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OPTIMAL TIME FOR INSECTICIDE APPLICATIONS TO REDUCE THE ONION THRIPS, *Thrips tabaci* POPULATION ON GARLIC CROP AND THEIR EFFECT ON RESULTANT YIELD.

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ABSTRACT

An experiment was carried out under field conditions at Ziton village in Beni-Sueif Governorate during two successive seasons, 2011-2012 and 2012-2013 to choose the suitable time of insecticide applications and their effect on *T. tabaci* infestation on garlic plants and resultant yield. The four tested treatments by applying two recommended insecticides at different times of plant growth were Carbosulfan (Marshal 20% EC with recommended rate 200 cm^3/ fed.) and Spinetoram (Radiant 12% SC with recommended rate 120 cm^3/ fed) compared with the untreated garlic plants.

Results and their statistical analysis showed clearly that all treatments significantly decreased the population density of *T. tabaci* and increased the garlic yield comparing with control treatment. The applying of Carbosulfan and Spinetoram at 15 day intervals (12 times of applications) throughout the whole growing season of garlic plant till one month before harvesting (T1) lead to reduce the population density of *T. tabaci* infesting garlic plants and gave the highest yield in the two studied seasons, as an average head weight of 12463.50 kg / feddan. Although, garlic plants which treated by Carbosulfan and Spinetoram after one month of sowing date from Nov., 1st at 30 old days till Dec., 15th (4 times of applications) (T2) infested by higher number of *T. tabaci*,then gave the considerable head yield (9313.50 kg / feddan).

However the application of T3 (Spraying of Carbosulfan and Spinetoram from Jan., 1st of at 90 old days till Feb., 15th) and T4 (spraying of Carbosulfan and Spinetoram from March 1st at 150 old days till April, 15 th

Keywords: Garlic, *Allium sativum* L., onion thrips, *Thrips tabaci*, chemical control, application time, economic evaluation, net return, garlic yield.

INTRODUCTION

Garlic, *Allium sativum* L. is one of the most important commercial crops grown allover the world and consumed in various forms, it is generally used as vegetable, spices or as medicine. It was grown in Egypt for five millennia and is now considered as an important export agricultural crop. During the last two decades, the total production of garlic increased by about 43% (Mohamed, 2004). Garlic is extensively grown for both local

consumption and exportation to the foreign countries as fresh material, frozen paste, dried powder and extract oil (Sakr, 1996). The garlic crop is infested by numerous insect pests at different growth stages which cause considerable rate of losses in yield. The onion thrips *T. tabaci* is one of the main insect pests attacking garlic plants during their different growth stages and caused a great damage which resulted to reduce the crop production (Eltez and Karasavuran, 2006 and Mahmoud, 2008). This insect sucks the plant sap causing a considerable damage of the garlic yield production (Duchovskiene, 2006).

On garlic plants, thrips prefer to feed on newly emerged leaves in center of neck, therefore, majority of thrips are found at the base of youngest leaves in the lower center of neck. In case of sever infestation, the bulb remains undersized and distorted (Butani and Verma, 1976)). *Thrips tabaci* is responsible for curling of garlic leaves, low yield and poor quality of heads. Leaf curling reduces the activity of photosynthesis and thus reduces the crop yield.

Foliar application of some insecticides has been recommended against this pest on garlic plants (Rao and Swami, 1986 and Butani and Kapadia, 1999).The conventional or non-conventional insecticides were used against *T. tabaci* exhibited a high efficiency in controlling this pest (Abdel-Aziz, 2002; Khattak *et al*., 2006;Ahmad *et al.,* 2007; Waiganjo *et al.*, 2008; Fargalla ,2009; Ullah *et al.,* 2010; Awadalla *et al*., 2011; Ahmed and El-Mogy 2011; Verma *et al*., 2012; Lebedev *et al*., 2013; Shiberu *et al*., 2013 and Singh *et al*., 2014; Tripathy *et al*., 2014). Therefore, the aim of the present study is to determine the suitable time for controlling *T. tabaci* and the resultant yield of garlic crop.

