POPULATION DYNAMICS OF GREEN LEAF HOPPER, *NEPHOTETTIX* SPP. AND SPIDERS IN UPLAND TRANSPLANTED RICE AGRO-ECOSYSTEM: A BIO-METEOROLOGICAL INTERACTION STUDY

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Abstract: Rice occupies the prominent place in Indian agriculture. Rice fields are very important and environmental buffers. Field experiment was conducted at research farm of Indira Gandhi Krishi Vishwa Vidyalaya, Raipur during *kharif* season 2013-14. The maximum population green leaf hopper (GLH) was recorded in 1st week (40 SMW) of October with 53.25 nymph/adult/25 sweeps showed non-significant negative correlation with minimum temperature, average temperature, morning relative humidity, evening relative humidity and average relative humidity while non-significant positive correlation with minimum temperature and sunshine hours in upland transplanted rice agro-ecosystem. The maximum population of spiders were recorded during 4th week (43 SMW) of October with 11.00 adult/25 sweeps and showed significant negative correlation with Rainfall (r = - 0.656*) while positive correlation with maximum temperature and sunshine hours. GLH and spiders populations showed non-significant positive correlation (r = + 0.230) at 1% and 5% level of significance in upland transplanted rice agro-ecosystem.

Keywords: Ecosystem, Green leaf hopper, Rice, Upland, Weather parameters

INTRODUCTION

Chhattisgarh state is known as the rice (*Oryza sativa* L.) bowl of India because nearly 74-76 per cent area during rainy season is under rice cultivation. In Chhattisgarh there are 5 agro-ecosystems in which rice is cultivated with different practices. These ecosystems are: Upland ecosystem, 2. Midland ecosystem, 3. Lowland ecosystem: Drought prone and Lowland favourable, 4. Submergence prone and 5. Irrigated ecosystem: Controlled irrigation and Flood irrigated ecosystem (Annonymous, 2009). Raipur is situated in central-eastern part of Chhattisgarh and lies between 21° 6' North latitude and 18° 36' East longitude with an altitude of 289.56 meters above from the mean sea level. Two species of green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) are most common in upland transplanted rice ecosystem at Raipur rice agro-ecosystem. Both nymphs and adults suck the sap from the phloem. While direct damage seldom causes economic loss, viral disease (rice tungro, grassy stunt and yellow orange leaf) transmitted by both the species results in economic loss. Particularly in tungro endemic areas, suitable prophylactic measures need to be taken up. Pest outbreaks are sudden explosive increases in a pest population which are often associated with changes in the ecosystem caused by external environmental disturbances include very dry weather, elevated temperatures, floods, gales, and pesticide sprays (Heong,2009). Upland rice is usually grown in unfavourable soil and weather conditions and needs regular attention for obtaining good productivity. Insect pests menace is one among the many hurdles in reaching comprehensive rice grain productivity. The diversity of upland rice environments gives rise to a more heterogeneous insect fauna compared with the more homogeneous lowlands. A wide array of soil-inhabiting pests -ants, termites etc. common in upland rice cannot tolerate flooding. The less stable upland environment more restricted growing season, smaller area planted, greater drought stress-poses greater problems of survival to insects, which have overcome them by polyphagy, greater longevity, off-season dormancy and dispersal. In upland rice a rich fauna of natural enemies exists, but they face even greater problems of survival than the pests (Litsinger *et al.,* 1987). Aerobic rice is direct seeded in non-puddled field requires less water and labour than flooded rice established via transplanting thus aerobic rice system can reduce water application relative to conventionally transplanted system. Populations of leaf hopper and spiders in upland transplanted rice agro-ecosystem are influenced by ecological and biological factors, crop physiology, climate changed and farmer's control practices. The aims of this study was to determine the changes in population dynamics of green leaf hopper and spiders in rice field between the developments stages of rice and it's relation with the biotic and abiotic factors. It is hoped that the findings from the study can contribute to the more ecological precise ways in dealing with outbreaks and control of insect pests of rice.

