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Original Research Article

Studies on Population Dynamics of Spider in Rice Crop Regarding Bio-Control

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A B S T R A C T

The Wolf spider, *Pardosa psedonmulata* (Boes. & Strand) is probably the most important predator in rice fields in Asia. The diet of the wolf spider depends on type of insects that are available but leaf hoppers and plant hoppers are the major prey *Pardosa* feeds on both nymphs and adults and is considered to be a major regulator of brown plant hopper population. The first step in determining of the role of spiders in an agro- ecosystems is to identify the species present and determine their abundance and distributions. The biotic and abiotic factors of an environment often play an important role on the population buildup of spider. The experiment was carried out during Kharif session on rice variety Pant Dhan – 4 and NDR -359 at research field and on farmers field Sarjoo – 52, NDR -359, Pant Dhan – 4 and Sambha Mahsoori varieties was taken. The experiment was laid out and randomized in block designed with three replication plot size was assigned 7x25 m with border area of 1.5m between the replication. The transplanting was done in the first week of July both the year and observations were recorded with the help of hand net and quadrate methods at weekly interval starting at two weeks after transplanting and continue till maturity of crop. Also spider population data was recorded during off session, Main crop was harvested 6-7 cm above from the ground level and then given an irrigation after 20 days of harvesting. After four days of irrigation, area was applied and subsequent irrigation were also given as and when required and taken ratoon crop during off session. Observations on the hoppers and spiders population were recorded after 45 days of harvesting at weekly interval started from 45th to 18th meteorological week. Fourteen spider species was observed during studies viz., *Pardosa pesudoannulata* (Boes. & Str.), *Tetragnatha mandibulata* (Walk), *T. javana* (Thorell), *Hippasa holmerae* (Thorell), *Clubiona japonicola* (Boes. & Str.), *Araneus* spp., *Phidippus* spp. and *Neosconatheisi* (Walck). Amongst these *Pardosa pesudoannulata*, *Tetragnatha mandibulata* during kharif session and *Hippasa holerae*, *T. javana* and *Tetragnatha mandibulata* during off session were found dominant.

Keywords

Population dynamics, spider, weather factor

Introduction

Paddy (*Oryza sativa* L.) is one of the most important staple food crop of global importance. Rice helps to feeds almost half of the planet on a daily basis however at national level to feed the ever growing population and maintain our food security an additional two million tons of rice needs to be produced annually with less water, land and against a number of biotic and abiotic stresses that limits rice production.

Continuous research efforts are, therefore, needed to meet rice requirement of the country, which is estimated to be around 140 million tons by 2020 AD. Achieving this target in the next decade, without harming the environment would be a challenge.

Among the various yield constrains of paddy production, the insect pests are of prime importance diseases and insect-pest were estimated to cause yield losses to the tune of 30-40 % depending upon the severity of incidence. Out of 20 major insect pests infesting rice brown plant hopper (BPH), white backed plant hopper (WBPH) and green leaf hopper (GLH) has been identified as the major insect pests and pose challenges to rice production (Pathak and Dhaliwal, 1981). In general leaf hoppers and green leaf hoppers attack all aerial parts of the plant where as the plant hoppers attack basal portions (stem) by sucking the plant sap from the xylem and phloem tissues of the plant.

A number of practices have been recommended to suppress the paddy pests. The increased awareness on the deleterious side effect due to the intense use of pesticide for the pest control brought and universally accepted concept "Integrated Pest Management"-IPM is based on the ecological principle and is compatible with a suitable and environmentally benign agricultural system (Pedigo, 1991).

Among the Integrated Pest Management strategy, use of natural enemies viz., Parasitoids, Predators and Pathogens play an important role in regulating the population fluctuation level in rice crops. About 40-60% of the pests in rice are controlled by their natural enemies (Swaminathan and Siddiq, 1991). In ecological stable ecosystem, the natural enemies particularly predators have been recorded as potential weapon to regulate the rice insect pest (Baltazar, 1963; Gabriel 1978 and Chandra 1979). The predators were responsible to bring 95% mortality on plant hopper nymphs (anonymous, 1979). Spider one of the most important groups of predatory fauna in rice fields which has bio control agent play important role in regulation of insect pests. It reported that 80% of the total predatory community is represented by the spiders in the rice fields (Wang, 1985). They are magical gift of nature to farmers for suppressing the insect-pest population in rice fields (Singh *et al.*, 2005).

