

COMPARATIVE EFFICACY OF ACARICIDES AGAINST TWO SPOTTED SPIDER MITES, *TETRANYCHUS* *URTICAE* KOCH (ACARI: TETRANYCHIDAE) ON KIDNEY BEAN PLANTS UNDER LABORATORY AND FIELD CONDITIONS

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Abstract — The experiment was conducted at Department of Entomology, Khyber Pakhtunkhwa Agricultural University Peshawar and Agricultural Research Institute, Mingora Swat Pakistan during summer, 2015 to find out the comparative efficacy of commonly used, commercially available acaricides i.e. Fenpyroximate, Spiromecifen, Pyridaben and Hexythiazox against Two Spotted Spider Mites (TSSM), *Tetranychus urticae* Koch in the lab and field conditions. Fenpyroximate, Spiromecifen and Pyridaben were proved the best among the tested ones for the control of TSSM based on their LC₅₀ values and percent mortality in the lab and field experiment. All the tested acaricides caused significant mortality in the lab as well as in the field. Among the tested acaricides, Fenpyroximate, Spiromecifen and Pyridaben were found more effective against the two spotted spider mites than the other one. Mite population remained significantly lower in Fenpyroximate, Spiromecifen and Pyridaben treated plots (82-95 % mortality) than the Hexythiazox (17-30.83 % mortality, respectively). However, the Fenpyroximate showed the lowest LC₅₀ value. The recommended application rates used in the field and the LT₅₀ values further suggested judicious use effective acaricides.

Keywords: Two spotted spider mites, acaricides, Field and lab efficacy, LC₅₀, LT₅₀.

I. INTRODUCTION

Two spotted spider mite *Tetranychus urticae* (Koch) (Acari: Tetranychidae) is severe polyphagous species of the Tetranychidae, it attack on Fruit, vegetables and several other agricultural crops causing economic damage to the crops (Ripa *et al.*, 2006). *T. urticae* is Koch adapted to different environmental conditions affect yield, quality and quantity of

the crop or the death of the plants by sucking out the contents of plant sap (Geest, 1985; Cranham and Helle, 1985; Rott and Ponsonby, 2000). The (TSSM), *Tetranychus urticae* Koch is widely distributed and a common pest of many crop in greenhouses, nurseries and field crops. Population of TSSM can increase rapidly especially during hot and dry weather (Cagle, 1949). The two-spotted spider mite, is a widespread agricultural pest, causing severe damage on a variety of greenhouse and field crops (Cranham 1985). Most of the difficulties in controlling of this pest are initial detection and economically damaging levels that are closely associated with insecticide applications (Wilson *et al.*, 1991; Iftner & Hall, 1981). At high population densities of (TSSM) may destroy the whole plant result in crop yield loss. It affects plant, growth yield and quality of crop (Reddal *et al.*, 2004). Under IPM program high population of the pest was not completely control by its natural enemies (Prokopy *et al.*, 1990). Therefore, new approaches in pest management were applied, specially the use of bio pesticides that have received recently considerable attention. Many experiments all over the world have been done succeeded through the use of bio-pesticides in management of mite pests in different fruit orchard, vegetable and field crops, such as studies by (Abo *et al.*, 1986, Ibrahim *et al.*, 1993, Ibrahim *et al.*, 1994, Amer *et al.*, 1988, Amer *et al.*, 1989, Aucejio *et al.*, 2003, El-Ghobashy and El-Sayed, 2002, El-Halawany *et al.*, 1989, Kim *et al.*, 1999 and Sato *et al.*, 2002 and Aimee and Oscar., 2007). Now mites have a very serious problem because of widespread use of insecticides and acaricides for the control of mites and other sucking insects, farmer only depend on chemical control. Improper uses of

chemical control not only reduce of its natural enemies but also create resistance and pollute the environment. (APRD, 2007). The present experiment was conducted to find out the comparative efficacy and toxicity of some used acaricides (Fenpyroximate, Spiromecifen, Pyridaben and Hexythiazox) in the laboratory as well as in the field condition against the two spotted spider mites with the objective to find out the most effective acaricides among them to use by the farming community for the better control of spider mites.

II. MATERIALS AND METHODS

The experiments were conducted at Department of Entomology lab, Khyber Pakhtunkhwa Agricultural University Peshawar and Entomology Section, Agricultural Research Institute Mingora, Swat, Pakistan during, 2015.

Kidney bean plants *Phaseolus vulgaris* L were grown in earthen pots (30cm) diameter which were kept inside insect rearing cages (45 × 45 × 45cm) made up of fine mesh transparent green cloth with a zipper window at the front side. Water and fertilizer were applied to the plants frequently. Two spotted spider mite culture was established on the caged kidney bean plants to avoid the entrance of predatory mites as well as of other pests.

