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Impact of insecticides on predatory arthropods of the rice ecosystem

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Abstract : The influence of commonly used insectides on the predatory population was studied. The results indicated that acephate, chlorpyriphos and monocrotophos were safer to *Lycosa pseudoannulata, Tetragnatha javana* and *Paderus fuscipes* while acephate, was also found to be safe to *Microvelia atrolineata* and *Cyrtorhinus lividipennis.* Phorate and carbofuran were found to be more toxic to both predators. ***(Key words** : Predators, Rice, Insecticidal effect, Lycosa pseudoannulata, Tetragnatha javana, Paderus fuscipes, Microvelia atrolineata, Cyrtohinus lividipennis)*

The potential of natural enemy action in the regulation of rice pests is affected by the result of interference of these beneficial agents through indiscriminate insecticidal usage. Successful biocontrol of rice insect pests is still feasible as is evident from the apparent occurence of naturally occurring biological control. Regular application of insecticides is found to almost totally suppress the beneficial arthropod population. The present study was taken up during the year 1994-95 at the Paddy Breeding Station, Tamil Nadu Agricultural Univeristy, Coimbatore with a view to assess the influence of certain insecticides used for suppressing the leaf and planthoppers on the non-target, predatory fauna on rice.

Materials and Methods

To assess the effect of recommended insecticides on selected natural enemies of hoppers, a field trial was laid out with a plot size of 50 sq. m. The treatments are presented in Table 1.

Observations were taken on the predators of leaf and planthoppers of rice on 20 hills at random per plot 10 days after each application. All the treatments were given on 10, 30 and 50 days after transplanting (DAT). Individual plots were isolated by bunds and channels to regulate water movement from one plot to another and efforts were also made to eliminate drift between treatments while spraying. Observation on *Microvelia atrolineata* (Berqroth) was taken as implied by Bhathal and Dhaliwal (1991). The area between four adjacent rows were taken as equivalent to one hill to count the predators floating on water.

Results and Discussion

The population of the wolf spider *Lycosa pseudonnulata* Boes. et. Str. was significantly lower

in all the insecticide-treated plots (Table 1). Among the insecticides tested, acephate recorded the highest population of 7.88 spiders/20 hills and was significantly superior to the other treatments. The minimum population was recorded in quinalphos (1.42) which was statistically on par with phorate (2.04) and carbofuran (2.21). The present findings are in accordance with that of Chiu and Cheng (1976) who have also reported the safety of acephate to *L. pseudoannulata* and the toxicity of carbofuran to the same spider. The toxicity of carbofuran could be attributed to the habit of the spider to drink water directly.

The maximum population of the orb-weaver, *Tetragnatha javana* (Thorell) was noticed in the untreated control plots and it was statistically on par with acephate (4.17), chlorphyriphos (4.00) and monocrotophos-treated plots (3.21). Application of quinalphos at 0.5 kg a.i./ha as a spray recorded the

Table 1. Effect of calendar based application of insecticides on the population of *L. pseudoannulata*

