ACARINES, 9:63-68, 2015

Interaplant Distribution of the Predatory Mite, *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) and its Prey, *Tetranychus urticae* Koch on Cucumber Plants under Plastic House Condition

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ABSTRACT

Experiments were conducted to evaluate searching behavior of the predatory *Phytoseiulus persimilis* to allocate its prey inhabiting cucumber plants on different heights; high, medium and low in Giza governorate (latitude 30° 2'43.77"N and longitude 31°12'17.38"E). The plastic house was made of anti UV polyethylene sheet 200 mµ for all sides and covered with white shade net and planted with cucumber Barcode variety. The predator was released when leaflets were infested with the red spider mite, *T. urticae* at the rate of about 10 predator-individuals / plant. Predator releasing was reapplied twice; first post-count and second post-count at the same rate; 10 predator-individuals/plant at each release. The cucumber plant was divided into 3 levels (high, intermediate and low) based on the plant length. *P. persimilis* preferred warm and high relatively humid conditions, allocated at plant surfaces near the soil on contrast the plant surfaces far of soil. That is where the steaming rate of irrigation water provides the predator with the optimal high humidity for population increase, and reduction of the prey. In addition, the best biological control of *T. urticae* was achieved when multiple releases were applied. The best reduction rates were achieved starting from the third week.

Key words: *Tetranychus urticae*; *Phytoseiulus persimilis*; cucumber; plastic house; teraplant distribution.

INTRODUCTION

Cucumis sativus is a widely cultivated plant in the family Cucurbitaceae. It is a creeping vine that bears cylindrical fruits used as culinary vegetables. There are three main varieties of cucumber: slicing, pickling and burpless. It naturally thrives in both temperate and tropical environments, and generally requires temperatures between 15-33°C. The red spider mite, *T. urticae* is considered one of major pests that attack cucumber plants. The economic yield of cucumber began to significantly decrease as early as 4 weeks after heavy mite infestations (Park and Lee, 2005).

Phytoseiulus persimilis Athias-Henriot is a specialist predator that is able to suppress spider mite populations rapidly, due to a high numerical and functional response (Laing and Oshorn 1974; and Friese and Gilstrap, 1982; van Lenteren and Woets 1988). It gave control of *T. urticae* at temperature from 15 to 27°C and humidity fluctuation from 60%-90% R. H. and the most rapid and efficient control was obtained at 27°C at 60% to 85% R.H. ; while its predator did not give sufficient control of *T. urticae* at 27°C and 40% R.H. (Stenseth, 1979).

Experiments were conducted to evaluate the interplant distribution of releasing *P. persimilis* for controlling *T. urticae* on cucumber plant

MATERIALS AND METHODS

A plastic house made of anti UV polyethylene sheet 200 mµ for all sides and covered by white shade net at Giza governorate used. The plastic house area, about 1200 m^2 (30 x 40 m dimensions), was divided into 15 equal lines each of about 38 m long. About 120 seedless cucumber germinated plants, Barcode variety, were planted in each line. Ten lines treatments were applied for releasing the predatory mite, *P persimilis*. Three lines were left without releasing as control, located in the plastic house left side. Two lines were left as buffer plant (predator trapping) to separate the treatment area from the control. The leaflets were investigated daily and the predator was released after determining the leaflets infested with the red spider mite, *T. urticae* at the rate of about 10 predator-individuals/plant. Releasing the predator was reapplied twice, at the same rate of 10 predator-individuals/plant. The cucumber plant was divided into 3 levels (high, intermediate and low) based on the plant length. Randomized samples of 30 leaflets were taken from every plant level just before every release. The collected leaflets were placed in plastic bags and transferred to the laboratory for examination. Eggs and post-embryonic stages of *P. persimilis* and only post-embryonic stages of *T. urticae* were counted and the statistical equation of Henderson and Tilton (1955) was applied to calculate the reduction in the two-spotted spider mite populations.

RESULTS AND DISCUSSION

The reduction of *T. urticae* on cucumber plant by releasing *P. persimilis* is presented in table 1. Its infestation was generally low in the pre-count (just before the predator release) on May 6, 2013 ranged between 6 to 9%; while average numbers of *T. urticae* ranged between 6.1 to 9.7 moving stages/ replicate.

