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Efficiency of certain insecticides compared to selected alternatives on onion thrips (*Thrips tabaci* Lind.) under field conditions

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Abstract

The experiments were carried out at farm of Plant Protection Department, Faculty of Agriculture, Al Azhar University, Assiut governorate, Egypt during two successive seasons 2014/2015 and 2015/2016 to evaluate the impact of the commonly insecticides, methomyl (Lannate ® 90% SP), imidacloprid (Chinok35%sc), spinetoram (Radiant 12% SC) comparedto some alternatives, mineraloil (Super misrona 94% EC) and azadirachtin (Nemazal 17 % EC) against thrips, *Thrips tabaci* Lindeman; Thysanoptera: Thripidae. The highest and lowest thrips reduction percentages were observed in plots treated with methomyl and azadirachtin, respectively. The use of azadirachtin suggested as an alternative to conventional insecticides which proved to be a potential biological control agent of *T. tabaci*. Methomyl gave the highest mean weight of the crop by percentage (4.75), while the treatment of azadirachtin achieved the lowest mean weight of the crop by percentage 3.46 while the values of 4.54, 3.87, 3.71 where found with imidacloprid, spinetoram and mineral oil respectively.

Keywords: onion, thrips, insecticides, alternatives, control.

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1. Introduction

Onion (*Allium cepa* L.) belonging to the family Alliaceae which is one of the important bulbous vegetable crop of economic importance and widely cultivated all over the world (Ramalingam *et al.,* 2013). In Egypt, onion is the major export crop. The production of onion from sets has traditionally been performed in the Upper Egypt regions of BeniSuef, Menia, Assiut and Sohag, with a minor extent in a few scattered localities in the Lower Egypt like Kalubia, Dakahliya and Gharbia (Attallah and Zein El-Abedin, 2012). In this regard the total area cultivated with onion crop in 2013/2014 season exceeded 5433 feddan produced over 89880 tons in Assuit governorate and 176704 feddan (feddan = 1.038 acres) produced over 2508803 tons in total area at Egypt, Furthermore, the total area cultivated with onion crop in 2014/2015 season exceeded 4082 feddan produced 65435 tons in Assuit governorate and 204942 feddan produced over 2894106 tons in total area at Egypt (Anonymous, 2016). Onion thrips (*Thripstabaci*, Lindman; Thysanoptera: Thripidae) is considered to be the most economically important pest of onion worldwide. It is responsible for causing considerable reduction in yield (Trdan *et al*., 2005; Shiberu and Negeri, 2014). As well as, it is the vector of Iris yellow spot virus (IYSV), genus Tospovirus (Bunyaviridae), a severe and widespread disease infecting onion, leek, iris and wild Allium species (Gent *et al.,* 2006; Nagata *et al.,* 1999; Pappu *et al*., 2009). Most insecticides are ineffective because a large number of thrips are always protected themselves between the inner leaves of the onion plant and the pupal stage is hidden in the soil. In addition, *T. tabaci* is a very prolific species with many overlapping generations (Nault and Shelton, 2010). Some alternatives to pesticides, such as botanical extract from *Parthenium hysterophorus*, *Datura alba* and *Azadirachtin indica* have proved very effective in integrated management program against these pests, thrips, *T. tabaci,* and the onion aphid, *A. Gossypii* (Fathi *et al*., 2008; Wabale and Kharde, 2010; Khan *et al*., 2013). The effectiveness of certain chemicals and safe alternatives compounds in reducing *T. tabaci* infesting onion at Assiut, Upper Egypt, were arranged the ability of the tested compounds in reducing thrips numbers in a descending order as follows: Spinosad by 85.87% >Sumithion by 80.89% >Achook by 64.05% >Remsol oil by 48.25%. Also, application of the tested compounds increased the yield by 21% then untreated plants (Amro *et al*., 2009). New chemistry spinosyn products Spinosad (Tracer®) and Spinetoram (Radiant®), give better control for *T. tabaci* in onion even at low lethal doses (Greenberg *et al.,* 2012).Botanical pesticides offer a safer alternatives to synthetic chemicals and have less or no impact on the environment and non-target organisms. Further, botanicals can also prevent pest resurgence; the effect of *A. indica* seed extract was confirmed to be safe for the biological control agents and can effectively reduce the damage of onion thrips (Shah and Khans, 2015). Both carbofuran and profenofos gave the best results for the average ofbulbs diameter in the season, (2000–2001) and (2001–2002), respectively. The average of total yields for two varieties i.e., Giza 6 and south valley of onion showed that there were significant differences among the pesticides, carbofuran, profenofos, methomyl and pirimiphos-methyl and mineral oil. The results demonstrated that methomyl pesticides gave the highest value for total yield in the first season while in the second season both carbofuran and pirimiphos-methyl pesticides gave the highest values comparing with the control which gave the lowest values in both seasons (Sallam and Hosseny, 2003). The data on onion for the management of onion thrips revealed that significantly highest gross yield (282 q/ha) was recorded with profenofos at 1 ml/lit and it was found at par with spinosad at 56 g ai/ha and lowest gross yield (189 q/ha) was recorded in control (Pandey *et al*., 2014). Therefore the Present study were conducted to evaluated the efficiency of two chemical insecticides, Methomyl, Imidaclopride and two botanical insecticides, Spinetoram, Azadirachtin as well as one mineral oil, Supermisrona for controlling onion thrips in relation to yield of onion.

