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Research article

INCIDENCE AND ABUNDANCE OF IMPORTANT PREDATORY BEETLES WITH SPECIAL REFERENCE TO *COCCINELLA SEPTEMPUNCTATA* IN SUB-HIMALAYAN REGION OF NORTH –EAST INDIA

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ABSTRACT: Among the different predators coccinellid beetles play an important role in the natural suppression of destructive insect pests viz., jassid, aphid, thrips, hoppers mites and eggs of many other insect pests infesting brinjal, ladysfinger and rice crop. *Coccinella septempunctata*, an important coccinellid beetle in the sub-Himalayan region of north-east India was found very active on different insect pests of brinjal, ladysfinger and rice during kharif and post kharif season. This coccinellid beetle is an important biological pest control agent. Field experiment in pesticide untreated fields for three consecutive years (2005-2007) on the three different *kharif* crops at the agricultural research farm of Uttar Banga Krishi Viswavidyalaya, West Bengal, India showed the presence of 12 species of coleopteran beetles as generalized predator. Among them *C. septempunctata* was found in maximum in brinjal field and the higher was being recorded during September-October (32-38 SMW) and population declined in November. Similar seasonal incidence pattern was followed for ladysfinger and rice crop and higher average populations were achieved during October (37-38 SMW) and late September (35 SMW) respectively. Incidence of *C. septempunctata* showed significant positive correlation (p= 0.05) with maximum and mean temperature and significant negative correlation with maximum and gradient relative humidity and rainfall whereas with humidity gradient and rainy days the correlation was negative but non-significant.
Keywords: Climatic parameters, crop variety, insect pest, bio-agent, natural suppression

INTRODUCTION

Biodiversity both theoretically and practically has relevance in addressing many problems of contemporary agriculture and allows the formation of functional groups that drive key ecosystem processes [8]. The green revolution was literally and metaphorically a technology packaged for mass consumption. The package usually included the HYV seeds, nitrogen and phosphate fertilizers, insecticides, and fungicides. In many countries farmers were obliged to use all of these inputs, including calendar-based insecticide applications [11]. Insecticide inputs were based on the assumption that crop yields are limited by insect pests, and that insecticides could control these pests. The key focus of IPM is now diversity, instead of single pest populations. Increased genetic and species diversity favour the resistance and resiliency of the ecosystem to pest attack, and should, therefore, be enhanced. A more diverse composition of primary producers (crops and weeds) prevents specialized pests from becoming abundant, and provides better conditions for the survival of natural enemies [1]. The first two principles emphasize the importance and maintenance of naturally occurring ecological processes and defense mechanisms favouring crop production that should be taken advantage of by the farmer. Healthy crops can resist pest attack and compensate for incidental damage, whereas a healthy ecosystem with plenty of natural enemies helps to defend against pest attack.

The biological control that is the diminution of pest populations as influenced by agro-bio-conenoses is due to unfavorable environment factors and, on the other hand, to biotic factors. Consistently high levels of natural biological control may often result from a complex set of community-level interactions that lead to a far more stable and robust system, vis-à-vis insect pest populations characterization of the potential natural enemy population on an ecosystem basis in the north-east sub-Himalayan parts India is hardly been carried out. The importance, abundance and effectiveness of many species of natural enemies of important economic crop insect pests have not yet been thoroughly investigated in the northern parts of West Bengal, India. Therefore, their importance as biological control agent is seldom be recognized from the entomological and ecological point of view. The pioneering role in the development of biological pest control has rendered by the Coccinellidae has great practical and scientific interest. The species found in the agro-ecosystem in terms of biodiversity can be recruited as bio-indicators owing to their climatic and trophic characteristics [5].

MATERIALS AND METHODS

Sampling site and agro-climatic conditions: Field observation was conducted during three consecutive years (2005-2007) at the adjoining area of University research farm [26.50^0 N-89.52^0 E] of UBKV (Agricultural University), Pundibari, Cooch Behar, West Bengal, India. The soil of the experimental field was sandy loam with PH value 6.9 and EC value 0.25mmhs/cm. Available N, P_2O_5 and K_2O was 311, 55 and 351 kg/ha respectively. The important climatic factors during the period of study pertaining to the incidence of coccinellid population are delineated in the table-1.