These values ranged between 7 to 13% and 5.3 to 12.9 moving stages/ replicate in the non-releasing areas. The first and second post-count showed frequent increase of the mean numbers of *T. urticae* to reach 111.3, 104.1 and 42.4 moving stages/replicate in the first post-count at cucumber plant high, intermediate and low treatment levels, respectively. These values were 267.5, 172.9 and 51.7 moving stages/ replicate in the second post-count. On the other hand, the number of *T. urticae* showed great increase in the non released lines to reach 106.7, 162.7and 83.2 moving stages/replicate in the first post-count at cucumber plant high, intermediate and low control levels, respectively. These values were 267.5, 241.6 and 153.5 moving stages/ replicate in the second post-count. *T. urticae* numbers then decreased to reach 51.2, 24.9 and 10.1 moving stages/replicate in the third post-count and continued decline in fourth, fifth and sixth post-count till reached 0.5, 0.3 and 0.0 moving stages respectively replicate in the seventh post-count treatment levels, respectively. On the other hand, *T. urticae* population continued great increase in the non- release lines from third to sixth post-count till reaching 2040.4, 1806.2 and 1050.6 moving stages/replicate in the seventh post-count at the three cucumber plant levels high, intermediate and low, respectively.

Reduction of the red spider mite population on the first post-count reached 9.37%, 14.88% and 32.23% at the three cucumber plant levels, respectively. These values increased gradually after every release to reach 99.98%, 99.98% and 100% at the seventh post-count on the previous levels, respectively.

High numbers of the predatory mite, *P. persimilis* were recorded in different releasing lines at the first and second post-count. The numbers of *P. persimilis*/replicate at the first post-count were 7.7, 2.8 and 12.4 at cucumber plant highest, respectively. The numbers started to decrease at third, fourth, fifth and sixth post-count until reached 6.0, 1.2 and 0.0 total stages/replicate in the seventh post-count at cucumber plant differant high, intermediate and low, respectively.

The results showed that at first post-count, time of second release, the increasing of population number of *P persimilis* was less than that of *T. urticae* on high, intermediate and low treatment levels that gave lower prey reduction rate on all plant levels, despite the lower plant level which showed high reduction compared with other plant levels. Under experimental condition, *P. persimilis* would developed from egg to adult in an average of 7.45 days; this is approximately half the time required for development of the two-spotted spider mites under similar conditions. Furthermore, the mean generation time (t) was 17.32 days (compared with 24 for the prey), during which the predator population increased 44X (compared to 31X in the prey). Finally, the maximum rate of increase (r_{max}) for the predator was higher than that for the prey (Laing, 1968). The results of predator population, compared with the two-spotted spider mite population, increase was contrary of Laing results, which might be attributed to the average temperature and relative humidity which were 26°C and 55% at this week as relative humidity increased the predator population potential to increase. The prey consumption, generation time, ovivposition and longevity of the predator, *P. persimilis* was affected by temperature (Pruszynski, 1976; Plotnikov and Sadkowskij, 1972; Sabelis, 1981; Shaw, 1982; Laing, 1968; McClanahan, 1968; Takafuji and Chant, 1976). The ultimate outcome of the prey predator interaction was also influenced by temperature (Force, 1967). At relative humidity 75%, the average consumption of the spider mite deutonymphs by a single female was 8.8 at 17°C compared with 13.5 at 26°C (Pruszynski, 1976). The author reported that the consumption of prey increased when the relative humidity decreased and the temperature increased. Developmental time could affected by relative humidity. A slight increase in the predator's developmental time was observed when humidity increased from 40% to 70% (Begljarow, 1967; Ustchekow and Begljarow ,1968 and Stenseth, 1979).

The second and third releases were applied to increase the predator population number, to compensate the negative effect of low humidity on the maximum rate of the predator increase. It supported the prey reduction rate to increase, which reached 90.51%, 91.4% and 93.98% for high, intermediate and low plant levels treatments, respectively at third post-count. On the other hand, the lower plant level showed best reduction rate in all weeks compared with other plant levels. This might be attributed to the steaming of water irrigation, which provided the predator with relative humidity to play its role for reducing the *T. urticae* population.

In addition, the results indicated that the predator population number at fifth, fourth and seventh post-count were low due to the low of prey population. The density of both predator and prey might play a part in the rate at which predators leave an infested plant in search of new sources of food. Young female predators increase the rate at which they depart from a colony as their density increases and that of the prey decreases (Sabelis, 1981; Eveleigh and Chant, 1982). When prey density is relatively low to number of predators, the adult predators begin to disperse in search of new food sources. On the other hand, nymphs of *P. persimilis*

Table (1) Intraplant distribution of the predatory mite, *P. persimilis* and its prey, *T. urticae* Koch individuals/leaf on cucumber plants under plastic house condition

