Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(1): 07-16

Received: 03-11-2015
Accepted: 06-12-2015

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Population dynamics of thrips, whiteflies and their natural enemies on mustard (*Brassica campestris* L.) Crop in different localities of Sindh, Pakistan

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Abstract
Present studies were conducted on population dynamics of sucking insect pests; thrips, *Thrips tabaci* and whitefly *Bemesia tabaci*, and their predator, *Geocoris* spp., on Mustard crop *Brassica compestris* L. Results showed that weekly mean population per leaf of thrips, whitefly and their predator, *Geocoris* varied with different dates and phenology of mustard localities**.** Initially, population of thrips and whitefly were very low (3.69±0.45, 1.00±0.25) in 3rd week of December 2010, and highest recorded (100.62±0.51, 24.77±0.89) in 3rd week of March, respectively. Correspondingly, predator *Geocoris* remained maximum (15.33±0.31) in 3rd week of February and minimum (4.50±0.25) in 1st week of January at Tando Allahyar. The present results demonstrated that mean population of thrips and whitefly at Tandojam fields was maximum (129.46±0.84, 40.85±0.90) in 3rd week of March and minimum (4.92±0.55, 2.69±0.21) in 3rd week of December, respectively. Predator's *Geocoris* population was minimum (5.00±0.32) in 3rd week of December at initial stages and reached at peak (10.50±0.31) in 3rd week of March. Temperature and humidity varied during different dates and time, and played an important role in increasing thrips, whitefly and *Geocoris* population.

Keywords: Population Dynamics, Thrips, Whitefly, *Geocoris*, Mustard.

1. Introduction
Rapidly increasing population and changes in dietary habits associated with urbanization increased the demands for food and fuel. Pakistan has become world's third largest edible oil importer [1]. Edible oil seed crops of Pakistan are classified as conventional (rapeseed, mustard, sesame, groundnut), non-conventional (sunflower, safflower, soybean) and non-true oilseeds (cotton, maize and rice bran) [2]. Oil seed mustard (*Brassica compestris* L.), has become one of the most important oil crops in the country. Conventional mustard varieties impose health concerns due to the presence of erucic acid in oil and glucosinolate in meal. Canola has the advantage over other vegetable oils because it contains lowest content of saturated fatty acids and moderate content of poly-unsaturated fatty acids [3, 4]. In Sindh, the farmers associated with brassica crops face a lot of problems from insect pests, particularly whitefly, thrips, aphid and painted bug. The control of pest insects has relied heavily on chemical insecticides which are often overused or misused. The beneficial species, such as parasites and predators are used to control pest insects that established a solid foundation for environmentally safe system for brassica growing farmers [5].

Whiteflies and thrips are piercing-sucking insects and cause major damage to vegetable crops cultivated in the field and greenhouses. The *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is polyphagous in nature, its damage may be the result of direct feeding on leaves, flowers or fruits, transmission of viruses, as well as product contamination. The *T. tabaci* has very small slender body almost of 1 mm long. Damage by thrips in early stages of crop growth is more important and is likely to result in substantial reduction in yield [6]. The major host crops of thrips are cotton, cucumber, onion, leek, tomato, potato, tobacco, peach, cabbage, lucerne and ornamental plants [7]. The *T. tabaci* causes serious damage on cultivated crops, mainly of family Alliaceous (e.g., onion and garlic) and on family Brassicaeae, such as radish, cabbage and cauliflower in many parts of the world [8].

Whiteflies (Homoptera: Aleyrodidae) are amongst the key pests of vegetable, ornamental and agronomic crops throughout the world, and it is polyphagous in nature. The two species that cause most damage to crops are the silver leaf whitefly, *Bemisia tabaci* (Gennadius) and the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) [9, 10]. The use of biological control is a fundamental tactic for pest suppression within an effective Integrated Pest Management (IPM) program. It is one of the safest methods of pests control since this is not toxic, pathogenic or injurious to humans.

Big-eyed bugs *Geocoris* spp., (Hemiptera: Lygaeidae) are small insects (approximately 1/6 inch long) that occur in many parts of the world. They are regarded as beneficial because they prey upon numerous kinds of insect and mite pests of turf, ornamental and agricultural crops. It has been successfully used as biological control agents against Western flower thrips, for instance in cucumbers, strawberries, sunflower and gerbera [11-19]. Big eyed bugs overwinter either as adults or as eggs in trash, crop debris, or in other protected areas. The eggs are sub cylindrical and pink or yellowish-white in color. Eggs hatch into nymphs, which feed on prey for several weeks before molting to the adult stage. Adults appear in the spring and begin feeding on available prey. Females deposit eggs in plant tissues. Adults and nymphs have oval bodies and broad heads. Their most distinguishing characteristic is their large, bulging eyes. Adults and nymphs feed by sucking the body fluids from their prey [21]. Thus, the objectives of this field studies were observing population dynamics of sucking insect pest, thrips, *T. tabaci* and whitefly *B. tabaci*, and their predator, *Geocoris* spp., on mustard crop *Brassica compestris*, as a component of pest control plan.

