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Effect of soil type on the insect population associated with onion plants, with special attention to onion thrips *Thrips tabaci* (Thysanoptera: Thripidae) and crop yield

Hamdy, H. Mahmoud
Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

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Abstract:

The onion thrips *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is a major pest of onion in Egypt. The present studies were carried out at Assiut Governorate throughout the two successive onion growing seasons (2016 / 2017 and 2017 / 2018) on onion plants in three different types of soil which are clay soils, silty soils and reclaimed sandy soils to determine the main pests of onion, their occurrence time and associated predators in addition, to further studies of *T. tabaci* in different soils during both seasons. Also, the effect of someone compound on population of *T. tabaci* and onion yield. Results obtained showed that 15 insect pests and 4 insect predators were present in onion plants. As a general observation, *T. tabaci* was the major and most economically important insect pests threatening onion plantations in the fields. Infestation with thrips prevailed from January until May in three different soils. Significant variation in the total yield of soil type was observed in the two successive growing seasons of study. The silty soil gave the highest total yield and followed by the clay, while the sandy soils gave the lowest total yield. Application of someone compounds increased the yield more than untreated plants in different soils during two seasons.

Introduction

Onion (*Allium cepa* L.) is an important field crop cultivated in all over Egyptian regions for fresh green onion or onion bulbs. Onion plantations as well as bulbs during the storage are eventually subject to considerable insect infestation which effected in the crop quality and quantity (Mahmoud, 2008). Onion plantations usually suffer insect attacks throughout their different growth stages from immediately after transplanting in December until harvest-time in May. During this period onion thrips *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) dominates as the most destructive threat. According to the statistics of the Ministry of Agriculture and Land Reclamation the total area cultivated onion in Assiut Governorate in 2019 exceeded 3464 feddan.

Literature on the insects associated with onion plantations in Egypt refer to El-Sherif (1971) and Haydar and Sherif (1987) at Giza; Abd-El-Fattah (1980) at Giza and Sohag; El-Bolok *et al*. (1990) at Giza and Assiut ; Abd-El-Wahab (2004) , El-Gendi (1998), Sabra *et al*. (2007), at Fayoum

and Kafr-El-Shiekh; Mahmoud (2008), El-Sherif and Mahmoud (2008 a and (2008 b); Amro *et al*. (2009) at Assiut and Awadalla *et al*. (2011) at El-Mansoura.

Abroad, literature refers to Thiramurthi *et al*. (1989), Gupta *et al*. (1991) and Satinder *et al.* (2019) in India; Ahn *et al.* (1991) in Korea; Szwejda (1998 and 2005) in Poland; Ciociola-Jr *et al.* (2002) in Brazil; Duchovskiene (2003) in Lithuania; Chernenko and Chernenko (2004) in Ukraine; Mesic and Baric (2004) in Croatia and Gebretsadkan (2017) in Ethiopia.

The present work aims to determine the occurrence time of main onion pests and their associated predators and also to study the population of *T. tabaci* on two cultivars at three soil types and the effect someone chemical compound in *T. tabaci* and yield income of onion in three different soil types during 2016 / 2017 and 2017 / 2018 seasons in Assiut Governorate.

Materials and methods

1. Survey of insect pests and associated predators on onion plants:

Survey of insect pests associated with onion plants at open field, was carried out in farmers fields cultivated with the commonly planted onion cultivar (Giza 6 Mohassan) at different localities at Assiut Governorate from early January until May in 2016 / 2017 season. Random samples of 40 plants were carefully pulled off from selected fields in the morning (Between 6 and 8 a.m.). Sampling plants were carefully introduced into cloth bags the transferred to the laboratory for inspection. In addition to the plant samples, 40 full-length double-net strokes were also taken across the two diagonals of randomly selected parts of the examined onion. Net catch was killed in an ordinary cyanide jar, then transferred through both plant samples and net-sweeps were carefully examined for identification. In the case of uncertain taxonomic identification, the suspected specimens were conveyed to the appropriate specialist of Insect Classification Research Department at the Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, for proper identification.

2. The population abundance of the onion thrips *Thrips tabaci*:

These experiments were carried out in three different types of soil which are clay soils, silty soils and reclaimed sandy soils by onion farmers and the agricultural research station farm in Arab-Al-Awamer in Assiut Governorate using the commercial variety (Giza 6 Mohassan) during two successive seasons 2016 / 2017 and 2017 / 2018.

