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Evaluation of Acaricides and Botanicals Against the Vegetable Mite Tetranychus Neocaledonicus Andre On Brinjal Crop Under Laboratory and Field Conditions

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Conventional acaricide Dicofol 18.5EC along with novel acaricides Propargite 57EC, Clofentazine 50EC, Cyflmetofen 20SC, Fenproximate 5EC, Dicofol 18.5EC and botanical Azadirachtin 0.03EC were evaluated against *T. neocaledonicus* on brinjal in laboratory and in field condition on brinjal crop var. Punjab Sadabahar. Fenproximate 5EC was most toxic with lowest LC50 value 7.095ppm, followed by Dicofol 18.5 EC 20.971ppm, Cyflumetofen 20SC 22.53ppm, Clofentazine 50SC 87.20ppm, Propargite 57 EC 108.62ppm and least was Azadirachtin 0.03 EC 319.35ppm. Relative toxicities of Fenproximate 5EC, Cyflumetofen 20SC, Clofentazine 50SC, Propargite57 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. The mean percent mortality of *T. neocaledonicus* in field condition was highest that of Clofentazine 80.36 &73.07 percent followed by 59.28 & 62.29 percent by Fenproximate, 53.83 & 57.85 percent by Cyflumetofen, 51.38 & 60.77 percent by Propargite, 50.56 & 52.3 by Dicofol and lastly 25.22 & 33.81 percent mortality by Azadirachtin in first and second spray. All the acaricides proved superior over control and gave protection to the crop upto 14 days after spray and the novel acaricides were much effective over standard acaricide Dicofol in field condition.

Keywords: Novel Acaricides, *T. neocaledonicus*, Laboratory and field efficacy.

Tetranychus neocaledonicus André (Acari: Tetranychidae) the vegetable mite is a common phytophagous mite of vegetables, fruit, field crops and more than 110 economic important crops (Ehara and Yamaguchi,2001) as well as plants of medicinal and ornamental importance (Chhillar *et al*.,2007; Gupta, 2005). This non insect pest is widely distributed and causes heavy damage to crops. The vegetable mite in generally present in the underside of leaf near the veins where it sucks the sap and is protected by silken web woven by female mites for protection , transport and to keep eggs safe (Sadana, 1985; Chillar *et al*.,2007). All the stages larvae, nymph and adults feeds on plant sap causing damage to chlorophyll, leaf yellowing, burning, stippling, stunting of growth and general reduction in health , vigour and growth and productivity of plants. The mites due to multi generation per season high reproductive potential, phytophagous nature and short life cycle have all contributed to development of resistance towards many acaricides (Devine *et al*., 2001; Stumpf and Nauen, 2001, Van Leeuwen *et al*., 2010).The indiscriminate use of pesticides have resulted in resistance development as well as environmental degradation. Two spotted mite has been reported as resistant, horizontal or vertical to more than 80 pesticides of different groups (APRD, 2007).

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MATERIALS AND METHODS

The Laboratory experiment to study the relative toxicity of acaricides and botanical was carried out in the Acarology Laboratory, Department of Entomology and Agricultural Zoology, Institute of Agricultural sciences, Banaras Hindu University, Varanasi in year 2013-15.

Leaf disc bioassay were used to estimate the LC_{50} (the lethal concentrations that kill 50% the population) of a particular acaricide. Using a fine brush (10/0), ten adult *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 .

The mortality test was conducted twice in laboratory condition at different concentration of 7 treatments of propargite 57EC, clofentazine 50SC, cyflumetofen 20 EC, fenpyroximate 05 EC, dicofol 18.5EC, azadirachtin 0.03EC. The temperature and relative humidity was 27-29^{0}C and 81-84% respectively in both the years of experiment. The adults' 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. All the acaricide efficacy was tested by leaf dipped method F.A.O Method No. 10a (Busvine, 1980).

$$\text{Percent mortality of adult mites} = \frac{\text{No.of dead mites per dish}}{\text{Total no.of mites per dish}} * 100$$

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).

