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ECOLOGICAL AND BEHAVIORAL ASPECTS OF *Thrips tabaci* LINDEMAN (THYSANOPTERA: THRIPIDAE) ON ONION PLANTS

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ABSTRACT

Effect of three planting dates of onion plants (November, 15th, December, 15th, and January, 15th) on levels of infestation by thrips, *Thrips tabaci* Lindeman and on its yield, were studied during two successive seasons (2013/14 and 2014/15) at El-Beheira Governorate, Egypt. The degree of infestation with thrips increased significantly by delaying planting date, as onion plants cultivated in the earliest planting date (November, 15th) were attacked by the fewest numbers with highest weight of onion bulbs, while the plants of the latest planting date (January, 15th) were more liable to insects infestation with lowest weight of onion bulbs. The population density and life stage composition of *T. tabaci* populations were determined in the two consecutive seasons and in the three planting dates. The intra-plant distribution of thrips was studied and a clear pattern in the diel periodicity of the intra-plant distribution of *T. tabaci*, was noticed in that the adults tended to be located higher on the plant during the hottest periods of the afternoon. The vast majority of nymphs occupied the basal half of the leaves and remained there throughout the day. The effect of thrips damage on onion yield was studied and the mean percentages of yield losses in onion bulb as a result of thrips damage during two successive seasons ranging from 26.17 % to 42.39 % in different planting dates in the 1st season. In the 2nd season loss in bulb yield recorded 20.45, 30.85 and 35.23 % in the 1st, 2nd and 3rd planting date, respectively. Statistical analysis of correlation coefficient values showed that the effect of climatic factors on the population density of *T. tabaci* wasn't differed according to planting date during two studied seasons. The population density of onion thrips correlated positively with minimum, mean, maximum temperature, mean of wind speed and negatively correlated with average relative humidity.

INTRODUCTION

Onion is one of the most important vegetable crops grown in Egypt either for local consumption or for export. The cultivated area reached to 102703 fed. in 2010 and total production was 1259007 ton with an average yield of 12.633 tons /fed. (Annual Report of the Statistics and Agricultural Economics Department, The Ministry of Agriculture, Egypt). Onion Thrips, *Thrips tabaci* Lindeman, is minute, phytophagous, invasive, highly fecundative, polyphagous, multivolatine, cosmopolitan and vector insect pest (Reitz *et al*., 2011). In Egypt, the cotton thrips, *T. tabaci* is considered as one of the important insect pests attacking onion crops. (Afifi and Hayder, 1990; Elkhayat *et al.* 1997; Moawad, 2003 and Abd El-Hameed *et al*., 2011). The infestation by thrips appears early on onion and the outer leaves have silvery spots. Nymphs and adults of this species feeding on leaves and in heavy infestation, they may cause stunded growth of plants (Hudak and Penzes, 2004). The attack of thrips population not only kills onion seedlings, but also may cause the older crops to mature early which results in reduction of yield

(Anon., 2004). About 40-60% reduction in yield has been reported due to pest attack (Fournier, *et al*. 1995). The careful selection of sowing date makes it possible to ensure that the vulnerable stage in a crop does not coincide with the period of pest abundance (Pollard, 1955). Knowledge of the population dynamics and life stage composition for a certain thrips population in a given field and time may be useful for providing management recommendations because different life stages of thrips (i.e., adult-larva ratio) respond differently to insecticides (Liu *et al*., 2004). A population with more larvae may be more susceptible to insecticides compared with one with more adults. In contrast, thrips larvae may be hard to manage with insecticides because they are not migratory and hide inside the leaf whorls. The total variability in thrips populations in crops is determined by the natural growth of population and the influence of weather on activity and rate of multiplication of the insects (Kirk, 1997). An understanding of the factors that influence these population changes is essential in predicting thrips population. Weather variables including rainfall, temperature, relative humidity and wind have been reported as important factors that significantly affect thrips numbers (Ananthakrishnan, 1993; Kirk, 1997; Legutowska, 1997). Relatively high temperatures and lack of rainfall have been associated with increase in onion thrips population, while high relative humidity and rainfall reduce thrips population (Hamdy and Salem, 1994). Understanding the diurnal periodicity of the intra-plant distribution of *T. tabaci* are very important to improve the timing of insecticide spray. The possibility that the intra-plant distribution of thrips could be affected by time of day, and therefore all the physical factors associated with it (temperature, light intensity, humidity etc.) was investigated by Sites *et al*. (1992) and Burnstone, (2009).

Present studies were conducted to evaluate the effect of planting dates on infestation by *T. tabaci*, the population density and life stage composition of *T. tabaci* population, the diel periodicity of the intra-plant distribution, assess the yield losses due to this insect if uncontrolled and effect of main weather factors on population density of *T. tabaci*.

