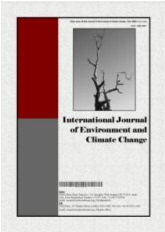

International Journal of Environment and Climate Change

12(11): 586-595, 2022; Article no.IJECC.89842
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Population Dynamics of Sucking Pests in Dual Season Cotton Ecosystem and Its Correlation with Weather Factors

A. Kiruthika [a*], M. Murugan [a], S. Jeyarani [a], N. K. Sathyamoorthy [b] and K. Senguttuvan [c]

[a] Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore-641003, India.
[b] Agro Climatic Research Center, Tamil Nadu Agricultural University, Coimbatore-641003, India.
[c] Department of Cotton, Tamil Nadu Agricultural University, Coimbatore-641003, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2022/v12i1131010

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/89842

Original Research Article

Received 09 May 2022
Accepted 18 July 2022
Published 21 July 2022

ABSTRACT

Population dynamics of sucking pests in cotton ecosystem were studied at Tamil Nadu Agricultural University, Coimbatore during winter (2021) and summer (2022) seasons. Weekly observations were recorded on 20 randomly selected plants representing top, middle and bottom canopy of the crop which was raised in regular planting dates of winter and summer and were maintained as per the recommended regular agronomic practices except insect management interventions. During winter season, sucking pests *viz.,* leafhopper, aphids, thrips, and whitefly were first observed in field from 39th SMW *i.e.* one month after sowing. Mealybugs were first observed during 41st SMW *i.e.* 43 days after sowing (DAS) of crop. The highest population of leafhopper, aphids, thrips, whitefly and mealybug recorded was 4.7, 18.7, 4.6, 2.45 no. per 3 leaves and 13.7 no. per 3 twigs, respectively. The mean population of sucking pests was high in October, 2021 and coincided with square formation to flowering stage except mealybug, which attained peak during January, at the boll bursting stage of crop. During summer season, the sucking pests were found to colonize from 8th SMW, corresponded to 20 DAS crop, while the mealybug occurred at 11th SMW, 40 DAS crop. The peak population of leafhopper, aphids, thrips, whitefly and mealybug registered was 5.4, 38.4, 4.9,

*Corresponding author: E-mail: kiruthiarumugam99@gmail.com;

7.07 no./ 3 leaves and 2.4 no./ 3 twigs, respectively. The mean population of sucking pests was high from mid march to first fortnight of april 2022, and by that time the crop was at square formation to flowering stage. On comparison of both the season, summer season crop was infested by intensive level of sucking pests. Correlation results revealed that maximum temperature (^{0} C) showed positive correlation, whereas rainfall (mm) showed negative correlation with population growth of sucking pests. Results of multiple linear regression analysis revealed that all the weather parameters collectively caused 51.1% – 88.4% influence on the population fluctuation of sucking pests.

Keywords: Cotton; sucking pests; population dynamics; weather factor correlation.

1. INTRODUCTION

Cotton (*Gossypium.spp.*) is the most important fiber and cash crop of India and it plays an essential role in the agricultural economy of the country. Cotton occupies nearly 2.5% world's arable land and accounts for about 25 per cent of total global fibre production. It provides direct livelihood to 6 million farmers and employs nearly 40-50 million people under the processing [1]. India, China and the United States of America are the global leaders in cotton production. The four cultivable species of cotton *viz., Gossypium hirsutum, G.barbadanse, G.arboreum, and G.herbaceum* are commercially grown in India under a diversified ecosystem. However, 90% of global production comes only from *G. hirsutum* [2] During 2021-22, India produced 340.62 lakh bales of 170 kg of cotton from an area of 123.50 lakh ha with a productivity of 468.87 kg per ha [3].