MATERIAL AND METHOD

The population of rice green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) and spiders was recorded through sweeping net. Sweeping net sampling device is usefull for catching

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immature and adult stages of insect pest and their natural enemies present in rice ecosystem. A specification of sweep net is 30 cm diameter and 65cm depth. Sampling was done randomly four places by 25 sweep of rice field in morning, at weekly interval. The observations on occurrence of green leaf hopper and spiders were recorded by taking total 4 samples from 4 locations in rice ecosystem. All samples were collected near the center of the ecosystem, at least 5 m from the edge in order to reduce edge effects. Weekly collection were calculated for determining the population dynamics of rice green leaf hopper and spiders according to standard meteorological weeks prescribed by the Agro-meteorological Department, Raipur IGKV (C.G.) were used. Correlation analysis was carried out between field incidence and weather parameters of GLH during *kharif* season 2013-14. Regression analysis was worked out as per method given by Gomez and Gomez (1985).

RESULT AND DISCUSSION

Population dynamics of green leaf hopper, *Nephotettix virescens* (Distant) and *N.nigropictus* (Stal.) in upland transplanted rice ecosystem

Green leaf hopper, *Nephotettix* spp. nymph/adult population initiated in the upland transplanted rice ecosystem (UTP) during 1st week (36 SMW) of August with 0.75 nymph/adult/25 sweeps and remain up to crop harvesting. The maximum population of rice green leaf hopper was recorded in 1st week (40 SMW) of October with a population of 53.25 nymph/adult/25 sweeps. The average population varied from 0.00 to 53.25 nymph/adult/25 sweeps during *kharif* season (Table 1). The seasonal mean of green leaf hopper, *Nephotettix* spp. population was 2.98 nymph/adult/25 sweeps) during cropping season. The present findings are corroborates with Shukla *et al.,* (2008), Dogra and Chaudhary (2005), Shamim *et al.,* (2009) and Garg (2012) reported that the maximum populations of green leaf hoppers were observed during October- November, August-September, October (43 SMW) and 2nd fort night of October respectively. Girish (2010) reported that the green leaf hopper population appeared at 45 DAS and their population (nymphs and adults) increased to attain peak at 75 DAS in month of September and disappeared at 120 DAS in month of October in upland in transplanted method at Mugad, Karnataka.

Population dynamics of spiders in upland transplanted rice ecosystem

The spider populations mainly *Tetragnatha* spp., *Oxyopes* spp. and *Araneus* spp. were recorded from 30 days old crop up to maturity with varied population level in rice ecosystem. The maximum population of spiders was recorded during 4th week (43 SMW) of October with 11.00 adult/25 sweeps in upland transplanted rice ecosystem. The average population varied from 0.00 to 11.00 nymph/adult/25 sweeps during *kharif* season. The seasonal mean population of spiders was 5.29 adult/25 sweeps) during cropping season (Table 1).The present findings on the population dynamics of spiders are in agreement with Girish (2010) reported that the population of spider highest during October (105 DAS) in upland transplanted rice ecosystem. Rajendra (2009) Spiders were common predators on many rice insects, species identified in upghat transplanted ecosystem were *Pardosa heteropthalmus, P. pseudoannulata, Tetragnatha* sp., *Argiope bruennichi* and *Leucauge decorate.* The spiders were noticed throughout the cropping period starting from transplanting to till harvest and maximum during reproductive stage of crop. These findings also corroborates with the reports of Shivamurthappa (1993) and Venkateshalu (1996) and Schoenly *et al*. (1998) from India and China. Okuma *et al.,* (1978) who also reported that the spiders fauna as relatively poor in the early period of crop growth (July) and from August onwards, spider fauna became rich. On the contrary, Garg (2012) reported the spider was most active during September.