MATERIALS AND METHODS

Effect of planting dates on infestation with *T. tabaci*:

Field experiment was conducted at Abou-Elmatamir district, El-Beheira Governorate, Egypt during 2013/2014 and 2014/2015 seasons, to evaluate the effect of three planting dates of onion (*Allium cepa L*.) cv. Giza 20 varity on thrips population. Plots of 6 × 7 (42 m^2) equal sizes were laid in complete randomize blocks design (CRBD) with four replicates. Each planting date was represented by four plots. Sampling of onion plants were taken weekly after sowing until the end of experiment. In each sampling date, four plants were picked randomly per plot, and the collected samples were kept in paper bags to examine in the laboratory with sterio-microscope to count the mean number of adults and immature stages of *T. tabaci* per plant in each sowing date. Also, population of *T. tabaci* in onion plantations was carried out to evaluate the population density and life stage composition of this pest during the two seasons.

Infestation Rate: For studying the infestation rate of *T. tabaci* on onion plants, sixteen plants were chosen randomly by weekly intervals for each planting date. The selected plants were visually inspected for thrips infestation symptoms, and classified as infested plants or non infested plants and the percentage of the infested plants were calculated.

The effect of the time of the day on the intra-plant distribution of *T. tabaci*:

To study the effect of the time of the day on the intra-plant distribution of *T. tabaci*, sampling took place over a series of six replicate days between the latest week of February and the 1st week of April during the two seasons. Samples were taken four times a day from the three planting dates and four plants of each planting dates (12 plants for each time) randomly selected. The samples were taken at 6:00 am, 10:00 am, 2:00 pm and the last at 6:00 pm. Sampling plants were separated into three sections: stem, basal half of leaves and apical half of leaves. The three sections were sealed in separate plastic bags and taken to the laboratory for assessment. The numbers of adults and nymphs of *T. tabaci* on each section of each plant were recorded. Similar technique was established by Burnstone, (2009).

Assessment of yield loss due to *T. tabaci*:

Each sowing date under study consisted of two plots (one sprayed and other unsprayed). The treated plots were sprayed with Carbosulfan (Marshal 25 % WP) (Syngenta) at the rate of 100 ml/Fed. Controlled plots remained unsprayed throughout the season. After harvesting the crop, total weight of 16 onion bulbs per planting date (4/plot) was measured. The reduction in weight estimated by the following formulae (Karar, *et al*. 2014):

$$\%\text{Weight loss} = \frac{\text{Avg. Weight of onion Bulbs in sprayed plots - Avg. weight of onion bulbs in unsprayed plots}}{\text{Avg. Weight of onion Bulbs in sprayed plots.}}$$

The climatic factors effect:

The considered and dominating meteorological factors during the investigation were the maximum, minimum, mean temperature, the average relative humidity and mean wind speed (Km/h). Values of such factors were supplied by the meteorological organization, Cairo, Egypt to clarify the role of the selected environmental factors in regulating the population density of onion thrips. The fluctuation in the values of the environmental factors was used for calculating the simple correlation (r values).

Data analysis: The data were analysed using a general analysis of variance (ANOVA) according to Snedecor and Cochran (1982). Means were separated by L.S.D. test at $P<0.05$. (using SAS institute statistical software, SAS, 2003)

RESULTS AND DISCUSSION

Effect of planting dates on infestation with *T. tabaci*:

As shown in Table 1 the results revealed that the population density of *T. tabaci* (nymphs and adults) on onion plants differed significantly according to the sowing date during the two successive seasons 2013/14 and 2014/15. In the 1st season, the population density of *T. tabaci* individuals increased by delaying planting date. The onion plants were sown in the earliest planting date

(November, 15th) infested significantly by the lowest mean number of *T. tabaci* (23.02 individuals /plant). On the contrary, the plants of the last planting date (January, 15th) harboured highest numbers of *T. tabaci* (45.49 individuals/plant). In the 2nd season (Table 2), results took the same trend as obtained in the 1st season despite the population density per plant by *T. tabaci* was lower than those recorded in the 1st season. The seasonal mean numbers of *T. tabaci* found in this season were (18.38, 31.37 and 39.45 individuals / plant) for the three tested planting dates, respectively. The obtained data in the two studied seasons and their statistical analysis showed clearly that the degree of infestation of *T. tabaci* was significantly affected by changing the time of sowing and the planting of onion and the earliest planting date (November, 15th) escaped mostly from the infestation of *T. tabaci*.