2. Materials and methods

This study was conducted at the experimental station of the Faculty of Agriculture, Al- Azher University, Assiut, Egypt throughout two successive seasons (2014/15 and 2015/16).

2.1 The host plant

The bulbs of Onion *Allium cepa* L. variety Giza 6 Moghassan was purchased from seed production Unit, Agricultural Research Center, Shandaweel, Sohag, Egypt.

2.2 The compounds used

Three commercial insecticides belongto different chemical groups and two alternatives were used in this study are shown in Table (1).

2.3 Experimental design

The experimental area was about two *Kirat* divided into twenty-two plots. Each plot 10.5 m^2 (each 3x3.5 m^2), held five rows 3.5 m length and 60 cm inter rows). Each plot was separated from each other by 1 m of bare ground. Randomized completely block design (RCBD) was followed in the whole experimentation area, and used in 6^{th} treatments each with three replications plus control. Usual agricultural practices were done according to Egyptian Ministry of Agriculture recommended and weeds were controlled using different agricultural practices. Pre-spray count and beneficial insects were recorded every week from five randomly selected plants from each plotuntil the thrips populations were reach economic threshold level (5-10 thrips/plant), After the population of onionthrips reached economic threshold level (40 day old crop) the insecticides were sprayed and post spray count was taken after 1, 3, 7 and 14 days.

2.4 Toxicological studies in filed

The compounds were applied with recommended concentrations to evaluate their toxic effect on onion thrips (Table 1).

2.5 Spraying technique

The amount of water required to provide sufficient spray liquid was found to be 200 liters/fed.The insecticides, methomyl**,** imidacloprid**,** mineral oiland two botanical insecticides (Nimazal) and spinetoram were sprayed with knapsack sprayer .Two sprays were applied duringexperiment, in 2015 1st spray in 6th January, 2nd spray in 21th January and in 2016 1st spray in 4th January, 2nd spray in 19st January when the infestation percent was started economic threshold at10 insects on the plant.

2.6 Effect on reduction percentage

Samples of five plants were investigated from both diagonals of each plot to assess the onion plant infestation and the numbers of *T. tabaci*. A total of fifteen plants / treatment were externally and internally examined. The sampling procedure was conducted on the pre-treatment and in 1, 3, 7 and 14 days after treatments in each plot according to Mound *et al.* (1976).

2.5 Effect on onion yields

At harvest, on 10th April, the plants of the three central lines in each plot were collected and allowed to dry for a three week period under a shelter, afterwards, bulbs were individually weighed to each plot on a precision balance. Effect of infestation in relation to the onion yield was also estimated.

