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Research Article

Estimation of interaction between sucking insect/pests of cotton crop and their predator

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Abstract
The basic purpose of the current research was to determine the predator **(***Geocoris*, *Chrysoperla* and *Argiope*) and prey (jassid, dusky bugs, mites, thrips and white flies) relationship in cotton growing region of south Punjab during 2014 to 2016. Number of adult pests and their predators were noted from seedling to harvesting. Pearson coefficient of correlations was calculated after the analysis of data. *Geocoris carinatus* showed correlation coefficient with the pests ranged from 0.23 to 0.43 in 2014, 0.20 to 0.36 in 2015 and 0.07 to 0.26 in 2016 respectively at site I. *Chrysoperla carnea* showed the correlation with pests population was 0.27 to 0.35, in 2014, 0.02 to 0.36 in 2015 and 0.08 to 0.27 in 2016 respectively at site I. Correlation of coefficient between *Argiope catenulate* and their pests was 0.13 to 0.37 in 2014, 0.15 to 0.25 in 2015 and 0.10to 0.22 in 2016 respectively at site I. During 2014, 2015 and 2016, the correlation between *Argiope, Chrysoperla and Geocoris* and their pest were positive, significant and ranges from 0.30 to 0.49, 0.17 to 0.36 and 0.32 to 0.58 respectively at site II. At site III, the correlation of coefficient during 2014, 2015 and 2016 was positive, significant and ranged from 0.12 to 0.34, 0.15 to 0.45 and 0.11 to 0.42 respectively. These observations helped scientific community to find out the predators population from pests population effectively at the experimental sites. The sucking insects/pests of cotton crop might be controlled biologically and cotton yield increases.

Keywords: Correlation; Predators; Sucking Insects/Pests; Transgenic Cotton

Introduction

Numerous species of insect pest attacks cotton crop to damage its quantity and quality. Sucking pests play an important role to reduce the yield of this cash crop of Pakistan. Different kinds of sucking pest like white flies (*Bemisia tabaci*), thrips (*Thrips tabaci*), dusky bugs (*Oxycarenus laetus*), Jassid (*Amrasca biguttula*) and mites (*Tetranychide acarira*) attacked on cotton at the start of seedling. Some other insects like *Chrysoperla* (*Chrysoperla carnea*), *Argiope* (*Argiope catenulate*) and *Geocoris* (*Geocoris carinatus*) that act as a predator were also found along with these sucking pests in cotton farms. There is an existence of relationship between prey and predator because population of predators depends upon the availability of prey. The relationship between the two is naturally and very

common in every biome and can be calculated by using the techniques of statistics such as regression and correlation coefficient. One of the basic fundamental features of an ecosystem is the relationship between prey and predators populations [1]. Tropic structure of pest and predator shows regular proportions in their increasing trends. These proportions indicate the effect of living and nonliving component of an ecosystem on each group of population trends [2, 3]. The proportions of the pest and predators populations are directly depend upon the factors related to the natural habitat and the way of entrance of two species into the crops in an ecosystem [4]. The proportions of prey and predators also linked with complex pattern of food web. The complex combination of food chain and availability of food shows a link between the pests and their requirements [5-7]. Several investigations among vertebrate's predator and prey relationship are present [8, 9]. While the insect predator and insect prey investigations are lacking in Pakistan. The current research clearly indicates the relationship between invertebrates sucking pest and invertebrates predators which were largely found in extreme environmental conditions. The interactions between prey and predators population is very beneficial to get the maximum productivity of an ecosystem because both the population controls each other's [10] *Chrysoperla carnea*, *Chrysoperla sexmaculata*, *Coccinellase ptempunctata*, *Geocoris carinatus* and *Argiope catenulate* are the most common predator of great economic value and majorly influenced on the population dynamics of sucking pest in the cotton field of southern Punjab. These polyphagus predators are found everywhere in southern Punjab. The present study helps to get the first hand information about the proportions of predator - prey relationship of different species in the cotton fields of south Punjab.

