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Abundance of Natural Enemies Associated with *Rhopalosiphum maidis* (Fitch) in Maize Based Planting Pattern

M.K. Tali, G. Chhangani, M.K. Mahla, A. Vyas and K.V.N. Reddy*

Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan-313001, India

**Corresponding author*

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A B S T R A C T

The present investigation on Abundance of natural enemies associated with *Rhopalosiphum maidis* (Fitch) in maize based planting system was carried out at Instructional farm and Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur. Maize variety Pratap maize-5 was sown with different intercrops *viz*., green gram, black gram, cowpea and soyabean in kharif, 2017. The coccinellids appeared in first week of August and thereafter gradually increased with aphid population reaching to its peak in second week of September, 2017. The maximum seasonal mean population of coccinellids was recorded in maize + cowpea (5.09 aphids/ plant). The mean population of coccinellids had a significant positive correlation with mean atmospheric temperature in all the intercrop treatments. The predation of aphids by the larval population of syrphid fly maggots was observed from the first week of August, in the maize + greengram, maize + blackgram and maize + cowpea; while, in sole maize and maize + soybean the predation began in second week of August. The maximum seasonal mean population of syrphid fly maggots was recorded in maize + cowpea (2.00 maggots/ plant).

Introduction

Maize (*Zea mays* L.) belongs to family Poaceae and is one of the most versatile crop having high yield potential and wide adaptability. It is used as human food, animal feed, in starch industry, corn oil production and as baby corn (Singh, 2014). Its grain contains protein (10 %), oil (4 %), carbohydrates (70 %), fat (5 to 7 %), fiber (3 to 5 %) and minerals (2 %). Maize is cultivated on an area of 8.69 mha with a production of 21.80 million tonnes and productivity of 2509 kg/ ha (Anonymous, 2016). Rajasthan is one of the major maize growing states in India covering an area of 0.88 mha with a production of 1.14 million tonnes and productivity of 1318 kg/ ha (Govt. of Rajasthan. 2016). Maize can be grown in both *rabi* and *kharif* seasons in Rajasthan, but it is a major *kharif* season crop in the maize growing districts. The area under *rabi* maize is increasing in Banswara and Dungarpur districts of the state where irrigation facilities are available. Among the cultural methods, inter and mixed cropping systems, the popular forms of crop-crop diversity, have become more popular in the rainfed regions. The

interest to shift pest management strategies from the intensive use of agrochemicals to more sustainable and ecologically friendly practices has increased in recent years. One alternative to conventional farming system is the implementation of diversification that increases diversity in and around the field to increase the occurrence of natural enemies, reduce pest pressure and enhance crop production. The diversification practices (a) enhance natural enemies in 52 per cent, (b) reduce pest pressure in 53 per cent and (c) increase yield in only 32 per cent of the cases where this was examined (Poveda *et al.*, 2008). Among the cultural methods, inter and mixed cropping systems, the popular forms of crop-crop diversity, have become more popular in the rainfed regions. Intercropping is one of the important cultural practices for pest management, which is based on the principle of reducing insect pests by increasing the diversity of an ecosystem (Letourneau and Altieri, 1983; Risch *et al.*, 1983 and Baliddawa, 1985). Intercropping can affect the microclimate of the agro ecosystem and ultimately produce an unfavorable environment for pests.

Materials and Methods

The experiment to record the seasonal incidence of aphids was conducted in plots size of 3.0 m x 5.0 m replicated four times with row to row and plant to plant spacing of 60 cm and 20 cm, respectively. The insect pest complex infesting the maize crop was recorded from 21 days after germination till harvest of crop at weekly interval. The population of associated enemies in maize ecosystem was recorded and data obtained were using suitable statistical tools.

Sampling techniques

The associated natural enemies were recorded by the visual count technique from the 5 randomly selected plants per replication during early hours of the day. The numbers associated natural enemies were correlated with prevailing meteorological parameters using suitable statistical tools.

Statistical analysis

The abiotic factors *viz*., temperature, relative humidity and rainfall were recorded throughout the crop season and simple correlation with the population of associated natural enemies was workout using the method suggested by Karl Pearson.

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient.