2. Materials and Methods

The present field studies were conducted during 2010-2011 to determine the population dynamics of thrips and whitefly pests, and their natural enemies such as predator, *Geocoris* spp., on mustard *Brassica compestris* L., crop, at different localities such as Tando Allahyar and Tandojam, District Hyderabad of Sindh, Pakistan.

2.1. Procedure

Mustard variety namely, Rai S-9 was grown in 2010 in a Completely Randomized Block Design with four replications. The subplot size of each study area was 15×8 meter, while the row-to-row and plant-to-plant distances were maintained 9 and 6 inches, respectively. All agronomical practices were applied to grow crop as and when required. The population fluctuations of thrips and whitefly, and their natural enemies were carried out at weekly intervals. Twenty five plants were randomly selected from each locality of crop, then five leaves were selected, two from bottom, two from middle and one from top and counted the population of thrips and whitefly pests and natural enemies with the help of magnifying glass and visual count. The plants were carefully handled to avoid disturbing of the whitefly and thrips, and their natural enemies such as predator, *Geocoris* spp., on the plants. Time of observation was 8-10 am and no pesticide was applied in or around the study field. Abiotic factors (temperature and humidity) data for study period were obtained from Agro-metrological Department, Tandojam.

2.2. Statistical analysis

The data obtained were statistically analyzed using Statistix 8.1 computer software, to determine superiority of treatment means [22]. Means were determined statistically and the standard error (SE) was calculated.

3. Results and Discussion

The studies on population dynamics were conducted to determine the population of thrips and whitefly and their predator, *Geocoris* spp., at different localities such as Tando Allahyar and Tandojam. The present results on observations taken on mustard, *Brassica compestris* L., crop at weekly interval had shown that crop was attacked by sucking insect pests, i.e., thrips and whitefly. Similarly, the earlier workers had also reported that brassica crop is severely attacked by a number of insect pests which suck the cell sap of plants and damage the process of photosynthesis [23]. Thrips was considered as one of the most harmful insect pests of mustard crop, sunflower, cauliflower, *Brassica* and cotton [24].

The results on the weekly mean population per leaf of thrips and whitefly and their predator, *Geocoris* spp., on mustard showed that thrips and whitefly and natural enemy population varied with different dates and phenology of plant in the field of Tando Allahyar**.** Initially, the population of thrips was found to be very low (3.69±0.45) in the 3rd week of December, the population increased and highest pest's density was recorded (100.62$\pm$0.51), in the 3rd week of March. The identical results were reported by Bjorn [24], and McCall *et al.,* [26]. Similarly, Ramsey *et al*., [27] have reported that the whitefly is a major pest of brassica. The population of whitefly was very low in the same field and found (1.00$\pm$0.25) in the 3rd week of December, the population increased and highest whitefly density was recorded (24.77$\pm$0.89) in the 3rd week of March. The predator, *Geocoris* spp., was recorded during the observations days from 22-12-2010 to 22- 03-2011. Initially, very low number of predator was recorded, but their numbers increased in the month of February (15.33$\pm$0.31). The population again decreased till the end of March, 2011. Likewise, Evans and Youssef [28] had observed that the predator-prey ratio was the lowest on 1st week of March. The temperature and humidity varied during different dates and time, and remained maximum in the month of March and minimum in the month of January (Table 1). The present results are in agreement with those of Liu [29], who reported that the population of whitefly adults and immatures fluctuated greatly from April to June.

Table1: Population of Thrips and whitefly and Predator, *Geocoris* Spp., in Mustard at Tando Allahyar from December 2010 to March 2011 (Mean±S.E)