Table (1): Mean number of *Thrips tabaci* individuals/plant on onion plants in different planting dates during the 1st season of 2013/14.

Investigation date	1st sowing date (mid November)			2nd sowing date (mid December)			3rd sowing date (mid January)		
	Nymphs	Adults	Total	Nymphs	Adults	Total	Nymphs	Adults	Total
22/11/2013	0	0	0	-	-	-	-	-	-
29/11/2013	0	0	0	-	-	-	-	-	-
06/12/2013	0	0	0	-	-	-	-	-	-
13/12/2013	0	0	0	-	-	-	-	-	-
20/12/2013	0	0	0	0	0	0	-	-	-
27/12/2013	0	0	0	0	0	0	-	-	-
03/01/2014	0	0.25	0.25	0	0	0	-	-	-
10/01/2014	0.563	1.312	1.875	0	0	0	-	-	-
17/01/2014	0.75	1.563	2.313	0	0.188	0.188	0	0	0
24/01/2014	4.5	1.125	5.625	0.688	1.5	2.188	0	0	0
31/01/2014	10.19	4.375	14.56	5.563	2	7.563	0	0.625	0.625
07/02/2014	17.31	6.313	23.63	10.94	4.875	15.81	0.313	1	1.313
14/02/2014	13.94	16.13	30.06	22.38	3.938	26.31	6.875	3.313	10.19
21/02/2014	42.5	15.56	58.06	37.75	11.63	49.38	18.31	5	23.31
28/02/2014	59.25	11.13	70.38	39.81	10.25	50.06	41.5	18.31	59.81
07/03/2014	67.5	20.31	87.81	61.88	11.81	73.69	53.44	13.38	66.81
14/03/2014	40	23.75	63.75	54.19	21.25	75.44	46.06	18.94	65
21/03/2014	43.5	7.5	51	70.63	16.88	87.5	61.81	16.5	78.31
28/03/2014	26.06	9.313	35.38	80.31	11.5	91.81	49.13	20.88	70
04/04/2014	12.69	2.938	15.63	61.06	17.25	78.31	48.5	23.81	72.31
11/04/2014	-	-	-	40.06	12.44	52.5	62.88	27.13	90
18/04/2014	-	-	-	38.13	10.13	48.25	87.5	18.38	105.9
25/04/2014	-	-	-	26.56	4.563	31.13	56.31	26.56	82.88
02/05/2014	-	-	-	7.438	6.563	14	49	15.69	64.69
9/05/2014	-	-	-	-	-	-	32.5	11.75	44.25
16/05/2014	-	-	-	-	-	-	19.75	11.56	31.31
23/05/2014	-	-	-	-	-	-	17.69	7.188	24.88
30/05/2014	-	-	-	-	-	-	10.63	7.625	18.25
Mean±SE	16.93 ±4.89	6.08 ±1.68	23.02 ±6.34	27.86 ±6.04	7.33 ±1.48	35.2 ±7.38	33.11 ±5.8	12.38 ±2	45.49 ±7.61

L. S. D. for Nymphs = 15.861, F= 2.170
L. S. D. for Adults = 4.9205, F= 3.685
L. S. D. for Total = 20.2178, F= 2.484

Table (2): Mean number of *Thrips tabaci* individuals/plant on onion plants in different planting dates during the 2nd season of 2014/15.