Material and Methods

This experiment was carried out under field conditions at Ziton Village in Beni-Sueif governorate during two successive seasons, 2011-2012 and 2012-2013. Five treatments were conducted to evaluate their efficiency in reducing the population density of *T. tabaci* and choose the proper time of application. The first four treatments by applying two recommended insecticides at different times of plant growth as Carbosulfan (Marshal 20% EC with the recommended rate 200 cm^3/ fed.) and Spinetoram (Radiant 12% SC with the recommended rate 120 cm^3/ fed.) and the fifth treatment was untreated check as Table (1).

In both studied seasons, the experimental area was about 1050 m^2 cultivated with garlic plants (Balady variety) on the 1st of October for each season. The whole area was divided into 15 plots (each plot was 70 m^2). Three plots were adopted for each treatment. All plots were distributed in a randomized complete block design. All the usual agricultural practices were followed except for keeping the whole area free from any other insecticidal treatments.

Table (1): Time of insecticide applications

Treatment	application time
T1	Spraying of Marshal and Radiant throughout the whole growing season (from seedling at Nov., 1st to one month before harvesting at the end of April) with 15 day intervals between sprays (12 successive applications).
T2	Spraying of Marshal and Radiant after one month of sowing date from Nov., 1st at 30 old days till Dec., 15th (4 times of applications).
T3	Spraying of Marshal and Radiant from January 1st of at 90 old days till February,15th (4 times of applications)
T4	Spraying of Marshal and Radiant from March 1st at 150 old days till April, 15 th (4 times of applications).
T5	Control (Untreated check).

Samplings of garlic plants started at 30 days after sowing were taken weekly until the end of experiment. Five garlic plants were collected randomly from each plot, examined directly in the field and kept in a tight closed paper bags and transported to laboratory in where all samples were thoroughly examined by stereomicroscope to count the adult and nymphs number of *T. tabaci* and calculate the mean number / plant. To study the effect of the five tested treatment on the final yield of garlic plants, fifty garlic plants were collected from each plot during harvesting (May,7th from each season) and then measured of length, whole weight of garlic plant and bulb weight only.

Gross returns were based on yield harvested from each treatment in this experiment; the value of garlic yield was calculated based on the pound average price per kg of heads (LE 1.30). Data were analyzed according to SAS program (1988) and mean separation was conducted by using F-test in this program.

Gross return were calculated by the equation :

Net return LE/Feddan=Garlic heads return LE/Feddan- Cost of treatments LE

Garlic heads return=Garlic heads weight(kg)/Feddan×Price of fresh garlic head

Cost of treatments LE= number of sprays × cost of each application.

RESULTS AND DISCUSSION

1:Effect of different treatments on the *T. tabaci* infestation on garlic plant.

Data tabulated in (Tables 2 &3) showing that *T. tabaci* remained a constant pest on garlic plants during the whole growing studied seasons, 2011-2012 and 2012- 2013 and it was observed from the beginning of the season in all studied treatments.

During first season, data indicated that the lowest population density of *T. tabaci* recorded on plants treated with Carbosulfan and Spinetoram throughout the whole growing season till one month before harvesting at the end of April (12 sprays with 15 days intervals between them) (T1), as the seasonal mean number was 2.13 individuals/ plant, followed by garlic plants received the same compounds on 90 old days of garlic plants (4 times of

applications) (T3), showing a mean number 34.56 individuals/ plant (Table, 2).

Table (2): Impact of application time of insecticides for reducing *T. tabaci* population on garlic plant during 2011-2012 season.