Sampling date May – June 2013	Treatments (Plant level release)	Mean no. of *T. urticae*/ plant level	Reduction of *T. urticae* %	Infested leaflets %	No. of *P. persimilis*/plant level			°C	R. H. %
					Eggs	M.S.	Total		
May, 6	high treatments	6.1		6%				25	62
	Intermediate treatments	6.4		7%					
	Low treatments	9.7		9%					
	high control	5.3		11%					
	Intermediate control	9.2		13%					
	Low control	12.9		7%					
May, 13	high treatments	111.3	9.37%	16%	3.9	3.8	7.7	26	55
	Intermediate treatments	104.1	14.88%	20%	1.7	1.1	2.8		
	Low treatments	42.4	32.23%	38%	5.7	6.7	12.4		
	high control	106.7		62%					
	Intermediate control	162.7		41%					
	Low control	83.2		20%					
May, 20	high treatments	267.5	13.11%	27%	25.3	29.5	54.7	28	55
	Intermediate treatments	172.9	4.84%	30%	10.4	7.4	17.8		
	Low treatments	51.7	55.21%	54%	28.4	31.9	60.3		
	high control	267.5		69%					
	Intermediate control	241.6		61%					
	Low control	153.5		34%					
May, 27	high treatments	51.2	90.51%	26%	15.1	9.5	24.6	30	46
	Intermediate treatments	24.9	91.40%	27%	18.9	8.8	27.7		
	Low treatments	10.1	93.98%	43%	5.1	1.8	6.9		
	high control	468.7		86%					
	Intermediate control	384.8		82%					
	Low control	223.8		47%					
June, 3	high treatments	15.7	98.12%	25%	2.9	2.8	5.7	30	48
	Intermediate treatments	0.9	99.81%	24%	1.3	1.2	2.5		
	Low treatments	7.8	97.10%	32%	1.2	1.4	2.6		
	high control	726.2		100%					
	Intermediate control	612.8		100%					
	Low control	356.4		61%					
June, 9	high treatments	0.6	99.95%	24%	2.8	9.1	11.9	27	61
	Intermediate treatments	0.3	99.96%	21%	2.8	2.6	5.4		
	Low treatments	0.5	99.88%	22%	2.5	3.6	6.1		
	high control	1125.2		100%					
	Intermediate control	938.2		100%					
	Low control	545.7		74%					
June, 16	high treatments	0.8	99.95%	21%	2.3	2.8	5.1	28	66
	Intermediate treatments	0.2	99.98%	18%	1.0	0.9	1.9		
	Low treatments	0.0	100.00%	11%	0.1	0.3	0.4		
	high control	1515.2		100%					
	Intermediate control	1436.5		100%					
	Low control	835.6		100%					
June, 23	high treatments	0.5	99.98%	13%	3.0	3.0	6.0	27	67
	Intermediate treatments	0.3	99.98%	7%	0.8	0.4	1.2		
	Low treatments	0.0	100.00%	0%	0.0	0.0	0.0		
	high control	2040.4		100%					
	Intermediate control	1806.2		100%					
	Low control	1050.6		100%					

have a much lower capacity--and tendency--to disperse than adults and, as a result, they remain behind and feed on whatever food left before begin to disperse (Takafuji, 1977). This behavioral characteristic can be a contributing factor to the extinction of prey. Also, the elimination or extinction of the prey in the plastic house is possible because *P. persimilis* has much greater dispersal potential than its prey (Nachman, 1981). In cases where little or no spider mite damage can be tolerated, such as on ornamental plants, this is a desirable situation. Because some damage can be tolerated in cucumber and tomato crops, it would be desirable to have a stable interaction between the predator and prey over an extended period of time.

The results showed that *P. persimilis* preferred warm and high relatively humid, conditions, which located at plant surfaces near the soil on contrast of the plant surfaces far from soil. This is where the steaming rate of irrigation water provides the predator with high humidity for the predator to population increase and thus prey to reduce. In addition, the best biological control of *T. urticae* was achieved when multiple releases were applied. The best reduction rates were achieved starting from the third week. We agreed with (Hamlen and Lindquist, 1981) on the predator:prey ratio of 1:6-1:25 and disagreed with the sufficient numbers of predators to be released to create a desirable predator:prey ratio of 1:10 (Markkula and Tiittanen, 1976) specially at restricts which have relative humidly below 75%. A specific predator:prey ratio can therefore be established early in the season and the predator will become established uniformly throughout the greenhouse prior to the crop becoming infested naturally (Markkula and Tiittanen, 1976).

P. persimilis was rated as having high dispersal potential, and its distribution and that of its prey were highly correlated (MCMurtry, 1982). The ability of *P. persimilis* to disperse and find new colonies of prey depends on the physical characteristics of the environment (Takafuji, 1977), prey distribution and density (Nachman, 1991; Zhang and Sanderson, 1995), predator density (Zhang and Sanderson, 1995), and duration of infestation or the amount of the spider mite webbing present (Schmidt, 1976; Sabelis, 1981; Sabelis and Bakker; 1992). *P. persimilis* has been shown to respond to volatiles (Synomones) produced by leaves infested with *T. urticae* (Bruin *et al*., 1992; Dicke *et al*., 1993; Dicke and Dijkman, 1992; Takahayashi and Dicke, 1992).

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