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Spider population and their predatory efficiency in different rice establishment techniques in Aduthurai, Tamil Nadu.

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ABSTRACT

The role of spiders in regulation of insect pests has been studied in the rice ecosystem ADT 39 cultivated by different Rice Establishment Techniques, namely Transplantation (T1), System of Rice Intensification (T2), Integrated Crop Management (T3), Drum Sowing (T4), Random Planting (T5) and Seedling Throwing (T6). The study was carried out in Tamil Nadu Rice Research Institute (TRRI), Aduthurai between December 2005 and March 2006. Two aspects, namely population of spiders and pests, and role of spiders in the reduction of insect pests were studied. The number of spiders and pests found in the field were recorded by sweeping net and visual observation. A total of five spiders, namely *Lycosa pseudoannulata, Callitrichia formosana, Tetragnatha javanas, Argiope catenulata* and unidentified *Plexippus* species were identified from all the six different technique plots. Among them, Integrated Crop Management, showed the maximum percentage (20.93%) of spiders, whereas the minimum was observed in Seedling Throwing (8.58%). The population of spiders fluctuated during different days after transplantation (DAT). *Lycosa pseudoannulata* and *Callitrichia formosana* were the maximum during 42 DAT to 53 DAT, while *Argiope catenulata* was predominant from 88 DAT to 113 DAT. Six different insect pests, namely *Nephotettix virscens*, *Scripophaga incertulas*, *Cofana spectra, Cnaphalocrosis medinalls*, *Nilaparvata lugens* and *Leptocorisa acuta* were recorded in all the six technique plots. The population of pests in the different treatments showed rise and fall during the observation. The Maximum population of pests was recorded during 66 DAT. Among the techniques, Drum Sowing (25%) showed the highest percentage, whereas the minimum was recorded in Transplantation and Random Planting (11% each). All the spiders showed the positive correlation with rice pests *Nilaparvata lugens* and *Leptocorisa acuta* and negative correlation with *Cnaphalocrosis medinalls*. High population of spider in the different treatment plots limits the exponential growth of pest population.

Key words: *Lycosa pseudoannulata, Callitrichia formosana, Tetragnatha javanas, Argiope catenulata.*

INTRODUCTION

Green planthopper and Brown planthopper are considered the most important pests in rice and their populations were unstable in irrigated rice field. For many decades, insecticides have been widely used to control rice pests. However the continuous uses of pesticides have caused many side effects including loss of biodiversity, residual toxicity, the resurgence of insect pests and environmental pollution (Heinrich and Mochida, 1984; Ganeshkumar and Velusamy, 1996; Holland *et al.*, 2000; Amalin *et al.*, 2001; Lu Zhong-xian, 2007). Due to these constraints, researchers developed an alternative, economical and ecofriendly method of insect control (Venturino *et al.*, 2008; Chatterjee *et al.*, 2009).

Agricultural entomologists recorded the importance of spiders as a major factor in regulating pest and they have been considered as important predators of insect pests and serve as a buffer to limits the initial exponential growth of prey population (Snyder and Wise, 1999; Nyffeler, 2000; Sigsgaard, 2000; Maloney *et al.*, 2003; Venturino, *et al.*, 2008; Chatterjee *et al.*, 2009). However researchers have exposed that spiders in rice field can play an important role as predators in reducing planthoppers and leafhoppers (Chiu, 1979; Visarto Preap, 2001; Lu Zhong-xian, 2006)

Several workers reported the predatory potency of spiders in rice ecosystem (Samiyyan, 1996; Sahu *et al.*, 1996; Pathak and Saha, 1999; Bhattacharya, 2000; Sigsgaard, 2000; Vanitha, 2000; Mathirajan, 2001; Sunil Jose, *et al.*, 2002; Satpathi, 2004; Sudhikumar *et al*., 2005; Sebastian *et al.*, 2005; Motobayashi *et al.*, 2006). According to Bhatnagar *et al.* (1982) and Peter (1988), the crop having more insects or insect visitors always had more spiders. Among the identified species, *Lycosa pseudoannulata*

(Boes & Stand) was the most prevalent followed by *Atypena formosana* (Oi), *Argiope catenulate* (Doleschall) and *Clubiona japonicola* (Boesenberg and Strand) (Sahu, *et al.,* 1996). The population of these four species also varied at different growth stages of rice.

