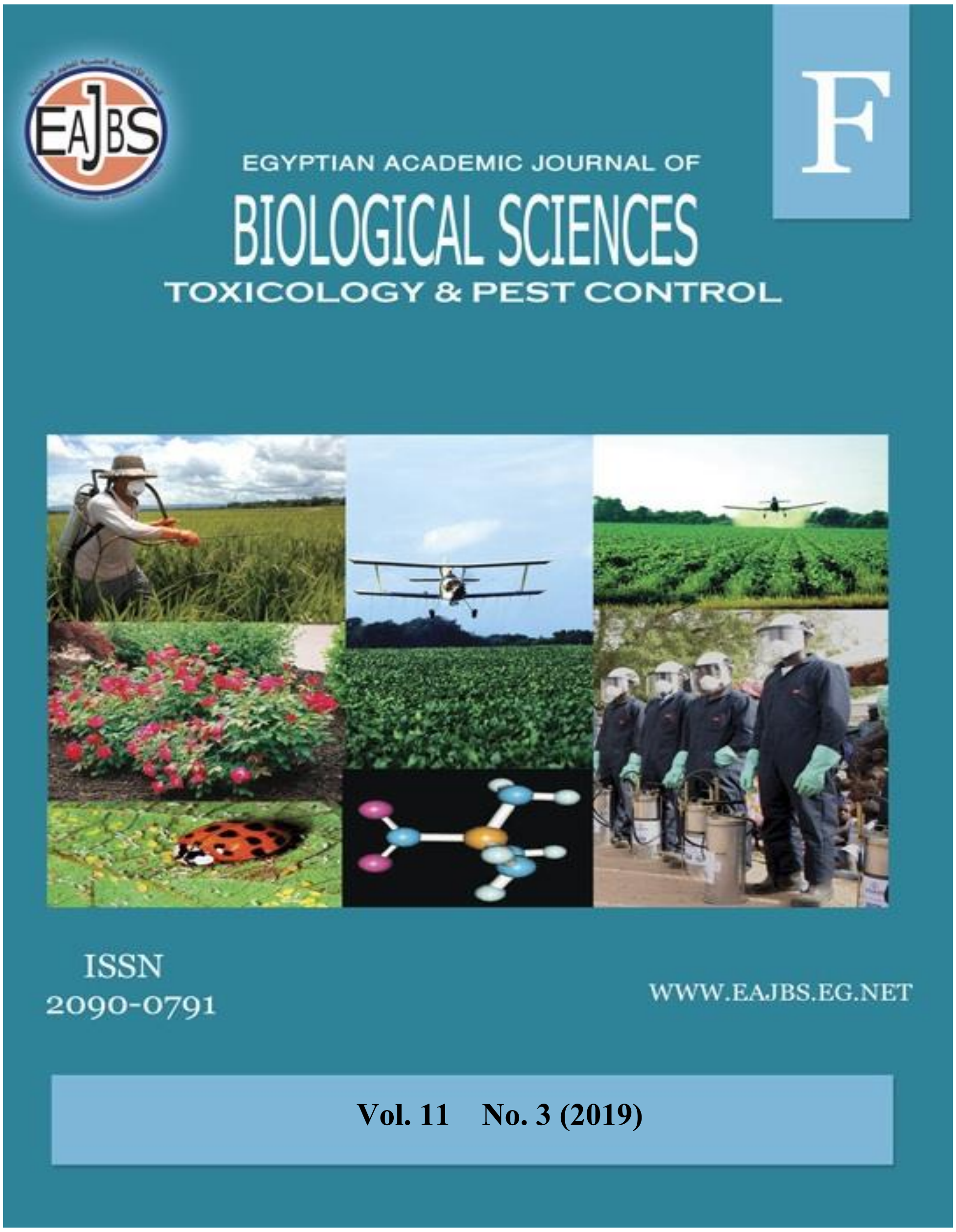

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Suppression of the Two-Spotted Spider Mite, *Tetranychus urticae* Koch Infestations by Some Biocontrol Agents on the Sweet Pea, *Lathyrus odoratus* Crop under A Greenhouse.

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ABSTRACT

Field experiments were conducted to determine the efficacy of three predators- *Phytossulus persimilis, Neoseiulus californicus* and *Orius albidipennis,* two pathogenic fungi- *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* and Azadrachtin at single and combined releases against two spotted spider mite, *Tetranychus urticae* on sweet pea, *Lathyrus odoratus* crop during two consecutive seasons, 2016/2017 and 2017/2018 at Behera Governorate, Egypt. Highly reduction percentages in the population of *T. urticae* stages was stated with the combined treatment of *Ph. persimilis* +*N. californicus*, followed by *Ph. persimilis* + *M. anisoplie* and *Ph. persimilis* + *P. fumosoroseus*. The combined releasing of *Ph. persimilis* + *O. albidipennis*, and each of *M. anisoplie, P. fumosoroseus*, and Azadrachtin had the lowest effect of reducing *T. urticae* populations.