These experiments were carried out during survey studies of the pests associated with onion plant. Also, to determine population abundance of the main insect pests in the three types of soil under study. Approximately 1/6 feddan for each soil type was divided into four plots (Replicates) and transplanted with healthy onion seedlings by late November. A random sample of 10 plants was taken from each replicate at quarter-monthly intervals, thus making a total sample size of 40 plants from the whole experimental field, from the beginning of January until the beginning of May. All plots were left to grow normally, and no control measures were applied until harvest-time. Sampled plants were introduced into clean cloth bags, then transferred to the laboratory where they were examined for the occurrence and count of thrips (Larvae and / or adults) associated with onion plants. Date were analyzed with analysis of variance (ANOVA) test.

3. Effect someone chemical compound on *Thrips tabaci* in three

different soil types in relation to the onion yield:

The study was executed in three different types of soil at selected farmer fields and the agricultural research station farm in Arab-Al-Awamer planted with the commonly grown onion cultivar (Giza 6 Mohassan) during the two seasons 2016 / 2017 and 2017 / 2018. For each season, an area of 425 m^2 from both soil types was divided into four plots (Replicates) and transplanted with onion seedlings by late November. Two applications were applied at 30 days approximately. The first application was on 2 and 4 February and the second application on 2 and 4 M arch in two the seasons, respectively. The use of the chemical compound was [Carbosulfan (Marsal 25 % WP) 2,3-dihydro-2,2-dimethylbenzofuran- 7 yl (dibuty-laminothimethyl carbamate) at the rate of 150 gm. / 100-liter water].

To evaluate the reduction percentage of *T. tabaci* infestation caused by each compound, 5 plants was picked up from each replicate and transferred to the laboratory wherein they were examined for the occurrence of thrips larvae and / or adults. The samples were examined before spray and consequently after 7, 14, 21 and 28 days of application. Reduction percentage in thrips infestation was calculated according to Henderson and Tilton (1955) equation. The reduction in weight estimated by using formulae:

$$\% \text{ Increase weight} = \frac{\text{Weight of onion bulbs in sprayed plots} - \text{weight of onion bulbs in unsprayed plots}}{\text{Weight of onion bulbs in sprayed plots}} \times 100$$

Results and discussion

1. Survey and occurrence time of onion pests and associated predators:

Data presented in Table (1) reveals 19 species belonging to 17 families and 7 orders. Among these species 15 were pests belonging to 14 families and 5 orders and 4 predators belonging to 4 families and 4 orders were recorded in onion plants during the 2016 / 2017 season at Assiut Governorate. Abd-El-Fattah (1980) surveyed 21 insect species on onion plants, El-Bolok *et al.*(1990) found that onion plantations are inhabited by a variety of insects belonging to 38 genera from 23 families and 9 orders, Thiramurthi *et al.* (1989) reported 10 species of insects on onion flowers, Ahn *et al.* (1991) surveyed the insect pests in onion fields, Szwejda (1998 and 2005) identified 23 insect species from onion fields, Ciociola *et al.* (2002) gave notes on the insect pests of onions, Duchovskiene (2003) reported 11 insect species from onion plantations and Mesic and Baric (2004) listed the dipterous pests associated with onion plants.

Also, on the other hand, data in Table (1) showed that, the onion thrips *T.tabaci* recorded the main insect pests attacking onion plants throughout the whole onion growing season. Such observation seen to coincide with the findings of El-Sherif (1971), Khalil *et al.* (1971), Haydar and Sherif (1987), Abd-El-Wahab (2004), Sabra *et al.* (2007), Mahmoud (2008), El-Sherif and Mahmoud (2008a and 2008b), Amro *et al.* (2009) and Awadalla *et al.* (2011) who agreed that *T. tabaci* is a dominant insect species in onion plantations in Egypt. Some other studies referred to *T. tabaci* as a major pest in onion plantations in India (Thiramurthi *et al.*, 1989 ; Gupta *et al.*, 1991 ; Maher and Shafiq (2014) and Satinder *et al.*, 2019); Korea (Ahn *et al.* ,1991), Poland (Szwejda, 1998 and 2005); Brazil (Ciociola *et al.*, 2002), Lithuania (Duchovskiene, 2003); New York (Elaine *et al.* ,2014), and Ethiopia (Gebretsadkan, 2017).

