POPULATION DYNAMIC OF APHIDS AND THRIPS ON CERTAIN BREAD WHEAT CULTIVARS IN RELATION TO YIELD, GENOTYPIC PREFERENCE AND FACTORS REGULATING THEIR FLUCTUATION UNDER DROUGHT AND IRRIGATION CONDITIONS[†]

[DINÁMICA POBLACIONAL DE ÁFIDOS Y TRIPS EN CIERTOS CULTIVOS DE TRIGO CON RELACIÓN AL RENDIMIENTO, PREFERENCIA GENOTÍPICA Y FACTORES QUE REGULAN SU FLUCTUACIÓN BAJO CONDICIONES DE RIEGO Y SEQUÍA]

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SUMMARY

The study was conducted during (2015/2016 and 2016/2017) on bread wheat cultivars: Sahel1, Seds4, Gemaza9, Giza168, and Misr2 in Plant Protec. Dept. farm, Fac. of Agric., Assiut Univ., Assiut, Egypt to determine the separate effect of some abiotic and biotic factors on the population dynamics of aphid species: *Mayzus persicae*; *Brivecoryne brassicae*; *Rhopalosiphum padi*, and onion thrips, *Thrips tabaci* Lindeman under drought and irrigation conditions. The considered abiotic factors: plant age, chlorophyll AB; climatic factors: Daily Maximum Temperature (DMxT), Daily Minimum Temperature (DMnT), Soil Daily Maximum Temperature (SMxT) and Soil Minimum Temperature (SMnT) at 3 to 5 cm depth from soil surface, beside the biotic factors which presented in natural enemies (N.E.) to clarify which cultivar is suitable to be planted under drought or irrigation conditions under free insecticides use for both pests with references to cultivars yields. The infestations of both pests started in February during 1st season and January for 2nd season in all replicates with a high mean numbers of pests on cultivars under irrigation conditions than drought conditions. The peaks of aphids recorded from the middle of the 2nd month to the 3rd month; and thrips in the 2nd month to the half of 3rd month from sampling date under both conditions. The most important factors regulated the fluctuation of pests under drought conditions were arranged according to their efficiency as (DMnT= 26.70), (DMxT= 16.91), and (N.E= 16.40); respectively out of (66.50 %). Under irrigation conditions, fluctuations were determined by the efficiency of (N.E.= 38.17), (Chlorophyll AB= 14.97), and plant age (9.96); respectively out of (83.19 %) with positive significant correlations on all selected cultivars. Top yields were gained from Giza186, Misr2, and Sahel1; respectively during seasons of the study under both conditions, except Gemeza9 under irrigation condition in 1st season ranked the 3rd yield.

Keywords: climatic factors; wheat insects; wheat aphids; onion thrips; natural enemies; wheat cultivars.

RESUMEN

El estudio se realizó durante los años 2015-2016 y 2016-2017, en variedades de trigo harinero: Sahel1, Seds4, Gemaza9, Giza168 y Misr2 en el Depto de Protección de Plantas de la Fac. de Agricultura en la Universidad de Assiut, Egypt. El objetivo fue determinar los efectos de algunos factores abióticos y bióticos en la dinámica poblacional de especies de áfidos: *Mayzus persicae*; *Brivecoryne brassicae*; *Rhopalosiphum padi*, y trips de cebolla, *Thrips tabaci* Lindeman en condiciones de sequía y riego. Los factores abióticos considerados fueron: edad de la planta, clorofila AB; factores climáticos: temperatura máxima diaria (DMxT), temperatura mínima diaria (DMnT), temperatura máxima diaria del suelo (SMxT) y temperatura mínima del suelo (SMnT) a una profundidad de 3 a 5 cm desde la superficie del suelo, además de los factores bióticos que se presentan en los enemigos naturales (NE) para