Date of observation	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature ºC	R.H.%
22-12-2010	3.69±0.45	1.00±0.25	6.00±0.25	26.57	55.00
29-1-2011	5.85±0.82	2.85±0.34	5.72±0.33	23.64	56.57
6-1-2011	8.00±0.90	3.69±0.41	4.50±0.25	20.27	56.57
13-1-2011	65.62±0.23	5.69±0.54	7.33±0.29	20.47	58.57
20-1-2011	68.92±0.88	7.46±0.58	8.00±0.25	22.50	60.00
27-1-2011	77.62±0.20	7.85±0.60	12.00±0.70	25.48	60.28
3-2-2011	71.08±0.11	8.31±0.72	10.72±0.33	28.72	60.42
10-2-2011	86.69±0.33	9.77±0.70	11.50±0.31	25.07	61.00
17-2-2011	89.92±0.37	11.69±0.65	12.00±0.60	25.35	62.27
24-2-2011	85.38±0.51	13.62±0.81	15.33±0.31	24.71	65.57
1-3-2011	101.23±0.52	15.00±0.79	10.00±0.25	22.51	65.00
8-3-2011	91.15±0.39	17.31±0.80	10.33±0.29	28.07	66.85
15-3-2011	100.53±0.53	19.54±0.81	9.50±0.41	31.80	64.00
22-3-2011	100.62±0.51	24.77±0.89	8.00±0.25	37.42	66.00

The regression analysis of thrips with predator, *Geocoris* spp., was determined. The correlation of thrips with predator showed highly positive correlation (r^2= 0.66) value (Fig: 1), which means that with increase in thrips' population, the population of predators also increased. The correlation between temperature and thrips showed positive correlation (r^2= 0.18) value (Fig: 2), which means that with increase in temperature the population of thrips also increased. Similarly, the correlation between thrips and R.H% was with positive (r^2 = 0.77) value (Fig: 3). However, the thrips' population increased when the percent R. H. increases. The regression analysis of whitefly with predator, *Geocoris* spp., was as well determined. The correlation of whitefly with predator showed highly positive (r^2= 0.17) value (Fig: 4), which means that with increase in whitefly population the population of predators also increased. The correlation between temperature and whitefly showed positive correlation (r^2= 0.52) value (Fig: 5), which means that with the increase in temperature, the population of whitefly also increases. Similarly, the correlation between whitefly and R.H% was with positive (r^2 = 0.84) value (Fig: 6). However, the whitefly's population increased when the R.H% was also increases. Kumawat *et al*., [30] have investigated that the seasonal incidence of whitefly (*Bemisia tabaci*) on okra and reported that maximum temperature was significantly correlated with whitefly's density. Deepesh *et al*., [31] mentioned that *B. tabaci* population showed a significant positive association with temperature. There was poorly positive correlation between predators and temperatures (r^2 = 0.02) values (Fig: 7), but in opposite there was positive correlation between predators and R.H% (r^2 = 0.49) values (Fig: 8). The results showed that thrips and whitefly were thriving on mustard, and their predator also increased, the temperature and relative humidity played an important role in increasing thrips and whitefly, and their natural enemy *Geocoris* population.