The experiment to test the relative toxicity of new molecules and botanical on mite population in field condition on brinjal crop was conducted at Vegetable Research Farm, I.A.S., B.H.U., Varanasi. The commercial grade formulation of pesticides propargite 57 EC, clofentazine 50 SC, cyflumetofen 20 SC, fenpyroximate 5 EC, dicofol 18.5 EC and azadirachtin 0.03 EC were tested at their recommended dose as foliar spray.

The observations were recorded from five selected tagged plants from each plot. Two leaves from each tagged plant were plucked from upper, middle, and lower part and total of 6 leaves were collected from each plant and 30 leaves from each plot for observations. Collected leaves were kept in polythene bags and brought to laboratory. The mite population was counted on the basis of per leaf area with the help of stereoscopic binocular microscope. Mite count was done first pre-treatment and after 1, 3, 7 and 14 days of spraying. The corrected percent mortality was calculated through Abbot's formula (1925).

The corrected percent mortality values were transformed to arc sine values before subjecting to analysis of variance to discriminate the treatment effect. The ANOVA of the data recorded during the experiment was done by SPSS VS 16. The significance of difference between treatments was judged by CD at 5% level of significance.

RESULTS AND DISCUSSION

The LC_{50} value, heterogenicity, regression equation, fiducial limit of the acaricides and botanical is given in Table 1. The laboratory experiment with different concentration revealed that fenproximate had lowest LC_{50} values of 11.77, 8.91, 7.09 and 5.44 ppm at 12, 24, 48 and 72 hrs respectively; this was followed by LC_{50} value of dicofol 30.18, 25.03, 20.97, 18.09 ppm at 12, 24, 48, and 72 hrs respectively. The calculated LC_{50} value of cyflumetofen at different concentrations after 12, 24, 48 and 72 hrs was 41.10, 32.79, 22.53, 8.56 ppm respectively, for clofentazine the LC_{50} value calculated was 104.85, 94.25, 87.20, 78.66 ppm after 12, 24, 48 and 72 hrs of treatment respectively, in same exposure period of 12, 24, 36 and 48 hrs the LC_{50} value of propargite was 126.46, 115.18, 108.62, 88.05 ppm respectively. Among all the tested acaricides the highest calculated LC_{50} value was that of azadirachtin 246.01, 216.86, 183.28, 152.70ppm after 12, 24, 48 and 72 hrs of exposure respectively.

Muhammad, *et al* (2012) also reported lowest LC_{50} value (5.18mg l^{-1}) in lab 48hrs after treatment proving its effectiveness against *T. urticae* on cotton in laboratory. Reddy, *et al* (2014) reported 31.13 to 100 percent mortality while comparaing the toxicity of abamectin, fenazaquin, spiromesifen, fenproximate and hexythiazox with standard acaricide dicofol and propargite against *T. urticae*. Whereas, Akashe, *et al.* (2003) 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 percent mortality followed by clofentazine and amitraz and least effective miticide was sulphur.

In the field experiments also (Table 2) there was significant difference in the application of acaricides among treatments. When the data was pooled of both the years the result showed that all the novel and conventional acaricides were effective with mean percent mortality in the range of 25.22 to 80.36 in first spray and 33.81 to 73.07 percent mortality over control in second spray. Clofentazine recorded highest mortality with 90.64, 91.31, 86.28 and 80.36 percent after 1, 3, 7 and 14 days after spray and lowest protection was given by azadirachtin with 47.61,46. 04, 35.91 and 25.22 percent mortality over control after 1, 3, 7, and 14 DAS. Mean percent mortality recorded by fenproximate was 81.11, 83.90, 75.92, and 59.28 percent was followed by cyflumetofen 75.63, 76.96, 70.25 and 53.83 percent, propargite with 69.42, 72.47,

Table 1. LC_{50} values of Acaricides and botanical against the vegetable mite *T. neocaledonicus* after treatment in laboratory on brinjal

