Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(1): 509-515
© 2016 JEZS
Received: 16-12-2015
Accepted: 18-01-2016

Muhmmad Siddique Khanzada
Department of Entomology, Sindh Agriculture University Tandojam-70050, Pakistan.

Tajwar Sultana Syed
Department of Entomology, Sindh Agriculture University Tandojam-70050, Pakistan.

Shagufta Rani Khanzada
Department of Entomology, Sindh Agriculture University Tandojam-70050, Pakistan.

Ghulam Husssain Abro
Department of Entomology, Sindh Agriculture University Tandojam-70050, Pakistan.

Muhammad Salman
Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, Pakistan.

Sajjad Anwar
Sugar Crops Research Institute, Mardan, KPK, Pakistan.

Muhammad Sarwar
Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, Pakistan.

Adeel Aslam Perzada
Sindh Agriculture University Tandojam-70050, Pakistan.

Su Wang
Institute of Plant and Environmental Protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing-100193, China.

Azmat Hussain Abro
University of Sindh, Jamshoro, Pakistan.

Correspondence
Muhmmad Siddique Khanzada
Department of Entomology, Sindh Agriculture University Tandojam-70050, Pakistan.

Occurrence and abundance of thrips, whitefly and their natural enemy, *Geocoris* Spp. on cotton crop at various localities of Sindh, Pakistan

Muhammad Siddique Khanzada, Tajwar Sultana Syed, Shagufta Rani Khanzada, Ghulam Husssain Abro, Muhammad Salman, Sajjad Anwar, Muhammad Sarwar, Adeel Aslam Perzada, Su Wang, Azmat Hussain Abro

Abstract
Present studies were carried out on occurrence and abundance of insect pests, thrips, *Thrips tabaci*, whitefly, *Bemesia tabaci* and their predator, *Geocoris* spp., on cotton, *Gossypum arborium* L. Results revealed that thrips, whitefly and their natural enemy populations varied with different dates and plant's phenology. At Tando Allahyar, thrips and whitefly population was very low (3.00±0.15, 1.00±0.35 per leaf) in 2nd week of April, but peaked during last week of July (75.6±0.78, 24.45±55), respectively. Predator, *Geocoris* remained minimum (1.00±0.14) in 3rd week of April and maximum (12.00±0.85) in last week of July. Likewise at Crop Protection Field, Sindh Agriculture University, Tandojam, thrips and whitefly population was minimum in 1st week of May (15.55±0.52, 5.56±0.42) and reached at peak (191.6±0.85, 91.6±0.85), respectively on last week of August. Predator, *Geocoris* population was minimum (4.00±0.60) in 1st week of May and maximum (25.6±0.59) during 3rd week of August. Temperature and humidity varied during different dates and time to play imperative role in increasing thrips, whiteflies and their predators.

Keywords: Occurrence, Abundance, Thrips, Whitefly, *Geocoris*, Population, Cotton.

1. Introduction
Cotton, *Gossypium arborium* L. (Family Malvaceae), is one of the most commercially important fiber crops in the world. It is a perennial semi-shrub grown as an annual crop in both tropical and as well as in warm temperate regions. In addition to provide raw lint for textile manufacturing, it produces seeds with a potential multiproduct base such as hulls, oil and food for animals [1, 2, 3]. During the last one and half decades, the production of cotton has been doubled in Pakistan, but it is still low as compared to major cotton growing countries of the world [4]. The major factors responsible for its low yield are insect pests and diseases attacks [5, 6]. Production of cotton is mainly limited by various factors among which insect pests are the most important. In cotton field, the infestation of insect pests caused deterioration in lint quality and 10-40% losses in crop production [7]. The key insect pests of cotton are thrips, *Thrips tabaci*; whitefly, *Bemisia tabaci*; spotted bollworm, *Earias insulana*; pink bollworm, *Pectinophora gossypiella* and American bollworm, *Helicoverpa armigera* [8]. Among these insect pests, the whitefly *Bemisia tabaci* (Genn.), (Homoptera: Aleyrodidade), and thrips, *Thrips tabaci* Lind., (Thysanoptera: Thripidae) are polyphagous species and injurious pests with a world-wide distribution, which destroy the cotton plant by sucking the sap from the leaves and transmitting certain viral diseases [9, 10].
A large number of beneficial insects are found in cotton fields, wherein their food habits are different. A high reproductive rate of natural enemies is important so that their population can increase rapidly when hosts are available [11, 12, 13]. Several authors have made causal reference to trace natural enemies in cotton on certain varieties. Han Xu [14] had recorded eight species of natural enemies belonging to 8 genera and 5 families in cotton fields, and most of these species composition related to spiders, which are believed to be important natural enemies of cotton pests. Big eyed bug, *Geocoris puntipes*is compact, brightly colored, most abundant and important predator of many insect species in cotton crop, and feeds on all life stages of whiteflies, thrips, aphids, jassids and eggs of the bollworms. The most distinguishing characteristics are their large, bulging eyes. Bigeyed bugs walk with a distinctive "waggle"

style. Both the immatures and adults feed by sucking juices from their prey through a "needle-like" beak. Adult and immature can consume dozens of eggs, larvae and adults of *Heliothis zea* per day [15]. Therefore, the main objective of the present work is to study pests and natural enemies to develop an insecticide free model for the management of cotton pests in Pakistan.