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aclarar qué cultivar es adecuado para ser establecido bajo condiciones de sequía o irrigación, sin el uso de insecticidas para ambas plagas con referencias a los rendimientos de cultivares. Las infestaciones de ambas plagas comenzaron en febrero durante la 1ª temporada y enero en la 2ª temporada en todas las réplicas, con un promedio alto de plagas en cultivares en condiciones de riego en comparación a los cultivares condiciones de sequía. Los mayores picos de incidencia de áfidos ocurrieron desde la mitad del segundo mes hasta el tercer mes; y de trips en el segundo mes hasta la mitad del tercer mes. Los factores más importantes que regulan la fluctuación de las plagas en condiciones de sequía fueron organizados de acuerdo con su eficiencia como (DMnT = 26.70), (DMxT = 16.91) y (N.E = 16.40); respectivamente de (66.50 %). Bajo condiciones de riego, las fluctuaciones se determinaron por la eficiencia de (N.E. = 38.17), (Clorofila AB = 14.97) y la edad de la planta (9.96); respectivamente, de (83.19%) con correlaciones significativas positivas en todos los cultivares seleccionados. Los mejores rendimientos se obtuvieron en Giza186, Misr2 y Sahel1; respectivamente, durante las temporadas del estudio en ambas condiciones, excepto que Gemeza9 en condiciones de riego en la 1ª temporada obtuvo el 3er rendimiento.
Palabras clave: factores climáticos; insectos del trigo; pulgones del trigo; trips de la cebolla; enemigos naturales; cultivares de trigo.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most nutritious and strategic cereal crop which contribute in various dietary products especially for bread production which consumed by 70% around the world (Qamar, 2011).

Insect pests especially aphids and thrips are the most devastating pests among wheat cultivars and their outbreaks presenting a typical example of pest's risk which directly reducing the quantity and quality of wheat yields. However, the highly cost of chemical control became the main problem not only for its costs which reaches to approximately $40 billion worldwide (FAO, 2011), but also the repetition of pesticides which shows unacceptable reasons of pest resistance and toxicity (Lewis *et al.,* 1997).

Thrips tabaci Lindeman, is a minor and common pest adapt to destruct various plant species and genus more than 300 species of host plant groups (Ahmed *et al.,* 2016; Ghabn, 1948), which makes difficult to be controlled by farmers, due to their behaviour in escaping from sunlight and high temperatures by hiding in plant parts where it difficult to insecticides to be reached such as flowers and folded leaves (Palumbo, 2000).

Aphid species infesting wheat cultivars which considered as the most dangerous and significant sucking insect pest infesting various crops with significant damage shown as distortion, chlorosis, curling of leaves and afterwards affect the growth (Dedryver *et al.,* 2010; Akhter and Khaliq, 2003; Kindler *et al.,* 1995). It has been recorded that there are 29 species of aphids are known with their ability in infesting wheat cultivars (Geza, 2000). The most common species are bird cherry oat aphid: *Rhopalosiphum padi* (L.); English grain aphid: *Sitobion avenae* (Fabricius); the greenbug: *Schizaphis graminum* (Rondani); Russian wheat aphid: *Diuraphis noxia* (Mordvilko), and the rose-grass aphid: *Metopolophium dirhodum* (Walker) (Bospucperez and Schotzko, 2000). Specially, *R. padi* was the most abundant pest among aphid species (Shah *et al.,* 2006). The direct damage of aphids reached up to 35 - 40% with direct loss in reducing the numbers of wheat heads, grains per head, and loss in grains weight, and 20- 80% of the indirect loss occurs by fungal, virus transmission and excreting honeydew followed by the growth of fungi and moulds afterwards affect photosynthesis process (Kiechefer and Gellener, 1992; Rossing *et al.,* 1994). Among aphid species, *R. padi* can be responsible for causing damage up to 600 kg/ha in yield losses for wheat plantations (Hallqvist, 1991).

Wheat plantations are exposed to intensive spread of insecticides and stoping use of pesticides is stills the first demand for food safety to reduce the risks of environment pollution, pest resistance, and killing of natural enemies. However, wheat plantations under free insecticides uses show some resistant cultivars to pest infestations, while others are hypersensitive and in between there are some cultivars need a better documentation due to the differences among cultivars characteristics which play an important role in the defence mechanism against insect pests attack. In this regard, the fluctuations of insect pests individuals occurs due to some complex interactions between various biotic and abiotic factors which mainly determine the general changes of population patterns, and time of peaks for pest population (Gaston and Lawton, 1988).