Materials and Methods

Study area and experimental design

The present study was planned during 2014-2016 at three different cotton growing sites of southern Punjab i.e. site-I (Multan), site-II (Khanewal) and site-III (Vehari). Ten plots were randomly selected in each of three sites where cotton was cultivated. Local farming practices were adopted. Cotton raised beds were prepared. Two to three seeds cultivate at the distance of 25cm. Irrigation was provided when required. Urea and diamonium phosphate were used as fertilizers. No pesticides were used. Signboards were placed for numbering the plants at suitable places inside the fields for counting purpose.

Sampling

Number of adults and their eggs count of five different types of sucking pests(Dusky bugs, thrips, white flies, jassid, mites) along with their predators (*Chrysoperla*, *Argiope* and *Geocoris*) were recorded simultaneously at three experimental sites starting from seedling to harvesting fortnightly.

Data analysis

The data of pest and their predator counts were recorded safely by using computer tools and were analyzed by computing Pearson correlations coefficients using Statistix (Version 8.1) software. The significant correlations were calculated by using the following formula:

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sum(X - \bar{X})^2}$$

Where X represent prey population and Y shows predator population.

Results

Correlations between predator and sucking pest populations in 2014 at site-I, II and III

Population of *Geocoris* shows the positive correlation coefficient with the sucking pest population. The correlation of thrips and dusky bugs with *Geocoris* were moderate and highly significant ($P<0.01$). Mites had

moderate and significant while white fly had high and significant correlations with *Geocoris* at site I (Table 1). Population of dusky bugs showed highly significant and very high positive correlation coefficient with *Geocoris*. The correlation coefficients between Jassid and *Geocoris* were significant, positive and high (P<0.001). Thrips, mites and white fly had moderate, positive and significant correlation with *Geocoris* population. Dusky bugs, white flies, thrips, mites, and jassid showed moderate, significant and positive correlation with *Chrysoperla* while with *Argiope* population they had moderate, highly positive and significant correlation at site II (Table 1). At site III**, C**orrelation between *Geocoris* and their prey such as mites, white fly, thrips, jassid, and dusky bugs was moderate while it was low to moderate, positive and significant with *Chrysoperla* and *Argiope* populations (Table 1).

Table 1. Correlations between sucking pests (prey) and predators during 2014 at site-I, II and III

		Jassid	Dusky bugs	Mites	Thrips	White fly
Site I	*Geocoris*	0.39***	0.23**	0.26**	0.35*	0.43***
	Chrysoperla	0.34*	0.29**	0.27**	0.33*	0.35*
	Argiope	0.35*	0.13**	0.26**	0.34*	0.37*
Site II	*Geocoris*	0.49***	0.45***	0.37**	0.47***	0.46***
	Chrysoperla	0.30**	0.41***	0.43***	0.30**	0.29**
	Argiope	0.33*	0.43***	0.35**	0.34*	0.35*
Site III	*Geocoris*	0.34*	0.13*	0.21*	0.32*	0.29**
	Chrysoperla	0.24*	0.12*	0.23*	0.27**	0.21**
	Argiope	0.29*	0.12*	0.25*	0.32*	0.34*

!Given values are *r* values from correlations showing significance difference
*= significant, **= Highly Significant, ***= very highly significant, ns= non-significant

Correlations between predator and sucking pest populations in 2015 at site-I, II and III

At site I, Dusky bug, white fly, jassid and thrips population showed moderate and significant while mites had low and non-significant correlation with *Chrysoperla*. The correlation coefficient between *Argiope* and sucking pests (thrips, white fly, dusky bug and mites) were low, positive and significant. Jassid had moderate, positive and significant correlation with *Argiope* (Table 2). At site II *Argiope*, *Geocoris* showed positive, moderate and significant correlation with all the sucking pests (jassid, thrips, white flies, mites, and dusky bugs) while *Chrysoperla* had low, moderate and significant correlation with these insects (Table 2). At site III, The correlation coefficient between *Geocoris* and dusky bug, *Geocoris* and jassid, *Geocoris* and Thrips, *Geocoris* and white fly, Geocoris and mites were low to moderate positive and significant. *Chrysoperla* populations had low to significant, moderate and positive correlation with white fly, dusky bugs, mites, jassid and thrips populations. *Argiope* was moderately correlated with their prey (Table 2).

