Field Performance of Insecticides Treatments against the Immature and Adult Stages of Whitefly on Tomato Plant

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ABSTRACT

Field experiments were carried out during 2015 and 2016 seasons at the experimental farm, Faculty of Agriculture, Saba-Basha, Alexandria University to evaluate the efficacy Prev-AM®, Planta® and Mospilan® against *B. tabaci* on tomato plants. prev-AM® achieved the highest initial and residual reduction% of whitefly adults giving (84.8%, 69.7%), respectively. Planta® achieved the highest initial and residual reduction% of whitefly immature giving (78.7%, 81.2%), respectively. On the other hand Mospilan® achieved the least initial effect. Sequence 4 (prev-AM®, Planta®) recorded the highest initial and residual reduction% of whitefly adult giving (86.3%, 83.1%), respectively. Sequence 5 (Planta®, Mospilan®) gave the highest initial and residual reduction% of whitefly immature giving (89.2%, 88.8%), respectively. Natural pesticides based on plant-essential oils may represent alternative crop protectants. From this study, orange oil and pyriproxyfen may introduce an effective control agents against whitefly in tomato field.

Key words: *Bemisia tabaci*, tomato plants, insecticide sequences.

INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill is considered to be one of the most important vegetable crops for consumption and processing. It is a rich source of lycopene, beta-carotene, folate, potassium, vitamin C, flavonoids, and vitamin E (Willcox *et al*., 2003; Bose and Agrawal, 2007). Tomato is exposed to a great number of insect pests. Insects attacking tomato plants are becoming increasingly difficult to control in the field in particular. Among the dangerous pests which attacking tomato is whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae)

Whitefly is attacking various vegetable, ornamental and field crops (Byrne and Bellows, 1991; Oliveira *et al*., 2001; Stansly and Naranjo, 2010). It directly damages the plant by feeding on phloem sap, and excretes honeydew on the leaves and fruits. This sticky and sugary surface is suitable for the growth of black sooty mold fungi that stain the crop and cover the leaves, thus preventing proper photosynthesis. In addition, stickiness and discoloration greatly reduce the value of agricultural crops such as ornamental, vegetables and cotton. Also, *B. tabaci* is a vector of several important families of plant viruses (Jones, 2003; Hogenhout *et al*., 2008). In some crops (e.g. tomatoes and cassava) the resulting virus diseases are limiting growth factors and may cause total crop loss. Mostly, this insect pest is controlled by synthetic insecticides. Such reliance is expected to increase tolerance or the development of resistance in addition to the adverse effects on non-target organisms (Palumbo *et al*., 2001). To overcome these problems, insect control alternatives must be used for management of this insect such as pyriproxyfen and orange oil.

Pyriproxyfen is a potent juvenile hormone (JH) mimic, affecting the hormonal balance in insects, suppressing embryogenesis, metamorphosis and adult formation (Itaya, 1987; Langley, 1990; Koehler and Patterson, 1991). It has been considered a leading insecticide for controlling whiteflies (Ishaaya and Horowitz, 1995; Crowder *et al*., 2008; Castle *et al*., 2010), especially biotype B. Therefore, the aim of the present work was to evaluate orange oil, pyriproxyfen and acetamiprid against *B. tabaci* in tomato field. Also, some sequences of these insecticides were evaluated for successive control of this insect.

MATERIALS AND METHODS

Tested insecticides:

Acetamiprid (Mospilan® 20%SP) supplied by Nippon Soda Co., Ltd. was used at field rate of 25 g/100 liter water. Orange oil (Prev- AM® 6% SL) provided by Bridgetrade comp., was used at field rate of 400 ml/100 liter water. Pyriproxyfen (Planta®10%EC) was used at field rate of 75 ml/100 liter water.

Field experiments were carried out during two successive summer seasons of 2015 and 2016 at the experimental farm, Faculty of Agriculture, Saba-Basha, Alexandria. One variety of tomato (6112) was used during the course of this study and cultivated on May 11 and May 15, at 2015 and 2016 season. Treatments were arranged in a randomized complete block design (RCBD). Each treatment was replicated three times (42 m^2 each). The normal agricultural practices were applied. The insecticides were sprayed by Knapsack sprayer equipment (CP3) at the rate of 200 liter per feddan. Control was sprayed only by water.