Treatment	Population (No. / 20 hills)*					
	Period (Days after transplanting)					
	10	20	30	40	50	60
Carbofuran 3G	0.75^{B}	0.50^{B}	2.00^{B}	6.75^{A}	2.25^{B}	1.00^{B}
0.75 kg a.i. ha^{-1}	$(100)^{c}$	$(0.93)^{c}$	$(1.56)^{c-f}$	$(2.67)^{bc}$	$(1.64)^{cd}$	$(1.18)^{bc}$
Phorate 10G	2.25^{B}	0.25^{B}	6.00^{A}	1.75^{B}	1.50^{B}	0.50^{B}
1.0 kg a.i. ha^{-1}	$(1.61)^{bc}$	$(0.84)^{c}$	$(2.52)^{a-d}$	$(1.48)^{d}$	$(1.40)^{d}$	$(0.93)^{bc}$
Quinalphos 5G	3.75^{B}	3.25^{BC}	2.75^{BC}	12.00^{A}	0.75^{C}	0.75^{C}
1.0 kg a.i. ha^{-1}	$(2.04)^{ab}$	$(1.92)^{b}$	$(1.73)^{b-f}$	$(3.44)^{b}$	$(1.06)^{d}$	$(1.00)^{bc}$
Monocrotophos 35 EC	2.75^{B}	3.25^{B}	4.00^{B}	13.00^{A}	5.50^{A}	2.25^{B}
0.5 kg a.i. ha^{-1}	$(1.79)^{bc}$	$(1.90)^{b}$	$(2.03)^{b-e}$	$(3.66)^{b}$	$(2.42)^{c}$	$(1.63)^{bc}$
Chlorpyriphos 20EC	4.00^{A}	4.00^{A}	7.00^{A}	4.00^{A}	2.50^{A}	3.00^{A}
0.5 kg a.i. ha^{-1}	$(2.08)^{ab}$	$(2.00)^{b}$	$(2.70)^{ab}$	$(2.09)^{ab}$	$(1.73)^{cd}$	$(1.86)^{b}$
Acephate 75WP	4.00^{BC}	3.50^{BC}	6.00^{B}	13.75^{A}	18.25^{A}	1.75^{C}
0.5 kg a.i. ha^{-1}	$(2.11)^{ab}$	$(1.92)^{b}$	$(2.53)^{abc}$	$(3.74)^{b}$	$(4.30)^{b}$	$(1.48)^{bc}$
Untreated control	8.25^{c}	14.75^{B}	11.50^{BC}	45.00^{A}	10.75^{BC}	8.25^{C}
	$(2.90)^{a}$	$(3.88)^{a}$	$(3.41)^{a}$	$(6.29)^{a}$	$(3.31)^{b}$	$(2.19)^{a}$

Table 2. Effect of calendar based application of insecticides on the population of *T. Javana*

Treatment	Population (No. / 20 hills)*					
	Period (Days after transplanting)					
	10	20	30	40	50	60
Carbofuran 3G	2.00^{AB}	1.25^{B}	3.00^{AB}	3.50^{A}	2.50^{AB}	1.50^{AB}
0.75 kg a.i. ha^{-1}	$(1.56)^{a}$	$(1.31)^{bc}$	$(1.82)^{bc}$	$(1.94)^{cd}$	$(1.67)^{ab}$	$(1.40)^{ab}$
Phorate 10G	1.25^{B}	1.75^{AB}	3.50^{A}	3.00^{A}	2.25^{AB}	1.75^{AB}
1.0 kg a.i. ha^{-1}	$(1.19)^{a}$	$(1.48)^{bc}$	$(1.95)^{b}$	$(1.85)^{cd}$	$(1.64)^{ab}$	$(1.45)^{ab}$
Quinalphos 5G	1.50^{B}	1.50^{B}	4.25^{A}	1.75^{B}	1.75^{B}	1.75^{B}
1.0 kg a.i. ha^{-1}	$(1.32)^{a}$	$(1.39)^{bc}$	$(2.15)^{b}$	$(1.45)^{d}$	$(1.49)^{b}$	$(1.41)^{ab}$
Monocrotophos35EC	1.75^{B}	4.25^{A}	3.50^{A}	4.25^{A}	4.00^{A}	1.50^{B}
0.5 kg a.i. ha^{-1}	$(1.49)^{a}$	$(2.15)^{a}$	$(2.00)^{b}$	$(2.14)^{c}$	$(2.11)^{a}$	$(1.39)^{ab}$
Chlorpyriphos 20EC	1.25^{C}	1.00^{C}	16.00^{A}	3.50^{B}	1.50^{C}	0.75^{C}
0.5 kg a.i. ha^{-1}	$(1.26)^{a}$	$(1.18)^{c}$	$(4.02)^{a}$	$(1.94)^{cd}$	$(1.35)^{b}$	$(1.00)^{b}$
Quinalphos 25EC	0.75^{B}	1.25^{B}	3.50^{A}	0.50^{B}	1.00^{B}	1.75^{C}
0.5 kg a.i. ha^{-1}	$(1.00)^{a}$	$(1.26)^{bc}$	$(1.98)^{b}$	$(0.93)^{e}$	$(1.13)^{b}$	$(1.18)^{b}$
Acephate 75WP	1.75^{BC}	3.00^{BC}	1.50^{C}	11.25^{A}	4.25^{B}	3.25^{B}
0.5 kg a.i. ha^{-1}	$(1.48)^{a}$	$(1.78)^{ab}$	$(1.32)^{c}$	$(3.40)^{b}$	$(2.17)^{a}$	$(1.91)^{a}$
Untreated control	1.25^{B}	3.00^{B}	2.75^{B}	15.75^{B}	1.25^{B}	1.50^{B}
	$(1.26)^{a}$	$(1.82)^{ab}$	$(172)^{bc}$	$(4.00)^{a}$	$(1.26)^{b}$	$(1.40)^{ab}$

