



ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(7): 274-279
© 2021 TPI
www.thepharmajournal.com
Received: 10-05-2021
Accepted: 12-06-2021

Sohrab
Ph.D. Scholar, Department of
Entomology, CSAUAT, Kanpur,
Uttar Pradesh, India

Ram Singh
Assistant Professor, Department
of Entomology, CSAUAT,
Kanpur, Uttar Pradesh, India

DR Singh
Professor, Department of
Entomology, CSAUAT, Kanpur,
Uttar Pradesh, India

YP Malik
Professor, Department of
Entomology, CSAUAT, Kanpur,
Uttar Pradesh, India

Corresponding Author:
Sohrab
Ph.D. Scholar, Department of
Entomology, CSAUAT, Kanpur,
Uttar Pradesh, India

Seasonal incidence of cotton aphid, *Aphis gossypii* glover on different cotton cultivars in central Uttar Pradesh

Sohrab, Ram Singh, DR Singh and YP Malik

Abstract

Study of seasonal incidence of cotton aphid on different five cotton cultivars, the initial incidence of aphid was observed in June month of 2018 and 2019. During the investigation period of 2018, lowest mean incidence's aphid of five cultivars (1.02 aphids/leaf) was recorded in June while during 2019 lowest mean incidence's aphid of five cultivars (0.90 aphids/leaf) was observed in December whereas highest mean incidence's aphid of five cultivars (26.83 and (25.67 aphids/leaf) were observed during October for the years of 2018 and 2019, respectively two consecutive years. Lowest mean incidence of aphid (9.28 and 8.01 aphids/leaf were recorded on cultivar CA-105 whereas maximum mean incidence of aphid (14.08 and 14.06 aphids/ leaf) were observed on cultivars RS-810 and F-1378 during 2018 and 2019 respectively on American cotton cultivars. However mean population density of aphid (4.45 and 4.94 aphids/leaf) was observed on conventional cotton cultivar CAD-3 which was lowest incidence of aphid had been observed in comparison of American Cotton cultivars in both years.

Keywords: cotton cultivars, incidence, *Aphis gossypii* (Glover)

Introduction

Cotton is most important commercial crop known as "king of fibers" and world over commonly referred as "white gold" that belongs to family Malvaceae and the genus *Gossypium*. It plays a pivotal role in employment and strengthening economy of 76 countries across the world. Cotton directly impact on 60 million farmers of India and several millions of people which employing in processing, textile industry and trade. Cotton's fiber is used as an important raw material for textile industry that contributes nearly 4% of GDP of India. Cotton seed is used for cattle feed and to make cooking oil which contribute about 8% of the world's vegetable oil consumption (Annual report of textile, 2012-2013). Globally cotton is cultivated on 35.7 M hectares area and which produced 154 million bales and average productivity was 734Kg/ha. In India, cotton was cultivated on 12.71 million hectare area and the Production was 40 million bales with 535 Kg/ha productivity (Annual report of ICAR- AICRPC, 2018). The causes of low yield of cotton are highly complex in India. Several factors are responsible for low productivity and quality deterioration of cotton such as unfavorable environmental factors, indiscriminant use of various kinds of chemicals, fertilizers and pesticides, lack of knowledge of plant protection measures, lack of extension education and lack of coordination between farmers and agricultural institutes. But among them, most important factor is considered to be insect pests which cause significant loss to cotton crop. Globally cotton has quite broad pest spectrum and cotton is called as heaven of insect pests. A number of insect pests attack on cotton during its growth, development and till processing. Hargreaves, (1948) ^[11] reported 1326 insect pests harboured on cotton right from time of planting till processing of the crop worldwide.

Major losses in India in cotton production are due to its susceptibility to about 162 species of insect pests. In which few dozen are very serious, causing sufficient loss of cotton (Dhaliwal *et al.* 2004) ^[7]. *Aphis gossypii* damages cotton plants during both vegetative and reproductive stages. Infestation on vegetative stages turn leaves shriveled, whereas infestation on reproductive stages, especially at fruit opening stage causes fowls and reduces fiber quality. Severe attacks of *A. gossypii* may also reduce leaf area by 58% and shoot biomass 45%. Cotton plants which infested by cotton aphid are shorter and produce fewer vegetative branches than non infested plants (Slosser *et al.* 2001) ^[21]. The incidence and development of pest depend upon the prevailing environmental factors and crop stand.

