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Comparative Toxicity of Conventional and Novel Acaricides against the Vegetable Mite Tetranychus Neocaledonicus André on Brinjal Crop

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ABSTRACT

Farmers in general use various pesticides for management of mites so it is very important to make comparative study of both conventional and novel acaricides before recommendation to farmers. Six acaricides were screened by leaf dip method and their LC^{50} value and relative toxicity was worked out by taking the LC50 of Dicofol as standard check. The mortality count was recorded and corrected mortality was calculated. The experiment was carried out in Acarology Laboratory, Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to test the relative toxicity of seven pesticides Propargite 57EC, Clofentazine 50SC, Cyflumetofen 20EC, Fenpyroximate 5EC, Dicofol 18.5EC, Azadirachtin 0.03EC and water as control against mites in laboratory conditions The experiment was conducted with objective to test the efficacy of acaricides in laboratory condition.

Keywords: Acaricides, relative toxicity, regression equation, T. neocaledonicus

INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L), a native of India is fourth largest vegetable produced in India. Vavilov (1928) considered Indo-Burma region as its centre of Origin. Various forms, shapes and colours of brinjal are found throughout the region showing its genetic variability. It is of much importance in warm countries like India, Bangladesh, Pakistan, China, Philippines and Far- East but is also popular in countries like, France, Italy and United States. In India, brinjal occupies an area of 722.1 thousand hectare nearly 7.8 % of total vegetable area with production of 13443.6 thousand metric tonnes contributing 8.3% of total vegetable production and productivity of 18.6 metric tonnes/ha (Anonymous, 2013). Brinjal is prone to attack by about 44 pests (Lal, 1975). Among them, shoot and fruit borer, leafhoppers, stem borer, leaf webber, aphids, whitefly, thrips and the non insect pests like mites especially the spider mites are the main bottle necks in brinjal productivity (Rizvi, 1996). Among the non-insect pests, mites are the notably notorious pests and gaining tremendous importance in recent years owing to their devastating nature and damage potential. Mites are serious pests of plants causing severe losses to economic crops (Gupta, 2003). Basu and Pramanik (1968) ranked red spider mites as a major threat next to fruit and shoot borer. Altogether 23 species of mite pests have been reported on brinjal from different parts of the world (Dhooria and Bindra, 1977).

Tetranychus neocaledonicus André the vegetable mite is now recognized as widely distributed causing economic injury to many important plants like vegetables, fruit crops, oilseeds, spices, tuber crops and weeds (Jeppson *et al.*, 1975; Manjunatha and Puttaswamy, 1989) making it a serious pest in tropical and subtropical countries of the world. It has tendency to colonies the lower surface of mature leaves, gathering along the midrib and veins of the leaves. The adult mites while feeding penetrate the epidermal layer of the leaves with their stylets to suck the cell content, feeding for 1-2 minutes at a particular point and moving to new feeding site. The stylet punctures leads to formation of small primary chlorotic spots which with time turn white, yellowish or greyish in colour. Due to sucking, the chloroplast along with mesophyll cells and palisade layers are destroyed. The vegetable mite produces white spots on leaves due to sucking of plant sap and as feeding continues the white spots coalesce, the leaves lose its green colour, dry and drop. All this leads to decreased vitality, growth, flowering and fruiting. The mites web profusely, covering the entire plant with thick sheath of webs.

To combat this incidence of mite attack farmers solely depend upon various pesticides, sometimes making multiple spray of different chemical without any satisfactory result, thereby causing increase in cost of cultivation besides causing detrimental effect on natural enemies and environment as whole as well as severe problem of pesticide residue. Therefore, it becomes necessary to evaluate new and safer molecules besides conventional acaricides to provide safe alternative and prevent development of resistance against acaricides. There is also need to develop economically feasible and viable pest management alternatives.

MATERIAL AND METHODS

The experiment was carried out in Acarology Laboratory, Department of Entomology and Agricultural Zoology,

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Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to test the relative toxicity of seven pesticides Propargite 57EC, Clofentazine 50SC, Cyflumetofen 20EC, Fenpyroximate 5EC, Dicofol 18.5EC, Azadirachtin 0.03EC and water as control against mites in laboratory conditions.