INTRODUCTION

Sweet pea, *Lathyrus odoratus* (Fabaceae) is an important vegetable crop that was cultivated in 43627.2 feddans and produced about 2505.384 tons/ feddan in Egypt (FAO report, 2017). *L. odoratus* is threatened by several mite pests, especially the two spotted spider mites, *Tetranychus urticae* Koch (Kamel *et al*. 2018). *T. urticae* was a ubiquitous and economically important agricultural pest that attacked about 1200 species of plants and caused numerous damages on vegetable crops in Egypt (Abdallah, 2002). it was very rapid population growth rates (Clotuche, 2011) .The over-reliance on conventional acaricides in controlling spider mites led to hazardous to human, environment and domestic animals (Tirello *et al*., 2012). *T. urticae* caused a great loss for > 150 host plants of vegetables, ornamentals and other agricultural crops in Egypt (Alatawi *et al*., 2005). Under favorable conditions, spider mites can rapidly build up to very large populations (Ginette *et al.,* 2014). Chemical applications were the most common control strategy for *T. urticae*. However, it was acquired a highly *T. urticae* population resistance to acaricides (Tirello *et al*., 2012). Thus, the biological control against *T. urticae* has been considered a good solve the prior mentioned problems. *Phytoseiulus presimilis* Athias-Henriot (type I lifestyle) exclusively fed on tetranychus species, especially *T. urticae* (McMurtry and Croft, 1997 and Abou-Awad *et al*., 2017).

The predatory mite, *N. californicus* type II and Type III predatory mites preferred tetranyched mites as food, but consumes other mites, thrips, and even pollen in absence of primary pry. In temperate and subtropical regions, *Ph. persimilis* and *N. californicus* was used to control *T. urticae* and other phytophagous mites on various crops (Elmoghazy *et al.,* 2011 and Abdallah *et al.,* 2014). Insect predator, *Orius* spp. had promising control capacities especially as *Orius albidipennis* in Mediterranean countries (Al-Kherb, 2013). The biological control using of *O. albidipennis* was the most effect bio-agent method against *T. urticae* under greenhouse conditions, which increased about 31.36% in yield, food safety, and reduce the environmental pollution (El-Arnaouty *et al*., 2018).

On the other hand, Azadirachtin act as a bio-agent, which isolated from Neem tree seeds, *Azadirachta indica* (Meliaceae) (Sundaram, 1996). Neem extract had a potent repellent, antifeedant, and growth regulator and oviposition deterrent against more than 200 pest species including *T. urticae* (Villar *et al*., 2005). Moreover, entomopathogenic fungi were important in regulation of natural mite populations and decimated the phytophagous mite populations, especially *T. urticae* (Afifi *et al*., 2015). entomopathogenic fungus had a long half-life and a wide range of pest arthropods as hosts, which increase its importance as a biocontrol candidate (Hassan, 2018 and Abou-Awad *et al*., 2017).

The objective of this study was carried out to evaluate the efficacy of eleven treatments, using three predators - *Phytossulus persimilis*, *N. californicus* and *Orius albidipennis*, and two fungi- *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* and Azadirachtin 0.03% EC. Moreover, a combined treatment between them was also applied during two consecutive seasons 2016/2017 and 2017/2018 against *T. urticae* on sweet pea plants.

MATERIALS AND METHODS

A sweet pea, *Lathyrus odoratus* (Fabaceae) snowbird verity seeds were planted in a large high tunnel of plastic net on 17^{th} August during two consecutive seasons 2016/2017 and 2017/2018 at El-Sadat region, Behera Governorate, Egypt. The greenhouse was divided into 12 equal plots (Each plot was divided into three separated replicates). The trial plots were arranged in randomized complete block design. Sweet pea plants were left for the natural infestation of *T. urticae*. All the experimental plots received the standard cultivation practices. Pesticides were avoided entirely.

Greenhouse trails were carried out on Sweet pea plants to evaluate the efficacy of eleven treatments against *T. urticae* infestations, using predators *Phytossulus. persimilis*, *N. californicus* and *Orius albidipennis*, the two fungi, *Metarhizium anisopliae* and *Paecilomyces fumosoroseus*, and Bio-pesticides Azadirachtin 0.03% EC at sigle applications, and a combined treatments of *Ph. persimilis* + *A. californicus, Ph. persimilis* + Orius albidipennis*, Ph. persimilis* + *M. anisopliae*, *Ph. persimilis* + *P. fumosoroseus and Ph. persimilis* + Azadirachtin applications was conducted with compared with untreated plants (check control).

The two-spotted spider mite, *T. urticae* was reared on kidney bean plants, *Phaseolus vulgaris* planted in plastic pots in isolated greenhouse. The phytoseiid predators, *Phytossulus persimilis* and *Amblyseius californicus* were reared at 25 ±1ºC and 70±5% RH according to methods modified by (Bakr, 2010). Predatory mites were collected in boxes contained the full dry leaflets as well as (Bakr, 2010).