Table.1: Climatic conditions during the time of study

Years	Temperature				Humidity				Average sunshine hour (hr/day)	Total Rainfall (mm)	Number of rainy days
	Tmax	Tmin	Tgr	Tavg	RHmax	RHmin	RHgr	RHavg			
2005	31.41	22.57	8.85	26.99	86.94	69.35	17.59	78.14	7.12	1614.05	58
2006	33.12	21.55	11.57	27.33	88.35	71.33	17.02	79.84	7.01	2570.10	70
2007	33.56	23.45	10.11	28.50	88.97	72.45	16.52	80.71	7.22	2183.22	64

Experimental layout

Incidence of coccinellid population was assessed by randomized block design (RBD) in three crop field *viz*., brinjal (vr.pusa purple long), ladysfiger (vr. nirmal-101) and rice (vr *swarna mashuri*, MTU-7029) were raised two times in each year covering both *kharif* and post *kharif* season for the three consecutive years, 2005-2007. Chemical inputs and field management was done in due time following the suggestive direction given in the National protocol for each of the three crop in due time with befitting modifications. The ladysfinger variety 'Nirmal-101' was grown under recommended fertilizer levels (120:60:60 kg NPK/ha) and cultural practices in 4 m x 5m plots at a spacing of 75 cm x 35 cm. Similar pattern was followed for another vegetable crop, brinjal with spacing of 75 cm x 75 cm. Rice was grown under recommended fertilizer levels (80:40:40 kg NPK/ha) and cultural practices in 8 m x 10m plots at a spacing of 20 cm x 10 cm.

Assessment on coccinellid incidence

Observation on the incidence of coccinellid population from each of the three crop field was recorded starting with the initiation of predator population. Field was inspected weekly in 'W' shaped pattern and the coccinellid abundance was assessed from 10 randomly selected plants from each of the five replicated plots.

Preservation and labeling

The collected coccinellid specimens were preserved in 70% ethanol in clean specimen glass vial with necessary tagging displaying the date, time crop variety and place of collection. Identification of the collected specimens was done.

Methodology

The diversity index was calculated using the formula [2].

Where; ni = Individual of each species caught, N = Total Individual of all species caught and D = Diversity index. This was used to know the level of dissimilarity of the plants used and this is to know the degree of similarity in taxonomic categories represented between the pair.

Morisita's index of similarity was used to calculate the similarity index between each paired group of the plants used [6]. Where, 8 and 8 = squares of total number of individuals in sample 1 and 2, respectively, n = Number of individuals ofspecies in sample 1 and n in sample 2. N , N = Total number of individuals in sample 1 and 2, respectively The graphs of population dynamics was also plotted for orders of insect using the mean number of insect collected in each month against the months of collection.

Statistical analysis: Periodically assessed GM number were correlated with the prevailing climatic factors such as maximum temperature (Tmax), minimum temperature (Tmin), temperature gradient (Tgr), Maximum humidity (RHmax), minimum humidity (RHmin), humidity gradient (RHgr), sunshine hour (Shr), rainfall (Rfall) and rainy days (Rdays). The interrelationship between the population number and the meteorological data was serially tabulated. Correlation values of both individual and cumulative years were worked out.