Preparation of Mites culture: two-spotted spider mites *Tetranychus urticae*, Koch were collected from various apple orchards at Swat, where no pesticides were used and were brought to the cage and were released on the potted kidney bean plants. Mites nymph and adults were collected from the culture and transpired to the leaf disc (25-30/leaf/petri dish) 90mm petri dish containing 1.5% water agar at the to keep the leaves green for more than ten days for normal development of mites. Mites regularly observed after 12 hours interval by Stereomicroscope.

Acaricides used in the experiment: For lab experiments, the recommended doses of four acaricides commercially available in the market for spider mites control were selected. (Table.1). The labeled concentrations of active ingredients (a.i.)/acre of all acaricides Used for mites control on kidney bean plants. For estimation of LC₅₀ values, they were used as different concentration of above and below the recommended dose.

Toxicity tests: Three different dilution of each acaricides were prepared in distilled water and 2.5 cm diameter bean leaf was dipped in each solution for 4-5 second. After 2 hours air drying the leaf disc was kept upside, on a bed of a thin layer of (1.5% water) agar, this layer of agar were made on the surface of moist cotton to prevent mite to escape at the base of 90mm petri dish. Adult female of two spotted spider mites (25-30 NOs) were shifted to leaf disc. All the replicates were put in growth chamber at 25 ± 1°C, 70 ± 5% RH and 16:8 L: D. The mortality was lookout after 2, 3, and 4 days under Stereomicroscope in all treated and control leaf disc. Individual incapable of moving (without any body movement) were considered as dead. The percent mortality was calculated in all the treatments by using Henderson Tilton's formula (Henderson and Tilton, 1955) and the bioassay were repeated

twice with three replications per concentration under CRD. The LC₅₀ and LT₅₀ values and their 95% fiducially limits were calculated from probit analysis (Finney, 1971) using SPSS statistical software.

Field experiment: This experiment was conducted at Entomology Section, Agricultural Research Institute Mingora, Swat, Pakistan during, 2015. There were four acaricides i.e. Fenpyroximate, Spiromecifen, Pyridaben and Hexythiazox and one control. The acaricides were used as distributor recommended dose on kidney bean plants against two spotted spider mite. The experimental area was divided into five treatments including the control. The plot size was taken as 10.0 × 15.0 sq ft with 1.5 and 1 ft row to row and plant to plant distance, respectively. All of the agronomic practices were kept uniform on all the plots throughout the experiment. The acaricides were sprayed with manual operated knapsack sprayer having 15 liters capacity fitted with hollow cone nozzle. The spray machine was clean completely before spraying operation. The control plot was sprayed with water only. Thirty plants per treatment were selected randomly for scouting of mites. Each treatment included four replicates. The replicates were distributed in a complete randomized block design. One sample was taken before treatment and then 2, 3, and 4 days after the application. Samples were collected randomly after spraying with each replicate. Adult and nymph of two spotted spider mite populations were counted on upper, lower and middle leaves of the plants. The lower surface of the leaf was carefully examined using a magnifying glass, where live mites were counted. Percentage of reduction was estimated according to the equation of Henderson and Tilton (1955).

Statistical analysis:

The formula of Henderson and Tilton (1955):

$$\% \text{ population reduction} = 95 \times (1 - (Ta \times Cb) / (Tb \times Ca)),$$

where Ta = number of *T. urticae*.

Tb = number of *T. urticae* before spray, Ca = number of *T. urticae* in the control after spray, Cb = number of *T. urticae* in the control before spray.

The above formula was used to calculate the reduction rate among *T. urticae* population after application of the four tested acaricides. The data were subjected to analysis of variance (ANOVA) and the means were compared using LSD test at 0.05, level using Minitab 15 program.

III. RESULT AND DISCUSSION

Adult female of two spotted spider mites were used in the laboratory experiments with different concentration (Table.3) shows that Fenpyroximate had the lowest LC₅₀ values of 9.67 and 4.87 mg per liter at 2 and 3 days, respectively; while, Spiromecifen had LC₅₀ values of 18.65 and 6.45 mg per liter at 2 and 3 days after exposure respectively, Similarly Pyridaben showed LC₅₀ values of 29.85 and 11.34 mg per liter after 2 and 3 days of exposure, respectively. The lower LC₅₀ values of above mentioned acaricides showed their high effectiveness against *T. urticae*. On the other hand, the last one Hexythiazox

had higher LC₅₀ values ranging from 181.26 and 59.50 at 2 and 3 days exposure.

