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Management of the two spotted spider mite on carnation with the use of biopesticides and the predator *Neoseiulus longispinosus* (Evans) (Acari: Tetranychidae, Phytoseiidae)*

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Abstract

Carnation holds a prominent place and a good market among the various cut flowers in Himachal Pradesh, India, but it can be severely attacked by the two spotted spider mite, *Tetranychus urticae* Koch. Indiscriminate use of pesticides has led to development of resistance in this species, affected human health and caused environmental pollution. The determination of safer and more cost effective and eco-friendly alternative approaches for the management of this pest is desirable. Different combinations of three weekly applications of a predator [the phytoseiid *Neoseiulus longispinosus* (Evans)], a fungus [a commercial formulation of *Lecanicillium* (= *Verticillium*) *lecanii* (Zimmerman)], a plant extract (a commercial neem formulation), a conventional chemical mitecide (Profenofos) or water (control) were tested in 2008 and 2009. In both years, the best results were obtained by three subsequent weekly releases of *N. longispinosus* and three subsequent applications of Profenofos. These results show the potential of this predatory mite as a control agent of two spotted spider mite on carnation under greenhouse conditions in Himachal Pradesh.

Key words: Biological control, natural products, pest management.

Introduction

Carnation holds a prominent place among the cut flowers in Himachal Pradesh, India. It can be grown successfully under greenhouse conditions, it is highly appreciated for ornamental purposes and it has adequate market value. *Tetranychus urticae* Koch, the two spotted spider mite, is a pest of a large number of field and greenhouse crops, including carnation (Kumar *et al*., 1996), turning its leaves first yellowish and then bronze, stunting growth and reducing yield and quality of marketable flowers (Pal, 1956; Sandhu & Gupta, 1977).

Indiscriminate use of pesticides has led to development of resistance of *T. urticae* to those products (Gopal, 2000), affected human health and caused environmental pollution. To avoid long term adverse effects of these chemicals, the determination of safer and more cost effective and eco-friendly alternative approaches for the management of this pest is desirable. One of he best available options to be exploited is the use of botanicals as such or in combination with natural enemies. Botanicals have either repellent (Schauer & Schmutterer, 1981; Reda *et al*., 1990; Sharma *et al*., 2010) or lethal (Amer *et al*., 1991) effects on that pest, and in this study we were interested on evaluating the possible effect of a commercial neem extract for the control of *T. urticae*. Amongst the natural enemies, we were interested on the evaluation of the possible effect of the predatory phytoseiid mite *Neoseiulus longispinosus* (Evans) and of the fungus *Lecanicillium* (= *Verticillium*) *lecanii* (Zimmerman) as control agents of *T. urticae*. Promising results for the use of these natural enemies for the control of different tetranychid mites have been reported in the literature by Ho *et al*. (1995), Zhang *et al*. (1998, 1999) and Gerson *et al*. (2003) as well as by Chandler *et al*. (2005), respectively.

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Materials and Methods

Stock colonies of *T. urticae* and *N. longispinosus* were maintained on potted French bean and strawberry plants in a glasshouse.

The study was conducted in the Department of Entomology and Apiculture, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Trials were conducted in a greenhouse with 18 beds, each accommodating 75 plants spaced at 20 x 20 cm, using carnation var. Master. The first trial was initiated in March 2008 and the second, in March 2009. In both, plant treatments were initiated in May, after sufficient build up of the spider mite population. In total, six combinations of treatments (six strategies) were tested, each with three replicates (Table 1). In the first four strategies, the predator as such or in combination with Econeem (0.4% of formulated material containing 40 ppm azadirachtin) and/or a commercial liquid formulation of *Lecanicillium* (= *Verticillium*) *lecanii* (Zimmerman) (Biocatch of T Stanes and Company Coimbatore, India, containing 10^9 c.f.u/mL, at a concentration of 1 mL/litre water) were used, while in the fifth and the sixth strategies, the acaricide profenofos 0.15% and water, respectively, were sprayed. For the release of predatory mites, 20 individuals were transferred to a mulberry leaf with the help of a fine brush and each of such leaves was attached to every third carnation plant of the bed where they were scheduled to be released; releases were done on 25 plants of each bed.

Immediately before each treatment, the density of all post-embryonic stages of *T. urticae* was evaluated by taking five randomly collected leaves from each of five plants of each plot at each sampling date. The leaves were taken to a laboratory, where the mites were counted under a stereomicroscope.

At each year, the data were analyzed in a completely randomized block design. Means were compared by least significant differences.

Results

In the pre-treatment evaluation of 2008, the average numbers of *T. urticae* varied from 42.5 to 49.6 mites per leaf for the different strategies. No significant differences were observed between strategies in relation to pre-treatment numbers (Table 2).