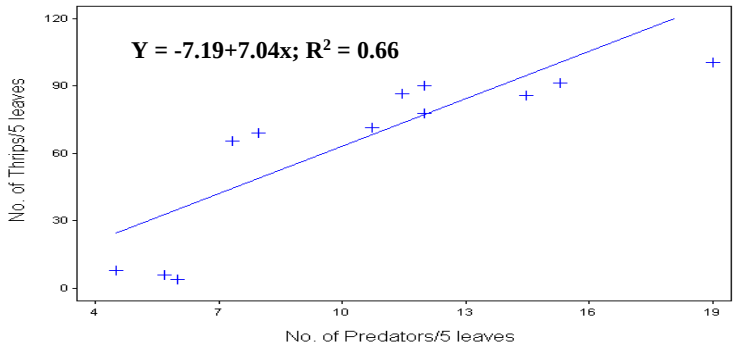

Fig 1: Relationship between No. of Thrips and No. of Predators on Mustard

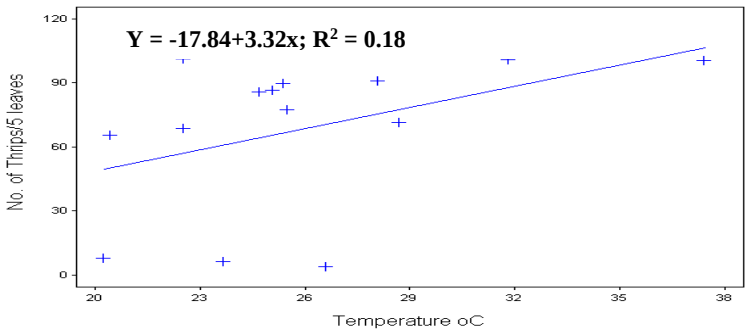

Fig 2: Relationship between No. of Thrips and field Temperature ºC on Mustard

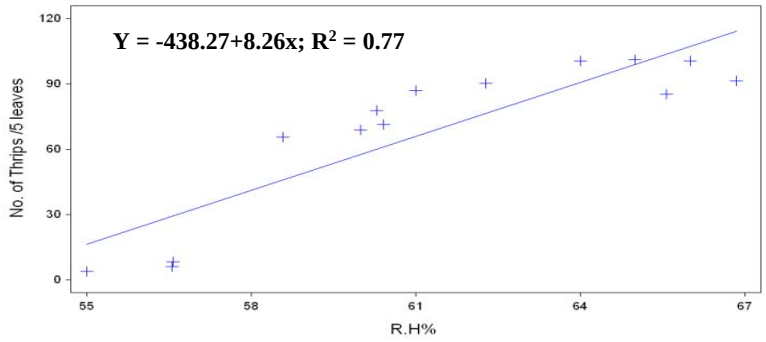

Fig 3: Relationship between No. of Thrips and R.H% on Mustard

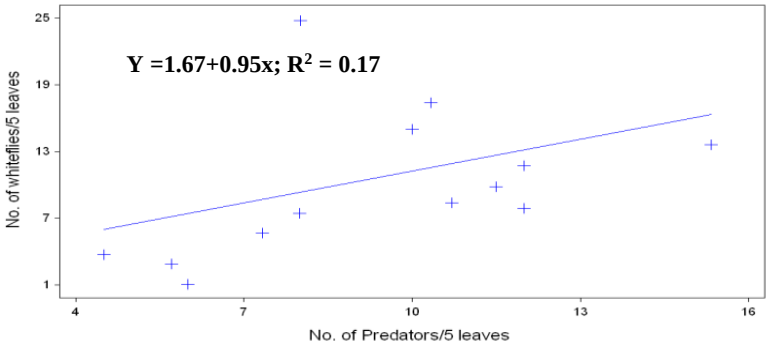

Fig 4: Relationship between No. of Whiteflies and No. of Predators on Mustard

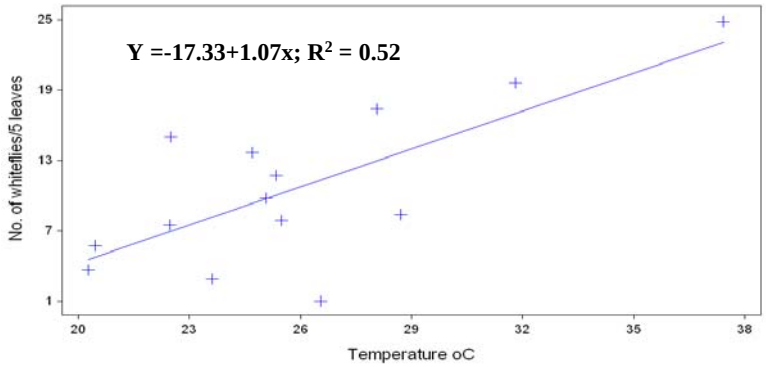

Fig 5: Relationship between No. of Whiteflies and field Temperature ^{o}C on Mustard