RESULTS AND DISCUSSION

Guild composition of predatory Coccnilids

In total of 640 specimens of coleopteran insects were captured out of which 213 the coccinellids were representing 12 species. In the field of brinjal crop there were 8-species of coccinellidae with highest population of *Coccinella septempunctata* (3.08 individuals/plant) was registered. While for field of ladysfinger and rice crop the maximum species number was 6 and 11 respectively with highest population of *Coccinella septempunctata* (1.44 individuals/plant and 3.78 individuals/hill respectively) was registered The evenness value showed that the whole of the crop area was evenly distributed with only the dominance of a few species namely *Coccinella septempunctata, Brumus suturalis,* following the species *Menochilus 6-maculata and Coccinella septempunctata* var *divaricata* with more population as compared to others. A survey of natural enemies in greenhouses was conducted during the 2004/2005 and 2005/2006 growing seasons. The results showed the presence of the following natural enemies: *Eretmocerus mundus* and *Encarsia formosa* (Hymenoptera: Aphilinidae), *Stethorus gilvifrons* (Coleoptera:Coccinellidae), *Aphidoletes aphidimyza*, *Feltiella acarisuga* (Diptera: Cecidomyiidae), *Scolothripssexmaculatus* (Thysanoptera: Thripidae), *Dicyphus* sp. (Hemiptera: Miridae), *Diglyphus isaea* (Hymenoptera: Eulophidae), *Hyposoter* sp.(Hymenoptera: Ichneumonidae) *Euplectrus* sp. (Hymenoptera: Eulophidae), *Praon* sp. (Hymenoptera: Aphidiidae). Moreover, the population changes of some of these natural enemies were determined. This study will be continued to select the most efficient natural enemies for applied biological control.

Incidence in relation to season (Table 4)

Grossly, *Coccinella septempunctata* was found active throughout the study period, 27 – 44 Standard Meteorological Week (SMW) on all the crops studied. Initiation of the population occurred during July – August (27 and 28 SMW) which was immediately followed by the moderate peak during late August - early September. Low population at the early study period in late July-August (27-31 SMW) gradually improved attaining the maximum during September-October (32-38 SMW) and population declined in November. Highest average population of 3.08/plant was recorded during October (38 SMW). Similar seasonal incidence pattern was followed for ladysfinger and rice crop and highest average population of 1.44/plant and 3.78/hill was achieved during October (38 SMW) and late September (35 SMW) respectively.

Table 2 Shannon-Weiner Diversity Index of *Coccinella* sp in different crop ecosystem

Index	Components	Brinjal	Ladysfinger	rice
Diversity	H	1.59	1.28	1.58
Max diversity	Hmax	1.97	1.39	1.44
Evenness	J	0.91	0.94	0.90
Dominance	D	0.09	0.06	0.08

H'= Shannon-Weiner Diversity Index, where absolute diversity = 1.00;J'= Evenness or relative Diversity (H'/ H'max), where absolute evenness=1.00; 1-J'= Dominance or heterogeneity (where absolute dominance =0.00)

Table 3: Correlation coefficient of incidence of *Coccinella* population with the climatic factors indicating the level of significance

Climatic parameters	Years of observation		
	2005	2006	2007
Maximum temperature (Tmax)	0.781*	0.655*	0.788
Minimum temperature (Tmin)	-0.772*	-0.721*	-0.821*
Temperature gradient (Tgr)	0.314	0.452	0.334
Mean temperature (Tavg)	0.713	0.742*	0.812*
Maximum humidity(RHmax)	-0.824*	-0.571*	0.522
Minimum humidity (RHmin)	-0.166	0.656*	0.756*
Humidity gradient (RHgr)	-0.352	-0.796	-0.734
Mean humidity (RHavg)	0.609*	0.355	0.766*
Sunshine hours / day(Shr)	0566*	-0523	0781*
Rainfall (Rfall)	-0611*	-0.512*	-0732*
Rainy days (Rdays)	-0602	-0710	-0621

Significant at 5% level

Incidence in relation to crop cultivar (Table 4)

Incidence varied from year to year depending on their host and prevailing weather conditions. In the early crop growth stage for the three crops studied the predator population was very low during July-August and gradually increased with the development of vegetative growth of the crops. Abundant population was noted throughout the growing period of the crops, achieving the maximum being recorded at the active vegetative growth stage. In brinjal and tomato field higher population was found in active vegetative growth phase during September-October, 34-39 SMW recording the predator population range 0.89-3.08/plant and 0.56-1.44/ plant respectively. In rice field about similar pattern of incidence followed and higher population of 2.56-3.78/hill was recorded during September-October, 31-37 SMW. After that the population gradually declined with the maturity of the crops in all the three crop fields. The beetle population was distributed vertically along the entire length of the plant canopy. As the growth stage advances, due to the micro climatic zonation most of the beetles congregate to the upper part of the canopy.