Investigation date	1st sowing date (mid November)			2nd sowing date (mid December)			3rd sowing date (mid January)		
	Nymphs	Adults	Total	Nymphs	Adults	Total	Nymphs	Adults	Total
21/11/2014	0	0	0	-	-	-	-	-	-
28/11/2014	0	0	0	-	-	-	-	-	-
05/12/2014	0	0	0	-	-	-	-	-	-
12/12/2014	0	0	0	-	-	-	-	-	-
19/12/2014	0	0	0	0	0	0	-	-	-
26/12/2014	0	0	0	0	0	0	-	-	-
02/01/2015	0.125	0.188	0.313	0	0	0	-	-	-
9/01/2015	0.313	2.188	2.5	0	0.125	0.125	-	-	-
16/01/2015	1.563	1.188	2.75	0.125	0.563	0.688	0	0	0
23/01/2015	4.375	3.125	7.5	2.438	1	3.438	0	0	0
30/01/2015	6.25	4.75	11	9	2.125	11.13	4.25	3.313	7.563
06/02/2015	15.44	7.188	22.63	10.25	4	14.25	5.563	3.563	9.125
13/02/2015	31.44	9.75	41.19	20.31	5.438	25.75	9.813	2.125	11.94
20/02/2015	25.88	11.75	37.63	33.69	7.5	41.19	34.44	3.5	37.94
27/02/2015	18.88	15.13	34	28.44	9.125	37.56	24.44	5.563	30
06/03/2015	45.06	10.44	55.5	33.19	10.31	43.5	37.38	6	43.38
13/03/2015	33.88	14.56	48.44	47.31	20	67.31	33.06	12.25	45.31
20/03/2015	34.38	9	43.38	52.38	16.06	68.44	36.06	10.44	46.5
27/03/2015	36.69	7.563	44.25	55.13	15.31	70.44	55.13	12.88	68
03/04/2015	11.56	5.125	16.69	58.13	19.5	77.63	59.5	15.5	75
10/04/2015	-	-	-	34.88	14.5	49.38	78.06	22.06	100.1
17/04/2015	-	-	-	35	10.75	45.75	69.5	16.63	86.13
24/04/2015	-	-	-	27.81	9.688	37.5	43.94	21.38	65.31
01/05/2015	-	-	-	24.5	8.875	33.38	45.81	17.44	63.25
8/05/2015	-	-	-	-	-	-	29.5	9.938	39.44
15/05/2015	-	-	-	-	-	-	23.63	6	29.63
22/05/2015	-	-	-	-	-	-	15.97	2.76	18.73
29/05/2015	-	-	-	-	-	-	10.25	1.375	11.63
Mean±SE	13.29 ±3.48	5.1 ±1.16	18.38 ±4.51	23.62 ±4.5	7.74 ±1.51	31.37 ±5.97	30.81 ±5.14	8.63 ±1.58	39.45 ±6.58

L. S. D. for Nymphs = 12.5439, F= 4.955
L. S. D. for Adults = 4.0544, F= 1.652
L. S. D. for Total = 16.306, F= 3.405

The present results are in agreement with the findings of Metwally *et. al*. (1994) who recorded that the population density of *T. tabaci* increased by delaying planting date on squash and common bean. Also, the present results agree with those of Shetgar *et. al*. (1994), on groundnut, Wnuk and Wiech (1996), on pea plants, Salman and Abou-Elhagag (2001) on faba bean, Sahu *et. al*. (2005) on linseed crop and Emam *et. al*. (2006) on sweet pea plants, as all reported that there was significantly less thrips population on plants sown in the earliest planting date, while those sown in the latest planting date had the highest thrips population. But it contrast with Efil (2003) who stated that the late sowing date of cotton resulted in a very low *T. tabaci* population. Mohamed, (2011) recorded that the degree of infestation with three pests, aphid, *Aphis gossypii* Glover, whitefly, *Bemisia tabaci* (Genn.) and thrips, *T. tabaci* Lind. increased significantly by delaying planting date on

squash plants. Also, in Nigeria Ibrahim and Adesiyun (2009) found that the infestation with thrips increased by delaying planting date on onion plants.

The infestation rate of *T. tabaci* represented as the percentage of infested plant with *T. tabaci* per 16 plants was increased gradually throughout the season from transplanting to harvest dates in the different planting dates with increasing of plant age then decreased in the end of season. The general means of infested plants were statistically highly significant in the latest planting date than other planting dates (Table 3).

Table (3): Infestation percentages of onion plant with *thrips tabaci* in three planting dates during two successive seasons 2013/14 and 2014/15:

Planting date	1st season 2013/14 (Mean±SE)	2nd season 2014/15 (Mean±SE)
15 – November	34.37±6.22[b]	30±5.45[b]
15- December	47.81±6.86a[b]	43.75±28.1[ab]
15 – January	55.62±7.29[a]	49.67±6.61[a]
L.S.D.	19.28	17.68

Means in each column followed by the same letter(s) are not significantly different at 5% level

Population density *T. tabaci*:

Concerning the population density of *T. tabaci*, illustrated in Fig. 1 and 2, during the 1st season 2013/14, the mid November transplant was free of thrips up to seven weeks after transplanting, mid December transplant up to four weeks after transplanting, January transplant up to two week after transplanting, the insect was first observed on January 3rd, January 17th and January 31st (0.25, 0.18 and 0.62 individual / plant) for the 1st, 2nd and the 3rd sowing dates, respectively. The population increased to record the peak population on 7th March, 28th March and 18th April i.e. 87.81, 91.81 and 105.9 thrips / plant, respectively. Afterward the pest population declined during the month of March, April and May for the three sowing date, respectively. The decline in population may be due to maturation of crop, leaf hardening and migration of thrips to other crops. In the 2nd season similar trend was obtained whereas the insect remained a consistent pest on onion during the growing season and the first observation was recorded on 2nd January, 9th January and 30th January during the 1st, 2nd and 3rd sowing dates, respectively. Then the population increase to record peaks on 6th March (55.5 thrips / plant), 3rd April (77.63 thrips / plant) and 10th April (100.1 thrips / plant). Then the population declined due to maturation of onion crop. Ullah *et al*. (2010) in Pakistan and Hussain *et al.* (1997), Hyder and Shariff (1987), El-Gendi, (1998) and Abd El-Hameed *et al*. (2011) in Egypt also recorded almost similar findings. These results refer to the peaks of thrips population were more related by the plant growth stage in different planting dates than other factors such as the suitability of weather for population growth.