Acaricides	Hours after treatment	X^2	Slope + S.E	LC50	Fiducial limit 95%
Propargite	12	0.54	1.40 + 2.84	126.46	113.91 - 169.63
	24	0.56	1.30 +2.74	115.18	104.59 - 140.99
	48	0.36	1.32 + 2.68	108.62	92.24 - 139.86
	72	0.62	1.35 + 2.71	88.05	64.41 – 98.08
Clofentazine	12	0.58	1.22 + 2.42	104.85	94.43 – 129.60
	24	0.68	1.27 + 2.38	94.25	82.30 – 108.82
	48	0.23	1.19 + 2.36	87.20	67.16 – 99.90
	72	1.50	1.24 + 2.45	78.66	64.54 – 86.51
Cyflumetofen	12	2.79	0.29 + 0.40	41.10	27.19 - 100.08
	24	3.86	0.28 + 0.38	32.79	20.79 – 82.61
	48	2.16	0.27 + 0.37	22.53	11.61 – 53.32
	72	0.88	0.27 +0.36	8.56	0.95 – 15.44
Fenproximate	12	0.07	0.18 + 0.14	11.75	4.86 -420.90
	24	0.13	0.18 + 0.14	8.91	4.23 – 60.22
	48	0.69	0.19 + 0.14	7.09	3.77 – 22.71
	72	1.93	0.18 + 0.14	5.44	2.90 - 13.84
Dicofol	12	0.26	0.19 + 0.21	30.18	15.48 – 145.09
	24	0.54	0.18 + 0.21	25.02	25.02 -81.97
	48	0.94	0.17 + 0.22	20.97	12.42 – 51.38
	72	1.93	0.19 + 0.22	18.09	11.30 – 36.84
Azadirachtin	12	0.09	0.19 + 0.42	529.10	246.01 – 4783.98
	24	0.26	0.18 + 0.43	422.48	216.86 -2029.51
	48	0.67	0.19 + 0.43	319.35	183.28 – 886.62
	72	1.63	0.19 + 0.43	243.32	152.70 – 484.54

Table 2. Per cent mortality of Brinjal mite, *Tetranychus neocaledonicus* Andre´ to different acaricides (Pooled data of 2013 and 2014)

Treatments	Dose (ml/lit)	Pre-count (No. of mites /leaf)	Per cent Mortality (Ist spray)				Pre-count (No. of mites/leaf)	Per cent Mortality (II nd spray)			
			1 DAS	3 DAS	7 DAS	14 DAS		1 DAS	3 DAS	7 DAS	14 DAS
Propargite	2.00 ml	7.48	69.42^{b}	72.47^{b}	63.43^{b}	51.38^{b}	8.57	67.44^{b}	73.94^{b}	67.15^{b}	60.77^{b}
57EC			(56.43)	(58.35)	(52.79)	(45.79)		(55.21)	(59.30)	(55.03)	(51.22)
Clofentazine	0.05 ml	7.35	90.64^{a}	91.31^{a}	86.28^{a}	80.36^{a}	8.96	84.22^{a}	82.06^{a}	76.41^{a}	73.07^{a}
50SC			(72.19)	(72.85)	(68.26)	(63.69)		(66.60)	(64.94)	(60.94)	(58.74)
Cyflumetofen	0.50 ml	7.40	75.63b^{c}	76.96^{b}	70.25^{c}	53.83^{b}	8.72	59.47^{c}	65.43^{c}	61.81^{bc}	57.85^{bc}
20SC			(60.42)	(61.32)	(56.95)	(47.19)		(50.46)	(53.98)	(51.83)	(49.52)
Fenproximate	1.00 ml	6.98	81.11^{c}	83.90^{c}	75.92^{d}	59.28^{c}	8.87	78.91^{a}	74.46^{b}	66.79^{bc}	62.29^{bc}
5 EC			(64.24)	(66.34)	(60.61)	(50.35)		(62.66)	(59.65)	(54.81)	(52.11)
Dicofol	2.50 ml	6.80	55.83^{d}	59.14^{d}	51.40^{e}	35.88^{d}	9.02	49.43^{d}	58.53^{d}	50.83^{d}	50.41^{d}
18.5 EC			(48.35)	(50.27)	(45.80)	(36.80)		(44.67)	(49.91)	(45.47)	(45.24)
Azadirachtin	5.00 ml	7.12	47.61^{d}	46.04^{e}	35.91^{f}	25.22^{e}	8.43	41.36^{e}	39.18^{e}	40.12^{e}	33.81^{e}
0.03 EC			(43.63)	(42.73)	(36.81)	(30.14)		(40.03)	(38.75)	(39.30)	(35.56)
Control		7.04	0.00	0.00	0.00	0.00	8.82	0.00	0.00	0.00	0.00
			(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)
SEm ±	0.28	3.18	1.85	1.35	1.58	0.31	2.14	1.62	2.07	1.56	
CD at 5 %	NS	9.29	5.40	3.94	4.62	NS	6.26	4.75	6.05	4.56	

DAS – Days after spraying
In vertical columns means followed by similar letters are not different significantly (P = 0.05) by DMRT.
Figures in parenthesis are Arcsine transformed value.