2.5 Statistical analysis

Percent of reduction of infestation under field conditions was made according to Henderson and Telton formula (1955), as follows:

$$\text{Reduction (\%)} = \left[1 - \frac{(\text{Ta x Cb})}{(\text{Tb x Ca})}\right] \times 100$$

Where: Cb= Average percentage of infestation in control before spray, Ta = Average percentage of infestation in treatment plots after spray, Tb= Average percentage of infestation in treatment plots before spray, Ca= Average percentage of infestation in control after spray.

The effects infestation of onion thrips on onion bulbs, the average weight of bulbs per plot was determined according to Kibanyu (2009). The reduction in onion grade was evaluated using the formula:

Bulb yield (t/fed.) = (Total weight of bulbs per plot (Kg)/ Effective harvested area (m^2) x 100

Reduction in yield (%) = (Yield of protected plot – Yield of unprotected plot/ Yield of protected plot) x 100

Data from field experiments were analysis using one-way ANOVA and presented as mean ± S.E.M (Standard Error of Mean were separated by Duncan's (1955) Multiple Range Test (DMRT) as described by Steel and Torrie (1982).

Table (1): Profile of compounds used in this study.

Common name	Trade name	Type of formulation	Conc. (%)	Chemical group	Rate /Fed. (cm^3)
Methomyl	Lannate	SP	90	Carbamate	200
Imidacloprid	Chinok	Sc	35	Neonicotinoid	250
Spinetoram	Radiant	SC	12	Spynosynes	120
Azadirachtin	Super misrona	EC	94	Aliphatic hydrocarbons	1000
Mineral oil	Nemazal	EC	1	limonoid group	2000

3. Results and Discussion

3.1 Reduction percentages of effect of tested compounds on T. tabaci through the two seasons

3.1.1 in the first season 2014/2015

This experiment was conducted to evaluate the efficacy of methomyl, imidacloprid, spinetoram, mineral oil and azadirachtinafter two applications on onion plants under field conditions to control *T. tabaci* in Assiut governorate, Egypt. The first spray was applied after thirty days from transplanting onion and the second spray was carried after forty five days from transplanting onion during 2014/2015 season. Data of treatments after thirty days from transplanting onion (Table 2 and Figure 1) showed response of *T. tabaci* to the tested compounds after 1, 3, 7 and 14 days of applications. After one day from application, the reduction percentages of *T. tabaci* population were 74.78, 65.54, 28.16, 27.12 and 21.82 % for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Results were obtained with Greenberg *et al.* (2012), they stated that spinosyn products, Spinosad (Tracer®) and Spinetoram (Radiant®), give better control for *T. tabaci* in onion even at low lethal doses, also the mineral oil at the rate of 7·51/ha significantly reduced the population of thrips (Moustafa and El-Attal, 1985). After three days from application, the percentage reduction of *T. tabaci* was 84.58, 75.67, 40.29, 37.81 and 37.58 % for thomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. After seven and fourteen days the reduction percentage recorded 81.32, 70.26, 51.76, 50.21 and 32, 7.60, 50.58, 42.14, 36.60 and 10.77 % with methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Results showed significant variation between the average of reduction percentages of *T. tabaci* population after the different periods of inspection for the first application during 2014/2015 season. The average reduction percentages of the first application were 74.84, 67.74, 40.33, 38.19 and 25.54 % for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Data of treatments after forty five days (Table 2 and Figure 2) showed response of *T. tabaci* to the mentioned compounds after 1, 3, 7 and 14 days from application. After one day the reduction percentages of *T.tabaci* population were 74.72, 70.19, 27.31, 25.84 and 23.42 when applied methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively.

The corresponding values after three days were 83.26, 65.90, 32.02, 34.70 and 27.65 %. While seven days achieved reduction percentages of *T. tabaci* values of 70.16, 66.72, 55.16, 42.02 and 33.33 %, then the reduction percentages of *T. tabaci* population were 65.99, 59.63, 50, 38.33 and 31.66 % fourteen days post treatment when used methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Similarly, as the first application results showed significantly differences in the average of the reduction percentages of *T. tabaci* after fourteen days compared to the second application during 2014/2015 season. The average of the reduction percentages was 73.53, 65.61, 41.12, 35.22 and 29.01 % for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively.