Incidence in relation to climatic factors (Table.3)

Tmax was found to exhibit positive correlation with the field population. Significant positive correlation occurred only in the years 2005 and 2006. In all the cases, Tmin showed significant negative correlation with the predator population. Incidence of the predator showed non-significant positive correlation with Tgr in all the years. Except in 2005, in all other years, the field populations had a significant positive correlated with Tavg. Significant negative correlation was found with RHmax only in 2005 and 2006. Effect of RHmin upon the occurrence of the predator population was non-significant in the year 2005 but had a significant positive correlation in other two years. No significant relation existed between the RHgr and the field populations of predator in any of the years studied

Table 4: Dynamics of *Coccinella* population on different crops

SMW	Brinjal				Ladys finger				Rice			
26	2005	2006	2007	Mean	2005	2006	2007	Mean	2005	2006	2007	Mean
27	0.33 (0.91)	0.00 (0.71)	0.33 (0.91)	0.22 (0.85)	0.33 (0.91)	0.00 (0.71)	0.12 (0.79)	0.15 (0.81)	0.33 (0.91)	1.50 (1.41)	1.05 (1.24)	1.05 (1.24)
28	0.33 (0.91)	0.50 (1.00)	0.50 (1.00)	0.44 (0.97)	0.32 (0.91)	0.12 (0.79)	0.67 (1.08)	0.37 (0.93)	1.00 (1.22)	2.00 (1.58)	1.44 (1.39)	1.44 (1.39)
29	0.34 (0.92)	0.67 (1.08)	0.50 (1.00)	0.50 (1.00)	0.27 (0.88)	0.00 (0.71)	0.16 (0.81)	0.14 (0.80)	0.67 (1.08)	2.00 (1.58)	1.22 (1.31)	1.22 (1.31)
30	0.34 (0.92)	0.67 (1.08)	0.67 (1.08)	0.56 (1.03)	0.32 (0.91)	0.33 (0.91)	0.00 (0.71)	0.15 (0.81)	0.67 (1.08)	3.00 (1.87)	1.45 (1.40)	1.45 (1.40)
31	0.67 (1.08)	0.16 (0.81)	0.67 (1.08)	0.50 (1.00)	0.53 (1.01)	0.00 (0.71)	0.50 (1.00)	0.34 (0.92)	3.33 (1.96)	3.25 (1.94)	3.28 (1.94)	3.28 (1.94)
32	2.67 (1.78)	2.01 (1.58)	1.16 (1.29)	1.94 (1.56)	0.67 (1.08)	0.33 (0.91)	0.50 (1.00)	0.50 (0.92)	3.67 (2.04)	3.00 (1.87)	3.00 (1.87)	3.00 (1.87)
33	2.00 (1.58)	0.68 (1.09)	1.67 (1.47)	1.45 (1.40)	0.33 (0.91)	0.67 (1.08)	0.67 (1.08)	0.56 (1.03)	3.33 (1.96)	3.33 (1.96)	3.44 (1.98)	3.44 (1.98)
34	2.33 (1.68)	2.33 (1.68)	3.33 (1.96)	2.63 (1.77)	0.33 (0.91)	0.67 (1.08)	0.67 (1.08)	0.56 (1.03)	3.57 (2.02)	3.67 (2.04)	3.19 (1.92)	3.19 (1.92)
35	1.67 (1.47)	2.00 (1.58)	3.67 (2.04)	2.45 (1.72)	0.67 (1.08)	1.00 (1.22)	1.00 (1.22)	0.89 (1.18)	3.33 (1.96)	4.35 (2.20)	3.78 (2.07)	3.78 (2.07)
36	2.67 (1.78)	1.00 (1.22)	2.67 (1.78)	2.11 (1.62)	1.00 (1.22)	1.33 (1.35)	1.00 (1.22)	1.11 (1.27)	3.67 (2.04)	2.30 (1.67)	3.21 (1.93)	3.21 (1.93)
37	2.67 (1.78)	0.67 (0.89)	3.67 (2.04)	2.34 (1.69)	1.67 (1.47)	1.00 (1.22)	1.33 (1.35)	1.33 (1.35)	3.00 (1.87)	2.00 (1.58)	2.56 (2.07)	2.56 (1.75)
38	3.01 (1.87)	1.33 (1.35)	4.91 (2.33)	3.08 (1.89)	1.33 (1.35)	1.33 (1.35)	1.33 (1.35)	1.44 (1.39)	2.00 (1.58)	1.50 (1.41)	1.83 (1.93)	1.83 (1.53)
39	1.00 (1.22)	1.00 (1.22)	0.67 (1.08)	0.89 (1.18)	1.00 (1.22)	0.67 (1.08)	0.33 (0.91)	1.00 (1.22)	2.00 (1.58)	3.25 (1.94)	2.53 (1.75)	2.53 (1.74)
40	0.33 (0.91)	0.30 (0.89)	0.67 (1.08)	0.43 (0.96)	0.67 (1.08)	0.00 (0.71)	0.27 (0.88)	0.33 (0.91)	1.67 (1.47)	1.30 (1.22)	1.42 (1.53)	1.42 (1.39)
41	0.12 (0.79)	0.01 (0.71)	0.31 (0.90)	0.12 (0.79)	0.17 (0.82)	0.33 (0.91)	0.33 (0.91)	0.26 (0.87)	1.67 (1.47)	1.00 (1.22)	1.33 (1.35)	1.33 (1.35)
42	0.12 (0.79)	0.00 (1.71)	0.33 (0.91)	0.15 (0.81)	0.00 (0.71)	1.00 (1.22)	0.33 (0.91)	0.44 (0.97)	1.33 (1.35)	1.33 (1.35)	1.44 (1.39)	1.44 (1.39)
43	0.00 (0.71)	0.67 (1.08)	1.67 (1.47)	0.78 (1.13)	0.00 (0.71)	1.00 (1.22)	0.67 (1.08)	0.44 (0.97)	1.33 (1.35)	2.00 (1.58)	1.67 (1.47)	1.67 (1.47)
44	0.67 (1.08)	1.00 (1.22)	0.33 (0.91)	0.66 (1.08)	0.00 (0.71)	0.67 (1.08)	0.67 (1.08)	0.44 (0.97)	1.50 (1.41)	1.33 (1.35)	1.00 (1.22)	1.28 (1.33)