As seen in Table (1), survey results revealed the rare occurrence of only four predator species mostly by early spring. These predators are the dragonfly *Hemianax ephippiger* (Odonata: Aeschnidae), the aphid lion *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae), the syrphus fly *Syrphus corollae* Fabricius (Diptera: Syrphidae), the eleven spots beetle *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae). All these predators occurred as adults only, except for *C. undecimpunctata* which occurred as both larvae and adults.

Table (1): A systematic list of the insect pests and predators associated with onion plants in the fields at Assiut Governorate during 2016 / 2017 onion growing season.

No.	Species	Stage (s)	Frequency of occurrence	Period of occurrence
P E S T S				
1	*Thrips tabaci* Lind. (Thysanoptera : Thripidae)	A and L	C	Jan. – May
2	*Aphis gossypii* Glover (Hemiptera : Aphidiae)	A and N	Fe	Mar. – May
3	*Empoasca discipiens* Paoli (Hemiptera : Cicadellidae)	A and N	Fe	Mar. - Apr.
4	*Lyperosia minuta* Bezzi (Diptera : Muscidae)	A	Fe	Feb. - Apr.
5	*Eumerus amoenus* Loew. (Diptera : Syrphidae)	L and P	Fe	May
6	*Actia crassicornis* (Meigen) (Diptera : Tachinidae)	A	Fe	Feb. - Apr.
7	*Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae)	A	Fe	Feb. - Apr.
8	*Melanagromyza cunctans*(Meigen) (Diptera : Agromyzidae)	A	Fe	Jan. - Mar.
9	*Ephydra macellaria* Eggr (Diptera : Ephydridae)	A	Fe	Feb. - Apr.
10	*Hydrellia griseola* Fallen (Diptera : Ephydridae)	A	Fe	Feb. – Mar.
11	*Melieria nigritarsis* Becker (Diptera : Otitidae)	A	Fe	Mar. - Apr.
12	*Lepidocentinus insertus* Handschin (Collembola : Entombryidae)	A	R	Mar.
13	*Delia alliaria* Fonseca (Diptera : Anthomyiidae)	A	R	Mar.
14	*Carpophilus hemipterus* Linne (Coleoptera : Nitidulidae)	A	R	Mar. - Apr.
15	*Sitona lividipes* Fahrs. (Coleoptera : Curculionidae)	A	R	Mar. - Apr.
P R E D A T O R S				
1	*Hemianax ephippiger* Selys. (Odonata : Aeschnidae)	A	R	Feb. - Apr.
2	*Chrysoperla carnea* Steph. (Neuroptera : Chrysopidae)	A	R	Mar. - Apr.
3	*Syrphus corollae* Fabricius (Diptera : Syrphidae)	A	R	Mar.
4	*Coccinella undecimpunctata* L. (Coleoptera : Coccinellidae)	A and L	R	Mar. - Apr.

N = Nymphs L = Larvae P = Pupae A = Adults C = Common (More than 7 once) Fe = Few (4 – 6 once) R = Rare (1-3 once)

2. Population density of *Thrips tabaci* on onion in different soil at Assiut Governorate:

The quarter-monthly population densities of thrips individuals (larvae and adults) in onion fields and cultivated on three different soil types at Assiut Governorate throughout the two successive onion growing seasons (2016 / 2017 and 2017 / 2018) are graphically illustrated in Figure (1) and Figure (2), respectively.

In clay soils, were varied to *T. tabaci* infestation as shown in Figures (1 and 2) thrips individuals began to occur in relatively small numbers (6.3 and 6.0 / plant in two season, respectively) during the 2nd half of January and gradually increased in number throughout February and March until they reached a high peak of (33.4 and 34.2 / plant in early April in the first season and mid-March in the second season, respectively). Thrips counts tended to decrease until harvest-time.

In silty soils, Figures (1 and 2) showed that, the mean number of *T. tabaci* began to occur in relatively small numbers (7.2 and 6.5 / plant in two season, respectively) during the 2nd half of January and gradually increased in number throughout February and March until they reached a high peak of (41.9 and 32.8 / plant by mid-March in two season, respectively). Thrips counts tended to decrease until harvest-time.