Correlations between predator and sucking pest populations in 2016 at site-I, II and III

At site I, The correlation between *Chrysoperla* and white fly, thrips and jassid was moderate, positive and significant while it had low and significant correlation with mites and dusky bug (Table 3). The correlation coefficient between *Geocoris* population and their prey (jassid, dusky bugs,

mites, thrips, and white fly) was moderate, high positive and significant. *Chrysoperla* had moderate to high correlation while *Argiope* had positive, high and significant correlations with all these sucking pest at site II (Table 3). At site III, *Geocoris*, *Chrysoperla* and *Argiope* populations showed low to moderate correlations with jassid, dusky bugs, mites, thrips and white fly (Table 3).

Table 2. Correlations between sucking pests (prey) and predators during 2015 at site-I, II and III

		Jassid	Dusky bugs	Mites	Thrips	White fly
Site I	*Geocoris*	0.34**	0.20*	0.24*	0.36**	0.31*
	Chrysoperla	0.33*	0.25**	0.02	0.31*	0.36*
	Argiope	0.21**	0.15*	0.17**	0.21**	0.25**
Site II	*Geocoris*	0.34*	0.20**	0.24**	0.36*	0.31*
	Chrysoperla	0.34*	0.16**	0.17**	0.37*	0.35**
	Argiope	0.29**	0.24**	0.31*	0.33*	0.22*
Site III	*Geocoris*	0.39***	0.43***	0.45***	0.40***	0.37*
	Chrysoperla	0.33*	0.15**	0.18**	0.30**	0.33*
	Argiope	0.32*	0.33*	0.23**	0.39***	0.38***

!Given values are *r* values from correlations showing significance difference
*= significant, **= Highly Significant, ***= very highly significant, ns= non-significant

Table 3. Correlations between sucking pests (prey) and predators during 2016 at site-I, II and III

		Jassid	Dusky bugs	Mites	Thrips	White fly
Site I	*Geocoris*	0.07	0.25**	0.21*	0.11	0.12
	Chrysoperla	0.14	0.08	0.27*	0.17	0.19*
	Argiope	0.10	0.15	0.22*	0.12	0.10
Site II	*Geocoris*	0.48***	0.44***	0.54***	0.55***	0.55***
	Chrysoperla	0.50***	0.32*	0.56***	0.56***	0.56***
	Argiope	0.51***	0.38***	0.55***	0.56***	0.55***
Site III	*Geocoris*	0.29**	0.33*	0.17**	0.42***	0.37*
	Chrysoperla	0.31**	0.21**	0.08*	0.35*	0.28*
	Argiope	0.34*	0.21**	0.11*	0.38***	0.32*

!Given values are *r* values from correlations showing significance difference
*= significant, **= Highly Significant, ***= very highly significant, ns= non-significant

Discussion

The current research is focused to determine the interaction between the two variables. Value of one variable used to find the value of other variable effectively. On the basis of this interaction, one variable can be efficiently used to make changes in other variable. Statistical tools used to find the relationship between the variables are correlation coefficient. The values of these coefficient ranges from -1 to +1 showing the perfect –ve to perfect +ve correlations. Grant *et al.* [11] used to measure the effect of predatory arthropod by using standardized techniques. They observe predation in field and used techniques which provide them a quantitative assessment for the action of predators. Variable amount of relationship between prey and predators population were present. It was noted that *Geocoris* had moderate to high, positive and significant relationship with sucking pests population. Its value indicates that *Geocoris*