2. Materials and Methods

The field studies were carried out to observe occurrence and abundance of thrips and whitefly pests, and their natural enemy, *Geocoris* spp., on cotton, *Gossypium arborium* L., cropat Tando Allahyar, and Crop Protection Field, Sindh Agriculture University, Tandojam. The surveys of both localities were carried out to record the thrips and whitefly, and their predator, *Geocoris* spp., populations from 10-4-2011 to 30-07-2011. At the experimental fields, the observations were started 2 weeks after growing of cotton crop.

2.1. Occurrence and Abundance of Thrips, Whitefly and Their Natural Enemy, *Geocoris*

The experiments were conducted in randomized completely block design replicated thrice. For conducting the observations on occurrence and abundance of thrips and whitefly pests, and their natural enemies from the localities of Tando Allahyar, and at Tandojam, fields of cotton crop were selected randomly. The surveys on the population fluctuation of thrips and whitefly, and their natural enemies were carried out at weekly intervals. Twenty five plants were randomly selected from each locality of cotton crop, five leaves were selected, two from bottom, two from middle and one from top, and counted the insect populations on them with the help of magnifying glass. The plants were carefully handled to avoid disturbing of the thrips and whitefly, and their natural enemies on the plants. The observations were taken at weekly interval to find per leaf populations. Normally, time of observation was 8-10 am from randomly selected plants in the crop season. The populations of thrips and whitefly, and their natural enemies were also collected by using sucker machine (Devil Bliss Suction Unit Model No. NM09 PU-103386), for identification purpose. The metrological data was also taken for observing the effects of temperature and humidity on the pests and natural enemy's populations.

2.2. Statistically Analysis

The data were statistically analyzed using Statistix 8.1 computer software, to determine dominance of treatment means, means were separated using LSD test and the standard error (SE±) was found at 0.5 level of significance.

3. Results and Discussion

The results on the weekly mean per leaf population surveys conducted to determine the mean population dynamic of thrips, whitefly and *Geocoris* at different localities such as Tando Allahyar, and Crop Protection Field, Tandojam, on cotton *G. arborium* crop are presented in Tables 1 and 2. At Tando Allahyar, thrips and whitefly populations were very low (3.00±0.15, 1.00±0.35 per leaf) in 2nd week of April, but peaked during last week of July (75.6±0.78, 24.45±55), respectively. Predator, *Geocoris* remained minimum (1.00±0.14) in 3rd week of April and maximum (12.00±0.85) in last week of July (Table 1).

The data showed that thrips and whitefly populations varied with different dates and penology of plant in the beginning, the same result was found by Liu [16], who reported adult whiteflies *Bemisia argentifolii* on spring collard first appeared on the plant in early April, increased rapidly within the month, peaked in May and declined at the end of the season. Fiedler and Sosnowska [17] had recorded that the number of whiteflies was the highest in spring (April, May) and in autumn (October). Similarly, the maximum population of whitefly (24.45±55) was in last week of July and minimum (1.00±0.35) in second week of April. Gerling *et al*., [18] had found that, an extreme relative humidity of both high and low conditions were unfavorable for the survival of immature stages of whitefly. In the second cropping season, the immature whiteflies successfully maintained their population until at the end of cropping period, probably because they could adapt the surrounding field conditions.

Table 1: Population of Thrips, Whiteflies and Predators *Geocoris* Spp., in Cotton at Tando Allahyar from April 2011 to July 2011(MEAN±S.E)

Date of observation	No. of Plant Observed	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature ºC	R.H%
10-4-2011	25	3.00±0.15	1.00±0.35	0.00±0.00	35.47	50.57
17-4-2011	25	5.00±0.45	2.00±0.55	1.00±0.14	36.50	52.57
24-4-2011	25	6.00±0.65	2.86±0.35	2.00±0.54	36.48	54.28
1-5-2011	25	9.00±0.75	4.00±0.75	2.00±0.54	37.50	55.85
8-5-2011	25	17.00±0.83	5.45±0.53	4.45±0.90	39.07	56.85
15-5-2011	25	12.4±0.88	7.4±0.85	5.00±0.70	40.42	56.85
22-5-2011	25	24.00±0.72	8.00±0.52	7.00±0.25	41.57	60.00
29-5-2011	25	29.6±0.86	9.6±0.76	9.00±0.29	41.64	60.57
6-6-2011	25	29.6±0.76	9.86±0.66	8.00±0.60	41.27	62.57
13-6-2011	25	35.2±0.48	11.2±0.38	9.00±0.25	42.47	63.57
20-6-2011	25	49.4±0.66	11.4±0.46	10.00.±0.80	42.50	65.57
27-6-2011	25	56.2±0.50	15.2±0.40	9.33±0.29	42.48	60.28
4-7-2011	25	63.4±0.44	17.4±0.34	9.00±0.25	41.50	62.42
11-07-2011	25	65.6±0.57	19.6±0.77	10.00±0.80	38.47	63.57
18-07-2011	25	67.6±0.66	21.6±0.36	11.33±0.69	38.50	65.57
30-07-2011	25	75.6±0.78	24.45±55	12.00±0.85	36.48	67.28