X = Variable *i.e.* abiotic component.
(Average temperature, relative humidity and total rainfall)

Y = Variable *i.e.* mean number of aphid and their associated natural enemies per plant.

n = Number of observations.

The correlation coefficient (r) values will be subjected to the test of significance using t-test:

$$t = \frac{r}{\sqrt{1 - r^2}} \times \sqrt{n-2} \sim t_{n-2} \text{ d.f.}$$

The calculated t-value obtained will be compared with tabulated t-value at 1% and 5% level of significance.

Results and Discussion

The occurrence of aphidiphagous coccinellid beetles during the course of study has been given in Table 1. The coccinellids appeared in first week of August and thereafter gradually increased till second week of September, 2017.

The respective mean values of coccinellids per plant in intercrop treatments were maize sole (5.80), maize + green gram (8.40), maize + black gram (10.00), maize + cowpea (10.80) and maize + soybean (6.00). The maximum seasonal mean population of coccinellids was recorded in maize + cowpea (5.09 aphids/ plant).

The mean population of coccinellids had a significant positive correlation with mean atmospheric temperature in all the intercrop treatments. The correlation coefficient values in the maize based planting patterns were as: sole maize (r=0.62), maize + greengram (r=0.61), maize + blackgram (r=0.61), maize + cowpea (r=0.69) and maize + soybean (r=0.62). The mean relative humidity and total rainfall did not influence the coccinellid population.

During the experimental period, the syrphid fly maggots population varied during the different weeks of observations under the sole & intercrop treatments (Table 2). The predation of aphids by the larval population of syrphid fly maggots was observed from the first week of August in the maize + green gram, maize + black gram and maize + cowpea; while, in sole maize and maize + soybean the predation began in first week of August, 2017. Their population gradually increased and reached to the maximum in second week of September, 2017 with mean values of 2.80, 2.80, 4.20, 4.60 and 1.80 maggots per plant in sole maize, maize + green gram, maize + black gram, maize + cowpea and maize + soybean, respectively.

The maximum seasonal mean of syrphid fly maggots was recorded in maize + cowpea (2.00 maggots/ plant), followed by that in maize + black gram (1.84 maggots/ plant), maize + green gram (1.33 maggots/ plant) and sole maize (0.96 maggots/ plant); whereas, the minimum syrphid fly maggots were recorded in maize + soybean (0.76 maggots/plant). The abiotic factors of the environment did not evince a significant influence on the syrphid fly population.

The mean population of syrphid fly maggots had a significant positive correlation with mean atmospheric temperature in the treatments maize + green gram (r=0.61) and maize + cowpea (r=0.67). The syrphid fly population under maize + black gram (r=0.61) showed a significant positive correlation with mean relative humidity.

Treatments details

S. No.	Treatment
T_1	Maize sole
T_2	Maize +Greengram (1:1)
T_3	Maize +Blackgram (1:1)
T_4	Maize +Cowpea(1:1)
T_5	Maize +Soybean(1:1)

Table.1 Occurrence of coccinellids on maize aphids in sole and intercropped maize during *kharif*, 2017

Dates of observation	Mean Atm. Temp. (°C)	Mean RH. (%)	Total Rainfall (mm)	Mean No. of coccinellids /plant				
				M	M + Gg	M +Bg	M + C	M + S
07 – Aug	25.70	87.80	0.00	0.80	1.00	1.80	4.00	0.60
14 – Aug	26.40	85.40	2.80	2.00	4.00	3.80	4.00	1.80
21 – Aug	27.00	69.80	4.20	2.80	6.00	6.80	5.20	2.60
28 – Aug	27.40	82.10	107.20	5.20	6.40	8.00	8.80	5.80
04– Sept	25.40	85.70	71.80	0.40	1.20	2.40	6.80	0.20
11 – Sept	26.10	73.90	0.00	5.80	8.40	10.00	10.80	6.00
18 – Sept	26.20	83.90	38.60	1.20	3.00	8.00	9.80	0.80
25– Sept	26.60	62.60	0.00	4.60	4.60	6.00	3.00	4.40
02 – Oct	27.00	54.30	0.00	3.00	3.80	6.20	2.00	2.80
09– Oct	26.60	43.80	0.00	2.40	2.80	2.20	1.00	2.20
16-Oct	25.00	45.00	0.00	1.00	1.60	0.40	0.60	0.80
Seasonal Mean	**26.31**	**70.39**	**20.42**	**2.65**	**3.89**	**5.05**	**5.09**	**2.55**
Coefficient of correlation (r) b/w coccinellids and mean Atm. Temp.				0.62*	0.61*	0.61*	0.69*	0.62*
Coefficient of correlation (r) b/w coccinellids and mean RH				-0.09	0.06	0.28	0.54	-0.06
Coefficient of correlation (r) b/w coccinellids and Total Rainfall				0.08	0.06	0.21	0.35	0.15