Inspection date	Mean number of *T. tabaci* adult and nymphs / plant.				
	T1	T2	T3	T4	control
Oct.,28th 2011	0.8	1.0	0.6	1.4	1.2
Nov.,4th	0.2	2.8	1.8	0.6	0.8
11st	1.2	1.8	8.3	5.8	7.4
18th	2.2	2.0	15.4	10.2	12.8
25th	2.8	2.0	17.0	13.4	14.6
Dec.,2nd	1.8	1.4	17.2	12.8	16.0
9th	2.8	2.4	17.2	19.4	23.0
16th	3.2	3.6	23.2	25.0	38.6
23rd	2.2	2.4	42.4	28.2	25.4
30rd	1.6	1.8	48	33.2	41.6
Jan.,6th 2012	2.4	2.4	62.2	42.6	64.4
13rd	1.6	4.2	2.6	44.6	70.0
20th	1.8	10.6	2.4	63.2	69.0
27th	1.6	28.4	1.6	87.6	123.6
Feb.,3rd	1.8	65.8	2.6	111.2	156.8
10th	1.6	158.4	1.6	105.6	117.8
17th	2.0	198.8	2.6	151.6	187.2
24th	2.4	201.0	3.0	223.6	236.0
Mar.,2nd	2.8	100.2	10.0	113.0	126.0
9th	3.4	91.2	82.4	3.4	77.4
16th	3.4	116.0	70.0	3.0	113.6
23rd	2.2	113.0	103.2	3.2	97.2
30rd	2.2	143.8	194.0	3.6	60.8
Apr.,6th	2.0	96.4	129.0	3.8	120.0
13rd	3.8	24.4	36.6	2.2	43.8
20th	1.6	6.8	3.6	2.2	9.8
Mean	2.13 c	53.18 a	34.56 b	42.86 ab	71.34 a
F value	9.00				
L.S.D	23.96				

On the contrary, the highest mean numbers of *T. tabaci* was observed in the two remaining treatments, the first one by applying these two compounds on garlic plants at 30 old days after planting (T2) and the second one after150 old days of planting to the end of growing season (T4) which sprayed for 4 times at 15 days intervals, being 53.18 and 42.86 individuals/ plant, respectively. On the other hand, untreated garlic plants harbored the significantly heaviest infestation of *T. tabaci* (71.34 individuals/plants) (Table, 2).

By using statistical analysis, the obtained data was classified into four groups as the highest infestation group (a) which contained untreated plants and foliar spray of T2, followed by the intermediate groups (ab and b) which was represented by application of T3 and T4. The lowest infestation group (c) when using foliar applications of T1 (spraying of the previously

mentioned two compounds throughout the whole growing season except one month before harvesting (Table, 2).

From the results obtained during the second season 2012-2013, the five tested treatments were took the same trend as the first season, 2011-2012 which arranged descendingly as an untreated check (control), T2, T4, T3 and T1 recording mean numbers 44.71, 31.86, 30.36, 26.62 and 2.29 thrips /plant with a significant difference between them (Table, 3).

Table (3):Impact of application time of insecticides for reducing *T. tabaci* population on garlic plant during 2012-2013 season.

Inspection date	Mean number of *T.tabaci* adult and nymphs / plant.				
	T1	T2	T3	T4	control
Oct.,25th	7.0	7.0	2.0	7.0	3.0
Nov.,1st	1.0	0.6	3.6	8.0	5.4
8th	2.0	1.6	8.4	10.0	8.0
15th	2.0	2.0	17.8	11.4	26.4
22nd	3.0	3.0	30.6	30.7	32.1
29th	2.2	2.2	43.6	50.0	46.2
Dec.,6th	2.8	3.8	42.0	39.4	41.2
13rd	3.1	3.2	58.1	54.1	43.4
20th	3.4	2.6	71.8	68.8	59.6
27th	2.1	2.6	92.4	94.2	93.6
Jan.,3rd 2013	4.2	34.2	10.6	59.6	53.0
10th	3.0	50.0	6.0	49.0	50.2
17th	1.6	77.0	1.0	69.6	71.8
24th	1.6	45.6	3.1	39.6	38.4
31st	1.2	46.2	2.2	43.4	46.0
Feb.,7th	1.2	45.0	1.8	49.6	52.9
14th	1.0	55.6	1.4	54.2	57.2
21st	1.8	63.6	2.2	64.0	66.2
28th	1.6	49.4	1.4	1.0	46.8
Mar.,7th	2.2	51.8	21.3	0.8	51.4
14th	1.6	57.0	49.4	1.6	57.4
21st	1.6	59.0	56.1	2.0	60.4
28th	2.0	63.5	63.4	2.6	67.0
Apr.,4th	3.4	56.0	55.4	2.2	57.8
11th	2.6	47.4	43.1	2.4	42.2
18th	2.6	23.2	23.1	1.6	21.4
25th	1.0	7.0	7.0	2.8	8.2
Mean	2.29[c]	31.86[b]	26.62[b]	30.36[b]	44.71[a]
F value	12.11				
L.S.D	12.44				

Generally, the above mentioned results and their statistical analysis showed clearly the applying of Carbosulfan and Spinetoram at 15 days intervals throughout the whole growing season of garlic plant till the one

month before harvesting (12 applications) (T1) lead to the highest reduction of *T. tabaci* population density on garlic plants.