Spiders are obligate carnivores and hold the unique position of being the only large part of the predatory arthropod fauna of rice ecosystem and prey upon plant and leaf hoppers, dipterans mainly whorl maggot and stem borer (Barrion and Litsinger, 1980; Pantua *et al.*, 1980).

Spiders belong to class – Arachnida and order –Araneae. They are truly cosmopolitan in distribution and have many forms and colourations with varied type of habitats and food habit. In general, spiders are insectivores but cannibalism it also quite common. They run or jump or hang very swiftly irrespective of nature of living i.e web and non-web (Bristow 1939-41)reported that the size and abundance of spider are in relation to size and abundance of their prey in each and every set of agro-climatic conditions. A hungry spider may accept any insect while a fully fed spider may not. This indicates that spider distaste in relative and not absolute. Several works advocates the predatory role of spider in rice ecosystem both in India and abroad (Nath & Shankar, 1978, Kirtani, 1979 and Ghode *et al.*, 1985).

There is increasing evidence that spiders play and important role in the suppression of insect density under field condition. Predacious arthropods including insects and

spiders, attack all stages of rice insects. Spiders are abundant in rice fields throughout the world.

The wolf spider, *Pardosa pseudoannulata* (Boes. & Strand) is probably the most important predator in rice field in Asia. The diet of wolf spider depends on the type of insect that are available but leaf hopper and plant hopper are major prey. *Pardosa* feeds on both nymphs and adults and is considered to be a major regulator of brown plant hopper population.

Materials and Methods

In order to study the Population dynamics of spiders, experiment was conducted during kharif session and off session. Experiment was laid out in randomized block design with three replication for the rice variety NDR-359 at college of agriculture experimental field and at farmers field district Jaunpur. The plot size was assigned 7x25m with border area 1.5m between the replication. The planting was done in the first week of July and observations were recorded with the help of hand net and quadrate methods at weekly interval starting at two weeks after transplanting and continue to till maturity of crop.

In order to record temperature, minimum and maximum thermometer and humidity, the dry and wet bulb thermometer were installed below the canopy, close to the ground level on a wooden plank. Installed thermometer was carefully avoided from stagnant water and any type of touch in field during irrigation as well as rain also.

Dry and wet bulb readings were recorded to computebrelative humidity (at 0600 and 1430 hr), whereas minimum and maximum readings for temperature of the previous 24 hrs (at 0800 hr).

During off session data was recorded after the main crop harvested from 6-7 cm above the ground level and then an irrigation was given after 20 days of harvesting. After four days of irrigation, urea was applied and subsequent irrigations were also given as and when required.

Observations on the hoppers and spiders' population were recorded after 45 days of harvesting at weekly interval starting from 49^{th} to 18^{th} meteorological week (December to April).

Both net sweeping and quadrate methods were used in this case also. The spiders' population thus obtained, was subjected to statistical analysis to find out correlation with the weather factors and hoppers populations.

Results and Discussion

Main crop during kharif session

To study the influence of age of crop population density of insect pests and weather factor on the population dynamics of spiders a sequential survey was carried out at weekly intervals from the 29^{th} meteorological week till the 42^{nd} meteorological weeks (kharif session) in standing paddy crop of agricultural farm of college of agriculture.

The data was recorded during various meteorological weeks on population of spiders in relation to both biotic and abiotic factors are presented in table 1 and 2.

It is apparent from the data that population of spiders recorded in net sweeping varied from 0.27 to 4.33and 0.27 to 4.47 per 5 sweeps while 2 to 22.47 and 6.13 per sq m in quadrate method during first year and second year, respectively.

Population of spiders in net-sweeping method was 0.27 per 5 sweeps with (0.53, 0.0, 0.07) and (0.43, 0.0, 0.03) population of WBPH, BPH and GLH insect pests during the 29th meteorological week in first year and second year respectively.