In spite of being the best cotton producing country, India faces a plenty of issues in cotton production and out of which damage by insect pests attract greater importance. In India, over 166 insect species affect cotton, and of which 15 are considered key pests [4,5,6], which include bollworms and sucking pests complex. With the wider cultivation of Cry toxin protein expressing transgenic cotton, the pest status on cotton has experienced a shift. Incidence of bollworms and leaf feeding insects are low ebbed, but sap feeders, including whitefly *Bemisia tabaci* (Gennadius), leafhopper *Amrasca devastans*(Dist.), mealybug *Phenacoccus solenopsis* (Tinsley), thrips *Scirtothrips dorsalis* Hood and *Thrips tabaci* (Lindemann), aphids *Aphis gossypii* (Glover) and mired *Creontiades biseratense* (Distant) are emerging as serious pests [7,8]. The average yield loss due to leafhopper alone was 1.10 q/ha [9]. The yield loss of 726.12 kg/ha can be saved by giving protection against sucking pests in cotton [10]. It is important to monitor the occurrence of these sucking insect pests in a given set of natural weather conditions to draw pest management strategies and will help to establish sustainable management of the sucking insect pests in a changing pest scenario due to reduced impact of bollworm complex by *Bt* cotton cultivation. With the above background, the current research was focused on studying the population dynamics of major sucking pests in cotton ecosystem and their correlation with weather parameters.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was conducted at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore, India (Lat: 11.015°N, Long: 76.92°E) to study the sucking pests (leafhopper, aphid, whitefly, thrips, and mealybug) population dynamics in relation with different climatic factors (temperature (℃), relative humidity (RH) (%), rainfall (mm), leaf canopy temperature (℃), sunshine hours, wind speed (Km/hr), solar radiation during 2021-2022. As a winter season crop, cotton (Co17 variety) was sown in a plot size of $100m^2$ with 90 x 45 cm spacing on 25.08.2021. And again, sown on 30.01.2022 as summer season crop with same plot size and spacing. The crop was grown and maintained as per recommended agronomical practices except insecticide spraying.

2.2 Sampling Method

Observations on sucking pests *viz*., leafhopper (nymphal population), aphids (adult population), whitefly (adult population), and thrips (adult population) were recorded from 20 randomly selected plants avoiding the borders of the field plot on 3 leaves per selected plant representing the top, middle and bottom canopy of the crop. For mealybug, 3 twigs per plant (10cm length) were selected and adult population was counted. Insect counts were taken at weekly intervals (based on standard mean week) from early stage to maturity of crop during morning hours (8.00 - 9.00 AM). Weather data recorded by Agro Climatic Research Center, TNAU, Coimbatore for the selected corresponding Standard Mean Week (SMW) of the study period were used for analysis of correlation and regression using statistical procedures.

2.3 Statistical Analysis

Correlation and multiple linear regression analysis were performed between weekly mean weather parameters and pest counts using IBM SPSS Statistics version 22. The sucking pests population recorded were correlated with the weather parameters and correlation coefficient (r) was arrived to assess the influence of weather factors on the population dynamics. Regression analysis determined the strength of relationship between population and abiotic factors from R^2 value.

3. RESULTS AND DISCUSSION

3.1 Leafhopper Population

During winter season (Fig. 1), leafhopper incidence started from 39th SMW (Standard Mean Week) that is one month after sowing with the mean population of 1.09 leafhopper/3 leaves. The weekly mean maximum temperature (31.4 ^{o} C), minimum temperature (23.3^{o} C), morning RH (83%), evening RH (59%), and rainfall (17.5mm) were observed during the initiation of leafhopper incidence. Leafhopper population gradually increased and reached peak population of 4.7 per 3 leaves during 42nd SMW (3rd week of October 2021) that is 50 days after sowing (DAS) at flowering stage of crop. The weekly mean of maximum temperature (31^{o} C), minimum temperature (23.5^{o} C), morning RH (86%), evening RH (66%), and rainfall (66.5mm) were observed during the peak period. Thereafter, declining trend was observed and reached below ETL (>2 numbers per leaf [11]) during 45th SMW. Then, the population moderately increased and remained throughout the cropping period. During this season the mean leafhopper population ranged from 1.09 to 4.7 no. /3 leaves.

The weekly mean computed for the SMW (Table 1) during the season pertaining to maximum temperature (r=0.028), morning RH (r=0.025), leaf canopy temperature (r=0.224), sunshine hours (r= 0.360), solar radiation (r= 0.330) had a non significant positive influence on population growth of leafhopper. Whereas, a non-significant negative correlation was observed in case of minimum temperature (r= -0.165), evening RH (r= -0.125), rainfall (r= -0.143), evaporation (r= -0.445), and wind speed (r= -0.02). The results of multiple regression analysis revealed that all the weather parameters collectively contributed for 88.3% variability in leafhopper population.

During summer season (Fig. 2), leafhopper population started its appearance from 8th SMW onwards (last week of February, 2022) that is 20 DAS. Maximum temperature (32.6 ^{0} C), minimum temperature (22.3^{o} C), morning RH (83%), evening RH (39%), rainfall (0.00mm) were observed during the initiation of leafhopper incidence. It attained pest status from 9th SMW and the highest population recorded at 14th SMW (first week of April, 2022) that is 61 DAS at flowering stage of crop with the mean population of 5.4 / 3 leaves. An average maximum temperature (35.4^{o} C), minimum temperature (24.7^{o} C), morning RH (83%), evening RH (41%), rainfall (0.00mm) were observed during the peak period. Then the population gradually declined when the crop reached near harvesting stage. During this season the population range was 1.8 – 5.4 leafhopper / 3 leaves.

