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Control of the Two-Spotted Spider Mite, *Tetranychus urticae* Koch on Kidney Bean and Pea Plants

A. A. Abdallah*; M. M. Al-Azzazy*; M. H. Mowafi*; E. M. A. El-Saiedy and M. A. Pastawy***

*Agric. Zoology and Nematology Dept. Fac. of Agric., Al - Azhar Univ., Cairo, Egypt

**Plant Protection Dept., National Research Centre, Dokki, Giza, Egypt

ABSTRACT

The effect of the two predatory mite species *Phytosiulus persimilis* Athias-Henriot and *Typhlodromips swirskii* (Athias-Henriot), fungal entomopathogen, *Beuvaria bassiana* and the biochemical compound Abamectin (Vapcomic) were investigated against the two-spotted spider mite**,** *Tetranychus urticae* Koch on kidney bean (Paulista) and sugar snap pea (Snow wind) in a greenhouse at Behaira governorate during 2013 season. The average number of spider mite population was significantly different among the different treatments on Paulista ($F_{4,99}$= 39.025; $P < 0.001$; Table 1), and on Snow wind ($F_{4,99}$= 32.17; $P < 0.001$). The mean reduction percentage of spider mite populations on both plant varieties by *P. persimilis* was significantly the highest (95.2%), followed by treating with Vapcomic (90.0 %) and the fungus *B. bassiana* (84.8%); *T. swirskii* caused the least (71.9%). Thus, using *P. persimilis* to control the two spotted spider mite on the two plant varieties (Paulista and Snow wind) is recommended.

Key Words: *Tetranychus urticae*, *Phytosiulus persimilis*, *Typhlodromips swirskii*, *Beuvaria bassiana*, Vapcomic.

INTRODUCTION

Bean, *Phaseolus vulgaris* L. and Pea, *Pisum sativum* L. are the most important economic vegetable crops in Egypt for both local consumption and export.

The two spotted spider mite, *Tetranychus urticae* Koch is one of the most important pests of many horticultural and field crops and attacks more than 200 host plant species.

The intensive use of insecticides and acaricides has led to resistance in many insect and mite species (van Leeuwen *et al*., 2010). Therefore, there has been an increasing interest in controlling spider mites by alternative control tactics such as biological control agents. The phytoseiid mite, *Phytoseiulus persimilis* is a specialist predator feeding on *Tetranychus* species (McMurtry and Croft, 1997). As considered its most frequent biological control agent especially in greenhouses (van Lenteren and Woets, 1988).

The predatory mite *Typhlodromips swirskii* (Athias-Henriot) is a generalist predator known to feed on other pests, e.g. whitefly, thrips and lepidopteran eggs (Swirski *et al*., 1967; Ragusa and Swirskii, 1975; Hoda *et al*., 1986; McMurtry and Croft, 1997). It is a recent addition to the beneficial assortment, developed and marketed by the Dutch producer of beneficial, Koppert B.V. (van Houten *et al.*, 2005). It is capable to prey on spider mites (Swirski *et al*., 1967; El-Laithy and Fouly, 1992; Momen and El-Saway, 1993; van Houten *et al*., 2007).

The use of entomopathogenic fungi to control certain pests may be an alternative for solving problems of chemical resistance (Omoto *et al*., 1994) and environmental contamination, thereby improving the economical and biological sustainability of this agro-ecosystem (Alves *et al*., 2005). *Beauveria bassiana* (Balsamo) is one of the major entomopathogen fungal (Rashki *et al*., 2009). It is widely distributed in nature (St. Leger *et al.*, 1992) and has been formulated for application in agricultural insect pest management systems with successful results (Wright and Kennedy, 1996; Faria and Wraight, 2001; Inglis *et al*., 2001; Feng *et al.*, 2004) and also has potential for mite control (Irigaray *et al.*, 2003; Wekesa *et al.*, 2006; Maniania *et al*., 2008).

It has been estimated that the spider mite, *T. urticae* has evolved resistance to more than 80 acaricides to date (Knowles, 1997; Devine *et al*., 2001; Choi *et al*., 2004; Van Pottelberge *et al*., 2008 and 2009) and resistance has been reported from many countries. As for mechanisms of resistance to acaricides with new modes of action (e.g. Abamectin, fenpyroximate, chlorphenapyr, METI-acaricides, spirodiclofen) enhanced detoxification in *T. urticae* strains has been reported (Devine *et al*., 2001; Stumpf and Nauen 2001and 2002; Kim *et al*., 2004a and b; Van Leeuwen *et al*., 2006; Van Pottelberge *et al*., 2008 and 2009).

