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RESEARCH ARTICLE

A COMPARATIVE STUDY OF VARIOUS CONTROLLING METHODS TO MONITOR PINK BOLLWORM (*PECTINOPHORA GOSSYPIELLA*) INFESTATION ON THE YIELD OF COTTON: A CASE STUDY OF DISTRICT VEHARI, PAKISTAN

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ABSTRACT

Cotton is the most important crop producing natural fibre which has been under commercial cultivation for domestic consumption and export needs. A research was carried out for the management of pink bollworm in BT Cotton using different modules as controlling methods at Cotton Research Station, Vehari, Pakistan during kharif season of 2016 and 2017. Among different modules, the lowest number of Pink bollworm (PBW) larvae (32.5/25 green bolls) and locule damage (71/100 fully opened bolls) was noticed in chemical control module followed by biological control module (47 larvae/25 green bolls; 102 damaged locules/100 fully opened bolls) and biological + chemical control module (52.5 larvae/25 green bolls; 105.5 damaged locules/100 fully opened bolls). The highest number of PBW larvae (67 /25green bolls) and locule damage (130.5 damaged locules/100 fully opened bolls) was observed in untreated control module. Over all, the highest benefit cost ratio was recorded in chemical control module as compared to other modules. From this study, it is concluded that for management of PBW insecticidal sprays at ETLs proved better than biological control and other methods.

KEYWORDS

BT Cotton, Pink Bollworm, Modules, Management.

1. INTRODUCTION

Cotton is the most important crop producing natural fibre which has been under commercial cultivation for domestic consumption and it fulfils export needs of about 111 countries in the world and hence called "King of fibres" or "White gold ". Cotton plays a vital role in human civilization, political and social affairs of the world. There are four cultivated species of cotton G.herbaceum (cultivated), G.arboreum (cultivated), G.hirsutum and G.barbadense. The cotton crop is attacked by many pests but pink bollworm is worst enemy which not only causes loss to crop but also affects the lint quality. The economic loss it inflicts is heavier than the impact of any other worm (Shahina, 2014). The crop is attacked by 1326 species of insect pests throughout the world, of which about 130 different species of insects and mites are found to devour cotton at different stages of crop growth. Cotton is a pest-loving plant and is attacked from sowing to picking stage of its growth and of 30 most important pests of cotton which are injurious to growth, development and production of crop include; the caterpillars of pink, spotted and American bollworms, aphids, whitefly, jassids, mealy bugs and the spider mites.

The bollworm complex is a primary insect pest problem with larvae attacking squares and bolls causing significant yield losses if left uncontrolled (Ali, 2007). Among the bollworms, pink bollworm assumed major pest status in recent past and has known to cause loss in seed cotton yield, oil content, loss in normal opening of bolls, damage of locules, and reduction in seed cotton yield. The economic importance of cotton depends upon different properties of its products like cotton lint, cotton seed, fuzz, cotton seed cake and cotton stem. It is estimated that the yearly loss from pink bollworm in Pakistan is about one million bales (Shahina, 2014). Worldwide, pink bollworm has become economically the most destructive pest of cotton and has known to cause 2.8 to 61.9 per cent loss in seed cotton yield, 2.1 to 47.1 per cent loss in oil content and 10.7 to 59.2 per cent loss in normal opening of bolls (Anjum, 2019).

Pakistan is ranked 4th in position among cotton growing countries in the world. Cotton is recognized as the backbone of the economy for the country as it is grown since long time along the Indus river irrigation system. Despite the fact that Pakistan is overwhelmingly an agricultural based economy. Cotton cultivation is mainly focused on its fiber but cotton seed oil is significantly used as a comestible vegetable oil and makes major contribute in the national oil industry (Fan Shuli, November 19, 2018). It accounts for 6.9 percent of value added in agriculture and 1.4 percent of GDP. Cotton crop was cultivated on an area of 2878.8 thousand hectares and cotton production is 11,935000 (Ali, 2007).

Production of cotton increased 11.4 percent to 81.1 million tons over last year, which was 75.5 million tons and when compared with the target (68.5 million tons) it is 18.4 percent higher. The yields however remain relatively low due to a number of factors such as unfavourable weather conditions at the time of sowing which affects germination, incidence of pest attack during the early growth of the crop as well as at the time of flowering and boll formation.

