Seasonal Incidence of Major Sucking Insect Pest in Bt Cotton and Its Correlation with Weather Factors in Jalna District (MS), India

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Abstract

Cotton is one of the important cash crop of farmers community in India and its production affected by insect pest. In order to determine seasonal incidence of sucking insect pest on Bt cotton and its correlation with weather factors this studies was carried out in 5 blocks of Jalna district. Incidence of sucking insect pests surveyed from 20 randomly selected plants in each plots on weekly interval throughout the season. The results of two years study reveals that highest incidence of Jassid (12.28/3 leaves) observed during 3rd week of October in 2009-10 and (8.28/ 3 leaves) during first week of October in 2010-11. Maximum population of whitefly (34.59/ 3 leaves) observed during 3rd week of October in 2009-10 and (32.55/ 3 leaves) during 3rd weeks of October in 2010-11. Similarly thrips reached at highest peak (36.81/ 3 three leaves) during first week of September in 2009-10 and (42.66/ 3 leaves) during 3rd week of September in 2010-11. Highest incidence of aphid 67% recorded during 4th week of August in 2009-10 and 58% during 2nd week of September in 2010-11. Whereas highest incidence of mealybug observed about 10% during 5th week of September in 2009-10 and 9% incidence during 3rd week of October in 2010-11.

Correlation studies revealed that all sucking pest Jassid, Whitefly, Thrips, Aphid and Mealybug shows positive correlation with maximum temperature, minimum temperature and maximum relative humidity in both the season except Mealybug in 2009-10 which had negative correlation. Significant positive correlation observed between Thrips and Aphid with average rainfall during 2009-10. Non-significant negative correlation observed between minimum relative humidity and average rainfall with Jassid, Whitefly, Aphid during 2010-11 and mealybug in both season.

Key words: *Sucking pest, Bt cotton, Jassid, Whitefly, Thrips, Aphid, Mealy bug, Correlation.*

I. INTRODUCTION

Cotton (*Gossipium Spp*) is commonly known as 'White gold' of India. It is one of the important commercial fiber crop of farmers community and significantly contributes to the national economy. It provides the raw material to allied sectors like ginning, fabric production, textile processing, garment manufacture and their marketing etc. It provides employment about 6 million and contributed 1/3rd of total foreign exchange earning of India (Mayee and Rao, 2002). In India cotton cultivated on 12.2 million ha area with production of 347.05 lakh bales (170 kg) and productivity of 484 kg lint/ha, however Maharashtra state comes under central which zone occupies an area of 40.95 lakh ha with production of 73.75 lakh bales and productivity of 306 kg lint /ha (Anonymous, 2011).

After introduction of Bt cotton in India from 2002 cultivation of American/ Bt cotton (*Gossypium hirsutum*) started. Transgenic Bt cotton (Cry 1AC & Cry 1AB) is effective against lepidopteron pest (Bollworms), but not against sucking pest complex and thus farmers was getting higher yield of cotton. Ultimately reduced usage of insecticides in *Bt* cottons has led to increased population of sucking insect pests (Krishna and Qaim, 2012). Bt cotton is more vulnerable to the attack of sucking insect pest complex as compared to desi cotton (*Gossypium arborium*) (Nath et al 2000). For the better yield of cotton crop its need to control pest because they damage crop and reduce the yield. The insect pest constitutes one of the major limiting factors and heavy damage caused by insect pests and it has been estimated about 20-25% yield losses (Bhutani and Jotwani, 1984). Approximately 162 species of insects and mites reported to be attack on cotton in India and the yield loss in *Gossypium hirsutum* cotton due to sucking pests, bollworms and both has been recorded up to 8.45, 16.55 and 17.35 quintal/hector respectively (Satpute et al, 1988).