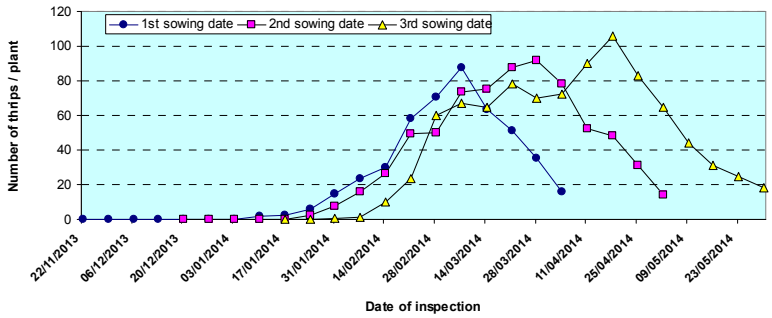

Fig. 1: Population density of the total population of onion thrips on the three different sowing dates during 2013/14 season in onion crop at El-Beheira Governrate.

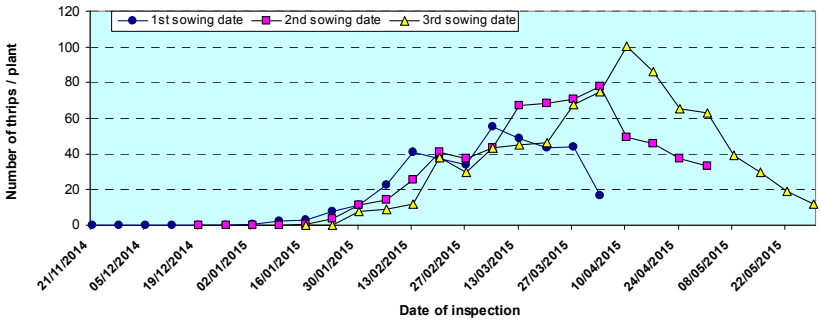

Fig. 2: Population density of the total population of onion thrips on the three different sowing dates during 2014/15 season in onion crop at El-Beheira Governrate.

Life stage composition of *Thrips tabaci* on onion plants:

Percentages of nymph thrips abundance to total thrips abundance on onion plants varied on different sampling dates during each season and between the three planting dates. Overall percentages of nymph to total thrips ranged from 61.48 % on 3rd sowing date (mid January) to 43.46 % on 1st sowing date in 2013/14 season, and from 69.75 % to 43.79 % in 2014/15 season (Table 4). Generally, adult thrips composed about of <32 % of all thrips on onion plants. With the increase of adult thrips population, more immatures were produced, lowering the adult percentage. The lower percentages of adults in the late season could be caused by fewer nymphs molting to adults, or more adults leaving the plants as the plants became mature. In addition, adult thrips may migrate from plants, especially when plants were senescing. In general, developmental stages of *T. tabaci* on onion plants consisted of 43.46 -69.75 % Nymphs, and 20.25 - 31.58 % adults. In similar work Liu, (2004) found that developmental stages of *T. tabaci* on onion plants consisted of 76-85% larvae, <0.1% pupae, and 10-

28% adults. While, Liu and Chu. (2004) found that the adult thrips comprised ≈16.4 and 15.8% of total thrips in the absolute estimates and field visual counting, respectively.

Table (4): The life stage composition of the onion thrips, *Thrips tabaci* on onion plants:

Season	Sowing date	Mean/plant ± SE			
		All thrips	% adults	% nymphs	Nymphs/adult
1st season (2013/14)	Mid November	23.02±6.02	26.53±6.16	43.46±8.04	1.84±0.43
	Mid December	35.2±7.38	24.45±5.39	55.54±7.86	2.73±0.5
	Mid January	45.49±7.61	31.58±4.98	61.48±5.72	2.17±0.3
2nd season (2014/15)	Mid November	13.29±3.48	26.2±5.24	43.79±7.43	1.56±0.34
	Mid December	31.37±5.97	27.53±5.32	57.46±7.21	2.37±0.33
	Mid January	39.45±6.58	20.25±2.45	69.75±5.66	3.73±0.53