In summer (Table 1), the maximum temperature (r=0.508), minimum temperature (r=0.098), morning RH (r=0.069), leaf canopy temperature (r=0.351), evaporation (r=0.404), and solar radiation (r= 0.080) had a positive influence on population growth of leafhopper. Whereas, negative correlation was observed in case of evening RH (r= -0.178), rainfall (r= -0.206), sunshine hours (r= - 0.060), and wind speed (r= -0.385). The maximum temperature only was significantly correlated with leafhopper population. The multiple regression analysis results revealed that all weather parameters contributed about 62.7% variability in leafhopper population.

With the winter season planting of cotton by August – September months of each year, it seems leafhopper required at least a month time to build its population and studies on population of leafhopper also confirmed the same. From 39th SMW onwards leafhopper incidence showed increasing trends and crossed ETL from 42nd to 47th standard week at Bapatla, Andhra Pradesh [12]. By 42nd SMW, the crop is in early reproductive phase and has given peak build up of population and similar increased leafhopper population by 42ndSMW at Guntur, Andhra

Pradesh [13]. By the month of October all timely sown cotton attains reproductive phase and the canopy build up and intensive growth of the cotton crop might have helped the leafhopper to quickly build up its population. A two year study reported highest incidence of leafhopper during the third week of October in 2009-10 and during first week of October in 2010-11 [14]. Similar such reports had emerged from other studies also [15,16,17,18,19,20].

A positive correlation between cotton leafhopper population with maximum temperature [16,21] was reported. However, a negative correlation with morning and evening RH [17], rainfall [21]. A non-significantly positive association with all meteorological variables except minimum temperature and rainfall was found [20]. Maximum temperature had a significant favourable effect on the incidence of leafhoppers, while minimum temperature, rainfall, morning and evening RH all indicated a positive but non-significant association [18,19,22].

Regression analysis had revealed that meteorological parameters cumulatively contributed towards overall fluctuation in the leafhopper population was reported to be 75% (R^2 = 0.75) [19], 67-80% [23], 64.1% [17] and 57.2% [13].

3.2 Aphid Population

In winter cotton aphid infestation begun by 39th SMW that matched to one month after sowing and by 42nd SMW (3rd week of October, 2021) the highest aphid population was reached that coincided with 50DAS and was at flowering stage of crop with 18.7 adults / 3 leaves. An average maximum temperature (31^{0} C), minimum temperature (23.5^{0} C), morning RH (86%), evening RH (66%), rainfall (66.5mm) were observed during the peak period. After that, aphid population quickly decreased and the lowest population of 4.01 no./ 3 leaves was noticed during 46th SMW. Again the population had moderately increased and persisted till harvesting of crop. It was observed that the presence of aphid population in cotton field was maximum during early stage (Fig. 1).

In winter cotton season, occurrence of aphid infestation was positively affected by maximum temperature (r=0.318), leaf canopy temperature (r=0.534), sunshine hours (r= 0.601), evaporation (r=0.030), wind speed (r= 0.466), solar radiation (r= 0.634) (Table 1). Whereas, negative correlation was observed in case of minimum temperature (r= -0.236), morning RH (r= - 0.518), evening RH (r= -0.425), rainfall (r= - 0.468). Solar radiation showed highly significant correlation while factors *viz.,* morning RH, leaf canopy temperature and sunshine hours had a significant correlation with aphid population growth.

During summer cotton season, 8th SMW onwards i.e. after 20 days of sowing, the aphid infestation occurred. From 9th SMW, population spurted and reached the peak of 38.4 adult / 3 leaves by 14th SMW and the crop was at 62 DAS at flowering stage. An average maximum temperature (35.4^{0} C), minimum temperature (24.7^{0} C), morning RH (83%), evening RH (41%), and rainfall (0.00mm) were observed during the peak period. Then, the population suddenly declined from 16th SMW but persisted throughout the season. The aphid population had ranged from 2.6 – 38.4 no. / 3 leaves (Fig. 2).

Maximum temperature (r=0.481), minimum temperature (r=0.140), morning RH (r=0.306), leaf canopy temperature (r=0.173), evaporation (r=0.279), and solar radiation (r=0.095) had positive influence on population growth of aphids during the period of investigation. Whereas, a negative correlation was observed in case of evening RH (r= -0.169), rainfall (r= -0.007), sunshine hours (r= -0.075), and wind speed (r= -0.385). Among all these factors, only wind speed showed a highly significant correlation with aphid population. Overall, results of multiple regression analysis revealed that all the abiotic factors contributed to 88.4% and 69.4% variability in aphid population during winter and summer season, respectively.

