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Survey on population fluctuations of thrips, whitefly and their natural Enemies on sunflower in different localities of Sindh, Pakistan

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Abstract
Present studies were carried out on occurrence and abundance of thrips *Thrips tabaci*, whitefly *Bemisia tabaci* and their predator, *Geocoris* spp., on sunflower, *Helianthus annuus* L., at vegetable fields of Tandojam and Sultanaabad in Sindh. Population of thrips, whitefly and *Geocoris* spp., were recorded from January 15, 2010 upto April 16, 2011. Results showed that at Tandojam, maximum thrip's population was observed at the end of March till mid of April, whitefly's population was found to be low in 2nd week of January and maximum in 2nd week of April and predator, *Geocoris* was found low initially while higher till the end of observation period. In Sultanabad, thrip's population was minimum in 1st week of January, and the highest recorded in 3rd week of April. Whitefly was recorded minimum in 1st week of January and the highest in 3rd week of April, while predator, *Geocoris* was initially found very low during 1st week of January, but increased in 2nd and 3rd week of April. The temperature and humidity varied during different dates and significantly affected the abundance of insect population.

Keywords: Incidence, abundance, thrips, whitefly, *Geocoris*, sunflower.

1. Introduction
Sunflower (*Helianthus annuus* L.), belongs to the member of the family Asteraceae (Compositae), and it is known as Surajmukhi locally. It is one of the important oilseed crops in the world which ranks third in area after soybean and groundnut. It is one of the four major important oilseed crops (soybean, peanut, rapeseed and sunflower) globally. It is grown on over 23.31 million hectares worldwide, with a production of 29.90 million tones [1, 2]. As an oil seed crop, sunflower has been introduced in Pakistan during 1960 with the object of bridging the gap between production and consumption of edible oil in the country [3].
In Pakistan, sunflower is planted on about 0.363 million hectares in the four provinces. It is grown twice a year (spring and autumn) in Sindh, Pakistan [4]. Sunflower seeds contain 40% oil content of high quality with low cholesterol contained fat and soluble vitamins A, B, E and K. It is quiet good for health of heart patients, as reported by Evertt *et al.*, [5], and Goasal *et al.*, [6]. Low yield of sunflower may be attributed to several reasons such as occasional adverse climatic conditions, poor agronomic methods of cultivation, non-availability of improved seed, prevalence of diseases and damage caused by pests. Insect pests of sunflower are broadly classified as seedling pests, sucking pests, soil insects, defoliators and inflorescence pests [7]. Sucking pests like leafhoppers, thrips and whiteflies contribute to a considerable extent for losses to the crop. Leafhopper alone can cause damage upto 46 percent to this crop. Whiteflies under favorable conditions also pose severe threat to the crop. Several species of thrips are associated with the crop, which cause direct damage to plant; however, these also cause enormous losses indirectly as vector of viral diseases, especially in the transmission of sunflower necrosis virus [8]. Whiteflies and thrips are piercing-sucking insects that cause major damage to this crop. These insects transfer viral diseases from the infected to uninfected plants and are associated with serious losses in the yield. Early detection of these damaging insects is very important because symptoms of feeding often go unnoticed until serious damage is done [9-14]. Thus, population monitoring is useful to detect insect problems in crops and to determine whether control measures have been effective or not [15].

The big-eyed bug, *Geocoris punctipes* (Say), is a common and the generalist predator of numerous pest species that feed upon ornamental plants including whiteflies, aphids and spider mites [16]. Several aspects of the biology of *G. punctipes* suggest that they are potential antidotes for use in biological pest control programs. These include 1) wide prey range, 2) long life span, 3) facultative omnivore, and 4) all life stages are predaceous. The wide prey range of *Geocoris* spp., includes many common pests of both agricultural and ornamental crops, while sunflower seeds when are added to an artificial diet increase survival of *Geocoris* spp [17].

2. Materials and Methods

The field studies were carried out on occurrence and abundance of thrips and whitefly pests on sunflower, *Helianthus annuus* L., which is economically an important crop grown at vegetable fields of Agriculture Research Institute (ARI), Tandojam and Sultanaabad. For conducting survey on occurrence and abundance of thrips and whitefly pests, and their natural enemies from the fields of Tandojam and Sultanaabad, observations were conducted on sunflower, *Helianthus annuus* L., crop during whole growing season. The experiment was conducted in randomized completely block design replicated four times.

The surveys on the population fluctuations of thrips, whitefly and their natural enemies were carried out at weekly intervals. Twenty five plants were randomly selected from each locality of sunflower crop, five leaves were selected, two from bottom portion, while, two from middle and one from top of plant, and the pest population were counted with the help of magnifying glass. The plants were carefully handled to avoid disturbing of the pests and their natural enemies on the crop. Time of field observations was between 8 and10 am. The metrological data were also taken to note the effects of temperature and humidity on the thrips and their natural enemy populations invading sunflower. The data were statistically converted to mean values of all replicates before analyzing. Then data obtained were statistically analyzed by analysis of variance and means were compared using DMR test by computer program Statistix 8.1. The coefficient of correlation between various parameters was also determined [18].

