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Survey and Seasonal incidence of Pink Bollworm *Pectinophora gossypiella* (Sounders) in *Bt* Cotton Growing areas of North Gujarat

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ABSTRACT: To determine the extent of damage caused by pink bollworm at various stages of the cotton crop the survey was undertaken. In *Bt* cotton growing areas of Banaskantha district of North Gujarat. Among the villages surveyed for the presence of pink bollworm, all the nine villages of Deesa, Deodar and Kankrej talukas of Banaskantha district of North Gujarat consisting of semi arid climate, recorded its incidence during *kharif* 2019. The maximum flower, locule and boll damage were recorded at Raiya village of Deodar (16.53, 17.19 and 30.00 %) and minimum flower, locule and boll damage were recorded at Thervada village of Deesa (11.86, 12.12 and 19.20 %, respectively). Seasonal incidence of pink bollworm at Sardarkrushingar in Dantiwada taluka revealed that the infestation of the pest and its activity were observed from second week of September to fourth week of December. The rosette flower damage appeared from second week of September (2.32 %), while the larval population initiated from fourth week of September (1.2 larvae/10 unopened bolls). The flower damage and larval population were maximum (14.28 % and 7.8 larvae/10 unopened bolls) during the second week of November and fourth week of November, respectively. The opened boll damage ranged from 35.00 to 40.55 per cent and maximum (40.55 %) during 4th week of November, while the locule damage varied from 19.28 to 22.77 per cent and maximum (22.77 %) locule damage were observed during 4th week December. Correlation between larval population of pink bollworm and weather parameters indicated that significantly negative correlation with morning relative humidity and rainfall.

Keywords: Survey, incidence, pink bollworm, cotton.

INTRODUCTION

Cotton is an important commercial crop grown for fibre, fuel and edible oil. India ranks first in the world with regard to cotton acreage, however the productivity is low as compared to other cotton growing countries. According to Cotton Corporation of India the estimated area of cotton cultivation is 123.50 lakh hectares with a production of 340.62 lakh bales and productivity of 469 kg per ha during 2022 (COCPC, 2022). Among various factors responsible for low productivity, the losses caused by insect pests are of major importance. In India, over 160 species of insect pests have been reported to damage the cotton crop. Among the several pests that attack cotton crop from sowing to harvest, about dozen pests cause economic damage as sap feeders and bollworms.

Among the bollworm complex pests, pink bollworm, *Pectinophora gossypiella* (Sounders) is one of the major cotton insect pest with widespread across India leading to heavy loss to cotton production (Dhurua and Gujar 2011; Naik *et al*., 2018). It has become apparent as a menace to cotton cultivation in south and central cotton growing zones of India where the pest developed resistance to Cry1Ac and Cry2Ab expressing cotton also developing resistance to insecticides and infesting late season cotton (Kranthi, 2012; Naik *et al*., 2018). In recent years, severe damage to bolls by pink bollworm and yield losses were observed in *Bt* cotton in many regions of Gujarat and some parts of Andhra Pradesh, Telangana and Maharashtra (Kranthi, 2015). It causes locule damage to an extent of 55 per cent and reduction in seed cotton yield in the range of 35 to 90 per cent was also reported by Agarwal and Katiyar (1979). Pink bollworm infestation was observed in flowers of different Bollguard II hybrids up to 80.0 per cent (Naik *et al*., 2015). In Gujarat, the pink bollworm activity has become more pronounced during recent past and the incidence has been identified from the middle of crop season seriously damaging the kapas in late pickings. The pink bollworm under unprotected condition has been known to cause 2.81 to 61.87 per cent loss in seed cotton yield, 3.44 to 37.83 per cent loss in germination,

2.12 to 47.13 per cent loss in oil content and 10.66 to 59.15 per cent loss in normal opening of bolls (Patil, 2003). The recent problems of bollworm occurrence, especially of the pink bollworm on *Bt* cotton, irrespective of any hybrids may be attributed to the reasons of congenial climate or resistance build up or low expression of genes for pink bollworm management leads to re-look into dynamics of bollworms on cotton hybrids. The development of resistance for pink bollworm is due to several factors like absence of refuge or supply of fraudulent refuge (Wan *et al*, 2012), mono cropping, cultivation of long duration hybrids, extended cropping season (Kranthi *et al.*, 2017). Therefore, in the present investigation an attempt was made for survey and incidence of pink bollworm in selected talukas of Banaskantha district to ascertain its damage at various stages of the crop.

