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RESEARCH ARTICLE

TOXICOLOGICAL STUDIES ON SPIDERS OF KUTTANAD RICE AGROECOSYSTEM, KERALA, INDIA

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ABSTRACT

Spiders are obligate carnivores and hold the unique position of being the only large class of arthropods which are entirely predatory in nature. To form a basis for research into the role of spiders to determine the economic importance of them in the rice agro ecosystem of Kuttanad region of Kerala, a toxicity study of 3 commonly used insecticides on dominant spiders were conducted in the laboratory. Topical application (spraying) and dipping method were used for study. Of the three insecticides tested, Methyl parathion recorded the lowest lethal concentration values indicating its comparatively high toxicity in both methods. This is followed by Quinalphos and Monocrotophos. The exposure to Methyl parathion resulted in 80% mortality of experimental spiders compared to 65% and 40% of mortality with Quinalphos and Monocrotophos respectively. This is suggestive of the usefulness of Monocrotophos as a component of integrated pest management strategy for sustainable paddy cultivation. Of the three dominant species tested, *Pardosa pseudoannulata* was the least susceptible to application of insecticides both by topical application method and the dipping method under laboratory conditions. *Tetragnatha mandibulata* was the most susceptible to the insecticides tested under laboratory conditions. Among the two methods used, dipping method was found to be more fatal compared to topical application. Spiders are very important biological control agents in agroecosystems and play a major role as potential defenders by suppressing the pest population to a safe level which emphasizes the concept of Integrated Pest Management (IPM) in modern agriculture. Faced with the need to reduce pesticide usage on crops and optimize natural biological control, full investigation on the means by which spiders influence pest abundance and effect of insecticides on spiders is long overdue.

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INTRODUCTION

Integrated pest management is a part of the broader overall phenomenon of natural control. Natural control may be defined as the regulation of populations within certain more or less regular upper and lower limits over a period of time by any one or any combination of natural factors. Natural enemy populations have the unique ability of being able to interact with their prey or host populations and to regulate them at lower levels. In biological control, natural enemies are referred to as parasites, predators and pathogens. In order to appreciate the biological workings and ecological basis of biological control, it is first desirable to have an idea of different pest groups and their major characteristic natural enemies. If the natural enemies of a potential pest under complete biological control are killed off by insecticides, a great upset will occur. If the potential pest is under partial biological control only a mild upset may occur (De Bach, 1974).

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The past experience in the pest control has indicated that no single method is successful. Viewing this multifactor problem associated with ecology, behaviour and biology of the pest and inherent limitations of each method of control, it is now almost universally accepted that the final solution lies with Integrated Pest Management (IPM) and biological control. The utilization of naturally occurring predatory arthropods is a major component of IPM. The compatibility of chemical and biological control may be achieved by determining the relative susceptibility of parasites and predators to the insecticides and to use only those which are relatively harmless to them. The integration of chemical and biological control should be brought about in such a manner that both of them should be able to exert their optimum beneficial effects.

Effect of persistent insecticides to non-target and useful organisms such as predators, parasites and pollinators is causing a chain of reactions leading to the appearance of several minor pests in epidemic form. When insecticides are used to control pests, care should be taken to ensure that the most important beneficial organisms are not seriously affected. When predators are allowed to operate undisturbed in the fields, less insecticidal treatments may be needed to control pests. Evaluation of the effects of insecticides on beneficial arthropods has attracted increasing attention of scientists in many parts of the world. The increasing use of insecticides for the pest control has come to the need for evaluating their effects on the beneficial arthropods. Even though insecticide application is the most commonly used method for controlling the insect pests in the rice fields; its usage has inevitably been followed by pest resistance and outbreaks of secondary pests. In the present study, the effect of certain insecticides used in the field on some dominant spiders was studied.

MATERIALS AND METHODS

Sensitivity of spiders to widely used insecticides in the fields was evaluated in the laboratory condition. Adult females of three dominant species, *Araneus ellipticus* (Araneidae), *Pardosa pseudoannulata* (Lycosidae) and *Tetragnatha mandibulata* (Tetragnathidae) from the Kuttanad rice agroecosystem were selected for the toxicological studies. The insecticides tested were Ekalux EC 25 (*Quinalphos* 25% EC), Hilcron 36 SL (*Monocrotophos* 36 SL) and Metacid (*Methayl parathion* 50% EC). All these three insecticides are commonly used in the study area for the control of rice bug, brown plant hopper, green leaf hopper and other insect pests of paddy. The insecticides were diluted to four different concentrations (0.02%, 0.04%, 0.06% and 0.08%) by adding water. Before the tests, the field collected and reared spiders were kept at 27^{o}C to 30^{o}C at 70% R.H. They were fed on *Drosophila melanogaster* Meiger and *Corcyra cephalonica* Stainton in the laboratory.