3. Results and Discussion

The results on observations of sunflower, *H. annuus* taken at weekly interval for per leaf populations of thrips and whitefly, and their predator, *Geocoris* spp., are presented in Table1. These data showed thrips and whitefly, and their predator *Geocoris* spp., populations on sunflower at Tandojam. The data showed that thrips and whitefly, and their predator *Geocoris* spp., populations varied from 15-01-2010 to 16-04-2011 at study site. The thrip's population appeared throughout the season and increased at the end of March till 16-04-2011. Initially, the thrip's population was very low (7.92+0.70) in 2nd week of January, the population increased and highest was recorded (90.46+0.96), in the 2nd week of April. Reitz [19] gave the findings that the thrips were much more abundant in the spring than in autumn. Similarly, during the present observations, initially the whitefly's population was very low (1.15+0.10) in 2nd week of January, thereafter population increased and the population was recorded the highest (17.77+0.78), in the 2nd week of April. Our result was much closed to [20, 21], they reported that the number of whiteflies were the highest in spring (April, May) and in autumn (October). Sarwar [22, 23] had stated that the abundance and population dynamics of whiteflies were varied depending on species of whiteflies, area and crops attacked. The predator, *Geocoris* spp., was recorded during the days of observations from 22-12-2010 to 22- 03-2011. Initially, the very low population of predator was recorded (1.00+0.50), but its density increased during the 3rd week of March and peak numbers were noted (12.45+0.95) per plant. Population again decreased till the end of March 2011.

The *Geocoris* spp., was a frequent predator of whitefly, *B. tabaci* and other pests including species of thrips. Gonzalez *et al.*, [24] had reported that these pests were primary foods for both *G. punctipes* and the minute pirate bug, *Orius tristicolor*. Adult big-eyed bugs were tested positive for whitefly and whitefly egg antigen using the ELISA method [25, 26], and these workers reported that whitefly, spider mites, and thrips are all common greenhouse pests as well. Crocker and Whitcomb [27] both have given the findings that the predator *Geocoris* spp., had been observed feeding on dozens of different prey species, and they are important predators of aphids and whiteflies in various field crops. The temperature and humidity varied during different dates and time and remained maximum in the month of March and April, respectively, and minimum in the month of January. The study on natural enemies (spiders) and aboitic factors in sunflower and on different crops are in much correlated with other workers [28-34]. Nahiyoon *et al*., [35] had found that sucking insect complex, and natural enemies correlated with abiotic factors on different aspects of the different studies.

Table 1: Population of Thrips and Whitefly, and Predator *Geocoris* spp., in Sunflower at Tandojam from Jan 2011 to Apr 2011(Mean +S.E)

Date of observation	No. of Plant Observed	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature. ºC	R.H%
15-1-2010	25	7.92+0.70	1.15+0.10	1.00+0.50	18.07	56.85
22-1-2010	25	10.38+0.81	2.31+0.38	1.33+0.29	19.42	56.85
29-1-2010	25	12.54+0.89	4.15+0.51	3.33+0.29	20.57	60.00
5-2-2010	25	18.15+0.07	4.69+0.54	6.00+0.50	21.64	61.57
12-2-2010	25	28.23+0.33	6.85+0.65	7.50+0.31	22.27	62.57
19-2-2011	25	31.38+0.40	7.77+0.86	7.00+0.00	23.47	63.57
26-2-2011	25	36.77+0.52	8.15+0.71	9.00+0.25	24.50	65.57
5-3-2011	25	43.54+0.65	9.00+0.75	10.00+0.70	27.48	65.28
12-3-2011	25	56.08+0.88	9.92+0.75	11.00+0.25	28.72	64.42
19-3-2011	25	73.08+0.14	10.92+0.83	10.00+0.75	29.07	61.00
26-3-2011	25	73.85+0.15	10.31+0.80	12.45+0.95	30.35	64.27
2-4-2011	25	78.54+0.81	12.62+0.89	11.33+0.49	30.71	65.57
9-4-2011	25	89.23+0.92	14.69+0.74	11.33+0.29	31.51	60.00
16-4-2011	25	90.46+0.96	17.77+0.78	12.33+0.69	32.55	60.00

The regression analysis of thrips and predator *Geocoris* spp., was determined in sunflower in the present studies. The correlation of thrips and predators was found to be highly positive and significant (F=47.23; DF=1, 12; P=0.0000) (Fig: 1), which means with the increase in thrip's population, the population of predator also increased. The correlation between temperature and thrip's population was also highly positive and significant (F=289.66; DF=1, 12; P=0.0000) (Fig: 2).The correlation between thrips and R.H% was poorly positive and not significant (F=1.47; DF=1, 12; P=0.2489) (Fig: 3).This means with the temperature and relative humidity increases, the population of thrips was also increased. Regression analysis of whitefly and predator *Geocoris* spp., was also determined in sunflower. Sarwar *et al.*, [36], have reported a positive correlation of thrip's population with maximum temperature and negative correlation with minimum temperature, relative humidity (morning and evening) and rainfall**.** It has also been reported that maximum and minimum air temperature appreciated whitefly's population build-up, while, high relative humidity discouraged pest's build-up. The correlation of whiteflies and predators was highly positive and significant (F=54.44; DF=1, 12; P=0.000) (Fig: 4), which means with the increase in whitefly's population, the population of predator also increased.

