

RELEASE DIFFERENT LEVELS OF *PHYTOSEIULUS MACROPILIS* (BANKS) AND *NEOSEIULUS CALIFORNICUS* (MCGREGOR) ON WATERMELON PLANTS TO CONTROL THE TWO-SPOTTED SPIDER MITE, *TETRANYCHUS URTICAE* (ACARI:PHYTOSEIIDAE & TETRANYCHIDAE)

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Abstract

An area of about one feddan (about 4200 m²) at El-Mahala El-Kobra district (El-Gharbia Governorate) was chosen to study the effective of the two predatory mites, *Phytoseiulus macropilis* (Banks) and *Neoseiulus (Amblyseius) californicus* (McGregor) on the two-spotted spider mite, *Tetranychus urticae* Koch infested watermelon. The predator individuals were released in each predator's area, once or twice (at two weeks intervals), at the rate of 3, 6 and 9 individuals/2plants. The obtained results indicated that single release of *P. macropilis* gave high reductions for the two-spotted red spider mite, *T. urticae* population comparing with those of *N. californicus* during the different post-counts.

Double release of the predatory mite, *P. macropilis* was the best for reducing the red spider mite population, this may be due to the behavior of the predatory, mite *P. macropilis* which is known to be specific predator of spider mite and the nature of *N. californicus* which is known to be a generalist predator, which does not exhibit an equally strong numerical and functional response towards spider mites as prey specialist.

One release of the predatory mite, *N. californicus* with the medium rate (6 predators/2 plants) or low rate (3 predators /2 plants), as well as releasing the predator two releases with the low rate resulted in low mite population reduction.

INTRODUCTION

Watermelon is an important crop in Egypt for local market and exportation. Its cultivated area reached in 2007 about 149000 feddan, most of them were cultivated in Nobaria district, Behera, Matrooh and Ismailia Governorates. In the recent years the organic area has been increased to produce healthy and save foods to keep man healthy. Besides, exportation of agricultural crops is expected to be increased in the coming years especially during autumn and winter months where production of such crops in European countries is nearly reduced or restricted under control greenhouses. The two-spotted spider mite, *Tetranychus urticae* Koch is considered as one of the most important pests of watermelon. As chemical control measures turned out increasingly inefficient, thus, integrated and biological pest management were

proposed as alternative strategies. Predaceous phytoseiid mites are important biological control agent of pest mites affecting many crops in different parts of the world (Helle & Sabelis,1985).In some agro-ecosystems , natural enemies may drive spider mite numbers below economically damaging levels (Nyrop *et al.*,1998) .The two phytoseiid mites *Phytoseiulus macropilis* (Banks) and *Neoseiulus californicus* (McGregor) are considered as promising agents for successful *T. urticae* control on many crops(Blümel &Walzer,2002,Greco *et al.*,2005 and Heikal *et al.*,2008).The aim of the present study was to investigate the efficacy of the two phytoseiid mites , *P.macropilis* and *N. californicus* as bio-control agents for *T. urticae* on watermelon plants .Both predator were released either one or two releases with different rates.