Single releasing, *Phytossulus persimilis* and *amblyseius californicus* was released with ratio 1:7 predator: prey two times thought the experimental periodat15^{th} of November and 3^{rd} of January. The combined releasing, the three previous predators was conducted by ratio 1:5 predator: prey. The predatory mite releases in ratio were calculated according to EI-Saiedy (2003). The releasing of predators was started at 15 November in both seasons. The control treatment was sprayed by water only. The predatory mites were transferred in ice-box to the sweet pea plants. The 2^{nd} nymph of *Orius albidipennis* (Reuter) was obtained from the Chrysopa mass rearing unit, Plant Protection Research Institute, Agriculture Research Center, Egypt. The *Orius albidipennis* was released in ratio 1:20 predator: prey. Another bio-control agent, two fungi - *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* at $5cm^3$/l liter, contained spores and mycelia fragments $1{\times}10^9$ CFU's/ml and Azadirachtin 0.03% EC by rate of 500 cm^3/hl water.

Samples of 30 leaves/3 replicates from each treatment and untreated check were weekly randomly picked up before the releasing. Samples were also obtained at weekly intervals from the time of application until the end of this experiment. Each sample was kept in a tightly closed paper bag and transferred to the laboratory to inspect under a stereomicroscope. A number of eggs, immatures (larvae and nymphs) and adults of *T. urticae* were counted and recorded for each treatment. The pre-count of *T. urticae* stages was recorded before treatments.

Statistical analysis: The reduction percentages in *T. urticae* populations were calculated by using the equation of Henderson and Tilton (1955). The statistical analyses (ANOVA) of the obtained data were performed by using SAS program (SAS Institute, 2003). Also the difference between means was conducted by using Duncan's multiple range tests in this program.

RESULTS AND DISCUSSION

Seasonal prevalence of *T. urticae* stages with different applied of biocontrol agents:

Weekly fluctuation in the population of *T. urticae* stages (egg, immatures, and adults) during both tested seasons on sweet pea plants indicated that high numbers were reported at the pretreatment in all treatments (Figs. 1 & 2). One week after the application, fluctuation in *T. urticae* egg, immature and adult stages after these treatments was decreased till the experimental end. Meanwhile, the mean numbers of *T. urticae* individuals with single treatment of *M. anisoplie*, *P. fumosoroseus* and Azadirachtin 0.03% EC were sharply declined after one week from applications, whereas, it took to increase during the next weeks. After the second spraying, the population of *T. urticae* was nearly similar as well as that it was obtained after the first spray (Figs. 1& 2).

Effect of some Biocontrol Agents in Single and Combined Applications against *T. urticae* Stages With Reference To Growth Stages of Sweet Pea Plant:

During 2016 / 2017 Season:

Flowering Stage:

Results in Table (1) showed that the most reduction in *T. urticae* egg density (93.19, 90.52, 86.52 and 83.33%) were observed at the combined releasing of *Ph. persimilis* + *N. californicus*; *Ph. persimilis* + Azadirachtin 0.03% EC; *Ph. persimilis* + *M. anisoplie* and *Ph. persimilis* + *P. fumosoroseus* for egg, respectively**.** Mean that, these combined applications were more effective *T. urticae* eggs than other tested bio-agents. The single releasing of *Ph. persimilis* and *N. californicus* provided a moderate reduction being 75.49 and 69.37 %, respectively. While, the lowest reduction occurred in egg populations showed at combined releasing of *Ph. persimilis/ O. albidipennis* and single releasing of *M. anisoplie* and *O. albidipennis* with 51.13, 52.50 and 49.68 %**,** respectively**.** Similar observations were recorded in case of the immature stages. The combined releasing of *Ph. persimilis* + *N. californicus* gave highly reduction (92.06%), followed by *Ph. persimilis* + Azadirachtin 0.03% (90.82 %), *Ph. persimilis* + *M. anisoplie* (86.20%) and *Ph. persimilis* + *P. fumosoroseus* (83.50%).Contrariwise, the combined releasing of *Ph. persimilis* +*O. albidipennis* and single releasing of *M. anisoplie* and *P. fumosoroseus* showed statically lower reduction in immature stages (49.13, 48.64 and 53.08 %, respectively). In case of adults, the single release of *Ph. persimilis* was more effective in reducing the *T. urticae* incidence with reduction being 83.21%. On the other hand, *O. albidipennis* releasing was presented by 67.63 % reduction (Table 1).