Among sucking pests; Aphid, *Aphis gossypii* (Glover), leafhoppers, *Amrasca biguttula biguttula* (Ishida), Thrips, *Thrips tabaci* (Lind.), Whitefly, *Bemisia tabaci* (Genn.) and Mealybug, *Phenococcus solenopsis* (Tinsley) are of major importance and it causes the considerable damage in Bt cotton. Jassid is reported to cause 18.78 % decline in cotton yield (Ali 1992). Similarly whitefly vector of CLCuV (Malik et al, (1995) injure to cotton by secreting honeydew and transmitting cotton leaf curl viral diseases that caused normal yield loss in Pakistan up to 38.7% during 1993 (Khan & Khan1995). Similarly in the absence

of thrips 56% plants produced 40% more lint than infested plants and young seedlings of cotton were severely infested by thrips (David 1958). The mealybug had shattered 0.2 million bales (170 kg lint per bale) and 150,000 acres (out of the 8.0 million acres) of cotton area all across Pakistan, chiefly in Punjab and Sindh provinces (ICAC 2008). Dhavan (1980) reported 58-73% reduction in seed cotton yield due to mealy bug. Jhala and Bharpoda (2008) also reported 50% reduction in cotton yield in Gujrat during 2006 due to severe mealybug infestation. According to Goswami (2007) in India due to mealybug plague nearly 2000 acres of cotton crop were ruined. Now apart from yield losses, the cost of insecticide application only for mealybug has been increased by 250-375 US$ per acre (Nagrare et al, 2009).

For control of insect pest on Bt cotton farmers frequently rely on the chemical control (Arif et al, 2007). Use of chemical control is not only creating health hazards and ecological contamination but also growing the resistance in the insects and disturbing the balance between the forces of destruction (predators, parasitoids and pathogens) in agro-ecosystem (Hamburg & Guest 1997; Sorejani 1998). The occurrence and progress of all the insect pests are much dependent upon the customary environmental factors such as temperature, relative humidity and precipitation (Aheer et al, 1994). The activities of these insect pests are fluctuated under erratic environmental conditions. The knowledge about incidence of pest during the cropping season and its possible dynamics help in designing pest management strategies (Santhosh et al, 2009). To develop the suitable integrated pest management practices close monitoring of insect pest complex of Bt cotton is necessary. Thus by keeping in mind the present studies was carried out to investigate the seasonal occurrence and peak activity of sucking insect pest of cotton throughout cotton growing season and its correlation with weather factors. This information of pest surveillance will be useful for devising the suitable pest management strategies for researchers and farmers.

II. MATERIALS and METHODS

The field studies carried out during two consecutive cotton season 2009-10 and 2010-11 to investigate the seasonal incidence of major sucking pest on Bt cotton in five major cotton growing blocks of Jalna districts (19º 49.48 North & 75º 52.48 East) *viz.* Ambad, Bhokardan, Ghansawanghi, Jalna and Partur (Fig. 1).