Correlation co-efficient between green leaf hopper and abiotic factors in lowland rice field

It was evident from the data (Table 2) that the green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) showed non-significant positive correlation with maximum temperature (r = + 0.097) and sun shine hours (r= + 0.194) but non-significant negative correlation with minimum temperature (r = - 0.092), average temperature (r = - 0.025), morning relative humidity (r = - 0.420), evening relative humidity (r = - 0.187), average relative humidity (r = - 0.269) and average rainfall (r = - 0.444) at 5 and 1 per cent level of significance. The regression equation for weather parameter like maximum temperature are [$y = 0.007x + 30.11$, $R^2 = 0.009$], minimum temperature [$y = -0.011x + 23.65$, $R^2 = 0.008$], Average temperature [$y = -0.001x + 26.88$, $R^2 = 0.000$], Rainfall(mm) [$y = -1.947x + 94.96$, $R^2 = 0.196$], morning relative humidity [$y = -0.074x + 93.74$, $R^2 = 0.176$] evening relative humidity [$y = -0.132x + 73.80$, $R^2 = 0.034$], average relative humidity[$y = -0.103x + 83.77$, $R^2 = 0.072$] and bright sunshine hours[$y = 0.028x + 3.849$, $R^2 = 0.037$].

Correlation co-efficient between spiders and abiotic factors in lowland rice field

Perusal of data presented (Table 3) mean population of spiders showed non-significant positive correlation with maximum temperature (r = + 0.100) and sun shine hours (r= + 0.308) but non-significant negative correlation with minimum temperature (r = - 0.400), average temperature (r = - 0.270), morning relative humidity (r = - 0.297), evening relative humidity (r = - 0.473), average relative humidity (r =

- 0.505) while spiders showed significant negative correlation with average rainfall (r = - 0.656*) at 5 per cent level of significance. The regression equation for weather parameter like maximum temperature are [y = 0.044x + 29.98, R^2 = 0.010], minimum temperature [y = -0.281x + 24.99, R^2 = 0.16], Average temperature [y = -0.118x + 27.48. R^2 = 0.073], Rainfall (mm) [y = -16.56x + 157.2, R^2 = 0.429], morning relative humidity [y = -0.303x + 94.37, R^2 = 0.087] evening relative humidity [y = -1.927x + 82.28, R^2 = 0.223], average relative humidity[y = -1.115x + 88.32, R^2 = 0.254] and bright sunshine hours[y = 0.255x + 2.862, R^2 = 0.094]. These findings also corroborates with Chau (1987) reported highest peak of spiders at mean temperature of 23-25°C and with relative humidity of 89.94 per cent. On the contrary Rajendra (2009) reported that the correlation studies has been made on spider population revealed negative and non significant relationship with maximum temperature (r = -0.804). Whereas, positive and significant relationship with minimum temperature (r = +0.851*) and morning relative humidity (r = + 0.889*). Similarly positive non significant correlation with average rainfall (r = + 0.676) and evening relative humidity (r = + 0.692). Venkateshalu (1996) also reported during *kharif* season, spider population showed significant negative correlation with maximum temperature and evaporation.

Correlation co-efficient between green leaf hopper and spiders

It was evident from the data (Table 4) that the spiders showed non-significant positive correlation with green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) (r = + 0.230) at 5 and 1 per cent level of significance. These findings are in agreement with Kaushik *et al.*,1985 who reported that the *Lycosa pseudoannualata* exhibited positive correlation with the hopper population having the regression equation of 3.14 = - 4.09 + 42.8x1 – 3.42x2 + 19.7x3. High positive correlations for spiders with the delphacids and cicadellids were obtained in Kiangan, IRRI and Bayombong, but significantly lower correlation in Cabantuan and Banaue during the survey conducted in the Philippines (Heong and Rubia, 1990). The fluctuation of plant hoppers and leaf hoppers population in the rice fields was closely correlated to that of the spiders (Ye and Wang, 1987; Cheng, 1989).