Regardless of *T. urticae* stages, the highest depreciation in *T. urticae* populations (91.74, 90.16 and 85.79 %) was recorded at combined releases of *Ph. persimilis* + *N. californicus*; *Ph. persimilis* + Azadirachtin 0.03% and *Ph. persimilis* + *M. anisoplie*. However, the lowest reduction was observed with the combined releasing of *Ph. persimilis* + *O. albidipennis* and single releasing of *M. anisoplie*, *P. fumosoroseus*. Thus, the present results were in concordance with those findings by Rhodes *et al.* (2006). They observed that the combined effect of *Ph. persimilis* + *N. californicus* was significantly reduced in population numbers of *T. urticae* infestations.

Table (1): Mean reduction percentage in population of *T. urtiae* stages/ leaf after bio-control agents at single and combined applications throughout flowering stage of sweet pea plant during 2016/2017 season.

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	75.49 bcd	49.68 e	69.37 dc	52.50 e	61.99 de	69.45 dc	51.13 e	93.19 a	86.52 ab	83.33 abc	90.52 a	14.88
Immature	72.99 bcd	62.00 def	66.36 de	48.64 f	53.08 ef	69.71 dc	49.13 f	92.06 a	86.20 ab	83.50 abc	90.82 a	15.81
Adult	83.21 a	67.63 bc	73.76 abc	41.23 d	49.55 d	66.52 c	38.57 d	89.16 a	84.03 a	82.58 ab	88.71 a	15.44
All stages	76.91 bcd	58.79 efg	69.60 cde	47.85 g	55.21 fg	68.79 def	47.24 g	91.74 a	85.79 ab	83.21 abc	90.16 ab	14.56

Values signed by the same letter in the same row are non-significantly different at alpha=0.05 level

Overlapping the flowering and fruiting growth stages:

As observations in the flowering stage, Data in Table (2) indicated that the highest reduction of *T. urticae* during 2016/2017 season were attained with combined releases which exceeded than 92% reduction except with *Ph. persimilis* + *O. albidipennis*for *T. urticae* stages. For adults, the parallel effect was obtained with the previously mentioned applications (98.39 and 97.30, 92.46, 95.50 and 97.98 %). In addition, the single releasing of *N. californicus* and *O. albidipennis* exhibited the highest reduction in *T. urticae* adults as 92.95 and 89.83 % reduction (Table 2). Regarding the general mean of *T. urticae* stages, the overlapping releases were also achieved the highest reduction extended between 94.61 and 98.82% in the population of *T. urticae*. While the two fungal pathogens, *M. anisoplie* and *P. fumosoroseus* was recorded low reduction less than 90% on *T. urticae* stages at single treatment being 53.54 and 58.37%, respectively (Table 2).

Table (2): Mean reduction percentage in the population of *T. urtiae* stages/ leaf after bio-control agents at single and combined application throughout overlapping the flowering and fruiting stages of sweet pea plant during 2016/2017 season**.**

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	94.23 abc	88.39 c	91.71 bc	56.85 e	62.31 e	70.10 d	88.40 c	99.57 a	98.50 ab	97.01 ab	98.25 ab	6.87
Immature	93.52 abc	82.30 d	90.58 bc	58.39 f	63.44 f	70.70 e	90.00 c	99.04 a	98.08 a	97.01 ab	98.39 a	6.91
Adult	96.61 a	89.52 ab	92.94 ab	42.27 d	46.00 d	57.73 c	85.79 b	97.30 a	92.46 ab	95.50 a	97.98 a	9.07
All stages	94.61 abc	86.26 d	91.61 bcd	53.54 f	58.37 f	66.96 e	88.41 cd	98.82 a	96.82 ab	96.65 ab	98.24 ab	7.14