The present findings are in close conformity with following results. The peak population of aphids was recorded in 42nd SMW with the population of 40.40 aphids/ 3 leaves [15]. Similar findings were reported in previous studies also [17,10,24,20,13]. In correlation studies conducted previously, aphid population showed a positive correlation with all weather parameters except maximum temperature, which showed a significant negative correlation [12], likewise, a negative correlation with minimum temperature was also noticed [17]. It was also affirmed that aphid population exhibited a non-significant negative association with maximum temperature, rainfall and relative humidity, whereas showed a positive link with minimum temperature [25]. In a two year study, the population of aphids exhibited significantly positive relation with maximum temperature, minimum temperature, and evening RH, but a non-significant positive link with morning RH and rainfall in 2013-14, and there was a significant positive relation with minimum temperature and a non-significant positive correlation with all other meteorological factors in 2014-15 [20]. A positive association with sunshine hours for aphid population was also elucidated in previous analysis [13,22,26]. Fluctuation in aphid population due to abiotic factors varied from 42.9% and 69.6% was registered in studies [13,17]. All these information along with the present reports clearly suggested that the weather factors have a profound influence on aphid population build up in cotton crop, however the host plant age and nutritional status also may contribute to the same cause.

3.3 Thrips Population

Thrips started infesting winter cotton from 39th SMW that is one month after sowing with the mean population of 2.3 adults per 3 leaves. The mean weekly maximum temperature (31.4 ^{0} C), minimum temperature (23.3^{0} C), morning RH (83%), evening RH (59%), and rainfall (17.5mm) were observed during thrips infestation. By 2nd week of October 2021 (41st SMW) i.e. 43 DAS, the crop being at square formation stage recorded the peak population (4.6 no./ 3 leaves). An average maximum temperature (30.9^{0} C), minimum temperature (23.3^{0} C), morning RH (83%), evening RH (65%), and rainfall (11.5mm) were observed during the peak thrips infestation period. Throughout the season thrips were observed in leaves but had not increased beyond ETL. The population range was 0.8 no. - 4.6 no./ 3 leaves (Fig. 1).

The weekly mean maximum temperature (r=0.354), minimum temperature (r=0.078), leaf canopy temperature (r=0.550), sunshine hours (r= 0.553), evaporation (r=0.154), wind speed (r= 0.309), and solar radiation (r= 0.359) had a favorable influence on population growth. Whereas, morning RH (r= -0.286), evening RH (r= -0.226), and rainfall (r= -0.354) had showed negative correlation. Leaf canopy temperature and sunshine hours significantly correlated with thrips population (Table 1).

Thrips were observed from 8th SMW onwards in summer cotton coincided with 20DAS and attained a peak (4.9 adults / 3 leaves) during 11th SMW of 2022 and that is 40 DAS of cotton crop. A mean maximum temperature (35.3^{0} C), minimum temperature (21^{0} C), morning RH (78%), Evening RH (30%), Rainfall (0.00mm) were observed during the peak period. The average population of thrips ranged from 0.1 to 4.9 no. / 3 leaves (Fig. 2).

The weekly mean maximum temperature (r=0.745), minimum temperature (r=0.200), morning RH (r=0.130), leaf canopy temperature (r=0.536), sunshine hours (r= 0.138), evaporation (r=0.538), and solar radiation (r= 0.168) had a favorable influence on population growth of thrips. However, evening RH (r= -0.167), rainfall (r= -0.028), and wind speed (r= -0.548) had shown a negative association with thrips field incidence. Among all these parameters, maximum temperature, and leaf canopy temperature, evaporation and wind speed had recorded a highly significant and significant correlation with thrips population growth, respectively (Table 1). The results of multiple regression analysis had revealed that all abiotic factors studied had contributed 67.9% and 87.6% variability in thrips population during winter and summer season, respectively.

In past years also thrips population reached peak during 41st SMW in winter cultivated cotton crop [13,17,16]. In general cool dry weather encouraged build up of thrips population and also the profuse and luxurious presence of cotton canopy may support thrips build up.

Earlier findings had revealed various patterns of correlation with different weather parameters prevailed, a significant positive correlation with maximum temperature [12,22] and minimum temperature [12,22,27], morning RH [27] evening RH [12,27], sunshine hours [28] and rainfall [12]. In contrast, negative correlations of thrips population with maximum temperature [27], rainfall [28,22], minimum temperature [28], wind speed [28], morning RH [28], evening RH [28], morning vapour pressure [28] and evening vapour pressure [28]. Abiotic factors had a significant influence on thrips population. As found in the present study, in previous reports also 70.0% and 69.7% variation in thrips population due to influence of weather factors were explained [17,13].