The present study aims to control the phytophagous mite, *T. urticae* on plants by using two predatory mite species, *P. persimilis*, and *T. swriskii* and the entomopathogenic fungi *B. bassiana* as well as Abamectin.

MATERIALS AND METHODS

Experimental design:

The two plant species, kidney bean "Paulista" and the sugar snap pea "Snow wind" were cultivated in a greenhouse to study the control of the spider mite, *T. urticae* by using two predatory mite species, on entomopathogenic fungi and a chemical compound at Nubariya, El-Behaira governorate in 2013. Five treatments for each plant species were conducted; each treatment was replicated three times. The experimental design was complete randomized block. In order to study the population of phytophagous species, leaf samples were collected weekly, starting on 22th Septmber 2013 until 2nd February 2014.

Sampling Procedure:

Twenty leaves of each treatment were randomly collected from the two plant species, placed directly into plastic bags and transported to the laboratory. All mite stages were counted to evaluate the reduction percentage of the pest populations on the cultivars after treated.

Rearing the predatory mites:

The predatory mites, *P. persimilis* and *T. swirskii* were reared using the methods modified by McMurtry and Scriven (1965); large plastic boxes 26 x 15 x 10cm were used. Cotton pad was placed in the middle of each box, leaving a space provided with water as a barrier to prevent predatory mites from escaping. Excised bean leaves highly infested with *T. urticae* were provided every day as a food source and the plastic boxes were kept in an incubator at 25±2 °C.

Mass rearing the predatory mites:

For mass rearing of the predatory mites, bean plant, *P. vulgaris* was served as host plant which reared in a small glasshouse divided into three isolated parts (a) clean bean plants, (b) clean plants at stage of 12 leaves infested with spider mite, *T. urticae* (c) bean plants infested with five gravid females of the predatory mites for every plant (El-Saiedy, 2003 and El-Saiedy and Romeih, 2007). Temperature in the glasshouse ranged from 18 to 25°C and relative humidity from 50 – 60%.

Release of Predatory mites:

The predatory mite species: *P. persimilis*, was released on 22th of September as the population density of *T. urticae* build up on two plant species with a rate of 1:7 predatory mite/prey, respectively for one time. The second predatory mite species, *T. swirskii* was released two times on 22th of September and repeated again on 27th of October. Repetitions of releasing samples were conducted weekly. Both mite pest and predatory mite individual were calculated.

Other control type:

B. bassiana Anti-Insect© was sprayed three times (on 22th of September, 27th of October and on 1st of December) at a rate of 1 L /100 Liters water.

The chemical compounds: Vapsomic (Abamectin) was used three times at a rate of 40 Cm3 /100 Liters water + 250 cm3 oil kaby.

The reduction percentages of the average population number of phytophagous species were calculated according to the equation of Henderson and Titton, 1955).

Statistical analysis:

One-way analysis of variance (ANOVA) and mean comparison using Fisher's least significant difference (LSD) were conducted for the number of spider mite, using the software packages SPSS 16.0.0 (USA) for windows. Significance level was $P \leq 0.05$.

RESULTS AND DISCUSSION

The two predatory species, *P. persimilis* and *T. swriskii*; the biochemical compound Abamectin (Vapcomic) and the entomopathogen fungal *B. bassiana* were used to evaluate their effect in reducing the population densities of the two spotted spider mite, *T. urticae* on kidney bean "Paulista" and the sugar pea "Snow wind".

The control experiments were started on both plant hosts from the 4th week of germination when the infestation of the two plant species with *T. urticae* started. The average number of spider mite was about the same on both plant species (about 40 individuals/compound leaf, on 22nd of September then the experiments started).

Table 1 showed that the average number of spider mite and the reduction percentage for all treatments, on each of Paulista and Snow wind.

For Paulista: There was high significant difference between the average number of spider mite populations of the different treatments on Paulista ($F_{4,99}$ = 39.025; $P < 0.001$). *P. persimilis* and the Vapcomic treatments gave the highest reduction percentage of spider mite population 94.9% (with 13.15individual/leaf) and 92.2% (with 19.81individuals/leaf), respectively. The fungus treatment caused 86.3% (with 35.03 individuals/leaf); while *T. swriskii* gave the lowest reduction percentage of spider mite population 68.5% (with

Table 1: The population average of spider mite, *T. urticae* / leaf and their corresponding reduction percentage by the two predatory mite species, fungus and Vapcomic on the two plant hosts.