The effect of the time of the day on the intra-plant distribution of *T. tabaci*:

The results in Tables (5-8) illustrated distinct correlation between time of day and the position of adults and nymphs of *T. tabaci* on the onion plants through the two seasons. Concerning adults of *T. tabaci*, (Tables 6 & 8) the majority of them were found on the basal section of the plant throughout the day. Few numbers of *T. tabaci* adults were recorded on the stem through all time of the day. A large proportion of *T. tabaci* adults make a regular migration to the apical half of the leaves with increase of warmth throughout the day. This may be due to temperature that has a direct effect upon the activity and behaviours of *T. tabaci*, including its flight behaviours. In case of nymphs, the vast majority of them occupied the basal half of the leaves and remained there throughout the day (Tables 5 & 7). This was true for every sampling date during the experiment. Although there was some movement between zones, it was undertaken by very a small percentage of the overall nymph population. The present results agree with Sites *et al*. (1992) who reported that the intra-plant distribution of thrips could be affected by time of day, and therefore all the physical factors associated with it (temperature, light intensity, humidity etc.). They were able to show that, in midsummer, there was a tendency for thrips to aggregate on the apical half of leaves in the early afternoon, when temperatures were highest. This may reflect dispersion behaviour, as the thrips climb to higher parts of the host plant to initiate flight. It also highlights the importance of understanding the diurnal periodicity of the intra-plant distribution of *T. tabaci* to improve the timing of insecticide sprays. Also, these results agree with Burnstone, (2009) in UK on his study on the diel periodicity of the intra-plant distribution of *T. tabaci* and Mo *et al*. (2008) who found that higher proportions of larvae than adults of *T. tabaci* congregated at the basal sections of plants, particularly when plants were young and thrips density was low. Regardless of plant size, there were always more adults in the upper than basal plant sections. These results reveal to the insecticides spraying efforts should be focus in the mid day and warmer days when *T. tabaci* is to be more active.

Table (5): Mean numbers of *T. tabaci* nymphs on the different onion plant parts at the different times of day during the 1st season 2013/2014:

Plant parts	Time				General mean
	6:00 am	10:00 am	2:00 pm	6:00 pm	
Apical half of leaves	1.18±1.17	1.98±0.5	2.19±1.42	1.18±0.67	1.63±1.06[b]
Basal half of leaves	39.06±9.43	46.86±13.28	48.27±11.2	43.61±6.66	44.45±10.38[a]
Stem	0.67±0.35	0.98±0.45	1.18±0.9	0.83±0.61	0.92±0.6[b]
General mean	13.63±19.2[a]	16.61±23.16[a]	17.21±23.42[a]	15.2±20.98[a]	15.66±21.34

Means in each column or row followed by the same letter(s) are not significantly different at 5% level
L.S.D. for General means of plant parts = 3.4586
L.S.D. for General means of times = 3.9936

Table (6): Mean numbers of *T. tabaci* adults on the different onion plant parts at the different times of day during the 1st season 2013/2014:

Plant parts	Time				General mean
	6:00 am	10:00 am	2:00 pm	6:00 pm	
Apical half of leaves	2.24±1.93	6.46±1.88	8.11±2.75	1.63±0.59	4.61±3.34[b]
Basal half of leaves	10.61±4.2	9.8±2.9	10.31±2.65	13.72±6.23	11.11±4.25[a]
Stem	0.42±0.26	0.47±0.34	0.44±0.31	0.63±0.27	0.48±0.29[c]
General mean	4.42±5.21[a]	5.58±4.39[a]	6.28±4.82[a]	5.33±7[a]	5.4±5.37

Means in each column or row followed by the same letter(s) are not significantly different at 5% level
L.S.D. for General means of plant parts = 1.7988
L.S.D. for General means of times = 2.077

Table (7): Mean numbers of *T. tabaci* nymphs on the different onion plant parts at the different times of day during the 2nd season 2014/2015:

Plant parts	Time				General mean
	6:00 am	10:00 am	2:00 pm	6:00 pm	
Apical half of leaves	1.43±0.84	2.13±1.02	2.2±1.53	1.37±0.84	1.78±1.09[b]
Basal half of leaves	35.66±3.92	42.08±10.09	48.05±7.48	31.72±4.61	39.38±9.09[a]
Stem	0.62±0.4	0.83±0.46	0.61±0.42	0.63±0.3	0.68±0.38[b]
General mean	12.57±16.94[bc]	15.01±20.45[ab]	16.95±23.01[a]	11.24±15.11[c]	13.94±18.85

