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Performance of the predator *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) on plastic greenhouse pepper sprayed vs unsprayed pine pollen

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Abstract

From sucking pests, a one of the most known important pest, flower thrips *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) in protected vegetable cultivation in Turkey. The predatory mite, *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) was used to control to suppress the pest population especially on pepper plant in more than 50 countries worldwide since 2005. According the literature on *A. swirskii*, it can survive on pepper plants sprayed with pine and cattail pollen, where there is no prey. Therefore, it was expected that population of a well-known pollenophagous species, *A. swirskii* can be increased by spraying pine pollen to peppers. Pollen was diluted in water and sprayed on the plants with backpack sprayer at the dose of 5 kg ha^{-1}. In both experiments, the thrips populations was less than 2 per flower in the predatory mite released plots (with predators and without pollen and with predators and pine pollen) throughout the experiments. Contrary to our expectation, the provision of pine pollen to peppers did not result in increased number of the predatory mite. Our results clearly show that, the pine pollen was less suitable food source than the pepper own pollen for the predatory mite. Some study on pine pollen as a non-prey food source for *A. swirskii* with a full analysis of constituents is necessary.

Keywords: *Frankliniella occidentalis*; Predatory mite; Biological control; Protected crops

Predatör, *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae)'nin plastic seralarada çam poleni uygulanmış ve uygulanmamış biber bitkilerindeki performansı

Öz

Türkiye'de açık ve kapalı alan sebze yetiştiriciliğinde sokucu emici zararlılardan, çiçek thripsi, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) bilinen önemli zararlı türlerden biridir. Söz konusu zararlı çiçek thripsi özellikle biber bitkilerinde 2005 yılından bu yana dünyada 50 den fazla ülkede predator akar, *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) ile baskı altına alınmaktadır. Daha önceki yapılan çalışmalar ile *A. swirskii*'nin avının olmadığı durumlarda çam ve kamış bitkisi polenlerinin püskürtüldüğü biber bitkileri üzerinde yaşamlarını sürdürebildiklerini göstermektedir. Polenlerle beslendiği bilinen *A. swirskii*'nin biber bitkilerindeki populasyonun bitkilerin üzerine çam poleni püskürtülmesi yoluyla artırılacağı beklenilmektedir. Bu amaçla sui le karıştırılan çam poleni 5 kg ha^{-1} dozunda olacak şekilde el pülverizatörü yardımıyla biber bitkilerine uygulanmıştır. Yürütülen her iki denemede predator akarın salındığı parsellerde (predator akar salınmış fakat biber bitkilerine çam polleni püskürtülmemiş; predator akar salınmış aynı zamanda biber bitkilerine pollen püskürtülmüş) thrips populasyonu 2 adet çiçek^{-1} oranından daha düşük seyretmiştir. Ancak beklentinin aksine biber bitkilerinin üzerine sırt pülverizatörü yardımıyla çam poleni püskürtülmesi predator akar populasyonunda artış ile sonuçlanmamıştır. Bu çalışmadan elde edilen bulgular daha önceki yürütülen çalışmalardan elde edilen sonuçlar ile birlikte değerlendirildiğinde, predator akar için biber bitkilerinin sahip olduğu kendi doğal poleninin çam poleninden daha uygun olduğu sonucuna ulaşılmıştır. Çam poleninin predator, *A. swirskii* için ilave besin olarak düşünülmesi için polenin besin içeriğinin analiz edildiği bir çalışmaya ihtiyaç duyulmaktadır.

Anahtar Kelimeler: *Frankliniella occidentalis*; Predatör akar; Biyolojik mücadele; Örtüaltı

1. Introduction

Either in open field or protected vegetable cultivation, one of the most important pest group is sucking insects, such as *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), *Bemisia* spp. Quaintance & Baker (Hemiptera: Aleyrodidae) and *Tetranychus urticae* Koch (Acarina: Tetranychidae) that have short life span and high reproductive potential. Growers has been used intensively insecticides and acaricides against these pests. Solution of the problems based on sustainable agriculture system especially via biological control tactic is a challenge for researchers and growers in all around the World. In the protected cultivation system, augmentative releases of mass-reared natural enemies to suppress the pest population has been a cleverly chosen as an alternative to the chemical control (van Lenteren and Bueno, 2003). Provision additional food sources, such as pollen to improve biocontrol efficacy in greenhouse has been known by the researchers for a long time. The Pollen availably have a strong effect on establishing of *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) population in greenhouse crops even before pest are present (Bolckmans et al., 2005). The plants families including Betulaceae and Pinaceae are important pollen providers for generalist predatory mite species in spring, especially when prey abundance was poor (Addison et al., 2000).