MATERIAL AND METHODS

A. Survey of pink bollworm incidence in cotton growing areas of Banaskantha district of North Gujarat

Survey for pink bollworm incidence was carried out in total nine villages of three talukas (Deesa, Deodar and Kankrej) of Banaskantha district. Three villages were selected randomly from each taluka and five cotton fields were selected randomly in each village for the survey. In each field, the observation on flower, boll and locule damage were recorded. The observations were taken starting from blooming till the end of pickings

Flower damage: Observations on the damage of pink bollworm in flowers were made at monthly intervals starting from flowering. At the time flowering, 50 flowers were observed randomly from each field. Then total number of flowers and damaged flowers were counted and expressed in terms of per cent flower

$$\text{Flower damage (\%)} = \frac{\text{Number of damaged flowers}}{\text{Total number of flowers observed}} \times 100$$

Locule damage**:** Locule damage was made at 90 days after sowing. At the time of cotton picking, 50 opened bolls were observed randomly from each field. Then total number of locules and damaged locules were counted and expressed in terms of per cent locule damage

$$\text{Locule damage (\%)} = \frac{\text{Damaged locules}}{\text{Total number of locules}} \times 100$$

Open boll damage: At the time of cotton harvesting, 50 opened bolls were observed randomly from each field. Then total number of bolls and damaged bolls were counted and expressed in terms of per cent boll damage

$$\text{Boll damage (\%)} = \frac{\text{Number of damaged bolls}}{\text{Total number of bolls observed}} \times 100$$

Seasonal incidence of pink bollworm in *Bt* cotton: The experiment was carried out at Agronomy Instructional Farm, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar during *Kharif*, 2019. All recommended package of practices were followed to maintain good plant stand throughout the crop period except plant protection measures. The *Bt* cotton hybrid Ajeet-155 BG-II was dibbled at 120 cm × 60 cm spacing with plot size of 12 × 10 m^2. The observations on number of healthy and damage rosette flowers by pink bollworm from five randomly selected plants were counted at 15 days interval starting from the initiation of flowering to till the harvesting. Similarly, number of pink bollworm larva per 10 unopened bolls was recorded at 15 days interval starting from 80 days after sowing till the harvesting. For these purpose, 10 unopened bolls were plucked and brought to the laboratory for critical observation of the pink bollworm larvae from the bolls. Open bolls and locules damage by pink bollworm were recorded at the harvest by counting the number of healthy and damaged open bolls and locules by the pink bollworm separately from five plants in plot.

RESULTS AND DISCUSSION

A. Survey of pink bollworm incidence in cotton growing areas of Banaskantha district of North Gujarat

Flower damage (%): The results of the survey (Table 1) indicated that flower damage at all the locations varied from 11.86 to 16.53 per cent. The intensity of flower damage due to pink bollworm was low (11.86 %) at Thervada village of Deesa followed by 12.39 per cent at Javal village of Deesa. Highest (16.53 %) flower damage was noticed in Raiya village of Deodar followed by 15.33 per cent flower damage at Isarva village of Kankrej. The villages Nathpura (Kankrej), Ludra, Goda village of Deodar, Kudva (Kankrej) and Tetoda village of Deesa recorded 15.20, 15.06, 14.79, 14.40 and 13.99 per cent flower damage, respectively

Locule damage (%): Locule damage across locations varied from 12.12 to 17.19 per cent. M inimum (12.12 %) damage was recorded at Thervada village of Deesa followed by 12.66 per cent at Javal village of Deesa taluka while, maximum (17.19 %) damage was noticed in Raiya village of Deodar taluka followed by 16.26 per cent locule damage at Isarva village of Kankrej. The village's Nathpura (Kankrej), Ludra, Goda village of Deodar, Kudva (Kankrej) and Tetoda village of Deesa observed 15.86, 15.59, 15.46 14.79 and 14.66 locule damage (%), respectively.