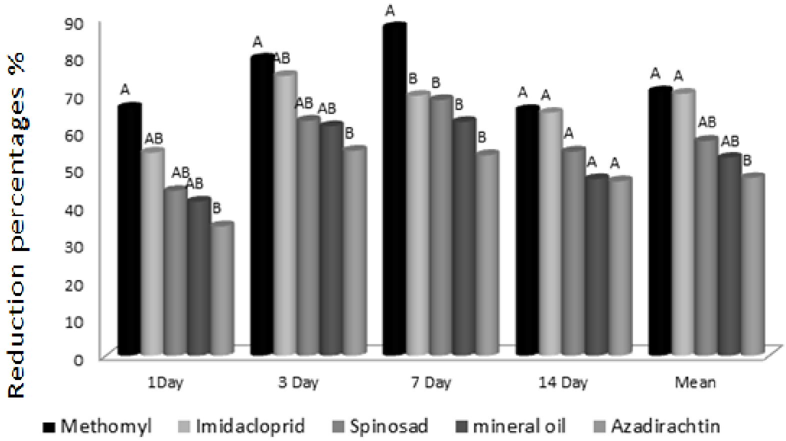

Figure (1): Reduction percentages of *T. tabaci* by the tested compounds after the first application at 2014/2015 season

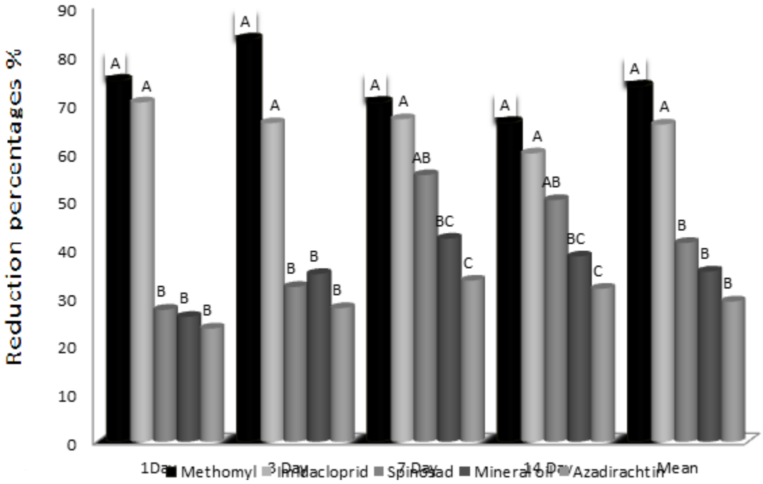

Figure (2): Reduction percentages of *T. tabaci* by the tested compounds after the second application at 2014/2015 season.

Table (2): Activity of tested compounds on reduction percentages of *T. tabaci* after two applications in onion field at 2014/2015 season.

Treatment	Application after										General mean
	Thirty days					Forty five days					
	Reduction (%) after				Mean 1st Application	Reduction (%) after				Mean 2nd Application	
	1 day	3 days	7 days	14 days		1 day	3 days	7 days	14 days		
Chemical insecticides											
Methomyl	74.78 ^{A}	84.58 ^{A}	81.32 ^{A}	67.60 ^{A}	74.84 ^{A}	74.72 ^{A}	83.26 ^{A}	70.16 ^{A}	65.99 ^{A}	73.53 ^{A}	74.19 ^{A}
Imidacloprid	65.54 ^{A}	75.67 ^{A}	70.26 ^{AB}	50.58 ^{A}	67.74 ^{A}	70.19 ^{A}	65.90 ^{A}	66.72 ^{A}	59.63 ^{A}	65.61 ^{A}	66.68 ^{A}
Bio insecticides											
Spinetoram	28.16 ^{B}	40.29 ^{B}	51.76 ^{CB}	42.14 ^{AB}	40.33 ^{B}	27.31 ^{B}	32.02 ^{B}	55.16 ^{AB}	50 ^{AB}	41.12 ^{B}	40.73 ^{B}
Azadirachtin	21.82 ^{B}	37.58 ^{B}	32.00 ^{C}	10.77 ^{B}	25.54 ^{B}	23.42 ^{B}	27.65 ^{B}	33.33 ^{C}	31.66 ^{C}	29.01 ^{B}	27.28 ^{B}
Mineral oil											
Mineral oil	27.12 ^{B}	37.81 ^{B}	50.21 ^{CB}	36.60 ^{AB}	38.19 ^{B}	25.84 ^{B}	34.70 ^{B}	42.02 ^{BC}	38.33 ^{BC}	35.22 ^{B}	36.71 ^{B}