63.43, 51.38 percent after 1,3, 7 and 14 days respectively after first spray.

In second spray also clofentazine was highly effective with mean percent mortality of 73.07 and recording 84.22, 82.06, 76.41 and 73.07 percent mortality after 1,3,7 and 14DAS. Second best result was given by fenproximate with mean percent mortality of 62.29 percent and recording 78.91, 74.46, 66.79 and 62.29 percent mortality after 1, 3, 7, 14 DAS. Propargite recorded 67.44, 73.94, 67.15 and 60.77 percent mortality followed by 59.47, 65.43, 61.81 and 57.85 percent mortality by cyflumetofen, 49.43, 58.53, 50.83 and 50.41 percent mortality by dicofol and least percent mortality over control was provided by azadirachtin 41.36, 39.18, 40.12 and 33.81 percent mortality over control after 1,3,7 and 14 DAS.

The overall mean percent mortality was highest that of clofentazine 80.36 percent followed by followed by 59.28 percent by fenproximate, 53.83 percent by cyflumetofen, 51.38 percent by propargite, 35.88 by dicofol and lastly 25.22 percent mortality by azadirachtin in first spray. In pooled data of second spray also the best performer was clofentazine with highest 73.07 percent mortality over control and lowest that of Azadirachtin 33.81 percent over control. The standard acaricide Dicofol recorded percent mortality of over 50% in second spray as compared to clofentazine (73.07%), fenproximate (62.29%), propargite (60.77%), and cyflumetofen (57.85%). All the acaricides used in the experiment were effective against *T. neocaledonichus* infestation in both the years with clofentazine a novel acaricide which acts primarly as an ovicide but also has some action against early stages of mites (Renshaw and Moretto, 2005), whereas, fenproximate belonging to pyrozole group is mitochondrial electron transport inhibitor with quick knockdown effect on adults and nymphs of mite was more effective as compared to standard acaricide dicofol. In present investigation propargite and cyflumetofen also possessed good acaricidal property with high percent mortality over control in both the years. Similarly, Shridhar and Jhashi Rani (2011) had reported clofentazine 50SC to be at par with acaricide abamectin (8.55 gai/ha) and superior over dicofol (23.25g ai/ha) against *T. urticae* on rose under polyhouse cultivation. The results were in agreement with Bhardwaj *et al* (2007) who had also reported that Clofentazine 0.01percent and 0.02 percent gave very good control of egg and motile stages of *Panonychus ulmi* on apple.

The results were in agreement with Reddy and Pushpa latha (2013) who reported fenzazaquin, spiromesifen, hexythaizox and fenproximate to give 55.55 to 99.66 % mortality of *T. urticae* after 14 days of spray as compared to dicofol. Reddy, *et al* (2014) reported fenproximate to give 79.20%; 59.74 % mortality as compared to dicofol (74.00%; 22.30%) and propargite (81.30; 39.24%) mortality of *T. urticae* on 1st and 14th day of spray respectively in field condition as found in our result. Chakrabarti and Sarkar (2014) have recorded fenproximate to give 68.25 and 68.23% in two sprays against *polyphagotarsonemus latus* on chilli. Reddy *et al*. (2014) reported 100% mortality of *T. urticae* on Chrysanthemum in polyhouse after 5, 10 and 15 days of treatment.

CONCLUSION

All the acaricides tested for their relative toxicity against *T. neocaledonicus* were found to be very effective both in laboratory and field condition. The novel acaricides can be successfully integrated with standard acaricides like dicofol and propargite in rotation which will not only provide effective management but also delay the development of resistance in the vegetable mite.

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