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Studies on seasonal incidence of sucking pests and pink bollworm, *Pectinophora gossypiella* (Saunders) in cotton (*Gossypium* spp.)

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Abstract
A field experiment was conducted at AICRP on cotton, Haradanahalli, Chamarajanagara during *kharif* 2018 to know the population dynamics of insect pests of cotton on HB2110 cultivar. The peak incidence of aphids (64.28 aphids/3 leaves), leafhoppers (5.24 leafhoppers/3 leaves), thrips (5.51 thrips/3 leaves) and whiteflies (4.97 whiteflies/3leaves) were observed during 36, 28, 40 and 38th SMW. Pink bollworm incidence was started during 32 SMW and attended its severity at 46th (15 larvae/20 bolls).The correlation results of the meteorological variables with insect population revealed that aphids, thrips, whiteflies and PBW showed significant positive correlation with maximum temperature while, leafhopper showed positive non-significant correlation. However, all the above pests showed non-significant negative correlation with minimum temperature, evening relative humidity and rainfall except leafhopper and aphids showed significant positive correlation and non-significant negative correlation with morning relative humidity, respectively.

Keywords: Mumbai, sewage, railway track, micronutrients, heavy metals

Introduction
Cotton is an important fibre crop grown in India and more than seventy countries in the world. It belongs to the genus *Gossypium* of the family Malvaceae. Cotton plays a major role in industrial sector, economy and foreign exchange, hence it is called as 'White gold'. India gains foreign exchange annually to the tune of 12-14 US $ billion from the cotton yarn, thread, fabrics and apparels exports. It provides employment opportunities to millions of people in the country who are involved in its cultivation, trading, processing, manufacturing, fabricating and marketing 13.5 million bales of 170 kg each. The extent of international and domestic trade from India is estimated as (Rs. 15,000 Cr.) 30 US $ billion annually (Anonymous, 2015b) [2]. In India, 160 species of insect pests have been reported to attack the cotton crop right from germination till the final harvesting of the crop (Agrawal, 1978) [1]. The pests have the potential to reduce yield by 20 to 80 per cent (Thakare *et al.*, 1983) [12]. Few of them are considered as key pests causing huge damage to cotton crop all over the country. The major pests attacking on Bt cotton are aphid, jassid, thrips, whitefly, mealybug and mite
At present, severe yield loss of cotton is due to development of resistance in pink bollworm, *Pectinophora gossypiella* on first and second generation *Bt* cotton hybrids. It causes 2.8 to 61.9 per cent loss in the seed cotton yield, 2.1 to 47.1 per cent loss in oil content and 10.00 to 55.00 per cent damage to green bolls (Anonymous, 2018b) [3].
Climatic conditions have a great influence on the population, survival, development, out-breaks, reproductive capacity and activity of pest as well as predators and parasites either directly or indirectly (Arif *et al.*, 2007) [4]. For developing a weather based pest fore-casting system, information regarding population dynamics in relation to prevalent meteorological parameters (temperature, relative humidity, rainfall *etc*.) is needed. Moreover, the same meteorological parameters also influence the growth and development of crop. Therefore, a thorough understanding of interaction between the crop growth stage and meteorological parameters/pest dynamics is a prerequisite for weather based pest forecasting model (Zia *et al*., 2015).

Materials and Methods

To study the population dynamics of sucking pests and pink bollworm on HB2110 Bt cotton hybrid during kharif season in relation to different meteorological variables. The Hybrid was sown during first week of May, 2018 in a plot size of 500 m^2 with 90 × 60 cm spacing and was maintained with good agronomic practices as per the requirements under unprotected conditions.

Observations on seasonal incidence of sucking pests like aphids, leafhopper, whiteflies and thrips were recorded on cotton hybrid at 15 days interval from 45 days after sowing. Sucking pests were recorded on 3 leaves/ plant on top, middle and bottom of 10 randomly selected plants. The number of pink bollworm larvae were recorded from 20 bolls by destructive sampling method. Destructive sampling was done at 15 days intervals from 60 days after sowing till the harvest of the crop.

