Minufiya J. Agric. Res. Vol.37 No. 4(2): 955 - 963 (2012) **"http://www.mujar.net"**

EFFECTS OF SPRAYER TYPES AND DOSES OF PESTICIDES IN THE CONTROL OF WHITEFLY, *BEMISIA TABACI* (GENN.) INFESTING TOMATO PLANTS

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(Received: Mar. 17, 2012)

ABSTRACT: *Field experiments were conducted to evaluate the initial and residual effects of Biofly, Beauveria bassiana and Actra efficiency on the whitefly, Bemisia tabaci (Genn.) by using three sprayer types, Knapsack motor sprayer (Arimitsu 25 L/Fed.), Conventional sprayer (200 L/fed.) , and Rotary sprayer Micron ULV (15 L/fed.) in Mitawa Village, Fakous district in Sharkia Governorate, Egypt during tomato summer plantation of 2010 season. Results showed that, Actra ¾ recommended rate by using Conventional sprayer after three days of the 1st and the 2nd sprays proved to be the most effective against B. tabaci adults (87.5% and 93.5%) reduction, respectively followed by Actra recommended rate and ¾ recommended rate by using Rotary micron ULV sprayer after the 1st spray recorded the same reduction percentage 79.4. Actra recommended rate occurred highest initial effect after three days from the 1st and the 2nd sprays against B. tabaci eggs showing 95.0% and 94.3% reduction, respectively, with Conventional sprayer. In general, the average of residual effect after the 1st and the 2nd sprays was significantly different between the tested materials and untreated. It could be concluded that controlling B. tabaci depends mainly on the efficacy of the used insecticide and the sprayer type.*

Key words: *Bemisia tabaci, tomato plants, Insecticides, Sprayer types, Beauveria bassiana , Biofly , Actera.*

INTRODUCTION

Tomato, *Lycopersicon esculentum* Miller is one of the economically important vegetables in Egypt as well as in the world. Its fruits are used freshly and/or as processed juice. Tomato, may be considered as one of the major host plants of the whitefly, *Bemisia tabaci* (Gennadius). Whitefly cause direct damage by sucking juice and indirect damage by excretion honeydew, which interferes with the photosynthetic process reducing crop development and decreased the yield (Amir *et al.,* 2007). But control methods of whitefly are difficult because the immature stages develop on the undersides of the leaves and applications are usually ineffective in delivering control agents to the leaf undersides and leaf surfaces (Sharaf *et al.,* 2003).

Several strategies can be employed to control *B. tabaci* but insecticidal application is the most effective way and widely used. The insect has developed resistance to most of the commercially available insecticides (Forer, 1990 and Sharaf *et al.,* 2003). Therefore, pesticides which are recommended for the vegetable crops in the integrated pest management program should have a quick effect and a low residual level to overcome problems of building up resistance which may be emerged through intensive use of pesticides. Residues, which exceeded the maximum level, may also reduce the product quality and induce health hazards to humans (Kotb, 2000). Also, effectiveness of insecticides is not only dependent on the material used, but also on other factors such as application technology, timing, rate of application and weather conditions (Carlos *et al.,* 1995).

Undoubtedly, appropriate application techniques can improve pesticide efficacy and reduce hazards particulary those cause by pesticides drift (Matthews, 1981). Thus

for insecticide applications, spray droplet size is important for insect control, when small droplets are applied, drift potential increases, thereby increasing the possibility of adverse effects on surrounding plants and animals. Many efforts have been directed toward determining droplet size effect on insect control (Abd-Allah and Ammar, 2008).

The present study aimed to evaluate different spray parameters of three sprayers on the efficacy of the two insecticides against *B. tabaci* on the tomato plants.

MATERIALS AND METHODS

Experimental design:

Field experiment was carried out at Mitawa Village, Fakous district in Sharkia Governorate, Egypt. Experimental area about 2250 m^2 was chosen and divided into 45 plots (each of 50 m^2) planted with tomato, *Lycopersicon esculentum* Miller, Super Strain B Variety after seeded in green house and then transferred to the field on 25th June 2010 summer seasons. Three designs of sprayers were chosen to apply the two tested insecticides. All treatments were distributed in complete randomized block design; each treatment was replicated three times. Untreated plots were sprayed with water alone as control. The sprayers were chosen as of light weight, low volume application and commonly used.

Sprayer types:

1-Knapsack motor sprayer (Arimitsu).
2-Conventional sprayer.
3-Rotary sprayer, Economy Micron ULV.

