Univ. j. zool. Rajshahi Univ. Vol. 25, 2006. pp. 15-18

ISSN 1023-6104

Control of two–spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) by some selected chemicals

S. Hossain, M. M. Haque* and N. Naher
Department of Zoology, University of Rajshahi, Rajshahi 6205, Bangladesh
*Corresponding author

Abstract: The experiment was conducted to study the effectiveness of four commonly used chemicals *viz.*, deltamethrin, cypermethrin, malathion and sulphur against two-spotted spider mite (TSSM), *Tetranychus urticae* Koch on potted bean plants and on excised leaf discs. Mite population remained significantly lower in all treated plots except malathion treatment. The population of *T. urticae* differed significantly due to different chemicals and it remained lower up to 4th week on single-sprayed plants, which again increased. But in double-sprayed plants mite population was checked and remained significantly lower. The estimated LC_{50} values for cypermethrin, malathion, deltamethrin and sulphur were 2.9956, 15.8663, 0.5386 and 20.7045 nl.cm^{-2} respectively when the chemicals were sprayed before mite release. But the LC_{50} values for these chemicals sprayed after mite release were estimated 1.8110, 8.2746, 0.2192 and 6.8308 nl.cm^{-2}. The use of chemicals is essential for better yield of crops. Among the four tested chemicals the pyrithroids (cypermethrin and deltamethrin) were found more effective against the TSSM than the other two.

Key words: Two-spotted spider mite, *Tetranychus urticae*, bean, deltamethrin, cypermethrin, malathion, sulphur

Introduction

The two-spotted spider mite (TSSM), *Tetranychus urticae* Koch is widely distributed and a common pest of many plant species in greenhouses, nurseries and field crops. A population of TSSM can increase rapidly especially during hot and dry periods. It infests many crops including tomatoes, beans, peepers, eggplants and ornamental plants (Cagle, 1949). Of more than 130 species of spider mites known, TSSM is the major pest species on agricultural crops worldwide (Wu *et al.*, 1990; Ho, 2000; Takafuji *et al.*, 2000). Most of the difficulties in controlling this pest are initial detection and economically damaging levels that are closely associated with insecticide applications (Wilson *et al.*, 1991; Iftner & Hall, 1984). One explanation for this is that insecticides reduce natural enemies of TSSM, causing a reduction in predation pressure, which may allow mite number to increase. Foliar applications to crops are known to greatly reduce predators of TSSM (Wright, 2001), however, synthetic applications can also reduce number because of its omnivorous feeding behaviour (Mitchell, 1973).

Development of resistance by *T. urticae* to numerous acaricides has caused difficulties in controlling outbreaks (Carbonaro *et al.*, 1986). Many new acaricides are now available in the market but they have a high cost associated with their use and application restrictions listed on the label to prevent the development of resistance. Treatment with acaricides that have long residual toxicity may be required to suppress high-density spider mite populations. However, use of acaricides with long residual periods may promote resistance in spider mite populations. Low-density populations may be suppressed with acaricides that have short residual toxicity. Diverse natural enemies have an important role in the ecology of the TSSM (Brandenburg & Kennedy, 1987). Acaricide applications are necessary to suppress the TSSM population, but selective use of acaricides that are compatible with natural enemies may preserve predator population of TSSM and enhance control (Trumble & Morse, 1993). To combine predators with acaricide applications, the chemical must be non-toxic to the predators.

Since TSSM is a major pest of important vegetable crops including beans (Naher *et al*., 2006), its control is essential for maximum yield of this crop. The present investigation was aimed at studying the effectiveness of four selected insecticides namely, deltamethrin, cypermethrin, malathion and sulphur against TSSM on potted bean plants and the toxicity of these chemicals on this pest on excised leaf discs. The reasons for selecting the chemicals are they are very common, comparatively cheaper, available and are widely used to control other pests of different vegetable crops.