These insects multiply tremendously during the favourable weather conditions and take huge toll. The role of temperature and relative humidity is likely to affect the occurrence (Aheere *et al.* 1994) [3]. The knowledge about occurrence of pest during the cropping season and its possible dynamics help in making pest management strategies (Santhosh *et al.*, 2009) [20]. Effective population monitoring is crucial for successfully implementing insect pest management programs, for making timely decisions against pests when reach on economic threshold level and to assess their effect on pests. The scanty research work on the seasonal incidence of cotton aphid on cotton crop particularly central Uttar Pradesh. Therefore, keeping these points in view, the studies of the seasonal incidence of cotton aphid, *Aphis gossypii* Glover on cotton crop were conducted during *kharif* 2018 and 2019.

Material and Methods

The experiment was conducted in Randomized Complete Block Design (RCBD) by sowing five cotton cultivars. Each one cultivar replicated four times in 5.4×4.2 m plot size with adopting plant to plant and row to row (60 cm x 60 cm) spacing to know the incidence of major sucking insect pest, cotton aphid. All the recommended agronomical practices except plant protection were followed for raising the cotton crop at Student Instructional Farm (SIF) of the Department of Agronomy, C. S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh). The cotton seed of different kind of varieties of cotton viz., F-1378, CA-105, RS-810, CA-110 and CAD-3 were taken from the cotton unit of oilseed farm, C.S. Azad University of Agriculture and Technology, Kanpur and the each variety seed was sown @ 20 kg per hectare. Before sowing, the seed was delinted by soaking in water for 12 hours followed by rubbing with cow-dung and ash thereafter sowing of cotton seed was done in furrows behind desi plough by adopting similar row to row spacing during first week of May of two consecutive years 2018 and 2019. During the experiment, gaps were filled by resowing after 10-12 days after sowing of the crop to ensure even plant stand and thinning of cotton crop was done 25 days after sowing by hand pulling of the plants to maintain a plant to plant distance of about 60 cm and equal plant population in different plots and keeping one healthy seedling plant per hill. In each plot five plants were selected and tagged to record the population of pests. The populations of sucking pests were recorded at standard week interval during morning hours, starting after germination till the maturity of the crop. Whole plots were kept free from insecticidal application throughout the crop season. The numbers of aphids were recorded. For the purpose of observations, five plants were selected and tagged from each plot. Observations were recorded from three leaves, each from top, middle and lower portion of each selected plants from each plot at weekly interval. From this, the average population per leaf was worked out (Chauhan *et al.*, 2017) [4].

Results and Discussions

According to the data of seasonal incidence of aphid both years 2018 and 2019 during *kharif* revealed that aphid occurrence on five different cotton cultivars was commenced in June month. The initial incidence of cotton aphid (1.81 aphids/leaf) started on first cotton variety F-1378 on 24th SMW while maximum aphid population intensity (36.28 aphids/leaf) was observed on 40th SMW and lowest population intensity 0.72 aphids/leaf was observed on 50th

SMW. The mean population density of pest (12.43 aphids/leaf) was found on this American cotton cultivar throughout crop growing season. Generally, aphid incidence associated this variety was reported second highest during the cropping season 2018. However as per second year finding the minimum occurrence of aphid was observed (1.17 aphids/leaf) on 50th SMW of December although maximum aphid intensity (41.13 aphids/leaf) was found on 43th SMW of November, 2019 and mean population density of aphid (14.06 aphids/leaf) was observed on this cultivar which was the highest incidence among the five cotton cultivars during second *kharif* season. These findings supported by Kulkarni *et al.* (2008) [14] who observed that the period of activity of aphids from the end of August to early December, with major activity period during the second fortnight of September and Chauhan *et al.* (2017) [4] as they observed that aphid invaded on the *Bt.* cotton on five cotton cultures from third week of July to second week of August and this caused damage continue throughout the crop season.