3.4 Whitefly Population

During winter cotton season, whitefly population emerged in field at the end of September, 2021 (39th SMW) that is one month after sowing with the mean population of 0.5 no./ 3 leaves. The peak population was attained during 41st SMW (second week of October) that is 43 DAS at that time crop attain square formation stage. The peak population was 2.45 no. / 3 leaves which was very low when compared with ETL of whitefly pest in cotton. Whitefly population ranged from 0.5 to 2.45 no. / 3 leaves during this period of investigation. The abiotic factors used in correlation studies with whitefly population did not produce any significant correlation (Fig. 1).

However, in summer cotton season (Fig. 2), the whitefly population ranged between 3.3 to 7.07 no./ 3 leaves with its appearance from 8th SMW (20 DAS) and attained pest status from 9th SMW and peaked by 12th SMW, that is 7th week after sowing when the crop was at vegetative to square formation stage (7.07 no./ 3 leaves). After that, whitefly population gradually decreased and reached below ETL (4.05 whitefly/ 3 leaves) from 16th SMW but persisted throughout the season (Fig. 2).

Among the weather parameters studied, evaporation (r=0.650), and solar radiation (r=0.661) while evening RH (r= -0.604) had shown highly significant positive and negative correlation with whitefly population, respectively, However, leaf canopy temperature, maximum temperature were significantly positively correlated with whitefly population growth. For whitefly population development (Table 1), all the abiotic factors had contributed 83.5 % and 85.7% variability during winter and summer season, respectively.

In earlier studies also whitefly population was found to reach peak during 42nd SMW and afterwards it got decreased up to 51st SMW at Hisar, Haryana, India [29]. In summer season, the peak of whitefly was noticed during April second fortnight with a record of 29.50 population per three leaves at Shimoga, Karnataka [26]. In yet another study, the incidence of peak population of whitefly recorded in 44th SMW with the population of 12.60 whitefly/ 3 leaves at Parbhani, Maharastra [15].

In previous studies, weather parameters *viz*., rainfall, rainy days, morning RH and evening RH showed negative correlation, whereas maximum temperature and minimum temperature recorded significant positive correlation [16]. However,maximum and minimum temperature exerted negative correlation, while morning RH showed positive correlation [17]. Regression analysis of whitefly population against weather parameters had shown a fluctuation range of 50-69% [23,17] while it was only 27.6% in another study [13].

3.5 Mealybug Population

In winter season, mealybug infestation begun (0.04 no./ 3 twigs) from 41st SMW (2021) that is five weeks after sowing, when the crop is at vegetative stage. The peak population (13.7 adults / 3 twigs) was noticed by 2nd SMW of 2022 that is 18 weeks after sowing when the crop is at boll bursting stage (Fig. 1). The mealybug population was very low throughout the season, but at the time of harvesting the population drastically increased and attained pest status (Fig. 1). The mean maximum temperature (r=0.166), leaf canopy temperature (r=0.170), and sunshine hours (r= 0.371) had a non-sginificant positive influence, while minimum temperature (r= -0.233), morning RH (r= -0.102), evening RH (r= -0.461), rainfall (r= -0.336), wind speed (r= -0.140), evaporation (r= -0.093), and solar radiation (r= -0.356) had a negative correlation with mealybug population (Table 1).

During summer season (Fig. 2), the mealybug population ranged from 0.9 (11th SMW) to 2.4 no. (14th SMW) / 3 twigs of plant. From 8th week after sowing (14th SMW), mealybug population showed decreasing trend but persisted till harvest. Only a non-significant positive or negative correlation was noticed for different abiotic factors studied (Table 1). All abiotic factors studied, had contributed a variability of 65.6% and 51.1% in mealybug population during winter and summer seasons, respectively.

Mealybug population in winter sown crop was noticed from August and had peaked by December [16,22]. Previous correlation studies revealed that all climatic factors showed a significant negative correlation with the mealybug infestation except maximum and minimum temperature. Mealybug infestation was found to have a positive correlation with maximum temperature, sunshine hours whereas minimum temperature, rainfall, morning and evening relative humidity had negative correlation [22].

