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Influence of weather parameters on the incidence of natural enemies in rice fallow blackgram ecosystem

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Abstract
Studies were undertaken at Agriculture College Naira, during *rabi*, 2017-2018 to assess the influence of weather parameters on the occurrence of natural enemies fauna in rice fallow blackgram. The incidence of the coccinellid predator (*Cheilomenes sexmaculata*) and spiders (*Oxyopes javanus*) were observed on the insect pests of blackgram. The populations of natural enemies were recorded at regular weekly intervals along with pest complex population, and correlated with the corresponding meteorological data to understand the relationship between them during the season. The incidence of natural enemies initiated during 50th standard week *i.e*., 12 days after sowing and reached the peak at 6th standard week *i.e*., 60 days after sowing. The co-efficient of determination (R^2) for coccinellids was 0.682, which showed that the abiotic factors were able to explain the variation in the population of coccinellids to the extent of 68.2 out of 100. The coefficient of determination (R^2) for spiders was 0.570 which shows that the abiotic factors were able to explain the variation in the population of spiders to the extent of 57.0 out of 100.

Keywords: Backgram, coccinellids, spiders, seasonal incidence

1. Introduction
Pulses are wonderful gifts of nature. They are well known as cheap and excellent source of dietary proteins to humans and animals and also soil fertility restorers. India is a major pulse growing country in the world, sharing 35-36 percent area and 27- 28 percent production of pulse crops and it is producing 12-14 million tones of pulses from 22-24 million ha of land [1]. Urdbean, commonly known as blackgram, *Vigna mungo* (L.) Hepper, is an important short duration pulse crop and the crop growing states of the country are Andhra Pradesh, Assam, Bihar, Gujarath, Haryana, Maharashtra, Karnataka, Kerala, Tamil Nadu, Madhya Pradesh Rajasthan, Uttar Pradesh, West Bengal and Tripura [2]. In Andhra Pradesh it is grown throughout the year in under different agro climatic conditions, such as *kharif* (rainy), *rabi* (winter) and summer crop both in uplands as well as in rice fallows though, urdbean is being grown throughout the year in varied agro-climatic conditions, the productivity was low, because of various biotic and abiotic stresses [3]. Natural enemies are the important biological agents which are responsible for reducing the pest population without any environmental impairment. We must find the ways to enhance their bio control potential so that they can contain the pest populations at levels where no damage occurs. Several natural enemies have been reported from other countries, but the information regarding the incidence of natural enemies from India was very much scanty which need to be studied intensively [1]. In view of this, the studies on seasonal incidence of the natural enemy fauna in rice fallow blackgram ecosystem is highly essential towards the exploration and augmentation of the potential predators for the effective management of the noxious insect pests.

2. Materials and methods
2.1 Site and Location of Experiment
The present investigations were conducted at Agricultural College farm, Naira during *Rabi*, 2017-18 which is geographically situated at an altitude of 27 m above mean sea level, 83.84^0 E longitudes and 18.24^0 N latitude in the North Coastal Agro climatic Zone of Andhra Pradesh.

2.2 Field Preparation and Sowing
Cultivation of rice fallow blackgram involved sowing by dibbling the seeds immediately after harvest of rice. Therefore, no field preparation was done for the experimental crop.

2.3 Experimental layout

A field investigation was carried out to study influence of weather parameters in relation the population dynamics of natural enemies in rice fallow balckgram The experiment was laid out in a bulk plot with an area of 100 m^2 with a popularly growing blackgram cultivar *i.e*., LBG-752 in North Coastal Andhra Pradesh with a spacing of 30 x 10 cm^2 between the rows and plants. Inter cultivation operations like thinning and gap filling were taken at 10 days after sowing.

2.4 Observations recorded

Ten plants each at five different locations were selected randomly and tagged for recording the observations on pest complex and also natural enemies *viz*., coccinellid beetles and spiders. The pest populations and the coccinellid predators and spiders per plant were recorded at weekly intervals from one week after sowing and continued upto the crop maturity. All the weather parameters like, temperature, relative humidity, mean sunshine hours, rainfall and wind velocity were recorded from the meteorological observatory at Agricultural College Farm, Naira and correlated the weather parameters with the incidence of insect pests and their natural enemies on rice fallow blackgram.