The initial incidence of aphid on second American cotton cultivar CA-105 was started from (0.43 aphids/leaf) which was observed the least population density of this pest in second standard week of June however highest incidence of this pest (30.75 aphids/leaf) was recorded in third standard week of October with average population density (9.28 aphids/leaf) in 2018 whereas in second year, the initial occurrence of aphid on this cultivar started from (0.58 aphids/leaf) on 24th SMW and the least population density of this pest (0.38 aphids/leaf) was observed in fourth standard week of July, however highest incidence of this pest (20.53 aphids/leaf) was recorded in first standard week of November with overall mean population density (8.01 aphids/leaf). These findings corroborate with findings of Prasad *et al.* (2009) [18] who observed the incidence of aphid ranged from 3.2 to 55.7/15 leaves among different hybrids and conventional under unprotected conditions in Guntur (AP) and Potai and Chandrakar (2018) [17] who observed the major activity period of *Aphis gossypii* from August 2016 to October 2016 with one distinct peak 40th SMW (39.24 Aphids/per plant), respectively on okra during *kharif* season of 2016 at Raipur, Chhattisgarh.

Generally, aphid population's range was observed from (1.65 aphids/leaf to 41.25 aphids/leaf) on 50th SMW to 39th SMW respectively with a mean incidence of aphid was (14.08 aphids/leaf) in 2018 whereas during second year, aphid range was recorded from (1.23 aphids/leaf to 30.35 aphids/leaf) on 29th SMW 44th SMW, respectively with average incidence of aphid was (11.47 aphids/leaf) on third American cotton RS-810 cotton cultivar in 2019. Present finding corroborate with Udikeri *et al.* (2012) who recorded the population of aphid ranged between 8.58 /leaf (34 ISW) to 42.15/leaf (50 ISW) with a mean incidence of aphid was 23.82/leaf in RCH 2 Bt and 6.22 to 37.08/leaf (46 ISW) with a mean incidence of aphid was 21.37/leaf in RCH 2 non-Bt cotton respectively indicating no significant variation at Dharwad farm.

Commonly, in case of fourth American cotton variety CA-110, the initial incidence of aphid (0.88 aphids/leaf) was recorded in June while least population density of aphid (0.73 aphids/leaf) was observed in July and highest aphid population (30.03 aphids/leaf) was seen in October and mean population density of aphid (11.01 aphids/leaf) was observed in first year trial conducted during *kharif* season 2018. Generally, the initial occurrence of aphid was recorded 2.28 aphids/leaf and least and maximum population intensity of

aphid (0.42 and 29.97 aphids/leaf) were noticed in December and October of 2019 and mean population density of aphid (10.03 aphids/leaf) was observed under irrigated conditions of central Uttar Pradesh during 2019. Present findings partially associated with some researchers findings namely, Mohapatra (2008) [15] who found that the aphids and other sucking insects infested the crop from 30th std. week to 50th std. week. Peak population of *A. gossypii* (23/leaf) was attained during 35th std. week (Aug. 27- Sept. 2) on *G. hirsutum* cotton during *kharif* under rainfed conditions of Orissa and Tomar (2010) [22] who recorded aphid population the first time in 28th standard week, which remained active up to 1st standard week having its peak density (18.15/leaf) in 37th standard week. The present findings are in contrary with findings of Chavan *et al.* (2010) [6] who observed that *A. gossypii* had two peak periods of incidence i.e. 1st peak from second week of August to 1st of September and 2nd from first week of November to last week of November to last week of November on conventional cotton at Parbhani. The present study not corroborate with Jindal *et al.* (2010) [13] who recorded the population of sucking pests from vegetative stage to maturity of the crop.

Aphid population was highest during 1st week of July and mid-October, respectively and Dhawan *et al.* (1987) [8] who was observed maximum population of cotton aphid on August 13th on two varieties LD- 230 and G-27 varieties, however, on LD- 133 the maximum population of aphid was observed on July.

In case of conventional cotton variety CAD-3, the initial incidence of aphid was started from (0.65 and 0.67 aphids/leave) in June and least intensity of aphid (0.00 and 0.00 aphid/leaf) was reported in June and December even though highest aphid population density (14.23 and 16.45 aphids/leaf) was observed in October and September months of 2018 and 2019, respectively. The mean population density of aphid (4.45 and 4.94 aphids/leaf) observed on this conventional cotton (*G. herbaceum*) cultivar and least seasonal incidence of aphid was noticed on this cultivar in compare of *G. hirsutum* cultivars during both years. This study corroborates with Chavan *et al.* (2011) [5] who reported that the population aphid ranged from 0.8 to 27.45 per plant on conventional cotton and observed peak incidence of aphid during November (47th Std. Week).