Materials and Methods

Control on potted bean plants: Control of *T. urticae* by chemicals on potted bean plants was conducted in

the premises of the Laboratory of Ecology, Department of Zoology, Rajshahi University. For this purposes twenty clay-made pots (30×50 cm) with bean plant were maintained.

Plantation: The seeds of the bean *Lablab purpuseus* were collected locally. More than five seeds were sown in each pot. After germination the pots were maintained properly. Three seedlings were maintained in each pot and excess seedlings were removed.

Plotting: All the twenty pots were arranged in 10 groups taking two in each. Among these eight were selected for chemical treatment, one for control and the remaining one for mass culture of TSSM. Every group was placed separately and covered with fine net to protect from the natural infestation. Bamboo sticks were used to support the bean plants.

Infestation: After two months of sowing when the bean plants grew enough, they were infested by TSSM. TSSM used for infestation were collected from the Integrated Pest Management (IPM) laboratory, Institute of Biological Sciences, Rajshahi University. Ten adult females were released on each bean plant. Placing the infested plant parts on leaf at the height of 0.75 m made release of the mites.

Spray: Four selected insecticides *viz.*, deltamethrin, cypermethrin, malathion and sulphur were tested against *T. urticae*. Two groups selected for each chemical, was again separated for single spray and double sprays where insecticide was sprayed once after two week of mite infestation on single spray grouped plant and the insecticide was sprayed twice on the double-sprayed grouped plants. On these plants, first spray was done after two weeks of infestation and second spray after four weeks of infestation. The dilution of insecticides and amount were maintained as prescribed by their distributors. No chemicals were sprayed on control and culture plants.

Counting: Counting of mites was started from the first week of infestation. Fifteen leaflets were collected from each group of plants that were selected randomly. Total number of adult and mature mites was recorded. The counting was made every week on all the nine groups of plants and continued till twelve weeks after infestation.

Toxicity of the chemicals: The effectiveness of the selected chemicals against *T. urticae* was done on excised leaf discs. This test was conducted in two ways: (1) solution was sprayed on leaf discs before mite release, and (2) solution was sprayed after mite release.

Before mite release: This method was based on the surface film technique devised by Busvine (1971). For this purpose 1.5 cm^2 leaf discs were made from fresh bean leaf. The discs were checked under microscope for mites other insects. Then the discs were placed in petridish having a water soaked cotton bed. The chemicals were serially diluted with water. Fixed volume (0.1 ml) of chemical solution was dropped on each leaf disc and allowed to dry for five min at room temperature. Ten adult TSSM were transferred to each disc with the help of a fine brush. The chemicals were tested against the mites. Each chemical was treated with four different doses having four replications of each dose. The doses were calculated by considering the actual quantity of chemical in 0.1 ml of solution divided by the surface area of the leaf disc. A separate control batch was maintained, in which only water was dropped on the leaf discs.

After mite release: This is similar to the above-described method. The only exception was that the dropping of the chemical solutions was done after releasing the mites. The doses and replications were the same as the above method.

Mortality analysis: Mortality was assessed under a stereo binocular microscope after 24 h treatment. Mites were scored dead if they failed to make active movement after light tapping. Corrected mortality percentage was calculated using Abbot's formula (Abbot, 1925):

$$P_t = \frac{P_o - P_c}{100 - P_c} \times 100$$

Where P_t = corrected mortality; P_o = observed mortality percentage and P_c = control mortality percentage. Probit regressions were estimated from mortality data according to the probit analysis of Finney (1947) and Busvine (1971) using software developed in the Department of Agricultural and Environmental Science, University of Newcastle upon Tyne, UK.

Results and Discussion

T. urticae population per leaflet during different weeks after infestation on single-sprayed and double-sprayed plants is presented in Table 1. The mite population remained significantly lower in all treated plots except the malathion-treated one. The population of *T. urticae* differed significantly due to different chemicals (single spray: $F_{55,4}$=8.571, P<0.01; double sprays: $F_{55,4}$ =7.217, P<0.01). Mite number in control plots increased gradually up to the 5th week, then decreased and became nil due to damage of host plants.