Means with the same letter within the same column are insignificantly different ($P \leq 0.05$) according to Duncan's Multiple Range test.

3.1.2 in the second season 2015/2016

Data of treatments after thirty days had the same trend of the first season where data in (Table 3 and Figure 3) showed response of *T.tabaci* to the tested compounds after 1, 3, 7 and 14 days from application. After oneday from application, the reduction percentages of *T. tabaci* population recorded 73.13, 49.57, 43.52, 21.22, and 17.94% for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. After three days from application, the reduction percentages achieved 71.71, 62.08, 33.04, 44.91 and 43.52 % with the same compounds are mentioned. The corossponiding values after seven days were 65.75, 66.50, 30.57, 52.59, and 59.46, used methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, while after fourteen days, the reduction percentages of *T. tabaci* population were 60.16, 52.58, 42.26, 33.57 and 38.69% for the tested compounds mentioned above, respectively. Results showed significant differences between the reduction percentages at the intervals of examination for the first application during 2015/2016 season. The mean of reduction percentages of 1st spray were 70, 57.68, 37.34, 38.08 and 39.98 % for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. From previous results, the botanical insecticides are considered excellent tool for control the *T. tabaci* because they are safe for environment, human health, affordable and they are locally available (Shiberu *et al.*, 2013; Fitiwy *et al.*, 2015) . Data of treatments after forty five days from transplanting onion (Table 3 and Figure 4) shows response of *T. tabaci* to methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin after 1, 3, 7 and 14 days from application. After oneday from application, the reduction percentages of *T. tabaci* populations were 77.74, 62.32, 54.68, 42.97 and 34.20 %. While the corresponding values after three days presented 80.78, 71.15, 62.16, 48.47 and 45.15. But, after seven and fourteen days reduction of *T. tabaci* population were 72.70, 57.09, 49.56, 51.66 and 53.21, 64.57, 52.33, 37.00, 45.66 and 45.94 for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Results obtained that the average reduction percentages of *T. tabaci* after fourteen days compared the other periods during 2015/2016 season. The average reduction percentages were 73.95, 60.72, 50.85, 47.19 and 44.63 respectively reduction for methomyl, imidacloprid, spinetoram, mineral oil and azadirachtin, respectively. Generally, the reduction percentages decreased with the increasing of period especially at fourteen days post application with the two seasons. In a field experiment in India, fipronil was most effective treatment in reducing thrips population with increased yield, also basil and Geranium oil significantly reduced pest incidence (Krishna Moorthy *et al.*, 2013). The efficacy of azadirachtin as a systemic insecticide has been demonstrated against many of insect-pests with piercing sucking and chewing mouth, including cabbage aphid (*Brevicoryne brassicae*), western flower trips (WFT), (*Frankliniella occidentalis*), leafminer (*Liriomyza triflii*) and Japanese beetle (*Popillia japonica*) (Pavela *et al.*, 2004; Thoeming *et al.*, 2003; Vitullo and Sadof, 2007).

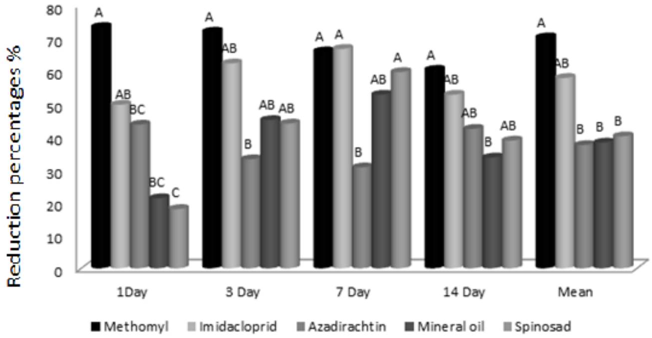

Figure (3): Reduction percentages of *T.tabaci* by the tested compounds after the first application at 2015/2016 season.