Means in each column or row followed by the same letter(s) are not significantly different at 5% level.
L.S.D. for General means of plant parts = 2.8246
L.S.D. for General means of times = 3.2615

Table (8): Mean numbers of *T. tabaci* adults on the different onion plant parts at the different times of day during the 2nd season 2014/2015:

Plant parts	Time				General mean
	6:00 am	10:00 am	2:00 pm	6:00 pm	
Apical half of leaves	1.04±0.56	4.76±0.83	6.68±0.87	1.3±1.23	3.44±2.56[b]
Basal half of leaves	9.92±3.54	7±1.33	10.67±3.33	11.04±2.38	9.65±3.07[a]
Stem	0.38±0.3	0.22±0.2	0.38±0.29	0.47±0.37	0.36±0.29[c]
General mean	3.78±4.87[b]	3.99±3.03[b]	5.91±4.74[a]	4.27±5.15[b]	4.49±4.51

Means in each column or row followed by the same letter(s) are not significantly different at 5% level
L.S.D. for General means of plant parts = 1.2681
L.S.D. for General means of times = 1.4643

Effect of planting dates and thrips damage on onion yield:

There were significant differences in weight of onion bulb between the planting dates in unsprayed plots during the two successive seasons, whereas the maximum average weight per bulb was recorded in 1st sowing date i.e., (89.56, 91.12 g/bulb), which differed from the other two sowing dates in average weight of onion bulbs (Table 9), the minimum weight was recorded in the latest date (58.68, 60.31 g/bulb) in 2013/14 and 2014/15, respectively. Similar results were obtained in case of treated plots, whereas the maximum average weight of onion bulb during consecutive two seasons elaborate that significantly higher weight per bulb was recorded in the 1st sowing date (121.31, 114.56 g/bulb) followed by the 2nd date (116.56, 104.93 g/bulb) then the latest date (101.88, 93.12 g/bulb) in consecutive two seasons, respectively.

Data presented in Table (9) revealed that, the mean percentages of yield losses in onion bulb as a result of thrips damage during two successive seasons (2013/14 and 2014/15). A loss in bulb yield in the 1st season ranging from 26.17 % to 42.39 % in different planting dates compared to treatment which sprayed against thrips. In the 2nd season loss in bulb yield recorded 20.45, 30.85 and 35.23 % in the 1st, 2nd and 3rd planting date, respectively. In similar work Karar *et al*. (2014) recorded that on average about 37% losses in yield per bulb of onion was recorded due to thrips as compared with sprayed crop. Mote (1978) also reported crop loss of upto 50 per cent due to onion thrips, *T. tabaci*. Similarly, Srinivasan (1982) also reported that onion crop protected from *T. tabaci* attack by giving seven sprays of 0.05 per cent dimethoate 30 EC, yielded significantly more bulb yield compared to unprotected plots causing crop loss upto 38.42 per cent.

Table (9): Effect of planting dates and thrips damage on onion yield (Bulb weight) during the two season of study:

Season	1st season 2013/14			2nd season 2014/15		
Planting date	Sprayed	Unsprayed	Yield loss %	Sprayed	Unsprayed	Yield loss %
15 - November	121.3±3.79[a]	89.56±4.5[a]	26.17	114.5±4.13[a]	91.12±4.27[a]	20.45
15 - December	116.5±5.19[a]	76.62±3.83[b]	34.26	104.9±6.23[ab]	72.56±3.43[b]	30.85
15 - January	101.9±4.68[b]	58.68±2.04[c]	42.39	93.12±3.68[b]	60.31±2.43[c]	35.23
L.S.D.	13.0698	10.2839		13.71	9.8734	
F value	4.877	18.44		4.97	20.03	

Means in each column followed by the same letter(s) are not significantly different at 5% level

Effect of climatic factors on *T. tabaci* density population on onion plants:

With regard to the effect of climatic factors on the population density of thrips infesting onion plants in three planting dates during 2013/14 and 2014/15 seasons, each of the correlation coefficient values were calculated and tabulated in Tables 10 and 11. Positive correlations were found in different planting dates between thrips population (nymphs, adults and total population) and minimum, mean and maximum temperature. The present

findings corroborated with Panwar *et al*. (2015) and Gupta *et al.,* (1997) who reported that the positive correlation of temperature with thrips population. Also, the present investigations are supported in findings of Khan *et al.,* (2008) who noticed that incidence of thrips was highly affected by weather factors like mean air temperature; relative humidity and rainfall. It was evident form Table 1 that thrips population in different planting dates was negatively correlated with mean relative humidity in agreement with Hamdy and Salem, 1994. Also, Waiganjo**,** *et al*. (2008) found that dry weather with moderately high temperatures increased seasonal thrips numbers, while wet season with moderately high relative humidity was negatively correlated with thrips numbers. While, positive significant correlation was found between thrips population in different planting dates and mean of wind speed (Km/h). These results were repeated in the consecutive seasons.