Table 1. Population of *T. urticae* in different weeks due to spraying of four selected chemicals

Weeks	Control	Single spray				Double sprays			
		Cyper-methrin	Malathion	Delta-methrin	Sulphur	Cyper-methrin	Malathion	Delta-methrin	Sulphur
1	41.20	47.33	87.73	20.80	77.86	47.60	91.73	110.93	39.66
2	41.86	0.80	31.60	5.00	0.46	0.60	17.13	0.93	0.73
3	36.93	0.00	57.53	3.00	10.06	0.00	62.93	3.20	2.13
4	64.40	0.80	86.93	6.86	9.73	0.00	82.86	0.00	0.00
5	108.53	2.46	141.86	9.26	8.13	0.66	106.86	1.40	1.00
6	63.26	2.53	84.86	4.80	8.33	0.00	61.86	3.00	4.13
7	35.20	8.93	83.93	2.73	12.93	3.26	87.46	5.93	7.40
8	22.20	11.06	51.86	5.86	10.13	1.13	40.86	3.20	2.80
9	0.00	19.06	3.20	4.33	1.60	0.46	23.60	2.93	5.66
10	0.00	4.60	0.00	0.93	0.80	0.23	0.00	2.00	2.33
11	0.00	2.86	0.80	0.66	0.33	0.00	0.86	1.66	0.86
12	0.00	1.93	0.33	0.33	0.26	0.60	0.00	0.13	0.20

Uses of chemicals reduce the increase of mite population in various crops. Labanowska (1990) evaluated the effectiveness of several preparations for the control of TSSM on strawberry. He sprayed before bloom and obtained satisfactory control. Labanowska & Tkaczuk (1991) conducted experiments with some new generation acaricides in the control of *T. urticae* on black currant and obtained excellent result with azocyclotin, fenbutatin oxide and bromopropylate. Chahine *et al.* (1992) compared the effectiveness of two acaricides on *T. urticae* infesting bean and reported that acaricides reduced the mite population effectively up to nine days of application.

Single spray of chemical cannot effectively control the mite population. Several sprays effectively control the mite population and increased the crop yield in various crops. The present experiment shows that mites increased exponentially up to fifth week of infestation in control plots. After the fifth week, the mites decreased gradually and the plants died due to the massive attack of the mite. Mite population remained lower up to the 4th week on single-sprayed plants but again increased. But in double-sprayed plots mite population was checked and remained significantly lower. The use of chemicals appears to be essential for better yield of crops. Among the four tested chemicals the pyritheroids (cypermethrin and deltamethrin) were more effective against *T. urticae.*

The LC_{50} values for the selected chemicals on *T. urticae* along with 95% confidence limits are presented in Table 2. The estimated LC_{50} values for cypermethrin, malathion, deltamethrin and sulphur respectively were 2.9956, 15.8663, 0.5386 and 20.7045 $nl.cm^{-2}$ when the chemicals were sprayed before mite release. But the LC_{50} values for these chemicals sprayed after mite release were 1.8110, 8.2746, 0.2192 and 6.8308 $nl.cm^{-2}$. The regression equations and χ^2 values indicated that there were no heterogeneity on the tested populations. LC_{50} value for deltamethrin was the minimum in both the methods applied. The order of toxicity was deltamethrin > cypermethrin > malathion > sulphur in the first method while deltamethrin > cypermethrin > sulphur > malathion was noted in the second method. It is apparent from the above results that deltamethrin was the most effective against *T. urticae*.

