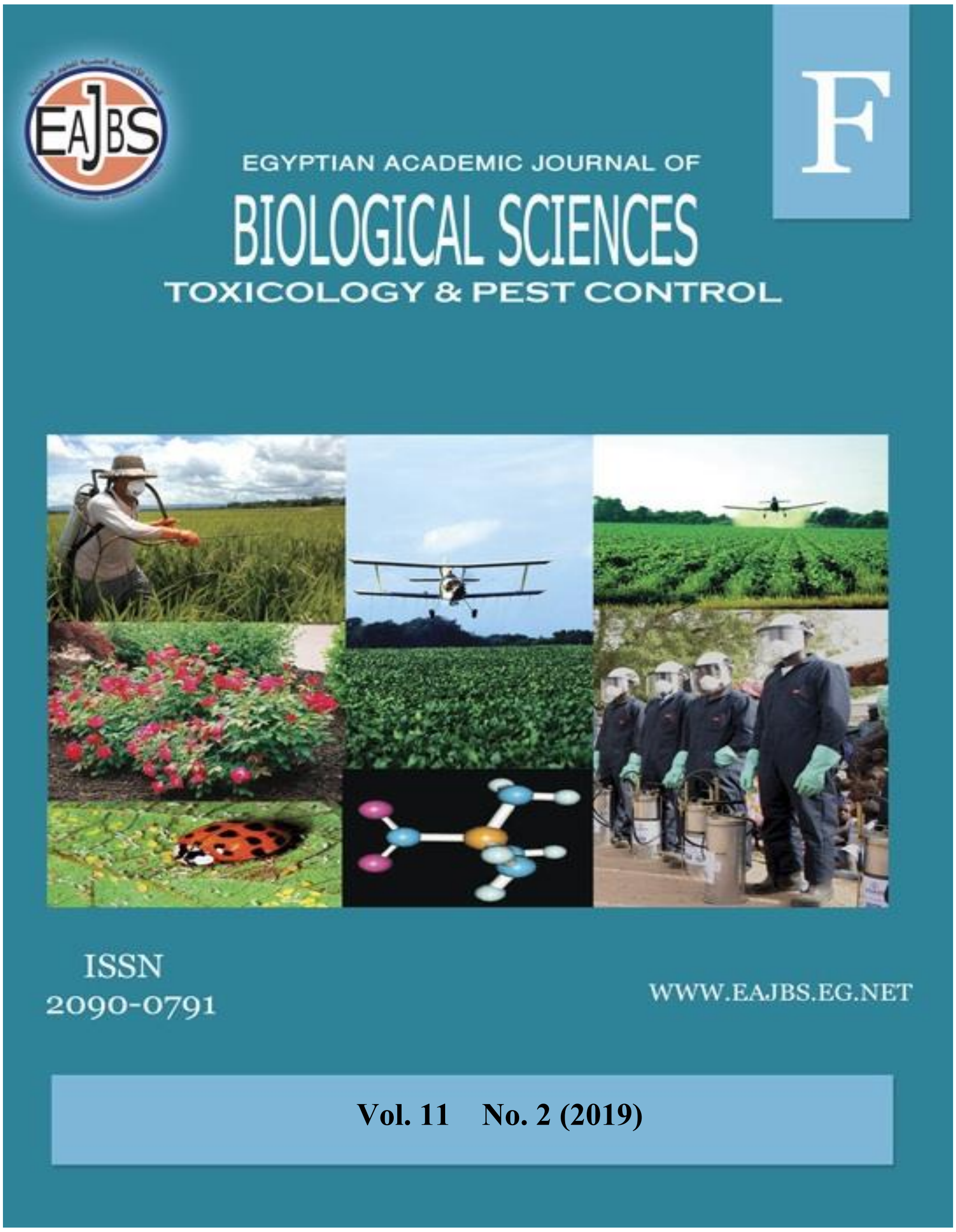

The journal of Toxicology and pest control is one of the series issued twice by the Egyptian Academic Journal of Biological Sciences, and is devoted to publication of original papers related to the interaction between insects and their environment.