Table (10): Effect of climatic factors on the population density of *T. tabaci* infesting onion plants in three planting dates during 2013/14 season:

Planting date	Stage	Max. Temp.	Mean Temp.	Mini. Temp.	Mean RH%	Mean wind speed (Km/h)
1st planting Date	Nymphs	0.193	0.025	-0.109	-0.058	0.885*
	Adults	0.068	-0.1	-0.211	0.02	0.819
	Total population	0.161	-0.008	-0.136	-0.038	0.869*
2nd planting Date	Nymphs	0.145	0.23	-0.082	-0.120	0.644
	Adults	0.408	0.279	0.147	-0.239	0.835*
	Total population	0.195	0.070	-0.041	-0.143	0.684
3rd planting Date	Nymphs	0.578	0.542	0.523	-0.762	0.688
	Adults	0.653	0.62	0.6	-0.8	0.698
	Total population	0.599	0563	0.544	-0.773	0.692

* **P = 0.01**

Table (11): Effect of climatic factors on the population density of *T. tabaci* infesting onion plants in three planting dates during 2014/15 season:

Planting date	Stage	Max. Temp.	Mean Temp.	Mini. Temp.	Mean RH%	Mean wind speed (Km/h)
1st planting Date	Nymphs	0.147	0.143	0.168	-0.536	0.259
	Adults	0.058	0.088	0.169	-0.698	0.183
	Total population	0.127	0.131	0.17	-0.583	0.243
2nd planting Date	Nymphs	0.538	0.63	0.67	-0.668	0.916*
	Adults	0.593	0.677	0.692	-0.646	0.901*
	Total population	0.552	0.643	0.676	-0.663	0.913*
3rd planting Date	Nymphs	0.531	0.516	0.447	-0.480	0.915*
	Adults	0.554	0.536	0.461	-0.401	0.843
	Total population	0.538	0.522	0.452	-0.463	0.901*

* **P = 0.01**

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النواحي الإيكولوجية والسلوكية لحشرة تربس البصل *Thrips tabaci* Lindeman علي نباتات البصل

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تم دراسة تأثير ثلاث مواعيد لزراعة نباتات البصل علي حشرة تربس البصل خلال موسمي (١٤/٢٠١٣ – ١٥/٢٠١٤) في محافظة البحيرة، جمهورية مصر العربية. وقد وجد أن درجة الإصابة بحشرة التربس تزيد معنويا بتأخير ميعاد الزراعة وأن الزراعات المبكرة (١٥ نوفمبر) تتعرض للإصابة بأعداد أقل من الحشرة بالإضافة الي وزن عالي للأبصال بالمقارنة بالنباتات التي يتم زراعتها في المواعيد المتأخرة والتي تهاجم بمستوي أكبر من أعداد الآفة وكذلك تصاحب بوزن أقل للأبصال. وتم دراسة التذبذب العددي والتركيب العمري لعشيرة التربس خلال موسمي الدراسة وفي مواعيد الزرعة المختلفة. كذلك تم دراسة توزيع حشرة التربس علي الأجزاء المختلفة لنباتات البصل خلال فترات اليوم المختلفة ولوحظ أن الحشرات البالغة للتربس تميل الي التواجد بأعداد كبيرة علي النباتات في الأوقات الدافئة خلال اليوم. أما الحوريات فالغالبية العظمي منها توجد في الجزء القاعدي من الأوراق وتستمر بهذا المكان طوال فترات اليوم. تأثير الضرر المتسبب عن التربس تم دراسته علي إنتاجية محصول البصل وتراوحت نسبة الفقد في المحصول من ٢٦,١٧ % الي ٤٢,٣٩ % في المواعيد المختلفة للزراعة خلال الموسم الأول. في الموسم الثاني كانت الخسائر في محصول البصل نتيجة لضرر التربس ٢٠,٤٥ % و ٣٠,٨٥ % و ٣٥,٢٣ % خلال مواعيد الزراعة الاول والثاني والثالث علي التوالي. وبين التحليلي الاحصائي لتأثير العوامل الجوية علي عشيرة التربس وجود ارتباط موجب بين كل من درجات الحرارة الصغري والمتوسطه والقصوي وبين تعداد التربس وكذلك ارتباط قوي وموجب بين سرعة الرياح وتعداد التربس علي البصل بينما يوجد إرتباط عكسي بين تعداد التربس وبين متوسط الرطوبة النسبية.