Table 1: Seasonal incidence of aphid, *Aphis gossypii* Glover/leaf on different cotton cultivars in 2018

From date	SMW No.	No. of aphids/leaf					
		F-1378	CA-105	RS-810	CA-110	CAD-3	Mean
Jun-11	24	1.81	0.43	2.13	0.88	0.00	1.02
18-Jun	25	3.05	1.02	3.03	2.07	0.65	1.96
25-Jun	26	6.11	4.28	7.55	5.92	1.47	5.07
2-Jul	27	12.2	7.2	12.53	10.83	2.07	8.97
9-Jul	28	9.48	5.15	9.97	7.22	3.12	6.99
16-Jul	29	15.83	10.22	17.08	12.6	2.5	11.65
23-Jul	30	8.7	6.12	11.13	4.43	2.02	6.48
30-Jul	31	2.46	2.1	3.12	0.73	0.5	1.81
6-Aug	32	6.26	2.77	6.32	2.12	2.57	4.01
13-Aug	33	5.18	2.02	7.08	1.87	3.23	3.88
20-Aug	34	3.46	3.1	4.43	1.48	1.25	2.74
27-Aug	35	8.68	5.2	10.32	3.77	2.57	6.11
3-Sep	36	3.58	2.52	6.02	2.1	1.12	3.07
10-Sep	37	13.13	11.05	15.88	6.48	3.75	10.06
17-Sep	38	22.41	18.3	25.7	12.2	4.62	16.65
24-Sep	39	31.25	20.07	41.25	17.77	6.12	23.29
1-Oct	40	36.28	23.30	35.22	25.2	10.9	26.18
8-Oct	41	32.55	25.78	36.13	22.53	14.23	26.24
15-Oct	42	31.12	30.75	30.35	29.3	12.63	26.83
22-Oct	43	25.78	23.81	23.68	30.03	13.1	23.28
29-Oct	44	18.48	16.08	19.42	27.02	11.66	18.53
5-Nov	45	13.08	10.35	17.78	22.25	8.53	14.40
12-Nov	46	11.05	7.93	12.18	18.37	6.12	11.13
19-Nov	47	7.25	5.97	10.92	14.45	3.55	8.43
26-Nov	48	3.92	2.55	6.13	9.07	1.25	4.58
3-Dec	49	1.9	1.28	3.28	4.6	0.35	2.28
10-Dec	50	0.72	1.08	1.65	2.08	0.17	1.14
Average		12.43	9.28	14.08	11.01	4.45	10.25

According to both years seasonal incidence study of cotton aphid on different five cotton cultivars, initial incidence of aphid was observed in June month of 2018 and 2019. Generally, in first year research study 2018, lowest incidence of aphid was recorded in August month and in second year finding lowest incidence of aphid was observed in July month whereas highest incidence of aphid was observed in October month for the years of 2018 and 2019. The lowest mean incidence of aphid (9.28 and 8.01 aphids/leaf) were recorded on CA-105 whereas maximum mean incidence of aphid (14.08 and 14.06 aphids/ leaf) were observed on (*Gossypium*

hirsutum) American cotton cultivars RS-810 and F-1378 respectively in 2018 and 2019. However mean population density of aphid (4.45 and 4.94 aphids/leaf) observed in first and second year findings on (*G. herbaceum*) conventional cotton cultivar CAD-3 which was lowest incidence of aphid had been observed in compare of *G. hirsutum* cultivars in both years. This investigations moderately supported by Ashfaq *et al.* (2011) who recorded the peak densities of different insect pests and natural enemies from June to October. Highest density of 2.61aphids leaf⁻¹ was recorded on 20th June, Vanitha and Banu (2011) reported that most of the

varieties of cotton were highly susceptible to one or more of the sucking pests on both 35 and 50 DAS. There was no significant difference in all the sucking pest population observed among Bt and non Bt cotton varieties. Among the sucking pests, aphids recorded very high population at both 35 and 50 DAS and Sathyan *et al.* (2018) who reported that the overall mean population ranged from 5.16 to 13.14/three leaves in Tuticorin. However the present findings are partially contrary with findings Raja *et al.* (2007) who observed that the aphid was appeared from 3 WAS and continued to infest cotton cultivars up to 19th WAS. In general, the lowest incidence was observed in Brahama (662.84 aphid/15 leaves) hybrid in comparison to other two cultivars. The peak incidence was recorded at 17th WAS and highest incidence was recorded at 17th WAS (November-December) in all the three cultivar, Pawar *et al.* (2008) who noticed that first appearance of aphid during 28th meteorological week of 2006-07 during *kharif* on Bt cotton in Marathwada region. The highest peak population (66.33aphids/leaf) was observed during 30th MW to 33rd MW. Aphid population increased significantly up to 38th MW and from last week of September decreased till end of season, Prasad *et al.* (2008) [18] who reported that the appearance of aphid was observed from 35th to 37th standard week (September) during 2001 to 2003, while it was observed from 32nd to 34th standard week (August) in succeeding years and the peak incidence of aphids varied widely among various season from 33rd to 2nd standard week