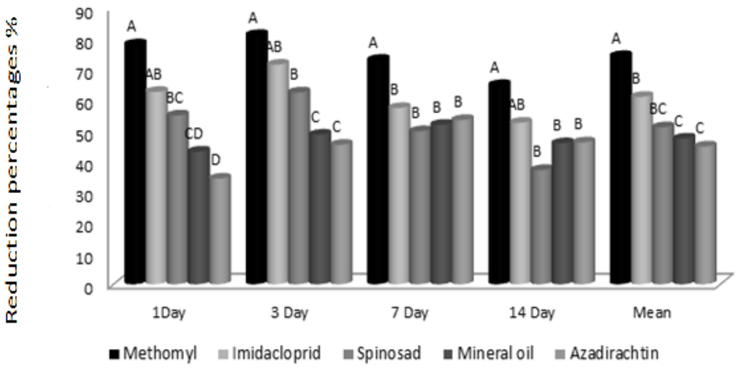

Figure (4): Reduction percentages of *T. tabaci* by the tested compounds after the second application at 2015/2016 season.

Table (3): Activity of tested compounds on reduction percentages of *T. tabaci* after two applications in onion field at 2015/2016 season.

Treatment	Application after										General mean
	Thirty days					Forty five days					
	Reduction (%) after				Mean 1st Application	Reduction (%) after				Mean 2nd Application	
	1 day	3 days	7 days	14 days		1 day	3 days	7 days	14 days		
Chemical insecticides											
Methomyl	73.13 A	71.71 A	65.75 A	60.16 A	70 A	77.74 A	80.78 A	72.70 A	64.57 A	73.95 A	71.98 A
Imidacloprid	49.57 AB	62.08 AB	66.50 A	52.58 AB	57.68 AB	62.32 AB	71.15 AB	57.09 B	52.33 AB	60.72 B	59.2 A
Bio insecticides											
Spinetoram	43.52 BC	33.04 B	30.57 B	42.26 AB	37.34 B	54.68 BC	62.16 B	49.56 B	37.00 B	50.85 BC	44.1 B
Azadirachtin	21.22 BC	44.91 AB	52.59 AB	33.57 B	38.08 B	42.97 CD	48.47 C	51.66 B	45.66 B	47.19 C	42.64 B
Mineral oil											
Mineral oil	17.94 C	43.85 AB	59.46 A	38.69 AB	39.98 B	34.20 D	45.15 C	53.21 B	45.94 B	44.63 C	42.31 B

Means with the same letter within the same column are insignificantly different ($P \leq 0.05$) according to Duncan's Multiple Range test.

3.2 Role of the tested insecticides on bulb weights at harvest in 2014/2015 and 2015/2016 seasons

Data in Table (4) and Figure (5) showed significant variation to various treatments of the different insecticides in bulb weight at harvest. The onion bulb weights ranged from 2733.33±133.33 kg/fed to 4433.33± 260.34 kg/fed and from 2266.7±240.37 kg/fed to 4400±115.47 kg/fed in 2014/2015 and 2015/2016 seasons, respectively. In this interim, the highest bulb weights were recorded in plots treated with methomyl, where the bulb weights were 4433.33±260.34 and 4400±115.47 kg/fed in two seasons, 2014/2015 and 2105/2016, respectively. The lowest bulb weights were obtained from untreated plots which represented 2733.33± 133.33 kg/fed and 2266.7± 240.37 kg/fed for the same corresponding seasons .Results indicated that weight of bulb followed in season 2014/2015, methomyl (4433.33±260.34 kg/fed)**,** imidacloprid (4266.67±133.33 kg/fed), spinetoram (3433.33±296.27 kg/fed), mineral oil (3633.33±409.61 kg/fed) and azadirachtin (3266.67±145.30 kg/fed) compared control (2733.33±133.33 kg/fed). While in season 2015/2016, methomyl was (4400±115.47 kg/fed), imidacloprid (4200±115.47 kg/fed), spinetoram (3566.7±348.01 kg/fed), mineral oil (3533.3±233.3 kg/fed) and azadirachtin (3200±100.0 kg/fed) compared control (2266.7±240.37kg/fed).