To correlate the relationship between incidence of insect pests on cotton and meteorological variables, the data on meteorological variables *viz.*, maximum and minimum temperature, relative humidity and rainfall prevailed during the investigation period were collected from the Agrometeorological observatory Unit, located at AICRP on cotton, Chamarajanagar and means were worked out for fortnight intervals.

The observation were made on the incidence of sucking pests and pink bollworm on cotton hybrids and weather parameters were subjected to Pearson's Rank Correlation co-efficient analysis with prevailing data of meteorological variable *viz*., temperature, humidity, rainy days and rainfall. Further the data was subjected to Multiple Linear Regression Analysis Technique (MLR) (Pans and Sukhatme, 1967) by fitting different function using software "SAS – Syntex Reference Guide 2016, version 16 (SPSS, 2016), South Wacker Drive, Chicago, IL (SPSS,2009)."

Results and Discussion

To correlate the relationship between insect pests of cotton with meteorological variables,the population dynamics of *Aphis gossypii, Amrasca biguttula biguttula, Bemisia tabaci, Thrips tabaci* and *Pectinophora gossypiella* were observed on cotton hybrid from flowering to harvest of the crop. The population of the aphids was occurred throughout the cropping season. Two peak incidence were observed *i.e.*, during first fortnight of September with 64.28 and in November with 32.50 mean number of aphids/ 3 leaves. The correlation matrix between aphids incidence on HB2110 cultivar and meteorological variables revealed that, the aphid population had showed significant positive correlation with maximum temperature (r = 0.59). While, minimum temperature (r = -0.09), morning relative humidity (r = -0.08), evening relative humidity (r = -0.18) and rainfall (r = -0.33) had shown non- significant negative correlation.

The peak incidence of leafhopper was recorded on 28th SMW in July and 30th SMW in August with 5.24 and 5.00 leafhopper/ 3leaves, respectively. The correlation study between weather parameters and leafhopper population indicated that, non-significant positive correlation with maximum temperature (r = 0.06) and significant positive correlation with morning relative humidity (r = 0.73). Other parameters *viz*., minimum temperature (r = -0.34), evening relative humidity (r = -0.13) and rainfall (r = -0.09) showed non-significant negative correlation with mean leafhopper population. The higher thrips population per three leaves were recorded during 40th SMW with 5.51 adults/ 3 leaves and showed significant positive correlation with maximum temperature (r = 0.59) and non-significant positive correlation with morning relative humidity (r = 0.39). While, minimum temperature

(r = -0.39), evening relative humidity (r = -0.27) and rainfall (r = -0.42) showed non- significant negative correlation with population of thrips. The adult population of whitefly fluctuated throughout the cropping season and ranged from 0.00- 4.97 adults per three leaves starting from 26th SMW. But during 38th SMW, a second fortnight of September, peak incidence with 4.97 whitefly adults/ 3leaves were observed, indicating significant positive correlation with maximum temperature (r = 0.73), non-significant positive correlation with morning relative humidity (r = 0.01). While, minimum temperature (r = -0.24), evening relative humidity (r = -0.46) and rainfall (r = -0.26) had shown non- significant negative correlation with population of whitefly. Highest number of pink bollworm larvae were recorded in second fortnight of November during 46th SMW with 15.00 larvae/ 20 bolls. The correlation data showed non-significant positive correlation with maximum temperature (r=0.37) and morning relative humidity

(r = 0.15) and negative significant correlation with minimum temperature (r = -0.60) and evening relative humidity (r = -0.81). While, non-significant negative correlation with rainfall (r = -0.06).