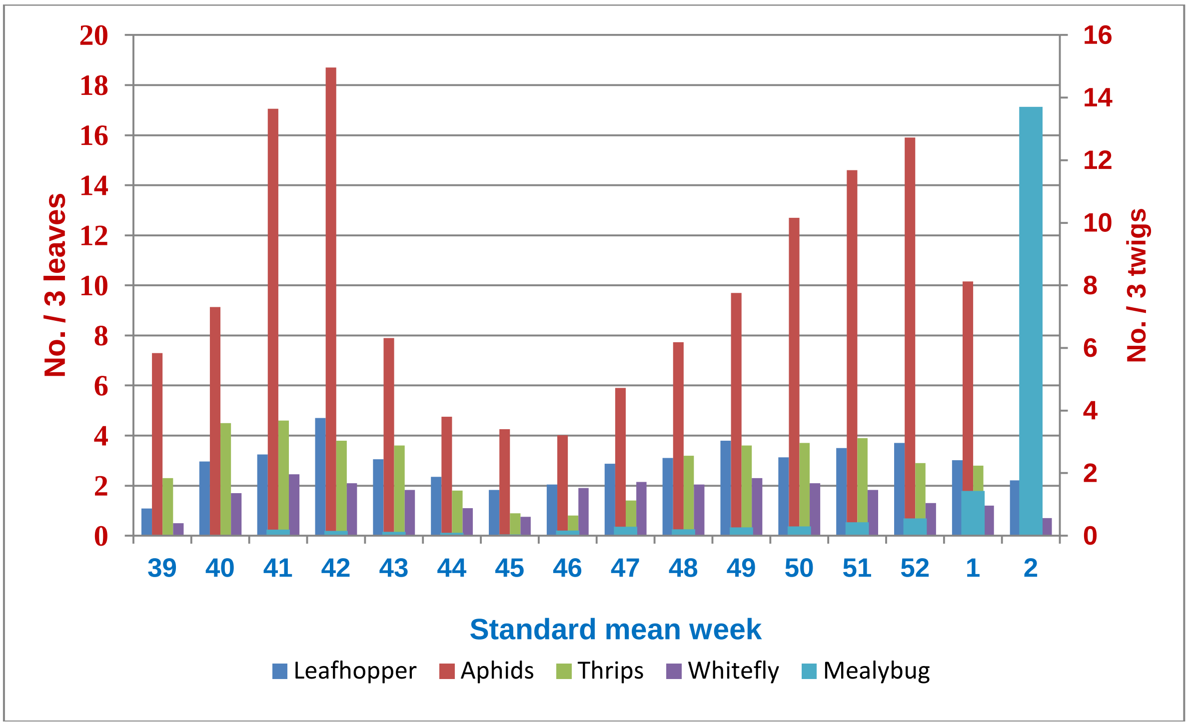

Fig. 1. Population dynamics of major sucking pests in cotton ecosystem- winter season 2021-22 (Coimbatore)

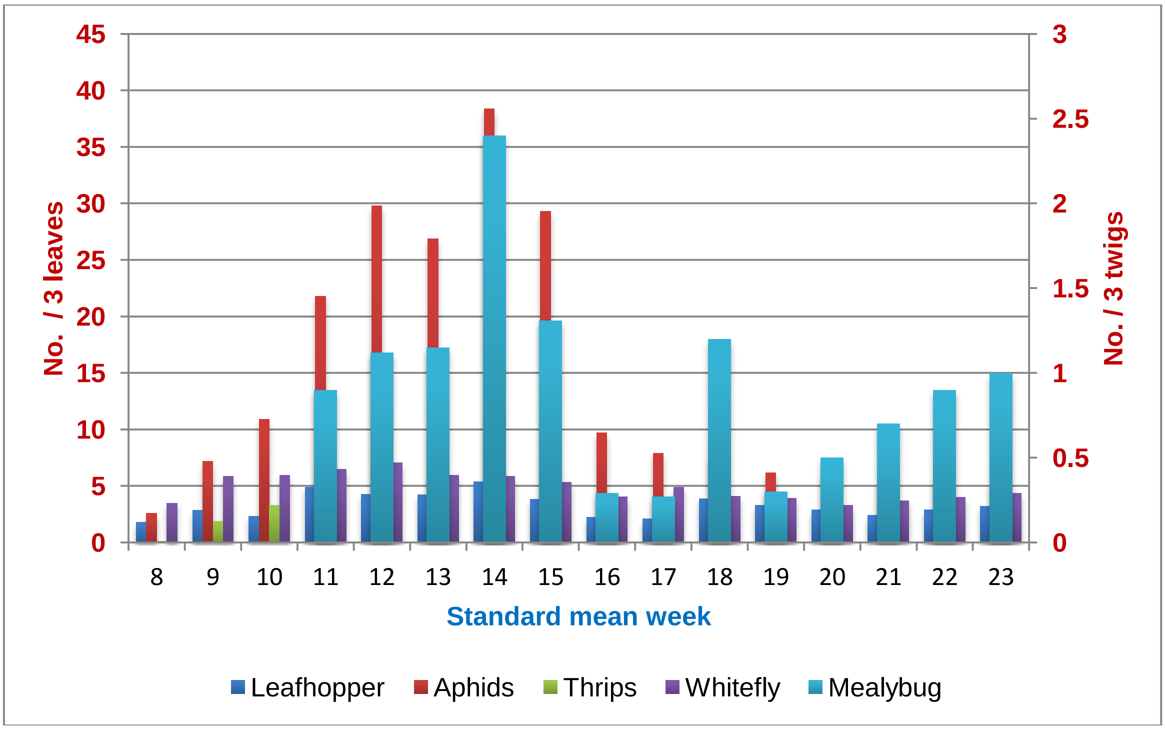

Fig. 2. Population dynamics of major sucking pests in cotton ecosystem- summer season 2022 (Coimbatore)