Table 2. Dose morality effect of different chemicals against *T. urticae* after 24 h of exposure in leaf disc method

Test methods	Chemicals	LC_{50} value ($nl/ng.cm^{-2}$)	95% confidence limits ($nl/ng.cm^{-2}$)	Regression equations	χ^2-values (at 2 df)
Before mite release	Cypermethrin	2.996	2.396 - 3.746	Y=3.902+2.306X	1.521
	Malathion	15.866	11.663-21.585	Y=3.028+1.643X	2.659
	Deltamethrin	0.537	0.425 - 0.6332	Y=3.184+2.483X	0.512
	Sulphur	20.705	15.665-27.366	Y=3.184+2.483X	0.512
After mite release	Cypermethrin	1.811	1.536 - 2.136	Y=0.820+3.323X	3.286
	Malathion	8.275	6.224-11.000	Y=3.376+1.770X	0.489
	Deltamethrin	0.219	0.142 - 0.339	Y=4.487+1.505X	0.457
	Sulphur	6.831	4.972 - 9.385	Y=3.211+2.144X	0.811

T. urticae suppression provided by chemicals vary greatly. Certain pyrithroids may suppress the mite populations while others may stimulate outbreaks by causing increase in the density of its population (Busvine, 1971). Chlorfenapyr provided excellent control of *T. urticae* infestations without short-term population resurgence (Allen, 1999). It provided quick and long-term suppression of TSSM populations. Abamectin has been shown to cause significant mortality and reduction in the mobility and fecundity of *T. urticae* (Zhang & Sanderson, 1990). Kim *et al.* (1997) obtained the negative result with mancozeb for controlling tea mite *T. kanzawai* in which it killed 100% mite predator, *Amblyseius womersleyi*. Hill &

Foster (1998) carried out an experiment with some chemicals on European red mite and its predator and found that mite outbreak occurred after few weeks of treatment as predators were killed due to insecticidal application. Sclar *et al*. (1998) obtained the increase of spider mite population rather than control on ornamental plants treated with imidacloprid.

Stanyard *et al.* (1998) observed that the application of paramethrin drastically reduced natural enemies, allowed European red mite outbreaks to occur. They also reported that selective acaricides varied in their effects on *Amblyseius fallacis* and European red mite. The above discussion suggests the use of chemicals that are tolerable to the predators of the TSSM. Naher (2005) made laboratory experiments on excised bean leaves applying only one method with 13 chemicals including cypermethrin, malathion and sulphur and reported that cypermethrin was the most effective one against *T. urticae*. The present experiment was done in two different ways. In addition to a control experiment, insecticides were applied on potted bean plants. The present results are in slight disagreement with that of Naher (2005). Here deltamethrin exhibited more effectiveness against *T. urticae* than cypermethrin.

References

Abbot, W.S. 1925. A method of computing the effectiveness of an insecticide. *J. Econ. Entomol.* **18:** 265.

Allen, C.T. 1999. Spider mite control in southeast Arkansas. *Proc. Beltwide Cotton Conf.* **2:** 1185-1186.

Brandenburg, R.L. & Kennedy, G.G. 1987. Ecological and agricultural considerations in the management of two-spotted spider mite (*Tetranychus urticae* Koch). *Agric. Zool. Rev.* **2:** 185-236.

Busvine, J.R. 1971. *A Critical Review of the Techniques for Testing Insecticides.* Commonwealth Agricultural Bureaux. London. 345 pp.

Cagle, L.R. 1949. Life history of the two-spotted spider mite. *Virginia Agric. Exp. Sta. Tech. Bull.* **113:** 31 pp.

Carbonaro, M.A., Moreland, D.E., Edge, V.E.N., Motoyama, R.G.C. & Dauterman, W.C. 1986. Studies on the mechanisms of cyhexatin resistance in the two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae). *J. Econ. Entomol.* **79:** 576-679.

Chahine, H., Aslam, M. & Michelakis, S. 1992. Comparison among two acaricides and a predator for *Tetranychus urticae* (Acarina: Tetranychidae) control on beans, *Phaseolus vulgaris. Arab J. Plant Prot.* **10(1):** 22-24.

Finney, D.J. 1947. *Probit Analysis: A statistical treatment of the sigmoid response curve.* Cambridge Univ. Press, Cambridge. London. 275 pp.