MATERIALS AND METHODS

The effective of the two predatory mites, *P. macropilis* and *N. californicus* on the two-spotted spider mite, *T. urticae* infested watermelon was studied in an open field area at El-Mahala El-Kobra district (El-Gharbia Governorate). An area of about one feddan (about 4200 m²) was chosen and divided into 39 equal plots each of about (105 m²). Watermelon seed (Variety, Sikata) treated with 0.1% Vitavax were sown at 1 – 2 cm deep and covered with thin layer of sulfur (to protect seeds from birds feeding). Thirty watermelon seeds were sown in each plot using double-row per bed. Six treatments were applied for releasing every predator species each with three plots as replicates, where plots were established in a randomized complete block design. The rest three plots were left without releasing (as control) and restricted in the field corner, separated with buffer watermelon lines. Ten days after emergence of the watermelon first leaflets, the predator individuals were released in each predator's area, once in the first half plots and twice in the second half plots (at two weeks intervals), at the rate of 3, 6 and 9 individuals/2plants. Each predator individuals were collected in gelatin capsules number 3 (1.5 – 0.5 cm) by using a special vacuum pump. Each predator individuals were released in its own field area by opening the gelatin capsules and pasting (by stick glue) the separated capsule parts on the watermelon leaflets. Randomized samples of 30 leaflets/replicate were taken just before every release and then every other week, where the first sample was considered as the pre-count and the second one as the first post-count and so on with the subsequent samples. The collected leaflets were put in plastic bags on cooled Ice box and transferred to the laboratory belonging to Plant Protection Research Institute at Dokki district (Giza Governorate). Eggs and post-embryonic stages of *P. macropilis* and *N. californicus* and only post-embryonic of *T. urticae* were counted with the aid of a stereo-microscope. 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 effect of a single release for the predatory mite, *P. macropilis* is presented in Table 1. The infestation of the two-spotted spider mite, *T. urticae* was generally low in the pre-count (just before the predator release) on April 12, 2006 ranged between 9 to 31%, while the numbers of *T. urticae* ranged between 16.3 and 32.8 moving stages / replicate. These values were 57.0% and 38.9 moving stages / replicate in the non-release plots. The first and second post-counts showed frequent increase of the mean numbers of *T. urticae* to reach 33.9, 20.6 and 38.7 moving stages/replicate in the first post-count when the predator was released at the levels of 9, 6 and 3 predators/2plants, respectively. These values were 110.9, 70.7 and 132.5 moving stages/replicate in the second post-count. On the other hand, the numbers of *T. urticae* showed greatly increase in the no release plots to reach 112.6 and 429.7 moving stages/replicate in the first and second post-counts, respectively. Then, the numbers of *T. urticae* increased to reach 228.3, 141.9 and 303.9 moving stages/replicate in the third post-count and 442.3, 243.9 and 516.6 moving stages /replicate in the fourth post-count with the predator release of 9, 6 and 3 predators/2plants, respectively.

Table 1. Single Release of *P. macropilis* to control *T. urticae* on watermelon plants during spring season.

Sampling date	Treatments (rate of predator release)	Mean no. of <i>T. urticae</i> / replicate	Reduction of <i>T. urticae</i> %	Infested leaflets %	No. of <i>P. macropilis</i> /replicate		
					Eggs	M. S.	Total
Apr. * 12, 2006	A (9 predators/2plants)	32.8	-	9.0	-	-	-
	B (6 predators/2plants)	16.3	-	18.0	-	-	-
	C(3 predators/2plants)	21.7	-	31.0	-	-	-
	D (no releasing)	38.9	-	57.0	-	-	-
Apr. ** 26, 2006	A (9 predators/2plants)	33.9	64.3	17.0	4	3	7
	B (6 predators/2plants)	20.6	56.3	21.0	1	2	3
	C (3 predators/2plants)	38.7	38.4	38.0	1	0	1
	D (no releasing)	112.6	-	62.0	-	-	-
May *** 10, 2006	A (9 predators/pit)	110.9	69.4	43.0	6	5	11
	B (6 predators/pit))	70.7	60.7	61.0	1	7	8
	C (3 predators/pit)	132.5	44.7	74.0	3	3	6
	D (no releasing)	429.7	-	100.0	-	-	-
May **** 24, 2006	A (9 predators/2plants)	228.3	75.4	63.0	13	9	22
	B (6 predators/2plants)	141.9	69.2	82.0	6	11	17
	C (3 predators/2plants)	303.9	50.5	100.0	8	6	14
	D (no releasing)	1099.5	-	100.0	-	-	-
Jun. ***** 7, 2006	A (9 predators/2plants)	442.3	80.6	79.0	29	16	45
	B (6 predators/2plants)	243.9	78.5	92.0	17	16	33
	C (3 predators/2plants)	516.6	65.8	100.0	9	19	28
	D (no releasing)	2708.0	-	100.0	-	-	-

* Pre-count, time of first release

** First post-count, time of second release

*** Second post-count

**** Third post-count

***** Fourth post-count

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On the other hand, numbers of *T. urticae* showed greatly increase in the no release plots to reach 1099.5 and 2708.0 moving stages/replicate at the third and fourth post-counts, respectively.

