



## Diversity of natural enemy fauna in rice ecosystem in relation to different levels of nitrogen

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**ABSTRACT:** Effect of nitrogen levels on the natural enemy fauna on rice variety PR118 was studied at Balloke village (Dist. Ludhiana) during *kharif* 2005 and 2006. The mean per cent populations of insect predators and parasitoids were higher at 103.69kg N ha<sup>-1</sup> (225kg urea), whereas spider fauna was more abundant at higher dose of nitrogen (172.81kg N ha<sup>-1</sup>; 375kg urea). During 2005 and 2006, the overall diversity index in the crop season was higher (2.162 and 1.948, respectively) when higher dose of N was applied (172.81kg N ha<sup>-1</sup>).

**KEY WORDS:** Diversity, insect predators, parasitoids, nitrogen level, rice, spider

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### INTRODUCTION

In Punjab, rice is cultivated over an area of 26.42lakh hectares, with an annual production of 101.93lakh tonnes (Anonymous, 2007). Among different physical and biological constraints, insect pests are the major ones and contribute substantially to yield loss. Rice is essentially a crop of warm, humid environment conducive to the survival and proliferation of insects. More than 100 species of insects are known to attack this crop, of which about 20 are of economic importance (Pathak and Dhaliwal, 1981). The overall losses due to insect pest damage in rice are estimated at 25 per cent (Dhaliwal *et al.*, 2004). The Punjab farmers usually apply higher doses of nitrogen to achieve better

crop yield, which leads to higher insect pest infestations (Sharma *et al.*, 1995). However, the information on the effect of nitrogen on the natural enemy fauna of rice insect pests is lacking in literature. Natural enemies usually play an important role in causing population fluctuations of insect pests. Keeping this in view, the present studies were conducted to determine the effect of different nitrogen levels on the diversity of natural enemies in rice ecosystem.

### MATERIALS AND METHODS

The experiment was conducted in a farmer's field in Balloke village (Dist. Ludhiana) on variety PR118 during *kharif* 2005 and 2006 in a randomized block design, with four levels of nitrogen replicated

five times. The plot size was 5x3m. Nitrogenous fertilizer was applied @103.69, 126.73 (recommended), 149.77 and 172.81 kg N per hectare (225, 275, 325 and 375 kg urea, respectively) in three split doses. The first 1/3<sup>rd</sup> dose was applied at last puddling, second at 3 weeks after transplanting and the last one at 6 weeks after transplanting. The other agronomic practices were followed as per PAU package of practices for *kharif* crops, except that the crop was kept unsprayed (Anonymous, 2005). Counts of natural enemy fauna were made at 10 days interval, beginning at 40 days after transplanting (DAT). For this, two quadrates of 1m<sup>2</sup> were selected in each plot and the natural enemy fauna was collected using sweep net (13.5 inches diameter and 31 inches bar length) by following five successive double stroke sweeps. Sometimes, spiders found or clinging on the leaf blades, leaf sheath or on the web were directly collected into vials (4cm diameter and 6 cm length) manually. The insect predator and parasitoid specimens were pinned with entomological pins (38x0.53mm), tagged and then kept in insect collection boxes. Spider specimens were preserved in Oudemans's fluid (87 parts alcohol, 5 parts glycerine and 8 parts glacial acetic acid) in homoeopathic vials. The natural enemy fauna was identified up to order family level from experts on different groups.

The diversity indices for natural enemies were computed as under:

a. Diversity index (Shannon and Weaver, 1949)

$$\text{Shannon-Weaver's index } (\bar{H}) = - \sum_{i=1}^{ST} p_i \log_e p_i$$

Where,  $p_i$  = Proportion of individuals in the  $i^{\text{th}}$  family/order ( $n_i / D N$ );  $n_i$  = Importance value for each family/order;  $N$  = Total of importance values;  $ST$  = Total families/orders in a habitat.