Despite the intense search for *T. tabaci*, the conventional approach of insecticides as Carbosulfan and Spinetoram still the main pesticides employed against this pest. The activity of the previously mentioned two compounds; the first one is contact, systemic and stomach action which caused inhibitor cholinesterase receptors and the other one is contact and inhibitor to nicotinic acetylcholine receptor and caused paralysis, then evenly starve to death the treated insect. In a similar work of the effect of insecticides on the population density of *T. tabaci* had been done in different countries. Rao and Swami (1986) they reported that Carbofuran and Endosulfan were very effective in reducing the incidence of *T. tabaci* on onion plants and Imidacloprid failed to suppress the population of *T. tabaci*. Ahmad *et al*., (2007) in Pakistan stated that Chlorpyiphos, Methamidophos and Acetamiprid gave significant control of *T. tabaci* on garlic plants. Ullah *et al*., (2011) in Pakistan found that Spinosad and and other 4 insecticides (Thioden, Confidor, Megamos and Actara) were significantly effect against *T. tabaci* on onion plants. Ahmed and El-Mogy (2011) in Egypt found that Malathion had a significant reduction in *T. tabaci* population during the vegetative and flowering period followed by Jojoba oil. Awadalla *et al*., (2011) in Egypt stated that Spinetoram (Radiant) had a significant role in reducing the population density of *T. tabaci* infesting onion plants. In India, Verma *et al*. (2012) recorded that spray of Imidacloprid resulted in minimum number of *T. tabaci* on garlic plants. Shiberu *et al*., (2013) in Ethiopia recorded that Botanical extract, *Beauveria bassiana* and Diazinon were more effective in reducing the incidence of *T. tabaci* on onion plants.

2: Effect of the insecticidal application time on garlic yield.

After harvest, the plant height (cm), full weight contains vegetative and heads (gm) and only garlic heads weight per plant (gm)were determined for each treatment to detect the suitable application time for control *T. tabaci* when based on their yield during both studied seasons 2011-2012 and 2012-2013 (Table, 4).

Table (4): Comparison between application times of insecticides on garlic yield during two successive seasons.

Treatment	Mean of plant height (cm)			Mean of plant full weight (gm)			Mean of garlic head weight (gm)		
	2011-2012	2012-2013	average	2011-2012	2012-2013	average	2011-2012	2012-2013	average
T1	105.67^{a}	106.60^{a}	106.14^{a}	181.00^{a}	194.33^{a}	187.67^{a}	118.67^{a}	118.73^{a}	118.7^{a}
T2	99.30^{b}	100.80^{b}	100.05^{b}	136.33^{bc}	137.33^{b}	136.83^{b}	89.27^{b}	88.13^{b}	88.7^{b}
T3	96.93^{b}	97.00^{cb}	96.97^{b}	142.53^{b}	115.13^{c}	128.83^{b}	93.00^{b}	68.87^{c}	80.94^{c}
T4	99.40^{b}	96.87^{cb}	98.14^{b}	132.53^{bc}	109.60^{c}	121.07^{bc}	88.33^{b}	70.40^{c}	79.37^{c}
Control	97.67^{b}	95.33^{c}	96.50^{b}	121.00^{c}	90.93^{d}	105.97^{c}	61.73^{c}	55.20^{d}	58.47^{d}
F value	6.21	6.81	4.67	10.40	44.67	20.27	70.92	35.86	81.48
L.S.D	3.91	4.91	5.72	19.95	16.82	21.70	7.56	11.53	7.61