Boll damage (%): The lowest boll damage (19.20 %) was recorded at Thervada village of Deesa followed by 22 per cent boll damage at Javal village of Deesa. Highest (30.00 %) boll damage was observed in Raiya village of Deodar followed by 26.40 per cent boll damage at Isarva village of Kankrej. Other villages recorded 25.20, 24.40, 24.00, 24.00 and 22.80 per cent boll damage in the Goda (Deodar), Kudva, Nathpura village of Kankrej, Tetoda (Deesa) and Ludra village of Deodar, respectively. Observations on per cent flower, locule and boll damage further indicated low to medium infestation of crop at all the locations. Thus, from the results of the survey conducted at different farmer's field of Banaskantha district revealed that the activity of pink bollworm was comparatively lower at Deesa taluka, low to medium at Kankrej and higher at Deodar taluka. The results were more or less in concurrence with the findings of Nadaf (2006) reported

maximum larval population, green boll damage and locule damage was recorded at Raichur in *Bt* cotton (5.44 larvae/50 bolls, 9.45 % 16.06 %) and non *Bt* cotton (10.75 larvae/50 bolls, 20.62 and 26.31 %). Pink bollworm damage ranged between 0.0 -80.0 per cent on BG-II in Bharuch, Vadodara, Anand, Bhavnagar, Amreli, Junagadh, Rajkot, Surendranagar and Ahmedabad districts (Kranthi, 2015). Similarly, Naik *et al*. (2016) observed the pink bollworm infestation at Bharuch, Vadodara, Anand, Bhavnagar, Amreli, Junagadh, Rajkot, Surendranagar and Ahmedabad districts of Gujarat. Further, Thumar *et al.* (2017) reported the infestation of pink bollworm in two districts (Kheda and Vadodara) of Gujarat

B. Seasonal incidence of pink bollworm in cotton

The infestation of the pink bollworm and its activity were recorded from second week of September (37th SMW) to fourth week of December (52nd SMW). The rosette flower damage ranged from 2.32 to 14.28 per cent during the cropping period (Table 2) The incidence was commenced from second week of September (37th SMW) and increased gradually with the progression of crop growth reaching its peak (14.28 %) incidence during the second week of November (45th SMW). Hereafter, the incidence of pink bollworm in rosette flowers declined in fourth week of November (47th SMW) (6.81 %). These results stand in the persuasion of (Muttappa and Patil 2019) who recorded the rosette flowers were ranged from (2.25 to 15.45 %) with seasonal mean of (9.05 %). However, it was contrast with Verma *et al*. (2017) who recorded maximum (26.66 %) rosette flower damage during second week of September (37th SMW). The incidence of pink bollworm larvae on unopened bolls of cotton was noticed from fourth week of September (1.2 larvae/10 unopened bolls) which increased gradually to its peak (7.8 larvae/10 unopened bolls) during the fourth week of November. Thereafter, the larval population gradually declined. Contradictory findings were recorded by Verma *et al*. (2017) the peak larval population on cotton bolls in the 2nd week of September with an intensity of 7.00 larvae/30 bolls in 2012 and in 3rd week of September with the intensity of 8.00 larvae/30 bolls during 2013. Similarly, Rathod (2016) also observed the highest pink bollworm larval population 7.33/10 green bolls during first week of November. The opened boll damage recorded due to pink bollworm infestation ranged from 35.00 to 40.55 per cent (Table 2) and reached its peak (40.55 %) during 4th week of November. These results slightly differed with Muttappa and Patil (2019) who recorded maximum (53.48 %) open boll damage during the cropping period. The locule damage due to pink bollworm infestation varied from 19.28 to 22.77 per cent. The maximum (22.77 %) locule damage was recorded during 4th week December. Similarly, Shinde *et al.* (2018) observed the locule damage in non *Bt* cotton from 0.44 to 39.08 per cent and in *Bt* cotton from 0.44 to 18.79 per cent.

C. Influence of weather parameters on incidence of pink bollworm in cotton

The data on larval population of pink bollworm were used to study the correlation with abiotic factors (Table 3). The correlation studies of larval population of pink bollworm indicated significantly negative correlation with morning relative humidity ('r' = -0.609*) and rainfall ('r' = -0.605*) whereas, non significant negative correlation with maximum temperature ('r' = -0.308), minimum temperature ('r' = -0.431), evening relative humidity ('r' = -0.226), wind velocity ('r' = -0.189) and positive non significant correlation with bright sunshine ('r' = 0.007) were observed. Kalkal *et al.* (2014) reported pink bollworm population which had significantly negative correlation with temperature ('r' = -0.83), relative humidity ('r' = -0.86) and rainfall ('r' = -0.93) while positive correlation with sunshine hours ('r' = 0.52), which were in concurrence to the present observations. According Matre *et al.* (2023) revealed that pink bollworm population had a significant positive correlation with maximum temperature, minimum temperature, evaporation and bright sunshine and significant negative correlation with rainfall, wind speed and relative humidity. While, Rathod (2016) also observed that the infestation of PBW larvae in green boll showed significant positive correlation with maximum temperature and sunshine hours, whereas negative, but highly significant correlation with minimum temperature and evening relative humidity, these findings were contradictory to the present findings.