The study aimed to determine the effect of abiotic and biotic factors on the population fluctuations patterns of aphid species and onion thrips on five of the most planted bread wheat cultivars in Egypt: Sahel1, Seds4, Gemaza9, Giza 168, and Misr2 under drought and irrigation conditions. The considered abiotic factors are plant age and climatic factors: [chlorophyll (A and B); climatic factors: the Daily Maximum

Temperature (DMxT), Daily Minimum Temperature (DMnT), the Soil Daily Maximum Temperature (SDMxT) and the Soil Minimum Temperature (SDMnT) at 3 and 5 cm depth from soil surface] and the biotic factors: presented in the sums of the population of natural enemies, to determine the fluctuations patterns, the most, the least infested cultivar with thrips and aphids species under drought and irrigation conditions in the mentioned cultivars with reference to their yields under the considered factors and insect pests infestation.

MATERIALS AND METHODS

The experiment was conducted throughout two successive seasons (2015/ 16 and 2016/ 17) at The Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Field experiment and design

Five of bread wheat cultivars: Sahel1, Seds4, Gemaza9, Giza168, and Misr2 were planted and maintained free of insecticides and weedicides for two successive seasons during (2015/16-2016/17). The randomized complete block design (RCBD) was used for an area planted with 30 replicates (15 replicates/ drought treatment and 15 replicates for irrigation treatment for the same cultivars) distributed as three replicates/ cultivar/ treatment and the replicate size was 3m x 4m and consisted of ten rows. Each row had 40 plants, the spaces between rows was 30 cm, and 30 cm within plants. A total of 15 replicates were allowed for irrigation and the other 15 were deprived for drought conditions.

Monitoring and sampling arthropods

Water and sticky traps: Water and sticky traps were used for the survey study according to the method of Nancy *et al.* (2008). The water traps were fixed at 50 cm height from the soil provided above with a yellow container of water supplied with three drops of Formaldehyde to prevent fungi growth. However, the yellow plastic sheets of sticky traps were installed at 1 m height from the soil. Both of water and sticky traps were well distributed in the field, two water and two sticky traps/ plot with total number of 30 water and 30 sticky traps for in order to well cover the experiment for survey study.

Direct count: The direct count was used according to the method of Cochran (1977) for collecting the mature and immature stages of arthropods for the survey and determination studies of population dynamics of wheat insect pests and related natural enemies.

Three plants/ cultivar/ replicate were collected randomly per week in polyethylene bags with total number of 60 samples/ month for all selected cultivars in irrigation condition and the same for drought. The samples were kept in refrigerator at The Laboratory of Economic Entomology/ Plant Protection Research centre at The Faculty of Agriculture Farm, Assiut University, Assiut, Egypt. The leaves were well examined (upper and lower surfaces) by binocular microscope, and the numbers of mature and immature stages of aphids, thrips, and related natural enemies were registered and the unknown species of aphids were maintained on glass slides and sent to specialist for identification by Atta (1989).

Biotic and abiotic factors: The biotic factors were presented as the sums of the natural enemies of aphids and thrips. However, the considered abiotic factors were: plant age and the main considered climatic weather factors are: the Daily Maximum Temperature (DMxT), Daily Minimum Temperature (DMnT) in degrees Celsius, the Daily Soil Maximum Temperature (SDMxT) and the Daily Soil Minimum Temperature (SDMnT) at 3 and 5 cm depth from soil surface in degrees Celsius. These factors were obtained from the Meteorological station of Assiut University, Faculty of Agricultural Farm, Assiut University, Assiut, Egypt.

Determination of chlorophyll A and B: The plants after insect examination were transferred to The Laboratory of Botany Science, Faculty of Science, Assiut University, Assiut, Egypt and kept fridge at (-10).

The pigment fraction (Chlorophyll A and B) were estimated in 95% ethanol extracts at 60°c following spectrophotometric method (Unico UV-2100 spectrophotometer recommended by Lichtenthater (1987).

