Research Article

Population Dynamics of Natural Enemies and their Correlation with Weather Parameters in Cotton

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Abstract | Cotton is an important crop for the Pakistan and in the globe too. Thus, to access the availability of biological fauna over a year, a study was designed. The study was carried out Research Farm of MNS-University of Agriculture, Multan, Department of Entomology, Faculty of Agriculture & Environmental Sciences during 2018. In the study, population of beneficial insects was corelated with the weather parameters (temperature, humidity and rainfall on two cotton genotypes; *Bt* (MNH-992) and Non-*Bt* (Cyto-124). The four natural enemies *i.e.* ladybird beetle, green lace wing, syrphid fly and spider were studied. The population of the natural enemies remained active throughout the studied period. The population of green lace wing and ladybird beetle were maximum in June to September, respectively. The study showed that green lace wing and ladybird beetle showed positive correlation with temperature while negative with rainfall. While, spider's population showed negative correlation with all-weather parameters except sunshine hours. The population of spider was maximum in last week of September while disappeared in the last week of October. The study revealed that the natural enemies were observed rarely in month of May, early stage of crop. The study resulted that weather parameters like temperature, humidity and rainfall play significant role in fluctuation of natural enemies.

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1. Introduction

Cotton, *Gossypium hirsutum* L. (Family: Malvaceae) is most important natural fiber crops, cultivated in various regions of the world (Anonymous, 2005) including Pakistan. It mostly grown in tropical and warm temperate areas of the world. Cotton is not only the cash crop but its products like lint and seed oil used for various purpose (Ozyigit *et al.*, 2007; Shivanna *et al.*, 2009). Pakistan is the third, fourth and fifth largest exporter, producer and consumer of cotton, respectively. Cotton is the main source of foreign income for economy of Pakistan (Saleem *et al.*, 2018).

There are several factors which affect the cotton yield and production. Among them, insect pests (sucking as well as chewing) are the major threat for the reduction of quality and quantity of cotton (Attique and Rashid, 1983). The sucking insect pests of cotton are Whitefly, *Bemisia tabaci*; Aphid, *Aphis gossypii*; Thrips, *Thrips tabaci*; Jassid, *Amrasca biguttula*

biguttula; Red cotton bug, *Dyesdercus koenigii* and Leaf beetle, *Cerotoma trifurcate* while chewing pests of cotton are Pink bollworm, American bollworm, Spotted bollworm and Army worm (Ashfaq *et al.*, 2011).

The severe attach of these pests caused 15-30% losses in cotton (Abro *et al.*, 2004; Amjad and Aheer, 2007). The sucking insect pests suck the cell sap from plants leaves and caused curling, shedding (Bayhan *et al.*, 2006; Hofs *et al.*, 2004) even death of plants.

The farmers depend on the use of the pesticides to control the insect pests, which are harmful for non-target organisms like predators and parasitoids. The excessive use of pesticides caused resistance in insect pests. The pesticides persistent in the environment and cause pollution which has negative effect on animals and humans. The residues of pesticides remain in crops causes diseases which are fatal for humans and animals (Pervez and Omkar, 2003).

At this time an alternative control needed to get rid from the harmful effect of pesticides on humans and animals. The losses can be minimized by using the biological fauna containing predators like Green lace wings, Ladybird beetle, Spider, Big eyed big, Pirate bug and parasitoids. These are predators of sucking insect pests like Whitefly, Jassid, Aphid and Thrips. The biological control is the important component of integrated pest management strategies and helpful in pollination (Isaacs *et al.*, 2009). Ladybird beetle and Green lace wing are the important predators of aphid (Pervez and Omkar, 2003) in agro-ecosystem of globe. Both are found in abundance and have wide host range (Tauber *et al.*, 2000).

Majority of farmers are growing Bt cotton due to less susceptibility against insect pests either sucking or chewing pests. The production of crops enhances and pests can be controlled through cultivation of Bt cotton (Wan *et al.*, 2002; Arshad and Suhail, 2011; Arshad *et al.*, 2015). The excessive cultivation of Bt cotton can reduce the natural enemies (Predators) population which pay negative impact on crops production (Schuler, 2000). The purpose of the study was to evaluate the natural enemies (Predators) population with relation to abiotic factors like temperature and humidity.