The weather condition (Temperature and RH above and below canopy, wind velocity, sunshine and rainfall) in the 29th meteorological week was recorded as 30.25° C, 75.30%, 4.9 Km/hr, 5.70 and 93.0mm in first year whereas 31.30°C, 79.20%, 5.10 km/hr and 7.20 mm in second year.

The spiders population in net-sweeping method in first year attained it's peak level of 3.93 per 5 sweeps in the 40th meteorological week with WBPH, BPH and GLH population being 1.83, 1.47 and 0.83, respectively at the mean temperature of 28.25°C and 33.00°C and average RH, 84.90 and 76.80 per cent above and below the canopy, while average wind velocity, sunshine hrs and total rainfall were 2.10 km/hr, 7.80 hr and 0.00 mm, respectively. The population of spiders in second year 4.47 per 5 sweeps was recorded during the 40th meteorological week with the population of WBPH, BPH and GLH, respectively at the weekly mean temperature 28.95°C above canopy and 33.20°C below the canopy.

The average RH above and below canopy was 84.40% and 78.00%, respectively with average wind velocity 2.90 km/hr, average sunshine 4.0 hr and total rainfall 39.4 mm. in second year, the highest spiders population was recorded as 24.47 spiders per squire m during same week, at WBPH, BPH and GLH population of 36.00,40.40 and 40.40 /sq m, respectively at mean temperature of 28.30°C and 31.00°, above and below canopy RH 84.40% and 76.00%, above and below canopy, wind velocity 4.10 km/hr, sunshine hrs 4.30 and total rainfall 31.90mm. During first year, the population of spiders under net-sweeping method showed two peak levels i.e. 3.33 and 4.33 per 5 sweeps at the 37th and 40th meteorological weeks.

Under quadrate method, the population of spiders had the first peak level of 22.47 per sq m during the 38th meteorological week in first year however, the second peak level could not be recorded. As evident from the data that during second year, the spiders' population in quadrate method had two peak level of 22.00 and 24.47 per sq m in 36th and 38th meteorological week, respectively but the population of spiders decreased at 39th meteorological week from 24.47 to 18.40 per sq m in 38th week.

Ratoon crop (off season)

The population fluctuation of spiders after the kharif rice main crop, the ratoon crop of paddy was taken to record available population of spider. the results obtained are presentedin table- 3 & 4. The average population of spiders in net- sweeping method fluctuated from 4.60 to 0.20/5 sweeps during first year and 4.60 to 0.20/5 sweeps during second year. In quadrate method the average population in first year ranged from 17.20 to 2.40/sq m and in second year ranged from 19.20 to 2.60/sq m in ratoon crop, the insect pests of rice could not survive in the 1st meteorological week in first year and the 52nd week in second year.

The spiders population during first year in net-sweeping reached its peak level of 4.60/5 sweeps with none of WBPH,BPH and GLH in the 9th meteorological week at an average temperature at an average temperature of 20.70°C, RH 61.80%,wind velocity 4.40 km/hr and sunshine hr 9.0 and total rainfall 0.00 mm.

Table.1 Population dynamics of spiders in relation to important biotic and abiotic factors in paddy first year, during *Kharif* session