SMW= Standard Meteorology Week

Figures in the parenthesis are square root transformed values

The predator populations exhibited significantly positive correlation in 2005 and 2007 with RHavg. Shr exerted a significant positive effect on the incidence of predator except in the year 2006 where the relation was negative with non-significant. High rain fall within a short spell of time showed a significant negative relation with the predator occurrence in all the three years studied. Intermittent rains with high temperature had insignificantly positive effect on this pest bionomics in 2005 and 2007. However, the number of rainy days had no significant effect on the predator population.

The ladybird beetles migrated between various crop fields throughout the season depending upon the availability of prey and habitat disturbance [4, 7] from the terai region of West Bengal reported that *Menochilus* sp. and *Coccinella* sp causes maximum suppression to brinjal insect pests particularly during summer crop

[10] Estimated that in Bangalore lady bird beetle accounted nearly 77-78% and 83-95% of the total predator populations in summer (March-May) and in kharif (August-October) respectively in cowpea field. They play their important role as bio-control for those crops that are especially susceptible to aphid attack [3, 12]. Seasonal changes influence the occurrence of pest outbreaks, the type of plant infested and thus the behaviour of the coccinellids. In early stage of crop growth different insect pests on vegetable crops and rice crop can be controlled with protective insecticides but cause harmful effect to natural enemies of the pests. An experiment in the cotton field was conducted by [9] in Tamil Nadu revealed that the activity and abundance of *Menochilus sexmaculatus* were reduced significantly when triazophos, monocrotophos or methamidophos were sprayed.

CONCLUSION

Coccinella septempunctata, the predator was found active during kharif and post kharif season in the field of brinjal, ladysfinger and rice throughout the study period. This predator is helpful for bio-control of insect pest in the three different crop fields studied. Pest control by using bio-control agent is an important component of Integrated Pest Management (IPM) and organic farming. Pesticide spray should be done carefully to the crops when population of the predator is abundant in the field.

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