Statistical analysis

The multiple stepwise regression **(Table 2)** was reapplied for both seasons by the Advanced Statistical Analysis Package (ASAP) to determine the separate effect of each considered biotic factors (plant age, Max.T, Min.T, Soil Max.T, Soil Min. T, and Chlorophyll A+B) and abiotic factors (natural enemies) under drought and irrigation conditions on each pest activity in the presence of the other tested factors (R-values) which were next squared to obtain the "squared partial regression coefficient (R^2)". The latter coefficients expressed the average rate of change in the dependent variable (population) per unit change in the independent variables. Squared partial regression coefficients were multiplied by 100 to obtain the percentages of explained variance

(Efficiency) which reflects the amount of effect expressed by a particular weather factor, plant age, and chlorophyll AB on the activity of each pest in the presence of the other considering factors.

The simple, partial and multi-regression analyses of the mean numbers of aphid species, thrips, and the sums of both pests aphids and thrips was done by the Advanced Statistical Analysis Package (ASAP) for both seasons 2016 and 2017 together **(Table 1 and 2)** with the considered biotic factors (plant age, Max.T, Min.T, Soil Max.T, Soil Min. T, and Chlorophyll A+B) and abiotic factors (natural enemies) under drought and irrigation conditions. To determine the efficiency of each factor and the efficient of all considered factors together on each pest under drought and irrigation condition.

RESULTS

Survey of arthropods associated with wheat cultivars:

The survey study was conducting by using water, sticky traps and the direct count method for surveying arthropods associated with wheat cultivars. Data of the survey study **(Table: 1)** revealed the presence of 9 insect species belonging to 9 genera under 6 families of 6 orders. Moreover, 1 mite species was represented one time during the survey. The data of the survey indicated that the collected arthropods can be classified according to their highly fluctuation and economic importance to 2 insect pests related to 4 insect species. The natural enemies included 6 predator's species and 1 species of parasitoid.

Population fluctuation of aphids and thrips under drought and irrigation conditions during the first season

In general, the population densities of aphids and thrips **(Fig. 1 and 2)** under irrigation conditions were higher (grand mean= 5134.0 for aphids and 5117.6 for thrips individuals/ season) than the drought conditions (grand mean= 3631.0 and 4601.0 individuals/ season; respectively for aphids and thrips) and particularly the thrips population was higher than aphids for both drought and irrigation conditions on the most selected wheat cultivars.

Fluctuation of aphid species under drought conditions during the first season

In the beginning of the season, the population density of aphids **(Fig. 1 and 2)** was in low levels of abundance during the middle and the end of February (avgs. of middle of February were 38.00, 51.67, 69.00, 29.00, and 29.67; and for the end of February were 76.00, 90.00, 101.00, 67.67, 68.6 individuals/ 3 plants/ replicate/ cultivar), then an increase in the population were occurred to moderate levels at the middle of March (avgs. of 103.67, 151.33, 168.67, 62.67, 76.33 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Sids4, Gemaza9, Giza186, and Misr2).

Table 1. A partial taxonomic list of arthropods associated with certain wheat cultivars under drought and irrigation conditions during (2015/16-2016/17) seasons.

No.	Insect pests			No.	Natural enemies		
	Order	Family	Scientific name		Order	Family	Scientific name
1	**Thysanoptera	Thripidae	*Thrips tabaci* L.	1	**Neuroptera	Chrysopidae	*Chrysoperla carnea* (Stephens)
			Mayzus persicae	2		Coniopterygidae	*Conwentzia barretti*
2	**Homoptera	Aphididae	*Brivecoryne brassicae*	3	**Coleoptera	Coccinellidae	*Coccinella septempunctata*
			Rhopalosiphum padi				*C. undecimpunctata*
3	*Hemiptera	Pentatomidae	*Nezara viridula* L.	4	*Orthoptera	Mantidae	*Mantis religiosa*
4	*Diptera	Tephritidae	*Ceratitis capitata*	5	Hemiptera	Geocoridae	*Geocores sp.*
			Bactrocera zonata	6	**Hymenoptera	Encyrtidae	*Psyllaephagus yaseeni*
5	*Hemiptera	Aleyrodidae	*Bemisia tabaci*				
6	*Diptera	Muscidae	*Musca domestica*				
7	*Acari	Phytosiidae	*Amblyseius cucumeris*				