In the first 35 DAT of rice, *Pardosa pseudoannulata* and *Atypena formosana* are considered as the important predators of Green leafhopper (Sahu *et al.,* 1996; Mathirajan, 2001). Moreover *P. pseudoannulata* is the vital predator against Brown planthopper and can also effectively regulate the pest population of Leafhoppers, Planthoppers, Whorl maggot flies, Leaffolders, Case worms and Stem borers (Kenmore *et al.,* 1984; Barrion and Litsinger, 1984; Shepard *et al.,* 1987; Rubia *et al.,* 1990; Ooi and Shepard, 1994; Visarto Preap, 2001; Drechsler and Settele, 2001; Lu Zhong-xian *et al.,* 2006).

Samiyyan and Chandrasekaran (1998) reported that spiders were effective against Leaf folders, Cut worms and Stem borers. *Atypena formosana* has been observed to hunt the nymphs of Planthoppers and Leafhoppers, small dipterans, such as whorl maggot flies (Barrion and Litsiger, 1984; Shepard *et al.,* 1987; Sigsgaard *et al*, 1999). According to Mathirajan (2001) *Tetragnatha javanas*, is one of the common spider found in rice ecosystem and they effectively reduce the population of Green leafhoppers and Brown planthoppers. The feeding efficiency of four spiders, namely *Lycosa pseudoannulata, Clubiona japonicola, Argiope catenulate* and *Callitrichia formosana* were also studied.

Several researchers were recorded concerning spiders' population and their predatory potential in traditional crop system in Tamil Nadu. Sofar no attempt has been made on the population of spiders and their predatory efficiency in different "Rice Establishment Techniques" in Cauvery delta region of Tamil Nadu. The present study was carried out in the rice field, with the following objectives. To study the population of spiders and pests in different treatments during different days after transplantations of crop and To study the role of spider in reduction of rice pest.

MATERIALS AND METHODS

The present study was carried out in the rice variety Aduthurai 39 (ADT 39) cultivated at the Tamil Nadu Rice Research Institute (TRRI), Aduthurai during December 2005 to March 2006. The observations were made on rice field at six different rice establishment techniques (treatments), namely transplantation, system of rice intensification, integrated crop management, drum sowing, random planting and seedling throwing. The survey was carried out over an area of 45 cent. In each technique, four random squares of 1.8 cent were chosen. The random squares were marked by the poles. The observations were made in all random squares once in a week during 7.00 am to 9.00 am and after 42 to 113 days of transplanting rice. The number of spiders and pests found in the field was recorded through sweeping net and visual observations. The number of sweeps (five times) was uniformly carried out in all the treatments.

Other management practices such as fertilizer application, weed management and plant protection were followed uniformly for all the treatments as per the Crop Production Guide (2005). Pearson's correlation coefficient was used to determine the association between the spiders and pests. The SPSS software (Version 10.0) was used for the data analysis.

RESULTS

Population of spiders

A total of 5 species of spider from 5 different families' videlicet, *Lycosa pseudoannulata* Boes & Stand (Lycosidae), *Callitrichia formosana* Oi (Linyphidae), *Tetragnatha javanas* Thorell (Tetragnathidae), *Argiope catenulate* Doleschall (Araneidae) and *Plexippus* species (Salticidae) were observed from six different treatments of rice crop during different days after transplantations. Among them, *L. pseudoannulata* and *Plexippus* species are hunting spiders. *Tetragnatha javanas* and *A. catenulata* are the orb web weavers and *C. formosana* build space web to capture the prey.