Susceptibility of three insecticides was evaluated in the laboratory by two methods viz., dipping method and topical application as described by Tanaka *et al*. (2000). In the topical application, the various concentrations of insecticides were applied with a hand compression sprayer to the dorsal side of each adult female spider keeping them in the plastic petri dishes. Distilled water was sprayed as control. A total of 10 spiders were examined for each concentration. The treated spiders were transferred to individual plastic tubes (rearing chambers) containing moist cotton. Mortality counts were made after 24 and 48 hours of the treatment.

In the dipping method, the bottom end of a glass tube was covered with nylon gauze, which was fixed with a rubber band. Then 10 pre-anesthetized test spiders were put into the glass tube. The bottom end of this tube was dipped in the insecticide solution in a petri dish for 20 seconds. The tube was then placed on several sheets of filter paper to remove the insecticide solution. The treated spiders were transferred to individual plastic tubes (rearing chambers) containing moist cotton. The process was repeated for all the concentration of these insecticides. In the control treatment, the test individuals were dipped in distilled water. Mortality counts were recorded for 24 and 48 hours after treatment. The observed mortality was corrected using Abbot's equation (Abbot, 1925) and the LC_{50} (median lethal concentration) and LC_{90} values were calculated by probit analysis (Finney, 1971).

RESULTS

Effect of insecticides on dominant spiders

Araneus ellipticus (Family: Araneidae)

Of the three insecticides tested, Methyl parathion recorded the lowest lethal concentration values (LC_{50} of 0.042 and LC_{90} of 0.134) indicating its comparatively high toxicity in the topical application method (Table 1). This is followed by Quinalphos in the order of toxicity with an LC_{50} value of 0.067 and LC_{90} of 0.124. Monocrotophos showed the least toxicity to *A. ellipticus* (LC_{50} of 0.085 and LC_{90} of 0.282). Mortality responses were high to all the concentrations of Methyl parathion, the highest being 77.80% mortality at a dose of 0.08%, 48 hours after treatment. As it would be expected, Monocrotophos proved to the safest among the three formulations, effecting only 44.40% mortality to the test spiders at its highest concentration of 0.08 at 48 hours after treatment.

Table 1. Susceptibility assays using adult females of *Araneus ellipticus* exposed to different concentrations of insecticides by topical application

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.067	5.02±2.14
	0.04	00.00	LC_{90} = 0.124	
	0.06	44.40	X^2 = 0.566	
	0.08	55.60		
Monocrotophos 36% SL	0.02	00.00	LC_{50} = 0.085	2.45±1.15
	0.04	00.00	LC_{90} = 0.282	
	0.06	33.30	X^2 = 1.114	
	0.08	44.40		
Methyl parathion 50% EC	0.02	11.10	LC_{50} = 0.042	2.61±0.97
	0.04	44.40	LC_{90} = 0.134	
	0.06	55.60	X^2 = 0.223	
	0.08	77.80		

* Corrected using Abbot's formula
** Hours after treatment

In the dipping method, Methyl parathion again showed the highest toxicity recording the least lethal concentration values as shown in Table 2. (LC_{50} of 0.038 and LC_{90} of 0.122). Quinalphos showed an LC_{50} value of 0.048 and LC_{90} of 0.112. Monocrotophos recorded the highest LC_{50} of 0.058 and LC_{90} of 0.137, indicating its least toxicity to *A. ellipticus* as was the case in the topical application method.