With respect to head yield, results indicated that garlic plants received the foliar application of (T1) which infested by the significantly lowest seasonal mean number of *T. tabaci* in the two studied seasons (2.13 and 2.29 individuals / plant, respectively), gave the significantly highest yield than the other insecticidal treatments and untreated check (control) in the two tested seasons, as the average head weight in the two seasons together was 118.7 gm/ plant, followed significantly by garlic plants treated with (T2) which infested by high mean number of *T. tabaci* (53.18 and 31.86 individuals / plant in the two seasons, respectively) and occupied the second group of resulted yield, showing the average head weight in the two seasons together which was 88.7 gm / plant. Although, the foliar application of T3 and T4 were the lowest infested group of the four tested insecticidal treatments (34.56 & 42.86 and 26.62 & 30.36 *T. tabaci* individuals / plant in the two seasons, respectively), it gave the significantly lowest garlic yield, as the average weight of garlic head in both seasons together were 80.94 and 79. 37 gm / plant, respectively. On the other hand, garlic plants which kept free from insecticidal applications (control) infested by the significantly highest number of *T. tabaci* in the two studied seasons (71.34 and 44.71 individuals / plant in the two seasons, respectively) and gave the significantly lowest yield when compared with the other tested treatments, as the average weight of garlic heads per plant in the two seasons altogether was 58.47 gm/ plant.

Accordingly, the observed data clearly showed that the application of T1 (subsequently spraying of the two compounds during whole season till one month before harvesting) was the best one for obtaining the minimum infestation rate of *T. tabaci* and best bulb yield.

3: Economics of insecticidal application for control of *T. tabaci* on garlic plants.

From obtained data in Table (5), it is clear that the net return of garlic yield increased in the 4 insecticide treatments when compared with untreated plants. The highest net return per feddan was 13322.55 L.E gained from garlic plants treated with Carbosulfan and Spinetoram throughout the whole growing season from seedling to one month before harvesting (12 times of applications) (T1), followed by net return obtained from garlic plants received Carbosulfan and Spinetoram after one month from sowing date for 4 times of applications (T2) (11147.55 net return per feddan). Lower net return of garlic yield were obtained from garlic plants treated with T3 (Spraying of Carbosulfan and Spinetoram at 90 old days (4 times of applications) and T4 (applying of Carbosulfan and Spinetoram at 150 old days (4 times of applications), as the net return were 10088.31 and 9874.01 L.E / feddan. On the other hand, the lowest net return was 7981.16 L.E / feddan resulted from garlic plants in the untreated plots.

Table (5): Economic evaluation of insecticidal application in different time against *T. tabaci* for galic yield during 2011-2012 and 2012-2013 seasons together

Treatment	Garlic heads weight (g)/ plant	Garlic heads weight (kg)/ Feddan	Garlic heads return LE / Feddan	Cost of treatments LE	Net return LE/ Feddan
T1(12 sprays)	118.7	12463.50	16202.55	2880	13322.55
T2 (4 sprays)	88.7	9313.50	12107.55	960	11147.55
T3 (4 sprays)	80.94	8498.70	11048.31	960	10088.31
T4 (4 sprays)	79.37	8333.85	10834.01	960	9874.01
Control	58.47	6139.35	7981.16	-	7981.16

Net return LE/ Feddan = Garlic heads return LE / Feddan - Cost of treatments LE
Price of fresh garlic head = 1300 LE/ ton

The above mentioned results of yield and economics evaluation agree with different authors in different countries. Ahmad *et al* (2007) in Pakistan, they recorded that the mean garlic yield increased by applying Chlorpyiphos, Methamidophos and Acetamiprid compared with untreated plants. Fargalla (2009) in Egypt stated that the highest net return of tomato yield increased by increasing the application times of Imidacloprid. Verma *et al*. (2012) in India stated that the highest garlic yield was obtained when crop was sprayed with Imidacloprid and lowest yield was recorded in untreated control. Shiberu *et al*., (2013) in Ethiopia mentioned that the onion plants gave the highest yield percentage after sprayed with botanical insecticides. Singh *et al*.,(2014) in India indicated that the application of insecticides on garlic plants lead to increase the resultant yield. Also in the same country, Tripathy *et al*. (2014) recorded that the onion bulb yield increased after dipping onion seedlings in Carbosulfan but the minimum yield recorded in untreated control. Finally, the observed data clearly showed that the application of T1 (subsequently spraying of the two compounds during whole season till one month before harvesting) was the best one for obtaining the minimum infestation rate of *T. tabaci,* the best bulb yield and net return of garlic crop.