In sandy soils, showed the Figures (1 and 2) relatively small counts of thrips individuals occurred during January (5.4 and 5.6 / plant in two seasons, respectively). Starting from early February, the population density tended to increase gradually but rather rapidly during the 2nd half of the month. Population increase continued to a peak of (32.7 and 31.1 / plant in two seasons, respectively) reached during the second half of March. This peak was followed by a drop in thrips count during the 3rd quarter of March then before harvest-time.

Generally, in three soil type population density began to occur in relatively small counts by early January until the start in counts increased throughout late of January and early February and March until a high peak of taking place in mid-March. This peak was followed by a gradual decline in thrips population until all larvae and adults completely disappeared from onion fields in early May.

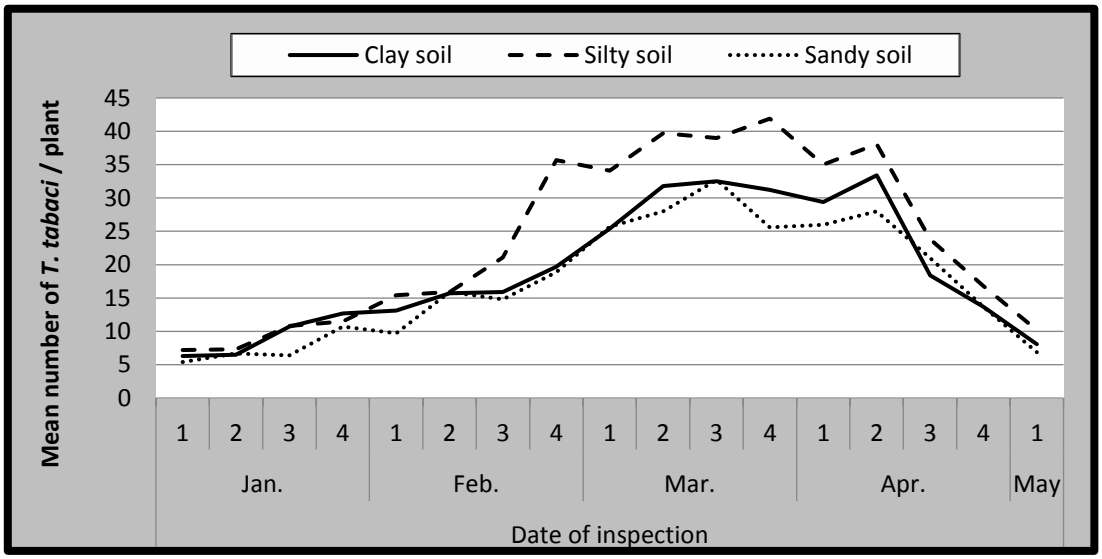

Figure (1): Mean number of individuals in onion plant for *Thrips tabaci*, in various soil types during 2016 / 2017 season.

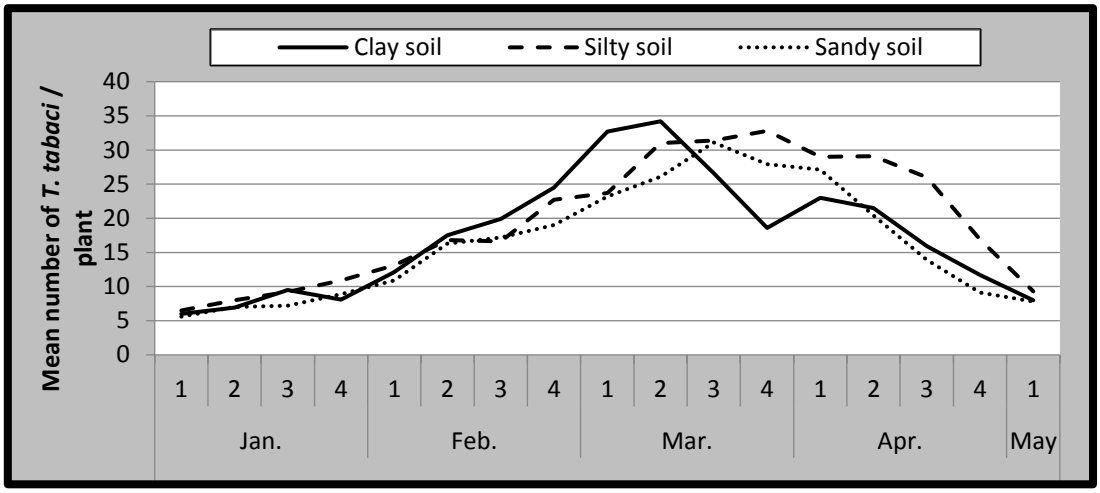

Figure (2): Mean number of individuals on onion plant for *Thrips tabaci*, in various soil types during 2017 / 2018 season.