Table 1. Correlation and regression values obtained in analysis between abiotic factors and mean population of major sucking pests in cotton ecosystem during winter 2021-22 and summer 2022

	Winter season					Summer season				
Abiotic Factors	**LH**	**AP**	**TH**	**WH**	**MB**	**LH**	**AP**	**TH**	**WH**	**MB**
Maximum Temperature (^{0} C)	0.028	0.318	0.354	0.014	0.166	0.508*	0.481	0.745**	0.527*	0.489
Minimum Temperature (^{0} C)	-0.165	-0.236	0.078	0.188	-0.233	0.098	0.140	0.200	-0.354	0.464
RH Morning (%)	0.025	-0.518*	-0.286	0.087	-0.102	0.069	0.306	0.130	-0.111	0.306
RH Evening (%)	-0.125	-0.425	-0.226	0.260	-0.461	-0.178	-0.169	-0.167	-0.604**	0.117
Rainfall (mm)	-0.143	-0.468	-0.354	-0.062	-0.336	-0.206	-0.007	-0.028	-0.254	-0.134
Leaf Canopy Temperature (^{0} C)	0.224	0.534*	0.550*	0.276	0.170	0.351	0.173	0.536*	0.336	0.271
Sunshine Hours	0.360	0.601*	0.553*	0.082	0.371	-0.060	-0.075	0.138	0.228	-0.017
Evaporation	-0.445	0.030	0.154	-0.396	-0.093	0.404	0.279	0.538*	0.650**	0.192
Windspeed	-0.022	0.466	0.309	-0.162	-0.140	-0.385	-0.695**	-0.548*	-0.262	-0.331
Solar Radiation	0.330	0.634**	0.359	-0.067	0.356	0.080	0.095	0.168	0.661**	-0.103
R^2Value	0.883	0.884	0.679	0.835	0.656	0.627	0.694	0.879	0.857	0.511