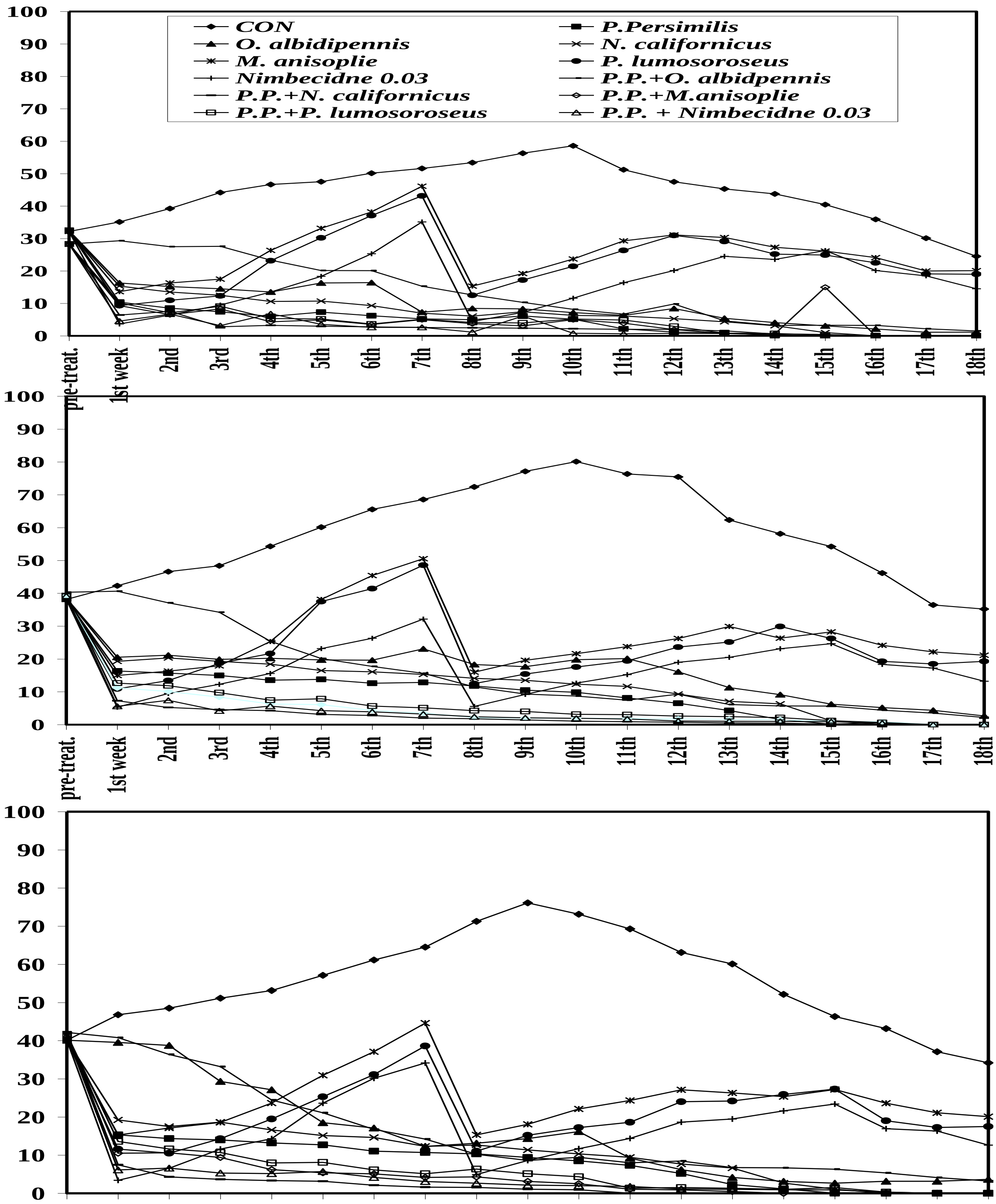

Fig. (1): Mean numbers of *T. urticae* stages / leaf after bio-control agents in single and combined applications during growth stages on sweet pea plants during 2016/2017 season.