The goal of the journal is to advance the scientific understanding of mechanisms of toxicity. Emphasis will be placed on toxic effects observed at relevant exposures, which have direct impact on safety evaluation and risk assessment. The journal therefore welcomes papers on biology ranging from molecular and cell biology, biochemistry and physiology to ecology and environment, also systematics, microbiology, toxicology, hydrobiology, radiobiology and biotechnology.

www.eajbs.eg.net

Citation: *Egypt. Acad. J. Biolog. Sci. (F. Toxicology & Pest control) Vol. 11(2) pp. 113- 119 (2019)*

Egypt. Acad. J. Biolog. Sci., 11(2): 113-119 (2019)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest Control
ISSN: 2090 - 0791
http://eajbsf.journals.ekb.eg/

Releasing of Predatory Mite, *Neoseiulus californicus* (McGregor) (Acari: Phytoseiidae) for Controlling the Red Spider Mite, *Tetranychus urticae Koch* (Acari: Tetranychidae) on Cantaloupe Plant

A. A. Ebrahim
Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt
E-mail: dr.ahmed.abdelhamed.ib@gmail.com

ARTICLE INFO
Article History
Received:9 /8/2019
Accepted:5/9/2019

Keywords:
Neoseiulus californicus,
Releasing,
Biological control,
Red spider mite,
Tetranychus urticae

ABSTRACT

An open field was chosen at El Mahala El Kobra district, El Gharbia governorate. An area of about one faddan (about 4200 m2) was cultivated by cantaloupe seed (variety, Egyptian Galia Melon). *N. californicus* 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 in the first and second three treatments of once and twice releases, respectively.

A single release of N. californicus provides low reduction for the red spider mites, *T. urticae*. This unlikely those obtained from the double release which provides preferable results on controlling the red spider mite, *T. urticae*. On the other hand, 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.

In conclusion, under the open field conditions, our results showed a preference for utilizing multiple releases of the predatory mite, *N. californicus* to regulate the populations of *T. urticae*. Either moderating reduction or not prevent *T. urticae* from exceeding the economic threshold level.

INTRODUCTION

The Cucurbitaceae family includes several species of cultivated plants of great economic importance, including watermelon (*Citrullus lanatus* L.), squash (*Cucurbita maxima* L.), cucumber (*Cucumis sativus* L.) and cantaloupe (*Cucumis melo* L.) (Ritschel *et al.*, 2004). Cantaloupe is one of the most consumed fruit crops worldwide especially in Egypt due to its sweaty flavour and nutritional value. Cantaloupes are a diverse group of fresh, dessert fruits that includes the orange flesh cantaloupes, green flesh honeydew, and mixed melons. A previous study showed that cantaloupe pulp has high antioxidant and anti-inflammatory properties (Vouldoukis *et al.*, 2004 and Mariod & Matthaus, 2008). From an environmental and economic perspective, it is very important that plant by-products produced by agro-food industry be used in food industry. However, mayonnaise, the most famous consumption by youth and child in Egypt and many countries, undergo oxidative degradation during storage, resulting in alteration of major quality parameters affecting its suitability for consumption. The development of rancidity reduces the shelf life of the product, which ultimately affects consumer acceptability (Mehta, 2006; Mariod *et al.,* 2010). The use of synthetic antioxidants is less desirable due to current recommendations and consumer preferences, so there is growing interest in finding alternative solutions, and thus results in preventing lipid oxidation of mayonnaise by using natural antioxidant. Therefore, the objectives of this study were; (1) to determine the phenolic content and antioxidant activities of methanolic extracts from different parts of cantaloupe, (2) to evaluate the efficiency of using agro cantaloupe wastes methanolic extracts in improving the nutritional value and oxidative stability of mayonnaise during storage under thermal-oxidative conditions.