2.5 Statistical analysis

Data on the influence of abiotic factors on the occurrence the natural enemies (coccinellids and spiders) on rice fallow blackgram were statistically analyzed by subjecting the data to simple correlation and multiple linear regression (MLR) analysis [4].

3. Results and Discussion

3.1 Influence of the weather parameters on the occurrence of coccinellids on Rabi rice fallow blackgram during, 2017 - 2018.

The incidence of the coccinellid predator (*Cheilomenes sexmaculata*) was reported on the insect pest complex (*viz*., aphids, Thrips, whitefly and spotted pod borer) of rice fallow blackgram. The results of the seasonal incidence of coccinellids in rice fallow balckgram is presented in the table 1& figure 1. The data recorded on the incidence of coccinellid predators revealed that its population was observed from seedling stage to until harvest. The initial incidence was observed on 50th standard week *i.e*., at 12 DOS with a mean population of 2 coccinellids per 50 plants per five locations. The average maximum and minimum temperatures prevailed during the initial infestation were 30.85 and 18.35 ^{0}C, respectively and the average morning and evening relative humidity were 82.57 and 47.85 percent, respectively. The coccinellid population increased gradually from 12 DOS and reached a peak by 60 DOS (5th standard week) with 92 coccinellids per 50 plants. The average maximum and minimum temperatures during the peak level of incidence were 32.78 and 14.42 ^{0}C, respectively and the average morning and evening relative humidity were 91.28 and 35.42 percent, respectively. Thereafter the coccinellid population declined gradually with rise in maximum and minimum temperatures and reached a minimum by 83 DOS (8th standard week) with a mean of 12 per 50 plants. The average maximum and minimum temperatures prevailed were 34.71 and 19.64 ^{0}C, respectively and the average morning and evening relative humidity were 85.14 and 32.28 percent, respectively. Correlations were worked out to find out the relationship between coccinellid population and major weather parameters (Table 2). The results indicated positive but non-significant association between coccinellids and maximum temperature (r = 0.389), morning relative humidity (r = 0.548) and mean sunshine hours (r= 0.334) while it was negative and nonsignificant with minimum temperature (r = -0.303) evening relative humidity (r = -0.374) and wind velocity (r = -0.237). These results are in conformity with that temperature and relative humidity showed non-significant positive correlation with populations of coccinellids [5]. Significant negative correlation effect of minimum temperatures and evening relative humidity on the population of coccinellids [6, 7]. Significant positive correlation was showed in between the coccinellid populations and minimum temperatures and sunshine hours on cow pea [8]. The co-efficient of determination (R^2) for coccinellids was 0.682, which showed that the abiotic factors were able to explain the variation in the population of coccinellids to the extent of 68.2 out of 100 (Table 3& figure 2). The data on the incidence of coccinellids when subjected to multiple linear regression analysis (Table 3), the following equation was arrived