* Significant at 5% level of significance

Legend: M = Maize sole, M + Gg = Maize + Geengram (1:1), M + Bg = Maize + Blackgram (1:1), M + C= Maize + Cowpea (1:1), M + S = Maize + Soybean (1:1)

Table.2 Occurrence of syrphid flies maggots on maize aphids in sole and intercropped maize during *kharif*, 2017

Dates of observation	Mean Atm. Temp. (°C)	Mean RH. (%)	Total Rainfall (mm)	Mean No. of syrphid flies maggots /plant				
				M	M + Gg	M + Bg	M + C	M + S
07 – Aug	25.70	87.80	0.00	0.00	0.20	0.60	1.00	0.00
14 – Aug	26.40	85.40	2.80	0.20	0.60	3.40	3.80	0.40
21 – Aug	27.00	69.80	4.20	0.80	0.80	3.00	0.60	1.00
28 – Aug	27.40	82.10	107.20	1.60	2.40	2.20	3.60	0.80
04– Sept	25.40	85.70	71.80	1.00	0.40	2.60	3.00	1.00
11 – Sept	26.10	73.90	0.00	2.80	2.80	4.20	4.60	1.80
18 – Sept	26.20	83.90	38.60	0.40	1.00	2.20	2.60	0.60
25– Sept	26.60	62.60	0.00	1.20	2.60	1.00	1.40	1.00
02 – Oct	27.00	54.30	0.00	0.80	2.00	0.40	0.80	0.80
09– Oct	26.60	43.80	0.00	0.80	1.60	0.20	0.40	0.40
16-Oct	25.00	45.00	0.00	1.00	0.20	0.40	0.20	0.60
Seasonal Mean	**26.31**	**70.39**	**20.42**	**0.96**	**1.33**	**1.84**	**2.00**	**0.76**
Coefficient of correlation (r) b/w syrphid flies maggots and mean Atm. Temp.				0.11	0.61*	0.10	0.67*	0.13
Coefficient of correlation (r) b/w syrphid flies maggots and mean RH				-0.14	-0.19	0.61*	0.46	-0.03
Coefficient of correlation (r) b/w syrphid flies maggots and Total Rainfall				0.17	0.09	0.23	0.47	0.09

* Significant at 5% level of significance

Legend: M = Maize sole, M + Gg =Maize + Geengram (1:1), M + Bg = Maize + Blackgram (1:1), M + C= Maize + Cowpea (1:1), M + S = Maize + Soybean (1:1)

As reviews on effect of intercropping on natural enemies in maize are scanty, the available literature on intercropping with different crops has been compared for discussion. The intercrops facilitated the natural proliferation of predators and recorded higher populations of coccinellids and spiders. Srinivasa Rao *et al.,* (2004) reported the increased activity of coccinellids and spiders in leguminous intercrops. The low incidence of insect pests in intercrop systems was often attributed to one factor (i.e., higher abundance) of their parasitoids and predators, which supports the "natural enemies hypothesis". Kiran Kumar *et al.,* (2008) reported that introducing fodder cowpea as an intercrop in paired rows of corn was significant in realising higher cob yield. Paired row of maize with 2 rows of black gram (2:2) was noticed to be productive intercropping row ratio (Naveena *et al.,* 2012). Avil Kumar *et al.,* (2003) observed that maize and soybean in 1:1 ratio was profitable. Components of intercropping system suffer significantly less damage from insects compared to their cultivation as a sole crops (Altieri & Letourneau, 1999), which has positive impact on yield (Sarker *et al.,* 2007).

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