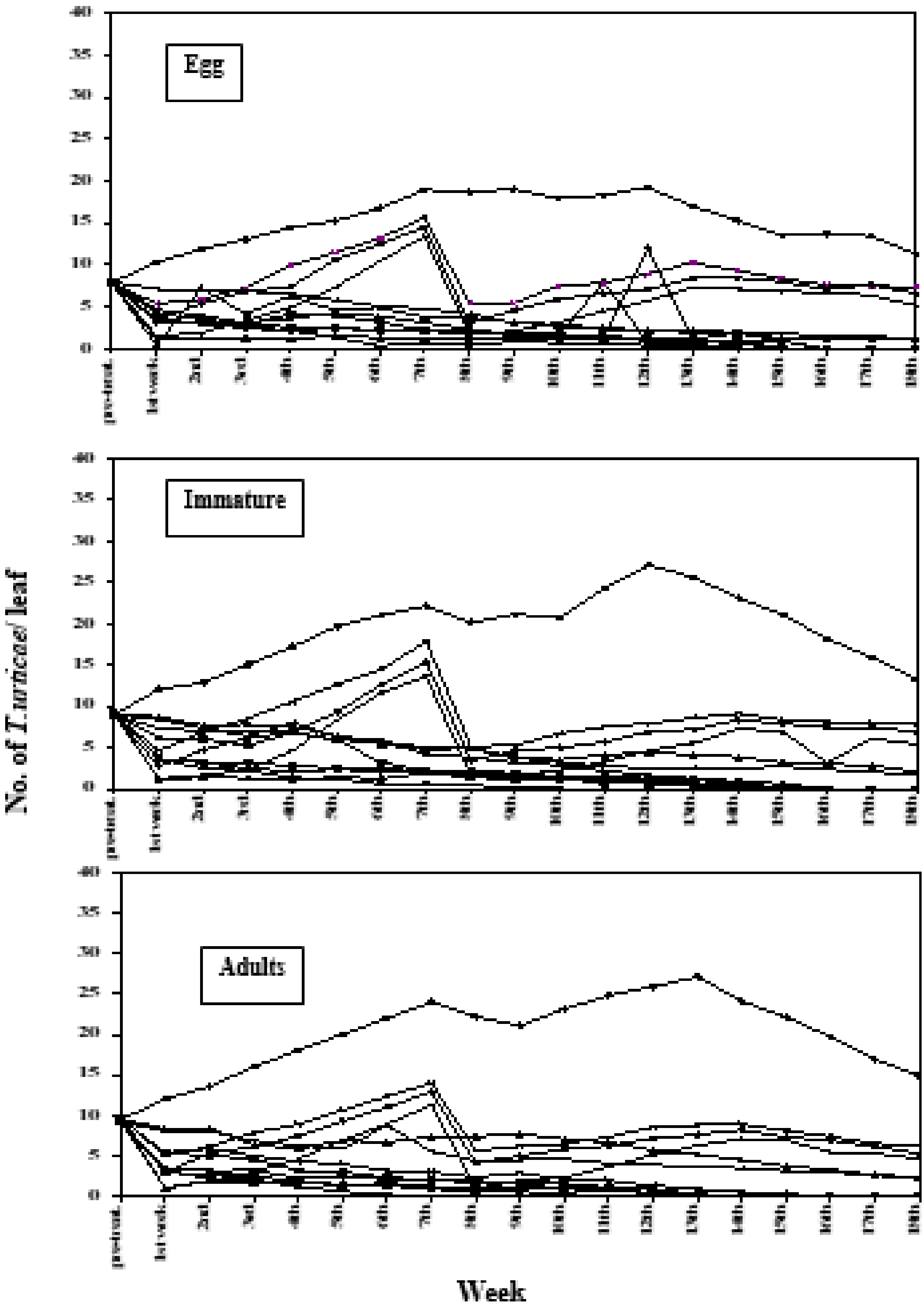

Fig. (2): Mean numbers of *T. urticae* stages / leaf after bio-control agents in single and combined applications during growth stages on sweet pea plants during 2017/2018 season.

All Growth Stages:

As shown in Table (3), the combined treatments of *Ph. persimilis* + *N. californicus*, *Ph. persimilis* + *M. anisoplie*, *Ph. persimilis* + *P. fumosoroseus* and *Ph. persimilis* + Azadirachtin 0.03 accomplished the highest reduction over 90% in *T. urticae* egg, immature and adult stages. Additionally, the releasing of *Ph. persimilis*, *N. californicus* and *O. albidipennis* at single releasing were demonstrated highest reduction being 91.40, 85.48 and 81.01 in *T. urticae* adult stages, respectively The general mean of all stages had the same direction of the earlier treatments. The lowest effect was reported with *M. anisoplie and P. fumosoroseus* spraying on all *T. urticae* stages (51.32 and 57.14%, respectively)(Table 3).

Table (3): General Mean reduction percentage in the population of *T. urtiae* stages/ leaf after bio-control agents at single and combined applications on sweet pea plant during 2016/2017 season.

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	86.95 bc	73.34 e	83.02 dc	55.16 g	62.19 gf	69.85 ef	73.90 ed	97.09 a	93.84 ab	91.69 ab	95.24 ab	9.38
Immature	85.54 bc	74.40 de	81.16 dc	54.60 f	59.41 f	70.32 e	74.11 de	96.32 a	93.46 ab	91.76 ab	95.44 a	8.91
Adult	91.40 a	81.01 b	85.48 ab	41.86 d	47.38 d	61.15 c	67.43 c	94.14 a	89.18 ab	90.48 ab	94.38 a	9.91
All stages	87.73 ab	75.57 cd	83.05 bc	51.32 e	57.14 e	67.67 d	72.40 d	96.07 a	92.53 a	91.42ab	95.10 a	9.07

During 2017 / 2018 Season:
Flowering Growth Stage:

Data in Table (4) indicated that combined treatment of *Ph. persimilis* +*N. californicus*, *Ph. persimilis* + *M. anisoplie*, *Ph. persimilis* + *P. fumosoroseus* and *Ph. persimilis* + Azadirachtin 0.03% was occupied the highest reduction of *T. urticae* ranged from 82.92 to 91.15 % for eggs controlling throughout the flowering stage with insignificant difference among each other, on the contrary, *O. albidipennis, M. anisoplie*, *P. fumosoroseus*, and *Ph. persimilis* + *O. albidipennis* showed the lowest reduction effect in egg populations as the corresponding values were 57.63, 50.30, 58.309 and 55.75% reduction.

For immature stages, the reduction in the infestation level was nearly similar as in the case of the previous stage. The previous four combined applications were more effective to enhance reduction being 88.28, 84.11, 82.29 and 92.08 %, respectively (Table, 4). Concerning adult stages, the overlapping treatments of *Ph. persimilis* releasing with each of *N. californicus*, *M. anisoplie*, *P. fumosoroseus* and Azadirachtin 0.03% were successively suppressed in adult populations which gave 84.86, 81.37, 79.68 and 90.52 %, respectively, followed statically by the single releasing of *Ph. persimilis* and *N. californicus* (74.32 and 72.01 %, respectively).