The populations of spiders in different treatments during different days after transplantations were given in Tables 1 and 2. The result indicates that except *T. javanas,* all the spiders were observed throughout the study period. *T. javanas* population was not observed after 102 DAT, and their population was higher in the early growth stages. *A. catenulata* was found abundant during 88 DAT to 113 DAT and its population was less up to 53 DAT. Similar trend was also observed in *Plexippus* species. *L.pseudoannulata* and *C. formosana* were distributed throughout the study period (42 DAT to 113 DAT). *L. pseudoannulata* was predominant only during 42 DAT to 53 DAT and lowest at 113 DAT. *C. formosana* was also found to be more in early growth stage of crop (42 to 66 DAT).

In transplantation technique, spiders were not observed after 88 DAT due to harvesting of the crop. More number of *L. pseudoannulata* was observed during early stage of the crop (42 to 88 DAT) whereas *A. catenulata* population was found to be more during later stage of the crop. In system of rice intensification techniques, nearly all spiders found during all the DAT. *Tetragnatha javanas* observed to be more during 42 to 66 DAT, *A. catenulata* was

Table 1. Spider population in transplanation, rice intensification and integrated crop management techniques

Transplanation technique								
Name of the spiders	42 DAT	48 DAT	53 DAT	66 DAT	88 DAT	102 DAT	109 DAT	113 DAT
L. pseudoannulata	24	11	24	18	9	H	H	H
C. formosana	2	17	14	21	24	H	H	H
T. javanas	15	7	12	14	3	H	H	H
A. catenulata	0	1	7	64	101	H	H	H
Plexippus spp.	0	1	5	4	4	H	H	H
System of rice intensification technique								
L. pseudoannulata	18	11	35	11	16	4	2	1
C. formosana	5	25	34	13	13	35	35	27
T. javanas	20	6	5	24	6	0	0	0
A. catenulata	2	1	3	9	37	37	25	16
Plexippus spp.	0	1	8	8	3	23	23	20
Integrated crop management technique								
L. pseudoannulata	19	7	25	11	16	1	8	0
C. formosana	1	15	31	15	9	43	16	20
T. javanas	13	5	8	20	7	5	0	0
A. catenulata	0	0	0	11	34	82	58	30
Plexippus spp.	0	0	6	6	12	21	11	13

H- Crop harvested, DAT- Days after transplantation.

predominant during 88 DAT, *C. formosana* was the maximum during 102 to 113 DAT and *L. pseudoannulata* was predominant during 53 DAT (Table 1). *A. catenulata* showed highest number during 88 DAT to 109 DAT and *C. formosona* found to be more during 102 DAT in integrated crop management techniques (Table 1).

In drum sowing technique, *A. catenulate* found to be more during 102 DAT followed by *Plexippus* species during 113 DAT. *T. javanas* was the maximum during 66 DAT (Table 2). In random planting and seedling throwing techniques the harvest was made after 88 DAT. More number of *L. pseudoannulata* and *C. formosana* was observed during 53 DAT and 48 DAT respectively. *A. catenulata* was high in the later stages of crop in random planting. The same trend was observed in seedling throwing (Table 2). Altogether L. *pseudoannulata, C. formosana* and *Plexippus* species observed to be more in system of rice intensification technique, whereas, *A. catenulata* was found more in seedling throwing and transplantation techniques. More or less equal number of *T. javanas* was observed in all the treatments. Seedling throwing had only less number of spiders when compared to other treatments except *A. catenulate.* The overall percentage composition of spiders in different treatments was also computed and shown in figure 1. System of rice intensification, integrated crop management and drum sowing had 20.43%, 20.93% and 20.31% of spiders respectively. Transplantation technique occupied the second rank followed by random planting. Seedling throwing had only less percentage of spiders.