Table 1. Population of Green leaf hopper, *Nephotettix* spp. and spiders in upland transplanted rice ecosystem

S. No	SMW	Date of observation	Mean population of GLH in upland transplanted rice ecosystem	Mean population of spiders in upland transplanted rice ecosystem	Temperature (^{0}C)			Rainfall (mm)	Relative humidity (%)			Sun shine (hours)
					Maxi. Temp.	Mini. Temp.	Avg. Temp.		Morn.	Even.	Avg.	
1	31	01/08/2013	0.75	0	28.30	23.90	26.10	255.80	95.10	83.90	89.50	1.30
2	32	08/08/2013	0	2	31.10	24.70	27.90	87.40	93.10	76.00	84.55	3.30
3	33	15/08/2013	2.25	3.5	31.30	24.40	27.85	177.00	94.70	79.60	87.15	3.30
4	34	22/08/2013	0	3	27.80	23.80	25.80	60.50	92.00	83.60	87.80	1.50
5	35	29/08/2013	1	6	29.30	24.50	26.90	120.80	94.90	78.10	86.50	3.10
6	36	05/09/2013	3.5	4.25	31.10	24.80	27.95	54.80	92.60	75.70	84.15	4.20
7	37	12/09/2013	6	7.25	31.90	25.20	28.55	11.60	91.70	73.30	82.50	6.20
8	38	19/09/2013	9.75	6.5	29.90	24.10	27.00	92.60	93.40	76.90	85.15	2.50
9	39	26/09/2013	16	5	32.00	24.90	28.45	28.60	93.00	68.00	80.50	6.30
10	40	03/10/2013	53.25	3	30.10	24.20	27.15	45.20	95.00	75.30	85.15	4.20
11	41	10/10/2013	45	8.5	30.20	23.30	26.75	8.60	83.70	71.10	77.40	3.50
12	42	17/10/2013	22.25	6	30.70	21.40	26.05	0.00	91.40	56.30	73.85	8.60
13	43	24/10/2013	13	11	28.80	22.60	25.70	32.60	95.90	73.10	84.50	2.10
14	44	31/10/2013	9	8	30.50	17.30	23.90	0.00	92.30	38.40	65.35	8.90
Seasonal mean/25 sweeps			12.98	5.29								

Table 2. Correlation coefficient (r) between mean population of *Nephotettix* spp. in upland transplanted rice ecosystem and abiotic factors

Correlation with			Correlation coefficient(r)	Coefficient of determination (r^2)	Coefficient of variation	Regression equation value
Rice insect	Weather parameter					
Mean population of GLH in upland	Temperature(^{0}C)	Maxi. Temp.	0.097	0.009	0.932	y = 0.007x + 30.11, R^2 = 0.009
		Mini.	-0.092	0.008	0.840	y = -0.011x + 23.65, R^2 =

transplanted rice ecosystem		Temp.				0.008
		Average Temp.	-0.025	0.001	0.062	y = -0.001x + 26.88, R^2 = 0.000
	Rainfall (mm)		-0.444	0.197	19.684	y = -1.947x + 94.96, R^2 = 0.196
	Relative humidity (%)	Morning	-0.420	0.177	17.678	y = -0.074x + 93.74, R^2 = 0.176
		Evening	-0.187	0.035	3.481	y = -0.132x + 73.80, R^2 = 0.034
		Average	-0.269	0.072	7.247	y = -0.103x + 83.77, R^2 = 0.072
	Sun shine (hours)		0.194	0.038	3.779	y = 0.028x + 3.849, R^2 = 0.037

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

Table 3. Correlation coefficient (r) between mean population of spiders in lowland rice ecosystem and abiotic factors

Correlation with			**Correlation coefficient(r)**	**Coefficient of determination (r^2)**	**Coefficien t of variation**	**Regression equation value**
Rice insect	**Weather parameter**					
Mean population of spiders in upland transplanted rice ecosystem	Temperature(^{0}C)	Maxi. Temp.	0.100	0.010	1.008	y = 0.044x + 29.98, R^2 = 0.010
		Mini. Temp.	-0.400	0.160	16.000	y = -0.281x + 24.99, R^2 = 0.16
		Average Temp.	-0.270	0.073	7.302	y = -0.118x + 27.48. R^2 = 0.073
	Rainfall (mm)		-0.656*	0.430	42.989	y = -16.56x + 157.2, R^2 = 0.429
	Relative humidity (%)	Morning	-0.297	0.088	8.794	y = -0.303x + 94.37, R^2 = 0.087
		Evening	-0.473	0.224	22.380	y = -1.927x + 82.28, R^2 = 0.223
		Average	-0.505	0.255	25.469	y = -1.115x + 88.32, R^2 = 0.254
	Sun shine (hours)		0.308	0.095	9.466	y = 0.255x + 2.862, R^2 = 0.094