2. Materials and Methods

An experimental study was carried out at Research Farm of Muhammad Nawaz Shareef University of Agriculture, Multan during 2018. The purpose of study was to determine the population dynamic of four natural enemies like Syrphid fly, spider, Green lace wing and Ladybird beetle with relation to abiotic factors. Two cotton genotypes Bt (MNH-992) and Non-Bt (Cyto-124) were sown during second week of May, 2018. The randomized block design (RBD) method with four replications was used for laid out the experiment. The field was divided into eight blocks and per block size is 25-26 sq. feet with 9″ and 2.5″ plant to plant and row to row distance, respectively. The topographical location of experiments was 30.1575° N Latitude, 71.5249° E Longitude and Elevation above sea level 129 m.

2.1 Data recording

In the experimental field no pesticide was sprayed throughout the crop season. During the whole crop duration, all recommended agronomic practices except insect pest management strategies were applied (Anonymous, 2008). Thirty plants were selected from each variety and tagged to record the population of natural enemies (Syrphid fly, Green lace wing, Ladybird beetle and spider). Data was recorded after 15 days of sowing. The population recorded from tagged as well as randomly selected plants leaves (upper, middle and lower) on the weekly basis at early morning time (7 AM) from second week of sowing till harvesting of crop. The data of natural enemies population was correlate with weather parameters (Temperature and Relative Humidity (RH)). The meteorological data was taken from Metrological Department of Central Cotton Research Institute, Multan, Pakistan.

2.2 Statistical data

The recorded data was analyzed by the analysis of variance in "Statistix v8.1" (Analytical Software, 2005) and treatment significance was determined by least significant difference test (LST) ($\alpha = 0.05$) to separate the means. Correlation between population of jassid and weather factors were calculated in Statistix v8.1.

3. Results and Discussion

The population of natural enemies was given below in (Table 1).

Table 1: Population of natural enemies/plant on cotton.

Months	May	June	July	August	September	October	November	December
Natural enemies								
Coccinella spp.	0.0	0.1	1.1	2.98	2.98	3.28	1.0	1.0
Chrysoperla spp.	2.2	2.4	3.0	6.2	6.21	1.4	1.7	2.0
Dictyna spp.	1.87	2.0	3.0	3.76	1.0	2.1	3.79	4.0
Syrphid fly.	0.01	0.1	0.25	1.69	5.23	3.0	3.2	2.0

3.1 Population of ladybird beetle

Coccinella septempunctata is ecofriendly and feed on the sucking insect pests like jassid, aphid, whitefly and thrips even mealy bug. During the present study *C. septempunctata* was seen maximum in non Bt cotton genotype (Cyto-124) (3.11 adults /plant) as compared to Bt cotton (MNH-992) (1.34 adults /plant), which is similar to the observation of (Udikeri *et al.*, 2003; Rajanikantha, 2004). The lowest population of on non Bt and Bt was 1.0 adult/plant and 0.45 adult/plant, respectively. However, our results are some extent different from other scientist who reported that predatory beetle was found maximum in Bt varieties (Aggarwal *et al.*, 2007). The current study showed that population of ladybird beetle was seemed in month of June (0.10 adult/plant). No population was seen during the month of May due to absence of its prey. The population was disappeared during last week of June and again appeared in the second week of July (1.0). The same observations were recorded by (Ashfaq *et al.*, 2011; Omkar and Srivastava, 2003).

During August to October the activity of ladybird beetle was gradually increase and reached the peak (2.98 adults /plant). The similar findings were observed by (Chauhan *et al.*, 2017; Godhani *et al.*, 2009). The maximum population was recorded in the month of September and October while minimum in November and June. Our findings are similar to (Bhute *et al.*, 2012; Nemade *et al.*, 2015). The population of *C. septempunctata* was found extensively in the months of August to October while decline gradually from November to December which is nearly close to our findings (Dhaka and Pareek, 2007; Mohan *et al.*, 2005; Purohit *et al.*, 2006). The population was disappeared during last week of October. The peak level of ladybird beetle are September and July 3.18 adults/ plant and July (3.09 adults/ plant), respectively (Purohit *et al.*, 2006) during the whole study. There are two peak level of ladybird beetle (Kedar, 2014). These months are in agreement with our study. The population of coccinellids predator was present throughout the crop season from June to December.