The inspection samples of whitefly adult individuals were carried out before treatment and 1day, 5, 7 and 10

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days post treatment (residual effect). Counts were done in the early morning for adults when flight activity is minimal according to Bulter *et al*., (1988). Ten leaves were picked at random from each plot and put in numbered paper bags and transferred to the laboratory for examining the immature stages by using stereoscopic binocular microscope.

The reduction percentages in numbers of whitefly adults and immature stages were calculated in accordance to Henderson and Tilton's equation (1955). Treatments were compared with each other using one way ANOVA with $LSD_{0.05}$ (CoStat Statistical Software, 1990).

RERSULTS

Reduction percentages of whitefly adults and immature as a result of some insecticide treatments: (2015)

According to the general means of initial and residual effects in season 2015, whitefly populations were significantly reduced by the insecticide treatments (Table 1). Results indicated that, Prev-AM® and Planta® achieved the highest initial (24hr) reduction% of whitefly adults with general mean 84.8% and 77.8%, respectively. On the other hand, Mospilan® achieved the least initial reduction with general mean 57.3%. Prev-AM® gave the highest residual toxicity against whitefly adults followed by Mospilan® which is followed by Planta® with general means reduction 69.7%, 57.3% and 54.6%, respectively.

Regarding the whitefly immature stage (Table 2), Planta® gave the highest initial reduction% with general mean78.7% followed by Prev-AM®63.0% which is followed by Mospilan® 60.4%. The general mean reduction percentages of immature stage for the residual effect revealed that, Planta® was the most effective treatment giving 81.2% followed by Prev-AM® with 66.5% which is followed by Mospilan® with 38.7%.

Reduction percentages of whitefly adults and immature as a result of some sequence of insecticide treatments (2016):

At season 2016, the exhibited data in Table (3) demonstrate the calculated reduction percentages of whiteflies after application of the six suggested sequences of tested insecticides. All tested insecticide sequences significantly reduced the numbers of whitefly adult stage. Sequence 4 (Prev-AM®, Planta®) recorded the highest initial reduction% of whitefly adult with general mean 86.3%, followed by sequence 3 (Prev-AM®, Mospilan®) with 81.2% reduction. On the other hand, sequence 1 (Mospilan®, Planta®) achieved the least initial effect with 64.0% reduction. According to the general mean reduction percentages of residual effect against the adult stage, sequence 4 achieved the highest efficiency, with 83.1% reduction followed by sequence 3 (Prev-AM®, Mospilan®) giving 78.1% reduction. On the other hand, sequence 1 exhibited the lowest residual efficacy.

Results in Table (4) show the initial and residual general mean reduction percentages of whitefly immature stage as a result of some insecticide sequences treatments. Sequence 5 (Planta®, Mospilan®) gave the highest initial reduction% with general mean 89.3%. There were no significant differences among other sequences. Regarding the general mean reduction percentages of residual effect, sequence 5 recorded the highest reduction 88.9% followed by sequence 6 (85.1% reduction). However, sequence 2 achieved the least residual effect (70.1%).

DISCUSSION

The sweet potato whitefly *B. tabaci* is an important pest of many plant crops, vegetables and ornamentals (Oliveira *et al.,* 2001). Damage by *B. tabaci* is caused by its sap-sucking activity, vectoring plant diseases and secreting honeydew that promotes the growth of sooty mould (Obeng-Ofori, 2007). *Bemisia* pest management programs are usually based on insecticide applications, but these products are often toxic to the environment and to non-target species. Therefore, it is important to search about more safe and effective alternatives to control this insect pest. In the present study, the IGR compound, pyriproxyfen and the orange oil are compared with acetamiprid for the whitefly control in tomato field. Some insecticide sequences were also evaluated.