The technical data, spray parameters and performances of the tested ground equipments are illustrated in Table (1).

Tested materials and their rates:

1- The bio-insecticide (Mycoinsecticide), Biofly liquid (active ingredient *Beauveria bassiana* 100% WW 3x10^6 live cell/cm) at a rate of 100 cm/100 litre of water.
2- Actra 25% WG (Thiamethoxam), Neonicotinoid at a rate of 20g/100 litre of water.

The tested materials were applied on 20th July as the first spray and on 4th August as the second spray.

Application, sampling and efficacy assays:

Early morning before spraying, the whitefly adults were counted on ten leaves of the plants per plot. Within each plot at each level of plants, ten leaves were randomly picked from plants for counting the immature stages. Plant leaves were collected in paper bags and transformation to laboratory for counting the immature stages under stereomicroscope. Samples were collected before spraying and then at 3, 5 and 10 days after spraying.

Table (1): Technical specification of spraying techniques applied on tomato plants.

Spray parameters	Knapsack motor sprayer (Arimitsu)	Conventional sprayer	Rotary sprayer Micron ULV
Rate of application (L/Fed.)	25	200	15
Working speed (km/h)	2.4	2.4	2.4
Swath width (m)	1.0	0.75	1.0
Spraying height (m)	0.50	0.50	0.50
Flow rate (L/min)	0.238	1.428	0.143
Productivity (Fed./day)	0.57	0.42	0.850
Rate of performance (Fed./day)	2.28	1.68	4.50

Reduction percentages were calculated according to Henderson and Tilton equation (1955). Initial effect was estimated 3 days after insecticidal application, while residual activity was calculated by the average numbers of inspection 5 and 10 days after spraying treatments. However, data were subjected to analysis of variance (ANOVA) and the means were compared by LSD test at 0.05% level, according to technique described by Snedecor (1970).

RESULTS AND DISCUSSION

1- Efficacy of tested sprayers and materials on *B. tabaci* adults:

Data in Table (2) clearly showed that, all treatments provided various reductions in population of *B. tabaci* adults compared with the untreated, during the three days after the 1st spray ranged from 53.7 to 87.5% and the 2nd spray ranged from 61.5 to 93.5%. The efficacy of Actra ¾ recommended rate by using Conventional sprayer after three days of the 1st and the 2nd sprays proved to be the most effective against adults, giving 87.5% and 93.5% reduction, respectively followed by Actra at the recommended rate and ¾ recommended rate by using Rotary micron ULV sprayer after the 1st spray recorded the same reduction percentage 79.4% , while *Beauveria bassiana* recommended rate applied by Rotary sprayer showed 70.2% reduction of *B. tabaci* adults.

Data also indicated that, *B. bassiana* recommended rate using Knapsack sprayer, three days after the first and the second sprays had low effect on the exposed whitefly adults resulting 53.7 and 61.5% reduction, respectively.

Generally, the residual effect after (5-10) days of the 1st and the 2nd sprayers was significantly different between the tested pesticides and untreated control, while the 2nd spray was insignificantly different among the used sprayers.

Regarding to the average of the residual effect of the tested insecticides against *B. tabaci* adults, *B. bassiana* ¾ recommended rate after the 1st and the 2nd sprays by using Rotary micron ULV sprayer exhibited high effect giving 94.8% and 99.2% reduction, respectively.

2- Efficacy of tested sprayers and materials on *B. tabaci* eggs :

Data in Table (3) show that the decline in egg numbers was the same trend as in adult stage. The highest reduction percentages of *B. tabaci* eggs ranged from 68.1 to 95.0% after the 1st spray with *B. bassiana* recommended rate and Actra recommended rate in eggs after three day, showing significant differences among the three sprayers. The corresponding mean reduction after (5 to 10) days after the second spray with Actra recommended rate and ¾ recommended rate was ranged from 93.8 to 97.1%, with significant differences between Conventional sprayer and other sprayers. Actra recommended rate recorded the highest initial effect after three days for the 1st and the 2nd sprays against *B. tabaci* eggs showing 95.0% and 94.3% reduction when applied with Conventional sprayer, while *B. bassiana* recommended rate registered the lowest initial effect after three days for the 1st and the 2nd sprays showing 68.1% and 85.8% reduction when applied with Knapsack sprayer.