Laboratory bioassay

Leaf disc bioassay was used to estimate the LC^{50} (the lethal concentrations that kill 50% the population) of a particular acaricide. Using a fine brush (10/0), thirty adults of T. neocaledonicus females of the same age were placed on a brinjal leaf disc (2 cm diameter) on water-saturated cotton (4 cm x 4 cm) in a petri dish (6 cm diameter). Leaf discs were placed on a single petri dish. Water saturated cotton was pushed up against the perimeter of the leaf disc, in order to create a barrier and prevent mites from walking off the disk, since mite walk-off is sometimes observed in these tests. Each bioassay consisted of acaricide concentrations with 4 replicate discs per tested concentration. Solutions of Propargite 57EC, Clofentazine 50SC, Cyflumetofen 20EC, Fenpyroximate 05EC, Dicofol 18.5EC, Azadirachtin 0.03EC were prepared.

Mortality test

This experiment was conducted twice in laboratory condition at different concentration of treatments. The trial was conducted in the month of September 2013-2014. The temperature and relative humidity was 27-290C and 81-84% respectively. The adult's mites were released on the treated fresh brinjal leaves which were dipped for two minutes in the pesticide solution, to ensure complete wetting and were taken out with forceps and were transferred onto wet cotton wad in the petridishes. On each leaf disc, 30 adult females of T. neocaledonicus were released using a fine camel hair brush. Care was taken while transferring the mites in order to avoid any injury to mites. All these petridishes were maintained at ambient temperature. All treatments of different solutions were replicated four times. The control treatment was treated with water. Observations on the mortality of mites were recorded in all the concentrations including the untreated check at 12, 24, 36, 48, 60, 72 hrs, after the release of mites. While recording the observations, the mites which were found out of the leaf disc and on the cotton wad were discarded. The mites which were showing moribund condition were regarded as dead. The mortality counts in untreated check were also recorded and used for calculating corrected mortality. Later, mortality counts (%) were corrected according to Abbott (1925). All the pesticides efficacy was tested by leaf dipped method (F.A.O Method No. 10a) (Busvine, 1980).

$$\textit{Per cent mortality of adult mites} = \frac{\text{No. of dead mites per dish}}{\text{Total no. of mites per dish}} \times 100$$

T. neocaledonicus mortality data were corrected using Abbot's formula (Abbott 1925). Concentration-mortality regressions, LC^{50} within 95% confidence intervals, were estimated by probit analysis as described by Finney (1971). Probit regressions were estimated with SPSS (version 16).

RESULT AND DISCUSSION

The LC^{50} value of propargite 57 EC was 108.62 ppm and fiducial limits of lower (94.24 ppm) and upper values (139.86 ppm) at 95%. The LC^{50} value calculated for clofentazine 50SC was 87.207 with lower and upper fiducial limits of 67.16 ppm and 99.90 ppm respectively. The calculated LC^{50} value of Cyflumetofen 20SC was 22.53 with the fuducial limits of 11.614ppm for lower and 53.320 upper limit. For Fenpyroximate 5 EC the LC^{50} value calculated was 7.095 and the fiducial limit of lower (3.771 ppm) and upper value (22.718) at 95%. The LC^{50} value calculated for Dicofol 18.5 EC was 20.971 with lower and upper fuducial limits of 12.425 and 51.385 ppm respectively. The LC^{50} value calculated for Azadirachtin 0.03 EC was 319.354 ppm with fiducial limit of lower (183.283 ppm) and upper Value (888.626 ppm) at 95%.

The LC^{50} value at 12 hrs after treatment with Propargite was 126.46 ppm and fiducial limits of lower (113.91ppm) and upper values (169.63 ppm) at 95%. The calculated chi-square value for heterogeneity was 0.54 which was less than the table value at five degrees of freedom. At 24 hrs after treatment the LC^{50} value was 115.18 ppm with a lower and upper fiducial limits of 104.59 to 140.99 ppm respectively at 95% and chi square value for heterogeneity was 0.56. The calculated LC50 values at 48 hrs after treatment was 108.62 ppm with a fiducial limit of 94.24 and 139.86 for lower and upper limits respectively at 95 per cent. The calculated chi square value for heterogeneity was 0.36. At 72 hrs after treatment the LC50 value was 88.05 ppm and fiducial limits of lower and upper values ranged from 64.41 to 98.08 ppm, respectively. The chi square value for heterogeneity was 0.62 (Table 1).