Similarly, the predator, *Geocoris* spp., remained the minimum (1.00±0.14) in 3rd week of April and maximum (12.00±0.85) in last week of July. Elkassabany *et al*., [19] had reported that the natural enemies like pirate bug, big eyed bug, green lacewing and ant were present throughout the season, while spider and *Stethorus* were mostly found in middle of the crop season, and wasp population was observed from middle of the season up to last picking of crop. Population of predators was heavily affected by the rain during August; *Orius insidiosus* peaked during late spring and summer, while population of *O. insidiosus* increased in association with increasing thrips population. Ge-Feng *et al*., [20] had reported that the population dynamics of *Stethorus punctillum*, *O. minutus*, *Geocoris pallidipennis* and some other predators were examined in

cotton field. The regression analysis of thrips with predator, *Geocoris* spp., in cotton crop was determined. The correlation of thrips with predators showed highly positive correlation with (r^2= 0.83) value (Fig: 1), which means with increase in thrips population the population of predators also increased. The correlation between temperature and thrips showed poorly positive correlation with (r^2 = 0.08) value (Fig: 2). The correlation between thrips with R.H% was of highly positive (r^2 = 0.77) value, (Fig: 3). The regression analysis of whitefly with predator, *Geocoris* spp., in cotton crop was determined. The correlation of whitefly with predators showed highly positive correlation with (r^2 = 0.82) value (Fig: 4), which means with increase in whitefly population the population of predators also increased. The correlation between temperature and whitefly showed poorly positive correlation with (r^2 = 0.05) value (Fig: 5). The correlation between whitefly with R.H% was highly of positive (r^2 = 0.77) value (Fig: 6). Soto *et al*., [21] had mentioned that the abundance and population dynamics of whiteflies varied depending on whiteflies species, area and crops. Furthermore, Kumawat *et al*., [22] had reported that temperature was significantly correlated with whitefly densities. Similarly, the correlation between predators with temperatures and R.H% was also of positive (r^2 = 0.30) and (r^2 = 0.93) value (Fig: 7 & 8), respectively. This means when the temperature and R.H% increased, the populations of thrips and *Geocoris* spp., also increased. The temperature and RH% played very important role in increasing the thrips and their predator *Geocoris* spp., population. Some other researchers [23, 24, 25, 26, 27] had also reported that increase in temperature, favored the population of *B. tabaci* and *T. tabaci*, while heavy rain and high humidity were deleterious to these insects.

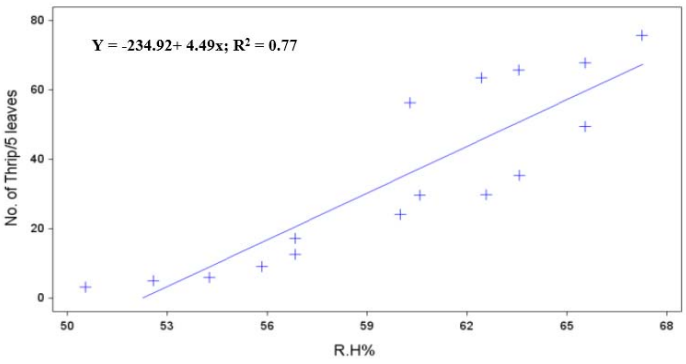

Fig. 03: Relationship between No. of Thrips and R.H% on Cotton

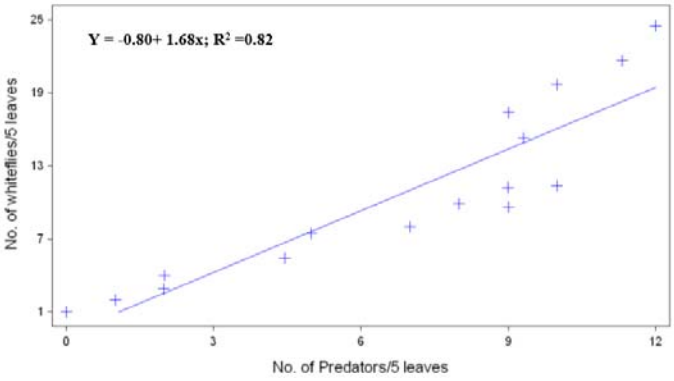

Fig. 04: Relationship between No. of Whiteflies and No. of Predator on Cotton

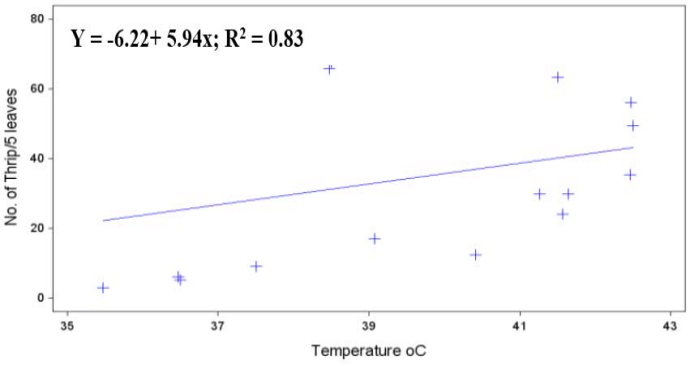

Fig. 01: Relationship between No. of Thrips and No. of Predator on Cotton

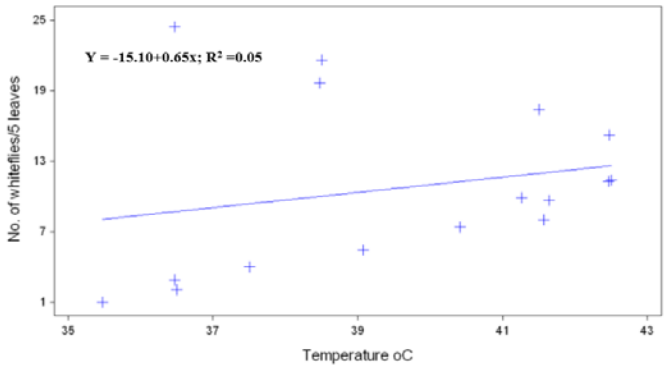

Fig. 05: Relationship between No. of Whiteflies and Field Temperature ^{o}C on Cotton