Hill, T.A. & Foster, R.E. 1998. Influence of selective insecticides on population dynamic of European red mite (Acari: Tetranychidae), apple rust mite (Acari: Eriophyidae), and their predator *Amblyseius fallacis* (Acari: Phytoseiidae) in apple. *J. Econ. Entomol.* **91(1):** 191-199.

Ho, C.C. 2000. Spider mite problems and control in Taiwan. *Exp. Appl. Acarol.* **24:** 453-462.

Iftner, D.C. & Hall, F.R. 1984. The effects of fenvalerate and permethrin residues on *Tetranychus urticae* Koch fecundity and rate of development. *J. Agric. Entomol*. **1**: 191-200.

Kim, D., Lee, S. C., Paik, C. H., Kin, S. S. & Ma, K.C. 1997. Population fluctuation of *Tetranychus kanzawai* and their natural enemies and related susceptibility of some pesticides to *Amblyseius womersleyi* and *Tetranychus kanzawai. J. Korean Tea Soc.* **3(1):** 83-93.

Labanowska, B.H. 1990. Effectiveness of some new generation acaricides in the control of two spotted mite *(Tetranychus urticae* Koch*)* on strawberries. *Fruit Sci. Report* **17(3):** 137-147.

Labanowska, B.H. & Tkaczuk, C. 1991. Effectiveness of some new generation acaricides in the control of two spotted spider mite (*Tetranychus urticae* Koch) on black currant. *Fruit Sci. Report* **18(4)**: 185-197.

Mitchell, R. 1973. Growth and population dynamics of a spider mite *(Tetranychus urticae Koch*, (Acarina: Tetranychidae). *Ecology* **54**: 1349-1355.

Naher, N. 2005. Integrated management of two-spotted spider mite infesting beans. Unpubl. Ph D thesis, Institute of Biological Sciences, Rajshahi University. 221 pp.

Naher, N., Islam, W. & Haque, M.M. 2006. Predation of three predators on two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae). *J. Life Earth Science* **1(1):** 1-4.

Sclar, D.C., Gerace, D.J. & Cranshaw, W. 1998. Observations of population increases and injury by spider mites (Acari: Tetranychidae) on ornamental plants treated with imidacloprid. *J. Econ. Entomol.* **91(1)**: 250-255.

Stanyard, J.M., Foster, R. E. & Gibb, T.J. 1998. Population dynamics of *Amblyseius fallacis (*Acari: Phytoseiidae*)* and European red mite (Acari: Tetranychidae) in apple trees treated with selected acaricides. *J. Econ. Entomol.* **91(1)**: 217-225.

Takafuji, A., Ozawa, A., Nemoto, H. & Gotoh, T. 2000. Spider mites of Japan: their biology and control. *Exp. Appl. Acarol.* **24**: 319-335.

Trumble, J.T. & Morse, J.P. 1993. Economics of the integrating the predaceous mite *Phytoseiuhis persimilis (*Acari: Phytoseiidae*)* with pesticides in strawberries. *Hort. Entomol.* **86**: 879-889.

Wilson, D. 1991. Spider mites (Acari: Tetranychidae) affect yield and fiber quality of cotton. *J. Econ. Entomol.* **86**: 566-585.

Wright, B. 2001 Know Your Friends: Minute. Pirate Bugs. http:///www. Entomology. Wige. Edu/mbcn/ ky f101. Html.

Wu, K.M., Liu, X.C., Qin, X.Q. & Luo, G.Q. 1990. Investigation of carmine spider mite (*Tetranychus cinnabarinus*) resistance to insecticides. *Acta Agric. Boreali Sinica* **5**: 117-123.

Zhang, Z. & Sanderson, J.P. 1990. Relative toxicity of abamectin to the predatory mite *Phytoseiulus persimilis (*Acari: Phytoseiidae*)* and two-spotted spider mite (Acari: Tetranychidae). *J. Econ. Entomol.* **83:** 1783-1790.

Revised manuscript received on 10 May 2007.