from the cotton crop. The Management strategies for Helicoverpa pest , a lot of care is taken to select the pesticides for which there is considerable level of resistance already declared for the plant. Different cases of resistance are depicted from various parts of India like Andhra Pradesh, Punjab, Haryana and Tamil Nadu especially against the pesiticides like Cypermethrin and Pyrethroids.

The Chemical Control Methods

Effective IPM skills are developed to facilitate safe application of pesticides through crop monitoring, conserving the natural biocontrol ability and observing the ETL in the plants. Two or more insecticides must not be mixed together. Neem based and selective insecticides must be used more specifically. The application of insecticides must be alternate with the different chemical groups like Organophosphates, Cyclodine, Carbamates, insect growth regulators and Pyrethroids. Effective spray techniques can be

used like power sprayer, knapsack sprayer and tractor mounted sprayers. The CDA sprayers must be discouraged. Recommended window strategy should be encouraged.

The effective insecticides used to control the H.armigera are Neem products, Endosulfan, Pholsalone, Quinalphos, Chlorpyriphos, Profenofos, Thiodicharb, Pyrethroids (Ministry of Agriculture, 2004).

Dispersal and movement of Pest

The pest has highly successful survival strategies; dispersal and diapause which makes it destroy the cotton plants in favourable conditions, escaping successfully from the natural predators. The pathogen being a facultative migrant, responds locally to the environmental changes and its own reproductive maturity. The pathogen adults migrate longer distances through the wind, resulting into huge losses in the cotton crop (CABI,2018).

The infestation of the cotton plants by the H.armigera pest can be depicted by the presence of bore holes at the flowering buds, the pest hollows the buds, spreads the bracteoles, curling them downwards. The larvae eats out the leaves and the shoots of the cotton plants, mature green bolls are bored by the pest, the young balls fall down by the impact of young larvae resulting into secondary infection on the plants.

Agro Eco System Analysis (AESA)

The AESA methodology directs the farmers to observe the fields for diseases and pests after the 20 days time period after the sowing is complete. The farmers are asked to record the data about the fields , and maintain the records of what happened to the crops physically as depicted by the investigation. The data is recorded about the plant growth, length, number of dead plants, plant health, weeds, disease and pests, weather conditions,

irrigation and soil texture. THE input costs are also recorded such as fertilizers, pesticides, seeds, labour. The farmers are also encouraged to record the details of yield and price of produce.

While taking the observations, the farmers are advised to collect the insects in plastic bags, through sweep nets. THE plant parts with disease symptoms need to be collected. If possible the insects can be killed using the chloroform. The pests are identified, the extent of damage and the natural enemies are identified, water and nutrient management is identified analyzing the role of natural enemies in the pest management and control. The AESA training to the farmers leads to IPM based sessions such as learning through field experience, meetings, learning about the ecology of cotton plants and depicting the role of beneficial insects in controlling the disease symptoms (National Centre for Insect Pest Management, 2018).

The pesticides are managed by the use of GM crops such as Bt cotton crops which have adequate genes from the Bacillus thuringiensis bacteria. These bacteria are extremely effective in eliminating the larvae of H. armigera, without affecting the other insect pests. The growth of Genetically modified crops is not an exact solution to the problem of infestation curbing. The target species of the pest may get resistant to the insecticides, the risk of achieving the resistance is higher in the plants involving the bt genes expression. These genes need to be stacked for prolonging the delay of the insect resistance development. At some times these GM crops may act offer favorable environment for the development of Bt Proteins. The GM crops lead to reduction in the level of pesticides which may further leads to development of more insecticide resistant pests causing further devastations.

Conclusion

Multiple approaches are used to control the growth and development of Helicoverpa armigera in India to improve the quantity and quality of cotton growth in different parts of the world however the use of synthetic insecticides such as Pyrethroids, Organophosphates and Biorational compounds are the most commonly used methods adopted to control the pest. The IPM practices may be adopted before during and after the sowing of seeds, monitoring the development of plants and further educating the farmers to use GM crops to mitigate the impact.