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

Table 4. Correlation coefficient (r) between mean population of *Nephotettix* spp. and spiders in upland transplanted rice ecosystem

Correlation with		**Correlation coefficient (r)**	**Coefficient of determination (r^2)**	**Coefficient of variation**	**Regression equation value**
Mean population of GLH in upland transplanted rice ecosystem	Mean population of spiders in upland transplanted rice ecosystem	0.23	0.053	5.273	y = 0.039x + 4.767, R^2 = 0.052

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

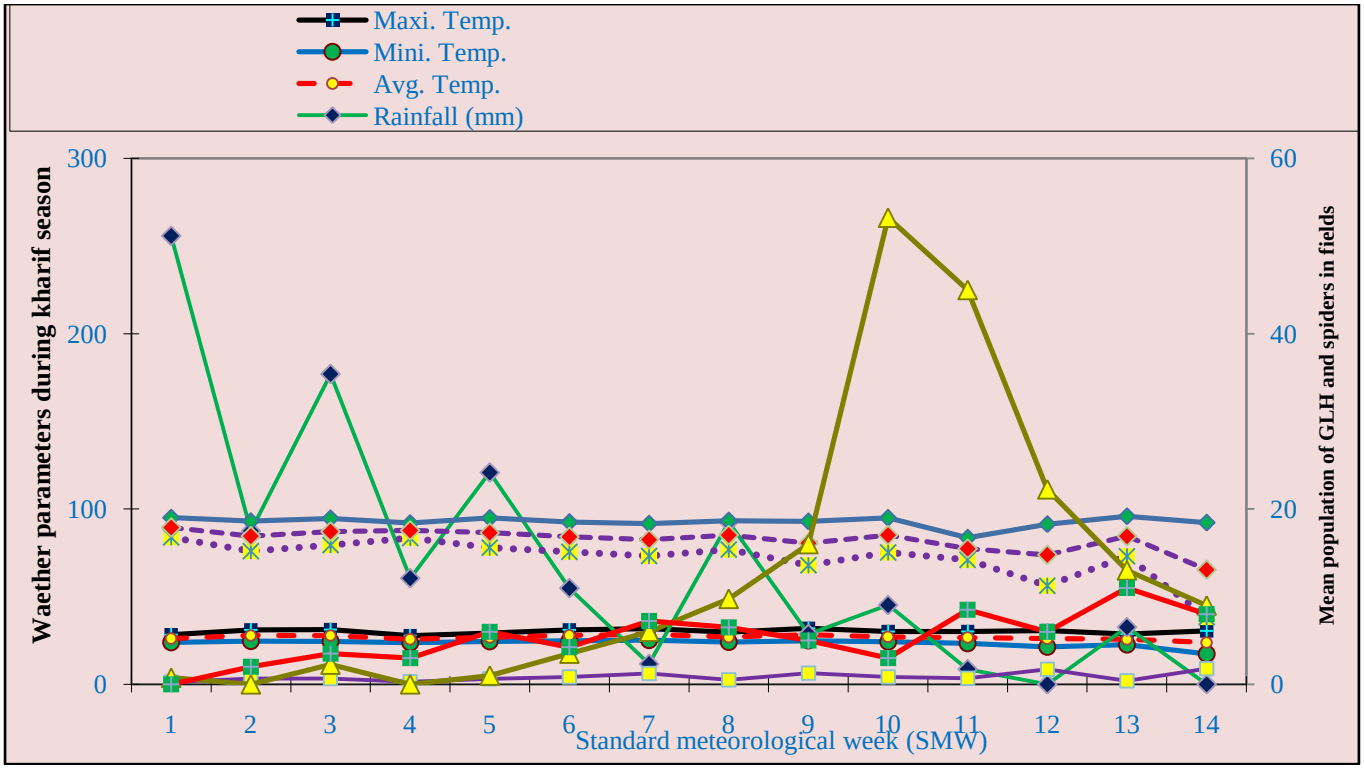

Fig: 1. Field population of Green leaf hopper, spiders and weather parameters

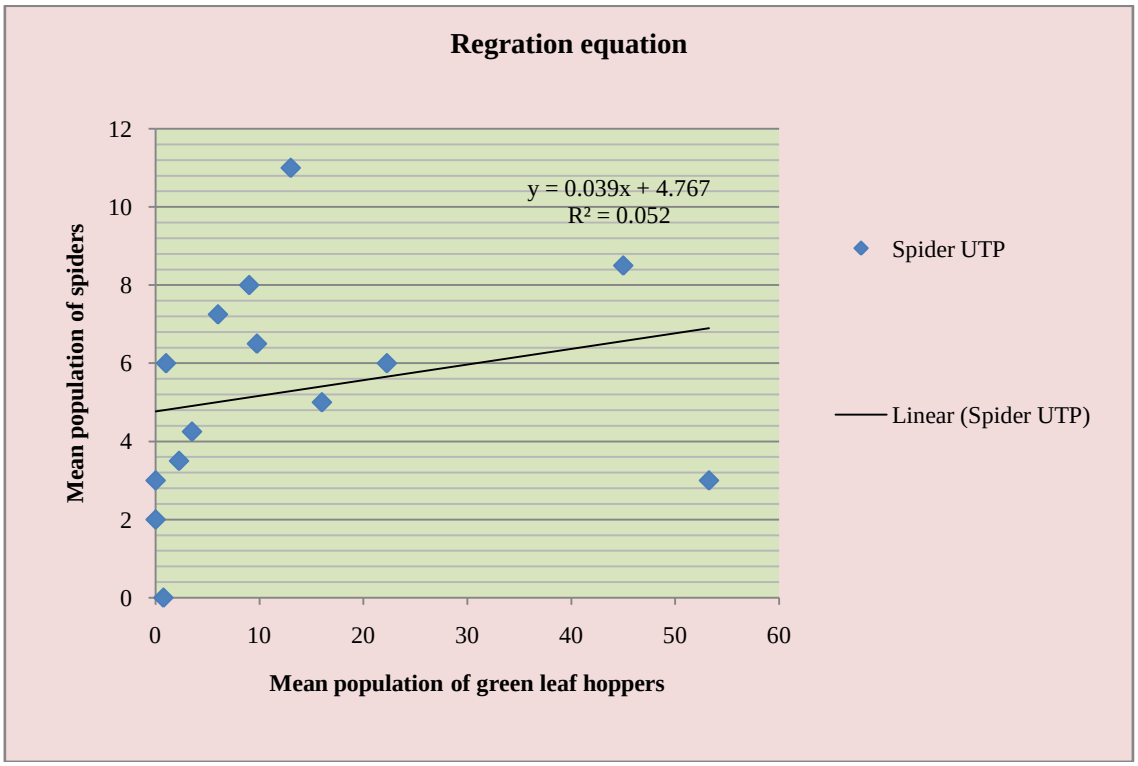

Fig: 2. Regression equation between mean populations of green leaf hopper and spiders in upland transplanted rice ecosystem (UTP).

CONCLUSION

From the above study it can be concluded that the October month is a crucial periods for pest and natural enemies protections because it is clear that the maximum population of green leaf hoppers and spiders were observed during 40 SMW and 43 SMW of October respectively. In bio-meteorological interaction study spiders showed negative significant correlation with average rainfall (r = - 0.656*) at 5 per cent level of significance and non-significant positive correlation with green leaf hopper,

Nephotettix spp. (r = + 0.230) at 5 and 1 per cent level of significance.

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