enhanced the availability of nutrients. The positive effects of N fertilisation attributed to the increased nutrient status in soil (Jat and Nepalia, 1995). In addition, under rainfed conditions intercropping with pulses also enhanced the nutrient availability in soil (Balasubramanian *et al.*, 1982).

Thus it may be concluded that the combined application of organic and inorganic fertilisers in equal proportion to supply the recommended level of N (40 Kg/ha) not only increased the yield of crops but also enhanced the nutrient availability in the soil.

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TOXICITY OF INSECTICIDES TO THREE SPIDERS IN RICE FIELDS

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ABSTRACT

Determination of median lethal concentration values for different insecticides to various instars of *Lycosa pseudoannuleta* Boes. et Str.showed the safety of ethofenprox to all the immature stages and adults of *L. pseudoannulata*. Chlorpyriphos, BPMC, phosphamidon and monocrotophos had comparatively higher LC_{50} values than acephate. Determination of median lethal concentration values for different insecticides to *Oxyopes javanus* Thorell and *Argiope catenulata* (Doleschall) revealed that BPMC, chlorpyriphos, acephate and ethofenprox had higher LC_{50} values to *O. javanus* and *A.catenulata* than phosphamidon and monocrotophos which were comparatively more toxic.

KEY WORDS : Toxicity, insecticides, spiders, *Lycosa pseudoannulata*, *Oxyopes javanus*, *Argiope catenulata*, rice field

Of late, there has been an increased emphasis in the utilization of natural enemies, particularly predators for the regulation of rice insect pests. This is exemplified by several integrated pest management programmes developed aginst rice insect pest like *Nilaparvata lugens* Stal. (Delphacidae:Homoptera). In the present study, the effect of commonly used insecticides as well as some newer ones were tested for their toxicity to three common spiders in rice fields which are potential predators of hoppers. Among them, *Lycosa pseudoannulata* Boes. et Str. (Lycosidae:Araenida) and *Oxyopes javanus* Thorell (Oxyopidae:Araenida) are hunters and their chances of coming across pesticide residues are greater while the third, *Argiope catenulata* (Doleschall) (Argiopidae:Araenida) is an orb weaver which has a greater chance of being directly exposed to pesticide spray.

METERIALS AND METHODS

The LC_{50} of acephate, ethofenprox, BPMC, phosphamidon, chlorpyriphos and monocrotophos to third, fifth, seventh and ninth instars and adult stage of *L. pseudoannulata* and to aduls of *O. javanus* and *A. catenulata* was determined using five graded concentrations of the insecticides in acetone. One l of of each concentration was placed over the cephalothoracic region of each spiderling/adult with a micro-syringe applicator (Fabellar and Heinrichs, 1986). There were three replications and each replication had ten individuals. Acetone served as control. The

Table 1. LC_{50} for *L. pseudoannulata*

Chemical/Instar	LC_{50} (%)	LL	UL	Chi^2*	Slope (b)
Acephate					
III	0.005496	0.004836	0.006247	7.767929	-8.04070
V	0.006650	0.005989	0.007385	7.573916	3.670132
VII	0.008694	0.006338	0.011926	4.350071	2.443058
IX	0.009007	0.007396	0.010168	1.739876	3.670727
Adult	0.009377	0.007617	0.011543	5.248871	3.81798
Ethofenprox					
III	0.06774	0.0397	0.1155	6.783658	2.51113
IV	0.070771	0.05562	0.090144	7.091537	2.540154
VII	0.063777	0.05357	0.075928	1.76209	3.39432
IX	0.091029	0.07445	0.106989	2.186692	3.275195
Adult	0.19375	0.093821	0.127508	3.101674	3.401557
Chlorpyriphos					
III	0.016912	0.0144	0.01986	2.329705	4.146647
V	0.019904	0.016115	0.0244584	3.474956	2.90933
VII	0.030698	0.025756	0.036587	0.111224	3.52284
IX	0.032987	0.026862	0.040510	0.589373	2.928371
Adult	0.052563	0.042016	0.065759	2.078311	2.490316
BPMC					
III	0.009098	0.006998	0.011828	4.320527	2.869025
V	0.010966	0.008379	0.014351	4.934598	2.452413
VII	0.015649	0.012105	0.020231	1.624265	2.751316
IX	0.020694	0.016669	0.02578	2.748974	2.828893
Adult	0.022958	0.019313	0.027290	3.297567	3.556563
Monocrotophos					
III	0.018838	0.01219	0.02911	7.339422	-2.37018
V	0.024475	0.00869	0.068933	2.628334	- 1.36015
VII	0.014254	0.010044	0.020228	4.554855	3.330799
IX	0.009236	0.003124	0.027037	7.341025	0.739893
Adult	0.016615	0.011775	0.023445	11.82756	3.230155
Phosphamidon					
III	0.007918	0.004567	0.013727	6.247416	1.60697
V	0.009640	0.005569	0.0016687	1.739738	1.38981
VII	0.014336	0.011795	0.017426	1.37413	2.63567
IX	0.019000	0.016004	0.022557	5.334998	2.83468
Adult	0.022354	0.019376	0.025790	1.420664	3.659734