**. Correlation is significant at the 0.05 level (2-tailed).*

***. Correlation is significant at the 0.01 level (2-tailed).*

LH- Leafhopper, AP- Aphids, TH- Thrips, WF- Whitelfy, MB- Mealybug,

4. CONCLUSION

The current research concluded that weather factor influences the seasonal activity and population growth of sucking pests. The correlation studies clearly demonstrate the significance of weather factors in predicting the sucking pests incidence in cotton ecosystem. These studies will undoubtedly be beneficial to farmers and extension workers in order to aptly monitor the pests and apply effective pest control strategies for increased cotton cultivation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous. Cotton sector- GoI; 2022. Available:http://www.texmin.nic.in/sites/default/files/Cotton%20Sector.pdf
2. Anonymous. Introduction-NFSM. National Food Security Mission. Available:https://www.nfsm.gov.in/BriefNote/BN_Cotton.pdf
3. Selected State-wise Estimated Area, Production and Productivity of cotton in India. Indiastat; 2021-22. Available:https://www.indiastat.com/table/cotton-lint-kapas/selected-state-wise-estimated-area-production-prod/1091688
4. Ayyar JVR. Insects affecting the cotton plant in India. Madras Agril Dept Bulletin. 1932;28:1-28.
5. Khan Q, Rao VP. Insects and mites. Cotton in India: a monograph. 1960;2:217-301.
6. Puri SN, Murthy KS, Sharma OP. Integrated pest management for sustainable cotton production. In: Sundaram V, Basu AK, Iyar KKR, Narayana SS, Rajendran TP, editors. Handbook of cotton in India. Indian Society for Cotton Improvement, Central Institute for Research on Cotton Technology, Mumbai; 1999.
7. Mann RS, Gill RS, Dhawan AK, Shera PS. Relative abundance and damage by target and non-target insects on Bollgard and BollgardII cotton cultivars. Crop Prot. 2010;29(8):793-801.
8. Kumar V, Dhawan AK, Shera PS. Transgenic cotton in India: Ten years and beyond. In: Singh B, Arora R, Gosal SS, editors. Biological and molecular approaches in pest management. Scientific Publishers, Jodhpur; 2015.
9. Dhawan AK, Sidhu AS, Simwat GS. Assessment of avoidable loss in cotton (*Gossypium hirsutum* and *G. arboreum*) due to sucking pests and bollworms. Indian J Agric Sci. 1988;58(4):290-2.
10. Makwana DK, Chudasama KA, Balas TK. Estimation of yield losses due to major sucking insect pests of Bt cotton. Int J Curr Microbiol Appl Sci. 2018;7:956-9.
11. Mohan S, Monga D, Kumar R, Nagrare V, Gokte-Narkhedkar N, Vennila S, et al. Integrated pest management package for cotton. Directorate of Plant Protection Quarantine and Storage, Government of India; 2014.
12. Soujanya PL, Prasad NV, Rao PA. Population dynamics of sucking pests and their relation to weather parameters in Bt, stacked Bt and non Bt cotton hybrids. Trends Biosciences. 2010;3(1):15-8.
13. Rajasekhar Y, Krishnayya PV, Prasad NV. Population dynamics and influence of weather parameters on the incidence of sucking pests on Bt and Non-Bt cotton (Gossypium spp.). J res PJTSAU. 2015; 28.
14. Harde SN, Mitkari AG, Sonune SV, Shinde LV. Seasonal incidence of major sucking insect pest in bt cotton and its correlation with weather factors in Jalna District (MS), India. SSRG- Int J Agric Env Sci. 2018;5(6):59-65.
15. Chavan DR, Zanwar PR, Ramesh KB, Babu HS, Manjunatha MK. Population dynamics of sucking pests and their natural enemies of Bt cotton. Adv Life Sci. 2016;5(3):954-8.
16. Bhute NK, Bhosle BB, Bhede BV, More DG. Population dynamics of major sucking pests of Bt cotton. Indian J Entomol. 2012;74(3):246-52.
17. Sitaramaraju S, Prasad NV, Krishnaiah PV. Seasonal incidence of sucking insect pests on Bt cotton in relation to weather parameters. Ann Plant Prot Sci. 2010;18(1):49-52.
18. Soni R, Dhakad NK. Seasonal incidence of cotton jassid, Amrasca biguttula biguttula (Ishida) on trasgenic BT cotton and their correlation with weather parameters. Int J Agric Innov Res. 2016;4(6):1119-21.
19. Akhila E, Upendhar S, Sree KV, Sagar BV. Population dynamics of leafhopper Amrasca biguttula biguttula (Ishida)(Homoptera: Cicadellidae) on

popular cotton hybrids in Telangana. J Entomol Zool Stud. 2020;8(5):511-15.
20. Mandi N, Nayak BS, Patnaik RK. Population dynamics of major sucking pests of hybrid cotton (*Gossypium hirsutum*) in Western Undulating Zone of Odisha. Indian J Entomol. 2018;80(3):798-801.
21. Kalkal D, Lal R, Dahiya KK, Singh M, Kumar A. Population dynamics of sucking insect pests of cotton and its correlation with abiotic factors. Indian J Agric Res. 2015;49(5):432-6.
22. Muchhadiya DV, Damasia DM, Saradava DA, Kabaria BB. Seasonal incidence of sucking insect pests of Bt cotton in relation to different weather parameters. J Agrometeorol. 2014;16(2):227.
23. Shera P, Kumar V, Aneja A. Seasonal abundance of sucking insect pests on transgenic Bt cotton vis-à-vis weather parameters in Punjab, India. Acta Phytopathol Entomol Hung. 2013;48(1):63-74.
24. Kumar D, Yadav SS, Saini VK, Dahiya KK. Impact analysis of genetically modified (Bt) cotton genotypes on economically important natural enemies under field conditions. Adv Entomol. 2016;4(2):61-74.
25. Akhila E, Upendhar S, Sree KV, Sagar BV. Population dynamics of aphid Aphis gossypii (Glover)(Homoptera: Aphididae) on popular cotton hybrids in Telangana. MH. J Entomol Zool Stud. 2020;8(6):2072-75.
26. Shivanna BK, Nagaraja DN, Manjunatha M, Naik MI. Seasonal incidence of sucking pests on transgenic Bt cotton and correlation with weather factors. Karnataka J Agric Sci. 2009;22(3):666-7.
27. Janu A, Dahiya KK. Influence of weather parameters on population of whitefly, Bemisia tabaci in American cotton (Gossypiumhirsutum). J Entomol Zool Stu. 2017;5(4):649-54.
28. Padaliya SR, Thumar RK, Aniyaliya MD, Timbadiya BG. Population dynamics of thrips, Scirtothrips dorsalis hood infesting Bt cotton ecosystem in middle Gujarat. J Entomol Zool Stu. 2019;7(1):420-2.
29. Sharma SS, Yogesh K. Influence of abiotic weather parameters on population dynamics of whitefly, Bemisia tabaci (Genn) on cotton. J Cotton Res Dev. 2014;28(2):286-8.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/89842