Reduction of the red spider mite population at the first post-count reached 64.3, 56.3 and 38.4% at the releasing levels 9, 6 and 3 predators /2plants, respectively. These values increased gradually after each release to reach 80.6, 78.5 and 65.8% (at the fourth post-count) on the previous plots, respectively.

Few numbers of the predatory mite, *P. macropilis* were found in different releasing plots at the first and second post-count. The numbers of *P. macropilis*/replicate at the first post-count were 7, 3 and 1 at the releasing levels 9, 6 and 3 predators /2plants, respectively, (where direct proportions were found between the numbers of predatory mite and the releasing levels). The number of predatory mite, *P. macropilis* greatly increased at the fourth post-count to reach 45, 33 and 28 predators/replicate in the releasing plots 9, 6 and 3 predators/ 2plants, respectively.

Data of single release of the predatory mite, *N. californicus* on watermelon plants to control the two-spotted spider mite, *T. urticae* are presented in Table 2. The percentages of infested leaflets by *T. urticae* at the pre-count, the time of release, were 80, 73 and 71% and mean number of *T. urticae* per replicate were 22.6, 21.4 and 17.6 moving stages/replicate on plots of release level of 9, 6 and 3 predators / 2 plants, respectively. These values were 79% and 38.9 moving stages / replicate at the no releasing plots. The mean numbers of *T. urticae* per replicate increased in the first post-count to reach 42.9, 45.0 and 46.8 moving stages / replicate at the releasing rates 9, 6 and 3 predators / 2 plants, respectively. The infested leaflets were also increased in the releasing plots to reach 73, 74 and 76 % at the same releasing levels, respectively. The population of *T. urticae* / replicate continued to increase at the next counts to reach 476.3, 572.6 and 1033.7 moving stages at the fourth inspection at the releasing rates 9, 6 and 3 predators / 2 plants, respectively, while they were 100% and 2708.0 moving stages/replicate in the no releasing plots. The reductions of *T. urticae* were 34.4, 27.4 and 8.2% at the first post-count on Apr. 26, 2006 and increased towards the fourth post-count to reach 69.7, 61.6 and 15.6% at the releasing levels 9, 6 and 3 predators/2 plants, respectively.

Very few numbers of predators were found after the first release in plots with the releasing level 9 predators/2 plants, and increased gradually in the next inspections with maximum populations on the fourth inspection as a result of abundant of prey individuals in these plots.

Table 2. Single release of *N. californicus* to control *T. urticae* on watermelon plants during spring season.

Sampling date	Treatments (rate of predator release)	Mean no. of <i>T. urticae</i> /replicate	Reduction of <i>T. urticae</i> %	Infested leaflets %	No. of <i>N. californicus</i> /replicate		
					Eggs	M. S.	Total
Apr. * 12, 2006	A (9 predators/2plants)	22.6	-	80	-	-	-
	B (6 predators/2plants)	21.4	-	73	-	-	-
	C (3 predators/2plants)	17.6	-	71	-	-	-
	D (no releasing)	38.9	-	79	-	-	-
Apr. ** 26, 2006	A (9 predators/2plants)	42.9	34.4	73	0	2	2
	B (6 predators/2plants)	45.0	27.4	74	1	0	1
	C (3 predators/2plants)	46.8	8.2	76	0	0	0
	D (no releasing)	112.6	-	84	-	-	-
May *** 10, 2006	A (9 predators/2plants)	115.7	53.6	74	6	3	9
	B (6 predators/2plants)	167.9	29.0	82	2	4	6
	C (3 predators/2plants)	168.6	13.3	86	1	4	5
	D (no releasing)	429.7	-	91	-	-	-
May **** 24, 2006	A (9 predators/2plants)	216.1	66.2	72	6	11	17
	B (6 predators/2plants)	290.3	51.9	86	5	7	11
	C (3 predators/2plants)	424.0	14.8	93	6	3	9
	D (no releasing)	1099.5	-	97	-	-	-
Jun. ***** 7, 2006	A (9 predators/2plants)	476.3	69.7	78	16	13	29
	B (6 predators/2plants)	572.6	61.6	92	9	18	27
	C (3 predators/2plants)	1033.7	15.6	97	3	9	12
	D (no releasing)	2708.0	-	100	-	-	-

* Pre-count, time of first release

** First post-count, time of second release

*** Second post-count

**** Third post-count

***** Fourth post-count

These values were: 29, 27 and 12 predators / replicate at the releasing predator with rates of 9, 6 and 3 predators / 2 plants, respectively.