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التوقيت الأمثل لتطبيق المبيدات الحشرية لخفض الكثافة العددية لحشرة التربس التى تصيب محصول الثوم وتأثيرها على المحصول الناتج فى مصر.

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معهد بحوث وقاية النباتات- مركز البحوث الزراعيه- الجيزة- مصر

تم تنفيذ هذة التجربة فى قرية الزيتون - محافظة بنى سويف خلال موسمين متتاليين 2011-2012و2012-2013 وذلك لإختيار الميعاد الأمثل لتطبيق مبيدى الكاربوسلفان (مارشال 20% EC بمعدل 200سم3 / فدان) والإسبنتورام (رادينت 12% SC بمعدل 120سم3/ فدان) على محصول الثوم بهدف خفض الكثافة العددية لحشرة تربس البصل *T. tabaci* والحصول على أعلى محصول.

وقد أظهرت النتائج أن تطبيق هذين المبيدين فى جميع الأعمار المختلفة لمحصول الثوم قد أدى إلى خفض الكثافة العددية لحشرة التربس وزيادة المحصول الناتج بمقارنتها بالكنترول مع وجود فروق معنويه بين جميع المعاملات وكانت أفضل المعاملات هى المعاملة الأولى (T1) التى أستخدم فيها هذين المركبين طوال الموسم بعدد 12 رشة بين الرشة والآخرى 15 يوم وكانت اخر رشة قبل الحصاد بشهر حيث أدت إلى خفض الكثافة العددية لحشرة تربس البصل *T. tabaci* حيث كان متوسط الأعداد للموسمين 2,13 و 2,29 فرد / نبات على الترتيب وأعطت أعلى إنتاجية لمحصول الثوم حيث كان متوسط إنتاج الرؤوس للموسمين معا 12463,50 كجم / فدان. فى حين أن نباتات الثوم التى تم معاملتها بالمعاملة الثانية (T2) التى تم رش المركبين فيها بعد شهر من الزراعة بعدد 4 رشات والفترة بين الرشة والآخرى 15 يوم إحتلت المرتبة الثانية فى الإنتاج حيث كان متوسط إنتاج الرؤوس للموسمين معا 9313,5 كجم / فدان وذلك بالرغم من إصابتها بأعداد كبيرة من حشرة التربس حيث كان متوسط الأعداد للموسمين 53.18 و 31.86 فرد / نبات على الترتيب.

وقد لوحظ أن رش المركبين خلال الأعمار الأخيرة لمحصول الثوم (بعد 90 و 150 يوم من الزراعة) كانت أكثر فعالية فى خفض الكثافة العددية لحشرة تربس البصل على محصول الثوم إلا أن النباتات المعاملة بهاتين المعاملتين أنتجت أقل إنتاج من محصول الرؤوس بمقارنتها بمعاملات المبيدات الآخرى حيث كان متوسط إنتاج الرؤوس للموسمين معا هو 8498,70 و 8333,85 كجم / فدان للمعاملتين على الترتيب. أما نباتات الثوم الغير معاملة فقد أظهرت النتائج أنها تعرضت لأعلى إصابة معنويه بحشرة التربس خلال موسمى الدراسة (71,34 و 44,71 فرد / نبات على الترتيب) وأنتجت أقل إنتاج معنوى بمقارنتها بكل المعاملات المختبرة حيث كان متوسط إنتاج الرؤوس للموسمين معا هو6139,35 كجم / فدان.

وأخيراً خلصت الدراسة إلى أن المعاملة الأولى أعطت أعلى عائد إنتاجى لمحصول الثوم بمتوسط صافى ربح 13322,55 جنية مصرى خلال موسمى الدراسة.