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Biological control of two spotted spider mite, *Tetranychus urticae* (Acari: Phytoseiidae) with releases of predatory mite, *Neoseiulus californicus* (Acari: Phytoseiidae) in strawberries

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Abstract:

The two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is one of the most important pests responsible for yielding losses to many agricultural crops. In this study, *Neoseiulus californicus* McGregor (Acari: Phytoseiidae) has been evaluated as a natural predator for *T. urticae* infesting strawberry. The results indicated that reduction in number of *T. urticae* after releasing the predator *N. californicus* were in the first week, 31.9% and 51.3% in single and double releases, respectively. The reduction in the second and third weeks reached to 70.8 &80% and 71.7 and 89.3% for single and double releases, respectively. It is concluded that the repeated releases of *N. californicus* was the best for preventing *T. urticae* to exceed the economic threshold level.

Introduction

The cultivated plants in green house particularly strawberries are greatly affected by the two spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) (Rhodes *et al.*, 2006). The high rate of *T. urticae* fecundity enables it to complete the life cycle within one week at quite high temperature ≥32°C. In that context, the growers frequently use acaricides which might reduce the infestation and its consequences for a short run. However, the use of these chemicals for a long run might lead to the development of *T. urticae* resistant population (Fraulo and Liburd, 2007). *T. urticae* is feeding on the lower surface of the strawberry leaves leading to change in shape and color and leaving fine webbing. For its fast growing, high reproductive potential and under favorable growing conditions, mites could rapidly reach damaging population levels at which berry number significantly reduced (Walsh *et al.*, 1998 and Sato *et al.*, 2007).

For their bad effect on the long run, coast and for environmental concerns it became necessary to find an alternative to acaricides to overcome such obstacles. The use of the predacious mites, family Phytoseiidae (Acari: Mesostigmata), which commercially available are commonly used for the control of *T. urticae* on various vegetable and ornamental crops (Palevsky *et al.*, 2008).

The predatory mite, *Neoseiulus californicus* (McGregor) (Acari: Phytoseiidae) is polyphagous in nature and it could survive in a wide range of temperature and humidity. This predator is currently mass

produced to be used as a bio-control agent against spider mites (Gerson and Weintraub, 2007). It has a high predation capacity of about 15-20 spider mite eggs per day. Additionally, it could feed on pollen, other mites, thrips and aphids, thus surviving for days without the presence of the prey in the field (de Moraes and Flechtmann, 2008 and Marafeli *et al.*, 2014). It may face the challenge of food limitation or its absence in the field during storage or during transportations (Ghazy *et al.*, 2015). For field application of *N. californicusis* to be successful, it is very important to adjust the prey/predator ratio and to maintain adequate long-term control of *T. urticae*, combined treatment of Acramite with *N. californicus* may be an effective strategy to reduce the of *T. urticae* in commercially grown strawberries (Rhodes *et al.*, 2006).

The purpose of this study is to determine the effectiveness of *N. californicus* release as a bio-control agent against *T. urticae* infesting strawberry fields.

Materials and Methods

Commercial strain of *N. californicus* that was obtained from bio-log Company. The experiment was conducted in strawberry field in Belkas city, Dakahlia Governorate in an experimental field with dimensions 15x20 meter. The field has a low infestation with *T. urticae*. The area was divided into 3 equal parts each one with 5x20 m dimensions. The first part was assigned to once release with *N. californicus* and the second with double release 2 times per week with *N. californicus* and the last one served as a control. It was applied (50 individuals /m^2) starts from 1st of February and calculate the reduction in number of *T. urticae* by randomly collecting 20 leaves (3 leaflets) before and after 1,2 and 3 weeks after releasing and examined by stereomicroscope in laboratory. The reduction percentages of mites were calculated by using the Henderson -Tilton formula (Henderson and Tilton, 1955).

$$\text{Corrected \%} = \left(1 - \frac{\text{n in Co before treatment X n in T after treatment}}{\text{n in Co after treatment X n in T before treatment}}\right) \times 100$$

Data were analyzed by one way analysis of varience (ANOVA) and the means were separated using Duncan's Multiple Range Test (Snedecor, 1980).

Results and Discussion

The effect of releasing of the predatory mite *N. californicus* in single and double times are represented in Table (1) the mean number of *T. urticae* after 1 week of single release was 5.4 (individuals/ leaflet) which increased to 6.9, 8.1 (individuals /leaflets after 2 and 3 weeks), respectively. Meanwhile, in double release of *N. californicus* the starting number of *T. urticae* was 6.2 individuals/ leaflets and slightly decreased after 1 week to 5.3 and significantly decreased to 4.3, 3.2 after 2 and 3 weeks of treatment. Reduction in number of *T. urticae* in the first week was 31.9% and 51.3% in single and double releases, respectively. The reduction in the second week reached to 70.8, 80% and in the third week reached to 71.7, 89.3% for single and double releases, respectively.