Results indicated that, orange oil (Prev-AM®) and pyriproxyfen (Planta®) achieved a good control of both adult and immature stages of whitefly. In addition, Sequence 5 (Planta®, Mospilan®) gave the highest control of whitefly adult and immature stages. These results are in agreement with those of Isaac and Horowitz (2006) who mentioned that treatment of whitefly larvae with 0.04–5 mg L^{-1} of pyriproxyfen resulted in normal development until the pupal stage; however, adult emergence was totally suppressed. Second instar of B. tabaci exposed to 5 mg L^{-1} pyriproxyfen, excreted honeydew at a level similar to the control level until the 4^{th} instar (pupation), after which a strong reduction was observed. Inhibition of egg-hatch on the lower surface of cotton leaves was observed when their upper surface was treated with 1–25 mg L^{-1} pyriproxyfen, indicating a pronounced translaminar effect.

Table 1. Field performance of certain insecticides and biorational agents against the adult stage of *B. tabaci* (Genn.) in tomato plants (Season 2015)

Treatments	**Pre spray	% Reduction of *B. tabaci* adult 1st spray					**Pre spray	% Reduction of *B. tabaci* adult 2nd spray					General mean of initial effect	General mean of residual effect
		1 day	5 days	7 days	10 days	*mean		1day	5 days	7 days	10 days	* mean		
Control	26.0	-	-	-	-	-	4.6	-	-	-	-	-	-	-
Mospilan®	13.0	54.5^{b}	37.2	63.7	47.7	49.5^{b}	7.6	60.2^{a}	61.9	67.1	66.0	65.0^{ab}	57.3^{b}	57.3^{b}
Prev-AM®	25.3	80.6^{a}	42.9	74.7	87.1	68.3^{a}	3.6	88.9^{a}	61.9	68.1	83.3	71.1^{a}	84.8^{a}	69.7^{a}
Planta®	27.0	77.0^{a}	42.2	37.8	83.0	54.3^{b}	5.0	78.6^{a}	41.7	64.2	34.4	54.9^{b}	77.8^{a}	54.6^{b}

In the same column numbers followed by the same letter are not significantly different according to LSD (P=0.05)
* Mean residual effect of reduction percentage for 5, 7 and 10 days
**No. of adults per ten leaves

Table 2. Field performance of certain insecticides and biorational agents against the immature stage of *B. tabaci* (Genn.) in tomato plants (Season 2015)

Treatments	**Pre spray	% Reduction of *B. tabaci* immature 1st spray					**Pre spray	% Reduction of *B. tabaci* immature 2nd spray					General mean of initial effect	General mean of residual effect
		1 day	5 days	7 days	10 days	*mean		1day	5 days	7 days	10 days	*mean		
Control	656.0	-	-	-	-	-	151.3	-	-	-	-	-	-	-
Mospilan®	618.6	63.7^{a}	40.74	20.0	23.7	28.1^{c}	205.3	57.1^{b}	50.5	58.4	38.8	49.3^{c}	60.4^{b}	38.7^{c}
Prev-AM®	674.0	61.2^{a}	62.8	62.6	72.6	66.0^{b}	111.0	53.7^{b}	46.0	56.5	79.4	67.1^{b}	63.0^{b}	66.5^{b}
Planta®	853.6	67.8^{a}	82.9	38.2	94.1	84.3^{a}	45.3	89.6^{a}	78.3	79.8	74.7	77.61^{a}	78.7^{a}	81.2^{a}

In the same column numbers followed by the same letter are not significantly different according to LSD (P=0.05)
* Mean residual effect of reduction percentage for 5, 7 and 10 days
**No. of adults per ten leaves

Table 3. Field performance of certain insecticides sequences against the adult stage of *B. tabaci* (Genn.) in tomato plants (Season 2016)