Meteorological weeks	Crop age (WAT)	Population/5 sweeps				Population/sq m				Average Temperature (°C)		Relative humidity (%)		Average Wind velocity (km/hr)	Sunshine (Hr)	Rainfall (mm)
		Spider	WBPH	BPH	GLH	Spider	WBPH	BPH	GLH	Above canopy	Below canopy	Above canopy	Below canopy			
29	2	0.27	0.53	0.00	0.07	2.00	5.20	3.60	3.60	30.25	-	75.30	-	4.90	5.7	93.0
30	3	0.47	0.70	0.17	0.37	8.20	6.80	4.40	4.80	28.95	-	75.10	-	4.50	5.3	237.8
31	4	1.40	1.13	0.47	0.77	14.33	4.80	12.00	6.80	28.60	-	82.60	-	3.50	2.2	24.7
32	5	2.07	1.17	0.60	1.03	12.53	7.20	13.20	7.20	31.30	-	77.40	-	1.70	6.4	2.4
33	6	2.00	1.33	0.83	1.10	15.27	5.60	18.80	9.20	30.15	-	86.20	-	2.80	1.6	206.2
34	7	2.40	1.57	0.17	1.43	16.87	7.60	15.20	8.80	29.95	-	82.10	-	2.60	4.6	388.6
35	8	3.00	1.70	0.97	1.63	19.27	12.00	14.00	13.20	29.70	34.10	82.80	75.60	1.80	6.7	76.4
36	9	3.20	1.83	1.93	2.03	20.33	19.20	18.80	17.20	28.45	33.50	85.30	78.50	3.20	5.0	59.1
37	10	3.33	2.43	2.43	2.27	19.53	22.40	28.00	39.20	28.90	33.00	84.20	77.40	3.50	5.7	35.0
38	11	3.00	3.37	3.30	2.47	22.47	36.40	40.80	40.80	28.95	33.20	84.40	78.00	2.90	4.0	39.4
39	12	3.20	3.37	2.10	2.17	16.80	30.80	50.40	36.80	27.05	32.40	85.70	77.00	2.70	3.2	115.6
40	13	3.93	1.83	1.47	0.83	12.67	21.60	36.40	25.60	28.25	33.00	84.90	76.80	2.10	7.8	0.00
41	14	4.33	1.03	0.70	0.57	14.47	15.20	25.60	20.00	26.20	28.30	73.50	66.80	3.50	8.0	0.00
42	15	1.47	0.63	0.13	0.00	11.80	5.60	19.20	6.00	25.00	27.10	72.80	66.00	2.10	8.0	0.00

Table.2 Population dynamics of spiders in relation to important biotic and abiotic factors in paddy second year, during *Kharif* session

Meteorological weeks	Crop age (WAT)	Population/5 sweeps				Population/sq m				Average Temperature (°C)		Relative humidity (%)		Average Wind velocity (km/hr)	Sunshine (Hr)	Rainfall (mm)
		Spider	WBPH	BPH	GLH	Spider	WBPH	BPH	GLH	Above canopy	Below canopy	Above canopy	Below canopy			
29	2	0.27	0.43	0.00	0.03	6.13	4.80	3.20	3.20	31.30	-	79.20	-	5.10	7.4	7.7
30	3	1.24	0.60	0.07	0.27	8.80	6.40	4.00	4.40	29.75	-	80.90	-	4.10	5.9	235.8
31	4	1.29	1.03	0.37	0.67	15.60	4.40	11.60	6.40	28.65	-	83.10	-	5.30	6.9	35.2
32	5	1.85	1.07	0.50	0.93	14.13	6.80	12.80	6.80	29.85	-	80.90	-	3.80	7.7	15.6
33	6	2.01	1.23	0.73	1.00	16.40	5.20	18.40	8.80	29.85	-	84.30	-	3.80	6.0	29.4
34	7	2.35	1.47	1.07	1.33	18.27	7.20	14.80	8.40	29.20	32.20	84.20	90.00	1.40	5.9	51.8
35	8	2.28	1.60	0.87	1.53	21.70	11.60	13.60	12.80	29.55	32.80	80.60	86.20	4.30	8.1	20.6
36	9	3.11	1.73	1.83	1.93	22.00	18.80	18.40	16.80	29.85	33.00	83.20	88.90	3.50	6.5	152.6
37	10	3.89	2.33	2.33	2.17	20.73	22.00	27.60	38.80	28.90	31.40	83.50	77.60	1.70	4.3	33.6
38	11	1.91	3.27	3.20	2.37	24.47	36.00	40.40	40.40	28.30	31.00	84.40	76.00	4.10	4.3	31.9
39	12	4.27	3.27	2.00	2.07	18.40	30.40	50.00	36.40	28.95	31.80	79.90	72.50	1.70	9.0	30.2
40	13	4.47	1.73	1.37	0.83	14.33	21.20	36.00	25.20	28.20	30.90	81.40	74.00	3.10	8.1	108.9
41	14	2.39	0.93	0.60	0.50	16.00	14.80	25.20	19.60	26.50	29.60	80.40	73.20	2.50	8.0	18.4
42	15	0.77	0.53	0.10	0.00	13.13	5.20	18.80	5.60	23.45	26.70	71.80	65.80	1.40	9.6	0.0