b. Evenness index (Pielou, 1966)

$$\text{Evenness index } (J) = 1 / \log s$$

Where,  $J$  = Shannon-Weaver's index;  $S$  = Number of families/orders

c. Index of Dominance (Southwood, 1978)

$$\text{Index of dominance } (D) = 1 - J$$

Where,  $J$  = Evenness index

## RESULTS AND DISCUSSION

### Population of natural enemy fauna

The natural enemy fauna at different levels of nitrogen pooled over different sampling dates during both 2005 and 2006 comprised different families, namely, Braconidae, Ichneumonidae, Coccinellidae, Coenagrionidae, Gryllidae, Araneidae, Tetragnathidae, Oxyopidae, Salticidae, Lycosidae, Metidae and Thomisidae. In addition to these, Carabidae (in 2005), Chalcididae, Staphylinidae, other Coleoptera and Hemiptera were also observed during 2006 (Table 1).

During 2005, the proportion of insect predators and parasitoids was more (50.63-64.48%) than that of spider predators (35.52-49.97%) among various nitrogen treatments (Table 1). The population of insect predators and parasitoids was higher (64.48%) at lower level of N (103.69 kg N ha<sup>-1</sup>) and it decreased progressively with increase in nitrogen level, the minimum (50.63%) being at highest level of nitrogen (172.81 kg N ha<sup>-1</sup>). However, in case of spiders, the trend was reverse, being minimum (35.52%) at 103.69 kg N ha<sup>-1</sup> and maximum (49.37%) at 172.81 kg N ha<sup>-1</sup>. Among insect predators and parasitoids, Coenagrionidae was predominant at all nitrogen levels, followed by Ichneumonidae (at 103.69 kg N ha<sup>-1</sup>), Braconidae (at 126.73 and 172.8 kg) and Coccinellidae (at 172.81 kg).

Among the spider predators, Araneidae dominated at all nitrogen levels, followed by Tetragnathidae. During 2006, the population of insect predators and parasitoids and spiders fluctuated throughout the season. Percentage population of insect predators and parasitoids was higher at lowest level of nitrogen (53.24%), followed by 149.77 kg N / ha (51.59%). The spider population was 56.34% at 126.73 kg N / ha and 55.11% at 172.81 kg N, while it was minimum (46.76%) at 103.69 kg N / ha. Among insect predators and parasitoids, Coenagrionidae was predominant, followed by Braconidae at all nitrogen levels. Among spider predators, Araneidae dominated, followed by Tetragnathidae. Overall, the mean per cent

**Table 1. Population of natural enemies on rice crop in relation to levels of nitrogen during 2005 and 2006**

Order/ Family	Number* of individuals (At dose of N kg/ha#)											
	2005				2006				Mean			
	103.69	126.73	149.77	172.81	103.69	126.73	149.77	172.81	103.69	126.73	149.77	172.81
Insect predator/ parasitoid												
Hymenoptera												
Braconidae	13	14	10	15	28	15	27	28	20.5	14.5	18.5	21.5
Ichneumonidae	14	13	14	12	4	4	7	6	9.0	8.5	10.5	9.0
Chalcididae	-	-	-	-	-	-	-	1	-	-	-	0.5
Coleoptera												
Coccinellidae	6	5	15	13	10	14	17	16	8.0	9.5	16.0	14.5
Carabidae	-	-	-	2	-	-	-	-	-	-	-	1.0
Staphylinidae	-	-	-	-	-	-	-	2	-	-	-	1.0
Others	-	-	-	-	-	-	1	-	-	-	0.5	-
Odonata												
Coenagrionidae	36	31	34	38	32	29	28	26	34.0	30.0	31.0	32.0
Orthoptera												
Gryllidae	-	1	-	-	-	-	-	-	-	0.5	-	-
Hemiptera	-	-	-	-	-	-	1	-	-	-	0.5	-
Population (%)	64.48	60.95	57.48	50.63	53.24	43.66	51.59	44.89	58.13	51.01	54.23	47.60
Spiders												
Araneidae	14	13	23	25	32	40	38	45	23.0	26.5	30.5	35.0
Tetragnathidae	10	10	12	21	22	25	25	35	16.0	17.5	18.5	28.0
Oxyopidae	4	8	5	12	3	4	9	12	3.5	6.0	7.0	12.0
Salticidae	3	6	8	3	3	7	4	4	3.0	6.5	6.0	3.50
Lycosidae	7	2	4	13	2	1	-	1	4.5	1.5	2.0	7.0
Metidae	-	1	-	1	2	1	-	-	1.0	1.0	-	0.5
Thomisidae	-	1	2	3	1	2	-	-	0.5	1.5	1.0	1.5
Population (%)	35.52	39.05	42.52	49.37	46.76	56.34	48.41	55.11	41.87	48.99	45.77	52.40