3- Efficacy of tested sprayers and materials on *B. tabaci* nymphs:

Data in Table (4) show that the reduction percentages of *B. tabaci* nymphs varied considerably by using different sprayers. After 3 days of application Actra recommended rate occurred the highest initial effect for the 1st and the 2nd sprays against *B. tabaci* nymphs showing 85.4% and 94.3% reduction when applied with Conventional sprayer, while *B. bassiana* recommended rate occurred the lowest initial effect after three days in the 1st spray showing 15.0% reduction when applied with Conventional sprayer.

Reduction in the population of *B. tabaci* nymphs in the 1st spray after 3, 5 and 10 days of tested pesticides was the lowest compared with that recorded in the 2nd spray. As the three days after the 1st spray ranging 15.0 % to 85.4% and the 2nd spray

Table 2

Table 3

Effects of sprayer types and doses of pesticides in the control of ……..

Table 4

ranging from 81.9 % to 94.3%. And average of residual effect in the 1st spray ranging 45.6 to 91.4% and the 2nd spray ranging 91.7% to 99.5%. Also, the average of residual effect of *B. bassiana* recommended rate after the 1st and the 2nd sprays by using Rotary micron ULV sprayer exhibited high effect 91.40 and 99.5% reduction, respectively. In general, the average of residual effect in the 2nd spray was no significantly different between the sprayers used and tested materials.

Reviewing the formentioned results it could be concluded that controlling, *B. tabaci* depends mainly on the efficacy of the used insecticide and the used sprayers. Therefore, the methods used for pesticide application play a vital role in obtaining effective pest control, meanwhile affect some potential hazards to health of applicators and hazards of pesticides drift into the surrounding environment. The traditional high volume sprayers gave close rates of insect reduction in comparison to low volume sprayers, which appear superior coverage of treated plant leaves and penetrating the majority of horizontal and vertical parts of the plants without rolling the droplets (Hindy *et al.,* 1997; Abd-Allah *et al.,* 2011;). In addition, the use of low volume sprayers ensures the arrival and the homogenous coverage of the spraying solution to the places inhabits the immature stages of the whitefly.

These results also in agreement with those obtained by Ridgway *et al.* (1996) and El-Dahan *et al.* (1997) who found that, the use of the bio-insecticides is a promising tool as a result of selection of specific insect pathogens and formulation. El-Bessomy *et al.* (1997) stated that the reduction percentages in *B. tabaci* (eggs, immature stages and adults) were 81.02 and 74.67% for Biofly 100 and 50 ml/100 L. of water, respectively. El-Hamady *et al.* (1997) found that the efficacy of Sumicidin and undoubtedly other pesticides could be enhanced when applied by ULV that proved to be more advantages than the Knapsack sprayer against *B. tabaci* infesting cotton plants. Mason *et al.* (2000) showed that thiamethoxam (Actra 25% WG) reduced the population of *B. tabaci* by killing activity and antifeedent or repellent action. Abd Allah and Hashem (2003) found that, Biofly as a biocide caused good effect, which recorded 80.04% reduction in population of eggs and nymphs of whitefly infestation after the 2nd spray on eggplant. Amir *et al.* (2007) who found that mineral oil used Knapsack sprayer equipped with one nozzle occurred poor effect where indicated 31.28 and 51.61% reduction in population of *B. tabaci* adult and nymphs stages infesting squash plants. Abd-Allah and Ammar (2008) reported that the use of low volume sprayer using biocide may be recommended to reduce the time lost in filling and spraying to minimize the expenses and to prevent the soil pollution with insecticides.

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Minufiya J. Agric. Res. Vol.37 No. 4(2): 955 - 963 (2012) **"http://www.mujar.net"**

تأثير أنواع آلات الرش والجرعة المستخدمة من المبيدات فى مكافحة الذبابة البيضاء فى حقول الطماطم

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الملخص العربي

أجريت هذه الدراسة في قرية مطاوع – مركز فاقوس – محافظة الشرقية لتقييم فاعلية المركبين بيوفلاي وأكتارا ضد ذبابة الطماطم البيضاء وذلك خلال الموسم الصيفي ٢٠١٠ بإستخدام ثلاث أنواع من آلات الرش وهي: موتور الرش الظهري أريمتسيو بمعدل ٢٥ لتر/فدان والرشاشة التقليدية بمعدل ٢٠٠ لتر/فدان والرشاشة روتاري ميكرون أولفا ذات القطرات المتناهية في الصغر بمعدل ١٥ لتر/فدان وذلك بغرض تحديد أفضل توزيع لمحلول الرش علي نباتات الطماطم للحصول علي أفضل نسبة لخفض أعداد الأطوار المختلفة للذبابة البيضاء.