As far as mortality responses are concerned, Methyl parathion caused the highest response of 77.80%, 55.50%, 44.40% and 11.10% at 0.08%, 0.06%, 0.04% and 0.02% concentrations respectively in topical application and 77.80%, 77.80%, 44.40% and 11.10% at 0.08%, 0.06%, 0.04% and 0.02% concentrations respectively in dipping method, 48 hours after the treatment. Monocrotophos affected the lowest mortality responses, causing only 44.40% and 33.30% at 0.08% and 0.06% concentrations respectively in topical application and 77.80%, 55.60, 22.20 and 11.10% at 0.08%, 0.06%, 0.04% and 0.02% concentrations respectively in dipping method, 48 hours after treatment. The lowest two concentrations of topical application did not cause any response to *A. ellipticus.* This is suggestive of the usefulness of Monocrotophos as a component of integrated pest management strategy for sustainable paddy cultivation. This study revealed that Monocrotophos and Quinalphos was the least toxic to this spider in spraying and dipping method respectively.

Table 2. Susceptibility assays using adult females of *Araneus ellipticus* exposed to different concentrations of insecticides by dipping method

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.048	4.61±2.02
	0.04	11.10	LC_{90} = 0.112	
	0.06	55.60	X^2 = 0.344	
	0.08	66.70		
Monocrotophos 36% SL	0.02	11.10	LC_{50} = 0.058	2.78±1.01
	0.04	22.20	LC_{90} = 0.137	
	0.06	55.60	X^2 = 1.007	
	0.08	77.80		
Methyl parathion 50% EC	0.02	11.10	LC_{50} = 0.038	3.03±1.00
	0.04	44.40	LC_{90} = 0.122	
	0.06	77.80	X^2 = 0.402	
	0.08	77.80		

* Corrected using Abbot's formula
** Hours after treatment

Pardosa pseudoannulata (Family: Lycosidae)

Of the three dominant species tested, *P. pseudoannulata* was the least susceptible to the application of insecticides both by topical application method and the dipping method under laboratory conditions. Among the three insecticides tested, Monocrotophos showed the highest toxicity to the spiders recording the lowest LC_{50} value of 0.072 and LC_{90} value of 0.125 (Table 3) in the topical application method. Methyl parathion recorded an LC_{50} of 0.084 and LC_{90} of 0.243. Quinalphos was the least toxic recording the highest lethal concentration values (LC_{50} 0.105 and LC_{90} 0.408). Mortality responses were the highest to Monocrotophos recording % mortalities of 60%, 40% and 10% at concentrations of 0.08, 0.06 and 0.04 respectively, 48 hours after treatment. The lowest concentration, 0.02 did not have any effect on *P. pseudoannulata* at 48 hours after treatment.

Table 3. Susceptibility assays using adult females of *Pardosa pseudoannulata* exposed to different concentrations of insecticides by topical application

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.105	2.16±1.98
	0.04	00.00	LC_{90} = 0.408	
	0.06	30.00	X^2 = 0.254	
	0.08	40.00		
Monocrotophos 36% SL	0.02	00.00	LC_{50} = 0.072	5.05±2.19
	0.04	10.00	LC_{90} = 0.125	
	0.06	40.00	X^2 = 0.064	
	0.08	60.00		
Methyl parathion 50% EC	0.02	00.00	LC_{50} = 0.084	2.78±1.01
	0.04	20.00	LC_{90} = 0.243	
	0.06	30.00	X^2 = 0.116	
	0.08	50.00		

* Corrected using Abbot's formula
** Hours after treatment

In the dipping method, the three insecticides did not show much variation in the toxicity and mortality responses. However, Monocrotophos recorded the lowest lethal concentration values (LC_{50} of 0.064 and LC_{90} of 0.012) as shown in Table 4 indicating its comparatively higher toxicity to *P. pseudoannulata.* Methyl parathion was the least toxic among the three insecticides with an LC_{50} of 0.075 and LC_{90} of 0.271. Monocrotophos affected the highest mortality of 70% at 0.08 concentration, 48 hours after treatment. Quinalphos and Methyl parathion affected 60% mortality each at the same concentration. Monocrotophos and Quinalphos did not cause any mortality response to *P. pseudoannulata*at 0.02, 48 hours after treatment. This study revealed that Quinalphos and Methyl parathion was the least toxic to this spider in spraying and dipping method respectively.