These results are in close agreement with the findings of Chauhan *et al*. (2017) [5] who reported that, peak incidence of aphids was recorded in the month of September. Similarly, the present findings are also in agreement with Nemade *et al.* (2018) [9] who observed that, the population of aphids showed non-significant negative correlation with morning and evening relative humidity and significant positive correlation with maximum temperature. The results on influence of meteorological variables on leafhopper population are in close occurrence with the findings of Kataria *et al*. (2017) [7] who reported peak incidence of leafhoppers was observed during second fortnight of July and their population showed non-significant positive correlation with temperature, relative humidity and negative correlation with rainfall. Similarly, the present findings are more or less related to findings of Janu *et al.* (2017) [6] who indicated that, minimum temperature and morning relative humidity had high impact on the population of thrips. The results of the present findings are in close agreement with Rawal *et al*. (2017) [11] who reported that, the population of bollworm were positively correlated with morning relative humidity. Minimum and maximum temperature, rainfall and evening relative humidity were negatively correlated. Similarly, Laxman *et al*. (2014) [8] indicated that, both american and pink bollworm showed positive correlation with morning relative humidity. Minimum and maximum temperature, rainfall and evening relative humidity were negatively correlated to the incidence of pink bollworm both on *Bt* and non-*Bt* cotton.

Table 1: Seasonal incidence of sucking pests and pink bollworm larvae on cotton hybrid during Kharief 2018

SMW	Dates of observation	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	Number of sucking pests/ 3 leaves				No. of Pink bollworm larvae/ 20 bolls
		Max.	Min.	Morning	Evening		Aphids	Leaf hoppers	Thrips	White flies	
26	Jul-07	32.15	19.95	99.05	57.00	1.25	19.30	2.52	1.26	1.52	0.00
28	Jul-21	28.85	20.75	98.05	70.40	10.70	12.11	5.24	0.57	2.28	0.00
30	Aug-04	28.55	22.05	93.85	64.65	4.25	4.11	5.00	0.20	0.29	0.00
32	Aug-18	27.85	21.65	97.10	66.75	20.75	6.32	2.34	0.20	0.21	3.00
34	Sep-01	28.70	23.65	89.90	63.25	15.35	8.61	0.87	0.48	0.87	5.00
36	Sep-15	31.55	22.50	88.75	45.75	0.00	64.28	0.56	1.44	3.72	5.00
38	Sep-29	31.50	20.65	98.40	49.70	54.65	13.99	1.00	0.00	4.97	9.00
40	Oct-13	30.85	20.90	99.90	56.20	19.25	7.42	4.74	5.51	2.00	7.00
42	Oct-27	30.60	18.90	99.90	50.15	24.60	7.16	3.41	1.92	3.72	4.00
44	Nov-10	31.05	17.50	99.90	41.95	1.10	4.00	1.26	4.73	2.91	12.00
46	Nov-24	30.65	16.60	90.35	34.65	2.50	32.50	1.61	0.91	2.74	15.00
48	Dec-08	30.70	17.57	94.72	40.90	0.00	26.72	1.84	1.10	1.25	7.00

Table 2: Correlation between sucking pests, pink bollworm larval incidence on cotton hybrid HB2110 and meteorological variables during *kharif*, 2018

	Maximum temperature (ºC)	Minimum temperature (ºC)	Morning RH (%)	Evening RH (%)	Rainfall (mm)	R^2 value
Aphids	0.59*	-0.09	-0.08	-0.18	-0.33	0.35
Leafhoppers	0.06	-0.34	0.73*****	-0.13	-0.09	0.54
Thrips	0.59*****	-0.39	0.39	-0.27	-0.42	0.39
Whitefly	0.73*****	-0.24	0.01	-0.46	-0.26	0.53
Pink bollworm	0.59*****	-0.39	0.39	-0.27	-0.42	0.39

Conclusion

In the light of the results obtain through the present investigation, it can be concluded that the cotton crop was initially invaded by aphids and leafhoppers .Even though the activities of thrips and whiteflies are noticed in early stage of the crop, but their severity increase later. Later-on, pink bollworm infested the cotton crop. prediction on peak period of activity of a given pest can authorize us to evolve appropriate management strategies that will eventually prevent the loss in productivity of cotton. The main problem in determining the pest management issue is the dearth of scientific awareness about the features of the pest dynamics that shows an inadequate pest management conditions. Thus, Population dynamics play a principal role in integrated pest management module.

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