population with the increase of their pests at site I during 2014. Correlation relationship between *Chrysoperla* and their prey were low to moderate, positive and significant but it was lower to *Geocoris* and their prey. *Argiope* also show low to moderate relationship that was lower than *Geocoris* and *Chrysoperla*. *Geocoris*, *Chrysoperla* and *Argiope* populations showed low to moderate and positive correlation relationship with their prey populations in 2015. Similar situation was found in 2016 where predator had low to moderate, positive and significant association with the prey at site I. Although the correlations were lower to moderate even than predator population can be estimated from prey population. A more longer and comprehensive study might provide good amount of relationships between the predators and their prey (thrips, jassid, mites, white fly, and dusky bugs). This positivity of correlation coefficient is natural and explains that predator's population is directly proportional to pest population. *Chrysoperla, Geocoris* and *Argiope* had association with white fly in 2014. It means that white fly was good indicator of these predators. In 2015 *Chrysoperla* and *Argiope* had association with white fly while *Geocoris* had relationship with thrips. Khanzada *et al*. **[12]** findings were also similar with this study. They studied that *Geocoris* population increases with the increase of thrips population. In 2016 scenario was completely changed because *Geocoris* had highest correlation relationship with dusky bugs, *Chrysoperla* and *Argiope* with mites. So, dusky population was a good indicator for *Geocoris* population while mites populations was estimator of *Chrysoperla* and *Argiope* populations at site-I. Predator populations possessed good amount of relationship with their prey populations at site I. At site II during 2014 *Geocoris* had highest while *Chrysoperla* and *Argiope* had moderate to high relationship with mites, dusky bug, jassid, white fly and thrips. All these relationship were significant and positive in nature. In 2014, The *Geocoris* population had highest correlation with jassid followed by thrips, white fly and dusky bug populations. In 2015 result was changed because *Geocoris* had low to moderate association with these pests. *Argiope* and *Chrysoperla* had low to moderate correlation with their prey population. The result of this correlation was too small as compared to the previous year but these are positive and significant and could be useful prediction. *Argiope* and *Geocoris* had highest correlation with thrips while *Chrysoperla* had affinity for white fly in 2015 at site II. Amount of correlation increases again in 2015, It was found that population of predator has highest, positive and significant correlation with the sucking pests which were higher in magnitude as compared to last year. *Geocoris* and *Argiope* had high affinity with thrips while *Chrysoperla* had high correlation with white fly. These correlations provided good predictions for predator-prey populations and indicated their strong association. The change in population size of prey can change the size predators' population. Solangi *et al*. **[3]** observed that the positive correlation relationship between insect predators and sucking insect pest population. The increase in sucking insect population also exhibited an increase in predator population which was similar to the findings of current studies during the growth stages of cotton crop **[12]**.

At site III during 2014, *Geocoris* showed lower to slightly moderate and positive correlation with their pests. It had highest affinity with the jassid. *Chrysoperla* had lowest and positive correlation with their prey and it had highest association with thrips. *Argiope* correlation was low to moderate and positive with all these sucking pests. It had highest relationship with white fly. The correlation coefficient between predator and prey population was little higher in 2015 as compared to the last year. *Geocoris* Showed higher correlation with the pests especially with mites. *Chrysoperla* correlation with the sucking pests was low to moderate. It had highest affinity with jassid and whitefly. *Chrysoperla* shows positive correlation with jassid and negative with the cotton aphid studied by Solangi *et al*. **[3]**. *Argiope* had highest correlation with thrips that was

moderately high. All these correlations were positive and significant in nature and could be applied to predict the predator populations and vice versa. During 2016, Correlation coefficient of *Geocoris*, *Argiope* and *Chrysoperla* with its prey was low to moderately high, positive and significant. All of these had highest correlation with thrips. All of these correlations can be used to predict the predator's population effectively.

Conclusion

Relationship between the two variables (Predators and prey) can be explained by observing the associations among them. These associations enable us to find the one variable with the help of other variable. During this study the predators (*Argiope, Chrysoperla* and *Geocoris*) population could be predicted with their prey (white fly, dusky bugs, thrips, jassid, and mites) populations. The correlation coefficient between predator and prey population are important tools to determine the future trends in their population because it provide the base for estimation. These correlation coefficient were low, moderate to High, High and significant and can be used to predict the strong association between prey and their predator.

Authors' contributions

Conceived and designed the experiments: A Ali, Performed the experiments: A Ali & MN Akhtar, Analyzed the data: A Farooq, Contributed materials/ analysis/ tools: A Li & MN Akhtar, Wrote the paper: A Ali.

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