The correlation between temperature and whitefly's population was also highly positive and significant (F=126.58; DF=1, 12; P=0.0000) (Fig: 5).The correlation between whitefly and R.H% was poorly positive and significant (F=1.93; DF=1, 12; P=0.1902) (Fig: 6).Which means as the temperature and relative humidity increased, the population of whitefly was also increased. Kumawat *et al*., [37] had reported that the temperature was significantly correlated with whitefly densities**.** Similarly, there was highly positive and significant correlation between predator and temperature (F=101.29; DF=1, 12; P=0.0000) (Fig: 7), and correlation between predators and R.H% was also highly positive and significant (F=9.82; DF=1, 12; P=0.0086) (Fig: 8).This means with the increase in temperature and relative humidity, the population of *Geocoris* spp., also increased. The results showed that when thrips population increased on sunflower, their predator was also increased, and the temperature and R.H% played an important role in increasing thrips and their predator *Geocoris* spp., populations.

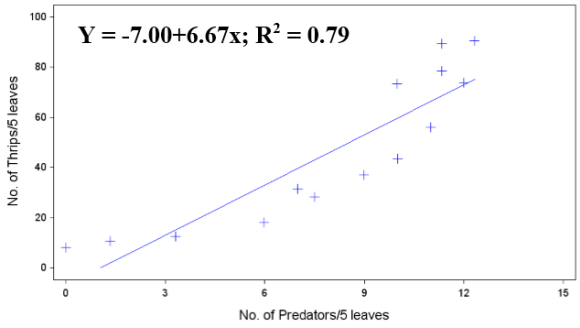

Fig 1: Relationship between No. of Thrips and No. of Predators on Sunflower

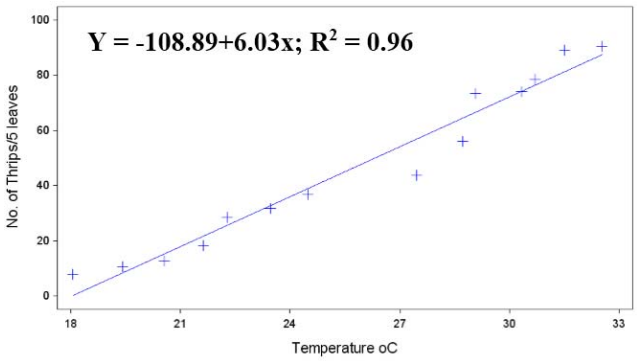

Fig 2: Relationship between No. of Thrips and Field Temperature °C on Sunflower

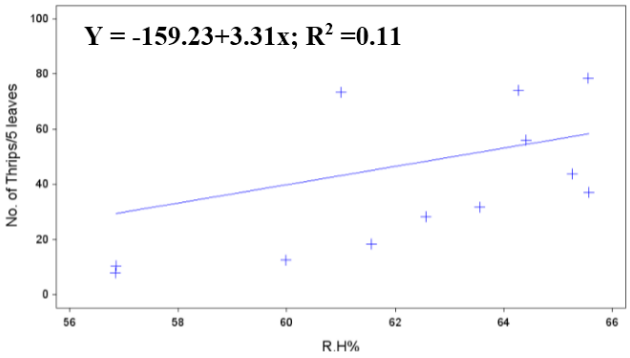

Fig 3: Relationship between No. of Thrips and R.H% on Sunflower

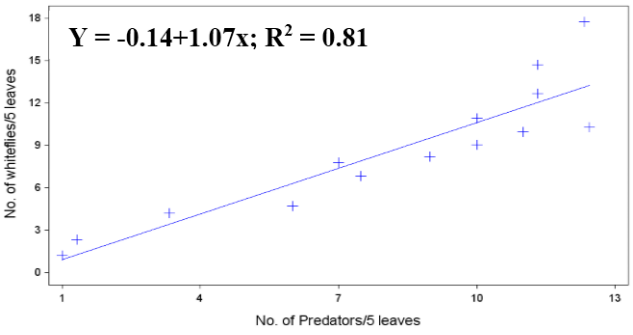

Fig 4: Relationship between No. of whitefly and No. of Predators on Sunflower

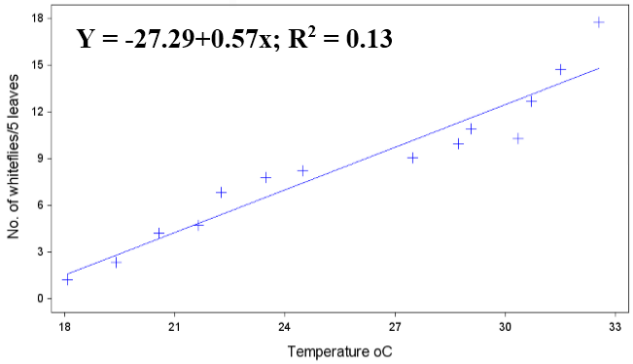

Fig 5: Relationship between No. of whitefly and Field Temperature °C on Sunflower