Table 1: Relative toxicity of acaricides against *T. neocaledonicus* by leaf dip method

Chemicals	No of mites exposed	χ^2 p=0.05	Regression equation (slope)	LC_{50} ppm	Fiducial limit (95%) LL	Fiducial limit (95%) UL	Relative toxicity
Propargite 57 EC	30	0.360	1.32 + 2.68	108.620	94.240	139.860	0.193
Clofentazine 50 SC	30	0.237	1.19 + 2.36	87.207	67.160	99.90	0.240
Cyflumetofen 20 SC	30	2.169	0.27 + 0.37	22.53	11.614	53.320	0.930
Fenproximate 5 EC	30	0.692	0.19 + 0.14	7.095	3.771	22.718	2.955
Dicofol 18.5 EC	30	0.948	0.17 + 0.22	20.971	12.425	51.385	1.000
Azadirachtin 0.03 EC	30	0.678	0.19 + 0.43	319.354	183.283	888.626	0.065

The relative toxicity of screened acaricides was worked out by taking the LC^{50} of dicofol as standard check (Fig.1). The relative toxicity was 2.955, 0.930, 0.240, 0.193, 0.065 and 1.00 for Fenpyroximate 5 EC, Cyflumetofen 20 SC, Clofentazine 50 SC, Propargite 57 EC, Azadirachtin 0.03 EC and Dicofol 18.5 EC respectively.

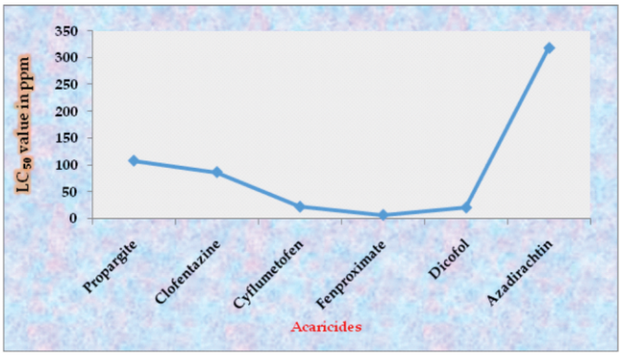

Fig.1: Relative toxicity of acaricides against *T. neocaledonicus* through leaf dip me

The experiment result on relative toxicity in laboratory conditions showed that Fenpyroximate 5EC was most toxic with lowest LC^{50} value, followed by Dicofol 18.5 EC, Cyflumetofen 20SC, Clofentazine 50SC, Propargite 57 EC and least was Azadirachtin 0.03 EC. Relative toxicities of Fenpyroximate 5EC, Cyflumetofen 20SC, Clofentazine 50SC, Propargite[57] EC, Azadirachtin 0.03 EC and Dicofol 18.5 EC was 2.955, 0.930, 0.240, 0.193, 0.065 and 1.00 respectively (Fig. 2 and 3). Muhammad *et al.* (2012) also reported lowest LC^{50} value (5.18 mg l-1) of Fenpyroximate in lab 48 hrs after treatment proving its effectiveness against T. urticae in laboratory.

Reddy *et al.* (2014) reported 31.13 to 100 per cent mortality while comparing the toxicity of abamectin, fenazaquin, spiromesifen, fenpyroximate and hexythiazox with standard acaricide dicofol and propargite against T. urticae. Whereas, Akashe *et al.* (2014) evaluated miticides for their toxicity against T. urticae under laboratory conditions and from his findings it was evident that abamectin was more toxic causing 100 per cent mortality followed by clofentazine and amitraz and least effective miticide was sulphur.