(mid-August to mid-January) in Guntur, Rajput *et al.* (2010) who observed that *A. gossypii* population showed peak activity during 23rd-29th July to 13th-19th August in 2001-02 and 23rd-29th July to 27th August, 2nd September in 2002 in August-September, Bhute *et al.* (2012) who observed that incidence of aphid was highest (86.45 aphid/3 leaves) during 37th MW on Bt cotton. During *kharif* 2008–2009 the peak incidence of aphid (75.40/3 leaves) was observed in 35th MW in Parbhani, Zala *et al.* (2014) who noticed that the degree of incidence by sucking pests in early sowing Bt cotton crop was minute during comparison of the six sowing periods i.e. 2nd and 4th week of May were less infested by sucking pests and thereby yielded higher seed cotton yield. The higher incidence of aphid was recorded in Bt cotton (RCH 2 BG II) raised during 2nd and 4th week of July, Gayi *et al.* (2017) [9] who observed the high aphid occurrences of aphids (38 individuals per plant) in the last week of August in Kasese and Pallisa districts during conducting surveys and the field experiments in 13 cotton growing districts in Uganda, Indira Kumar (2017) who observed in the survey the mean population of aphids was high with a value of 7.17 per leaf when the Bt cotton crop was 30-35 days old. The population of aphids, the population decreased significantly as the crop grew and the population was low during the maturity stages and Sathyan *et al.* (2018) who reported that the pest population was started from the first week of November on three weeks old crop.

Table 2: Seasonal incidence of aphid, *Aphis gossypii* Glover/leaf on different cotton cultivars in 2019

From date	SMW No.	No. of aphids/leaf					
		F-1378	CA-105	RS-810	CA-110	CAD-3	Mean
10-Jun	24	3.12	0.58	1.78	2.28	0.67	1.69
17-Jun	25	7.25	2.08	5.90	4.22	2.13	4.32
24-Jun	26	11.13	7.25	10.38	7.05	3.30	7.82
1-Jul	27	8.08	3.73	4.12	5.23	1.13	4.46
8-Jul	28	3.15	2.07	2.60	7.97	1.57	3.47
15-Jul	29	2.07	1.08	1.23	3.75	0.75	1.78
22-Jul	30	1.60	0.38	1.25	2.97	0.65	1.37
29-Jul	31	3.98	2.17	2.05	1.98	1.42	2.32
5-Aug	32	8.30	3.15	7.25	5.22	1.65	5.11
12-Aug	33	10.58	5.42	9.12	8.13	2.80	7.21
19-Aug	34	5.42	0.72	1.55	3.12	0.55	2.27
26-Aug	35	9.30	2.57	2.37	5.40	2.20	4.37
2-Sep	36	16.45	7.78	9.63	9.17	6.17	9.84
9-Sep	37	21.48	13.15	15.35	10.20	9.25	13.89
16-Sep	38	19.12	17.02	23.17	17.68	16.45	18.69
23-Sep	39	14.35	11.07	10.72	12.15	7.60	11.18
30-Sep	40	23.30	13.10	19.50	21.13	11.83	17.77
7-Oct	41	31.12	16.13	24.27	29.97	14.93	23.30
14-Oct	42	35.78	18.72	25.75	27.42	16.23	24.78
21-Oct	43	41.13	20.40	27.18	26.30	13.32	25.67
28-Oct	44	36.13	19.60	30.35	23.30	9.78	23.83
4-Nov	45	26.23	20.53	25.20	15.05	5.40	18.48
11-Nov	46	18.58	12.75	17.42	10.53	2.02	11.97
18-Nov	47	11.45	7.63	13.10	6.13	1.13	7.89
25-Nov	48	6.48	4.60	10.20	3.01	0.32	4.80
3-Dec	49	2.78	1.81	6.12	1.08	0.12	2.33
10-Dec	50	1.17	0.67	2.25	0.42	0.00	0.90
Average		14.06	8.01	11.47	10.03	4.94	9.70