A generalist predatory mite, *A. swirskii* feeds on different insects and mites, however, it is an important biological control agent of the whiteflies, *Bemisia tabaci* and *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae) and the Western flower thrips, *F. occidentalis* (Pergande) (Thysanoptera: Thripidae) (Cock et al., 2010; Gerson and Weintraub, 2012). In pepper grown greenhouse, *A. swirskii* has effectively provided long term control of western flower thrips (Calvo et al., 2012; Bolckmans et al., 2005). Previous studies carried out by Kütük and Yiğit (2011) and Kumar et al. (2015) found that this predatory mite *A. swirskii* can survive on pepper plants sprayed with pine and cattail pollen, respectively, where there is no prey. Therefore, we hypothesized that spraying pine pollen with *A. swirskii* release on the flowering peppers to increase *A. swirskii population* to a greater extent than the predatory mite releases. So, the effect of the provision of pine pollen on the dynamics of a predatory mite-pollen system was studied under greenhouse conditions.

2. Material and Method

2.1. Cultures

Predatory mite, *A. swirskii,* population were provided from Koppert prior to this study. *A. swirskii* was reared on *Carpoglyphus lactis* (Acari: Acaridae) in a climate room (25°C, 60% RH, 14/10 daylight) at the Biological Control Research Station in Adana, Turkey, according to developed method by Overmeer (1985).

2.2. Pollen source

Plants families including Betulaceae and Pinaceae were used to obtain their pollen for the generalist predatory mite in spring (Addison et al., 2000). The collected pollens used in the study from pine (*Pinus brutia*) plants, where they are at Toros Mountain were dried in the oven for 3 days at 37ºC and kept in a refrigerator at -10ºC.

2.3. Plastic greenhouse experiments

A heated (min. 10°C during winter months) and an unheated plastic high tunnels (min. 0°C during winter months) belongs to the Adana Biological Control Research Institute were used to carry out experiments. Peppers were planted in rows, each with 10 plants, on 16th of September 2009. The maintenance of the pepper plants was done according to the practices of growers. First, plastic tunnels were separated into three sections, then in each section was separated into 5 subdivisions (having 3 rows). The experiment was designed in a completely randomized block with 3 treatments each replicated 5 times: (A) 50 *A. swirskii* m^2 + pollen sprayed at 5 kg ha^{-1}; (B) 50 *A. swirskii* m^2 alone, (C) no *A. swirskii* and all plants were sprayed with water only.

Amblyseius swirskii (nymphs and adults) were released directly on different plants in treatments A and B on 17th of October 2009 (when the plants started flowering). Five plots treated with "treatment A", plants were first sprayed with pine pollen before releasing the predatory mite. Pollen was diluted in water and sprayed on the plants with backpack sprayer. Pollen spray was repeated three times at 27 October, 7 November, and 17 November.

Sampling started on 6th of November 2009 and continued weekly to monitor thrips and predators. Totally 28 and 18 sampling were conducted from 6 November 2009 in heated and unheated plastic tunnels, respectively. Nymphal and adult stages of *F. occidentalis* and all stages of *A. swirskii* on each sample leaves and flowers (10 leaves and 5 flowers from each section) collected randomly was recorded under a binocular microscope at 30 times magnification in the laboratory. It is provided an average estimation of thrips and predator density per section. HOBO (Onset Computer, Bourne, MA, USA) data loggers were used to monitor temperature and relative humidity during the experiment. Compatible insecticides: chlorantraniliprole (Altacor) and pymetrozine (Plenum) against *Spodoptera littoralis* and *Aphis* spp. with *A. swirskii* were used in the plastic greenhouses used for both experiments. Both insecticides do not negatively affect *A. swirskii* (Kütük and Karacaoğlu, 2012).

2.4. Data analysis

Differences in the number of thrips were calculated by analysis of variance and means were separated using Duncan's multiple comparison test (P≤0.05) at each sampling date. Average numbers of thrips (leaf+flowers) and numbers of predatory mite (leaf + flowers) were subjected to Student's t test (P≤0.05) presence or absence of pollen as factors.