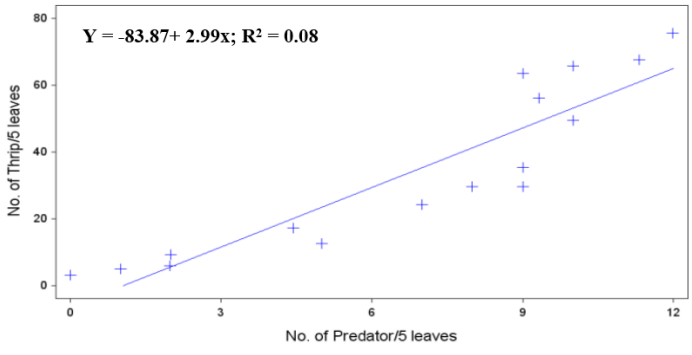

Fig. 02. Relationship between No. of Thrips and Field Temperature ^{o}C on Cotton

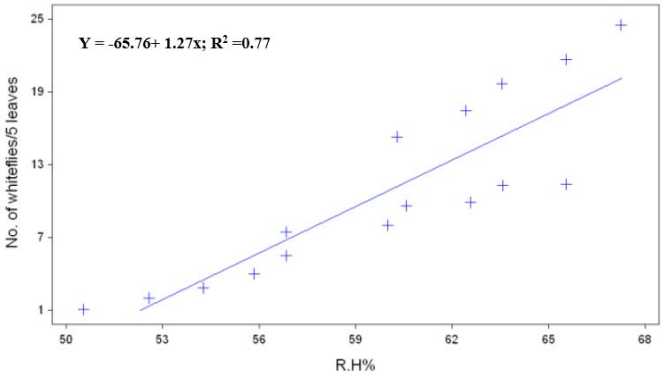

Fig. 06: Relationship between No. of Whiteflies and R.H% on Cotton

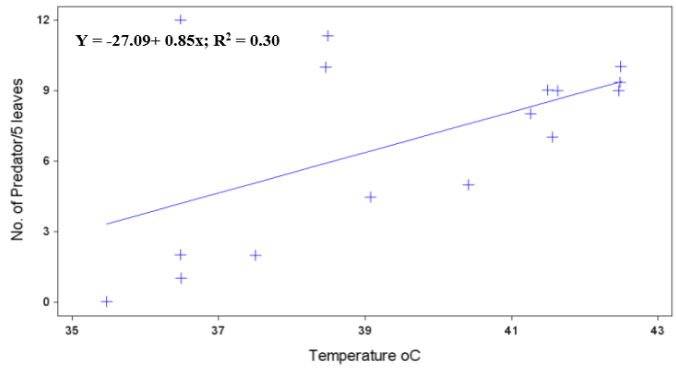

Fig. 07: Relationship between No. of Predator and Temperature on Cotton

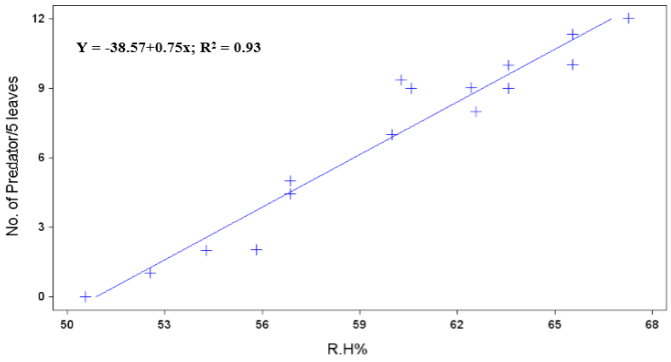

Fig. 08: Relationship between No. of Predator and R.H% on Cotton

The results on the weekly mean per leaf population of thrips and whitefly, and their natural enemy on cotton at Tandojam are presented in Table 2. At Crop Protection Field, Sindh Agriculture University, Tandojam, thrips and whitefly populations were minimum in 1st week of May (15.55±0.52, 5.56±0.42) and reached at peak (191.6±0.85, 91.6±0.85)), respectively on last week of August. Predator *Geocoris* population was minimum (4.00±0.60) in 1st week of May and maximum (25.6±0.59) during 3rd week of August.