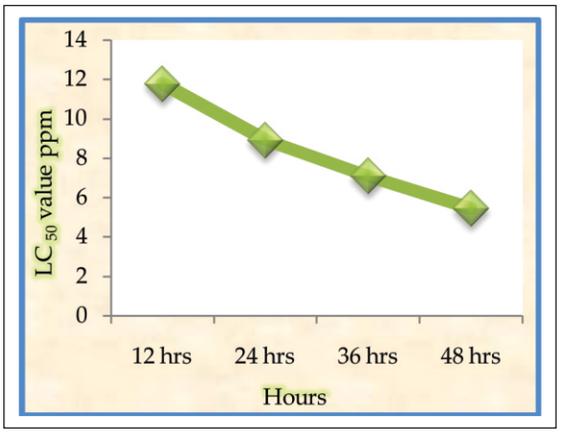

Fig 2: LC^{50} value of Fenproximate 5EC against *T. neocaledonicus*

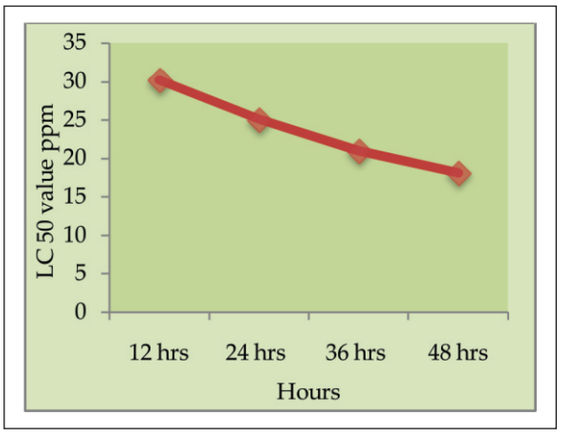

Fig 3: LC^{50} value of Dicofol 18.5EC against *T. neocaledonicus*

The LC50 value Clofentazine 50 SC after 12 hrs of treatment was 104.85 ppm with the fiducial limit of 94.43ppm lower and 129.60 ppm upper values at 95%. The calculated chi square value for heterogeneity was 0.589. The LC50 value after 24 hrs was 94.257ppm with a fiducial limit of 82.30 and 108.82 ppm for upper and lower limits respectively at 95 per cent. The chi square value for heterogeneity was 0.680.The calaulated LC50 value of Clofentazine after 48 hrs was 87.207ppm with lower 67.16 and upper 99.90 fiducial limit at 95%. The calculated chi square value for heterogeneity was 0.237. The LC50 value after 72 hrs was 78.66ppm with fiducial limit of upper and lower value ranged from 64.54 to 86.51 respectively at 95 per cent. The calculated chi square value for heterogeneity was 1.502 (Table 2).

Table 2: LC50 values, regression equation and fiducial limits of mites to Propargite 57 EC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC_{50} ppm	Fiducial limit (95%) LL	UL
12	30	0.54	1.40 + 2.84	126.46	113.91	169.63
24	30	0.56	1.3 + 2.74	115.18	104.59	140.99
48	30	0.36	1.32 + 2.68	108.62	94.24	139.86
72	30	0.62	1.35+2.71	88.05	64.41	98.08

The LC50 value at 12 hrs after treatment with Cyflumetofen was 41.10 ppm and fiducial limits of lower (27.190) and upper values (100.08 ppm) at 95 per cent. The calculated chi-square value for heterogeneity was 2.792 which was less than the table value at five degrees of freedom. At 24 hrs after treatment the LC50 value was 32.795 ppm with a lower and

upper fiducial limits of 20.792 to 82.714 ppm respectively at 95 per cent and chi square value for heterogeneity was 3.861.The calculated LC^{50} values at 48 hrs after treatment was 22.53 ppm with a fiducial limit of 11.614 and 53.320 for lower and upper limits respectively at 95%. The calculated chi square value for heterogeneity was 2.169. At 72 hrs after treatment the LC^{50} value was 8.566 ppm and fiducial limits of lower and upper values ranged from 0.956 to 15.448 ppm, respectively. The chi square value for heterogeneity was 0.887 (Table 3).

Table 3: LC^{50} values, regression equation and fiducial limits of mites to Clofentazine 50 SC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC 50 ppm	Fiducial limit (95%) LL	UL
12	30	0.589	1.22 + 2.42	104.85	94.43	129.60
24	30	0.680	1.20 + 2.38	94.257	82.30	108.82
48	30	0.237	1.19 + 2.36	87.207	67.16	99.90
72	30	1.502	1.24 + 2.45	78.66	64.54	86.51

The LC^{50} value of Fenpyroximate after 12 hrs of treatment was 11.775 ppm with the fiducial limit of 4.869 ppm lower and 420.90 ppm upper values at 95%. The calculated chi square value for heterogeneity was 0.077. The LC^{50} value after 24 hrs was 8.918 ppm with a fiducial limit of 4.234 and 60.222 ppm for upper and lower limits respectively at 95%. The chi square value for heterogeneity was 0.130 (Table 4).