Table.3 Population fluctuation of spiders in relation to important biotic and abiotic factors in ratoon paddy crop in first year

Meteorological weeks	Population/5 sweeps				Population/sq m				Average Temperature (°C)	Relative humidity (%)	Average Wind	Sunshine (Hr)	Rainfall (mm)
	Spider	WBPH	BPH	GLH	Spider	WBPH	BPH	GLH					
49	0.2	2.0	0.0	0.0	4.8	1.0	1.2	1.2	16.4	66.8	1.8	7.7	0.0
50	0.4	1.5	0.0	0.0	7.0	0.0	1.6	1.8	19.2	71.2	2.0	7.9	0.0
51	1.4	0.0	0.0	0.0	10.6	0.0	5.4	2.8	15.8	74.7	2.4	7.1	0.0
52	1.8	1.0	2.0	0.0	10.0	2.0	6.0	3.0	16.5	76.2	2.5	6.6	0.0
1	1.8	0.0	0.0	0.0	12.0	1.0	8.8	4.0	9.0	82.0	1.9	2.8	0.0
2	2.4	2.0	0.0	1.0	13.2	1.0	7.0	3.8	11.4	79.9	2.4	3.4	0.0
3	3.0	0.0	0.0	0.0	14.0	0.6	0.2	0.6	13.9	80.3	2.4	5.2	0.0
4	2.6	2.0	0.0	0.0	15.6	0.0	1.0	0.2	12.4	79.5	2.6	4.4	34.7
5	3.6	0.0	0.0	0.0	17.2	0.0	0.0	0.6	14.8	70.8	3.6	7.0	0.0
6	2.6	0.0	0.0	0.0	16.0	2.0	0.2	0.6	14.7	67.8	1.9	8.2	0.0
7	2.8	0.0	0.0	0.0	13.6	0.2	0.0	0.2	17.8	67.3	1.5	8.6	0.0
8	3.6	0.0	0.0	0.0	8.6	0.0	0.2	0.0	19.3	67.7	3.2	8.7	0.0.0
9	4.6	0.0	0.0	0.0	11.0	0.0	0.0	0.0	20.7	61.8	4.4	9.0	0.0
10	1.2	0.0	0.0	0.0	11.6	0.0	0.0	0.0	17.3	67.7	2.4	8.4	0.0
11	0.4	0.0	0.0	0.0	14.0	0.0	0.2	0.4	23.4	64.2	2.3	9.4	0.0
12	1.6	0.0	0.0	0.0	11.0	0.0	0.0	0.0	26.8	58.4	4.7	9.4	0.0
13	1.2	0.0	0.0	0.0	12.0	0.0	0.0	0.0	26.8	56.6	3.6	9.2	0.0
14	1.2	0.0	0.0	0.0	9.2	0.0	0.0	0.4	24.7	60.4	4.4	9.3	0.0
15	0.8	0.0	0.0	0.0	6.8	0.0	0.0	0.0	30.8	59.3	5.6	9.5	0.0
16	1.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	31.2	64.4	6.0	9.8	0.0
17	0.4	0.0	0.0	0.0	5.6	0.0	0.0	0.0	27.4	71.1	5.1	6.6	21.4
18	0.2	0.0	0.0	0.0	2.4	0.0	0.0	0.0	29.4	63.5	5.2	8.7	23.4

Table.4 Population fluctuation of spiders in relation to important biotic and abiotic factors in ratoon paddy crop in second year