The red spider mites *Tetranychus urticae* (Koch) (acari: Tetranychidae), is considered one of the world's most serious pests because of its ability to attack many plants including fruit vegetables. Bronze spots or speckling, leaf curling, and silk webbing are considered the main signs of infestation by *T. urticae. Neoseiulus cucumeris (*Audemars), *Amblyseius swirskii* athias-Henriot and *Neoseiulus californicus* (McGregor) are predatory mites belonging to family Phytoseidae and commonly used to control these pests in greenhouse crops (Gerson & Weintraub 2007; McMurtry, 1983; Childers, 1994; Wood *et al.,* 1994; Heikal *et al.,* 2004; Opit *et al.,* 2004). *Neoseiulus cucumeris* shows effective control on the red spider mites, *T. urticae* that attacks pepper plants under greenhouse (Weintraub *et al.,* 2003; Gerson & Weintraub 2007, Ebrahim *et al.,* 2013). *Neoseiulus californicus* shows the same success on *T. urticae* that attacks pepper plants (Weintraub & Palevsky 2008) and shows effective against broad mites (Peña & Osborne 1996; Jovicich *et al.,* 2009). Also, it appears to act as a generalist tetranychid predator and can initiate multiple attacking behaviors. On the other hand, its behavior suggests that it is opportunistic and capable of capturing several deferent types of prey (Takano-Lee and Hoddle, 2002). Although relatively numerous studies have been conducted in greenhouses, little research has been reported for open field crops. However, some promising results have been produced. For example, Heikal *et al.,* (2009) reported superior control of red spider mite, *T. urticae* with a double release of *N. californicus* on watermelon plants.

This study aims to shed light on the predator effectiveness to control the red spider mite under the open field. In addition, the most successful predator release methods of *N. californicus* suppresses the individual numbers of the red spider mite, *T. urticae* under open field conditions

MATERIALS AND METHODS

An open field was chosen at el Mahala El Kobera district, El Gharbia governorate. An area of about one faddan (about 4200 m2) was selected and divided into 39 equal plots each of about 105m2; cantaloupe seed (variety, Egyptian Galia Melon) treated with 0.1% vitavax were sown at 1 – 2 cm deep and covered with a thin layer of sulfur. This treatment was to protect seeds from bird feeding. Thirty cantaloupe 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 cantaloupe lines. Ten days after emergence of the cantaloupe 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 in the first and second three treatments of once and twice releases, respectively. Each predator individuals were collected in gelatin capsules number 3 (0.5 – 1.5 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 cantaloupe leaflets. Randomized samples of 30 leaflets/replicate were taken just before every release and then biweekly, where the first sample was considered as pre-count and the second one as 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 *N. californicus* and only post-embryonic of *T. urticae* were counted with aid of a stereo-microscope. The statically equation of Henderson and Tilton (1955) was applied to calculate the reduction in the two-spotted spider mite populations.

RESULTS

Data of single release of the predatory mite, *N. californicus* on cantaloupe plants to control the two-spotted spider mite, *T. urticae* are presented in table (1). The percentages of infested leaflets of *T. urticae* at the pre-count, the time of release, were 16, 22 and 18%, while the mean number of *T. urticae* per replicate were 16.7, 18.4 and 13.6 moving stages/replicate on plots of release level of 9,6 and 3 predators / 2 plants, respectively. These values were 24% and 42.6 moving stages / replicate at the no releasing plots. The mean numbers of *T. urticae* per replicate increased in the first post-count to reach 44.8, 46.8 and 34.4 moving stages per replicate while the infested leaflets were 26, 33 and 33% at the releasing rates 9, 6 and 3 predators / 2 plants, respectively. In parallel, the infested leaflets were increased in the releasing plots to reach 6.8, 11.6 and 12.1% at the same releasing levels, respectively. The population of *T. urticae* / replicate continued to increase at the next counts to reach 341.4, 422.8 and 512.7 at the fourth inspection at the releasing rates 9, 6 and 3 predators / 2 plants respectively, while they were 100% and 2505.6 moving stages / replicate in the no releasing plots. The reductions of *T. urticae* were 6.8, 11.6 and 21.1% at the first post-count on May 6, 2017, and increased towards the fourth post-count to reach 65.2, 60.9 and 35.9% at the releasing levels 9, 6 and 3 predators / 2 plants respectively.