In seasons 2016 / 2017 and 2017 / 2018 and Table (2) shows that the highest mean number of thrips individuals on onion plant occurred in silty soils (23.5 and 19.6 with a general mean of 21.5 in two season, respectively) and the lowest mean took place in sandy soils (16.8 and 16.4 with a general mean of 16.6 in two seasons, respectively) while in clay soils this mean was slightly less than in silty soils (19.1 and 17.4 with a general mean of 18.2 in two seasons, respectively).

The above results more or less agree with the findings of a group of investigations conducted in Egypt. Karaman (1970) and Khalil *et al.* (1971) coincided that the various stages of *T. tabaci* are found in onion fields in relatively low numbers during December, then increase rapidly to reach maximum abundance throughout April. Haydar and Sherif (1987) mentioned that the population of *T. tabaci* begins to build up by early February and reaches its maximum during April. El-Gendi (1998) stated that *T. tabaci* is active in onion fields from mid-December to mid-May. Embarak (2006) found that the daily rate of population fluctuation of onion thrips increase was lower in newly reclaimed are than in traditional cultivated land in the first planting date. While, in the second planting date, it was higher in the newly reclaimed area than in traditional cultivated land and Sabra *et al.*(2007) observed to thrips attack onion in nursery and perennial field and its population peaked in March. Furthermore, El-Serwiy *et al.*(1985) observed that in Iraq the population density of *T. tabaci* varies from one year to another and reaches a peak by early April. In Texas, USA, Edelson *et al.* (1986) found that *T. tabaci* individuals occur in onion fields from February till harvest-time in April or May with a peak of abundance in early April. Lu and Lee (1987) contributed that the population density of *T. tabaci* in Taiwan increases from November to April. Kalafchi *et al.* (2006) added that in Iran the population density of *T. tabaci* is the highest 130-158 days after planting.

3. Effect of different soil type on onion yield:

The results for total yield of the different soil type are shown in the same Table (2) and Figure (3) . Significant variation in the total yield of soil type was observed in the two successive growing seasons of study. The silty soil gave the highest total yield (15.351 and 16.054 with a mean 15.703 ton / fed. in seasons 2016 / 2017 and 2017 / 2018, respectively) and followed by the clay soils (13.242 and 13.801 with a mean 13.521 ton / fed. in

two seasons, respectively). While, the sandy soils gave the lowest total yield (11.932 and 11.256 with a mean 11.595 ton / fed. in two seasons, respectively). These results are in agreement with those obtained by Koriem and Farag (1990) who mentioned that Giza 20 gave the highest total yield under Mallawi conditions when compared with other cultivars. However, Gamie *et al*. (1996) showed that Giza 6 Mohassan cv. gave the highest total yield when sown on Sept. 20. Salman (2000) indicated that, the differences between onion yield at the different sowing dates were significant in both seasons. Amro *et al*. (2009) who found that significant variation in the total yield of cultivars and strains was observed in the two successive growing seasons of study. El-Azhar noua gave the highest total yield (15.62 ton/fed.) and followed by Giza 20 (14.16 ton/fed.). While Giza 6 Mohassan cv. gave the lowest total yield (13.06 ton/fed.).

Table (2): Impact of different soil types on mean number of *Thrips tabaci* on onion plants and yield during two growing seasons at Assiut Governorate.

Soil type	* Mean number of *T. tabaci* /plant			**Onion yield (ton / feddan)		
	2016 / 2017	2017 / 2018	General mean	2016 / 2017	2017 / 2018	Mean
Clay soil	19.1a	17.4a	18.2a	13.242a	13.801a	13.521a
Silty soil	23.5a	19.6a	21.5a	15.351b	16.054b	15.703b
Sandy soil	16.8b	16.4a	16.6b	11.932c	11.256c	11.595c
L.S.D. (0.05)	4.96	4.11	4.21	0.94	1.11	0.71

*** Mean followed by different letters are not significantly different at 5% level.**
*** * Mean followed by different letters are significantly different at 5% level.**