\* Based on 5 net sweeps in each of 2 quadrates (1 m<sup>2</sup>) in a replication; # Nitrogen applied in the form of urea @ 225, 275, 325 and 375 kg/ha

population of insect predators and parasitoids was higher (58.13%) at the lowest dose of nitrogen (103.69kg N ha<sup>-1</sup>), whereas spider fauna was higher (52.40%) at higher dose of N (172.81kg N ha<sup>-1</sup>) and minimum (41.89%) at 103.69kg nitrogen dose (Table 1). Overall, Coenagrionidae and Braconidae were predominant at all N levels. In case of spider fauna, Araneidae dominated followed by Tetragnathidae.

### Diversity

During 2005, the diversity index was high during early crop growth stage (40-60 DAT) at lower nitrogen level of (103.69-126.73kg N ha<sup>-1</sup>),

while it was high during 70-110 DAT at higher level of N (172.81kg N ha<sup>-1</sup>). In case of 40 DAT, the diversity was more (1.889) in 103.69kg dose than at other N levels, while evenness index (0.979) was more in higher dose of N (172.81kg N ha<sup>-1</sup>). At 50 and 60 DAT, diversity indices were the highest (1.697 and 1.978, respectively) in case of 126.73kg dose, which also showed higher evenness indices (0.947-0.951).

The diversity index at 172.81kg N ha<sup>-1</sup> dose at 70 (1.851) to 110 (1.826) DAT was high, which was more due to more evenness indices (0.891-0.964) at 70 (0.891), 90 (0.964) and 110 (0.938) DAT. However

**Table 2. Effect of different levels of nitrogen on the diversity of natural enemy fauna in rice crop during 2005**

Level of nitrogen (kg/ha#)		Diversity index (Days after transplanting)								Overall
		40	50	60	70	80	90	100	110	
103.69	- No.	7	5	6	7	4	6	6	4	9
	- H	1.889	1.462	1.529	1.568	1.089	1.566	1.635	1.234	1.934
	- J	0.970	0.909	0.853	0.806	0.786	0.874	0.912	0.890	0.880
	- D	0.030	0.091	0.147	0.194	0.214	0.126	0.088	0.110	0.120
126.73	- No.	5	6	8	8	5	5	4	5	12
	- H	1.506	1.697	1.978	1.540	1.522	1.418	1.333	1.264	2.068
	- J	0.936	0.947	0.951	0.741	0.946	0.881	0.962	0.786	0.83
	- D	0.064	0.053	0.049	0.259	0.054	0.119	0.038	0.214	0.168
149.77	- No.	6	5	7	7	5	5	6	5	10
	- H	1.683	1.425	1.651	1.510	1.386	1.490	1.563	1.414	2.047
	- J	0.939	0.886	0.848	0.776	0.861	0.926	0.872	0.878	0.889
	- D	0.061	0.114	0.152	0.223	0.139	0.074	0.128	0.122	0.111
172.81	- No.	6	6	7	8	7	6	6	7	12
	- H	1.754	1.570	1.800	1.851	1.722	1.727	1.658	1.826	2.162
	- J	0.979	0.876	0.925	0.891	0.885	0.964	0.925	0.938	0.870
	- D	0.021	0.124	0.075	0.109	0.115	0.036	0.075	0.062	0.130

No.- Number of natural enemy families/orders, H-Diversity index, J-Evenness index, D-Dominance index; # Nitrogen applied in the form of urea @ 225, 275, 325 and 375 kg/ha

at 80 and 100 DAT, the evenness indices (0.946-0.962) were maximum in case of 126.73kg dose. The overall diversity index in the crop season was higher (2.162) at higher dose (172.81kg N ha<sup>-1</sup>), followed by 126.73kg N ha<sup>-1</sup> (recommended) than at other doses of N (Table 2). Overall, at all the N levels, the diversity of natural enemy fauna was due to the high evenness indices, maximum (0.889) being at 149.77kg N ha<sup>-1</sup> dose.