Meteorological weeks	Population/5 sweeps				Population/sq m				Average Temperature (°C)	Relative humidity (%)	Average Wind	Sunshine (Hr)	Rainfall (mm)
	Spider	WBPH	BPH	GLH	Spider	WBPH	BPH	GLH					
49	0.2	1.0	0.0	0.0	5.8	1.0	1.4	1.4	17.8	66.0	1.7	7.4	0.0
50	1.2	1.0	0.0	0.0	8.2	0.0	1.8	2.0	17.3	70.4	1.2	5.9	0.0
51	1.4	3.0	0.0	0.0	12.0	0.0	5.6	3.0	14.4	81.2	1.6	4.9	0.0
52	1.8	1.0	0.0	0.0	11.8	1.0	6.2	3.2	15.2	70.7	1.6	4.8	0.0
1	1.6	0.0	1.0	0.0	13.8	1.0	9.0	4.2	15.0	65.6	2.2	5.8	6.2
2	1.8	0.0	0.0	2.0	15.2	1.0	7.2	4.0	15.2	66.4	2.4	6.6	2.0
3	1.8	0.0	0.0	0.0	16.0	0.7	0.4	0.8	15.3	73.6	3.0	6.9	8.2
4	3.2	1.0	0.0	0.0	18.4	0.0	1.6	0.4	15.0	72.6	2.5	5.5	23.0
5	4.0	0.0	0.0	0.0	19.2	0.0	0.4	0.8	14.7	76.6	2.2	5.1	9.6
6	1.6	1.0	0.0	0.0	18.2	2.0	1.2	0.8	17.5	74.1	2.2	8.0	1.2
7	4.2	0.0	0.0	0.0	16.0	0.2	0.4	0.4	19.8	71.4	5.0	8.7	3.2
8	4.6	0.0	0.0	0.0	9.6	0.0	0.0	0.0	17.5	70.8	3.4	7.5	8.6
9	2.4	0.0	0.0	0.0	13.2	0.0	0.0	0.0	22.0	64.4	5.5	8.7	0.0
10	0.8	0.0	0.0	0.0	13.2	0.0	0.4	0.0	23.9	66.2	4.5	7.5	11.2
11	0.6	0.0	0.0	0.0	16.4	0.0	0.0	0.0	23.6	66.9	1.9	8.7	0.0
12	1.8	0.0	0.0	0.0	12.8	0.0	0.0	0.5	24.5	63.7	3.5	8.3	11.7
13	1.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	25.5	56.0	3.6	8.7	0.0
14	1.2	0.0	0.0	0.0	11.0	0.0	0.0	0.0	25.5	68.7	3.5	8.3	11.2
15	1.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	27.6	57.2	4.6	8.0	0.0
16	1.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	29.5	56.8	2.7	9.8	0.0
17	0.8	0.0	0.0	0.0	6.2	0.0	0.0	0.0	30.5	58.7	4.1	7.3	0.0
18	0.2	0.0	0.0	0.0	2.6	0.0	0.0	0.0	28.4	57.5	3.8	8.7	1.2

In first year under quadrate method the highest population spider 17.20 /sq m. were recorded in the 5th meteorological week with 0.00 WBPH, 0.20 BPH and 0.60 GLH/ sq m at mean temperature of 14.80° C, RH 70.80%, wind velocity 3.60km/hr, sunshine hr 7.00 and 0.00 rainfall.

The spider population during second year highest population was recorded under net-sweeping and quadrat method was 4.60/5sweeps during 8th meteorological week and 19.20/sq m. during 5th meteorological week, respectively however there was no insect pest population in the 8th meteorological week at an average temperature of 17.5° C, RH 70.8%, wind velocity 3.4 km/hr, sunshine hr 7.5 and total rainfall 8.6 mm.

The spiders have been rated to be the most important group of predators in the nature and agricultural ecosystem. The biotic and abiotic factors of an environment often play an important role on the population buildup of spiders (Cheng, 1989; Bhathal & Dhaliwal, 1991). Also in ratoon crop spider is plays very important role to bio-control of insect pests.

Conclusion as per objective during studies in both the year was observed fourteen species viz., *Pardosa pseudoannulata* (Boes. & Str.), *Tetragnatha mandibulata* (Walck), *T. Javana* (Thorell), *Hippasa holmerae* (Rhorell), *Clubiona japonicola* (Boes. & Str.), *Araneus inustus* (Clkoch), *Thomisus* spp., *Pardosa birmanica*(Simon), *Atypena* spp., *Cupa* spp., *Oxyopes* spp., *Runsinia* spp., *Phidippus* spp., and *Neoscona theisi* (walck), spider were found prominent in rice field in distrct Jaunpur and eastern part of Uttar Pradesh. Amongst these *Pardosa pseuddoannulata, Tetraganathamandibulata* during kharif season and *Hippasa holmerae, T. javana* (Thorell) and *Tetragnatha mandibulata* (Walck), during off season were found dominant.

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