Treatments	Plant species								*Mean Reduction %
	Paulista				Snow wind				
	Mean±SE	Max.	Min.	Reduction	Mean ± SE	Max.	Min.	Reduction	
T. swirskii	80.30±5.67[c]	129.25	43.95	68.5	61.18±4.24[c]	48.10	18.10	75.2	71.9
P. persimilis	13.15±3.99[a]	44.05	0.00	94.9	11.20±1.66[a]	21.50	0.00	95.5	95.2
Fungus	35.03±5.78[b]	91.55	8.70	86.3	41.34±9.75[b]	73.75	1.75	83.3	84.8
Vapcomic	19.81±4.42[ab]	62.25	1.50	92.2	30.13±6.22 [b]	45.75	1.25	87.8	90.0
Control	255.30±37.92[d]	511.80	43.95	-	247.08±39.08[d]	258.70	21.00	-	-

*Mean reduction is the reduction of both treatments of the plant species. Means followed by different subscript letters within columns are significantly different from each other (P < 0.05) LSD test.

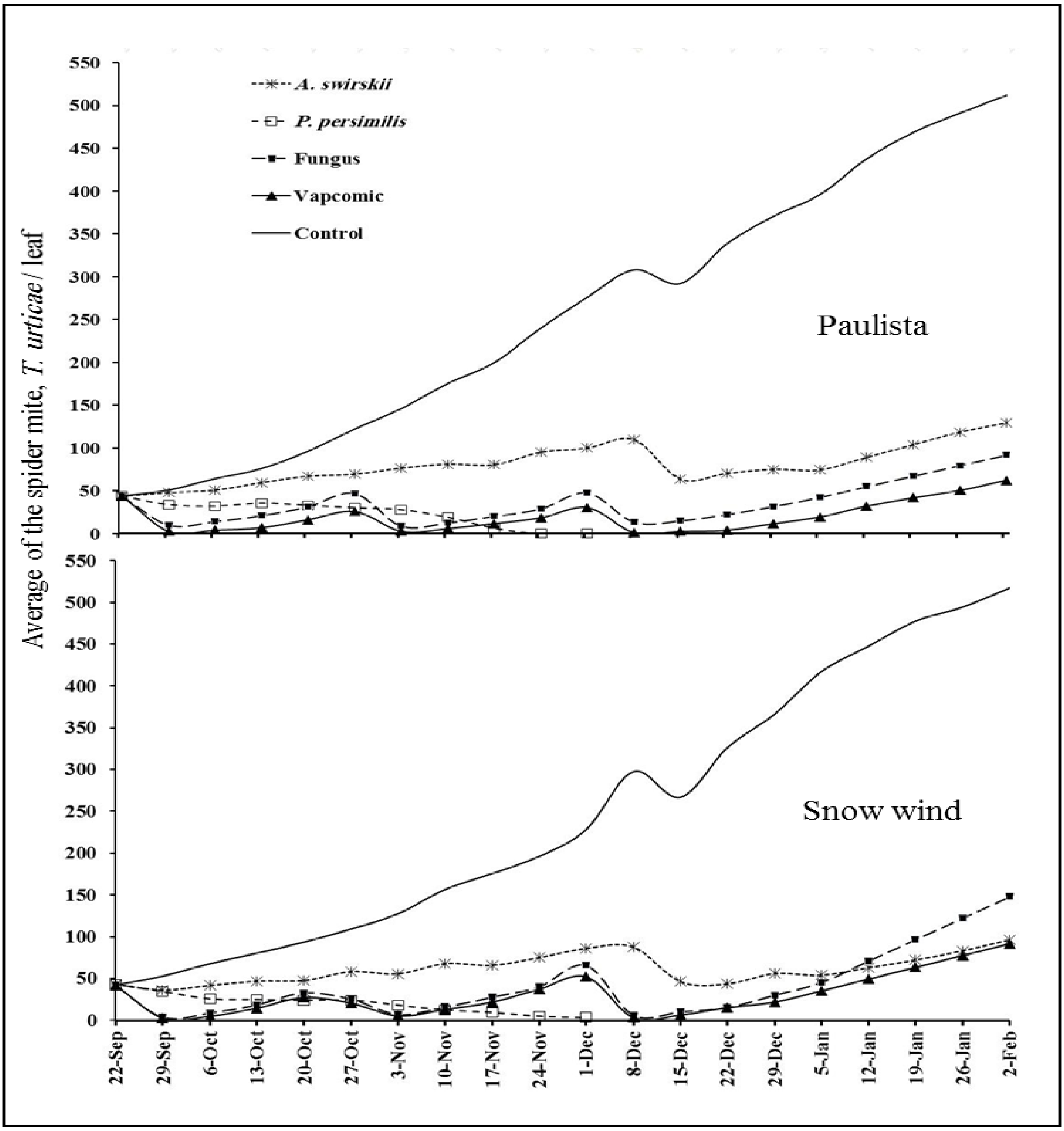

Fig. (1): The average number of the spider mite, *T. urticae*/leaf, week on the two plant species affected by releasing the two predatory mite species, fungus, and Vapcomic as well as the control**.**

80.30 individuals/leaf).