In a column means followed by the same letter (lower case) and in a row means followed by the same letter (upper case) are not significantly diferent (P=0.05; DMRT). * Mean of four replications.

minimum population of *T. javana* (1.33) which was statistically inferior to the other treatments but granular application of the same chemical was far safer to this spider (Table 2).

All the insecticides significantly suppressed the staphylinid *Paderus fuscipes* Curtis (Table 3). Among the insecticides, acephate (6.50) was the safest and was statistically on par with monocrotophos (6.33), carbofuran (4.92) and quinalphos (spray; 4.75). chlorpyriphos (3.88), quinalphos (granular application; 3.46) and phorate (3.17) inferior to the other treatments in supporting

Table 3. Effect of calendar based application of insecticides on the population of *P. fuscipes*

Treatment	Population (No. / 20 hills)*					
	Period (Days after transplanting)					
	10	20	30	40	50	60
Carbofuran 3G 0.75 kg a.i. ha^{-1}	1.00^{D} $(1.18)^{abc}$	2.25^{C} $(1.63)^{bc}$	4.75^{B} $(2.28)^{ab}$	3.75^{BC} $(2.04)^{a}$	4.75^{B} $(2.28)^{cd}$	13.00^{A} $(3.64)^{b}$
Phorate 10G 1.0 kg a.i. ha^{-1}	0.25^{C} $(0.84)^{a}$	2.25^{B} $(1.64)^{bc}$	1.00^{BC} $(1.22)^{c}$	1.75^{B} $(1.48)^{ab}$	11.00^{A} $(3.36)^{b}$	2.75^{B} $(1.77)^{c}$
Quinalphos 5G 1.0 kg a.i. ha^{-1}	0.25^{D} $(0.84)^{c}$	2.25^{B} $(1.59)^{bc}$	3.25^{B} $(1.83)^{b}$	2.25^{B} $(1.59)^{ab}$	2.00^{B} $(1.54)^{c}$	10.75^{A} $(3.34)^{b}$
Monocrotophos35EC 0.5 kg a.i. ha^{-1}	1.75^{D} $(1.49)^{ab}$	4.25^{BC} $(2.18)^{b}$	6.50^{B} $(2.59)^{a}$	2.25^{CD} $(1.59)^{ab}$	20.50^{A} $(4.53)^{a}$	2.75^{CD} $(1.76)^{c}$
Chlorpyriphos 20EC 0.5 kg a.i. ha^{-1}	0.50^{D} $(0.97)^{bc}$	2.25^{BC} $(1.64)^{bc}$	3.50^{B} $(1.94)^{b}$	1.25^{CD} $(1.26)^{b}$	3.25^{B} $(1.90)^{de}$	12.50^{A} $(3.54)^{b}$
Quinalphos 25EC 0.5 kg a.i. ha^{-1}	2.25^{B} $(1.65)^{a}$	3.25^{B} $(1.90)^{b}$	2.50^{B} $(1.71)^{bc}$	4.00^{B} $(2.11)^{a}$	12.75^{A} $(3.61)^{b}$	3.75^{B} $(2.03)^{c}$
Acephate 75WP 0.5 kg a.i. ha^{-1}	1.25^{C} $(1.26)^{abc}$	1.25^{C} $(1.19)^{c}$	3.50^{B} $(1.92)^{b}$	3.00^{BC} $(1.78)^{ab}$	4.50^{B} $(2.21)^{cd}$	25.50^{A} $(5.04)^{a}$
Untreated control	2.25^{C} $(1.64)^{a}$	7.25^{B} $(2.76)^{a}$	7.75^{B} $(2.85)^{a}$	3.50^{C} $(1.94)^{a}$	6.50^{B} $(2.62)^{c}$	30.00^{A} $(5.47)^{a}$