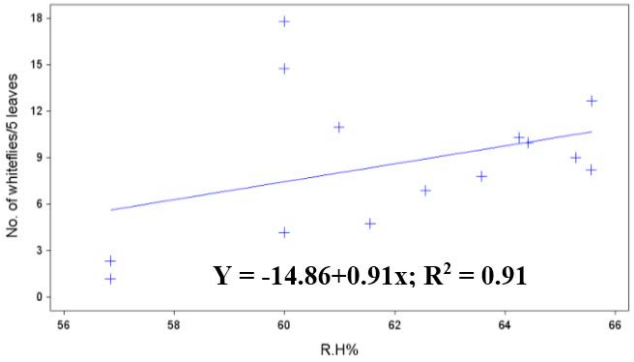

Fig 6: Relationship between No. of whitefly and R.H% on Sunflower

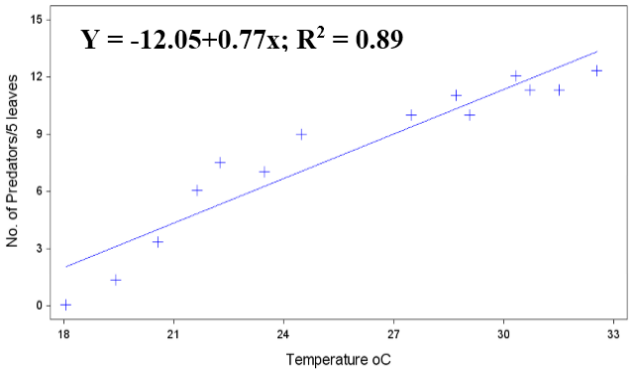

Fig 7: Relationship between No. of Predators and Field Temperature ^{o}C on Sunflower

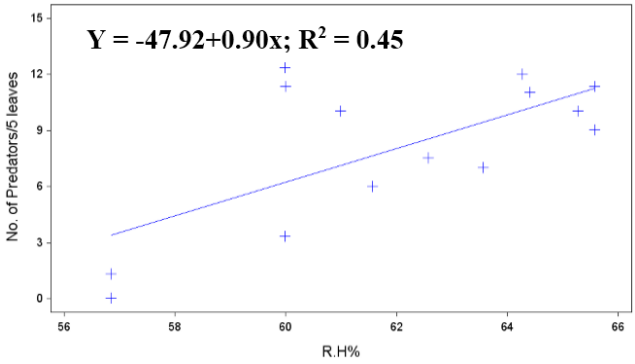

Fig 8: Relationship between No. of Predators and R.H% on Sunflower

Initially the thrips and whitefly populations were very low at Sultanabad, but afterward both these densities increased gradually. Similarly, the predator's population also increased in the month of March (Table 2). Papadaki *et al.*, [38], had reported that thrips is considered one of the most harmful insect pests of vegetable crops in greenhouses. The thrip's population was minimum (1.28+0.28) in 1st week of January, thereafter population increased and highest population was recorded (85.68+0.99), in the 3rd week of April. The whitefly population was minimum (1.69+0.33) in 1st week of January, then population increased and highest population was recorded (25.92+0.66), in the 3rd week of April. The predator, *Geocoris* spp., initially was very low in number (1.00+0.20) in 1st week of January, but numbers increased in the 2nd and 3rdweek of April (12.45+0.95)/plant. The temperature and humidity varied during different dates and time and remained maximum in the month of April and minimum in the month of January. Similar results were reported earlier that significant differences in the population of insects collected on sunflower were found, where the early-planted crops gave the highest population numbers of insect, while on the final date of observation found the least number of pests [39-41]. All these workers have studied that *Geocoris* spp, has been successfully used as biological control agent for whitefly, for instance in cucumbers, Amri, strawberries, sunflower and gerbera.

Table 2: Population of Thrips and Predator *Geocoris* spp., in Sunflower at Sultanaabad, Mirpurkhas from Jan 2011 to Apr 2011(Mean+S.E)

Date of observation	No. of Plant Observed	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature ^{o}C	R.H%
3-1-2011	25	1.28+0.28	1.69+0.33	1.00+0.20	19.07	55.85
10-1-2011	25	4.26+0.38	2.54+0.40	3.00+0.25	19.42	55.85
17-1-2011	25	6.83+0.42	3.62+0.48	5.00+0.35	20.57	56.00
24-1-2011	25	9.32+0.63	5.46+0.68	4.50+0.31	21.64	56.57
1-2-2011	25	15.00+0.61	6.00+0.61	7.72+0.33	22.27	58.57
8-2-2011	25	19.33+0.63	7.08+0.67	5.00+0.25	23.47	58.77
15-2-2011	25	20.15+0.62	9.15+0.62	7.60+0.32	24.50	59.57
22-2-2011	25	23.85+0.82	10.85+0.82	8.67+0.33	25.48	60.28
1-3-2011	25	32.00+0.87	12.00+0.87	9.00+0.50	28.72	60.42
8-3-2011	25	35.31+0.98	16.54+0.82	10.60+0.32	29.07	61.00
15-3-2011	25	47.00+1.03	17.07+0.55	10.00+0.25	30.35	61.27
22-3-2011	25	56.23+1.01	17.46+0.44	10.72+0.33	30.81	62.57
29-3-2011	25	68.00+1.06	18.00+1.06	11.75+0.43	31.51	62.00
5-4-2011	25	74.46+0.95	19.00+0.89	11.00+0.40	32.55	62.550
12-4-2011	25	78.31+1.07	20.31+1.37	12.00+0.25	33.07	63.85
19-4-2011	25	85.68+0.99	25.92+0.66	10.50+0.32	33.42	64.85

