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Efficacy of Certain Newer Insecticides against *Tribolium castaneum* by following Jute Cloth Disc Impregnation Method

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ABSTRACT

A laboratory experiment was carried out in the Department of Entomology to know the toxic effect of newer insecticides on *Tribolium castaneum*. Among the newer insecticides tested for the management of insecticide resistant Bapatla strain of *T. castaneum*, chlorantraniliprole was found to be the best at $LC_{99.9}$ level for complete incapacitation of *T. castaneum* with the highest relative toxicity (25.59, 6.30 and 18.80 times) than malathion, dichlorvos and deltamethrin respectively followed by emamection benzoate (14.52, 3.58 and 10.67 times). Lufenuron, spinosad and chlorfenapyr found effective at LC_{50} level (7.19, 3.07 and 13.35 times) compared to malathion.

Key words: *Bapatla strain, Newer insecticides, Tribolium castaneum.*

The red flour beetle, *Tribolium castaneum* (Herbst) is an important primary pest of flour and other milled products and secondary pest of all stored grains. Both the adults and larvae feed on broken grains or mechanically damaged grains and milled products. General practice of protecting stored food grains is through insecticides and continuous usage of these protectants has resulted in health hazards and increased resistance to insecticides in storage pests.

A number of novel insecticides have been recently tested for storage pest management. Insecticides with novel modes of action such as chitin synthesis inhibitors disrupt cuticle formation by inhibiting the synthesis, polymerization or deposition of chitin in insect eggs or larvae (Cohen, 1987). Lufenuron was found to be more selective control product than traditional organophosphorous sprays (Whiting *et al*., 2000). Spinosad is less toxic to many beneficial arthropods and relatively stable in stored grains (Fang *et al*., 2002) which is toxic to insects by ingestion and contact (Wanner *et al.*, 2000) and has a unique mode of action on the insect nervous system at the nicotinic acetylcholine receptor and gamma-amino butyric acid receptor sites (Sparks *et al.*, 2001). Chlorfenapyr is an insecticidal pyrrole that inhibits adenosine triphosphate (ATP) production in the cellular structure of insects (McLeod *et al.*, 2002) which is also being tested for the storage pest management. Emamectin benzoate is one of the most important avermectin insecticides which is isolated from *Streptomyces avermitilis*. It is a semi-synthetic second generation avermectin insecticide which is highly potent. Chlorantraniliprole is effective against major stored-product insect species. However, efficiency depends upon the type of commodity, the dose rate and the exposure interval (Kavallietatos *et al*., 2013).

MATERIAL AND METHODS

The experiment was carried out in the Department of Entomology, Agricultural college, Bapatla, Guntur district, Andhra Pradesh during 2015-16. Adults of *T. castaneum* of Bapatla strain were collected from Central Warehousing Corporation, Bapatla were brought to the department laboratory in wheat flour containing yeast powder in 10:1 ratio at 32 ± 2^0C and 75 per cent relative humidity and it was selected as test insect because of it showed higher degree of resistance compared to Amalapuram, Eluru, Machilipatnam, Visakhapatnam, Srikakulam, Tirupathi and Nellore strains. The commercial formulations of newer insecticides *viz.*, spinosad, emamectin benzoate, lufenuron, chlorfenapyr, rynaxypyr were tested initially for their toxicity against resistant Bapatla strain of *T. castaneum* by Jute Cloth Disc Impregnation method (Najitha ummer, 2013).

Mortality data were recorded at 24, 48 and 72 hours after the treatment (HAT). The experiment were repeated with a wide range of concentrations initially followed by a narrow range so as to get mortality in the range of 5 – 90% and the data were subjected to probit analysis (Finney, 1971), using SPSS to calculate LC_{50}, $LC_{99.9}$ and other parameters were calculated. The log concentration probit (1cp) lines were drawn by plotting log concentrations on X-axis and probits on Y-axis and the response of test insect populations was studied at different concentrations of the test insecticides (Finney, 1971). The relative toxicity of newer insecticides will be calculated by dividing the LC_{50} and $LC_{99.9}$ values of newer insecticides with the LC_{50} and $LC_{99.9}$ values of malathion, dichlorovas and deltamethrin respectively.