Table 4: LC^{50} values, regression equation and fiducial limits of mites to Cyflumetofen 20 SC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC^{50} ppm	Fiducial limit (95%) LL	UL
12	30	2.792	0.29 +0.40	41.10	27.190	100.08
24	30	3.861	0.28 + 0.38	32.795	20.792	82.714
48	30	2.169	0.27 + 0.37	22.53	11.614	53.320
72	30	0.887	0.27 + 0.36	8.566	0.956	15.448

The LC^{50} value at 12 hrs after treatment with Dicofol was 30.181 ppm and fiducial limits of lower (15.487) and upper values (145.099 ppm) at 95%. The calculated chi-square value for heterogeneity was 0.269 which was less than the table value at five degrees of freedom. At 24 hrs after treatment the LC^{50} value was 25.023 ppm with a lower and upper fiducial limits of 25.023 to 81.974 ppm respectively at 95 per cent and chi square value for heterogeneity was 0.547. The calculated LC^{50} values of Dicofol at 48 hrs after treatment was 20.971 ppm with a fiducial limit of 12.425 and 51.385 for lower and upper limits respectively at 95 per cent. The calculated chi square value for heterogeneity was 0.948. At 72 hrs after treatment the LC^{50} value was 18.093 ppm and fiducial limits of lower and upper values ranged from 11.302 to 36.848 ppm, respectively. The chi square value for heterogeneity was 1.934 (Table 5).

Table 5: LC^{50} values, regression equation and fiducial limits of mites to Fenproximate 5 EC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC^{50} ppm	Fiducial limit (95%) LL	UL
12	30	0.077	0.18+0.14	11.775	4.869	420.90
24	30	0.130	0.18 + 0.14	8.918	4.234	60.222
48	30	0.692	0.19 + 0.14	7.095	3.771	22.718
72	30	1.935	0.18 + 0.14	5.447	2.908	13.843

The LC^{50} value at 12 hrs after treatment with Azadirachtin was 529.105 ppm and fiducial limits of lower (246.011 ppm) and upper values (4783.982 ppm) at 95%. The calculated chi-square value for heterogeneity was 0.097 which was less than the table value at five degrees of freedom. At 24 hrs after treatment the LC^{50} value was 422.484 ppm with a lower and upper fiducial limits of 216.865 to 2029.518 ppm respectively at 95 per cent and chi square value for heterogeneity was 0.269. The calculated LC^{50} values at 48 hrs after treatment was 319.354 ppm with a fiducial limit of 183.283 and 888.626 for lower and upper limits respectively at 95%. The calculated chi square value for heterogeneity was 0.678. At 72 hrs after treatment the LC^{50} value was 243.328 ppm and fiducial limits of lower and upper values ranged from 152.703 to 484.547ppm, respectively. The chi square value for heterogeneity was 1.638 (Table 6).

Table 6: LC^{50} values, regression equation and fiducial limits of mites to Dicofol 18.5EC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC_{50} ppm	Fiducial limit (95%) LL	UL
12	30	0.269	0.19 + 0.21	30.181	15.487	145.099
24	30	0.547	0.18 + 0.21	25.023	25.023	81.974
48	30	0.948	0.17 + 0.22	20.971	12.425	51.385
72	30	1.934	0.19 + 0.22	18.093	11.302	36.848

The LC^{50} values so obtained indicates that Fenpyroximate 5EC was most toxic, followed by Dicofol 18.5 EC, Cyflumetofen 20SC, Clofentazine 50SC,Propargite 57 EC and least was Azadirachtin 0.03 EC (Table 7).

Table 7: LC^{50} values, regression equation and fiducial limits of mites to Azadirachtin 0.03 EC

Hours after treatment	No released	χ^2 P= 0.05	Regression equation (slope)	LC_{50} ppm	Fiducial limit (95%) LL	UL
12	30	0.097	0.19 + 0.42	529.105	246.011	4783.982
24	30	0.269	0.18 + 0.43	422.484	216.865	2029.518
48	30	0.678	0.19 + 0.43	319.354	183.283	888.626
72	30	1.638	0.19 +0.43	243.328	152.703	484.547

CONCLUSION

The LC^{50} value calculated for Propargite 57 EC was 108.62 ppm, Clofentazine 50 SC was 87.207, Cyflumetofen 20 SC was 22.53 ppm, Fenpyroximate 5 EC 7.095, dicofol 18.5 EC 20.971, azadirachtin 0.03 EC was 319.354 ppm. The LC^{50} values so obtained indicated that fenpyroximate 5EC was most toxic followed by Dicofol 18.5 EC, Cyflumetofen 20 SC, Clofentazine 50SC, Propargite 57 EC and least was Azadirachtin 0.03 EC. The relative toxicity of screened acaricides was worked out by taking the LC^{50} of Dicofol as standard check. The relative toxicity was 2.955, 0.930, 0.240, 0.193, 0.065 and 1.00 for Fenpyroximate 5EC, Cyflumetofen 20 SC, Clofentazine 50 SC, Propargite 57 EC, Azadirachtin 0.03 EC and Dicofol 18.5 EC respectively

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