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The high costs of chemical control, continuing economic losses, secondary pest problems and environmental considerations suggest the need for ecologically oriented PBW management strategies. Extensive research has resulted in a broad array of monitoring, biological control, cultural, behavioural, and genetic and host plant resistance methods that can serve as a base for the formulation of integrated PBW management systems (Henneberry and Naranjo, 1998). Govt. is not doing anything for the control of pink bollworm in Pakistan as reported by a Politician of Govt. PML-N lawmaker Sardar Mohammad Shafqat Hayat Khan on Sunday said the pink bollworm attack has ruined Bt cotton growers in Punjab. Mr Khan was responding to questions on why the National Assembly Standing Committee on Textile and Industry on March 4 did not approve funds for the 2016-17 fiscal year for the eradication of the pink bollworm, which has caused significant losses to the Bt cotton crop (Shahid, 2016).

The Pink bollworm (PBW) emerged as a major pest in cotton growing areas and caused the country around 4.5 million bales losses during current season (2015-16). "If the PBW could not be managed well in time, it would be the most catastrophic crisis to 1.3 million cotton farmers in Pakistan in the future", said officials of the Ministry of Textile Industry while briefing the National Assembly standing committee on Friday (Amin, 2016). As being the major pest of cotton, pink bollworm it is controlled by different methods.

1.1 Natural Mortality

Diapausing larvae are subjected to a number of adverse climatic and biological factors that result in mortalities of 48±99% (Slosser and Watson, 1972; Fullerton et al., 1975; Bariola et al., 1976; Bariola, 1983). However, in most cases, survival occurs in sufficient numbers to develop economic levels of infestation the following year. The mechanisms involved which induce larval mortality in the soil, except for the physical impact of tillage and soil burial, are not known.

1.2 Chemical Control

Early-season insecticide applications for PBW control should, in general, be avoided in order to preserve natural enemy populations and reduce secondary pest outbreaks. Chemical control has not provided a long-term solution for the PBW problem because of the high costs, environmental impact and related problems (insecticide-resistant insect strains, the reduction of pest insect natural enemies, the resurgence of pest populations in the absence of natural enemies and the occurrence of secondary pests). Insecticide control focuses on attacking localized populations on a farm by farm basis. In contrast to this approach, area-wide suppression and management has evolved with our increasing awareness of the limitations of attacking local infestations which represent only a small part of the total pest population (Knipling, 1979).

2. Material and Methods

Evaluation of different modules for control of Pink bollworm in BT cotton was studied in BT cotton during Kharif seasons of 2016 and 2017 at Cotton Research Station, Vehari, Pakistan.

The experiment was carried out with four modules:

1. Biological control (Module-1)
2. Chemical/Insecticidal control (Module-2)
3. Insecticidal + Biological control (Module-3)
4. Untreated control (Module-4)

each in 500 sq.m. area separated with 2m buffer distance. The crop was grown under irrigated conditions in clay loamy soil at a spacing of 90 x 60 cm following all recommended agronomic practices. Biological control module includes eco-friendly strategies and chemical control module comprised of chemical insecticidal sprays which are normally effective against Pink bollworm (Table1). Sowing was done on 15-4-2016 during 2016 and on 17-4-2017 during 2017. In untreated control plot, no insecticidal sprays were taken up during both the seasons. The pest management interventions were carried out only when the pests crossed economic threshold level. In all the treatments, cotton seed treated with imidacloprid 70 WS were sown in order to control the early sucking pests. Each plot was divided into four equal blocks to minimize the error while recording the data.

Table 1: Number of PBW larvae per 25 green bolls through destructive sampling at different days of crop growing period during 2016-17

Treatments	Days after sowing					Mean
	140 days	150 days	160 days	170 days	180 days	
Module 1	2	34	35	39	72	36
Module 2	2	14	13	33	27	18
Module 3	4	38	39	67	76	45
Module 4	10	54	64	78	98	61

Table 2: Number of PBW larvae per 25 green bolls through destructive sampling at different days of crop growing period during 2017-18.

Treatments	Days after sowing							Mean
	120 days	130 days	140 days	150 days	160 days	170 days	180 days	
Module 1	9	31	64	69	90	75	70	58
Module 2	13	33	55	50	64	53	60	47
Module 3	13	35	44	61	89	67	111	60
Module 4	17	45	64	90	107	78	108	73

Table 3: Effect of different modules on Pink bollworm

	No. of PBW larvae/25 green bolls		Pooled	No. of damaged locules /100 fully opened bolls		Pooled
	2016-17	2017-18		2016-17	2017-18	
Module 1	36	58	47	66	138	102
Module 2	18	47	32.5	49	93	71
Module 3	45	60	52.5	94	117	105.5
Module 4	61	73	67	119	142	130.5