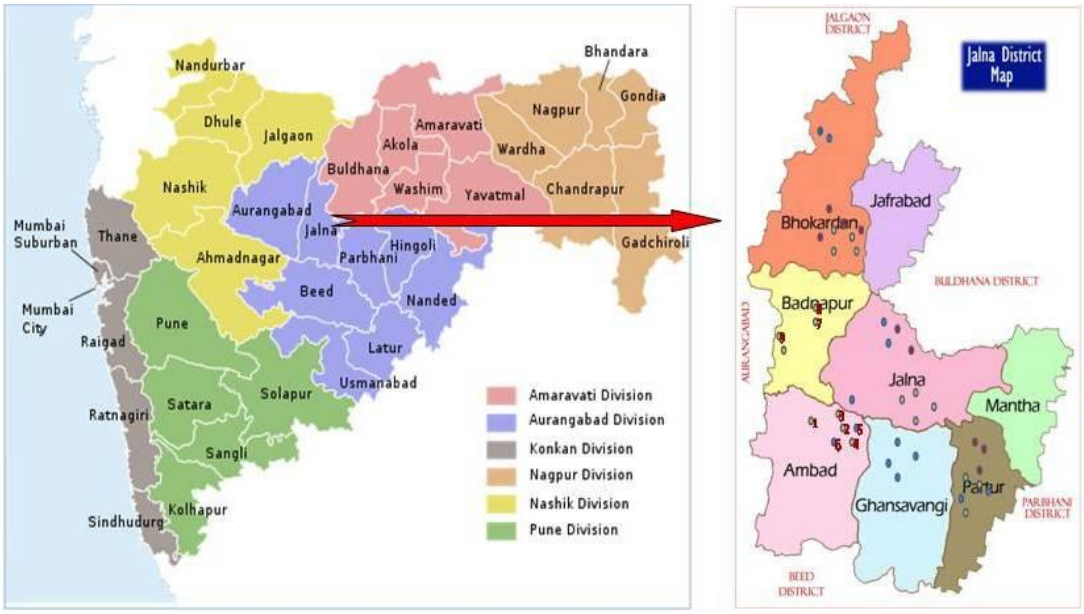


Figure 1 Locations of field surveyed (Map of Jalna district in Maharashtra state)

Twenty villages from five blocks of Jalna district has been selected and from each village two fixed and two random plots surveyed during July to January i.e. end of season. Average annual rainfall of Jalna district is 600-700 mm with frequent drought condition and farmers growing Bt cotton in rainfed condition by providing protective irrigation. Pest surveys carried out on farmer's fields that growing Bt cotton, generally sowing of cotton was completed from 1st June to 15 July in each season and farmers follow all the recommended package of practices (VNMKV Parbhani).

Incidence of sucking insect pests recorded by skill trained field scouts in pest datasheets on weekly interval early in the morning of 20 randomly selected plants from each plots and average calculated values put in table. Observations of sucking insect pest like Jassid, Whitefly, Thrips recorded number per three

leaves (each leaf from top, middle and bottom) of a plant. Incidence of Aphid calculated by counting the affected plants among 20 random plants in each plot and percentage was calculated by following formula.

$$\text{Aphid percentage} = \frac{\text{Aphid affected plants}}{\text{Total no. of plants}} \times 100$$

Incidence of mealybug recorded by using 0 to 4 scale grade viz.0=no incidence, 1=scattered appearance of mealybug on plant, 2= scattered appearance of mealybug on one branch of the plant, 3= appearance of mealybug more than one branch of the plant or half portion of plant and 4= appearance of mealybug on whole plant (Source: NCIPM, New Delhi). Percent infestation of mealybug worked out by conversion of grades into percent incidence following above formula. Rainfall data of two seasons collected from mini Weather station at Krishi Vigyan Kendra Jalna and information of other weather parameters like maximum temperature, minimum temperature, maximum relative humidity and minimum relative humidity downloaded online through link https://www.timeanddate.com/weather/india/jalna/historic . Relationship between incidence of sucking insect pest and weather parameters has been drawn by simple Correlation coefficient.

III. RESULTS and DISCUSSION

A. Jassid population

The present studies reveals that incidence of Jassid appears on BT cotton from third week of July and remained active from 2nd week of August to first week of November in both the season. Population of Jassid observed in range of 0.98 to 12.28/ 3 leaves with mean 2.94/3 leaves during 2009-10 and 1.11 to 8.28/ 3 leaves with mean of 2.7/3 leaves during 2010-11(Table 1). Maximum population of Jassid observed (12.28/3 leaves) during 3rd week of October in 2009-10 and (8.28/ 3 leaves) during first week of October during 2010-11(Fig 2). During highest incidence of Jassid maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall was 32˚C, 22˚C, 84%, 56% and 0 mm during 2009-10 and 30˚C, 23˚C,

TABLE 1 Incidence of sucking insect pest on Bt cotton in Jalna district during 2009-10 and 2010-11