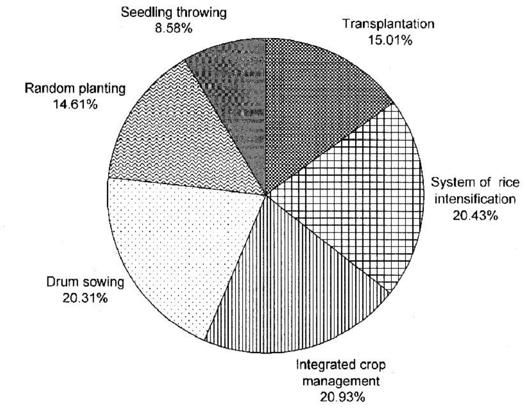

Figure 1. percentage composition of spiders (irrespective of the species) in different techniques.

Population of pests

During the study, *Nephotettix virescens* (Distant), *Scripophaga* incertulas (Walker), *Cnaphalocrosis medinalls* (Guenee), *Cofana spectra* (Distant) *Nilaparvata lugens* (Stal) and *Leptocorisa oratouris* (Fabricius) were recorded. *L. oratouris* was the only pest showed highest number during

Table 2. Spider population in drum showing, random planting and seedling throwing techniques.

Drum showing technique								
Name of the spiders	42 DAT	48 DAT	53 DAT	66 DAT	88 DAT	102 DAT	109 DAT	113 DAT
L.pseudoannulata	8	15	23	6	14	1	9	2
C.formosana	0	22	14	16	10	26	21	15
T.javanas	15	6	10	25	7	5	0	0
A.catenulata	0	0	0	12	43	77	39	37
Plexippus spp.	0	1	7	16	7	14	10	26
Random planting technique								
L.pseudoannulata	22	6	27	19	7	H	H	H
C.formosana	4	28	21	10	22	H	H	H
T.javanas	14	8	15	17	3	H	H	H
A.catenulata	1	0	7	82	76	H	H	H
Plexippus spp.	0	0	3	8	13	H	H	H
Seedling throwing technique								
L.pseudoannulata	19	7	25	11	16	1	8	0
C.formosana	1	15	31	15	9	43	16	20
T.javanas	13	5	8	20	7	5	0	0
A.catenulata	0	0	0	11	34	82	58	30
Plexippus spp.	0	0	6	6	12	21	11	13

H- Crop harvested, DAT- Days after transplantation.

Table 3. Pest population in transplantation technique, Rice intensification, Integrated crop management techniques

Transplantation technique								
Name of the spiders	42 DAT	48 DAT	53 DAT	66 DAT	88 DAT	102 DAT	109 DAT	113 DAT
Nephotettix virescens	0	7	5	8	0	H	H	H
Scripophaga incertulas	0	5	4	5	0	H	H	H
Cnaphalocrosis medinalls	0	1	1	1	0	H	H	H
Cofana spectra	0	0	1	10	0	H	H	H
Nilparvata lugens	0	0	0	3	0	H	H	H
Leptocorsia oratouris	0	0	0	10	27	H	H	H
System of rice intensification technique								
Nephotettix virescens	0	8	4	14	1	0	0	0
Scripophaga incertulas	0	1	3	7	0	1	2	1
Cnaphalocrosis medinalls	0	0	0	0	2	0	0	0
Cofana spectra	0	0	0	16	0	1	3	0
Nilaparvata lugens	0	0	0	2	0	0	0	0
Leptocorisa oratouris	0	0	0	2	35	21	4	3
Integrated crop management technique								
Nephotettix virescens	0	6	8	15	0	0	0	0
Scripophaga incertulas	0	3	6	12	0	1	0	0
Cnaphalocrosis medinalls	0	0	1	0	0	0	0	0
Cofana spectra	0	2	0	33	3	0	1	0
Nilaparvata lugens	0	0	0	7	0	0	0	0
Leptocorisa oratouris	0	0	0	2	6	41	3	2

H- Crop harvested, DAT- Days after transplantation.

Table 4. Pest population in drum showing technique, random planting and seedling throwing technique.