The first block was treated with Trichogrammatoidea bactrae @ 20,000/ ha at 10 days interval if the moth catches exceed 8 per trap for 3 consecutive days. The second block was treated with conventional insecticides, received a total of five sprays during the season. The third block received a combination of biological and chemical methods as soon as the moth catches reached an economic threshold level. The fourth block was untreated and served as a control. To record pink bollworm incidence 25 fruiting bodies per plot were plucked at 140, 150,160,170 and 180 days after sowing during kharif 2016 where the incidence was started at 140 DAS and 120, 130, 140, 150, 160, 170 and 180 days after sowing during kharif 2017 where incidence started early at 120 DAS. To record incidence of bollworms in fully opened bolls at harvest time, 100 opened bolls per plot were plucked randomly and were collected in polyethylene bags and estimated locule damage. The data of all the observations was pooled to arrive at seasonal means (Table 4 & 5). Cotton yield was recorded from each treatment and the data were presented as seed cotton yield in q/ha and benefit cost ratio of each treatment was worked out.

3. Results and Discussions

A study was conducted to evaluate different modules for effective management of Pink bollworm in Bt cotton during kharif 2016 and 2017. It is seen from the data in (Table 4) that all modules were significantly superior over untreated control during kharif 2016 and 2017. In the present investigation, incidence of Pink bollworm remained low when chemical control was adopted as compared to other methods of control during both the years. It was revealed that the lowest number of pink bollworm larvae (18) through destructive sampling was observed in module 2 followed by module 1 (36), module 3 (45) while, the highest was noticed in module 4 (61) during 2016-17. Similarly, the lowest number of pink bollworm larvae (47) through destructive sampling was observed in module 2 followed by module 1 (58), module 3 (60) while, the highest was noticed in module 4 (73) during 2017-18 indicating the influence of insecticidal interventions over biological and other modules.

Table 4: Effect of different modules on seed cotton yield

	Seed cotton yield (q/ha)		
	2016-17	2017-18	Pooled
Module 1	18.88	17.11	17.99
Module 2	25.17	18.82	21.99
Module 3	16.90	16.65	16.77
Module 4	13.87	13.47	13.67

The present findings are in conformity with reports of who reported low incidence of Pink bollworm in chemical control method. Similarly low incidence of Pink bollworm was observed in chemically treated plot. At the time of harvesting, locule damage was recorded from 100 fully opened bolls. The lowest locule damage (49) was noticed in module 2 followed by module 1 with 66 damaged per 100 fully opened bolls followed by module 3 with 94 damaged per 100 fully opened bolls while, the highest locule damage (119) was noticed in module 4 untreated control during 2016-17. Similarly, the lowest number of damaged locules (93) from 100 fully opened bolls was observed in module 2 followed by module 3 (117), module 1 (138) while, the highest damaged locules (142) per 100 fully opened bolls was observed in module 4 during 2017-18 (Table 4). The present findings reveal that chemical/insecticidal control (Module-2) is the best among all treatments followed by biological (Module-1), biological + chemical (Module-3) & Untreated (Module-4) for control of pink bollworms in cotton.

3.1 Seed Cotton yield in different modules

Results presented in Table-4 showed that during Kharif 2016 and 2017 all modules were significantly superior over untreated control. Highest seed cotton yield (21.99 q/ha) was obtained in module-2 followed by module-1 (17.99 q/ha), module-3 (16.77 q/ha) while, the lowest seed cotton yield (13.67 q/ha) was recorded in untreated control module.

3.2 Economics of various modules

Highest gross income was obtained in chemical control method (module-2) during both the years of investigation. Over all, the benefit cost ratio was high in chemical control module (module-2) as compared to other modules (Table-5). The results clearly indicated that initiation of chemical control methods at ETLs proved to be better for the management of Pink bollworm as compared to other methods.

Table 5: Economics of different modules

Particular	2016-17				2017-18			
	Module 1	Module 2	Module 3	Module 4	Module 1	Module 2	Module 3	Module 4
Yield (q/ha)	18.88	25.17	16.90	13.87	17.11	18.82	16.65	13.47
Income from crop (Rs./ha)	78,541	1,04,707	70,304	57,699	73,915	81,302	71,928	58,190
Gross income (Rs./ha)	78,541	1,04,707	70,304	57.699	73,915	81,302	71,928	58,190
Total Cost of cultivation (Rs./ha) 6	64,115	68,945	64.835	58.750	66.060	67.025	64.835	58.350
Benefit: Cost ratio	1.22	1.52	1.08	0.98	1.12	1.21	1.11	0.99

4. Conclusion

From the present study, it is concluded that among all modules, chemical control module is the best followed by biological control module, biological module + chemical module for the management of Pink bollworm in BT Cotton.

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