Month/ Date	SMW	No. /3 leaves/plant						Percent incidence %			
		Jassid		Whitefly		Thrips		Aphid%		Mealy bug%	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
July-III	29	1.73	1.02	0.82	0.45	0.98	0.35	14	15	1	1
July-IV	30	1.64	1.11	0.95	0.58	1.01	0.16	22	7	2	1
Aug-I	31	1.52	1.56	1.05	1.18	1.3	2.43	32	18	3	1
Aug-II	32	1.68	5.66	3.35	4.62	1.38	4.64	37	26	7	1
Aug-III	33	2.88	1.52	1.8	8.6	12.19	9.65	43	37	1	1
Aug-IV	34	3.3	1.42	3.56	9.7	26.04	7.45	67	41	3	1
Sept-I	35	3.92	2.25	6.31	12.75	36.81	12.32	63	52	1	1
Sept-II	36	4.45	2.39	14.44	22.91	28.03	26.95	60	58	7	2
Sept-III	37	4.18	2.56	16.74	28.76	16.67	42.66	45	54	1	1
Sept-IV	38	3.64	3.28	22.4	18.13	18.4	30.5	34	56	1	2
Sept-V	39	3.13	4.62	13.54	16.81	13.9	28.35	23	52	10	3
Oct-I	40	3.21	8.28	13.59	15.42	4.65	12.21	31	48	9	4
Oct-II	41	2.87	5.27	14.09	25.82	3.49	6.27	34	45	8	7
Oct-III	42	12.28	2.48	34.59	32.55	3.87	7.51	22	45	7	9
Oct-IV	43	8.94	3.22	13.59	21.55	3.06	8.67	19	40	8	4
Nov-I	44	1.60	3.06	6.17	15.19	2.28	4.39	17	36	6	1
Nov-II	45	1.88	2.48	2.65	5.19	1.98	3.92	12	32	9	1
Nov-III	46	1.83	2.37	2.2	3.86	1.62	0.79	13	31	5	2
Nov-IV	47	1.91	1.92	1.65	2.82	1.67	0.53	15	34	5	3
Nov-V	48	1.19	1.88	1.65	2.49	1.13	0.45	14	37	7	2
Dec-I	49	1.22	1.85	1.45	2.22	0.94	0.48	12	33	2	1
Dec-II	50	1.04	1.69	1.45	2.10	0.92	0.50	10	28	2	1
Dec-III	51	0.98	1.40	1.33	1.79	0.81	0.6	16	28	2	1
Dec-IV	52	2.85	1.36	1.26	1.48	0.94	0.57	19	27	2	1
Jan-I	01	1.25	1.53	1.18	1.90	0.93	0.56	23	29	2	1
Jan-II	02	1.21	1.38	1.08	1.54	0.81	0.50	16	24	2	1
Mean		2.94	2.60	7.03	10.02	7.15	8.21	27.42	35.81	4.35	2.08

TABLE 2 Correlation of sucking pest with weather parameters in 2009-10 and 2010-11

Weather parameters	Jassid		Whitefly		Thrips		Aphid		Mealy bug	
	2009 -10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Max Temperature (°C)	0.25	0.37	0.30	0.49	0.20	0.34	0.17	0.17	0.33	0.46
Min Temperature (°C)	0.40	0.37	0.55	0.50	0.50	0.53	0.57	0.43	0.25	0.29
Max R Humidity	0.12	0.31	0.10	0.39	0.39	0.33	0.38	0.24	-0.09	0.38
Min R Temperature	0.00	-0.01	0.18	-0.18	0.36	0.02	0.32	-0.18	-0.19	-0.05
Average Rainfall (mm)	0.05	-0.26	-0.05	-0.05	0.74	0.00	0.66	-0.07	-0.24	-0.16

98%, 68% and 0 mm during 2010-11 (Fig. 4). The results of present study are in confirmatory with the findings of Bhute et al. (2012) who reported highest population of Jassid (13.80/3 leaves) was observed during 40th MW in *kharif* 2007–2008 and (13.75/3 leaves) was recorded in 39th MW during *kharif* 2008–2009. Reddy K. et al. (2011) reported the peak incidence of leaf hopper (Jassid) was observed (10.11 to 10.82/leaf) from the second fortnight of October to first fortnight of November in 2009-10 and in the season of 2010-11, peak incidence was (6.02 to 5.48/leaf) noticed in mid September to first fortnight of October. Shahid et al. (2012) reported peak population (3.33/leaf) of Jassid was recorded on October 30. Boda and Ilyas (2017) reported the peak incidence of Jassid was recorded in 39th MW to 45th MW and Maximum population of Jassid recorded (42.60 Jassid/3 leaves) during 43rd MW.

