BIOASSAY OF PESTICIDES ON THE LIFE STAGES OF RED MITE, *TETRANYCHUS BIOCULATUS* (WOOD-MASON) (PROSTIGMATA : TETRANYCHIDAE)

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TETRANYCHUS BIOCULATUS TOXICITIES OF ACARICIDDES

SUMMARY : The toxicity of six pesticides at 800, 600, 400 and 200 ppm doses to the egg, nymphs and adult of *Tetranychus bioculatus* was investigated by bioassay using mashkalai leaf as a substratum. The eggs of mite remained unhatched at all dosage levels of six pesticides 72 hours after treatment. The ovicidal action of these compounds may be associated with the dose lower than 200 ppm. The acaricides, folimat and zolone and the insecticide, vapona killed 73-79 % and 46-48 % nymphs at highest dose 800 ppm and lowest dose 200 ppm respectively. Gusathion, malathion and diazinon produced nymphal mortality below those ranges. The LD_{50} values indicated that folimat was the most toxic followed by vapona and zolone ; malathion and gusathion were less toxic and diazinon was the least toxic to the mite nymphs. The adult mites had mortality almost in the same pesticide order as nymphs but significantly with lower proportion. Of the developmental stages of *T. bioculatus*, eggs appeared to be more susceptible than nymphs which were more susceptible than the adults.

TETRANYCHUS BIOCULATUS TOXICITÉS DES ACARICIDES

RÉSUMÉ : Les toxicités de six pesticides aux doses de 800, 600, 400 et 200 ppm, pour l'œuf, les nymphes et l'adulte de *Tetranychus bioculatus* ont été expérimentées par les essais biologiques sur feuille de mashkalai. Les œufs sont demeurés non éclos à toutes les concentrations de pesticides après un traitement de 72 h. On doit rapporter à une dose inférieure à 200 ppm l'action ovicide de ces composés. Les acaricides folimat et zolone, et l'insecticide vapona ont tué 73-79 % et 46-48 % des nymphes respectivement à plus de 800 ppm et à moins de 200 ppm. Le gusathion, le malathion et le diazinon ont provoqué une mortalité nymphale inférieure à ces rangs. Les doses léthifères pour 50 % des individus mis en expérience (LD 50) ont montré que le folimat est le plus toxique, suivi par le vapona et le zolone ; le malathion et le gusathion sont moins toxiques et le diazinon est le moins toxique pour les nymphes. Pour la mortalité des adultes l'ordre des pesticides est le même que pour les nymphes mais dans des proportions significativement plus basses. De tous les stades du développement, les œufs du *Tetrachynus bioculatus* sont apparus les plus susceptibles, puis les nymphes, enfin les adultes.

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Introduction

Tetranychus bioculatus (Wood-Mason) known as red mite in Bangladesh is a pest of a number of crops including jute (Kabir, 1975). The attack of this mite on mashkalai (*Phaseolus mungo* L.), one of the important pulse crops, was recorded for the first time during the present investigation. It multiplied rapidly under high temperature on mashkalai plants and built up large populations within a short time.

Published works indicate the chemical control of tetranychid mites using acaricides and insecticides (Asquith, 1955 ; Singh and Saini, 1957 ; Paul, 1960 ; Mohamed *et al.*, 1979 ; Bower and Kaldor, 1980). On the other hand there are several reports on the development of resistance by these mites to the pesticides, which ultimately reduces the levels of control (Allen *et al.*, 1964 ; Goult, 1973 ; Chapman and Penman, 1979). The change of pesticides is obviously necessary to achieve effective control against these pests. In the present study some organophosphorous acaricides and insecticides were bioassayed on the life-cycles of red mite in association with mashkalai plants as host with a view to assessing the effectiveness of the pesticides for the control of this mite pest.

Materials and methods

Two acaricides, zolone 35EC and folimat 50EC and four insecticides gusathion 40EC, diazinon 60EC, malathion 57EC and vapona 100EC were used to conduct bioassay in the laboratory from May to August, 1982. A mass culture of red mite, *Tetranychus bioculatus* was established in potted mashkalai plants before conducting the experiments in order to supply the test materials. For this some mashkalai leaves infested with red mites were collected from the non-spraying field in November 1981 and the mites were reared first in the petri dishes (8.5 cm × 1.0 cm) with mahkalai leaves as food. The mites multiplied in this situation within a weak after which they were inoculated in the potted mashkalai plants grown in the laboratory. The mite cultures continued at the end of this study. The eggs, nymphs and adult mites were tested at four dosage levels viz., 0.08, 0.06, 0.04 and 0.02 % active ingredient (AI) with three replicates. A control having three replicates was included in each pesticide.