The present result showed that thrips population was the minimum in the 1st week of May (15.55±0.52) and reached its peak (191.6±0.85) on last week of August. Hussain *et al*., [28] had reported that population of *T.tabaci* began to build up in early February and reached maximum during April. Vennila *et al*., [29] had reported that *T. tabaci* had population peaks during dry spell with high temperature and low humidity which were optimum for population build up. Domiciano *et al*., [30] had observed that typical conditions which favored rapid increase in the thrips population were temperature (20.29 ºC) and absence of rain fall. Likewise, in cotton field, the populations of thrips and predator *Geocoris* varied throughout the season when surveys were carried out at Tando Allayahar and at Tandojam. Similarly, the whitefly population was the minimum in the 1st week of May (5.56±0.42) and reached its peak (91.6±0.85) on last week of August. The present findings are in close agreement with the findings of Anitha and Nandihalli [31] who had reported peak incidence of whitefly noticed in last week of April.

Table 2: Population of Thrips, Whiteflies and Predator *Geocoris Spp* in Cotton at Tandojam from April 2011 to August 2011 (Mean±S.E)

Date of observation	No. of Plant Observed	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature ºC	R.H%
1-5-2011	25	15.55±0.52	5.56±0.42	4.00±0.60	35.50	56.85
8-5-2011	25	37.2±.58	7.2±0.68	6.00±0.80	36.07	58.85
15-5-2011	25	50±0.77	8.50±0.67	8.00±0.90	38.42	56.85
22-5-2011	25	48.8±0.75	10.8±0.55	9.00±0.25	38.57	60.00
29-5-2011	25	47.6±0.72	14.6±0.72	10.00±0.25	39.64	60.57
5-6-2011	25	109.2±0.84	19.2±0.34	12.33±0.29	40.27	62.57
12-6-2011	25	115.4±0.12	25.4±0.42	15.00±0.40	40.47	63.57
19-6-2011	25	125.6±0.21	27.6±0.28	14.00±0.25	41.50	64.57
26-6-2011	25	134.4±0.60	34.6±0.40	17.75±0.33	41.48	60.28
3-7-2011	25	148.8±0.61	38.5±0.65	16.33±0.29	41.50	62.42
11-07-2011	25	147.2±1.71	47.8±0.58	14±0.50	42.47	63.57
18-07-2011	25	152.8±1.63	52.7±0.63	18.0±0.76	42.50	65.57
30-07-2011	25	163.4±1.82	63.1±1.42	15.4±0.58	41.48	60.28
7-08-2011	25	166.6±0.81	66.2±0.85	19.4±0.52	39.50	65.85
14-08-2011	25	171.4±0.84	71.3±0.84	17±0.50	39.07	66.85
21-08-2011	25	186.4±0.57	86.4±0.37	25.6±0.59	37.42	60.85
28-08-2011	25	191.6±0.45	91.6±0.85	15.4±0.58	37.57	65.00

The predator, *Geocoris* spp., population was minimum (4.00±0.60) in the starting in the1st week of May and maximum predator density (25.6±0.59) in the 3rd week of August. Walker [31] listed nine species of anthrocorid, particularly *Orius* spp., considered to play an important role in the biological control of *T. palmi*. It had been concluded that big-eyed bugs, *Geocoris* spp., were the most prevalent predators during June, but populations of these insects decreased more rapidly than did spiders which was the second most abundant group. Big-eyed bugs were clearly the most abundant of the predators studied throughout the season.

There were many factors affecting the population of whitefly such as climate (temperature, rainfall and relative humidity), natural enemies, surrounding area and host plants. Horowitz *et al*.,[32] had found that the population dynamic of *B. tabaci* in cotton fields was mainly due to climatic factors such as humidity and temperature, but parasitism was not a decisive factor. The population varied when survey was carried out in cotton plant. In cotton at Tando Allayahar and at Tandojam, the thrips population appeared throughout the season, the population of this pest increased in the starting up to end of season in cotton crop. Variation in the thrips's population in crop may be due to differences in the initial numbers of arrivals or due to differences of multiplication in the crop or different mortality rates. Adesiyun [33] had stated that insects often were succeed in attacking crops because of synchronization between their arrival period in the crop and the susceptible stage of the plant.

The regression analysis of thrips with predator, *Geocoris* spp., was determined. The correlation of thrips with predators was highly of positive ($r^2 = 0.48$) value (Fig: 09). This means with increase in thrips population, the population of predators also increased. The correlation between temperature and thrips, and thrips and R.H% was also of positive ($r^2 = 0.20$) and($r^2 = 0.54$) value (Fig: 10 &11), respectively.

The regression analysis of whitefly with predator, *Geocoris*

spp., was also determined. The correlation of whitefly with predators was highly with positive (r^2 = 0.66) value (Fig: 12). This means with increase in whitefly's population, the population of predators also increased. The correlation between temperature and whitefly, and whitefly and R.H% was also with positive (r^2 = 0.02) and (r^2 = 0.38) value (Fig: 13&14), respectively. Similarly, the positive correlations was between predator and temperature, and predator and R.H% with (r^2 = 0.24) and (r^2 = 0.20) value (Fig: 15 & 16), respectively .Which means when the temperature and R.H% increased, the population of predator *Geocoris* spp., also increased. Temperature and R.H% played very vital role in increasing the thrips, whitefly and *Geocoris* spp., populations. The present studies are in line with other findings, which had reported that whitefly and thrips population did not show significant effect with minimum temperature and relative humidity, whereas precipitation was negatively correlated with the whitefly and thrips populations [34, 35, 36].