Table.1. Different acaricides used against TSSM, *T. urticae* Koch adult females in the lab and mixed population in the field with respective doses/ acre and (a.i) mg/L.

Acaricides	Formulation	Dose gm or ml/acre	Dose (a.i) mg/L
Unique-M 5% SC®	Fenpyroximate	200	95
Oberon2SC®	Spiromecifen	200	13
Sindhmite 1SEC®	Pyridaben	500	700
Nissorun 10% WP®	Hexythiazox	285	200
Control			0.00

Table.2. LT₅₀ values of different tested acaricides against two spotted spider mite, (*T. urticae*) in the laboratory at recommended doses.

Acaricides	LT ₅₀ (h)	95% FL ^a	Slope ± SE	χ ²	df	P
Fenpyroximate	20.45	18.20- 25.20	1.17 ± 0.0861	3.9	3	0.05
Spiromecifen	29.39	26.21 - 35.45	1.35 ± 0.41	4.20	3	0.162
Pyridaben	41.35	30.83.20- 25.21	1.16 ± 0.0865	6.21	3	0.06
Hexythiazox	87.45	69.95- 125. 45	1.05 ± 0.45	8.7	3	0.052

Table.3. LC₅₀ values of different tested acaricides against cotton mites (*T. urticae*) after 2 and 3 days exposure to the multiples serial dilutions of field recommended doses in the laboratory.

Acaricides	Observation Days	LC ₅₀	95% FL ^a	Slope ± SE	χ ²	df	P
Fenpyroximate	2	9.67	079.30.83-167.64	0.71 ± 0.45	2.25	2	0.16
	3	4.87	045.06-76.34	0.76 ± 0.072	4.35	2	0.059
Spiromecifen	2	18.65	285.53-394.82	0.49 ± 0.52	6.21	2	0.053
	3	6.45	069.64-130.63	0.71 ± 0.03	2.06	2	0.16
Pyridaben	2	29.85	30.831.41-749.38	0.76 ± 0.06	3.42	2	0.156
	3	11.34	138.75-946.35	1.82 ± 0.69	9.63	2	0.176
Hexythiazox	2	181.26	537.37-752.45	0.45 ± 0.82	4.94	2	0.086
	3	59.50	733.33-4934.61	0.93 ± 0.63	7.63	2	0.038

Under laboratory conditions, the application of acaricides to the adult females of *T. urticae* at field doses by leaf dip method at

2days (Fig.1) showed a significant difference between the treatments over control regarding mortality of adult female (F= 57.74, df = 6, 20, P<0.001). Fenpyroximate provided the highest mortality (59.22%), while Spiromecifen (52.45%) and Pyridaben (41.75%) also showed comparatively high mortality as compared to Hexythiazox (17.54%) at 2days. A significant difference was also observed for the results at 3 days after exposure (F = 98.48, df = 6, 20, P<0.001). Among the tested acaricides, Fenpyroximate (92.35%), Spiromecifen (79.27 %) and Pyridaben (58.67) again showed highest mortality, while Hexythiazox showed less than 50 % mortality. Similarly, at 4 days after exposure, again similar and significant results were observed (F = 133.67, df =6, 20, P<0.001). Fenpyroximate showed 95% mortality, while Spiromecifen and Pyridaben showed 88.56% and 81.56% mortality, respectively and were statistically at par. The lowest mortality after 4 days of exposure was observed with Hexythiazox (30.83%). The overall average mortality in control treatment remained 4% in the lab. In the field experiments (Fig. 2), the application of acaricides also showed the significant differences among treatments at 2days after exposure to the acaricides (F = 454.28, df = 6, 27, P<0.001), the Fenpyroximate (61.95%), Spiromecifen (52.70%) and Pyridaben (51.76%) gave control (more than 50 % mortality), of *T. urticae* suggesting that these are most effective in controlling of two spotted spider mite populations, while Hexythiazox gave lower mortality 36.5%.. The Spiromecifen and Pyridaben were found statistically at par at 3 days exposure the results obtained were also significant (F = 570.30, df =6, 27, P<0.001), and similar to those obtained after 2days. The Fenpyroximate gave higher mortality (76.57%) then Spiromecifen and Pyridaben (60.85%, 56.25% mortality respectively), and Hexythiazox gave lower mortality less than 50 % (41.0%). Almost similar significant results were obtained at 4 days (F = 420.85, df =6, 27, P<0.001) but with higher % mortality than that obtained after 2 and 3 days. The Fenpyroximate gave highest mortality (85.85%), while Spiromecifen and Pyridaben were with 74.40% and 68.94% mortality respectively were found at par. Hexythiazox gave lower mortality (47.20%). Overall results showed that Hexythiazox was the less effective acaricides after 4 days. Our results indicate that in the laboratory and field the Fenpyroximate, Spiromecifen and Pyridaben showed excellent results against two spotted spider mites, whereas, Hexythiazox was less effective. According to Nauen *et al.* (2001), Fenpyroximate, Pyridaben, mitochondrial electron transport inhibitors (METI), are very active against six legged larvae and adult females of *T. urticae* having LC₅₀ values of 50 and 10 mg per liter against six legged larvae and adult females, respectively. The high LC₅₀ values and reduced toxicity for different acaricides in the laboratory tests may be due to the development of resistance which has already been reported in different parts all over the world. For example, many