Disregarding the stage of *T. urticae*, the highest reduction was also earned with the overlapping releases of *Ph. persimilis* + *N. californicus*, *Ph. persimilis* + *M. anisoplie*, *Ph. persimilis* + *P. fumosoroseus* and *Ph. persimilis* + Azadirachtin 0.03% (87.90, 82.89, 83.11, 91.30 and 73.05 %, respectively). However, a low reduction (41.91, 52.47 and 56.88) was acquired with *M. anisoplie*, *P. fumosoroseus* and *Ph. persimilis* + *O. albidipennis*, respectively. The single releasing of *Ph. persimilis* was recorded a reduction of 73.05 % in the pest population.

Table (4): Mean reduction percentage in the population of *T. urtiae* stages/ leaf after bio-control agents at single and combined applications throughout the flowering stage of sweet pea plant during 2017/2018 season.

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	77.11 bc	57.63 d	73.06 c	50.30 d	58.39 d	73.14 c	55.75 d	90.15 a	82.92 abc	86.82 ab	91.15 a	12.23
Immature	67.55 bc	56.01 c	57.81 c	39.58 d	54.80 c	67.90 bc	59.54 c	88.28 a	84.11 a	82.29 ab	92.08 a	15.05
Adult	74.32 bcd	57.63 cde	72.01 bcd	33.88 g	42.23 fg	61.09 de	55.06 ef	84.86 ab	81.37 abc	79.68 ab	90.52 a	11.78
All stages	73.05 bc	60.29 cde	67.55 cd	41.91 f	52.47 ef	67.85 cd	56.88 de	87.90 a	82.89 ab	83.11 ab	91.30 a	12.78

Overlapping the Flowering and Fruiting Growth Stage:

The combined treatment of *Ph. persimilis +N. californicus*, *Ph. persimilis + M. anisoplie*, *Ph. persimilis +P. fumosoroseus* and *Ph. persimilis* + Azadirachtin 0.03% as in case of the single releasing of *Ph. persimilis* and *N. californicus* exhibited a high reducing of *T. urticae* eggs (100.0, 97.44, 98.16, 99.32 and 97.18%, respectively). A single releasing of *N. californicus* was recorded of a 95.36 % reduction in egg populations. Concerning immature stages, the two single fungicide applications gave the lowest reduction in the immature counts with 62.82 and 67.89 % reduction with no significant differences.

Regardless of *T. urticae* stages, the treated with *Ph. persimilis* + *N. californicus*, *Ph. persimilis + M. anisoplie*, , *Ph. persimilis + P. fumosoroseus*, *Ph. persimilis* + Azadirachtin 0.03 % in both releases of *Ph. persimilis* and *N. californicus* demonstrated the highest reduction elongated from 93.87 to 99.41. Whereas, the lowest reduction percentage was recorded with a single releasing of *M. anisoplie* and *P. fumosoroseus* (61.07 and 66.06 %, respectively) without significant difference (Table, 5).

Table (5): Mean reduction percentage in population of *T. urtiae* stages/ leaf after bio-control agents at single and combined application throughout overlapping the flowering and fruiting stages of sweet pea plant during 2017/2018 season**.**

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	97.18 ab	77.25 d	95.36 b	66.85 e	70.87 e	79.03 cd	83.02 c	100.00 a	97.44 ab	98.16 ab	99.32 ab	4.23
Immature	97.23 ab	82.68 cd	93.25 b	62.82 e	67.89 e	78.29 d	86.25 c	99.73 a	96.33 ab	96.04 ab	97.14 ab	5.72
Adult	95.18 abc	87.14 c	92.54 abc	50.14 e	56.46 e	65.88 d	86.50 c	98.30 a	89.20 bc	93.62 abc	95.92 ab	7.69
All stages	96.67 ab	81.9 c	93.87 b	61.07 e	66.06 e	75.31 d	85.19 c	99.41 a	94.82 ab	96.18 ab	97.59 ab	5.35

All Plant Growth Stages:

All over the season, the combined and single releases (Table, 6) indicated the same trends as fruiting growth stage respecting the highest reduction percentages of *T. urticae* stages as well as regarding when it regardless all stages of *T. urticae*.

The obtained results in concurrence with that reported in numerous isssues, in Egypt, El-Saiedy (2003) indicated that the releasing of *N. californicus* and *Ph. persimilis* for controlling *T. urticae* on strawberry resulted in reduction percentages ranged from 71.78 to 97.20%. Ahmed (2013) released the predator, *Ph. persimilis* during two seasons on sweet pepper that gave the highest reduction percentage in population of *T. urticae* movable stages, but a low reduction in egg populations, while *N. californicus* preferred *T. urticae* eggs than movable stages. El-Arnaouty *et al.* (2018) and Taghizadeh *et al.* (2018) stated that *O. albidipennis* exhibited suitable efficacy on *T. urticae* stages.