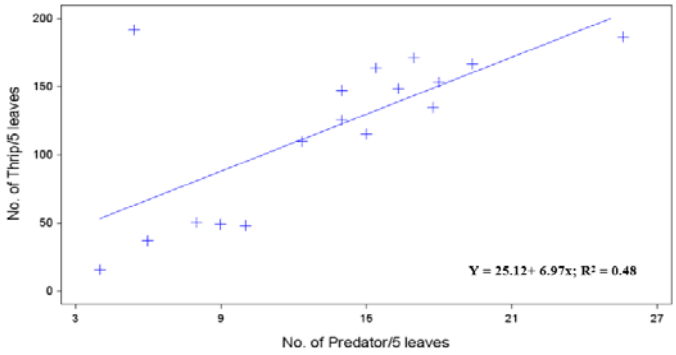

Fig. 09: Relationship between No. of Thrips and No. of Predator on Cotton

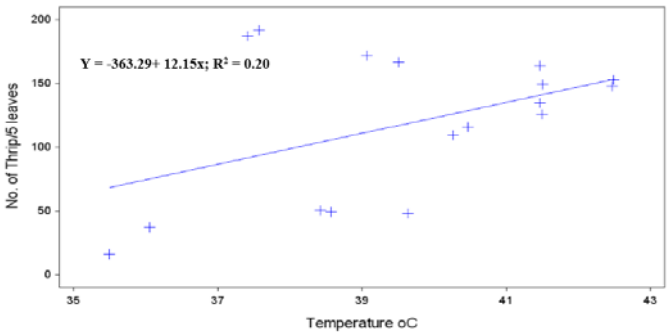

Fig. 10: Relationship between No. of Thrips and Field Temperature ^{o}C on Cotton

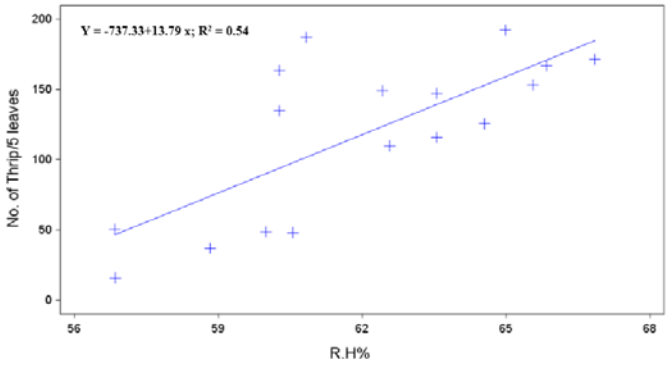

Fig. 11: Relationship between No. of Thrips and R.H% on Cotton

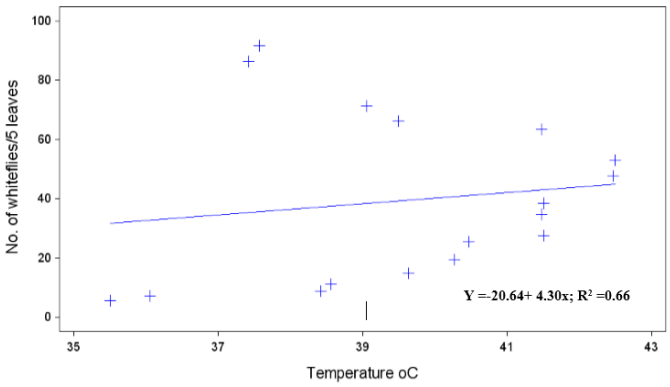

Fig. 12: Relationship between No. of Whiteflies and No. of Predator on Cotton

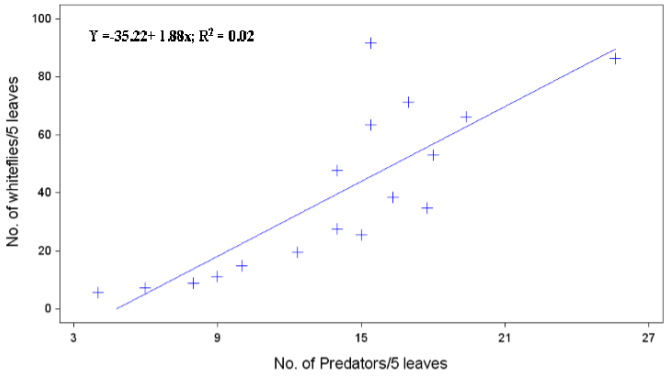

Fig. 13: Relationship between No. of Whiteflies and Field Temperature ^{o}C on Cotton