Fig 2: Incidence of sucking pest on BT cotton in Jalna during 2009-10 - 2010-11

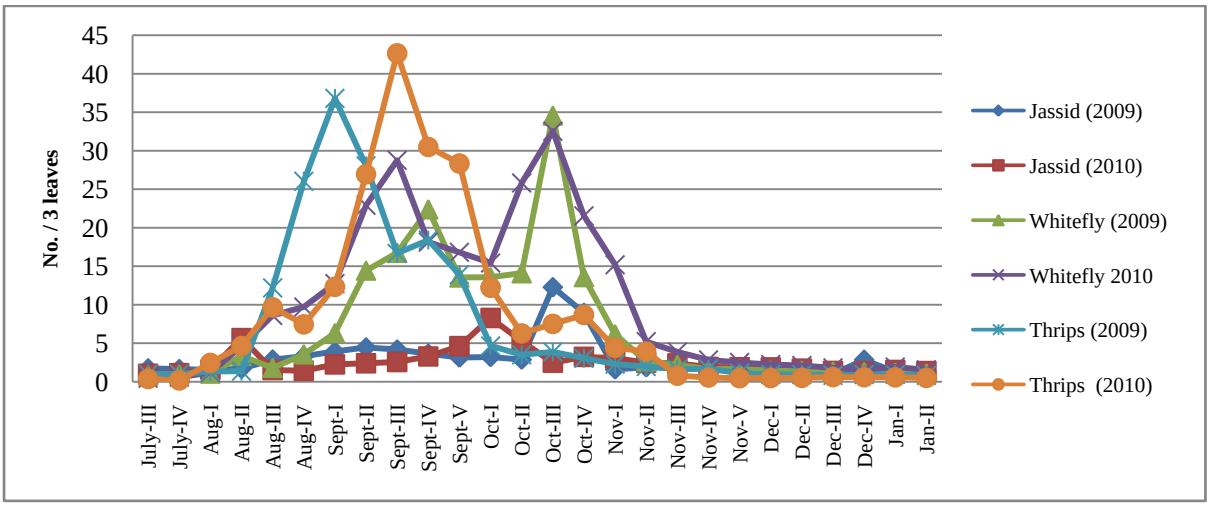


Fig 3: Aphid incidences on Bt cotton during 2009-10 - 2010-11

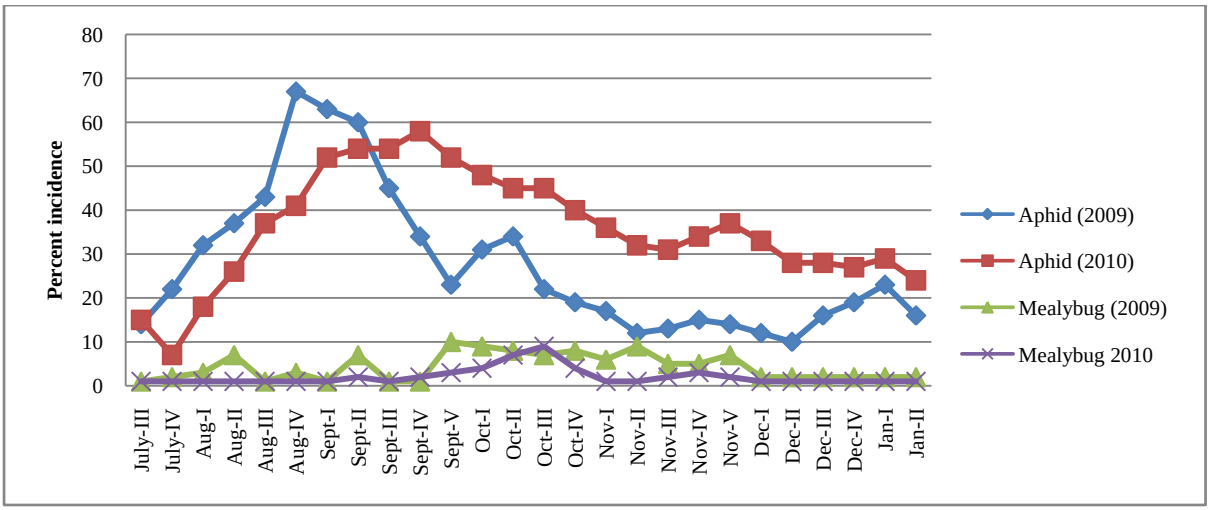
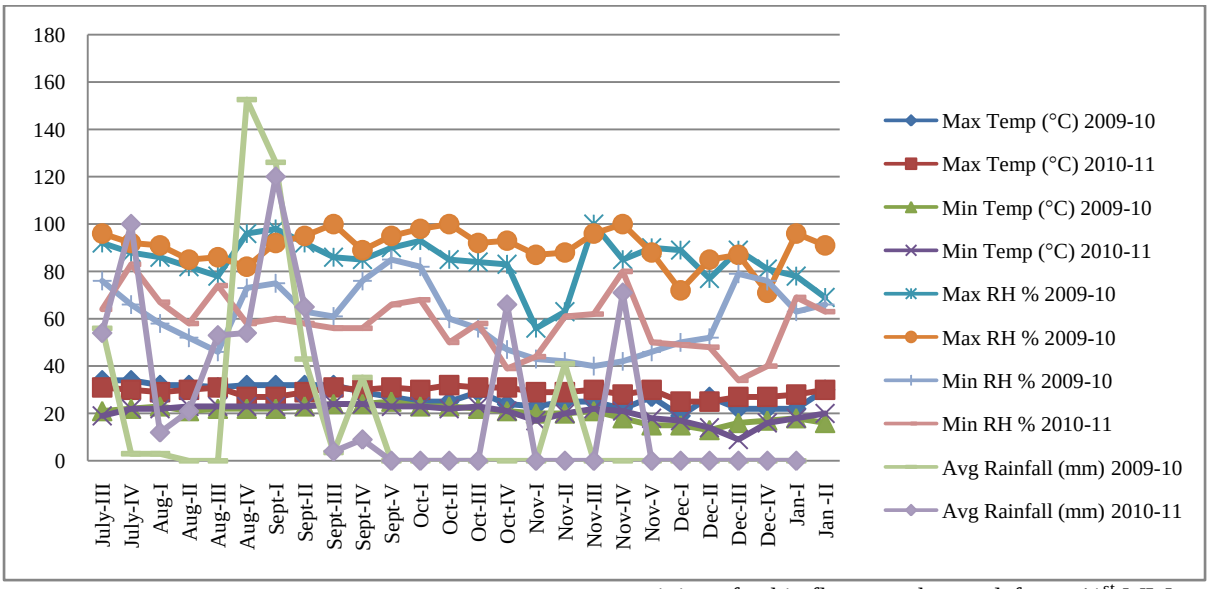


Fig 4: Weather parameters during 2009-10 - 2010-11



The present study reveals that incidence of Jassid shows positive correlation with maximum temperature (r = 0.25, r=037), minimum temperature (r = 0.40, r=037) and maximum relative humidity (r = 0.12, r=0.31) in both the season while it shows non-significant negative correlation with Minimum relative humidity (r = -0.01) and average rainfall (r = -0.26) during 2010-11 (Table. 2). Bhute et al. (2012) reported maximum temperature showed significant positive correlation with Jassids populations. Kalkal et al. (2015) reported leafhopper population was significantly and positively correlated with temperature (r = 0.49), relative humidity (r = 0.42) while significantly negatively correlated with rainfall (r = - 0.47).