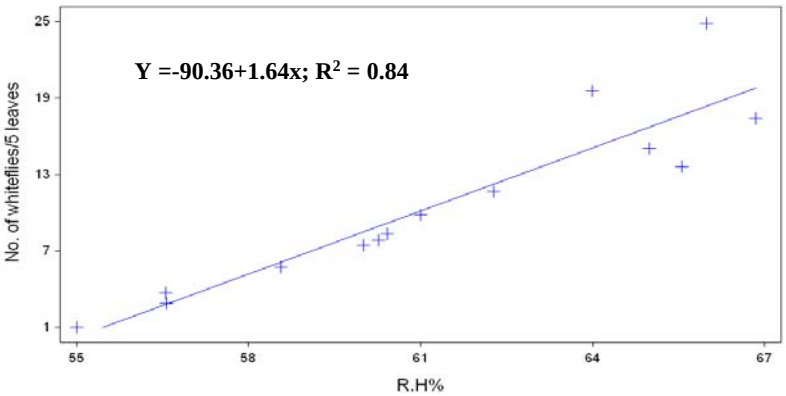

Fig 6: Relationship between No. of Whiteflies and R.H% on Mustard

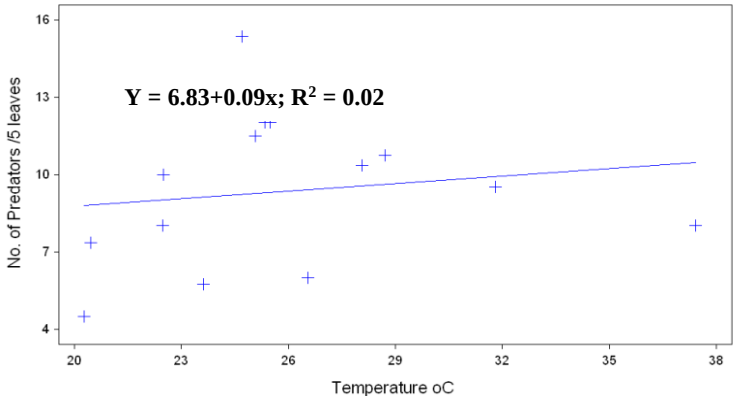

Fig 7: Relationship between No. of Predators and Temperature ºC on Mustard

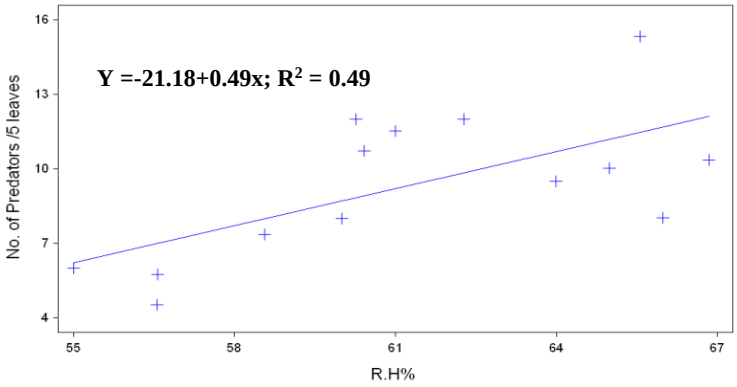

Fig 8: Relationship between No. of Predators and R.H.% on Mustard

The results on the weekly mean per leaf population of thrips and whitefly, and their predator, *Geocoris* spp., on mustard in Tandojam, are presented in Table 2. The present observations were carried out from 18-12-2011 to 20-3-2011. The data showed that thrips and whitefly population varied with different dates and phonology of plant. The maximum thrips' population was (129.46±0.84) in the 3rd week of March and minimum (4.92±0.55) in the3rd week of December 2010. Similarly, the maximum whitefly population was (40.85±0.90) in the 3rd week of March and minimum (2.69±0.21) in the 3rd week of December 2010. Shah and Baloch [32] had reported that lower whitefly population was revealed in crops sown between February 25 and March 20 as compared to the crops sown between April and July. The predator, *Geocoris* spp., population was minimum (5.00±0.32) in the 3rd week of December 2010 at initial stages and reached its maximum (10.50±0.31) in 3rd week of March. The results are in agreement with those of Gencsoylu and Yalc [33] who also reported the co-existence of these predators and pests in various agro- ecosystems.

Table 2: Population of Thrips and Whiteflies Pests and Predator, *Geocoris* spp., in Mustard at Tandojam from October, 2010 to January, 2011 (Mean±S.E).

Observation Period	No. of Thrips	No. of Whiteflies	No. of Predators	Temperature ºC	R.H.%
18-12-2010	4.92±0.55	2.69±0.21	5.00±0.32	24.50	55.85
25-12-2010	6.62±0.64	3.31±0.29	6.00±0.35	25.07	56.85
2-1-2011	9.46±0.77	5.15±0.37	8.00±0.25	25.42	56.85
9-1-2011	12.92±0.90	10.46±0.55	6.00±0.25	24.57	58.00
16-1-2011	21.69±0.16	15.46±0.68	8.33±0.29	24.64	58.57
23-1-2011	25.62±0.27	17.38±0.48	9.00±0.50	25.27	62.57
30-1-2011	36.08±0.50	20.08±0.83	7.00±0.25	26.47	63.57
7-2-2011	49.85±0.77	22.92±0.66	8.75±0.33	26.50	65.57
14-2-2011	60.46±0.95	24.08±0.71	10.33±0.29	27.48	65.28
21-2-2011	87.08±0.33	26.00±0.79	8.00±0.25	27.72	65.42
28-2-2011	99.69±0.50	28.08±0.49	9.33±0.29	28.07	65.00
6-3-2011	102.15±0.53	29.62±0.92	8.50±0.35	29.35	64.27
13-3-2011	118.23±0.72	37.31±0.91	9.60±0.32	29.71	60.57
20-3-2011	129.46±0.84	40.85±0.90	10.50±0.31	30.51	60.00

The regression analysis of thrips with predator, *Geocoris* spp., was determined. The correlation of thrips with predator was of positive (r^2= 0.54) value (Fig: 9), which means with increase in thrips' population, the population of predator also increases.