Table (6): General Mean reduction percentage in the population of *T. urtiae* stages/ leaf after bio-control agents at single and combined applications on sweetpea plant during 2017/2018 season.

T. urticae	Treatments											L.S.D
	Phytossulus persimilis	Orius albidipennis	Neoseiulus californicus	Metarhizium anisopliae	Paecilomyces fumosoroseus	Azadirachtin	Ph. Persimilis + O. albidpennis	Ph. persimilis + N. californicus	Ph. persimilis + M. anisoplie	Ph. persimilis +P. lumosoroseus	Ph. persimilis + Azadirachtin	
Egg	89.38 ab	69.62 cd	86.69 b	60.41 e	65.98 de	76.74 c	72.42 cd	96.17 a	91.79 ab	93.75 ab	96.14 a	7.49
Immature	85.69 bc	72.30 d	79.46 cd	53.78 e	62.80 e	74.25 d	75.86 d	95.28 a	91.58 ab	90.70 ab	95.17 ab	9.50
Adult	87.07 abc	79.87 cd	84.55 bc	43.82 f	50.93 f	64.02 e	74.27 d	93.07 ab	86.15 abc	88.20 abc	93.82 a	8.29
All stages	87.49 ab	73.50 c	83.64 b	53.62 d	60.78 d	72.41 c	74.18 c	94.94 a	90.18 ab	91.10 ab	95.14 a	8.23

In conclusion, the result showed that *Ph. persimilis* was more effective than *N. californicus* for reducing *T. urticae* populations and the two species were compatible when release together indicated that there was no sign of inter-specific competition between *Ph. persimilis* and *N. californicus*, while the lowest reduction in the combined applications of *Ph. persimilis* + *O. albidipennis* indicated the competition between these predators when released together in agreement with Barber *et al.* (2003), Rott and Ponsonby (2000) and El-Basha (2015). The higher reduction percentage in *T. urticae* populations achieved during fruiting stage compared with the flowering stage in accordance with Madadi *et al.* (2007), mentioned that the ability of predatory mites on their prey affected of intrigued predation, interspecific competition between predator species, host plant characteristics. The single application of foliar sprays of two fungi- *M. anisoplie* and *P. fumosoroseus* as well as Azadirachtin 0.03% was ineffective in reducing *T. urticae* infestation.In contrast, the combined treatments provide better reduction of *T. urticae*. During both seasons, the obtained results revealed that the combined applications achieved a high reduction percentage of *T. urticae* comparing with a single application in harmony with Rhodes *et al*. (2006), they indicated that the overlapping applications strategy was more effective than single treatment and could be an option for long-term of *T. urticae* control.

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ARABIC SUMMARY

خفض تعداد العنكبوت الاحمر ذو البقعتين *Tetranychus urticae* Koch على محصول البسلة السكرية باستخدام بعض عوامل المكافحة الحيوية تحت ظروف الصوب

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تعتبر البسلة السكرية من المحاصيل المهمة التى زادت مساحتها مؤخرا فى مصر و ذلك للاستهلاك المحلى وللتصدير.وتصاب البسلة بالعديد من الآفات ومنها العنكبوت الاحمر ذو البقعتين *Tetranychus urticae* الذى يسبب اضرار كبيره للمحصول لذلك أجريت تجربة حقلية في محافظة البحيرة منطقة السادات خلال موسمين متتاليين 2016-2017-و 2017-2018 فى الصوب لدراسة تأثير استخدام اثنين من المفترسات الاكاروسية (*Phytossulus persimilis*, *Neoseiulus californicus*) والمفترس حشرى *Orius albidipennis* واثنين من البكتيريا الممرضة (*Metarhizium anisopliae* and *Paecilomyces fumosoroseus*) ومستخلص النيم فى معاملات فردية ومعامعلات مجتمعة فى خفض تعداد هذه الآفة.

وقد اظهرت النتائج ان اعلى معدلات للخفض فى تعداد كلا من البيض او الاطوار الغير كاملة وكذلك الافراد الناضجة كان فى المعاملة التى تم فيها اطلاق المفترسين الاكاروسى *Ph. persimilis +N. californicus* تلاها المعاملات التى تم فيها اطلاق المفترس الاكاروسى مع كلا من معاملات البكتريا الممرضة *Ph. persimilis + M. anisoplie* and *Ph. persimilis + P. fumosoroseus*. بينما عند استخدام المفترس الاكاروسى مع المفترس الحشرى بقة الاوريس *Ph. persimilis + O. albidipennis* وكذلك عند استخدام كلا من البكتريا الممرضة *M. anisoplie*, *P. fumosoroseus* ومستخلص النيم فى المعاملات الفردية اعطى اقل معدلات خفض فى تعداد العنكبوت الاحمر.