3. Result and Discussion

3.1. Heated plastic greenhouse

Thrips densities were significantly different in the 3 treatments (without predatory mite and pollen; with predatory mite and without pollen and with predatory mite and pine pollen) at some dates (Table 1). Thrips, *F. occidentalis*, densities remained very low in release plots (with predatory mite and without pollen; with predatory mite and pine pollen) during the autumn and winter months. However, average thrips density increased rapidly on 30th of November in the control plot. On 14th of December, thrips density reached a peak level of 3.60 active stages per flower. This value exceeds the action threshold of 3 thrips per flower (Yücel et al., 2011; Keçeci and Gürkan, 2017). The thrips level then decreased to 2.40 thrips per flower on 4th of January, after which a steadily decline in population occurred. The number of thrips per flower averaged 1-1.5 during February 1 to March 23 (Table 1). A very small increase was seen in thrips populations on 12th of April, but they declined on 3th of May due to the presence of naturally occurring *Orius* species in the flowers. The number of *A. swirskii* (all stages) recorded on plants with pollen (treatment A) was not significantly different than plants without pollen (Treatment B) (Figure 1; t (49) =-0.789; P= 0.434). Additionally, similar density of thrips were recorded on plants with pollen (treatment A) and plants without pollen (treatment B), (t (54) = 1.772; P = 0.084).

3.2. Unheated plastic greenhouse

Thrips densities were significantly different in the 3 treatments (without predatory mite and pollen, with predatory mite and without pollen and with predatory mite and pine pollen) at some date (Table 2). Predator densities were not significantly different between plants treated with pollen than those without pollen (Figure 2; t (43) =-0.1; P= 0.921). Also, there was no significant differences in thrips density between plants with pollen (treatment A) and without pollen (treatment B), (Figure 2; t (14) =-0.999; P= 0.335).

Thrips populations, which was less than 2 per flower throughout the experiments in the release plots (with predatory mite and without pollen and with predatory mite and pine pollen) incidence with an increase in predatory mite density in both experiment. These results show that thrips can be effectively controlled by predatory mite, *A. swirskii* on greenhouse grown peppers in the eastern Mediterranean region of Turkey. It has been known that *A. swirskii* effectively control *F. occidentalis* in greenhouse grown peppers (Calvo et al., 2012; Kutuk et al., 2011)). However, we would expect that spraying pine pollen with *A. swirskii* release on flowering peppers to increase the number of *A. swirskii* to a greater extent than predatory mite releases without pine pollen in both experiments. Contrary to our expectation, the provision of pine pollen to peppers did not result in increased number of the predatory mite. This predator is a well-known pollenophagous species, feeds on different insects and mites (Ragusa and Swirski, 1975; Goleva and Zebitz, 2013). The previous studies carried out by Kütük and Yiğit (2011) and Kumar et al. (2015) found this predatory mite was able to survive in the absence of prey on pepper plants sprayed with pine and cattail pollen, respectively.

Table 1. Population dynamics of *Frankliniella occidentalis* on peppers treated with *Amblyseius swirskii* on pepper sprayed vs unsprayed pine pollen and control in heated plastic tunnel experiment

Sampling date	Treatments					
	Control	With pollen	No pollen	df	F	P
6 November	0.24±0.8	0.24±0.1	0.28±0.1	2;12	0.118	0.890
16 November	0.24±0.1	0.72±0.1	0.32±0.1	2;12	2.531	0.121
23 November	1.04±0.3	1.72±0.5	1.20±0.4	2;12	0.847	0.453
30 November	2.88±1.0	0.60±0.1	1.56±0.4	2;12	3.029	0.086
7 December	3.04±0.6 b	0.84±0.1 a	1.68±0.4 ab	2;12	5.220	0.023
14 December	3.60±0.5	1.64±0.3	0.88±0.2	2;12	3.341	0.070
21 December	2.44±0.4b	0.68±0.1a	1.08±0.2 a	2;12	8.108	0.006
28 December	2.32±0.8	1.08±0.2	0.60±0.1	2;12	2.170	0.157
4 January	2.40±0.4 b	1.72±0.3 a	1.24±0.2 a	2;12	5.808	0.017
11 January	1.68±0.2	1.36±0.3	0.92±0.2	2;12	2.757	0.103
18 January	1.40±0.1 b	0.48±0.1 a	0.58±0.2 a	2;12	3.933	0.049
25 January	1.72±0.5	0.72±0.2	0.32±0.1	2;12	2.699	0.108
1 February	1.16±0.2	1.20±0.3	0.60±0.1	2;12	2.414	0.131
8 February	1.24±0.3	0.68±0.2	0.56±0.3	2;12	1.788	0.209
15 February	1.00±0.6	0.52±0.1	0.12±0.0	2;12	0.560	0.585
22 February	1.00±0.5	0.76±0.2	0.32±0.1	2;12	0.689	0.521
1 March	1.00±0.3b	0.24±0.1 a	0.25±0.1 a	2;12	17.118	0.000
8 March	1.16±0.2	0.64±0.2	0.32±0.1	2;12	1.554	0.251
15 March	0.60±0.2	0.44±0.2	0.04±0.0	2;12	1.025	0.388
22 March	0.68±0.2	0.96±0.3	0.08±0.0	2;12	0.300	0.746
29 March	1.60±0.9	0.52±0.1	0.28±0.1	2;12	1.128	0.356
5 April	1.25±0.3	1.32±0.3	0.44±0.2	2;12	0.399	0.679
12 April	2.40±0.7	1.24±0.2	0.44±0.1	2;12	1.448	0.273
19 April	1.60±0.4	1.12±0.2	0.68±0.3	2;12	0.706	0.513
26 April	2.04±0.4	1.72±0.2	1.44±0.5	2;12	0.748	0.494
3 May	1.00±0.2 a	1.56±0.2 b	1.12±0.2 a	2;12	6.088	0.015
10 May	0.08±0.0	0.36±0.1	0.68±0.1	2;12	0.724	0.505
17 May	0.12±0.0	0.20±0.1	1.00±0.2	2.12	2.971	0.089