Table 4. Susceptibility assays using adult females of *Pardosa pseudoannulata* exposed to different concentrations of insecticides by dipping method

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.071	5.05±2.19
	0.04	10.00	LC_{90} = 0.125	
	0.06	40.00	X^2 = 0.064	
	0.08	60.00		
Monocrotophos 36% SL	0.02	00.00	LC_{50} = 0.064	4.49±2.05
	0.04	20.00	LC_{90} = 0.012	
	0.06	40.00	X^2 = 0.174	
	0.08	70.00		
Methyl parathion 50% EC	0.02	10.00	LC_{50} = 0.075	2.28±1.06
	0.04	30.00	LC_{90} = 0.271	
	0.06	30.00	X^2 = 0.805	
	0.08	60.00		

* Corrected using Abbot's formula
** Hours after treatment

Tetragnatha mandibulata (Family: Tetragnathidae)

T. mandibulata was the most susceptible to the insecticides tested under laboratory conditions. Among the three insecticides tested, Methyl parathion was the most toxic in the topical application method recording an LC_{50} value of 0.028 and LC_{90} of 0.062 (Table 5). Monocrotophos was the least toxic to *T. mandibulata* having lethal concentrations of 0.053 and 0.115 respectively. Complete mortality was resulted by Methyl parathion at 0.06 and 0.08, as well as Quinalphos 0.08, at 48 hours after treatment. Monocrotophos effected only 77.8% mortality at its highest concentration revealing its superiority over other insecticides as far as safety to the spiders is concerned.

The same trend was observed in the dipping method. However, dipping method proved rather more toxic to *T. mandibulata* in comparison with topical application. In the dipping method, Methyl parathion recorded the lowest LC_{50} value of 0.009 and LC_{90} of 0.06, revealing its high toxicity to the test arthropods (Table 6). Again, Monocrotophos was the least toxic among the three insecticides tested with values 0.041 (LC_{50}) and 0.097 (LC_{90}) and effecting maximum mortality of 87.5% at its highest concentration tested. Methyl parathion at all concentrations except at 0.02, as well as Quinalphos at 0.08 effected 100% mortality to *T. mandibulata* 48 hours after the treatment. The data clearly suggest that among the three insecticides tested, Methyl parathion was the most toxic to *T. mandibulata*.

Table 5. Susceptibility assays using adult female of *Tetragnatha mandibulata* exposed to different concentrations of insecticides by topical application

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.051	7.49±2.29
	0.04	11.10	LC_{90} = 0.074	
	0.06	77.70	X^2 = 0.538	
	0.08	100.0		
Monocrotophos 36% SL	0.02	00.00	LC_{50} = 0.053	3.78±1.19
	0.04	11.10	LC_{90} = 0.115	
	0.06	55.50	X^2 = 1.218	
	0.08	77.80		
Methyl parathion 50% EC	0.02	22.20	LC_{50} = 0.028	3.71±1.34
	0.04	66.70	LC_{90} = 0.062	
	0.06	100.0	X^2 = 0.026	
	0.08	100.0		

* Corrected using Abbot's formula
** Hours after treatment

Table 6. Susceptibility assays using adult females *Tetragnatha mandibulata* exposed to different concentrations of insecticides by dipping method

Insecticide	Dose (a.i. ml/L)	% mortality* (48 HAT**)	Lethal concentration (ml/L)	Slope±SE
Quinalphos 25% EC	0.02	00.00	LC_{50} = 0.041	5.15±1.66
	0.04	12.50	LC_{90} = 0.073	
	0.06	87.50	X^2 = 2.285	
	0.08	100.0		
Monocrotophos 36% SL	0.02	00.00	LC_{50} = 0.041	3.36±1.04
	0.04	25.00	LC_{90} = 0.097	
	0.06	62.50	X^2 = 0.812	
	0.08	87.50		
Methyl parathion 50% EC	0.02	62.50	LC_{50} = 0.009	1.58±1.29
	0.04	100.0	LC_{90} = 0.060	
	0.06	100.0	X^2 = 0.905	
	0.08	100.0		

* Corrected using Abbot's formula
** Hours after treatment

The overall LC_{50}values of the three chemicals to the three spiders by two different methods is given in Table 7. This study revealed that *P. pseudoannulata* was most resistant spider to these chemicals followed by *A. ellipticus* and *T. mandibulata*.