3.2 Population of green lace wing

Chrysoperla carnea is a potential predator against several soft bodied insects like sucking insect pests. It is used extensively in biological control as integrated pest management (Geetha and Swamiappan, 1998; Mannan *et al.*, 1995). The population of *Chrysoperla* is varies according to cotton genotypes. The current study showed that *Chrysoperla* population was highest in Bt. Cotton than Non-Bt.

The highest number of *C. carnea* eggs (1.16 eggs/ plant) while lowest (0.60 eggs/plant) were observed on Bt. cotton genotypes. The maximum and minimum number of eggs (0.30 eggs/plant) and (0.10 eggs/plant), respectively were found on local variety (Non-Bt.). The eggs population of *Chrysoperla* was approximately 50% reduced on local genotype as compared to Bt-cotton. Another study had revealed that no difference of *Chrysoperla* was found on both genotypes (Bt. and Non-Bt.) (Hegde *et al.*, 2004). The population of *Chrysoperla* was seen throughout the cotton season, increase as well as decrease with the sucking insect pests. Our findings are agreements with the findings of others studies (Babu and Meghwal, 2014).

The population of green lace wing is low at the early stage (May) of cotton while high in August and September (6.20 and 6.21 *C. carnea*/plant). The maximum adult of *Chrysoperla carnea* (6.21 *C. carnea*/ plant) were observed in last week of September while minimum (1.4 *C.carnea/plant*) in October. In the current study, Chrysoperla population was gradually reduce after second week of October. Similar observations had recorded by (Gosalwad *et al.*, 2009; Purohit *et al.*, 2006).

3.3 Population of spider

The population of spider, *Dictyna spp.* was low at the start while increase gradually at the middle or late stages of crop. Our observations are same with others (Liu *et al.*, 2003). At the end of the crop season its population reach to peak level (4 individual/plants).

The same results had been reported by (Liu *et al*., 2003). The spider, *Dictyna spp*. was observed in last week of July during the study. Its population (0.47 individual/plant) enhanced gradually in the month of second week of August. At last week of August, the population of spider was reduced and again increase in September. The population of spider was observed during last week of September (1.00 individual/plant) on Bt. cotton and disappeared in October.

The similar findings were recorded by many other researcher (Ashfaq *et al*., 2011). The maximum population of *Dictyna spp*. Was observed by (Dhaka and Pareek, 2007) in July which is not similar with our observations.

3.4 Population of syrphid fly

The current study revealed that syrphid fly population (0.25 adult/ plant) was initiated during last week of July. During the end of August, population was increased repeatedly and reached to extreme level (1.69 adult/ plant). After August, sudden reduction in fly population was occurred. The maximum population of flies was seemed at the last of second week of September. The similar observations had recorded by (Bhute *et al*., 2012). The population of these predatory flies was seen during the whole study. The similar findings had recorded by (Udikeri *et al*., 2013), which is similar to our results.

3.5 Natural enemies population with respect to abiotic factors

The abiotic factors like temperature, humidity and rainfall play significant role in fluctuation of natural population (Kavitha *et al*., 2003; Purohit *et al*., 2006; Chakraborty and Korat, 2013). During the current study, maximum temperature and humidity were 30-37.9^{0}C and 77.6%, respectively while 20-23.2°C and 26% were minimum. The population of Ladybird beetle and spider showed positive correlation with high temperature while negative correlation with rainfall. The population of both predators like ladybird beetle and spider were increase with increasing the temperature while reduced during rainy days. The similar conclusions had recorded by (Muchhadiya *et al*., 2014; Babu and Meghwal, 2014; Dhaka and Pareek, 2007).

It has been observed that maximum temperature showed positive effect on population of *Chrysopa* while relative humidity and rainfall showed no impact on green lace wing population. Our findings were similar to earlier studies (Dhaka and Pareek, 2007). Our current study results were different from the study of (Muchhadiya *et al*., 2014) who reported that *Chrysoperla* has significant positive relation with rainfall while negative with sunshine.

Conclusions and Recommendations

In the present study, has been seen that population of natural enemies persisted throughout the crop season. The environmental factors like humidity and temperature have positive impact on predatory insects like *Septempunctata spp., Dictyna spp. Chrysopa and syrphid* fly. Future work should focus on the correlation of natural enemies with the insect pests and impact of weather conditions.

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Conflict of interest

Authors have no conflict of interest.

Author's Contribution

MR wrote manuscript, UNU planned the study, GM and FM helped in data recording, MI and MAQ critically reviewed the manuscript.

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