Table 4. Effect of calendar based application of insecticides on the population of *M. atrolineata*

Treatment	Population (No. / 20 hills)*					
	Period (Days after transplanting)					
	10	20	30	40	50	60
Carbofuran 3G 0.75 kg a.i. ha^{-1}	55.25^{A} $(7.43)^{abc}$	17.75^{B} $(4.16)^{de}$	16.50^{B} $(4.06)^{e}$	5.50^{B} $(2.38)^{c}$	6.25^{B} $(2.58)^{c}$	6.75^{B} $(2.67)^{cd}$
Phorate 10G 1.0 kg a.i. ha^{-1}	34.50^{A} $(5.77)^{c}$	7.50^{B} $(2.82)^{e}$	13.75^{B} $(3.76)^{e}$	6.50^{B} $(2.60)^{c}$	5.50^{B} $(2.45)^{c}$	6.00^{B} $(2.51)^{cd}$
Quinalphos 5G 1.0 kg a.i. ha^{-1}	73.00^{A} $(8.49)^{ab}$	17.50^{B} $(4.21)^{de}$	17.25^{B} $(4.18)^{e}$	9.00^{B} $(3.07)^{c}$	8.50^{B} $(2.98)^{c}$	7.75^{B} $(2.86)^{cd}$
Monocrotophos35EC 0.5 kg a.i. ha^{-1}	72.50^{A} $(8.44)^{ab}$	25.25^{B} $(4.93)^{cde}$	18.00^{B} $(4.24)^{e}$	17.25^{B} $(4.19)^{c}$	14.50^{B} $(3.72)^{c}$	2.50^{C} $(1.71)^{d}$
Chlorpyriphos 20EC 0.5 kg a.i. ha^{-1}	94.00^{P} $(9.55)^{a}$	60.50^{B} $(7.81)^{b}$	237.25^{A} $(15.26)^{b}$	88.25^{B} $(9.28)^{b}$	890.00^{B} $(9.03)^{a}$	31.00^{C} $(5.54)^{b}$
Quinalphos 25EC 0.5 kg a.i. ha^{-1}	48.25^{B} $(6.88)^{bc}$	46.75^{B} $(6.78)^{bc}$	115.75^{A} $(10.71)^{b}$	16.75^{C} $(4.13)^{c}$	45.25^{B} $(6.73)^{bc}$	16.75^{C} $(4.12)^{bc}$
Acephate 75WP 0.5 kg a.i. ha^{-1}	35.00^{C} $(5.92)^{c}$	32.50^{C} $(5.65)^{cd}$	387.25^{A} $(19.46)^{a}$	116.75^{B} $(10.69)^{ab}$	115.00^{B} $(10.66)^{a}$	87.50^{B} $(9.32)^{a}$
Untreated control	72.00^{D} $(8.44)^{ab}$	115.00^{CD} $(10.43)^{a}$	178.25^{A} $(13.27)^{c}$	161.75^{AB} $(12.59)^{a}$	121.25^{BC} $(10.95)^{a}$	83.75^{CD} $(9.12)^{a}$

In a column means followed by the same letter (lower case) and in a row means followed by the same letter (upper case) are not significantly diferent (P=0.05; DMRT). * Mean of four replications.

very low populations of the predator. The maximum mean population of the staphylinid was observed 60 days after transplanting.

The effects of insecticides on the population of *M. atrolineata* is presented in table 4. Application of acephate at 0.75 kg a.i. ha^{-1} recorded the maximum population of *M. atrolineata viz.*, 129.00 per 20 hills which was higher than in untreated control and statistically on par with the same. The lowest population was noticed in granular application of phorate (12.29) which was statistically on par with carbofuran at 0.75 kg a.i. ha^{-1} (18.00). The population of *M. atrolineata* at the different periods and the interaction between treatments and periods were also statistically significant. The maximum population of *M. atrolineata* was noticed at 30 DAT (123/20 hills) which was significantly higher than at other periods. The minimum population of the predator was noticed at 60 DAT (30.25).