أوضحت النتائج أن الأكتارا (٤/٣ المعدل الموصي به) بإستخدام الرشاشة التقليدية بعد ثلاث أيام من الرشة الأولي والثانية أعطي أعلي نسبة مئوية للخفض في تعداد الحشرات الكاملة للذبابة البيضاء (٨٧,٥٪ ، ٩٣,٥٪) علي التوالي ، يليه الأكتارا (المعدل الموصي به و٤/٣ معدل موصي به) بإستخدام الرشاشة روتاري ميكرون أولفا بعد ثلاث أيام من الرشة الأولي والثانية حيث سجل نفس نسبة الخفض في التعداد (٧٩,٤٪).

كما أعطي المركب أكتارا (المعدل الموصي به) أعلي نسبة مئوية للخفض في تعداد بيض الذبابة البيضاء بعد ثلاث أيام من الرشة الأولي والثانية فسجل (٩٥,٠٪ ، ٩٤,٣٪) علي التوالي بإستخدام الرشاشاة التقليدية. كما أعطي عموماَ متوسط الآثر الباقي بعد الرشة الأولي والثانية إختلاف معنوي بين المبيدات المختبرة والمقارنة (غير المعاملة). بالنظر الي متوسط الآثر الباقي للمبيدات المختبرة ضد الحشرات الكاملة للذبابة البيضاء والحوريات فقد أعطي مركب البيوفلاي (٤/٣ ومعدل موصي به) بعد الرشة الأولي والثانية بإستخدام الرشاشة روتاري ميكرون أولفا أعلي نسبة مئوية للخفض في التعداد فسجل (٩٤,٨، ٩٩,٢٪) و (٩١,٤، ٩٩,٥٪) علي التوالي. كما أوضحت النتائج أنه عند إستخدام الرشاشات ذات الحجوم الصغيرة فإنه يتم الحصول علي تغطية منظمة لمحلول الرش والتصاق القطيرات علي أسطح الأوراق المعاملة والوصول الي أماكن تواجد أطوار الآفة.

Table (2): Effect of sprayer types and pesticides on average number and reduction percentage of *Bemisia tabaci* adults infesting tomato plants.

Treatment	Equipment	1st spray					2nd spray				
		Pre-treatment	%Initial Reduction	Residual effect (%Reduction)			Pre-treatment	%Initial Reduction	Residual effect (%Reduction)		
			3 days	5 days	10 days	Average		3 days	5 days	10 days	Average
Beauveria bassiana Recommended dose	Knapsack	9.3	8.6 (53.7)	6.3 (79.6)	4.0 (92.4)	5.2d (86.0)	2.6	2.0 (61.5)	0.6 (92.3)	0.6 (97.4)	0.6c (94.9)
	Conventional	16.6	13.3 (59.9)	10.6 (80.8)	9.3 (90.1)	10.0c (85.5)	4.0	2.0 (75.0)	1.3 (89.3)	0.6 (98.3)	1.0c (93.8)
	Rotary	17.3	10.3 (70.2)	7.3 (87.3)	3.3 (96.6)	5.3d (92.0)	8.6	3.3 (81.0)	0.6 (97.7)	0.6 (99.2)	0.6c (98.5)
Beauveria bassiana ¾ Recommended dose	Knapsack	15.3	11.6 (62.1)	11.3 (77.8)	8.0 (90.7)	9.7c (84.3)	5.3	3.0 (71.7)	2.6 (83.8)	2.0 (95.8)	2.3b (89.9)
	Conventional	10.6	8.6 (59.4)	7.6 (78.4)	3.6 (94.0)	5.6d (86.2)	4.0	2.0 (75.0)	1.3 (90.2)	0.3 (99.1)	0.8c (94.7)
	Rotary	14.0	8.6 (69.3)	3.3 (92.9)	2.6 (96.7)	3.0e (94.8)	7.3	2.6 (82.1)	0.3 (98.6)	0.2 (99.7)	0.3b (99.2)
Actra Recommended dose	Knapsack	13.3	5.6 (78.9)	8.5 (80.8)	11.3 (84.9)	9.9c (82.9)	3.3	1.5 (77.2)	1.6 (83.3)	3.6 (87.9)	2.6b (85.6)
	Conventional	8.0	3.3 (79.4)	4.0 (84.9)	5.6 (87.6)	4.8d (86.3)	3.3	0.5 (92.4)	0.6 (93.9)	1.3 (95.6)	1.0c (94.8)
	Rotary	8.0	3.3 (79.4)	5.0 (81.2)	6.6 (85.4)	5.8d (83.3)	6.0	1.4 (88.3)	2.0 (89.0)	2.6 (95.2)	2.3b (92.1)
Actra ¾ Recommended dose	Knapsack	14.0	9.3 (66.7)	14.0 (69.9)	16.0 (79.8)	15.0b (74.9)	3.3	1.8 (72.7)	1.9 (80.8)	4.3 (85.2)	3.1b (83.2)
	Conventional	16.0	4.0 (87.5)	5.6 (89.5)	7.3 (91.9)	6.5d (90.7)	4.6	0.6 (93.5)	0.7 (94.9)	1.6 (96.1)	1.2c (95.5)
	Rotary	8.0	3.3 (79.4)	5.3 (80.1)	7.3 (83.8)	6.3d (82.0)	7.3	1.4 (90.4)	1.8 (91.8)	4.6 (93.0)	3.2b (92.4)
Control	-	4.0	8.0	13.3	22.6	18.0a	2.0	4.0	6.0	18.0	12.0a