B. Whitefly population

Whitefly incidence on BT cotton was observed in range of 1.05 to 34/ 3 leaves with mean of 7.39/3 leaves during 2009-10 and 0.45 to 32.55/3 leaves with mean of 10.02 / 3 leaves during 2010-11 (Table 1). Maximum incidence of whitefly recorded from 2nd week of August to 2nd week of November with two peaks in both the season (Fig 2). Incidence of whitefly increased gradually in September with slight reduction in second fortnight of September and again it achieved highest peak during October month in both the season. Maximum population of whitefly observed (34.59 / 3 leaves) during 3rd week of October in 2009-10 and (32.55/ 3 leaves) during 3rd weeks of October 2010-11. Bhute et al. (2012) reported incidence of whitefly (52.75-63.00/3 leaves) during 45th standard week. Weather parameters *viz.*, rainfall, morning RH and evening RH showed significant and negative correlation whitefly population while maximum temperature showed significant positive correlation with whitefly populations. Boda and Ilyas (2017) reported the peak activity of whitefly was observed from 41st MW to 44th MW, while highest incidence (22.60 whiteflies/3 leaves) of whiteflies population observed in 42nd MW.

Correlation of current study reveals that incidence of whitefly shows significant positive correlation with maximum temperature (r = 0.30, r=0.49), minimum temperature (r = 0.55, r=50) in both the season and non-significant with maximum relative humidity (r=0.39) during 2009-10. It shows negatively non significant correlation with minimum relative humidity (r = -0.18) in 2010-11 and average rainfall (r = -0.05) in both seasons (Table 2). Bhute et al. (2012) reported weather parameters *viz.*, rainfall, morning RH and evening RH showed significant and negative correlation with whitefly population while maximum temperature showed significant positive correlation with whitefly populations. The results of the present studies are in confirmatory with findings of Kalkal et al. 2015 reported whitefly population was significantly positively correlated with temperature (r = 0.35), wind speed (r = 0.48), relative humidity (r = 0.08) and sunshine hours (r = 0.11) while significantly negatively correlated with rainfall (r = -0.38).

C. Thrips population

Population of thrips in cotton recorded with range of 0.81-36.81/3 leaves with mean of 7.66/ 3 leaves during 2009-10 and 0.16-42.66/ 3 leaves with mean of 8.2/ 3 leaves during 2010-11 (Table 1). Maximum incidence of thrips observed from second fortnight of August to second fortnight of October in both the season. Maximum population of thrips reached (36.81/ 3 three leaves) during first week of September in 2009-10 and (42.66/ 3 leaves) during 3rd week of September in 2010-11 (Fig. 2). Bhute et al. (2012) reported highest incidence of 110.10 thrips/

3 leaves in 40th standard week in Bt cotton. Babu and Meghwak, (2014) reported thrips population was in higher side and population was ranged from 0 to 87.0 /3 leaves and this was observed during the standard weeks of 39-41. Boda and Ilyas (2017) reported Maximum population of thrips observed in 41st MW (44.33 thrips/3 leaves). Phulse and Udikeri (2014) reported across Bt cotton genotypes the incidence of thrips ranged from 0.8 to 29.4 / 3 leaves. The incidence was peak during September. Arshad and Suhail (2010) found the maximum population was observed in unsprayed Bt and non-Bt cotton in the 3rd week of August in both years.

Incidence of thrips was positively correlated with maximum temperature (r = 0.20, r=0.34), maximum relative humidity (r = 0.39, r=0.33) and strongly positively significant with minimum temperature (r = 0.50, r=0.53) in both the seasons and average rainfall (r = 0.74) during 2009-10. Thrips incidence shows no correlation with Minimum relative humidity and average rainfall during 2010-11. Bhute et al. (2012) reported maximum temperature showed significant positive correlation with thrips populations. Phulse and Udikeri (2017) reported the peak thrips incidence was recorded in September 2nd fortnight to October first fortnight due to low rainfall and low humidity.

D. Aphid population

Incidence of Aphid incidence on Bt cotton observed throughout the year in both the cotton season. It ranged from 10-67% with mean of 28.68% during 2009-10 and 7-58% with mean of 38.79% during 2010-11. Highest incidence of aphid 67% recorded during 4th week of August in 2009-10 and 58% during 2nd week of September in 2010-11 (Fig. 3). Incidence of aphid population decreases gradually after September at the end of season in both seasons. Bhute et al. (2012), observed the higher incidence of aphid population in the range of 75.40-86.45 aphids/3 leaves during 35 and 37th standard week respectively. Boda and Ilyas (2017) reported the peak incidence of aphid population was recorded to be 73.40 per three leaves during 40th meteorological week of October 2013. Tomar S. P. S. et al. (2010) reported the population reached peak in 35th standard week with 22.0/leaf during 2004-05 and (17.0/leaf) on 37th standard week during 2005-06 and thereafter declined sharply up to 42nd standard week but subsequently drastically reduced.