In 2008, a trend for increase in the number of *T. urticae* was observed in strategy VI (control) in successive evaluations, whereas on plants of other strategies the number of *T. urticae* tended to remain stable (strategy IV) or to reduce (strategies I, II, III and V) from the first to the last evaluation. In the last evaluation, significantly lower numbers of *T. urticae* were found on plants of strategies I (two applications of Econeem followed by a release of *N. longispinosus*), III (three releases of *N. longispinosus*) and V (three consecutive applications of profenofos). The numbers

TABLE 1. Treatment combinations (strategies) used to control *Tetranychus urticae* on carnation in a greenhouse at Nauni, Solan, Himachal Pradesh, India. Treatments were applied in three consecutive weeks.

Strategy	Treatments[1]		
	First	Second	Third
I	Econeem	Econeem	Predator
II	*L. lecanii*	Econeem	Predator
III	Predator	Predator	Predator
IV	*L. lecanii*	*L. lecanii*	Predator
V	Profenofos	Profenofos	Profenofos
VI (Control)	Water	Water	Water

[1]Dosage used: Econeem: 0.4%; *V. lecanii* (as Biocatch): 1 mL/litre water; predator: 20 adults/third plant; Profenofos: 0.15%.

TABLE 2. Average numbers of post-embryonic *Tetranychus urticae* per carnation leaf for each combination of treatment (strategy), for trials conducted in 2008 and 2009. Evaluations done immediately before treatment and after seven days of each of the indicated treatment.

Strategy	Evaluations			
	Pre-treatment	First treatment	Second treatment	Third treatment
		2008		
I	42.5	31.8	22.7	16.8 a
II	43.8	46.5	34.9	22.6 b
III	49.6	42.7	31.6	11.4 a
IV	45.9	47.5	51.2	45.3 c
V	47.8	12.6	8.4	5.6 a
VI	44.5	52.7	54.6	64.7 d
LSD $_{p= 0.05}$				12.62
		2009		
I	9.1	5.3	4.4	3.5 b
II	9.3	6.9	7.5	-5.9 c
III	9.6	3.9	1.4	0.8 a
IV	9.3	6.8	6.4	4.5 b
V	9.7	1.5	1.0	0.2 a
VI	9.4	17.1	19.0	29.3 d
LSD $_{p= 0.05}$				1.2

corresponding to those strategies ranged from 5.6 to 16.8 mites per leaf, in comparison with 64.7 mites per leaf in the control.

In the pre-treatment evaluation of 2009, the average numbers of *T. urticae* were much lower than in 2008, varying from 9.1 to 9.7 mites per leaf for the different strategies. Also in this case, no significant differences were observed between strategies in relation to pre-treatment numbers.

In the subsequent evaluations, the number of *T. urticae* again tended to increase on plants of strategy VI, in contrast with what was observed in all other treatment, in which the number of *T. urticae* tended to reduce. In this year, the numbers of mites on plants of strategies III and V were also significantly lower than in other treatments. In treatment I, the number of *T. urticae* was slightly but significantly higher than in those two treatments, but still much lower than in the control, and similar to the number for strategy IV (two inoculations of *V. lecanii* followed by a release of *N. longispinosus*).

Discussion

The commercial formulations of neem extracts and the fungus *L. lecanii* showed significant effect in the control of *T. urticae*. The numbers of this mite in the strategies in which these products were used were significantly lower than in the control. Econeem has been recently reported to reduce the fecundity and hatchability of eggs of *T. urticae* on capsicum crop (Sharma Ajay *et al*., 2010). Natural infection of that mite by *L. lecanii* complex has been mentioned in the literature (Maniania *et al*., 2008). Experimental reduction of the population of that pest mite was observed under glasshouse conditions by Chandler *et al*. (2005). Thus, the results obtained in this study with these organisms warrant further investigations on their possible use as new alternatives for the control of *T. urticae*.

Neoseiulus longispinosus was found as effective as the mitecide Profenofos for the control of *T. urticae*. This predator was described from Indonesia and was first reported in India and other Asian countries quite a long time ago, although more recently it has been reported from other tropical and subtropical countries (Moraes *et al*., 2004). In India, it has been observed to feed on

Tetranychus species on apple and fig trees (Thakur & Dinabandhu, 2005). Kongchuensin *et al.* (2005) reported it to prey on *T. urticae* on 33 plant species, including ornamentals, in Thailand. The biology of this predator was studied by Ho *et al.* (1995). The results of this study showed that if *N. longispinosus* is released on about 30% of the plants at a density of 20 predatory mites per plant at the initial stages of pest buildup, it can very well manage the pest and reduce the pesticide pressure in the crop ecosystem.

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