*Means in rows followed by different small letters indicate significant differences among treatments at P ≤ 5% (ANOVA)

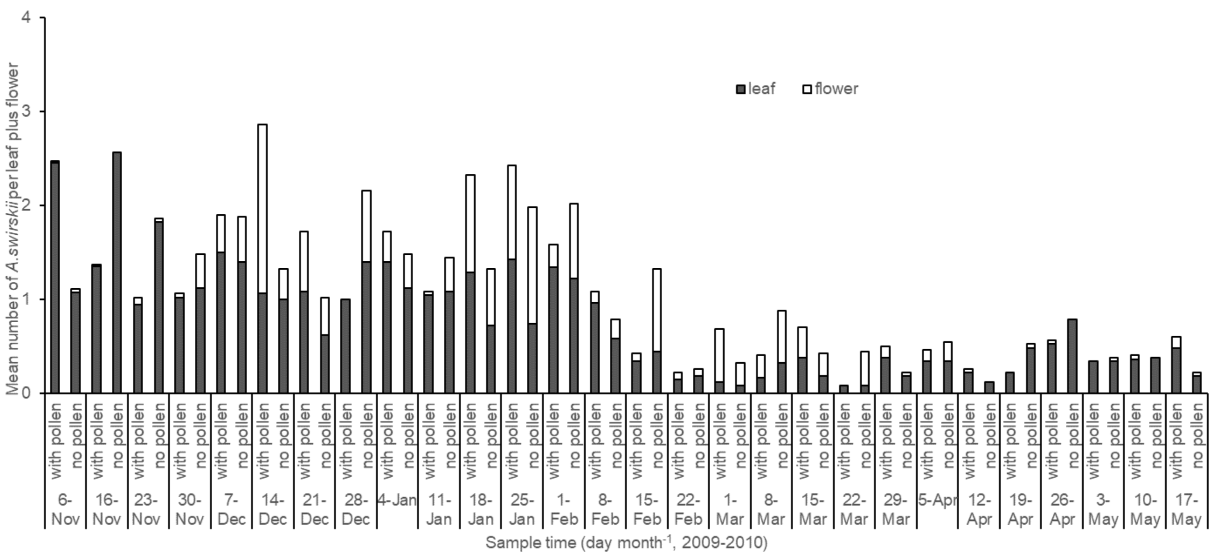

Figure 1. Effects of spraying pine pollen on the numbers of predatory mite, *Amblyseius swirskii* in heated plastic greenhouse experiment

Table 2. Population dynamics of *Frankliniella occidentalis* on peppers treated with *Amblyseius swirskii* on pepper sprayed vs unsprayed pine pollen and control in unheated plastic greenhouse experiment