The regression analysis of thrips and predator *Geocoris* spp., was determined in sunflower. The correlation of thrips and predators was highly positive and significant (F=39.86; DF=1, 12; P=0.0000) (Fig: 9), which means with the increase in thrip's population, the population of predator also increased. The correlation between temperature and thrips population was also highly positive and significant (F=161.19; DF=1, 12; P=0.0000) (Fig: 10).The correlation between thrips and R.H% was highly positive and significant (F=124.43; DF=1, 12; P=0.0000) (Fig: 11). Which means when the temperature and relative humidity increased the population of thrips was also increased. Kirk [42] had reported that with increase in temperature there was increase in thrips activity, development and population growth wherein plant hosts started to offer attraction to thrips pest. The regression analysis of whitefly and predator *Geocoris* spp, was determined in sunflower as well. The correlation of whitefly and predator was found to be highly positive and of significant value (F=61.29; DF=1,1 2; P=0.0000) (Fig: 12), which means with the increase inwhitefly' spopulation, the population of predator was also increased. Osekre *et al*., [43] had reported that the insidious flower bug, *Orius insidiosus* (Say), can effectively suppress *Frankliniella* species or thrips populations. Population fluctuations of the predator and thrips on the leaves, squares and flowers were tracked on plots and weekly predator-to-prey ratios were used to assess the effectiveness of the predator in regulating the thrip's populations. The correlation between temperature and whitefly population was also highly positive and significant (F=321.83; DF=1, 12; P=0.0000) (Fig: 13).The correlation between whitefly and R.H% was highly positive (F=270.42; DF=1, 12; P=0.0000) (Fig: 14), which means with the temperature and relative humidity increases the population of whitefly also increased. Similarly, there was highly positive and significant correlation between predator and temperature (F=97.13; DF=1, 12; P=0.000) (Fig: 15), and correlation between predators and R.H% was also highly positive and significant (F=77.09; DF=1, 12; P=0.000) (Fig: 16), which means when the temperature and relative humidity increased the population of *Geocoris* spp., was also increased. The results showed that when thrips increased on sunflower and their predator *Geocoris* spp., also increased, and temperature and R.H% played an important role in increasing thrips and whitefly, and their predator populations [44].