During 2006, the diversity index was high at higher dose of N (149.77 and 172.81kg N ha<sup>-1</sup>) from 40-90 DAT, whereas at 100 and 110 DAT it was higher at 126.73kg N ha<sup>-1</sup>. At 40 DAT, diversity index (1.529) and evenness index (0.853) were higher at

149.77kg N ha<sup>-1</sup>. At 50 and 60 DAT, diversity index was high (1.722-1.842) at 172.81kg N ha<sup>-1</sup> dose, while evenness index at 50 DAT (0.961) was high at 172.81kg N ha<sup>-1</sup> dose and at 60 DAT (0.900) it was high at 126.73kg N ha<sup>-1</sup> dose (Table 3).

At 70 DAT, diversity index was higher (1.616) at 149.77kg N ha<sup>-1</sup> while evenness was more (0.916) at 172.81kg N ha<sup>-1</sup>. At 80 and 90 DAT, evenness index was higher (0.921-0.934) at 103.69kg N ha<sup>-1</sup> level while diversity was higher at 80 DAT (1.943) and 90 DAT (1.803). The diversity index at 100 and 110 DAT was higher (1.713 and 1.851) at 126.73 kg dose than at other N levels and it was due to higher evenness index (0.906 at 100 DAT) at 172.81 and

**Table 3. Effect of different levels of nitrogen on the diversity of natural enemy fauna in rice crop during 2006**

Level of nitrogen (kg/ha#)		Diversity index (Days after transplanting)								
		40	50	60	70	80	90	100	110	Overall
103.69	- No.	6	5	6	5	8	6	6	7	11
	- H	1.499	1.434	1.453	1.464	1.916	1.674	1.414	1.393	1.897
	- J	0.836	0.891	0.811	0.910	0.921	0.934	0.789	0.716	0.791
	- D	0.163	0.108	0.189	0.090	0.078	0.066	0.211	0.284	0.209
126.73	- No.	6	6	7	6	6	7	7	7	11
	- H	1.388	1.642	1.752	1.591	1.476	1.768	1.713	1.851	1.927
	- J	0.775	0.916	0.900	0.888	0.824	0.909	0.880	0.951	0.804
	- D	0.225	0.084	0.099	0.112	0.176	0.091	0.120	0.049	0.196
149.77	- No.	6	6	6	6	8	7	5	6	10
	- H	1.529	1.612	1.563	1.616	1.819	1.803	1.384	1.533	1.934
	- J	0.853	0.899	0.872	0.902	0.875	0.926	0.860	0.856	0.840
	- D	0.147	0.100	0.127	0.098	0.125	0.073	0.140	0.144	0.160
172.81	- No.	7	6	8	5	9	7	5	5	11
	- H	1.527	1.722	1.842	1.474	1.943	1.729	1.457	1.506	1.948
	- J	0.784	0.961	0.886	0.916	0.884	0.889	0.906	0.936	0.812
	- D	0.215	0.039	0.114	0.084	0.116	0.111	0.094	0.064	0.188

No.- Number of natural enemy families/orders, H-Diversity index, J-Evenness index, D-Dominance index; # Nitrogen applied in the form of urea @ 225, 275, 325 and 375 kg/ha

(0.951 at 110 DAT) at 126.73kg N ha<sup>-1</sup> level. The overall diversity index during 2006 was higher (1.948 at 172.81kg N ha<sup>-1</sup>) than in case of other doses (Table 3) and the overall evenness index was maximum (0.840) at 149.77 kg N.

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