The number of predatory mite *N. californicus* (Figure,1) counted also in single, double and in control replicates which the mean number was 1.2, 1.7 in single and double releases but in control (no release) it was Zero individuals/leaflets. The mean number of *N. californicus* increased at 2 weeks after release to 2.7, 4 and 0.7 individuals/leaflets in single, double releases and control (no release), respectively. While in 3 weeks after release, the numbers were 3, 5.4 and 1.6 individuals/leaflets in single, double and control (no release), respectively.

The time of release and environmental conditions are important in the use of *N. californicus* as it never achieved control in the late release plots (Fraulo and Liburd, 2007 and Audenaert *et al.*, 2014).

Application of *N. californicus* could attain season-long control of *T. urticae* with substantial economic saving for growers compared with current recommendations acaricides. (Fraulo and Liburd, 2007). The current experiment has been done when the number of *T. urticae* was higher than injury threshold level because once harvest begins, strawberry plants become more tolerant to mite feeding and treatment thresholds increase to an average of 15–20 mites per mid-tier leaflet (Fraulo and Liburd, 2007 and Iwassaki *et al.*, 2015). In this study, *N. californicus* showed the ability to maintain numbers of *T. urticae* in the treated plants compared with the increasing numbers of this pest in the untreated plants.

Table (1): Effect of single and double release of *Neoseiulus californicus* on *Tetranychus urticae* population.

Date	Times of release	No. of *T. urticae*/leaflet	Reduction %	LSD
Pre-count	Single	5.7 ± 0.47	-	
	double	6.2 ± 0.64	-	
	No release	7 ± 0.17	-	
After 1 week	Single	5.4 ± 0.57 [b]	31.9	0.7605
	Double	5.3 ± 0.76 [b]	51.3	
	No release	12.4 ± 0.95 [a]	-	
After 2 weeks	Single	6.9 ± 0.63 [c]	70.8	0.595
	Double	4.3 ± 0.34 [b]	80	
	No release	27.9 ± 1.78 [a]	-	
After 3 week	Single	8.1 ± 0.21 [c]	71.7	2.27
	Double	3.2 ± 0.45 [b]	89.3	
	No release	33.5 ± 3.2 [a]	-	

The same letters in a raw are not-significantly different (ANOVA, P < 0.05)

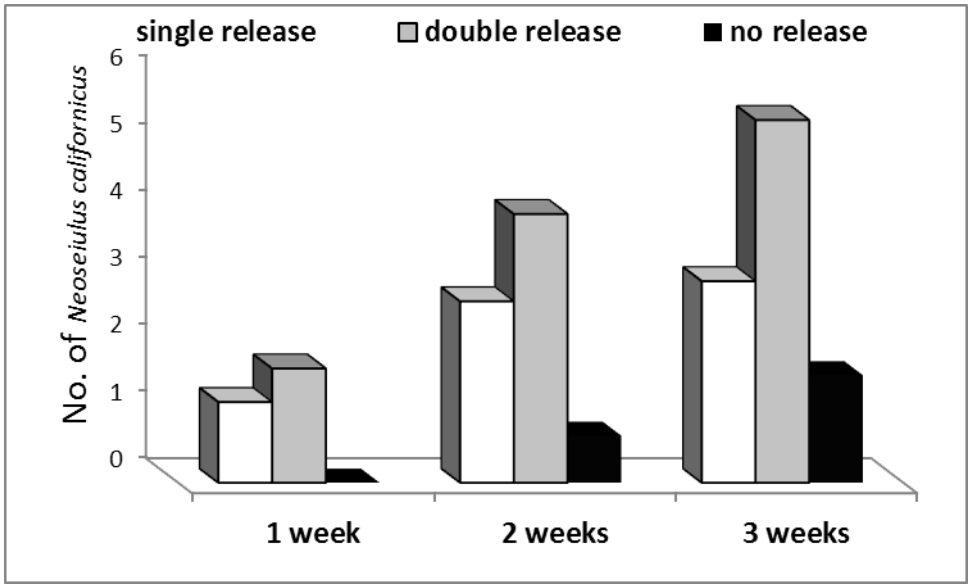

Figure (1): The number of *Neoseiulus californicus* after one, two and three weeks of release.

Compared with single release, double release treatment showed 89.3% reduction in mite population after three weeks. Greco *et al.* (2005) have contradicting results, they stated that *N. californicus* was very effective in limiting pest densities (*T. urticae*) at a 7-day period after releasing and within the range of pest-predator ratios and absolute densities used in this study.

The results here indicated that reduction in number of *T. urticae* after releasing of the predator *N. californicus* were in the first week, 31.9% and 51.3% in single and double releases, respectively. The reduction in the second and third weeks reached to 70.8, 80% and 71.7 and 89.3% for single and double releases, respectively. These data concluding that *N. californicus* keeps the balance between the numbers of predator to the number of prey in the rate limiting factor for such experiment to succeed. The same results conducted by Fraulo and Liburd, 2007 as they stated that *N. californicus* when was released at several times reduced *T. urticae* significantly.

It is concluded that *N. californicus* keeps the balance between the numbers of predator to the number of preys in the rate limiting factor for such experiment to succeed. The repeated releases of *N. californicus* was the best for preventing *T. urticae* to exceed the economic threshold level.

Conflict of Interest

The present study was performed in absence of any conflict of interest.

Acknowlegement

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