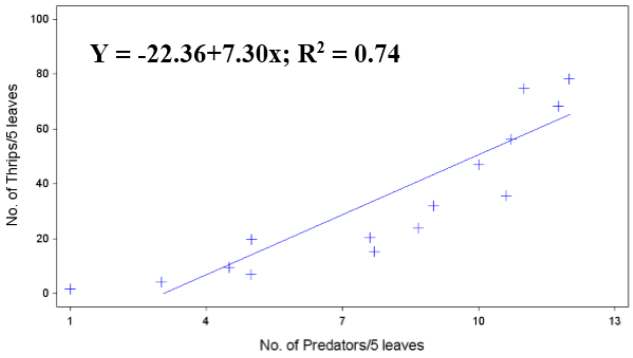

Fig 9: Relationship between No. of Thrips and No. of Predators on Sunflower

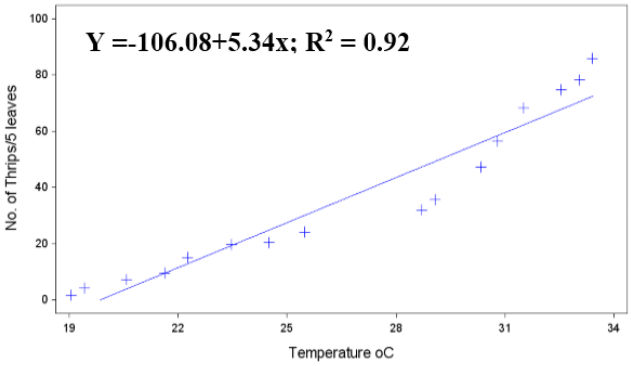

Fig 10: Relationship between No. of Thrips and Field Temperature °C on Sunflower

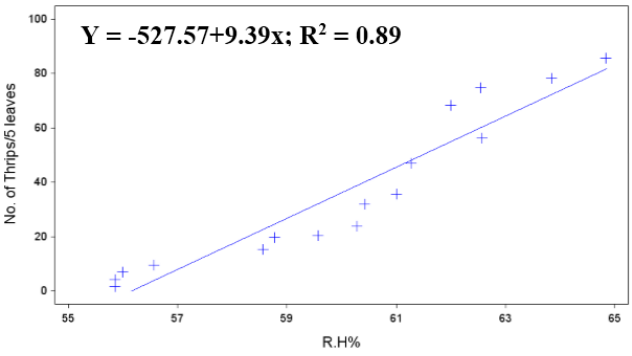

Fig 11: Relationship between No. of Thrips and R.H% on Sunflower

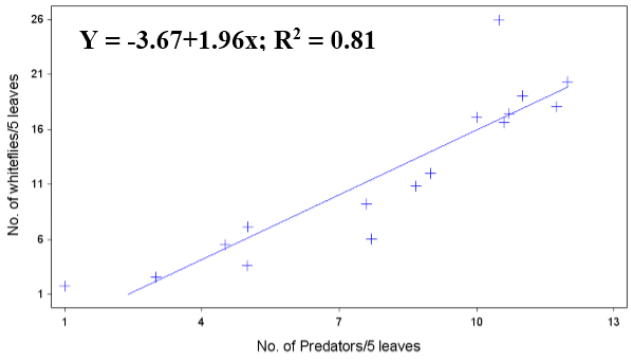

Fig 12: Relationship between No. of whitefly and No. of Predators on Sunflower

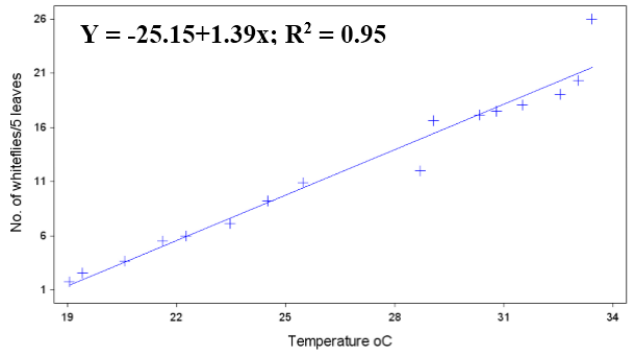

Fig 13: Relationship between No. of whitefly and Field Temperature °C on Sunflower

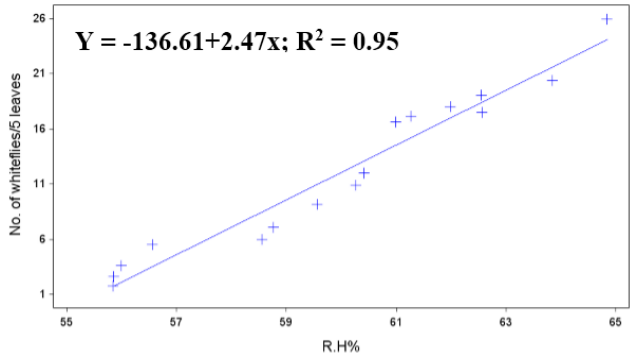

Fig 14: Relationship between No. of whitefly and R.H% on Sunflower

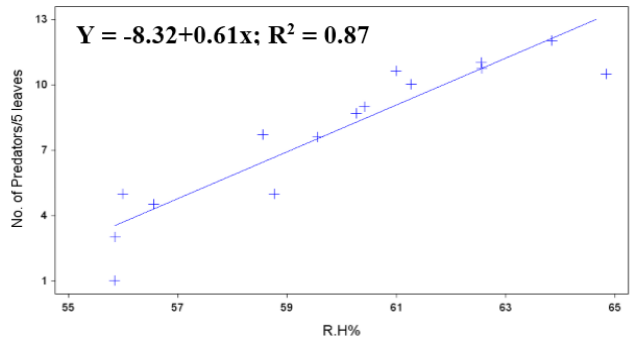

Fig 15: Relationship between No. of Predators and Field Temperature ºC on Sunflower

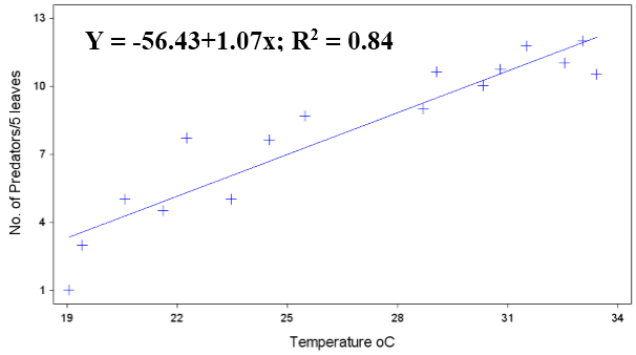

Fig 16: Relationship between No. of Predators and R.H% on Sunflower

4. Conclusion

The results on present surveys revealed the highest thrip's population was recorded as (90.46+0.96), in the 2nd week of April and population was very low (7.92+0.70) in 2nd week of January. On the other hand the *Geocoris* spp., population was increased in the 3rd week of March (12.45+0.95)/ plant. Whitefly population was very low (1.15+0.10) in 2nd week of January, while the highest population was recorded (17.77+0.78), in the 2nd week of April. The overall conclusion is that when pest populations increased on sunflower, their predator's density also increased, and temperature and R.H% played an important role in increasing thrips and whiteflies, and their predator's *Geocoris* spp., population. Future work should focus on correlation of natural enemies with the insect pests and effect of environmental conditions of the population abundance of pests and their natural enemies. However, near the sunflower crop, maize crop should be planted because *Geocoriss* spp., are highly attracted to maize crop. As maize crop is the most favorite host plant of *Geocoriss* spp., so naturally there can be more population of predators on the neighboring sunflower plants than other crops.