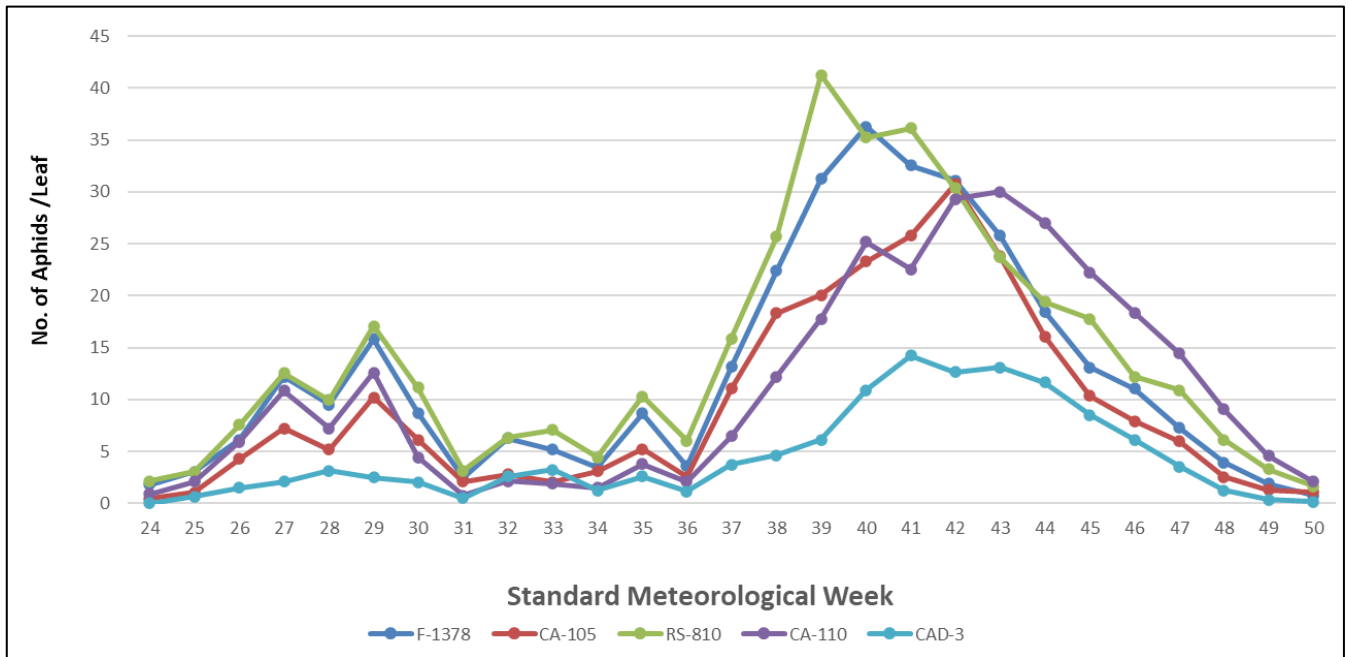


Fig 1: Seasonal incidence of aphid, *Aphis gossypii* Glover/leaf on different cotton cultivars in 2018