Table (4): Mean values of onion bulbs weight ± SE of at harvest in 2014/2015 and 2015/2016 seasons.

Treatment	Weight (Kg/Fed.)	
	2015/2014	2016/2015
Methomyl	4433.33±260.34 A	4400±115.47 A
Imidacloprid	4266.67±133.33 A	4200±115.47 AB
spinetoram	3433.33±296.27 BC	3566.7±348.01 BC
Mineraloil	3633.33±409.61 AB	3533.3±233.3 BC
Azadirachtin	3266.67±145.30 BC	3200±100.0 C
Control	2733.33± 133.33 C	2266.7±240.37 D
F	6.40	12.94
P≤ 0.05	0.004	0.0002

The same letter, with in the same column in not significantly different with P≤ 0.05at each treatment

In general, means of the two seasons referred that maximum weight of bulb (4400±115.47 kg/fed) was recorded with methomyl treatment and minimum weight of bulb (3266.67±145.30 kg/fed) was recorded with azadirachtin one compared with untreated treatment (2733.33±133.33 kg/fed). Agreement with our results in New York, 30–50% reduction in bulb yield (smaller bulb sizes) can occur due to severe thrips damage (Nault and Shelton 2008). Significantly higher yield of 24.32 t/ha over rest of the treatments and was statistically at par with the treatments of spinosad 45 SC (0.0135%) (Patil *et al.*, 2009). The maximum incremental cost benefit ratio (ICBR) was found with imidacloprid, being 12.16 due to low cost of treatment (Konar *et al.*, 2013).

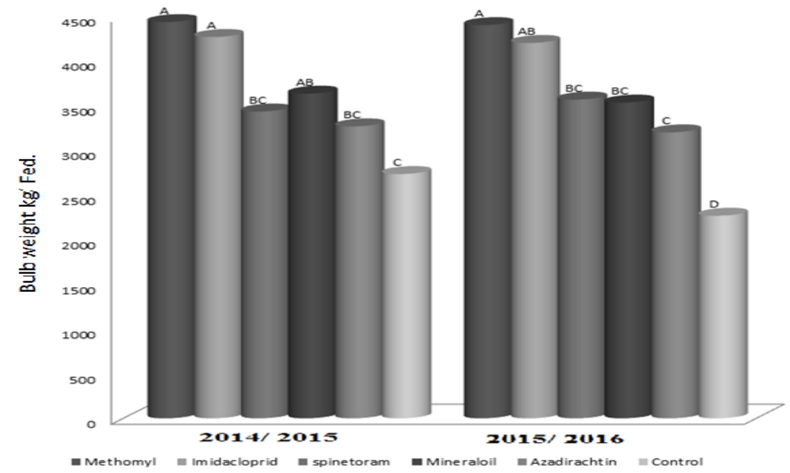

Figure (5): Mean values of weight bulbs in 2014/2015 and 2015/2016 seasons

4. Conclusions

The chemical control of onions is still one of the prominent control methods for controlling onion pests in Egypt. However, due to the use of pesticides for many years, they had many adverse effects in the environment, including the emergence of resistant strains of pests and pesticide hazards to the environment from acute and chronic toxicity on natural equilibrium and the appearance of many secondary pests. Therefore, a safe alternative that has a high impact on pest control, has little effect on the natural enemies and the environment, and low impact on mammals can be used in integrated pest management program (IPM) of controlling onion pests, Mineral oil, botanical insecticide and essential oils are promising alternatives rather than conventional insecticides to retain the *T. tabaci* population under the economic threshold level.

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