$Y = -75.711 + 7.58\ X1 - 11.71\ X2 + 1.71\ X3 - 1.64\ X4 - 2.62\ X5 - 2.29\ X6$

3.2 Influence of the weather parameters on the occurrence of spiders on Rabi rice fallow blackgram during, 2017 - 2018.

The incidence of spiders (*Oxyopes javanus*) on insect pest complex (*viz*., aphids, Thrips, whitefly and spotted pod borer) of rice fallow blackgram was recorded at regular weekly intervals and correlated with corresponding meteorological data to understand the relationship between them during the season table 1 & figure 1.The data recorded on the incidence of spiders revealed that its population was observed from seedling stage until harvest. The initial incidence was observed on 50th standard week i.e., at 12 DOS with a mean population of one spider per 50 plants. The average maximum and minimum temperatures prevailed during the initial infestation were 30.85 and 18.35 0 C, respectively and the average morning and evening relative humidity were 82.57 and 47.85 percent, respectively. The spiders population was increased gradually from 12 DOS and reached a peak by 60 DOS (6th standard week) with 102 spiders per 50 plants per. The average maximum and minimum temperatures during the peak level of incidence were 32.42 and 17.35 ^{0}C, respectively and the average morning and evening relative humidity were 87.7 and 41.57 percent, respectively. Thereafter the spider population decreased gradually and reached a minimum by 83 DAS (8th standard week) with a mean of 18 spiders per 50 plants. The average maximum and minimum temperatures prevailed were 34.71 and 19.64 ^{0}C, respectively and the average morning and evening relative humidity were 85.14 and 32.28 percent, respectively. Correlations were worked out to find out the relationship between spider population and major weather parameters (Table 4). The results indicated positive but non-significant association between maximum temperature (r = 0.45), evening relative humidity (r = 0.54) and sunshine hours (r = 0.33), and it was negative and non-significant with minimum temperature (r = -0.068) and evening relative humidity (r = -0.374). These results are in contradictory with the findings of [9]. Maximum temperature showed negative correlation between spiders and in cotton [7]. Maximum temperature had highly significant positive correlation with population of spiders in cotton [10]. The coefficient of determination (R^2) for spiders was 0.570 which

shows that the abiotic factors were able to explain the variation in the population of spiders to the extent of 57.0 out of 100 (Table 5). The data on the incidence of spiders when subjected to multiple linear regression analysis (Table 5 & Figure 2), the following equation was arrived

Y = -295.96 + 4.48X1 – 2.82 X2 + 3.67 X3 – 1.41 X4 + 6.11 X5 – 27.01 X6

Table 1: Influence of abiotic and biotic factors on the seasonal incidence of natural enemies on rice fallow blackgram cultivar LBG-752 during *rabi*, 2017– 18

Standard week of derivation	Temperature (°C)		Relative Humidity (%)		Mean sunshine hours	Wind Velocity (Kmph)	Natural enemies	
	Max.	Min.	Morning	Evening			Coccinellids / 50 plants	Spiders/ 50plants/
48th week	30.21	17.08	74.8	39.14	7.71	0.91	0	0
49th week	28.6	17.42	85.14	46.71	2.35	1.18	0	0
50th week	30.85	18.35	82.57	47.85	2.85	0.5	2	1
51st week	30.00	15.42	88.00	50.71	3.67	0.71	5	7
52nd week	33.94	17.14	85.87	61.50	3.65	0.85	9	11
1st week	29.21	15.00	88.57	65.42	4.72	1.02	12	17
2nd week	30.6	15.77	87.71	41.28	4.8	0.7	14	18
3rd week	31.14	14.9	88.57	56.85	7	0.5	22	16
4th week	30.5	16.61	92	45.42	3.57	1.2	33	27
5th week	32.78	14.42	91.28	35.42	7.9	0.71	92	81
6th week	32.42	17.35	87.7	41.57	4.62	0.64	72	102
7th week	33.07	17.85	90.85	39.14	7.22	0.65	36	84
8th week	34.71	19.64	85.14	32.28	8.61	0.92	12	18