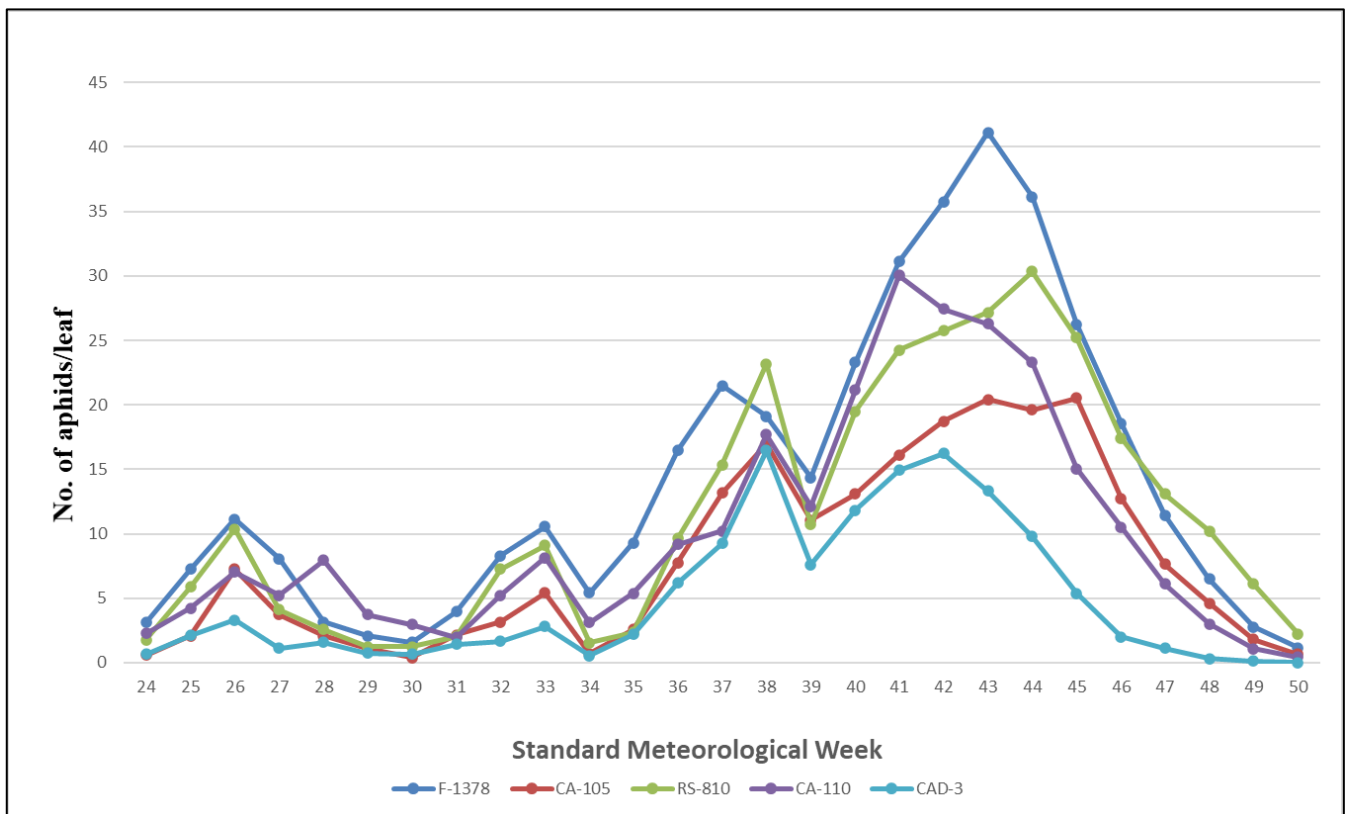


Fig 2: Seasonal incidence of aphid, *Aphis gossypii* Glover/leaf on different cotton cultivars in 2019

Conclusion

Based on two consecutive years, study of seasonal incidence of cotton aphid on different five cotton cultivars, the initial incidence of aphid was observed in June month of 2018 and 2019. During the investigation period of 2018, lowest mean incidence’s aphid of five cultivars (1.02 aphids/leaf) was recorded in June while during 2019 lowest mean incidence’s aphid of five cultivars (0.90 aphids/leaf) was observed in December whereas highest mean incidence’s aphid of five cultivars (26.83 and (25.67 aphids/leaf) were observed during October for the years of 2018 and 2019, respectively. Lowest mean incidence of aphid (9.28 and 8.01 aphids/leaf were

recorded on cultivar CA-105 whereas maximum mean incidence of aphid (14.08 and 14.06 aphids/ leaf) were observed on cultivars RS-810 and F-1378 during 2018 and 2019 respectively on American cotton cultivars. However mean population density of aphid (4.45 and 4.94 aphids/leaf) was observed on conventional cotton cultivar CAD-3 which was lowest incidence of aphid had been observed in comparison of American Cotton cultivars in both years.