LSD between treatments (first spray) = 3.89
LSD between sprayers (first spray) = 0.47
LSD between treatments (second spray) = 1.18
LSD between sprayers (second spray) = 0.36
Data based on 10 tomato leaves per treatment

Table (3): Effect of sprayer types and pesticides on average number and reduction percentage of *Bemisia tabaci* eggs infesting tomato plants

Treatment	Equipment	1st spray					2nd spray				
		Pre-treatment	%Initial reduction	Residual effect (%Reduction)			Pre-treatment	%Initial reduction	Residual effect (%Reduction)		
			3 days	5 days	10 days	Average		3 days	5 days	10 days	Average
Beauveria bassiana Recommended dose	Knapsack	22.0	18.6 (68.1)	16.0 (89.1)	15.3 (94.5)	15.65a (91.8)	21.3	8.0 (85.8)	1.3 (99.5)	1.0 (99.7)	1.15d (99.6)
	Conventional	15.3	11.3 (72.1)	10.6 (89.6)	8.0 (95.9)	9.30b (92.8)	22.0	7.3 (87.5)	3.3 (98.7)	1.0 (99.7)	2.15c (99.2)
	Rotary	22.6	19.3 (67.8)	6.0 (96.0)	2.6 (99.1)	4.3d (97.6)	21.3	6.0 (89.3)	0.6 (99.7)	0.3 (99.3)	0.45d (99.5)
Beauveria bassiana ¾ Recommended dose	Knapsack	35.3	23.3 (75.1)	22.0 (90.6)	14.0 (96.9)	18.0a (93.8)	13.0	2.6 (92.4)	2.0 (98.7)	0.6 (99.7)	1.3d (99.2)
	Conventional	34.6	23.3 (74.6)	16.6 (92.8)	13.3 (96.9)	14.95a (94.9)	11.3	3.3 (89.0)	1.3 (99.0)	0.6 (99.7)	0.95d (99.4)
	Rotary	30.6	11.3 (86.1)	8.0 (96.1)	5.3 (98.6)	6.65b (97.4)	13.3	2.6 (92.6)	1.3 (99.2)	0.6 (99.7)	0.95d (99.5)
Actra Recommended dose	Knapsack	20.3	4.0 (92.5)	9.0 (93.3)	14.0 (94.5)	11.50b (93.9)	4.0	1.0 (90.6)	3.0 (93.6)	4.0 (94.0)	3.5c (93.8)
	Conventional	15.3	2.0 (95.0)	3.3 (96.7)	4.0 (97.9)	3.65d (97.3)	15.3	2.3 (94.3)	7.3 (95.9)	8.6 (96.6)	7.95b (96.3)
	Rotary	28.0	5.0 (93.3)	7.0 (96.2)	10.0 (97.2)	8.50c (96.7)	7.3	2.6 (86.5)	4.0 (95.3)	4.6 (96.2)	4.3c (95.8)
Actra ¾ Recommended dose	Knapsack	18.6	6.0 (87.8)	12.0 (90.3)	14.0 (94.0)	13.00a (92.2)	14.0	2.6 (93.0)	9.0 (94.5)	7.3 (95.7)	8.15b (95.1)
	Conventional	22.6	3.0 (94.9)	3.6 (97.6)	6.0 (97.9)	4.80d (97.8)	2.6	0.6 (91.3)	1.3 (95.7)	1.6 (96.3)	1.45d (96.0)
	Rotary	26.6	6.0 (91.5)	7.0 (96.0)	10.0 (97.0)	8.50b (96.5)	19.3	4.0 (92.2)	7.3 (96.7)	8.0 (97.5)	7.65b (97.1)
Control	-	2.0	5.3	13.3	25.3	19.30a	2.0	5.3	23.3	33.6	28.45a