There was positive correlation between thrips and temperature (r^2= 0.94) values (Fig: 10). Similarly, the correlation between thrips with R.H% was also of positive (r^2= 0.29) value (Fig: 11). This means with increase in the temperature and R.H% the thrips' population was also increased. Findings of Umar *et al.*, [34] and Seif [35] support the present findings, who reported that whitefly population was positively correlated with temperature and relative humidity. Vennila *et al.*, [36] have reported that high temperature and scanty rainfall aggravated the severity of sucking pests and also reported *T. tabaci* had maximum population during dry spell with high temperature and low humidity which are optimum for population build up.

The regression analysis of whitefly with predator, *Geocoris* spp., was also determined. The correlation of whitefly with predator was of positive (r^2 = 0.64) value (Fig: 12), which means with increase in whitefly's population the population predator also increases. There was positive correlation between whitefly and temperature (r^2 = 0.85) value (Fig: 13). Similarly, the correlation between whitefly and R.H% was also of positive (r^2= 0.37) value (Fig: 14), which means with increase in the temperature and R.H% the whitefly population also increases. Kumawat *et al*., [24] have investigated that the seasonal incidence of whitefly (*Bemisia tabaci*) and reported that maximum temperature was significantly correlated with whitefly's density. Deepesh *et al*., [31] mentioned that *B. tabaci* population showed a significant positive association with temperature. Similarly, there was positive correlation between predator and temperature and R.H% (r^2= 0.52) and (r^2= 0.23) values (Fig: 15 & 16), respectively. The results showed that thrips and whitefly were thriving on mustard and their predator also increased, the temperature and relative humidity played important roles in increasing thrips and whitefly, and their *Geocoris* population. According to Sarwar [37], the natural enemies in canola *Brassica napus* L. (Brassicaceae) crop were active in 2nd week of February and the presence of predators on brassica correlated with sucking insect pests, which supports the present findings.