Sampling date	Treatments					
	Control	With pollen	No pollen	df	F	P
6 November	0.24±0.10	0.24±0.10	0.28±0.10	2;12	0.118	0.890
16 November	0.36±0.10	0.32±0.10	0.20±0.10	2;12	0.054	0.948
23 November	1.12±0.30	0.56±0.30	0.52±0.20	2;12	1.613	0.240
30 November	3.48±0.10 a	0.60±0.40 b	1.28±0.40 b	2;12	6.042	0.015
7 December	2.48±0.50 a	0.20±0.10 b	0.88±0.10 b	2;12	24.377	0.000
14 December	2.36±0.40 a	0.88±0.40 b	0.24±0.10 b	2;12	4.259	0.040
21 December	2.08±0.50	0.76±0.20	0.60±0.10	2;12	1.894	0.193
28 December	2.16±0.50a	0.24±0.10b	0.60±0.10 b	2;12	13.434	0.001

*Means in rows followed by different small letters indicate significant differences among treatments at P ≤ 5% (ANOVA)

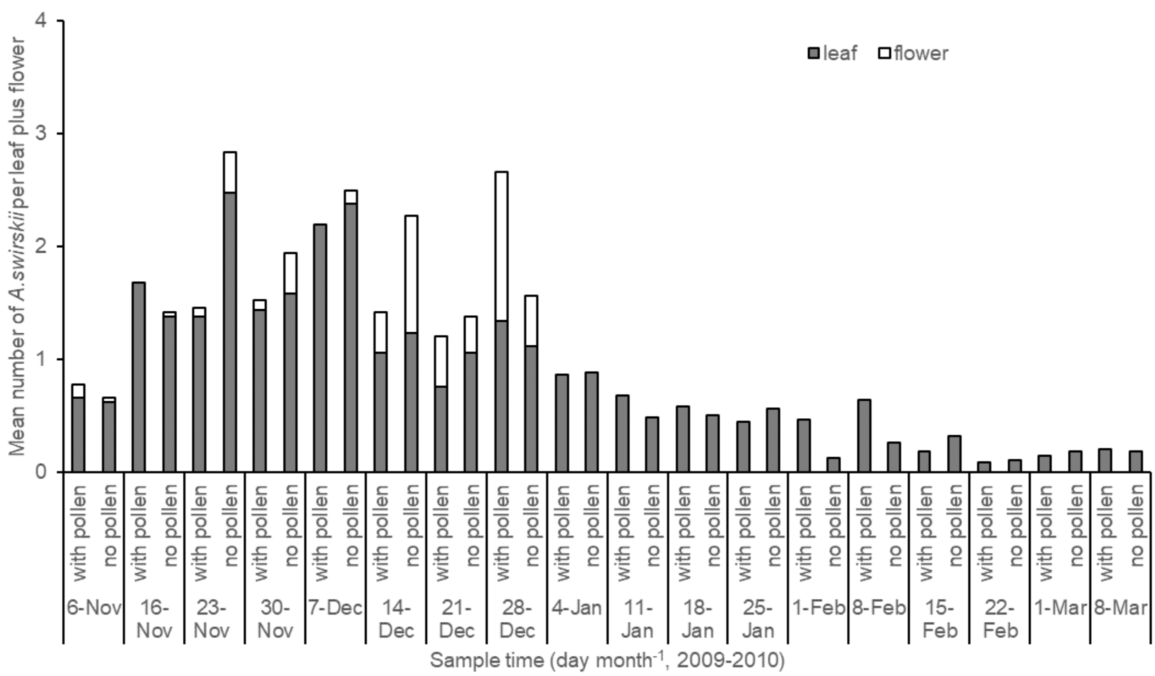

Figure 2. Effects of spraying pine pollen on the numbers of predatory mite, *Amblyseius swirskii* in unheated plastic greenhouse experiment.

Additionally, Bolckmans et al. (2005) suggested that *A. swirskii* is able to establish on flowering pepper in greenhouse without prey. When collaborated result of this study with the previous study carried by Kütük and Yiğit (2011), Kumar et al. (2015) and Bolckmans et al. (2005), pine pollen was less suitable food source than pollen own pepper plants for *A. swirskii*. Goleva and Zebitz (2013) suggested that *A. swirskii* can feed exclusively on pollen, but the nutritional value of pollens is significantly important for the performance of this predatory mite. However, the nutritional suitability of different pollens for *A. swirskii* is not sufficiently known yet.

4. Conclusion

Considering all these results, pollen own peppers is suitable food source to establish for *A. swirskii* in greenhouse grown pepper, additional pollen provision is not necessary. On the other hand, to obtain a better knowledge, the nutritional value of pine pollen as food source for *A. swirskii* with a full analysis of pine pollen constituents and the correlation of life-table is necessary.

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