LSD between treatments (first spray) = 6.32
LSD between sprayers (first spray) = 0.49
Data based on 10 tomato leaves per treatment

LSD between treatments (second spray) = 3.36
LSD between sprayers (second spray) = 0.59

Table (4): Effect of sprayer types and pesticides on average number and reduction percentage of *Bemisia tabaci* nymphs infesting tomato plants.

Treatment	Equipment	1st spray					2nd spray				
		Pre-treatment	%Initial reduction	Residual effect (%Reduction)			Pre-treatment	%Initial reduction	Residual effect (%Reduction)		
			3 days	5 days	10 days	average		3 days	5 days	10 days	average
Beauveria bassiana Recommended dose	Knapsack	19.3	6.6 (31.6)	6.0 (53.4)	0.6 (99.0)	3.3d (76.2)	39.3	22.6 (87.6)	6.6 (97.2)	2.6 (99.7)	4.6b (98.5)
	Conventional	36.0	15.3 (15.0)	4.6 (80.8)	0.6 (99.5)	2.6d (90.2)	14.6	6.0 (91.2)	3.3 (96.2)	0.3 (99.9)	1.8c (98.1)
	Rotary	21.0	6.0 (42.8)	2.3 (83.6)	0.6 (99.1)	1.5d (91.4)	21.3	7.3 (92.6)	1.3 (99.0)	0.3 (99.9)	0.8c (99.5)
Beauveria bassiana ¾Recommended dose)	Knapsack	36.0	22.6 (25.5)	16.6 (30.8)	9.3 (92.0)	13.0a (61.4)	12.6	10.6 (81.9)	4.6 (93.9)	0.3 (99.3)	2.5b (96.6)
	Conventional	20.0	13.3 (33.0)	8.0 (40.0)	2.0 (96.9)	5.0c (68.5)	12.0	7.3 (86.9)	4.6 (93.6)	4.0 (98.4)	4.3b (96.0)
	Rotary	20.0	8.3 (17.0)	2.3 (82.7)	1.0 (98.4)	1.7d (90.6)	8.6	2.6 (93.4)	1.0 (98.0)	0.6 (99.6)	0.8c (98.8)
Actra Recommended dose	Knapsack	11.3	4.6 (18.6)	6.0 (20.3)	10.6 (70.8)	8.3b (45.6)	6.6	3.0 (90.2)	3.3 (91.7)	6.0 (95.7)	4.7b (93.7)
	Conventional	20.6	1.5 (85.4)	1.7 (87.6)	6.0 (90.9)	3.9d (89.3)	6.0	1.6 (94.3)	2.0 (94.4)	4.0 (96.9)	3.0c (95.7)
	Rotary	18.6	2.0 (78.5)	2.6 (79.0)	5.0 (91.6)	3.8d (85.3)	9.3	4.5 (89.5)	4.6 (92.0)	6.0 (97.0)	5.3b (94.5)
Actra ¾ Recommended dose	Knapsack	19.3	6.6 (31.6)	7.3 (43.3)	11.3 (81.8)	9.3b (62.6)	7.3	5.0 (85.3)	5.6 (87.2)	6.0 (96.1)	5.8b (91.7)
	Conventional	22.0	2.6 (76.4)	3.3 (77.5)	7.0 (90.1)	5.2c (83.8)	6.6	3.0 (90.2)	3.3 (91.7)	6.0 (95.7)	4.7b (93.7)
	Rotary	21.3	2.5 (76.5)	3.0 (78.9)	10.6 (84.5)	6.8c (81.7)	6.0	4.0 (85.7)	4.3 (88.0)	5.3 (95.8)	4.8b (91.9)
Control	-	2.0	6.0	8.0	38.6	23.3a	2.0	9.3	12.0	42.6	27.3a

LSD between treatments (first spray) = 6.32 LSD between treatments (second spray) = 3.36
LSD between sprayers (first spray) = 0.49 LSD between sprayers (second spray) = 0.59
R = Complete recommended rate ¾ R = ¾ Complete recommended rate Data based on 10 tomato leaves per treatment