Treatments	**Pre spray	% Reduction of *B. tabaci* adult 1st spray					**Pre spray	% Reduction of *B. tabaci* adult 2nd spray					General mean of initial effect	General mean of residual effect
		1 day	5 days	7 days	10days	*mean		1day	5days	7 days	10 days	*mean		
Conrtol	26.0	-	-	-	-	-	4.9	-	-	-	-	-	-	-
			Mospilan®						Planta®					
Squence 1	23.0	67.9[cd]	44.7	62.0	57.7	57.7[d]	10.3	74.8[bc]	80.2	65.9	67.9	71.3[a]	64.0[c]	64.7[b]
			Mospilan®						Prev-AM®					
Squence 2	23.3	72.1[bc]	62.3	43.4	69.6	64.1[cd]	10.3	71.9[c]	83.6	79.2	87.3	83.4[a]	71.5[bc]	74.8[a]
			Prev-AM®						Mospilan®					
Squence 3	35.3	79.7[ab]	60.3	77.6	93.9	77.3[ab]	5.0	82.6[abc]	38.9	78.9	58.9	78.9[a]	81.2[ab]	78.1[a]
			Prev-AM®						Planta®					
Squence 4	39.3	81.4[a]	86.6	78.6	91.1	85.45[a]	3.6	91.1[ab]	93.3	70.0	55.5	80.7[a]	86.3[a]	83.1[a]
			Planta®						Mospilan®					
Squence 5	35.6	76.5[abc]	59.0	75.3	89.6	74.7[b]	6.0	78.4[abc]	79.5	55.7	45.4	80.1[a]	77.5[ab]	77.4[a]
			Planta®						Prev-AM®					
Squence 6	44.0	61.9[d]	67.5	41.7	77.01	69.5[bc]	11.0	95.8[a]	81.9	96.7	75.1	84.5[a]	78.9[ab]	77.0[a]

In the same column numbers followed by the same letter are not significantly different according to LSD (P=0.05)

* Mean residual effect of reduction percentage for 5, 7 and 10 days

**No. of adults per ten leaves

Table 4. Field performance of certain insecticides sequences against the immature stage of *B .tabaci* (Genn.) in tomato plants (Season 2016)

Treatments	**Pre spray	% Reduction of .*B tabaci* immature 1st spray					**Pre spray	% Reduction of .*B tabaci* immature 2nd spray					General mean of initial effect	General mean of residual effect
		1 day	5 days	7days	10 days	*mean		1day	5 days	7 days	10 days	* mean		
Control	647.7	-	-	-	-	-	149.7	-	-	-	-	-	-	-
Squence 1	924.3	88.8[a]	Mospilan® 78.6	86.2	60.6	75.2[c]	240.0	80.7[b]	Planta® 71.8	58.9	85.9	72.2[c]	84.8[b]	73.6[cd]
Squence 2	557.6	80.3[cd]	Mospilan® 63.9	51.0	50.0	55[e]	376.6	84.2[b]	Prev-AM® 87.6	77.9	89.9	85.1[a]	82.2[b]	70.1[e]
Squence 3	781.0	81.9[bc]	Prev-sAM® 67.8	70.8	54.7	64.4[d]	208.6	80.4[b]	Mospilan® 82.7	71.3	81.8	78.6[b]	81.1[b]	71.5[cd]
Squence 4	511.3	88.2[ab]	Prev-AM® 69.0	78.1	77.6	74.9[c]	94.3	79.6[b]	Planta® 59.8	74.6	84.4	72.9[c]	83.9[b]	73.9[c]
Squence 5	682.6	86.5[abc]	Planta® 92.7	94.1	96.6	94.5[a]	45.3	92.1[a]	Mospilan® 89.0	86.0	75.1	83.4[a]	89.3[a]	88.9[a]
Squence 6	882.6	74.5[d]	Planta® 80.1	85.3	92.6	86.0[b]	46.3	92.5[a]	Prev-AM® 96.6	80.5	75.6	84.2[a]	83.5[b]	85.1[b]

In the same column numbers followed by the same letter are not significantly different according to LSD (P=0.05)
* Mean residual effect of reduction percentage for 5, 7 and 10 days
**No. of immature per ten leaves

These findings indicate that pyriproxyfen is an efficient control agent of *B. tabaci***.** In addition, Naranjo (2001) reported that if growers rely on softer chemicals, such as IGRs, they may increase the population of natural enemies (predators, parasitoids and pathogens). When pyriproxyfen and buprofezin were used for whitefly control on cotton, they are much more selective than the broad-spectrum conventional insecticides and do not affect several predator taxa (Naranjo *et al.,* 2002; Naranjo and Akey, 2004).