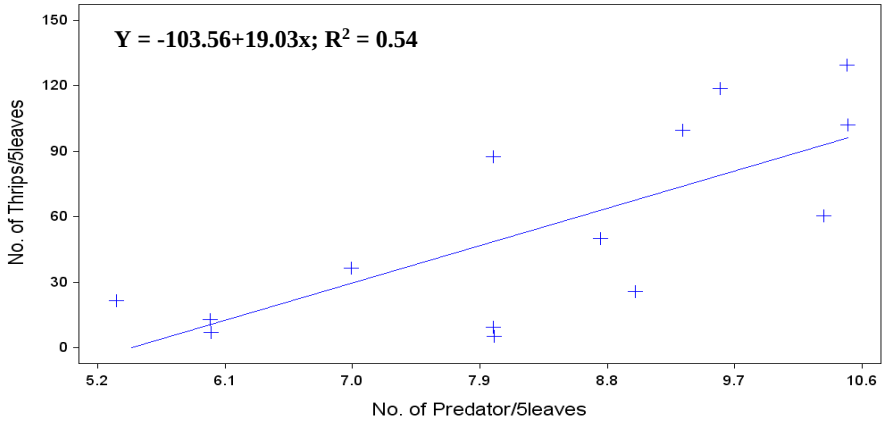

Fig 09: Relationship between No. of Thrips and No. of Predator on Mustard

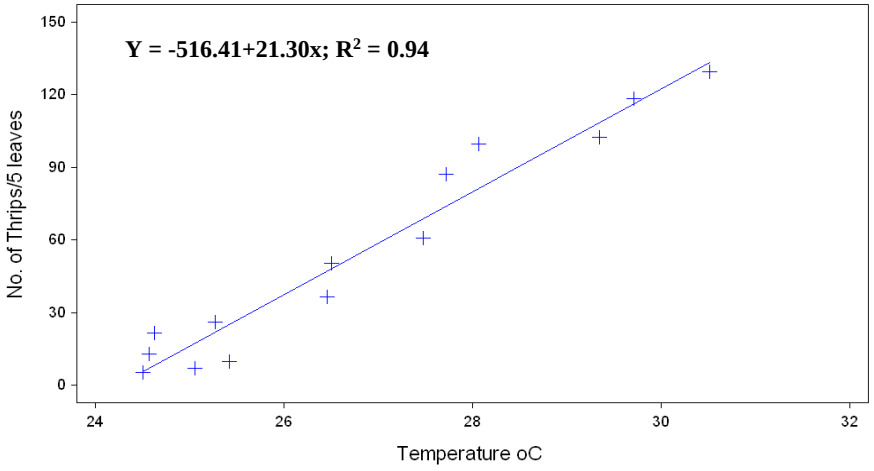

Fig 10: Relationship between No. of Thrips and Field Temperature ºC on Mustard

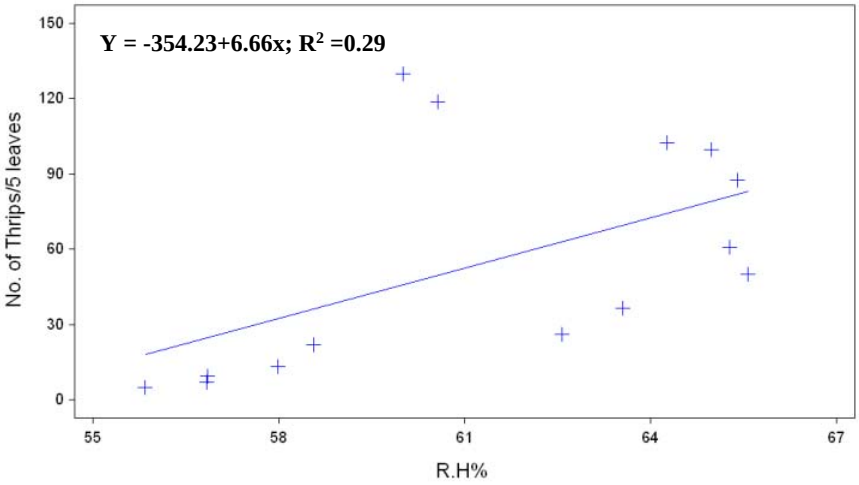

Fig 11: Relationship between No. of Thrips and R.H% on Mustard

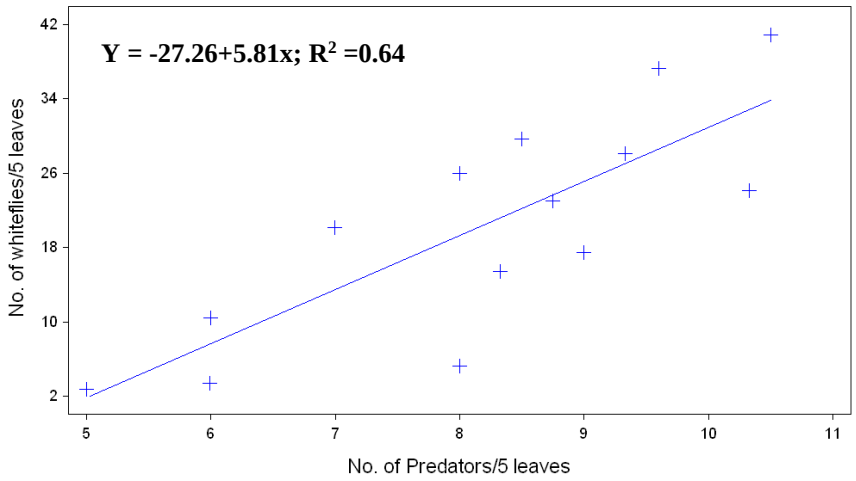

Fig 12: Relationship between No. of Whiteflies and No. of Predator on Mustard

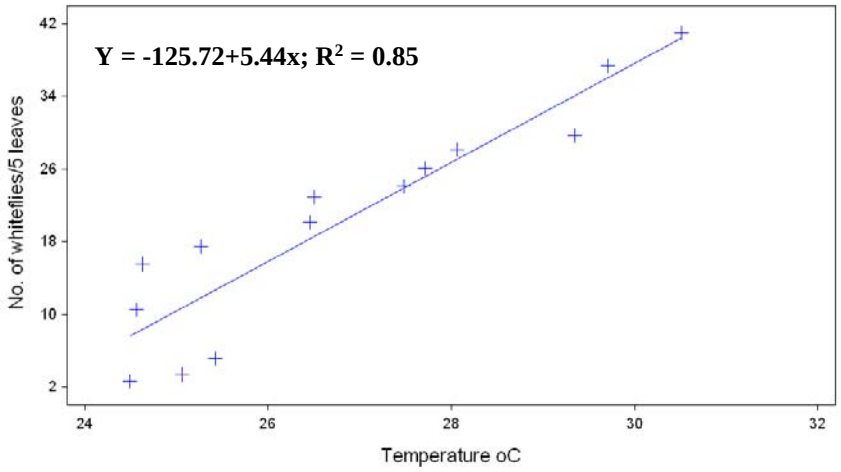

Fig.13: Relationship between No. of Whiteflies and Field Temperature ºC on Mustard