Data of double release of the predatory mite, *N. californicus* on cantaloupe 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 the first release, were 17, 19 and 18% and mean numbers of *T. urticae* per replicate were 24.1, 16.7 and 14.3 moving stages/ replicate at release plots level of 9, 6 and 3 predators / 2 plants, respectively. These values were 24% and 42.6 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 increased in the releasing plots to reach 63, 64 and 66% at the same releasing levels, respectively in the first post-count. Then the infested leaflets began to decrease gradually to reach 48, 62 and 67% at the same releasing levels. Respectively in the fourth post-counts. The population of *T. urticae* /replicates continued to increase at the next counts to reach 337.6, 324.7 and 296.4 at the fourth inspection at the releasing rates 9, 6 and 3 predators / 2 plants, respectively, while they were 2505 moving stages/replicate and 100% of leaflets infestation in the no releasing plots. Accordingly the reductions of *T. urticae* were 41.3, 30.3 and 11.6% at the first post-count on April 12, 2017 and increased at the fourth post-count to reach 76.2, 66.9 and 64.8% 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 the second release in all releasing plots with maximum populations on June 17, 2017 as a result of abundant or prey individuals in these plots.

Table (1): Single release of *N. californicus* to control *T. urticae* on cantaloupe plant

Sampling date	Treatment rate of predator release	Mean no. of T urticae/ replicate	Reduction of T. urticae%	Infested leaflets %	No. of *N. californicus*/ replicate		
					Eggs	M. S.	total
22/4/2017	A (9 predators /2 plants	16.7		16			
	B (6 predators /2 plants	18.4		22			
	C (3 predators /2 plants	13.6		18			
	D No releasing	42.6		24			
6/5/2017	A (9 predators /2 plants	44.8	6.8	26	0	2	2
	B (6 predators /2 plants	46.8	11.6	33	1	0	1
	C (3 predators /2 plants	34.4	12.1	33	0	0	0
	D No releasing	122.6		41			
20/5/2017	A (9 predators /2 plants	92.6	45.0	37	6	3	9
	B (6 predators /2 plants	114.7	38.2	42	2	4	6
	C (3 predators /2 plants	116.7	14.9	48	1	4	5
	D No releasing	429.7		91			
3/6/2017	A (9 predators /2 plants	165.5	57.7	72	6	11	17
	B (6 predators /2 plants	239.7	44.3	86	5	7	12
	C (3 predators /2 plants	287.6	9.7	93	6	3	9
	D No releasing	997.1		97			
17/6/2017	A (9 predators /2 plants	341.4	65.2	78	16	13	29
	B (6 predators /2 plants	422.8	60.9	92	9	18	27
	C (3 predators /2 plants	512.7	35.9	97	3	9	12
	D No releasing	2505.6		100			

Table (2): Double release of *N. californicus* to control *T. urticae* on cantaloupe plant

Sampling date	Treatment rate of predator release	Mean no. of *T urticae*/ replicate	Reduction of *T. urticae*%	Infested leaflets %	No. of *N. californicus*/ replicate		
					Eggs	M. S.	total
22/4/2017	A (9 predators /2 plants	24.1		17			
	B (6 predators /2 plants	16.7		19			
	C (3 predators /2 plants	14.3		18			
	D No releasing	42.6		24			
6/5/2017	A (9 predators /2 plants	40.7	41.3	63	0	2	2
	B (6 predators /2 plants	33.5	30.3	64	0	0	0
	C (3 predators /2 plants	36.4	11.6	66	0	0	0
	D No releasing	122.6		41			
20/5/2017	A (9 predators /2 plants	96.4	60.3	54	12.7	6	18.7
	B (6 predators /2 plants	98.6	41.5	62	11.6	6	17.6
	C (3 predators /2 plants	103.3	28.4	66	7.4	3	10.4
	D No releasing	429.7		91			
3/6/2017	A (9 predators /2 plants	142.6	74.7	47	20.6	31	51.6
	B (6 predators /2 plants	177.4	54.6	61	16.7	26	42.7
	C (3 predators /2 plants	227.1	32.1	68	12.3	9	21.3
	D No releasing	997.1		97			
17/6/2017	A (9 predators /2 plants	337.6	76.2	48	32	46	78
	B (6 predators /2 plants	324.7	66.9	62	14.2	41	55.2
	C (3 predators /2 plants	296.4	64.8	67	16.6	27	43.6
	D No releasing	2505.6		100			

DISCUSSION

Single and double release of *N. californicus* to control the two-spotted spider mite, *T. urticae* on cantaloupe plants showed that the double release of *N. californicus* provided a high reduction of the two-spotted spider mite, T. urticae unlike those obtained by the single release of the predatory mite, *N. californicus*.