On the other hand, El-Aswad and Abou-Taleb (2008) evaluated different regimens of some insecticides in controlling cotton bollworm, they found that the sequence No.5 (spinosad, chlorpyrifos, spinosad and carbosulfan) achieved high efficacy against *Pectinophora gossypiella* which gave the reduction percentage of 87.6 and 88.1 while, the sequence No.4 (deltamethrin, chlorpyrifos, deltamethrin and carbosulfan) achieved superior efficacy against *Earias insulana* which gave 89.3 and 92.5 reduction of infestation throughout season 2006 and 2007, respectively.

The use of plant extracts, including allelochemical compounds such as essential oils, with known effects on insects, could be a useful complementary or alternative method to the heavy use of classical insecticides. This could improve the biodegradability of insecticide treatments and therefore decrease the quantity of toxic insecticide residues, increase insecticide selectivity and develop a better respect for the environment. Various essential oils are documented to exhibit acute toxic effects against insects (García *et al*., 2007; Rajendran and Sriranjini, 2008; López and Pascual-Villalobos, 2010). Eucalyptus and citrus oils, such as lemon and orange, are widely utilized in various industries and are of low cost. Our results are compatible with results of Shehata *et al*., (2009), where they reported that prev recorded good reduction in whitefly numbers on cucumber plant.

Finally, concerns over health and environmental problems associated with synthetic insecticides currently in use in agriculture have led to an intensification of efforts to find safe alternatives. Plants may provide potential alternatives to currently used insect-control agents because they constitute a rich source of bioactive chemicals. Natural pesticides based on plant-essential oils may represent alternative crop protectants. From this study, orange oil and pyriproxyfen may introduce and effective control agents against whitefly in tomato field.

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الملخص العربي

التقييم الحقلى لبعض المبيدات ضد الذبابة االبيضاء فى نبات الطماطم

منى عبد الكريم عبد الظاهر محمود

تم إجراء تجربتين خلال موسمى نمو ٢٠١٥، ٢٠١٦ فى مزرعة كلية زراعة- سابا باشا، جامعة الإسكندريه وذلك بهدف تقييم كفاءة بريف ايه أم، بلانتا، موسبيلان فى مكافحة الذبابة البيضاء التى تصيب نباتات الطماطم تحت ظروف الحقل.

أظهرت النتائج خلال موسم ٢٠١٥ أن بريف ايه أم، كان أكثر كفاءة فى خفض تعداد الأطوار الكاملة معطيا أعلى متوسط عام للتاثير الفورى والباقى (٨٤,٨%، ٦٩,٧%) على التوالى، مركب بلانتا سجل أعلى كفاءه فى مكافحة الحوريات معطيا متوسط عام للتأثير الفورى والباقى (٧٨,٧%، ٨١,٢%) على التوالى. بينما الموسبيلان كان أقل المعاملات كفاءة فى مكافحة الذبابة البيضاء.

تم دراسة بعض تعاقبات المبيدات ضد أطوار الذبابه البيضاء خلال موسم ٢٠١٦ ، وقد وجد أن التتابع الرابع (بريف ايه أم، بلانتا) أكثر كفاءة فى مكافحة الأطوار الكامله للذبابه معطيا متوسط عام للتأثير الفورى والباقى (٨٦,٣%، ٨٣,١%) على التوالى. أما التتابع الخامس (بلانتا، موسبيلان) سجل أعلى كفاءة فى مكافحة الحوريات معطيا متوسط عام للتأثير الفورى والباقى (٨٩,٣%، ٨٨,٩%) على التوالى. ويتضح من ذلك أنه يمكن استخدام المبيدات الطبيعيه المحتويه على الزيوت الطياره فى وقاية المحاصيل كبدائل عن المبيدات، ونستنتج من هذه الدراسه أن زيت البرتقال، البيربوكسفين تعتبر وسائل مكافحة جيدة ضد حشرات الذباب الأبيض فى الطماطم.