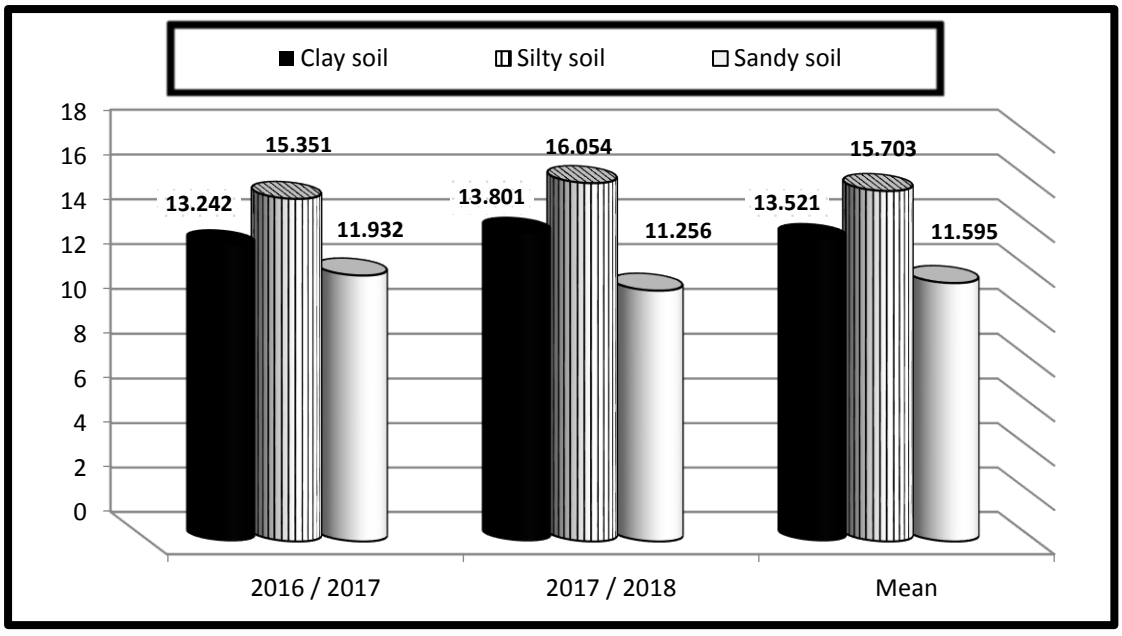

Figure (3): Effect of soil type on the total weight (Tons / feddan) of onion yield during two growing seasons.

4. Impact someone chemical compound on *Thrips tabaci* in three different soil types in relation to the onion yield:

The effect of the someone chemical compound on *T. tabaci* infesting onion plants in three different soil types in relation to the onion yield is presented in Tables (3 and 4). Data revealed that the used compound reduced the population density of *T. tabaci* on onion plants in comparison with the control in three soil types and in both two seasons. Regarding the initial effect (7 days after spraying), the chemical insecticide, Marsal 25 % WP were more effective in controlling thrips resulting in [(81.3 and 85.2) and (86.1 and 82.4) in clay soil], [(71.1 & 87.9) and (81.5 & 83.6) in silty soil] and [(81.1 and 88.5) and (80.1 and 82.7) in sandy soil] reduction in 1st and 2nd application during two seasons, respectively. The same observation was found after 14, 21 and 28 days of spray.

Reduction percentages of *T. tabaci* increased with the time elapsed after treatment. The general reduction percentage of the pest can be arranged in descending order as follows: Sandy soil (48.5 and 50.1) > clay soil (46.2 and 50.1) > silty soil (41.5 and 45.5) during two seasons, respectively. Although, the reduction percentage of the pest numbers caused by using the compound in the sandy soil was higher than other soils, there was no variation in crop yield. Also, it is of importance to notice that the yield increased by from (5.5 – 7.2 %) in season 2016 / 2017. Also, the same found in 2017 / 2018 season, these results are around from (5.5 – 8.3 %) increase in yield income in treating than untreated onion. In general, the used insecticide in sandy soil gave the highest mean percentage of reduction followed by the same used insecticide in clay soil, while the same used insecticide in silty soil gave the lowest mean percentage of reduction.

Similar results were also obtained by El-Sebae *et al.* (1971), El-Serwiy and Razouki (1986), Mourad (1992), Omar and El-Kholy (2001), Saleh (2004), Sebra *et al.* (2005), Amro *et al.* (2009), Ibrahim and Adesiyun (2009), Haider, *et al.* (2014), Neetu and Virendra (2016) and Satinder *et al.* (2019).