Various authors explained either numerical or functional responses of predacious mites as a result of prey interference and disturbance (Mori and Chant, 1966; Sandness and McMurtry, 1970; Reis *et al.*, 2003). For instance, the high prey densities may affect the disturbance of predacious mites and thus decrease their functional or numerical responses (Mori and Chant, 1966). In addition, the absence of ‘‘interference-stimulation” may explain the low predation efficiency recorded at low prey densities since contact with prey may have a stimulatory effect on predacious mites (Mori and Chant, 1966; Sandness and McMurtry, 1970; Reis *et al.*, 2003). That fact may explain the inability of the predatory mite, *N. californicus* to achieve the expecting efficiency of reducing the individual number of the red spider mite, *T. urticae* at single release. Simultaneously, this shows the importance of multiple release of the predator to reduce the disturbance caused by the distribution of prey.

On the other hand, the researchers have differed on the prey/predator ratio. For instance, Greco *et al*. (2005) performed a study with different ratios between the number of *T. urticae* and *N. californicus* on strawberry (*Fragaria* spp., Rosaceae). They concluded that at ratios of up to 1:10 (predator: pest) *N. californicus* prevented the pest from reaching the economic damage level (i.e. 50 *T. urticae*/leaflet). Fraulo and Liburd (2007) also observed that *N. californicus*, when released at ratios of up to 1:10 (predator: prey) was effective in controlling *T. urticae* on strawberry in the field and greenhouse, maintaining the pest population at low levels for long periods. On the other hand, Bellini (2008) stated that initial density of 10 predators/m^2 was not enough to control the pest, when the latter was above the level of the control (mentioned as 10 *T. urticae*/leaf), whereas initial density of 20 predators/m^2 provided quick and efficient control, even with a higher infestation of *T. urticae*. Although our studies agreed with Greco’s and Bellini’s results, this prey-predator ratio, 1-10, doesn’t indicate to the releasing success, especially if this release applied on the open field. Moreover, the other ecological factors, temperature, and relative humidity affect the determination of the prey/predator ratio and subsequently, determine the success of release. Another thing to draw our attention during that study is although the releasing predators started at prey predator ratio was 3:1 at single release, *N. californicus* did not prevent *T. urticae* from exceeding the economic threshold along 8 weeks of the entire experiment duration. Blümel and Walzer (2002) indicate that the importance of repeated releases of *N. californicus* combined with two supplementary treatments with selective acaricides to achieve the successful long-term suppression below the threshold. Although our studies agreed with Blümel and Walzer at this point, our studies indicate that we can eliminate the importance of utilizing the selective acaricides by conducting multiple successive predators releases on non-inoculated leaves that were not previously inoculated.

In conclusion, under the open field conditions, our results showed a preference for utilizing multiple releases of the predatory mite, *N. californicus* to regulate the populations of *T. urticae*. Either moderating reduction or not prevent *T. urticae* from exceeding the economic threshold level.

REFERENCES

Bellini, M. R. 2008. Manejo de *Tetranychus urticae* (Acari: Tetranychidae) em plantas ornamentais. Piracicaba, 2008. 138 p.ç Tese (Doutorado em Ecologia Aplicada). Escola Superior de Agricultura Luiz de Queiroz.

Blümel, S. and Walzer, A. 2002. Efficacy of different release strategies of *Neoseiulus californicus* McGregor and *Phytoseiulus persimilis* Athias Henriot (Acari: Phytoseiidae) for the control of two-spotted spider mite (*Tetranychus urticae* Koch) on greenhouse cut roses. Systematic & Applied Acarology, 7(1), 35-48.

Childers C. C. 1994. Biological control of phytophagous mites on Florida citrus utilizing predatory arthropods. In: Rosen, D., Bennet, F., Capinera, J. (Eds.), Pest Management in the Subtropics: Biological Control – A Florida Perspective. Andover, UK, pp. 255–288.