RESULTS AND DISCUSSION

Toxicity of newer insecticides against the resistant Bapatla strain of *T. castaneum*:

Lufenuron:

The toxicity of lufenuron to the adults of Bapatla strain of *T. castaneum* revealed the LC50 and LC99.9 values of 0.0892 and 5.6719; 0.0494 and 3.3649; 0.0299 and 1.8455 per cent at 24, 48 and 72 HAT, respectively. The chi-square test revealed that the population used in the study was homogenous (P<0.05%). At LC50 level lufenuron was 7.19, 1.77 and 5.28 times more toxic than malathion, dichlorvos and deltamethrin, respectively at 72 HAT, While at LC99.9 level it showed less relative toxicity.

Emamectin benzoate:

The toxicity of emamectin benzoate to the adults of Bapatla strain of *T. castaneum* revealed that the LC_{50} and $LC_{99.9}$ values were 0.0399 and 3.1940; 0.0233 and 2.2039; 0.0148 and 1.9315 per cent at 24, 48 and 72 HAT respectively. At LC_{50} emamectin benzoate was showed 14.52 times more relative toxicity than malathion, 3.58 times more toxic than dichlorvos and 10.67 times more toxic than deltamethrin at 72 HAT, while at $LC_{99.9}$ level it was showed less relative toxicity.

Spinosad:

The LC_{50} values of spinosad to the adults of resistant Bapatla strain of *T. castaneum* were 0.1661, 0.1015 and 0.0699 per cent while the respective $LC_{99.9}$ values were 5.1813, 2.3892 and 1.8446 at 24, 48 and 72 HAT, respectively. Spinosad at LC_{50} level showed 3.07, 2.26 times more relative toxicity than malathion and deltamethrin respectively at 72 HAT. At $LC_{99.9}$ level it did not show any increased relative toxicity in comparison with malathion and deltamethrin. Spinosad did not show any significant amount of relative toxicity in comparison with dichlorvos.

Chlorfenapyr:

The toxicity of chlorfenapyr to the adults of resistant Bapatla strain of *T. castaneum* revealed the LC_{50} and $LC_{99.9}$ values of 0.0447 and 11.6113; 0.0312 and 8.8360; 0.0161 and 3.6163 per cent at 24, 48 and 72 HAT, respectively. The chi-square test revealed that the population used in the study was homogenous (P<0.05%). Chlorfenapyr was 13.35 times more toxic than malathion, 3.29 times more toxic than dichlorvos and 9.81 times more toxic than deltamethrin at 72 HAT. While at $LC_{99.9}$ level it did not show relative toxicity in comparison with malathion, dichlorvos and deltamethrin.

Chlorantraniliprole:

Chlorantraniliprole showed LC_{50} and $LC_{99.9}$ values of 0.0227 and 4.2940; 0.012 and 4.1266; 0.0084 and 2.0923 per cent at 24, 48 and 72 HAT, respectively to the adults of resistant Bapatla strain of *T. castaneum* . At LC_{50} Chlorantraniliprole was recorded as 25.59 times more toxic than malathion, 6.30 times more toxic than dichlorvos and 9.81 times more toxic than deltamethrin at 72 HAT, respectively. While at $LC_{99.9}$ level it did not show relative toxicity in comparison with malathion, dichlorvos and deltamethrin.

Chlorantraniliprole was found effective at LC_{50} level for complete incapacitation of resistant Bapatla strain of *T. castaneum* followed by emamectin benzoate. The results are at par with the research findings of Kavallieratos *et al.* (2013) who reported that more than 92 per cent of mortality of *R. dominica* when exposed to chlorantraniliprole for about 14 days. Visalakshi (2006) reported that lufenuron @ 0.5g/kg could completely prevent the adult emergence of rice weevil, *Sitophilus oryzae* (Linn.). McLeod *et al.*

Table 1. Toxicity of newer insecticides to Bapatla strain of red flour beetle, *Tribolium castaneum*.