For Snow wind: There was a high significant differences of between average numbers of spider mite population when using the four treatments and compared with the control ($F_{4,99}$= 32.17; $P < 0.001$). *P. persimilis* gave the highest reduction percentage of the pider mite population 95.5% (with 11.20 individuals/leaf; $P < 0.05$), followed by the Vapcomic and the fungus treatments which were 87.8% (30.13 individuals/leaf) and 83.3% (with 41.34 individuals/ leaf), respectively; while *T. swriskii* caused the lowest reduction percentage of spider mite population among all treatments 75.2% (with 61.18 individuals/ leaf; $P < 0.05$ (Table 1).

Figure 1 summarizes the relation between time (week) and the mean average numbers of the spider mite (individuals) for the previously mentioned four treatments and the control for each of the two plant species.

The *P. persimilis* treatment curve was approximately consent for the first five weeks from the beginning of the experiment, then decreased and reaching approximately the zero value through the next three weeks and then continued at the zero value for the rest of the season (Fig.1).

The curves of the Vapcomic and fungus treatments revealed the same trend. For each of the two curves a sharp decrease was noted in spider mite population for one week after the first spraying on 22**th** of September. This decrease followed by a slight increase till the population reached its first peak after 5 weeks. The second spraying was carried out on 27th of October. For five weeks after the 2nd spraying, the spider mite population had the same cycle as that of 1st five weeks. After 10 weeks the 3rd spraying was carried out (on 1st of December). Whenever the spider mite population decreased sharply for one week then started to increase which continued till the end of the season.

For *T. swirskii* treatment, the spider mite population decreased significantly compared with that of the control. The spider mite population increased till the second release (on 8th of December, after which the spider mite population sharply decreased for one week due to the weather conditions. After that, the spider mite population remained constant for the next 3 weeks after which the population started to increase and this increase continued till the end of the season at which the population reached 129.25 individuals/ leaf (Fig.1).

For the curve which represents the control of both plant species; there was no significant difference of spider mite population on both plant hosts ($F_{9,199}$= 31.50; $P < 0.05$). Figure 1 indicates that the spider mite population gradually increased for both treatments till reached its first peak (about 300 individuals/ leaf), at the eleventh week (on 8th of September). Through the next week, the spider mite population decreased in both plant species due to the weather condition, after which the spider mite started to increase again and this increase continued till the end of the season at which the population reached about 500 individuals/ leaf.

Several species of natural enemies have been reported to prey on *T. urticae* and studies have been conducted in different countries to assess the effect and potential of natural enemies for controlling the pest without the use of pesticides (Garcia-Mari and Gonzalez-Zamora, 1999). The entomopathogenic fungi play an important role in the regulation of phytophagous mite populations and sometimes to decimate it (Van der Geest *et al.,* 2000) and consequently reduce the application of acaricides. So the biological control by the fungi is much more economical than chemical control. Successful biocontrol can be obtained in many cases (e.g. Brødsgaard and Enkegaard, 1997; Messelink *et al.,* 2005& 2006).

The predatory mite, *P. persimilis* enhanced the lowest population number of spider mite, *T. urticae* 13.15individuals for Paulista and 11.20 individuals/ leaf for Snow wind. The predatory mite *P. persimilis* was efficient to suppress the spider mite populations. These results agree with that of Gould (1971); French *et al.* (1976) and Mori & Saito (1979) which suggested *P. persimilis* type I as a specialist predator of all species of genus *Tetranychus* (McMurtry and Croft, 1997); and could provide the best control of this pest. Table 1 shows that the reduction percentage of spider mite populations by the predatory mite, *P. persimilis* was significantly the highest LSD; $P < 0.01$; 94.9% for Paulista and 95.5% for Snow wind (the mean reduction percentage for the two plant species averaged 95.2%. Also, the mean reduction percentages for the other treatments are 90.0% for Vapcomic, 84.8% for *B. bassiana* and 71.9% for *T. swirskii*.

As there is no significant difference between population reduction of spider mite when using each of *P. persimilis* and Vapcomic treatments Paulista, *P. persimilis* is more preferable to control spider mite than Vapcomic as a biochemical compound control requires 3 applications through the season; while application of *P. persimilis* requires only one release per season.

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