researchers reported resistance to dicopal (Dennehy and Granett, 1981, Grafton-cardwell *et al.*, 1991; Kim *et al.*, 2004; Van-Leeuwen *et al.*, 2005. Hexythiazox showed excellent acaricides activity to mite. these result not support our result . In our study, Fenpyroximate showed 95% mortality in the laboratory at 4 days after exposure, while in the field at the same time period, it showed 87.50 % mortality. This shows that resistance may develop against this acaricides in mites very quickly. Herron *et al.* (2004) have reported that the first resistance in *T. urticae* was detected on Australian cotton against Spiromecifen and the resistance management committee recommended for only one to two spray per season of this miticide. Pyridaben was excellent product in the field for the management of spider mites and extensively was used by the farmers. But now due to the development of resistance against this and many other products, the management of spider mites population is becoming more difficult and challenging. According, to some researchers, the frequent pesticide application in rose and other crops has intensified selection pressure facilitating the development of resistance (e.g. Campos *et al.*, 1995; Herron *et al.*, 1997). Secondly, the development of cross-resistance is also one of the factors of failure in the management of this pest. Kim *et al.* (2004) showed that resistance to the Hexythiazox conferred cross resistance. Looking at the LT_{50} data (Table 2), the Fenpyroximate killed 50% Hexythiazox of *T. urticae* in less than a day (11.35 h); whereas, Pyridaben required about four days (87.45 h) to killed 50% mites population. The others acaricides tested in the present study, like Spiromecifen and Pyridaben, were also fast killers (1 and 2 days, respectively). Hexythiazox was comparatively slow killer. The LT_{50} data further suggests that only the highly efficient acaricides further suggests that only the highly efficient acaricides should be employed for the pest management like Fenpyroximate, Spiromecifen and Pyridaben. Hexythiazox which is comparatively slow killer may not be recommended for field application. Introduction of some biological control agents against two spotted spider mites in the Pyridadaben scenario would be effective in reducing selection pressure on pesticides. Registration of some acaricides with distinct mode of action and proper training of farmers for using acaricides having different mode of action alternatively would also be effective in the better management of this pest. Growers need to use new products judiciously and in rotations to delay resistance development.

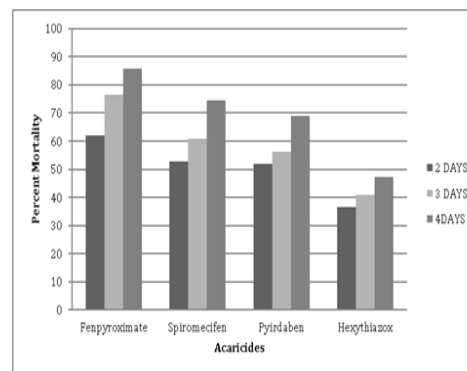


Fig.1. Mortality (% \pm S.D) of two spotted spider mite (*T. urticae*) adult female after 2,3 and 4 days exposure to the recommended dose of acaricides kidney bean leaves in the laboratory.

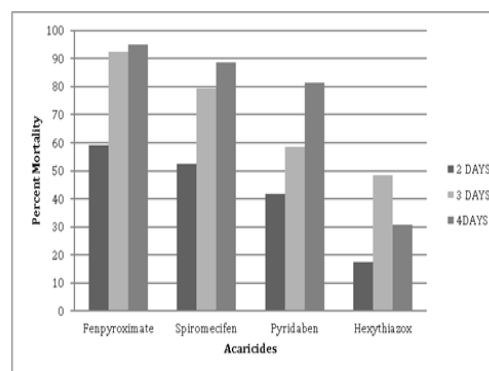


Fig.2. Mortality (% \pm S.E.) of two spotted spider mites (*T. urticae*) after 2, 3 and 4 days exposure to the recommended doses of acaricides in the kidney bean field.

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