S. No	Hours after treatment	LC_{50} % (95%FL)	$LC_{99.9}$ % (95%FL)	Slope b (±SE)	Hetero geneity÷2	Regression Equation Y=a+bx	Relative toxicity					
							Malathion		Dichlorvos		Deltamethrin	
							LC_{50} %	$LC_{99.9}$ %	LC_{50} %	$LC_{99.9}$ %	LC_{50} %	$LC_{99.9}$ %
1	LUFENURON 5.4 % SC											
	24	0.0892 (0.0520-0.1605)	5.6719 (3.3674-67.1371)	1.75 (±0.13)	13.26	Y= 2.37 +1.75x	-	-	-	-	-	-
	48	0.0494 (0.0260-0.0841)	3.3649 (2.0369-27.6959)	1.50 (±0.12)	14.00	Y= 2.25+ 1.50x	-	-	-	-	-	-
	72	0.0299 (0.0147-0.0494)	1.8455 (1.1301-11.2299)	2.00 (±0.11)	14.22	Y= 4.00 +2.00x	7.19	0.86	1.77	0.21	5.28	0.40
2	SPINOSAD 45 % SC											
	24	0.1661 (0.0970-0.3016)	5.1813 (6.2167-149.7368)	1.25 (±0.17)	25.37	Y= 1.00 +1.25x	-	-	-	-	-	-
	48	0.1015 (0.0519-0.1542)	2.3892 (2.3558-21.1705)	1.50 (±0.16)	27.62	Y= 1.50 +1.50x	-	-	-	-	-	-
	72	0.0699 (0.0374-0.1001)	1.8446 (1.3998-8.5731)	1.50 (±0.15)	20.78	Y= 2.00 +1.50x	3.07	0.86	0.75	0.21	2.26	0.40
3	EMAMECTIN BENZOATE 5 % SG											
	24	0.0399 (0.0209-0.0753)	3.1940 (1.8450-27.4504)	1.60 (±0.10)	14.64	Y= 2.80 +1.60x	-	-	-	-	-	-
	48	0.0233 (0.0127-0.0398)	2.2039 (1.1217-12.5102)	2.80 (±0.10)	11.25	Y=2.80 +1.60 x	-	-	-	-	-	-
	72	0.0148 (0.0065-0.0283)	1.9315 (1.0947-17.0482)	1.60 (±0.09)	15.35	Y=3.30 +1.60x	14.52	0.82	3.58	0.20	10.67	0.39
4	CHLORFENAPYR 10 % SC											
	24	0.0447 (0.0325-0.0623)	11.6113 (4.2991-50.1596)	1.20 (±0.09)	9.13	Y=2.10 +1.20x	-	-	-	-	-	-
	48	0.0312 (0.0109-0.0663)	8.8360 (5.2822-1466.1974)	1.25 (±0.12)	9.80	Y= 2.12 +1.25x	-	-	-	-	-	-
	72	0.0161 (0.0067-0.0319)	3.6163 (1.9278-49.1449)	1.20 (±0.09)	14.46	Y=2.60 +1.20x	13.35	0.44	3.29	0.11	9.81	0.20
5	CHLORANTRANILIPROLE 18.5 % SC											
	24	0.0227 (0.0154-0.0313)	4.2940 (1.7016-18.4836)	1.25 (±0.12)	4.79	Y= 2.12 +1.25x	-	-	-	-	-	-
	48	0.0126 (0.0085-0.0177)	4.1266 (1.7417-14.0805)	1.16 (±0.08)	6.30	Y= 2.58 +1.16x	-	-	-	-	-	-
	72	0.0084 (0.0056-0.0118)	2.0929 (0.9682-6.1505)	1.00 (±0.08)	7.85	Y=2.50 +1.00x	25.59	0.76	6.30	0.19	18.80	0.36

Lethal concentrations and 95% fiducial limits (FL) were estimated using probit analysis (SPSS 16.0).
The Chi-square test revealed the homogeneity of the test population ($P<0.05$ %).

(2002) reported that chlorfenapyr is an insecticidal pyrrole, and the primary mode of action is to affect oxidative phosphorylation in the mitochondria, which will eventually result in the death of the cell through inhibition of ATP synthesis. In view of Arthur (2008) this mode of action differs from that of a conventional neurotoxin, and mortality of *T. castaneum* as a result of exposure to chlorfenapyr is not immediate but is delayed for several days after the initial exposure. Our results are in contrary to Swathikumari (2009) who reported that spinosad at LC_{50} (0.06) per cent when sprayed on small jute bags caused 36.66, 46.66 and 56.66 per cent mortality in *S. oryzae* at 1,2 and 3 days after treatment. But in present study spinosad showed less relative toxicity it is due to less usage in gowdons and However, using high rates of spinosad may be cost-prohibitive.

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