For ovicidal test, ten male and female adult mites from the mass culture were released into the young mashkalai leaf covering it with another leaf in the petri dishes to allow oviposition. The eggs laid by females were counted in the next morning and then adults were removed keeping only twenty eggs in each dish and destroying the excess ones with a needle. Thirty nymphs and adults were transferred from the mass culture by a camel hair brush to a mashkalai leaf in the petri dishes separately each regarded as replicate. Vesseline was given around the leaf to avoid mite escaping from the dish. The eggs, nymphs and adults were sprayed separately with the pesticides using a hand sprayer. The control dishes were sprayed with water only. Mortality records of the eggs were taken after 24, 48 and 72 hr of treatment but for the nymphs and adults 24 and 48 hr after treatment.

A pot experiment was carried out under the same condition as the petri dish treatments to observe the differences of mortalities of eggs, nymphs and adults of the red mite. For convenience of the study, the whole treatment was divided into three batches, each of two pesticides tested at 0.06 and 0.04 % AI. One earthen pot (12 cm × 16 cm) having two mashkalai plants was considered as one replicate, and there were three replicates for each dose and control. Thirty male and female adults of red mite were released on the plants from the mass culture and allowed to build up its population. All the stages of the mite were found in the same leaf within a few days. The eggs, nymphs and adults were counted in three infested leaves randomly chosen per plant and then pesticides were sprayed when the plants were about 12-20 cm in height. Mortality records were taken 24 and 48 hr after treatment. The mortality data were analysed using probit analysis and analysis of variance.

RESULTS AND DISCUSSION

Ovicidal Action

The egg of *Tetranychus bioculatus* did not hatch in all doses of acaricides and insecticides after 72 hr of the treatment (Fig. 1). In the untreated control petri dishes, egg hatching commenced on the second day when 8-44 % eggs hatched and the incubation was complete in 72 hr. The tested pesticides provided very little indication of the lethal effects on the egg stage because of equitable mortality at all four dosage levels. The ovicidal activity might have been precisely obtained if the dose-range below 200 ppm would have been used. Kelthane among the most toxic acaricides and diazinon from the insecticides are reported to be the effective ovicides of red spider mite, *Tetranychus telatius* (MELTZER, 1955 ; ABUL-HAB and STAFFORD, 1966).

Action of Pesticides on Nymphs and Adults

Two acaricides wiz., folimat and zolone and one insecticide, vapona demonstrated similar effectiveness against nymphs of red mite. The LD_{50} values of these pesticides were found to be 302-327 ppm (Table 1). Folimat, zolone and vapona appeared to be most lethal to the immature mites in comparison with other pesticides such as malathion, gusathion and diazinon in which case the LD_{50} values were 345-537 ppm. The texicity differences of the pesticides were statistically significant ($P < 0.05$). This agrees with the low slopes of the regression lines and correspondingly wide range of the fiducial limits for less effective pesticides.

TABLE 1. Toxicity of pesticides to the nymphs of red mite, *Tetranychus bioculatus* using spraying method in the laboratory (30.42° ± 0.12°C).

Pesticide	Heterogeneity (X^2-value)	LD_{50} and LD_{90} values with 95 % fiducial limits			
		LD_{50} (ppm)	± × Sdm	LD_{90} (ppm)	± × Sdm
Acaricide					
Zolone 35EC	2.24	327.34	400.86 267.30	2449.06	4988.84 1202.26
Folimat 50EC	—11.59	301.99	388.84 263.02	1737.80	2691.53 1096.47
Insecticide					
Gusathion 40EC	—0.40	366.43	420.72 319.15	1581.24	2523.48 988.55
Diazinon 60EC	0.42	537.03	672.97 428.54	8254.04	40738.02 1601.03
Malathion 57EC	3.35	354.81	457.08 269.15	7079.45	35481.33 1412.54
Vapona 100EC	2.71	316.22	371.53 263.02	3090.00	6606.53 1412.53

Probit analysis on 24 hr mortality data.

The mortality of adults of *T. bioculatus* caused by the pesticides at all doses was less by 2-20 % than that of nymphs (Fig. 1). The statistical analysis indicated that mortality of adult mites differed significantly ($P < 0.01$). The LD_{50} comparison showed similar relationships in toxicity where zolone, folimat and vapona were found more toxic to the adult mites than gusathion, malathion and diazinon (Table 2). SALAMA and FARGHALY (1979) made toxicological studies of some acaricides on the spider mite, *Tetranychus cinnabarinus* and found folimat, kelthane and a few others as the most effective compounds.