Table 7. LC_{50} value of three different insecticides on three dominant spiders by two methods of application Quinalphos 25% EC

Spider species	LC_{50} (ml/L) Spraying	Dipping
A. ellipticus	0.067	0.058
P. pseudoannulata	0.105	0.071
T. mandibulata	0.051	0.041

Monocrotophos 36% SL

Spider species	LC_{50} (ml/L) Spraying	Dipping
A. ellipticus	0.085	0.048
P. pseudoannulata	0.072	0.064
T. mandibulata	0.053	0.041

Methyl parathion 50% EC

Spider species	LC_{50} (ml/L) Spraying	Dipping
A. ellipticus	0.042	0.038
P. pseudoannulata	0.084	0.075
T. mandibulata	0.028	0.009

DISCUSSION

Laboratory experiments to test the insecticidal effect on spiders revealed that the spiders are quite sensitive to insecticides which kill them by contact. Kiritani (1979) reported the reduction of spiders through contact toxicity by ingesting pests contaminated with insecticides. However, their behaviour to feed only on moving insects perhaps saves them from greater reductions in population as a result of insecticidal usage. The susceptibility to insecticides varied between species of spiders. In the present study, the tetragnathid spider (*Tetrgantha mandibulata*) was more susceptible to insecticides than the other spiders, *Araneus ellipticus* and *Pardosa pseudoannulata*. The similar result was obtained in experiments by Tanaka *et al*. (2000) with *T. maxillosa.* Mortality of predators usually occurs not only by direct contact but also by ingesting prey that had taken up the insecticides (Kiritani and Kakiya, 1975). Since the predator has to search out its prey, it is expected to pick up greater amounts of toxicant and thus suffer greater mortality than the more sedentary pests occupying the same habitat. In the present study, the effects of commonly used insecticides were tested for their toxicity to three common spiders in rice fields which are potential predators of hoppers. Among them, *P. pseudoannulata* is a hunter and their chances of coming across pesticide residues are greater while the other two, *A. ellipticus* and *T. mandibulata* are orb weavers which have a greater chance of being directly exposed to pesticide spray.

Thang *et al.* (1988) reported that *P. pseudoannulata* could tolerate common chemicals used in agro ecosystems for pest eradication. The results of present study also agree with this. The safety of different chemicals to different spiders has been reported earlier by Fabellar and Heinrichs (1986). This study also confirms the earlier report of Feber *et al*. (1998) that *P. pseudoannulata* could tolerate the common chemicals. One of the theories involved in the selectivity of certain insecticides is the involvement of the mixed function oxidases. In general, organophosphates have been reported to be highly selective to *P. pseudoannulata* compared to carbamate compounds (Thang *et al.,* 1988). Kiritani and Kakiya (1975) and Thang *et al.* (1988) have observed significant mortality of predators not only from direct toxicity but also from ingestion of prey that had taken up the insecticides. They have theorized that the coupling of low mixed function oxidase activity with slow penetration, weak binding to the integument and tissue and speedy excretion in *P. pseudoannulata* could be the explanation for its lesser susceptibility to insecticides.

Spider communities did change in many ways over the season, but this was not related to an incremental increase in the rate of pesticide application. One major factor which influenced the spider community composition over the season was the profound effect of differences in spider phenology. Apart from the fact that insecticide use is rarely necessary, it also poses a risk to farmer health and the environment (Heong *et al*., 1995). Continued insecticide use stresses the need to bridge the gap between research and farmers. FAO has supported Farmers' Field Schools in many countries and provided farmers with a practical understanding of integrated pest and nutrient management (Matteson, 2000). The expectation is that the farmers who receive training will pass their new knowledge on to other farmers. Another approach was developed by Heong *et al*. (1998), where farmers were motivated to 'test' a simple rule of thumb (no spray necessary in the first 40 days after sowing) by the use of communication media, including the radio. The practice of no early spray is now adopted by many farmers in southern Vietnam, and recommended by the National Agricultural Research and Extension Agencies in Malaysia, the Philippines, and Thailand (Matteson, 2000).