Data of double releasing of the predatory mite, *P. macropilis* to control the two-spotted spider mite, *T. urticae* on watermelon plants during summer season are presented in Table 3. The percentages of infested leaflets by *T. urticae* at the pre-count, the time of first release, were 52, 49 and 21% and mean numbers of *T. urticae* per replicate were 48.1, 20.1 and 23.7 moving stages/replicate at plots of release level of 9, 6 and 3 predators / 2 plants, respectively. These values were 57% and 38.9 moving stages / replicate at the no releasing plots. The mean numbers of *T. urticae* per replicate increased in the first post-count to reach 70.2, 39.6 and 59.4 moving stages / replicate at the releasing rates 9, 6 and 3 predators / 2 plants, respectively. The infested leaflets increased gradually in the releasing plots to reach 79, 92 and 100 % at the same releasing levels, respectively in the fourth post-count. The population of *T. urticae* / replicate continued to increase at the next counts to reach 162.3, 186.0 and 316.8 moving stages at the fourth inspection at the releasing rates 9, 6 and 3 predators / 2 plants, respectively, while they were 2708.0 moving stages/replicate and 100% of leaflets infestation in the no releasing plots. Accordingly the reductions of *T. urticae* were 49.6, 31.9 and 13.4% at first post-count on Apr. 26, 2006 and increased at the fourth post-count to reach 95.2, 86.7 and 80.8% at the releasing levels 9, 6 and 3 predators/2 plants, respectively.

Few numbers of predators were found after the first release in the releasing plots and increased after the time of second release in all releasing plots with maximum populations on June 7, 2006 as a result of abundant of prey individuals in these plots.

Data of double releasing of the predatory mite, *N. californicus* to control the two-spotted spider mite, *T. urticae* on watermelon plants in the open field during spring season are presented in Table 4. The percentages of infested leaflets at the pre-count and the time of first release, were 39, 46 and 28% and mean number of *T. urticae* per replicate were 24.1, 16.7 and 14.3 moving stages/replicate at plots of release levels of 9, 6 and 3 predators / 2 plants, respectively. These values were 79% and 38.9 moving stages / replicate at the no releasing plots. The mean numbers of *T. urticae* per replicate increased in the first post-count to reach 40.7, 33.5 and 36.4 moving stages / replicate at the releasing rates 9, 6 and 3 predators / 2 plants, respectively. The infested leaflets were also increased in the releasing plots to reach 73, 74 and 76 % at the same releasing levels, respectively. The population of *T. urticae* / replicate continued to increase at the next counts to reach 437.8, 447.1 and 463.7 moving stages at the fourth inspection at the releasing rates 9, 6 and 3

predators / 2 plants, respectively, while they were 2708.0 moving stages/replicate and 100% infestation of leaflets in the no releasing plots. The reductions of *T. urticae* were 41.7, 30.7 and 12.1% at first post-count on Apr. 26, 2006 and increased at the fourth post-count to reach 73.9, 61.5 and 53.4% at the releasing levels 9, 6 and 3 predators/2 plants, respectively.

Table 3. Double release of *P. macropilis* to control *T. urticae* on watermelon plants during spring season.