TABLE 2. Toxicity of pesticides to the adults of red mite, *Tetranychus bioculatus* using spraying method in the laboratory (30.42° ± 0.12°C).

Pesticide	Heterogeneity (X^2-value)	LD_{50} and LD_{90} values with 95 % fiducial limits			
		LD_{50} (ppm)	± × Sdm	LD_{90} (ppm)	± × Sdm
Acaricide					
Zolone 35EC	3.41	304.99	389.04 229.08	3467.36	9332.54 1258.92
Folimat 50EC	5.10	380.18	489.77 288.40	3715.35	9162.20 1506.60
Insecticide					
Gusathion 40EC	—13.16	457.08	977.23 213.80	2344.22	3630.70 1479.10
Diazinon 60EC	1.90	812.83	1047.12 616.59	7943.28	25118.86 2454.70
Malathion 57EC	0.80	549.54	616.59 478.63	3801.89	8128.30 1737.80
Vapona 100EC	—3.53	389.04	501.18 295.12	7244.35	33113.11 1348.96

Probit analysis on 24 hr mortality data.

Pot Experiment of Pesticides with Tetranychus bioculatus

The toxic action of pesticides on the eggs of red mite was noticed by the decrease oviposition in the potted plants. On the other hand egg production increased in the untreated control (Table 3). The