Many farmers use chemical pesticides to help control pests. An ideal biological control agent, therefore, would be one that is tolerant to synthetic insecticides. Although spiders may be more sensitive to insecticides than insects due in part to their relatively long life spans, some spiders show tolerance, perhaps even resistance, to some pesticides. Spiders are less affected by fungicides and herbicides than by insecticides (Yardim and Edwards, 1998). Spiders such as the wolf spider *P. pseudoannulata* are highly tolerant of botanical insecticides such as neem-based chemicals (Theiling and Croft, 1988; Markandeya and Divakar, 1999). They are also generally more tolerant of organophosphates and carbamates than of pyrethroids, organochlorines, and various acaricides, although this tolerance may be due to genetic resistance bred over a period of continuous exposure (Theiling and Croft, 1988; Wisniewska and Prokopy, 1997; Yardim and Edwards, 1998; Marc *et al*., 1999; Tanaka *et al*., 2000). For example, *P. pseudoannulata* (Lycosidae), *Tetragnatha maxillosa* (Tetragnathidae), *Ummeliata insecticeps* (Linyphiidae) and *Gnathonarium exsiccatum* (Linyphiidae) were highly sensitive to the pyrethroiddeltamethrin, but very tolerant of the organophosphate diazinon and the carbamatecarbaryl (Tanaka *et al*., 2000).

Some broad-spectrum organophosphates are highly toxic to spiders. For example, dimethoate sprays resulted in 100% mortality to the lycosid *Trochosa ruricola* at concentrations below recommended field application rates (Birnie *et al*., 1998). The organophosphate methyl parathion and the pyrethroidcypermethrin are highly toxic to spiders in the genus *Erigone* (Linyphiidae), while the carbamatepirimicarb is almost harmless (Brown, 1981; Huusela-Veistola, 1998). Toft and Jensen (1998) found that sublethal doses of dimethoate and cypermethrin had no effect on development and predation rates of the wolf spider *Pardosa amentata*. In fact, with very low doses of cypermethrin, killing rates of the adult and penultimate females increased. However, the insecticides did have knockdown effects that, although not influencing survival in the laboratory, would likely result in death in the field due to desiccation or predation (Toft and Jensen, 1998).

Other factors that influence effects of pesticides on spiders are type of solvent, soil type, moisture, percent organic matter, temperature, and time of day of spraying. Further, the microhabitat, hunting style, prey preference, and behaviour of the spider also influence their response to pesticide application (Marc *et al*., 1999). Wisniewska and Prokopy (1997) reported that if pesticides were only used early in the growing season, spider populations increased. Spatial limitation of pesticides (such as only applying the pesticides to certain plants or certain plots) also results in higher spider numbers, since they can move out of the treated areas and return when the chemicals dissipate (Riechert and Lockley, 1984; Balanca and de Visscher, 1997).

Spider density and diversity are significantly higher in orchards and fields where no pesticides have been sprayed (Feber *et al*., 1998; Huusela-Veistola, 1998; Yardim and Edwards, Bogya and Marko, 1999; Marc *et al*., 1999; Holland *et al*., 2000; Amalin *et al*., 2001). Restricting insecticide treatment to crucial periods in the pest life cycle or limiting spraying to midday when many wandering spiders are inactive and in sheltered locations can help conserve spider numbers (Riechert and Lockley, 1984). Spiders can recolonize if the interval between chemical applications is long enough, but several applications per season can destroy spider communities. Some pesticides are also retained in the webs of spiders and can be detrimental to those spiders that ingest their webs daily (Marc *et al*., 1999).

Spiders are the dominant predators in rice fields. Among them *Pardosa* sp., *Araneus* sp. and *Tetragnatha* sp. are the most common. Evidences are coming out of different countries that these spiders, because of their high population densities in rice fields have a damping influence on the populations of pest insects especially the plant and leaf hoppers. Regular application of insecticides is found to almost totally suppress the spider population. The present study was taken up to assess the safety of a few insecticides to these spiders. Application of insecticides is the most commonly practiced methods for controlling the rice hoppers. However, extensive use of insecticides has exposed limitations of providing temporary control and posing some adverse toxicological problems. Furthermore, the use of broad spectrum insecticides has almost inevitably been followed by pest resistance, resurgence and secondary pest outbreaks. In all probability, the hoppers have gained importance as pests due to the destruction of their natural enemies. Selectivity of insecticides is important for pest management. Careful choice of insecticides might not only restrict the adverse effects of chemical application on the spider fauna but also on the predator community as a whole. Restriction of the application of chemicals to local areas or only to randomly selected hills (Ressig *et al.,* 1982) could also permit recolonisation of predators. However, unsprayed, irrigated rice fields have relatively few insect pest problems. This is largely attributed to natural biological control, which keep planthoppers and other potential pests in check (Kenmore, 1991; Way and Heong, 1994).

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