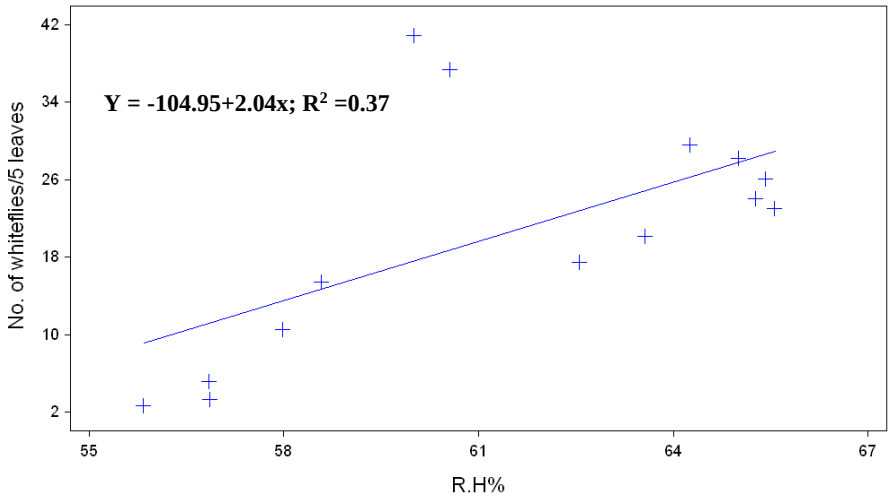

Fig.14: Relationship between No. of Whiteflies and R.H% on Mustard

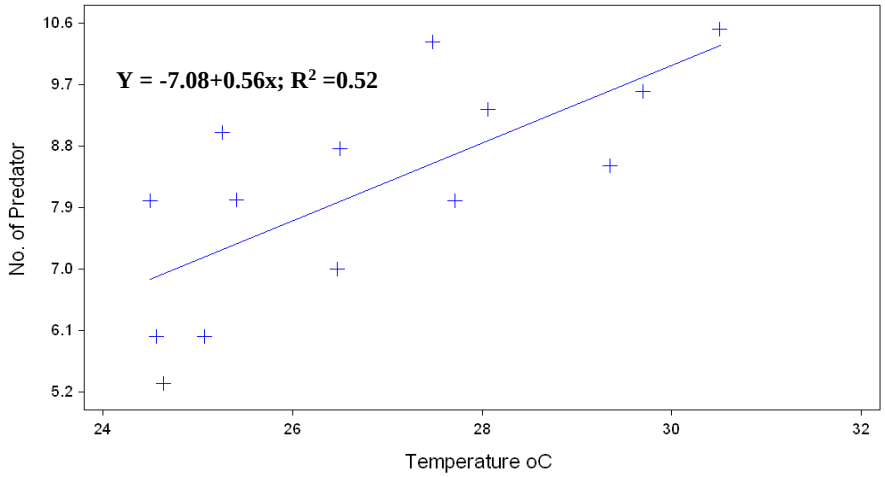

Fig 15: Relationship between No. of Predator and Field Temperature ^{o}C on Mustard

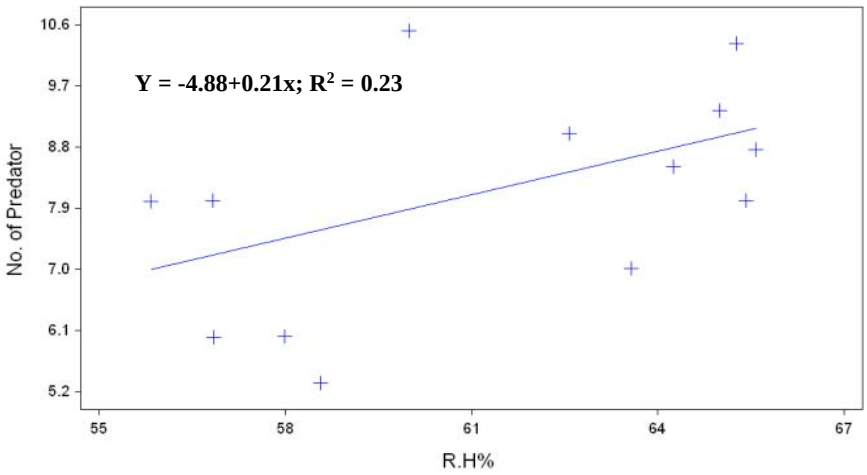

Fig 16: Relationship between No. of Predator and R.H% on Mustard

4. Conclusion

In the present research work, *Thrips* and *Bemisia* pests peaked (100.62, 24.77) on 22 March, respectively, and their predator, *Geocoris* peaked (15.33) on 24 February at Tando Allahyar. In other location Thrips, whitefly and their predator, *Geocoris* peaked (129.46, 40.85 and 10.50) on 22 March, respectively, at Tandojam. Future work should focus on correlation of natural enemies with the insect pests and effect of environmental conditions on the population dynamics of pests and their natural enemies. Moreover, maize crop being the host of *Geocoriss* spp., should be planted near the mustard crop to

attract the natural enemies' population for suppressing the insect pests.

5. References

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