Table (3): Effect someone chemical compound on *Thrips tabaci* and yield income of onion in three different soil type during 2016 / 2017 season.

Clay soil

Treat-ment	Application	Mean number of *T. tabaci* per plant and reduction percentage in infestation									%	Yield	
		Before spray	Days after spray								General reduction	Income (ton/fed)	% increase
			7 days		14 days		21 days		28 days				
			Mn/p	R%	Mn/p	R%	Mn/p	R%	Mn/p	R%			
Marsal	1 st.	12.7	2.3	81.3	6.3	58.6	13.7	21.0	19.7	10.1	42.7	46.2	14.063	**5.8**
25%WP	2 nd.	19.7	3.1	85.2	10.2	63.2	15.5	45.3	25.8	5.1	49.7			
Control	1 st.	13.1	12.7	--	15.7	--	17.9	--	22.6	--	--	--	13.242	--
	2 nd.	22.6	24.1	--	31.8	--	32.5	--	31.2	--	--			
Silty soil														
Marsal	1 st.	11.5	2.7	71.1	7.5	36.8	18.5	17.4	28.4	11.5	34.2	41.5	16.248	**5.5**
25%WP	2 nd.	28.4	3.4	87.9	13.4	59.4	21.3	34.4	39.7	13.7	48.8			
Control	1 st.	15.4	12.5	--	15.9	--	21.1	--	34.1	--	--	--	15.351	--
	2 nd.	34.1	33.9	--	39.7	--	39.0	--	41.9	--	--			
Sandy soil														
Marsal	1 st.	10.7	2.1	81.1	5.4	66.9	15.2	13.3	18.9	23.2	46.1	48.5	12.860	**7.2**
25%WP	2 nd.	18.9	2.5	88.5	7.7	67.5	19.6	29.2	25.7	18.4	50.9			
Control	1 st.	9.7	10.1	--	14.8	--	15.9	--	22.3	--	--	--	11.932	--
	2 nd.	22.3	25.7	--	28.0	--	32.7	--	25.6	--	--			

1 st. Application: 2 February 2017. **2 nd. Application: 2 March 2017**

Table (4): Effect someone chemical compound on *Thrips tabaci* and yield income of onion in three different soil types during 2017 / 2018 season.

Clay soil

Treat-ment	Application	Mean number of *T. tabaci* per plant and reduction percentage in infestation									%		Yield	
		Before spray	Days after spray								General reduction		Income (ton/fed)	% increase
			7 days		14 days		21 days		28 days					
			Mn/p	R%	Mn/p	R%	Mn/p	R%	Mn/p	R%				
Marsal 25%WP	1 st.	12.1	2.0	86.1	6.0	68.4	13.5	33.3	15.3	33.7	55.4	50.1	14.855	**7.1**
	2 nd.	15.3	2.9	82.4	7.7	65.1	17.5	21.3	19.9	11.0	44.9			
Control	1 st.	11.9	14.2	--	18.7	--	19.9	--	22.7	--	--	--	13.801	--
	2 nd.	22.7	24.5	--	32.7	--	33.0	--	26.6	--	--			
Silty soil														
Marsal 25%WP	1 st.	12.8	2.5	81.5	8.0	58.9	16.6	22.8	23.2	15.8	44.7	45.5	16.986	**5.5**
	2 nd.	23.2	3.2	83.6	9.9	60.1	19.8	25.3	31.4	16.4	46.3			
Control	1 st.	13.1	13.8	--	19.9	--	22.0	--	28.2	--	--	--	16.054	--
	2 nd.	28.2	23.7	--	30.2	--	32.2	--	32.8	--	--			
Sandy soil														
Marsal 25%WP	1 st.	10.9	1.9	80.1	5.0	74.9	11.7	44.5	16.5	32.9	58.1	50.1	12.272	**8.3**
	2 nd.	16.5	2.7	82.7	9.5	53.9	15.4	27.8	23.2	4.3	42.2			
Control	1 st.	8.9	7.8	--	16.3	--	17.2	--	20.1	--	--	--	11.256	--
	2 nd.	20.1	19.0	--	25.1	--	26.0	--	27.1	--	--			

1 st. Application: 4 February 2018. **2 nd. Application: 4 March 2018.**

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