Drum showing technique								
Name of the spiders	42 DAT	48 DAT	53 DAT	66 DAT	88 DAT	102 DAT	109 DAT	113 DAT
N. virescens	0	14	11	18	0	0	0	0
S. incertulas	0	4	8	12	0	1	0	0
C. medinalls	0	2	0	0	2	0	0	0
C. spectra	0	0	0	56	10	1	2	0
N. lugens	0	0	0	6	0	0	0	0
L. oratouris	0	0	0	0	3	38	8	0
Random planting technique								
N. virescens	0	17	2	10	1	H	H	H
S. incertulas	0	9	2	12	0	H	H	H
C. medinalls	0	0	4	0	0	H	H	H
C. spectra	0	1	0	14	0	H	H	H
N. lugens	0	0	0	0	0	H	H	H
L. oratouris	0	0	0	2	11	H	H	H
Seedling throwing technique								
N. virescens	0	22	1	24	0	H	H	H
S. incertulas	0	14	1	10	0	H	H	H
C. medinalls	0	7	0	1	0	H	H	H
C. spectra	0	10	7	6	0	H	H	H
N. lugens	0	0	0	0	0	H	H	H
L. oratouris	0	0	0	9	8	H	H	H

H- Crop harvested, DAT- Days after transplantation.

88 DAT. In system of rice intensification, *N. virescens* found to be more during 48 to 66 DAT whereas, *L. oratouris* was predominant during 88 to 113 DAT. *C. spectra* observed to be more during 66 DAT. *L. oratouris* was predominant during 102 DAT followed by *C. spectra* during 66 DAT in integrated pest management. Similar trend was also observed in drum sowing. A maximum number of *N. virescens* and *C. spectra* were observed during 48 and 66 DAT respectively in random planting. In seedling throwing, *N. virescens*, *S. incertulas* and *L. oratouris* were the major pests. Among them, *N. virescens* was more during 48 DAT and 66 DAT (Tables 3 and 4).

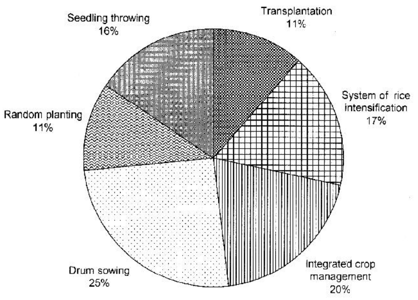

Figure 2. Percentage composition of pests (irrespective of the species) in different techniques

Table 5. Pearson's correlation analysis of spiders and pests found in the field during the study the period.

Name of the spiders	Name of the pests					
	Nephotettix virescens	*Scripophga incertulas*	*Cnaphalocrosis medinalls*	*Cofana spectra*	*Nilaprvata lugens*	*Leptocorisa oratouris*
Lycosa pseudoannulata	-0.748	-0.791	-0.812*	-0.264	0.189	0.741
Callitrichia formosana	-0.292	-0.330	-0.754	0.282	0.494	0.902*
Tetragnatja javamas	0.675	0.549	0.104	0.840*	0.328	0.338
Argiope catenulata	0.713	0.738	0.565	0.411	0.199	-0.364
Plexippus species	0.129	0.034	-0.494	0.650	0.597	0.842*

* $P < 0.05$

The overall percentage composition of pests in different treatments was shown in Figure 2. The result indicates that the drum sowing positioned the top rank (25%). The integrated crop management occupied the second rank (20%) followed by system of rice intensification (17%), seedling throwing (16%), transplantation (11%) and random planting (11%).

The ratio of spiders and pests population in the field was accessed through correlation analysis. *Lycosa pseudoannulata* had a positive maximum correlation with *L. oratouris* (r = 0.741; n = 6; P < 0.05) and *N. lugens* (r = 0.189; n = 6; P < 0.05). *T. javanas* had positive correlation with all the pest found in the field. *Tetragnatha javanas* had positive maximum correlation with *C. spectra* (r = 0.840; n = 6; P < 0.05) followed by *N. virescens* (r = 0.675; n = 6; P < 0.05) and *S. incertulas* (r = 0.549; n = 6; P < 0.05). *Argiope catenulata* had a positive maximum correlation with both *N. virescens* (r = 0.713; n = 6; P < 0.05) and *S. incertulas* (r = 0.738; n = 6; P < 0.05) and had a less correlation with *N. lugens* (r = 0.199; n = 6; P < 0.05). *Plexippus* species had a positive maximum correlation with *L. oratouris* (r = 0.842; n = 6; P < 0.05) followed by *C. spectra, N. lugens, S. incertulas* and *N. virescens*. They had negative correlation with *C. medinalls* (Table 5).