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6. References

1. Shirshikar SP. Mildew disease in India. Helia. 2005; 28:153-158.
2. Skoric D, Jocic S, Lecic N, Sakac Z. Development of sunflower hybrids with different oil quality. Helia. 2007; 30:205-212.
3. Burney K, Ahmad I, Aslam M. Charcoal rot and important disease of sunflower and its control. Progressive Farming, 1990; 10:34-36.
4. Pakistan Agriculture Research Council (PARC). Sunflower cultivation in Pakistan, Pakistan Agriculture Research Council Islamabad. 2007, 1-6.
5. Evertt NP, Rao KE, Mascarenhas D. Genetic engineering of sunflower (*Helianthus annuus.* L.). Biotech. 1987; 5(1):1201-1204.
6. Goasal SS, Vasilijevic L, Brar DS. Biotechnology and sunflower improvement. Proceedings of 12th International Sunflower Conference, Novi Sad, Yugoslavia, 25-29 July, 1988. 1988; 599.
7. Basappa H, Santha LPM. Insect pests and diseases of sunflower and their management (Ed. Hegde, D.M.). Directorate of Oilseeds Research, Hyderabad, 2005, 80.
8. Chander RS. First Report of Tobacco Streak virus Infecting Safflower (*Carthamus tinctorius*) in Maharashtra, India. Plant Disease, 2002; 87:1396.
9. Parker BL, Skinner M, Lewis T. Thrips Biology and management: Proceedings of the 1993 International Conference on Thysanoptera. NATO Asi. Series A, Life Sciences, Vol. 276. Plenum Pub. Crop., New York. 1995, 636.
10. Daughtrey ML, Jones RK, Moyer JW, Daub ME, Baker JR. Tospoviruses strike the greenhouse industry: INSV has become a major pathogen on flower crops. Plant Disease, 1997; 81(11):1220-1230.
11. Gupta MP, Sandeep S, Shrivastava SK. Population build-up of some sap sucking insects on cotton in Madhya Pradesh. J. Insect Sci., 1997; 10(2):153-156.
12. Labonne G, Quito JB, Lauriaut F. Searching for leafhopper vectors of phytoplasmas: the choice of trapping methods. Acta Horticulture, 1998; 472:655-663.
13. 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. Econom. Entomol., 2000; 93(3):750-756.
14. Fueutes S, Salazar LF. First report of Sweet potato leaf curl virus in Peru. Plant Disease, 2003; 87(1):98.
15. Milligan RH, Osborne GO, Ytsma G. Evidence for an aggregation pheromone in *Platypus gracilis* Broun (Col., Platypodidae). J. Appl. Entomol., 1988; 106(1):20-24.
16. Cohen AC. Using a systematic approach to develop artificial diets for predators. In: T. E. A. L. Anderson (ed.), Advances in Insect Rearing for Research and Pest Management. Boulder, CO, Westview Press. 1992, 77-91.