Table 5. Effect of calendar based application of insecticides on the population of *C. lividipennis*

Treatment	Population (No. / 20 hills)*					
	Period (Days after transplanting)					
	10	20	30	40	50	60
Carbofuran 3G 0.75 kg a.i. ha^{-1}	0.50^{D} $(0.93)^{bc}$	2.75^{B} $(1.76)^{b}$	0.50^{CD} $(0.97)^{bc}$	16.00^{A} $(4.05)^{ab}$	2.50^{BC} $(1.65)^{d}$	1.75^{BCD} $(1.49)^{b}$
Phorate 10G 1.0 kg a.i. ha^{-1}	0.00^{C} $(0.71)^{c}$	1.75^{B} $(1.41)^{b}$	1.75^{B} $(1.45)^{abc}$	3.00^{B} $(1.87)^{cde}$	11.50^{A} $(3.45)^{bc}$	2.75^{B} $(1.79)^{ab}$
Quinalphos 5G 1.0 kg a.i. ha^{-1}	0.50^{C} $(0.93)^{bc}$	1.50^{BC} $(1.39)^{b}$	2.50^{B} $(1.65)^{ab}$	12.75^{A} $(3.41)^{b}$	3.00^{B} $(1.83)^{d}$	2.75^{B} $(1.77)^{ab}$
Monocrotophos 35EC 0.5 kg a.i. ha^{-1}	0.75^{C} $(1.00)^{bc}$	2.50^{B} $(1.73)^{b}$	4.25^{B} $(2.13)^{a}$	5.25^{B} $(2.39)^{cd}$	16.00^{A} $(4.01)^{b}$	5.00^{B} $(2.32)^{a}$
Chlorpyriphos 20EC 0.5 kg a.i. ha^{-1}	0.00^{C} $(0.71)^{c}$	0.75^{BC} $(1.10)^{b}$	2.50^{B} $(1.68)^{ab}$	2.50^{B} $(1.70)^{de}$	9.00^{A} $(3.03)^{c}$	1.50^{BC} $(1.39)^{b}$
Quinalphos 25EC 0.5 kg a.i. ha^{-1}	2.00^{B} $(1.54)^{ab}$	2.50^{B} $(1.65)^{b}$	4.00^{B} $(2.10)^{a}$	21.25^{A} $(4.66)^{a}$	4.50^{B} $(2.20)^{d}$	3.75^{B} $(2.06)^{ab}$
Acephate 75WP 0.5 kg a.i. ha^{-1}	3.50^{B} $(1.92)^{a}$	5.75^{B} $(2.49)^{a}$	4.00^{B} $(2.18)^{a}$	5.75^{B} $(2.49)^{c}$	17.00^{A} $(4.13)^{b}$	5.75^{B} $(2.45)^{a}$
Untreated control	3.25^{BC} $(1.92)^{a}$	6.25^{B} $(2.56)^{a}$	0.5^{D} $(0.93)^{c}$	1.75^{CD} $(1.49)^{e}$	26.75^{A} $(5.19)^{a}$	5.25^{B} $(2.36)^{a}$

In a column means followed by the same letter (lower case) and in a row means followed by the same letter (upper case) are not significantly diferent (P=0.05; DMRT). * Mean of four replications.

Though the maximum population of the mirid *Cyrtorhinus lividipennis* Reuter was noticed in the untreated control plots, this was statistically on par with acephate (6.96) and quinalphos (spray 25 EC) (6.33) (Table 5). Carbofuran (4.00), quinalphos (3.83), phorate (3.46) and chlorpyriphos (2.71) recorded very low population of the mirid and were in fact inferrior to the other treatments. The population of the mirid touched a peak at 50 DAT.

The safety of acephate to *M. atrolineata* (Reissing *et al.*,1982) and *C. lividipennis* (Chiu and Cheng, 1976) has also been reported by earlier workers. The study indicates that further investigations on the direct and residual toxicity of commonly used pesticides on the natural enemies and the relationship between safety to natural enemies and pesticide application systems are necessary for better and more rational use of pesticides that would allow greater conservation and encouragement of natural enemies.

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