DISCUSSION

The present study clearly reveals that the spiders are effective biocontrol agent in rice ecosystem. The spider population always shows fluctuation with the crop stages and pest population. Except *T. javanas*, all the spiders were observed throughout the study. *T. javanas* was higher in early growth stage and *A. catenulata* was predominant during later stages of the crop. *Lycosa pseudoannulata* and *C. formosana* were observed throughout the study period and they were predominant in early stages of the crop. The occurrence of spiders in different days after transplantation in the field indicated that spider ensured protection of the crop from phytophagous insects. The result of the present study is similar to the findings of Sahu *et al.* (1996). They have been reported that the population of *L. pseudoannulata* in rice ecosystems varied from 10 to 32% being maximum at 95 and 110 DAT and lowest at 140 DAT. The abundance of *C. formosana* was more in the early growth stages of the crop and gradually declined at 80 DAT. However, orb-weavers usually become abundant when insect damage has already occurred (Barrion and Litsinger, 1984). Sigsgaard *et al.* (1999) reported that the highest population of *L. pseudoannulata* and *C. formosana* was found during the first 35 DAT as observed in this study. They also observed that both the spiders occur throughout the year. The present result is also similar with the findings of Heong *et al.* (1992), they have recorded orb weavers especially *Tetragnatha* species are the most abundant spider in the early stage of irrigated rice crop.

Overall population of spiders in six different techniques were also computed and the result indicates that the integrated crop management, system of rice intensification and drum sowing contains more percentage of spiders. Hence these three techniques can be adopted as the important techniques for rice establishment. Further, these techniques provide favorable microclimate for spider survival by having adequate space between plants and rows. This could be the reason for the more number of spiders in the field. Moreover the spiders can move around and to capture the prey easily. As a substitute of planting seedlings in clumps, single seedling is ample in system of rice intensification technique and this might serves the spiders towards catching the prey easily. Thus this may be the motive for the spiders found more in these techniques. The present study clearly reveals that six major pests attack the rice plant during this study period. Earlier studies by Sahu *et al.* (1996), Samiyyan and Chandra sekaran (1998), Sigsgaard (2000), Vanitha (2000), Mathirajan (2001), Sunil Jose *et al.* (2002), Satpathi (2004), Sudhikumar *et al.* (2005) and Sebastian *et al.* (2005) were also evidence for the identical pest species diversity in rice ecosystem in Tamil Nadu. They have also reported that the combination of all the four insects under test revealed host preference in the descending order as green leafhopper (43.33%) > rice hispa (6.67%) > stem borer and leaf folder (3.33%).

The nature of feeding habits of any animal depends on the nature of the food availability. The result clearly indicates that the number of spider depends on the availability of the pest. Our findings support the hypothesis is that the prey population increases, the population of the spider also increases. All the spiders showed the positive correlation with rice pest *N. lugens* while, *L. pseudoannulata* showed negative correlation with *S. incertulas, C. medinalls* and *C. spectra*. High population of spider in the different treatment plots limits the exponential growth of pest population. This result is similar to the findings of Sahu *et al.* (1996). They reported *L. pseudoannulata* preferred more *S. incertulas* and *C. medinalls*. *C. formosana* had a positive maximum correlation with pest *L. oratouris*. This result concurs with the result of Sigsgaard *et al.* (1999). They have reported that the spider density was less, planthopper and leaf hopper densities were high. According to Riechert and Bishop (1990), the increase of spiders' density could decrease the pest density and pest damage. Thus spiders serve as buffer in the rice establishment techniques and limit the exponential growth of prey population in all the techniques.

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