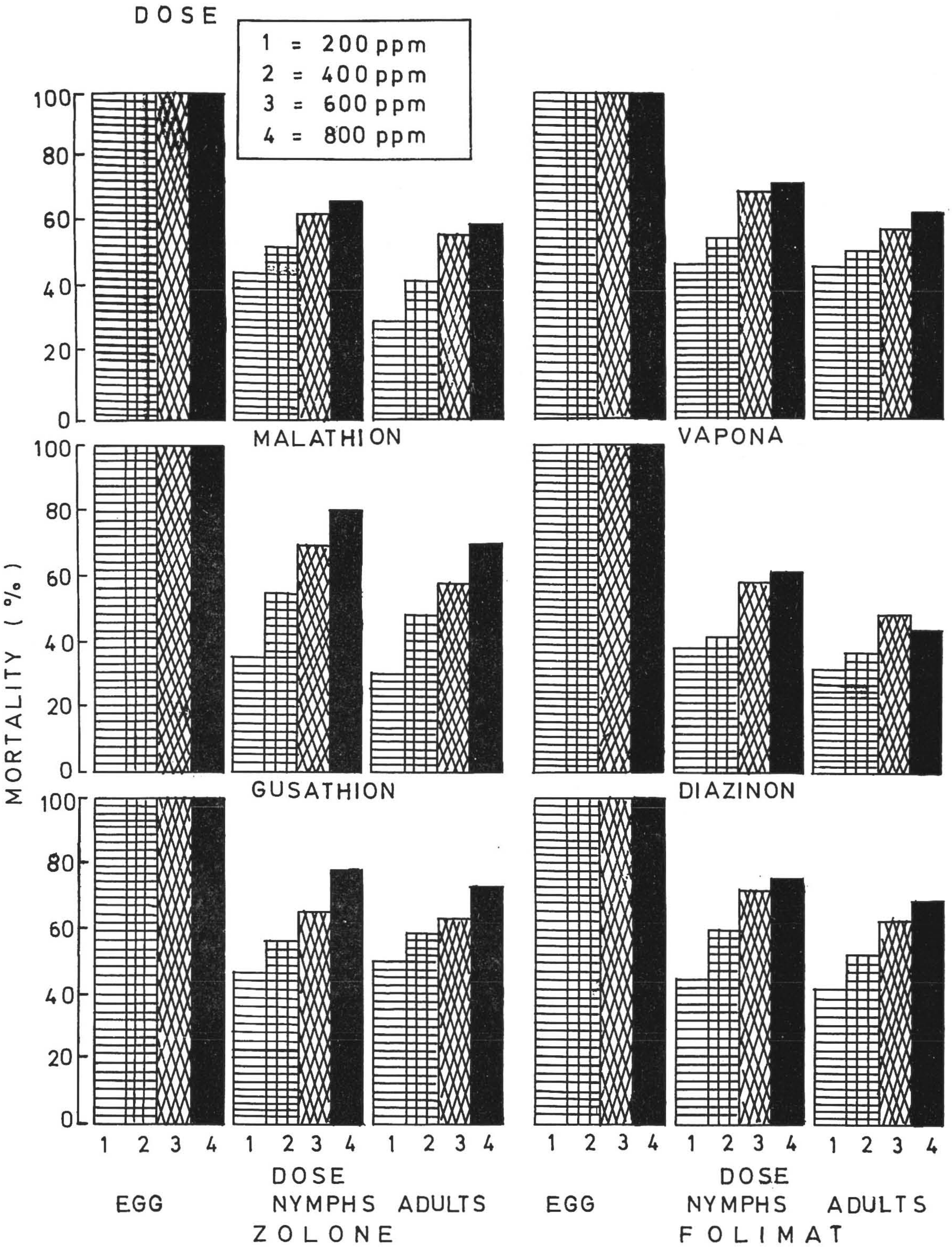

FIG. 1 : Comparative susceptibility of eggs, nymphs and adults of red mite, *Tetranychus bioculatus* against pesticides.

TABLE 3. Mortality of eggs, nymphs and adults of red mite, *Tetranychus bioculatus* treated with pesticides on the infested potted plants.

Pesticide	Dose (% AI)	Eggs: No. at pre-treatment	Eggs: Per cent unhatched at post treatment 24 hours	Eggs: Per cent unhatched at post treatment 48 hours	Nymphs: No. at pre-treatment	Nymphs: Per cent dead at post treatment 24 hours	Nymphs: Per cent dead at post treatment 48 hours	Adults: No. at pre-treatment	Adults: Per cent dead at post treatment 24 hours	Adults: Per cent dead at post treatment 48 hours
Acaricide										
Zolone 35EC	0.06	946	95.34	95.34	485	80.61	91.34	449	75.27	91.75
	0.04	1088	93.01	93.56	1187	78.93	91.74	610	73.77	85.08
Folimat 50EC	0.06	1581	90.89	92.03	385	76.10	91.68	478	73.84	88.28
	0.04	1083	87.53	87.87	594	74.74	77.94	319	71.15	84.63
Insecticide										
Gusathion 40EC	0.06	2072	95.31	98.32	377	80.37	96.28	376	79.78	93.88
	0.04	1783	92.54	92.54	406	77.09	84.48	409	76.77	82.88
Diazinon 60EC	0.06	1349	89.69	89.69	969	77.50	86.49	1283	70.77	74.74
	0.04	957	85.57	85.57	686	75.80	83.52	657	66.40	73.66
Malathion 57EC	0.06	1231	92.28	93.50	371	78.43	85.98	463	69.76	78.18
	0.04	746	94.22	94.22	371	59.02	66.57	294	62.24	71.08
Vapona 100EC	0.06	816	83.33	83.33	242	79.75	88.84	430	70.23	77.20
	0.04	951	86.01	86.01	253	72.33	81.81	423	68.32	75.17
Control	0.00	1136	67.86	46.51	460	9.66	11.08	377	8.75	9.54

decrease of egg numbers following pesticides treatment possibly was influenced by the toxic effects on the ovipositing mites. The majority of the eggs showed unhatched symptoms in vapona, diazinon and folimat after 24 hr of application.

The nymphal and adult mortalities were little higher in the potted plants than in the petri dish treatment (Table 3) and the analysis of variance also indicated that mortality of both nymphs and adults did not differ significantly between these two methods of pesticide application. But pesticides had differential significant effects in nymphs ($P < 0.05$) and adult mites ($P < 0.001$) in the potted plants almost in the same order as in the petri dish treatment.

The effects of pesticides are quite marked on the life cycles of tetranychid mites that the eggs are more susceptible than the larvae which are more susceptible than the nymphs but the adults are more tolerant than any other developmental stages (MAILLOUX and MORRISON, 1962; SHRIVER and THOMAS, 1962; ASANO and KAMEL, 1979; OGAWA *et al.*, 1981). Some of the authors put forward with the observations that the compounds are less toxic to larvae and nymphs at mobile stage than at quiescent or just after moulting. This is related to the activity level of the animals concerned. The adults of red mite are more active than the immatures and it is possible that adult stage was less susceptible to both acaricides and the insecticides than other developmental stages of this mite. The lethal doses of the most toxic compounds obtained from this study have some consistence on the actual doses of other effective acaricides like kelthane etc., usually applied for the control of tetranychid mites. The most toxic acaricides and insecticides as already discussed may have the attribution for the protection of mashkalai crop from the red mite damage.

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