17. Eubanks MD, Denno RF. Health food versus fast food: The effects of prey quality and mobility on prey selection by a generalist predator and indirect interaction among prey species. Ecol. Entomol. 2000; 25:140-146.
18. Steel RGD, Torrie JH, Dickey DA. Principles and Procedures of Statistics, A biometrical approach 3rd Ed. MeGram Hill Inc; New York. 1997.
19. Reitz SR. Seasonal and within plant distribution of *Frankliniella* thrips (Thysanoptera: Thripidae) in North Florida tomatoes. Florida Entomol., 2002; 85(3):431-439.
20. 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 Patho. J., 2015; 31(2):132-139.
21. Sarwar M. Studies on Incidence of Insect Pests (Aphids) and Their Natural Enemies in Canola *Brassica napus* L. (Brassicaceae) Crop Ecosystem. Int. J. Sci. Res. Environ. Sci., 2013; 1(5):78-84.
22. Sarwar M. Management of Spider Mite *Tetranychus cinnabarinus* (Boisduval) (Tetranychidae) Infestation in Cotton by Releasing the Predatory Mite *Neoseiulus pseudo longispinosus* (Xin, Liang and Ke) (Phytoseiidae). Bio. Control, 2013; 65(1):37-42.
23. 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.
24. Gonzalez DB, Patterson R, Leigh TF, Wilson LT. Mites: A primary food source for two predators in San Joaquin Valley cotton. California Agric. 1982; 36:18-20.
25. Hagler JR, Naranjo SE. Determining the frequency of heteropteran predation on sweet potato whitefly and pink bollworm using multiple ELISAs. Entomol. Exper. et. Appl. 1994; 72:63-70.
26. Wilson LT, Trichillo PJ, Gonzalez D. Natural enemies of spider mites (Acari: Tetranychidae) on cotton: Density regulation or causal association? Environ. Entomol., 1991; 20:849-856.
27. Crocker RL, Whitcomb WH. Feeding niches of the big-eyed bug. Environ. Entomol., 1980; 9:508-513.
28. Basappa H. Population of predators associated with leafhopper in sunflower. J. Bio. Cont. 2007; 21(2):85-87.
29. Lanjar AG, Sahito HA. Studies on varietal resistance of sunflower crop against *Bemesia tabaci* (Genn.) and *Amrasca devastans* (Dist.). Pak. J. Entomol., 2010; 25(2):147-151.
30. Sahito HA, Lanjar AG, Mal B. Studies on population dynamics of sucking insect pests of mustard crop (*Brassica campestris*). Pak. J. Agri., Agri. Engg., Vet. Sci. 2010; 26(1):66-74.
31. Sahito HA, Nahiyoon AA, Mahmood R. Occurrence of whitefly, *Bemisia tabaci* (Genn) on okra and its correlation with abiotic factors at Mirpur Khas, Sindh. National Symposium on Biodiversity of Pakistan. June 7-9-2011. Islamabad. Pak. Mus. of Nat. Hist., Islamabad. 2011, 35.
32. Sahito HA, Abro GH, Memon SA, Mal B, Mahmood R. Influence of abiotic factors on population development of Bemisia tabaci infesting Abelmoschus esculentus. Int. Res. J. Plant Sci. 2012; 3(2):12-18.
33. Sahito HA, Abro GH, Syed TS, Lanjar AG, Khajjak AS. Screening of pesticides against cotton mealybug, *Phenacoccus solenopsis* Tinsley and its natural enemies on cotton crop. Int. Res. J. Bioch.Bioinfo. 2011; 1(9):232-236.
34. Sahito HA, Haq I, Sulehria MAG, Nahiyoon AA, Mahmood R. Preliminary studies on egg parasitoids of cotton Jassid *Amrasca biguttula biguttula* (Ishida). Proceeding in 5th meeting Asian cotton research and development network, Lahore, Pakistan. 2011, 23-25.
35. Nahiyoon AA, Sahito HA, Mahmood R, Sulehria MAG, Samad A. Population dynamic of mealybug, *Phenacoccus solenopsis* (Tinsley) and field parasitism percentage of *Aenasius bambawalei* (Hayat) at District Mirpurkhas, Sindh. National Symposium on Biodiversity of Pakistan. June, 9-2011, Islamabad. Pak. Museum of Natural History, Islamabad. 2011, 59.
36. Sarwar M, Hamed M, YousafM, Hussain M. Identification of Resistance to Insect Pests Infestations in Cotton (*Gossypium hirsutum* L.) Varieties Evaluated in the Field Experiment. Int. J. Sci. Res. Environ. Sci., 2013; 1(11):317-323.
37. Kumawat RL, Pareek BL, Meena BL. Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. Annals of Biology, 2000; 16(2):167-169.
38. Papadaki M, HarizanovaV, Bournazakis A. Influence of host plant on the population density of *frankliniella occidentalis* pergande (Thysanoptera: Thripidae) on different vegetable cultures in greenhouses.Bulgarian J. Agric. Sci., 2008; 14(5):454-459.
39. Michelakis SE, Amri A. Integrated control of *Frankliniella occidentalis* in crete-greece. Bull. OILB-SROP, 1997; 20:169-176.
40. Sanchez JA, Garcia F, Lacasa A, Gutierrez L, Oncina M, Contreras J, Gomez YJ. Response of the anthocorids *Orius laevigatus* and *Orius albidipennis* and the phytoseiid *Amblyseius cucumeris* for the control of *Frankliniella occidentalis* in commercial crops of sweet peppers in plastic houses in Murcia (Spain). Bull. OILB-SROP, 1997; 20:177-185.
41. Funderburk J, Stavisky, Olson S. Predation of *Frankliniellao ccidentalis* (Thysanoptera: Thripidae) in field pepper by *Orius insidiosus* (Hemiptera: Anthocoridae). Environ. Entomol. 2000; 29:376-382.
42. Kirk WDJ. Distribution, abundance and population dynamics. In: T. Lewis (ed.) Thrips as crop pests. CAB, Oxon, United Kingdom. 1997, 217-257.
43. Osekre AE, Wright DL, MaroisJJ, Mailhot JD. Predator-Prey Interactions between *Orius insidious* (Heteroptera: Anthocoridae) and *Frankliniella tritici* (Thysanoptera: Thripidae) in Cotton Blooms. J. Cotton Sci., 2008; 12:195-201.
44. Sarwar M. The propensity of different larval stages of lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) to control aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) evaluated on Canola *Brassica napus* L. Songklanakarin J. Sci. Tech., 2014; 36(2):143-148.