Table 1: Survey of pink bollworm incidence in cotton growing areas of Banaskantha district of North Gujarat.

Taluka	Village	Flower damage (%)				Locule damage (%)				Boll damage at harvest (%)
		60 DAS	90 DAS	120 DAS	Mean	90 DAS	120 DAS	150 DAS	Mean	
Deesa	Javal	10.4	17.2	9.6	12.396	4	11.2	22.8	12.67	22
	Tetoda	12.8	18.4	10.8	13.996	5.6	13.2	25.2	14.67	24
	Thervada	9.6	16.4	9.6	11.862	3.6	10.8	22	12.13	19.2
Deodar	Goda	12.8	21.2	10.4	14.796	6	14.8	25.6	15.47	25.2
	Raiya	12.4	24.8	12.4	16.532	7.2	16.8	27.6	17.12	30
	Ludra	11.2	23.2	10.8	15.062	6.4	15.6	24.8	15.60	22.8
Kankrej	Isarva	12	20.4	13.6	15.33	5.6	16	27.2	16.27	26.4
	Nathpura	12	22.4	11.2	15.198	5.6	15.6	26.4	15.87	24
	Kudva	10.8	20.4	12	14.396	5.6	15.2	23.6	14.80	24.4

DAS = Days after sowing

Table 2: Seasonal incidence of pink bollworm, *P. gossypiella* in relation to abiotic factors in cotton.

SMW	Month	Week	Flowers damage (%)	Larvae/10 unopened bolls	Open boll damage (%)	Locule damage (%)	Weather parameters						
							Temperature (ºC)		Relative humidity (%)		Bright sunshine (hrs/day)	Wind speed (km/h)	Rainfall (mm/day)
							Max.	Min.	Morning	Evening			
35	August	**IV**	0.0	0.0	-	-	30.3	24.9	81	81	1.6	4.3	150.2
37	September	**II**	2.32	0.0	-	-	32.5	25.1	81	75	1.3	3.7	29.0
39		**IV**	6.25	1.2	-	-	31.8	24.1	79	78	4.3	4.4	68.8
41	October	**II**	7.81	2.0	-	-	35.4	21.0	68	54	9.2	2.0	0.0
43		**IV**	9.61	3.8	35.00	19.28	34.6	17.5	53	56	8.2	3.4	0.0
45	November	**II**	14.28	7.4	-	-	32.4	20.7	64	67	4.6	4.1	0.0
47		**IV**	6.81	7.8	40.55	21.32	31.8	15.3	53	58	7.8	1.8	0.0
50	December	**II**	-	5.6	-	-	27.1	9.5	49	42	8.4	3.4	4.0
52		**IV**	-	-	38.33	22.77	25.8	6.9	48	26	8.6	3.4	0.0

SMW: Standard Meteorological Week

Table 3: Correlation coefficient ('r') between pink bollworm infesting cotton and weather parameters.

Weather parameters	Larval population
Maximum Temperature (°C)	-0.308
Minimum Temperature (°C)	-0.431
Morning Relative humidity (%)	-0.609*
Evening Relative humidity (%)	-0.226
Bright sunshine hours (hrs/day)	0.007
Wind speed (km/h)	-0.189
Rainfall (mm/day)	-0.605*

* Significant at 5 per cent level ('r' = 0.553).

CONCLUSIONS

The survey for pink bollworm in cotton growing areas revealed that lowest flower, locule and boll damage was recorded at Thervada village of Deesa (11.86, 12.12 and 19.20 %). Its seasonal incidence revealed the maximum flower damage and larval population (14.28 % and 7.8 larvae/10 unopened bolls) recorded during second week of November and fourth week of November. The opened boll damage was maximum (40.55 %) during 4th week of November and highest locule damage (22.77 %) was observed during 4th week December. Correlation studies between larval population and weather factors shown that significantly negative correlation with morning relative humidity and rainfall.

Conflict of Interest. None.

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