In the case of aphid it shows positive correlation with maximum temperature (r = 0.17, r=0.17) and maximum relative humidity (r = 0.33, r=0.24) in both the seasons. It shows strong positively significant correlation with minimum temperature (r = 0.57, r=0.43) during both season and average rainfall (r = 0.66) during 2009-10. Aphid is negatively non significant with minimum relative humidity (r = -0.18) and average rainfall (r = -0.07) during 2010-11. Results of present work are confirmatory with findings of Bhute et al. (2012) who reported the rainfall, morning RH and evening RH showed significant and negative correlation with aphids. Aphid population showed strong positive (significant at p=0.01) correlation with maximum and minimum temperature while positive correlation (significant at p=0.05) with relative humidity. Aphid population did not show any association with rainfall.

E. Mealy bug Population

Incidence of mealybug on Bt cotton observed throughout the year in both season, it appears on cotton after one month after cotton sowing. The range of mealybug observed from 1-10% with mean of 4.65% in 2009-10 and 1-9% with mean of 2.16% during 2010-11. The highest incidence of mealybug in cotton observed about 10% during 5th week of September in 2009-10 and 9% incidence during 3rd week of October in 2010-11 after this period it decreased gradually at the end of season (Fig. 3). The results of present studies are in confirmatory with findings of Sharma O. P. et al. (2008) who found Bt cotton field indicates maximum infestation of 30.1, 8.5 to 27.7, 6.7 to 12.4, 10.3 to 32.8 and 7.1 to 20.2 mealybug/ 2.5 cm apical shoot observed in Parbhani, Nanded, Hingoli, Jalna and Aurangabad district of Marathwada region respectively. Tanwar R. K et al. (2011) In Maharashtra, field survey was conducted during August, 2008 in five cotton growing tehsils of Parabhani. Mealybug infestation in different cotton fields ranged from traces to 60.6%. Bhute et al. (2012) reported mealy bug's highest incidence (42.40 mealy bugs/2.5cm shoot length) was observed in 49 to 51st SW. The similar results observed in Singh and Kumar (2012) who reported the maximum population of mealybug recorded during October month from both cotton and okra crops. Babu and Meghwak, (2014) reported the peak incidence of mealy bug was observed during 42nd standard week and continued up to 50th standard week during 2011. Boda and Ilyas (2017) the peak activity of Mealy bugs was observed from 42nd to 46th MW while higher incidence (12.40 mealy bugs /3 shoots) of mealy bug observed in 45th MW.

Incidence of mealybug shows significant positive correlation with maximum temperature (r = 0.33, r=0.46), minimum temperature (r = 0.25, r=0.29) in both the season and maximum relative humidity (r = 0.38) during 2010-11. It shows negative non significant correlation with maximum relative humidity (r = -0.09) during 2009-10 and minimum relative humidity (r = -0.19, r=-0.05) and average rainfall (r = -0.24, r=-0.16) during both the season (Table 2). The results of present study are in agreement with findings of Bhute et al. (2012) who reported all weather parameters showed significantly negative correlation with the infestation of mealybugs except maximum and minimum temperatures. Boda and Ilyas (2017) reported mealy bug population shows negatively significant correlation with rainfall,

minimum temperature, morning RH and evening RH, whereas maximum temperature shows positively non significant correlation with mealy bug population.

IV. CONCLUSION

The present studies concluded that weather factor determines the seasonal activity and population buildup of insect pest in Bt cotton crop. The correlation studies clearly shows the importance of weather parameters in predicting the sucking pest incidence and this studies will be definitely helpful to farmers and extension workers for developing efficient pest management strategies for increased cotton production.

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