* All lines are significantly a good fit (P)

mortality was corrected (Abbott, 1925) and probit analysis was done (Finney, 1962).

RESULTS AND DISCUSSION

L. pseudoannulata

The LC_{50} values, fiducial limits, Chi^2 values and slope for six insecticides are summarised (Table 1). Among the insecticides tested, ethofenprox was the safest to all the immature stages and adults recording values ranging from 0.06774 to 0.19375. This was followed by chlorpyriphos, BPMC, phosphamidon, and monocrotophos. Acephate was the most toxic to the spider (0.005496 to 0.009377). Among the instars tested, the third instar was found to be the most susceptible.

O. javanus

For *O. javanus* adults, BPMC, chlorpyriphos, acephate and ethofenprox had similar LC_{50} values while phosphamidon (0.014540) and

Table 2. LC_{50} for *Oxyopes javanus* and *Argiope catenulata*

Chemical	LC_{50} (%)	LL	UL	Chi^2*	Slope (b)
O. javanus					
Ethofenprox	0.021978	0.018377	0.026286	6.543083	2.925033
Acephate	0.022833	0.017620	0.029588	12.93957	1.100213
BPMC	0.029841	0.023286	0.038241	20.68849	2.787220
Monocrotophos	0.01264	0.005962	0.0268	5.416843	0.788038
Phosphamidon	0.014540	0.009305	0.02272	7.192144	1.178459
Chlorpyriphos	0.02326	0.02024	0.02672	3.21932	2.42141
A. catenulata					
Ethofenprox	0.01613839	0.013219	0.019702	1.160116	2.02916
Acephate	0.01090072	0.009158	0.012975	2.328092	2.424634
BPMC	0.009353	0.00749	0.011677	2.721553	2.038465
Monocrotophos	0.007414	0.005895	0.009324	2.197075	2.27647
Phosphamidon	0.004289	0.003111	0.005931	11.69337	1.43383

* All lines are significantly a good fit (P)

monocrotophos (0.01264) were comparatively more toxic (Table 2).

A. catenulata

Ethofenprox was the safest recording the highest LC_{50} value of 0.01613839 (Table 2) followed by acephate, BPMC, monocrotophos, and phosphamidon.

All the three species of spiders BPMC ethofenprox and acephate. Thang *et al.* (1987) reported that *L. pseudoannulata* could tolerate acephate and BPMC. Chlorpyriphos, BPMC, phosphamidon and monocrotophos recorded comparatively higher LC_{50} values than acephate. The safety of chlorpyriphos, phosphamidon and monocrotophos to *L. pseudoannnulata* and toxicity of acephate to the same species has been reported earlier by Fabellar and Heinrichs (1986). The study also confirms the earlier report of Chu *et al.* (1976) that *L. psedoannulata* could tolerate BPMC. 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 *L. pseudoannulata* compared to carbamate compounds (Thang *et al.*, 1987). 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. Due to its inherent toxicity, an insecticide might kill pests but not their natural enemies. Careful choice of insecticides might, therefore, not only restrict the adverse affects 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.

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