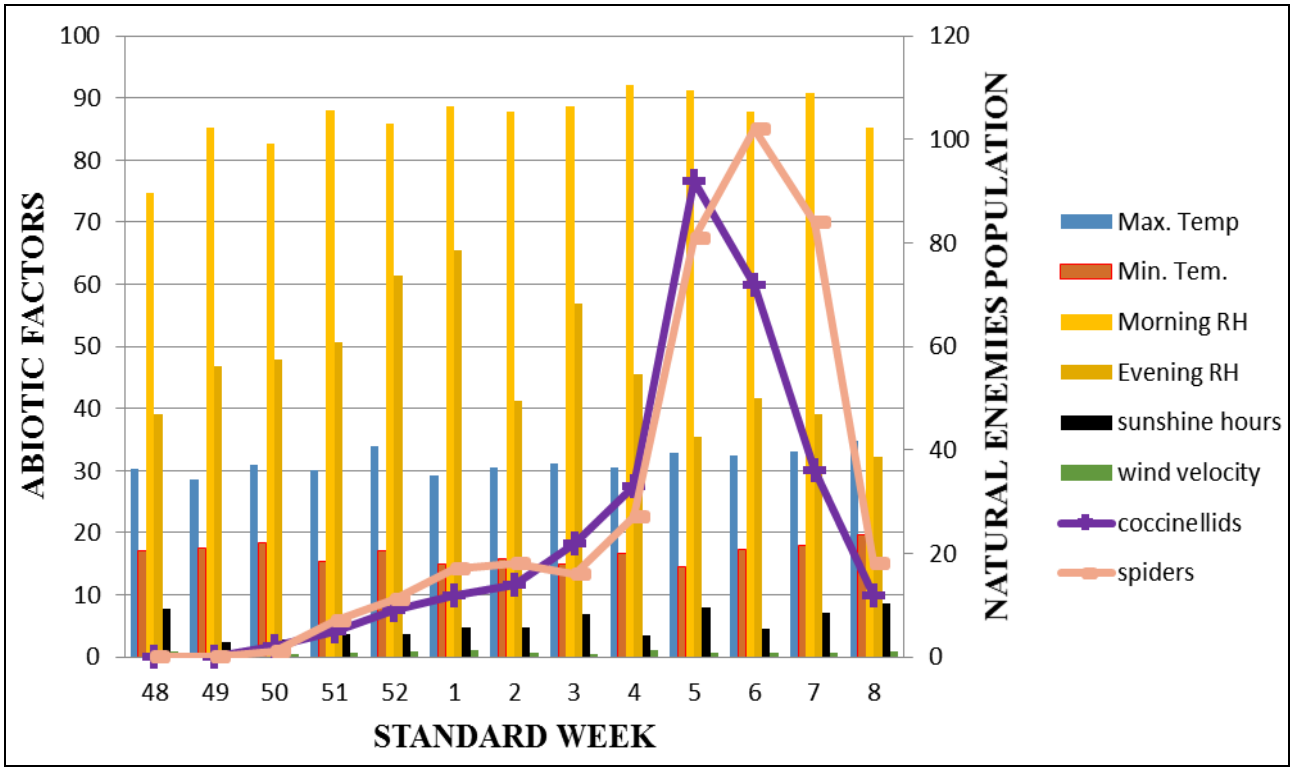

Fig 1: Influence of abiotic factors on the population of natural enemies

Table 2: Correlation between abiotic and coccinellids on blackgram cultivar LB G-752 during *rabi*, 2017 – 18

Abiotic factors	Correlation coefficient (*r*)
X_1 – Maximum temperature (^{0}C)	0.389
X_2 – Minimum temperature (^{0}C)	-0.303
X_3 – Morning relative humidity (%)	0.548
X_4 – Evening relative humidity (%)	-0.374
X_5 – Mean Sunshine Hours	0.334
X_6 – Wind Velocity (Kmph)	-0.237

Table 3: Multiple linear regression between abiotic and cocccinellids on blackgram cultivar LB G-752 during *rabi*, 2017- 18

Variable	Partial regression coefficient	Standard error	t-value
X_1 – Maximum temperature (^{0}C)	0.263	6.145	1.235
X_2 – Minimum temperature (^{0}C)	0.162	7.341	-1.595
X_3 – Morning relative humidity (%)	0.416	1.960	0.874
X_4 – Evening relative humidity (%)	0.115	0.892	-1.840
X_5 – Mean Sunshine Hours	0.614	4.930	-0.532
X_6 – Wind Velocity (Kmph)	0.945	32.044	-0.072
Intercept (A)	-75.71		
Regression equation	$Y = -75.711 + 7.58\ X_1 – 11.71\ X_2 + 1.71\ X_3 – 1.64\ X_4 – 2.62X_5 - 2.29X_6$		
R^2	68.2		

Table 4: Correlation between abiotic factors and spiders on blackgram cultivar LB G-752 during *rabi*, 2017 – 18