References

1. Annual report of textile Published by ministry of textile, government of India, 2012-13, 3-4.

2. Annual report of ICAR- (AICRPC) All India coordinated research project on cotton 2017-18, 1-16.
3. Aheer GM, Ahmad KJ, Ali A. Role of weather in fluctuating Aphid density in wheat crop and Bollworm and sucking pests on cotton in Punjab Province of Pakistan. Quarterly new commission 1994;34:10:11.
4. Chauhan RP, Vekaria MV, Chaudhary HK, Chaudhary NJ. Seasonal incidence of sucking pests and their natural enemies in Bt. cotton. Journal of Entomology and Zoology Studies 2017;5(5):1274-1282.
5. Chavan SJ, Bhosle BB, Bhute NK. Estimation of losses and population dynamics of major pest in desi cotton (*Gossypium arboreum*), Indian Journal of Entomology 2011;73(3):284-287.
6. Chavan SJ, Bhosle BB, Bhute NK, Pawar AV. Population dynamics of major insect- pests on desi cotton (*Gossypium arboreum*) in Maharashtra, Journal of Cotton Research and Development 2010;24(2):250-250.
7. Dhaliwal GS, Arora R, Dhawan AK. Crop losses due to insect pests in Indian Agriculture. Indian Journal of Ecology 2004;31(1):1-7.
8. Dhawan AK, Simwat GS, Sidhu AS. Effect of sowing dates on incidence of sucking pests and bollworms in arboreum cotton. Journal of Research, (PAU) 1987;24(3):75-85.
9. Gayi D, Lubbadde G, Biruma M, Echaku S, Ejiet E, Ocen D. Distribution and Seasonal Occurrence of major insect pests of cotton in Uganda. International Journal of Environment, Agriculture and Biotechnology 2017;2(5):2456-2478.
10. Gosalwad SS, Kamble SK, Wadnerkar DW, Awaz HB. Population dynamics of insects pests cotton and their natural enemies. Journal of Cotton Research and Development 2009;23(1):117-125.
11. Hargreaves H. List of recorded cotton insects of the world. Common wealth institute of entomology, London, 1948, 50.
12. Hegde, Mahabaleshwar, Srinivas M, Birajdar DP, Udikeri SS, Khadi BM. Seasonal incidence of key insect pest and their natural enemies on Cotton at Siruguppa, International Symposium on Strategies for Sustainable Cotton Production- A Global Vision 3, Crop Protection, UAS, Dharwad, Karnataka 2004, 114-115.
13. Jindal V, Arora R, Vikram S. Seasonal dynamics of key pests on cotton *Gossypium hirsutum* L. in Punjab. Indian Journal of Entomology 2010;72(4):315-320.
14. Kulkarni RD, Kale GB, Bhamare VK. Response of some promising cotton varieties to insect pests in agro-ecology of Chhattisgarh, India. International Journal of Plant Sciences, 2008;3(1):194-196.
15. Mohapatra LN. Population dynamics of sucking pests in *G. hirsutum* cotton and influence of weather parameters on its incidence in western Orissa. Journal of Cotton Research and Development. 2008;22(2):192-194.
16. More DG, Gitte AN, Bhosle Awaz HB, Pawar SV. Population dynamics of different pests of Bt cotton under rainfed condition. National Symposium on "Bt-cotton: Opportunities and Prospects" at CICR, Nagpur, 2009, 123.
17. Potai A, Chandrakar G. Studies on the seasonal incidence of major insect pests and its natural enemies on okra and their correlation with weather parameters. International Journal of Current Microbiology and Applied Sciences 2018;(6):204-210.
18. Prasad NVV, Mallikarjuna RSD, Hariprasad RN. Performance of Bt cotton and non Bt cotton hybrids against pest complex under unprotected conditions, Journal of Biopesticides 2009;2(1):107-110.
19. Rafee CM. Insect pest management in desi cotton. Ph. D. Thesis, University of Agricultural Science, Dharwad, Karnataka, India 2010.
20. Santhosh BM, Patil SB, Udikeri SS, Awaknavar JS, Katageri IS. Impact of Bt cotton on pink bollworm, *Pectinophora gossypiella* (Saunders) infestation. Karnataka Journal of Agriculture Science 2009;22(2):322-326.
21. Slosser JE, Parajulee MN, Idol GB, Rummel DR. Cotton aphid response to irrigation and crop chemicals. Southwestern entomologist 2001;26:1-14.
22. Tomar SPS. Impact of weather parameters on aphid population in cotton. Indian Journal of Agriculture Research 2010;44(2):125-130.
23. Udikeri SS, Patil BV, Basavanagoud K, Khadi BM, Kulkarni KA, Vamadevaiah HM. Impact of Bt transgenic cotton on population dynamics of aphids and natural enemies. Indian Journal of Agricultural Science 2012;82(6):555-60.