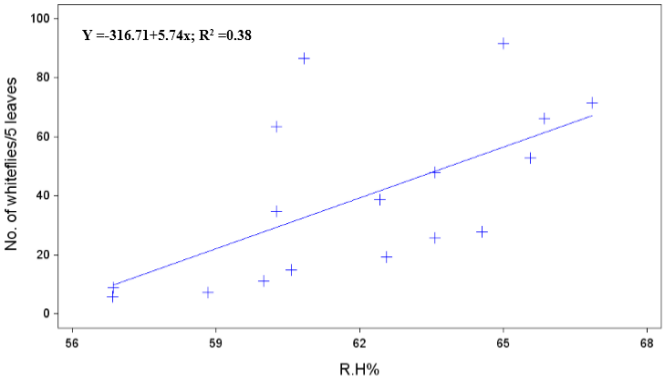

Fig. 14: Relationship between No. of Whiteflies and R.H% on Cotton

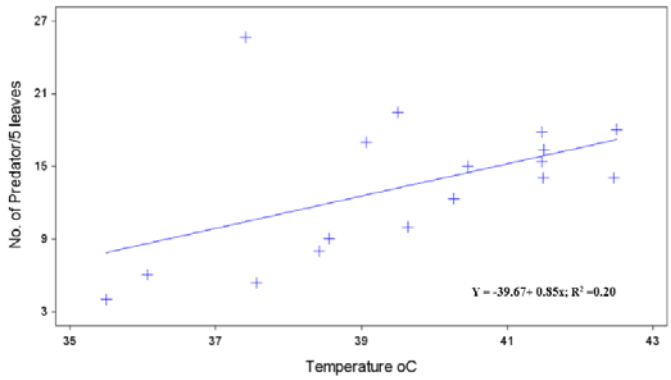

Fig. 15: Relationship between No. of Predator and Field Temperature ^{o}C on Cotton

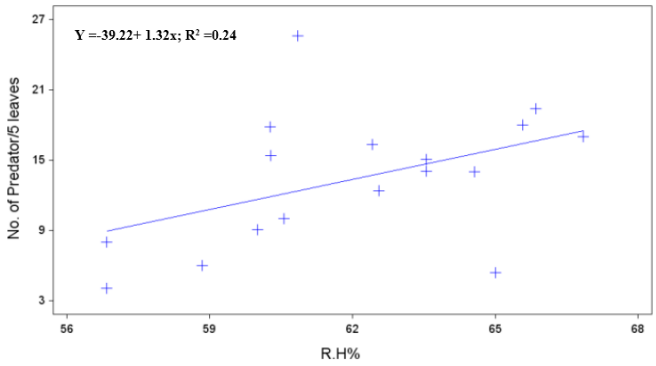

Fig. 16: Relationship between No. of Predator and R.H% on Cotton

4. Conclusion

The results of present research work revealed that the thrips, whitefly and their natural enemy population in cotton crop varied with different dates and phenology of plants. Use of pesticides for the control of insect pests creates many adverse effects including pesticide resistance, reduction in beneficial insect fauna, and environmental and human health hazards. Consequently, the insecticides spray in cotton field might be carried out keeping in view the population levels of harmful pests and natural enemies. As a result, eco-friendly methods such as insect resistant varieties including Bt cotton and the use of parasitoids or predators for pests control can receive further considerable research and field application emphasis. Implementation of suppression programs in cotton that reduces pesticide usage on insect pests such as sucking complexes will positively impact on resistance problem. The farmers can use beneficial insects directly in their crop without any dependency on costly insecticides, spray machinery, extra skills and fear of insecticide's over or under-dosages.

5. Acknowledgments

This research work was funded by the research project entitled "Development of Biocontrol Technology for Population Management of Whitefly and Thrips Pests" (Project no. 2010 ARS/Biocontrol Project) at the department of Entomology, Faculty of Crop Protection, Sindh Agriculture University, Tandojam, Sindh, Pakistan.