Abiotic factors	Correlation coefficient (*r*)
X_1 – Maximum temperature (^{0}C)	0.459
X_2 – Minimum temperature (^{0}C)	-0.068
X_3 – Morning relative humidity (%)	0.517
X_4 – Evening relative humidity (%)	-0.398
X_5 – Mean Sunshine Hours	0.332
X_6 – Wind Velocity (Kmph)	-0.300

Table 5: Multiple linear regression between abiotic and spiders on blackgram cultivar LB G-752 during *rabi*, 2017- 18

Variable	Partial regression coefficient	Standard error	t-value
X_1 – Maximum temperature (^{0}C)	8.816	0.508	0.629
X_2 – Minimum temperature (^{0}C)	10.532	-0.268	0.798
X_3 – Morning relative humidity (%)	2.811	1.308	0.239
X_4 – Evening relative humidity (%)	1.280	-1.104	0.312
X_5 – Mean Sunshine Hours	7.072	0.001	0.999
X_6 – Wind Velocity (Kmph)	45.971	-0.588	0.578
Intercept (A)	-295.961		
Regression equation	$Y = -295.96 + 4.48X_1 – 2.82\ X_2 + 3.67\ X_3 – 1.41\ X_4 + 6.11\ X_5 – 27.01\ X_6$		
R^2	57.0		

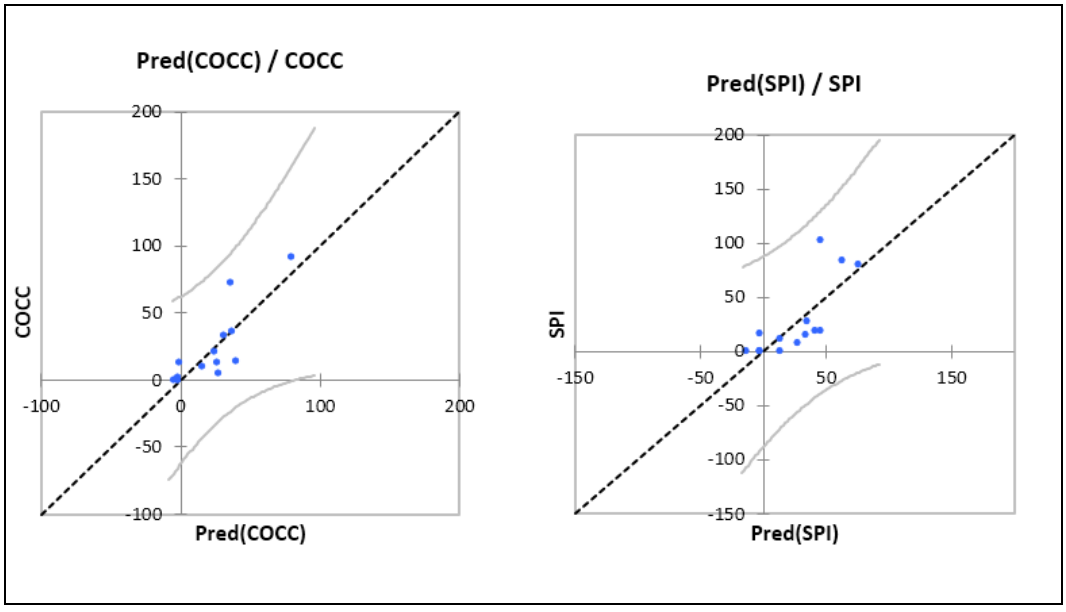

Fig 2: Distribution plots depicting the mean predicted natural enemies population in the blackgram cultivar LBG -752

4. Conclusion

Hence, uncertainty in climatic condition with a greater fluctuation in high and low temperature during winter and summer seasons and abnormal rain influences the activity and strength of the natural enemies population, therefore, a continuous study on the population dynamics of the natural enemies is desirable in order to conclude the conditions for their ups and down on the crop and exploration and augmentation of the potential predators in the pest prone area is highly essential towards the effective management of these noxious pests.

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