sampling date	Treatments (rate of predator release)	Mean no.of <i>T. urticae</i> / replicate	Reduction of <i>T. urticae</i> %	Infested leaflets %	No. of <i>P. macropilis</i> /replicate		
					Eggs	M. S.	Total
Apr. * 12,2006	A (9 predators/plant)	48.1	-	52	-	-	-
	B (6 predators/plant)	20.1	-	49	-	-	-
	C (3 predators/plant)	23.7	-	21	-	-	-
	D (no releasing)	38.9	-	57	-	-	-
Apr. ** 26, 2006	A (9 predators/plant)	70.2	49.6	30	4	3	7
	B (6 predators/plant)	39.6	31.9	47	1	2	3
	C (3 predators/plant)	59.4	13.4	68	1	0	1
	D (no releasing)	112.6	-	62	-	-	-
May *** 10, 2006	A (9 predators/plant)	88.2	83.4	43	7	8	15
	B (6 predators/plant)	69.1	68.9	61	7	6	13
	C (3 predators/plant)	108.0	58.7	74	2	6	8
	D (no releasing)	429.7	-	100	-	-	-
May **** 24, 2006	A (9 predators/plant)	116.9	91.4	59	11	16	27
	B (6 predators/plant)	139.9	75.4	62	12	13	25
	C (3 predators/plant)	198.5	70.4	91	7	9	16
	D (no releasing)	1099.5	-	100	-	-	-
Jun. ***** 7, 2006	A (9 predators/plant)	162.3	95.2	79	22	31	53
	B (6 predators/plant)	186.0	86.7	92	13	29	42
	C (3 predators/plant)	316.8	80.8	100	13	16	29
	D (no releasing)	2708.0	-	100	-	-	-

* Pre-count, time of first release

** First post-count, time of second release

*** Second post-count

**** Third post-count

***** Fourth post-count

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Table 4. Double release of *N. californicus* to control *T. urticae* on watermelon plants during spring season.

sampling date	Treatments (rate of predator release)	Mean no. of <i>T. urticae</i> / replicate	Reduction of <i>T. urticae</i> %	Infested leaflets %	No. of <i>N. californicus</i> /replicate		
					Eggs	M. S.	Total
Apr. * 12,2006	A (9 predators/2plants)	24.1	-	39	-	-	-
	B (6 predators/2plants)	16.7	-	46	-	-	-
	C (3 predators/2plants)	14.3	-	28	-	-	-
	D (no releasing)	38.9	-	79	-	-	-
Apr. ** 26, 2006	A (9 predators/2plants)	40.7	41.7	73	0	2	2
	B (6 predators/2plants)	33.5	30.7	74	0	0	0
	C (3 predators/2plants)	36.4	12.1	76	0	0	0
	D (no releasing)	112.6	-	84	-	-	-
May *** 10, 2006	A (9 predators/2plants)	116.8	56.1	76	4	6	10
	B (6 predators/2plants)	132.9	28.0	89	1	6	7
	C (3 predators/2plants)	122	22.8	90	0	3	3
	D (no releasing)	429.7	-	91	-	-	-
May **** 24, 2006	A (9 predators/2plants)	192.4	71.8	91	4	14	18
	B (6 predators/2plants)	273.6	42.0	91	2	13	15
	C (3 predators/2plants)	276.4	31.6	89	0	9	9
	D (no releasing)	1099.5	-	97	-	-	-
Jun. ***** 7, 2006	A (9 predators/2plants)	437.8	73.9	92	32	29	61
	B (6 predators/2plants)	447.1	61.5	94	16	41	57
	C (3 predators/2plants)	463.7	53.4	97	7	27	34
	D (no releasing)	2708.0	-	100	-	-	-

* Pre-count, time of first release

** First post-count

*** Second post-count

**** Third post-count

***** Fourth post-count

Few numbers of predators were found after the first release in plots with the releasing level 9 predators/2 plants, and increased rapidly after the second release in all releasing plots with maximum populations on June 7, 2006 as a result of abundant of prey individuals in these plots to reach 61.0, 57.0 and 34.0 predators/ replicate on the releasing levels 9, 6 and 3 predators/2plants, respectively.

Comparing the obtained data of single and double releases of the two predatory mites, *N. californicus* and *P. macropilis* to control the two-spotted spider mite, *T.urticae* on watermelon plants in the spring season, it could be concluded that:

- 1- Single release of *P. macropilis* gave high reductions for the two-spotted spider mite, *T. urticae* comparing with those of *N. Californicus* during the different post-counts.
- 2- Double release of the predatory mite, *P. macropilis* was the best for reducing the two-spotted spider mite, *T. urticae* , this may be due to the behavior of the predatory, mite *P. macropilis* which is known to be specific predator of spider mite and the nature of *N. Californicus* which is known to be a generalist predator, which does not exhibit an equally strong numerical and functional response towards spider mites as prey specialist. This agreed with that obtained by Friese & Gilstrap, 1985, Croft *et al.*, 1998.
- 3- One release of the predatory mite, *N. californicus* with the medium rate (6 predators/2 plants) or low rate(3 predators /2 plants) , as well as releasing the predator two releases with the low rate resulted in low mite reduction. This agreed with those of Garcia & Gonzalez (1999) who reported that between one and ten mites/ leaflet, the prey /predator ratio should be between 5 and 10/1predator to achieve a decline in the prey population 1-2 weeks later. The slope of the line that approximately separates both types of points shows that at low prey densities the prey / predator ratio should be lower to achieve a decrease in the population of the prey on the next sampling date. They attributed these findings to the longer time spent by predators searching for prey at low prey densities. They added that when the spider mite density ranges between 0.1 and 1 mite/leaflet, the prey : predator ratio should be between 1 and 5 for immediate decrease in the prey population.

On the other hand, Wilson *et al.*, 1984, González Zamora *et al.*, 1991, Strong & Croft, 1995 and Oatman & McMurtry, 1966 reported that release of 5 – 10 predators per plant gave good results, especially when accompanied by mulching of plastic and removal of old leaves from the plants. Pickett & Gilstrap (1986) stated that the spider mite densities in the *N. californicus* release plots were 67, 73 and 91% lower than the non release plots when *N. californicus* were released with a rate of 5 individuals /

plant. Greco *et al.* (2005) stated that different *T. urticae* to *N. californicus* ratio had a significant effect on the population abundance of the pest. At a *T. urticae* / *N. californicus* ratio of 5/1 the pest reduced below the ETL during a 7- day period (at pest initial densities from 5 to 15 females / leaflet). When ratios ranged from 7.5/1 to 15/1 *T. urticae* reached the ETL (the economic threshold level) but never surpassed it at a 7-day interval. Croft *et al.*, 1998 reported that *N. californicus* may stay in the field with few prey and feed with other sources or wait for the prey to return while minimizing starvation.

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إطلاق مستويات مختلفة من المفترسين فاييتوسيلولس ماكروبيليس و نيوسيلولس كاليفورنيكس

Neoseiulus californicus و *Phytoseiulus macropilis*

على نباتات البطيخ لمكافحة العنكبوت الأحمر ذو البقعتين

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تم إختيار مساحة واحد فدان (٤٢٠٠ متر مربع) بناحية المحلة الكبرى (محافظة الغربية)

لدراسة فعالية المفترسين (*Phytoseiulus macropilis* (Banks) و *Neoseiulus californicus* (McGregor) على العنكبوت الأحمر ذو البقعتين *Tetranychus urticae* Koch الذى يصيب نباتات البطيخ. وقد تم إطلاق أفراد كل من المفترسين مرة أو مرتين (على فترات كل أسبوعين) بمعدل ٣،٦،٩ أفراد/نباتين. ودلت النتائج المتحصل عليها أن إطلاقه واحدة من المفترس *P. macropilis* أعطت خفض عالى فى تعداد العنكبوت الأحمر ذو البقعتين بالمقارنة بمثيلتها من المفترس *N. californicus* خلال الفحصات المختلفة بعد الإطلاق.

كما أن إطلاقتين من المفترس *P. macropilis* كانت الأفضل لخفض تعداد العنكبوت الأحمر ذو البقعتين- وهذا يرجع إلى سلوك المفترس *P. macropilis* المعروف بأنه متخصص على العنكبوت الأحمر ذو البقعتين. وأيضاً طبيعة النوع *N. californicus* المعروف أنه مفترس عام غير متخصص على العنكبوت ذو البقعتين والذى لا يظهر إستجابة عددية فعالة لزيادة العنكبوت الأحمر ذو البقعتين.

كما دلت النتائج أن إطلاقه واحدة من المفترس *N. californicus* بمعدل إطلاق متوسط (٦ أفراد/نباتين) أو إطلاقتين بالمعدل المنخفض (٣ أفراد/نباتين) نتج عنها إنخفاض تعداد العنكبوت الأحمر ذو البقعتين ولكن أقل من مثيلتها من المفترس الأول.