6. References

1. Khalid PA, Hussain M, Hassan M, Sarwar M, Sarwar N. Evaluation of Bt-cotton Genotypes for Resistance to Cotton Leaf Curl Disease under High Inoculum Pressure in the Field and Using Graft Inoculation in Glasshouse. The Plant Pathol. J. 2015; 31(2):132-139.
2. Ahmad N, Sarwar M. The Cotton Bollworms: Their Survey, Detection and Management through Pheromones: A Review. J. Agric. Allied Sci., 2013; 2(3):5-8.
3. Ozyigit II, Kahraman MV, Ercan O. Relation between explants age, total phenols and regeneration response in tissue cultured cotton (*Gossypium hirsutum* L.). Afric. J. Biotech. 2007; 6(1):003-008.
4. Sarwar M, Hamed M, Yousaf M, Hussain M Identification of Resistance to Insect Pests Infestations in Cotton (*Gossypium hirsutum* L.) Varieties Evaluated in the Field Experiment. J. Sci. Res. Environ. Sci., 2013; 1(11):317-323.
5. Hashmi RA. Insect Pest Management, cereal and cash crops. Pak. Agric. Res. Council, Islamabad, 1994, 317.
6. Lohar MK. Text Book of Applied Entomology. 2nd Ed. Pub. Kashif Publ. Hyderabad. 2001, 242.
7. Gahukar RT. Improving the conservation and effectiveness of arthropod parasitoids for cotton pest management. Outlook on Agric. 2006; 35(1):41-49.
8. Dhaka SR, Pareek BL. Seasonal incidence of natural enemies of key insect pests of cotton and their relationship with weather parameters. J. Plant Prot. Res. 2007; 47(4):418-419.
9. Filgueira FAR. Novo manual de olericultura. Viçosa: UFV, 2000, 402.
10. Modarres AM. List of agricultural pests and their natural enemies in Iran. Ferdowsi University Press. 2001, 429.
11. Sarwar M. Management of Spider Mite *Tetranychuscinnabarinus* (Boisduval) (Tetranychidae) Infestation in Cotton by Releasing the Predatory Mite *Neoseiulus pseudo longispinosus* (Xin, Liang and Ke) (Phytoseiidae). Bio. Cont., 2013; 65(1):37-42.
12. Sarwar M. Comparing abundance of predacious and phytophagous mites (Acarina) in conjunction with resistance identification between Bt and non-Bt cotton cultivars. Afr. Entomol., 2013; 21(1):108-118.
13. Solangi BK, Talpur MA, Nizamani IA. Population of Spotted Bollworm *Earias* spp. and Its Predators (Natural Enemies) on Cotton. J. App. Sci. 2005; 5(8):1402-1404.
14. Han Xu. Spiders in cotton fields of Hebei Province in early winter. Acta Arachnologica Sinica, 2004; 13(1):52-54.
15. Tillman PG, Mullinix BG. Effect of prey species on plant feeding behavior by the big-eyed bug, *Geocorispunctipes* (Say) (Heteroptera: Geocoridae), on cotton. Envi. Entomol. 2003; 32 (6):1399-1403.
16. Liu TX. Population dynamics of *Bemisia argentifolii* (Homoptera: Aleyrodidae) on spring collard and relationship to yield in the Lower Rio Grande Valley of Texas. J. Econ. Entomol. 2000; 93(3):750-756.
17. Fiedler Z, Sosnowska D. Coloured sticky traps for monitoring the pests of ornamental plants in the palm House in Poznan. Progress in Plant Protection. 2002; 42(2):424-426.
18. Gerling D, Horowitz AR, Baumgaertner J. Autecology of *Bemisia tabaci*. Agric. Eco. Environ., 1986; 17:5-19.
19. Elkassabany N, Ruberson JR, Kring TJ. Seasonal distribution and overwintering of *Orius insidiosus* (Say), in Arkansas. J. Entomol. Sci. 1996; 31(1):76-88.
20. Ge F, Ding-yang Q, Ge F, Ding YQ. The population energy dynamics of predacious natural enemies and their pest control activity in different cotton agroecosystem. Acta Entomol. Sinica, 1996; 39(3):266-273.
21. Soto A, Ohlenschlager F, Garcia-Mari F. Population dynamics and biological control of the whiteflies *Aleurothrixus floccosus*, *Dialeuro descitri* and *Parabemisia myricae* (Homoptera: Aleyrodidae) in citrus orchards of Valencia (Spain). Boletin de Sanidad Vegetal, Plagas, 2001; 27(1):3-20.
22. Kumawat RL, Pareek BL, Meena B.L. Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. Annals of Biol., 2000; 16(2):167-169.
23. Horowitz AR, Podoler H, Gerling D. Life Table Analysis of the Tobaco Whitefly *Bemisia tabaci* (Gennadius) in Cotton Fields in Israel. Acta Ecologia Applicata, 1984; 5:221-233.
24. Lorini I, Dezordi J. Flutuaçaopopulacional de *Thrips tabaci* Lindeman, 1888 (Thysanoptera: Thipidae) nacultura da cebola. Anais da Sociedade Entomologica do Brasil, 1990; 19:361-365.
25. Horowitz AR, Forer G, Ishaaya I. Managing resistance in *Bemisia tabaci* in Israel with emphasis on cotton.

Pesticide Sci., 1994; 42:113-122.
26. Gonçalves PAS. Flutuaçãopopulacional de tripes, *Thrips tabaci* Lind., emcebolaemItuporanga, Santa Catarina. Anais da SociedadeEntomológica do Brasil, 1997; 26:365-369.
27. Leite GLD, Picanço M, Zanuncio JC, Moreira MD, Pereira PR. Fatores que influenciam o ataque de moscabrancaemjiloeiro. Pesquisa Agropecuaria Brasileira, 2002; 37:1033-1037.
28. Hussain T, Iqbal M, Ullah F, Anwar M. Population trends, varietal preference and chemical control of garlic Thrips (*Thrips tabaci* L.). Sarhad J. Agric. 1997; 13:175-180.
29. Vennila S, Biradar VK, Sabesh M, Bambawale OM. Know your cotton insect pest whiteflies. Crop Prot. 2007; Folder series: 4.
30. Domiciano NL, Ota AY, Jedardi CR. Population fluctuation of onion Thrips on onion Anasia-da-sociedade Ent. Brazil, 1993; 22:77-83.
31. Anitha KR, Nandihalli BS. Seasonal incidence of sucking pests in okra ecosystem. Karnataka J. Agric. Sci. 2008; 21:137-138.
32. Walker AK. A review of the pest status and natural enemies of *Thrips palmi*. Bio. News and Inform., 1994; 15:7-10.
33. Horowitz AR. Population dynamics of *Bemisia tabaci* (Gennadius): with special emphasis on cotton fields. Agric., Eco. Environ., 1986; 17:37-47.
34. Minfal. Agriculture Statistics of Pakistan; Cash crops. Govt. of Pakistan, Ministry of Food, Agric. & Livest. (Econ. Wing), Islamabad. 2008, 29-30.
35. Patel KI, Patel JR, Jayani D, Shekh AM, Patel NC. Effect of seasonal weather on incidence and development of major pests of okra (*Abelmoschus esculentus*). Indian J. Agric. Sci. 1997; 67:181-183.
36. Sarwar M, Sattar M. An Analysis of Comparative Efficacies of Various Insecticides on the Densities of Important Insect Pests and the Natural Enemies of Cotton, *Gossypium hirsutum* L. Pak. J. Zool., 2016; 48(1):131-136.