Ebrahim A. A.; Abdallah A. A. M. and Elsayed K. M. 2013. Possibility of utilizing *Neoseiulus californicus* (Mcgregor) (Acari: Phytoseiidae) to control *Oxycenus niloticus* Zaher and Abou-Awad (Acari: Eriophyidae). Journal of the Egyptian Society of Acarology (Acarines), 7(2):63-66.

Fraulo, A. B.; Liburd, O. E. 2007. Biological control of twospotted spider mite, *Tetranychus urticae*, with predatory mite, *Neoseiulus californicus*, in strawberries. Experimental & Applied Acarology 43: 109-119.

Gerson, U. & Weintraub P.G. 2007. mites for the control of pests in protected cultivation. Pest Management Science 63 (7): 658–676. https://doi.org/10.1002/ps.1380

Greco, N. M.; Sánchez, N. E.; Liljesthröm, G. G. 2005. *Neoseiulus californicus* (Acari: Phytoseiidae) as a potential control agent of *Tetranychus urticae* (Acari: Tetranychidae): effect of pest/predator ratio on pest abundance on strawberry. Experimental & Applied Acarology 37: 57-66.

Heikal I. H., Moafi M. H. and Ebrahim A. A. 2004. Release of the predator Phytoseiulus macropilis (Banks) on kidney bean plants to control Tetranychus urticae Koch in different seasons (Acari: Phytoseiidae & Tetranychidae). Egyptian Journal of Agricultural Research, 82(2): 27-38.

Heikal, I.H. and M.H. Moafi (2009): 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). Agriculture Research center, 7(1): 11-22.

Mariod, A. A., Ali, R. T., Ahmed, Y. A., Abdel-Wahab, S. I., Abdul, A. B., (2010): Effect of the method of processing on quality and oxidative stability of anhydrous butter fat (samn). Afr. J. Biotechnol. 9, 1046–1051.

Mariod, A. A., and Matthaus, B. (2008): Investigations on fatty acids, tocopherols, sterols, phenolic profiles and oxidative stability of Cucumis melo var. agrestis oil. Journal of Food Lipids, 15(1), 42–55.

McMurtry J. A. 1983. Phytoseiid predators in orchard systems: a classical biological control success story. In: Hoy, M.A., Cunningham, G.L., Knutson, L. (Eds.), Biological Control of Pests by Mites. ANR Publications, University of California, Berkeley, pp. 21–26.

Mehta, B., 2006. Ragi (Coracana eleusine L.), a natural antioxidant for ghee (butter oil). Int. J. Food Sci. Technol. 41, 86–89.

Opit G. P., Nechols J. R. and Margolies D. C. 2004. Biological control of two spotted spider mites, *Tetranychus urticae* Koch (Acari: Tetranychidae), using *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseidae) on ivy geranium: assessment of predator release ratios. Biological Control, 29, 445–452.

Ritschel, P. S., T. C. de Lima Lins, R. L. Tristan, G. S. C. Buso, A. Buso and M. E. Ferreira, (2004): Development of microsatellite markers from an enriched genomic library for genetic analysis of melon *Cucumis melo* L. Br. Med. Chem. Plant Biol., 14: 1-14.

Vouldoukis, I., Lacan, D., Kamate, C., Coste, P., Calenda, A., Mazier, D., et al. (2004). Antioxidant and anti-inflammatory properties of a Cucumis melo LC. extract rich in superoxide dismutase activity. Journal of Ethnopharmacology, 94(1), 67– 75.

Weintraub, P.G., Kleitman, S., Mori, R., Shapira, N. & Palevsky, E. 2003. Control of the broad mite (*Polyphagotarsonemus latus* (Banks)) on organic greenhouse sweet peppers (*Capsicum annuum* l.) with the predatory mite, *Neoseiulus cucumeris* (Oudemans). Biological Control 27 (3): 300–309. https://doi.org/10.1016/s1049-9644(03)00069-0

Wood L., Raworth, D. A. and Mackauer M. 1994. Biological control of the two spotted spider mite in raspberries with the predator mite, *Phytoseiulus persimilis*. Journal of Entomological Society BC 91, 59–61.

.