****:** Highly fluctuated orders
***:** Accidental or low fluctuated orders

The highest levels of population density were recorded on three cultivars at the end of March, the middle and end of April (avgs. 114.00, 97.67, 166.67; 171.00, 160.00, 201.33; 207.33, 219.00, 286.33 individuals/ 3 plants/ replicate/ cultivar for Sahel1, Seds4, and Gemaza9; respectively. In the same periods, the population of aphids on Giza186 and Misr2 weren't high enough compared to other cultivars, but interlay at each cultivar it was slightly high during the middle and the end of April on Giza186 (avgs. of 63.00 and 80.00 individuals/ 3 plants/ replicate/ cultivar), and at the end of March and the middle of April for Misr2 (avgs. of 84.00 and 69.33 individuals/ 3 plants/ replicate/ cultivar). Afterwards, at the end of the season the numbers of aphids rapidly declined on all wheat cultivars during the middle of May.

Aphids population recorded the highest grand total numbers under drought conditions on Gemaza9 (1246.33 individuals/ season) and the lowest numbers was occurred on Giza186 (374.67 individuals/ season).

Fluctuation of aphid species under irrigation conditions during the first season.

The aphid population was in slight levels of abundance **(Fig. 1 and 2)** during the beginning of the season in the middle and end of February on all selected cultivars on all cultivars. Afterwards, the population increased gradually to moderate levels of fluctuation during the middle of March. The highest levels of population were occurred on four out five of wheat cultivars at the end of March, middle and the end of April (avgs. 165.33, 218.33, 292.67; 153.67, 207.67, 284.33; 132.6, 192.6, 206.0; 116.0, 136.0, 178.0 of individuals/ 3 plants/ replicate/ cultivar on Sahel1, Gemaza9, Giza186, and Misr2; respectively). However, for Seds4 the population recorded the highest levels in the same mentioned periods and extend till the end of the season in the middle of May 299.00 individuals/ 3 plants/ replicate).

The maximum densities of aphids occurred in irrigation conditions on Seds 4 (1472.00 individuals/ season), and the minimum on Misr2 (648.00 individuals/ season).

Fluctuation of thrips under drought conditions during the first season:

The results concerning thrips population fluctuation **(Fig. 1 and 2)** showed that the moderate levels of the attack was occurred during the middle and the end of February for Sahel1, Seds4, and Gemaza9; respectively. However, the moderate levels of abundance exceeded one month more on the other two cultivars Giza186 and Misr2.

The high numbers of individuals were recorded during the middle, end of March, and in the middle of April in the same sequence for Sahel1, Seds4, and Gemaza9: avgs. 134.00, 198.33, 222.00; 168.00, 210.00, 187.33; 203.00, 214.00, 196.00 (individuals/ 3plants/ replicate/ cultivar). On the other hand, the high densities on Giza186 and Misr2, respectively were occurred in the end of March, the middle and the end of April (avgs. 112.67, 136.67, 152.00; 223.00, 244.67, 264.67 individuals/ 3 plants/ replicate/ cultivar). Afterwards, a Sharp descended of individuals occurred through the end of the season in the middle of May on all selected cultivars.

Fluctuation of thrips under irrigation conditions during the first season

The population was slightly high in the beginning of the season **(Fig. 1 and 2)** during the middle and the end of February on all selected cultivars. Then, the highest population occurred in the middle, end of March, and middle of April, but the peaks occurred in the end of March for all selected cultivars (avgs. 231.67; 247.00; 221.33; 205.00; 200.00 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Sids4, Gemaza9, Giza186, and Misr2).

The highest grand total of thrips was occurred on Seds4 (1183.33 individuals/ season) and the lowest was on Misr2 (812.67 individuals/ season).

Misr2 was the highly infested cultivar with grand total in avgs. 1148.3 (individuals/ 3 plants/ replicate), and the lowest one was Giza186 with grand total of 649.3 (individuals/ 3 plants/ replicate).

Population fluctuation of aphids and thrips under drought and irrigation conditions during the second season

Data of **(Fig. 1 and 2)** declared that the grand means of thrips were higher than aphids under irrigation than drought conditions (avgs. 6304.2; 4252.68 and 4618.9; 2615.61 individuals/ season; respectively for thrips and aphids under irrigation and drought conditions.

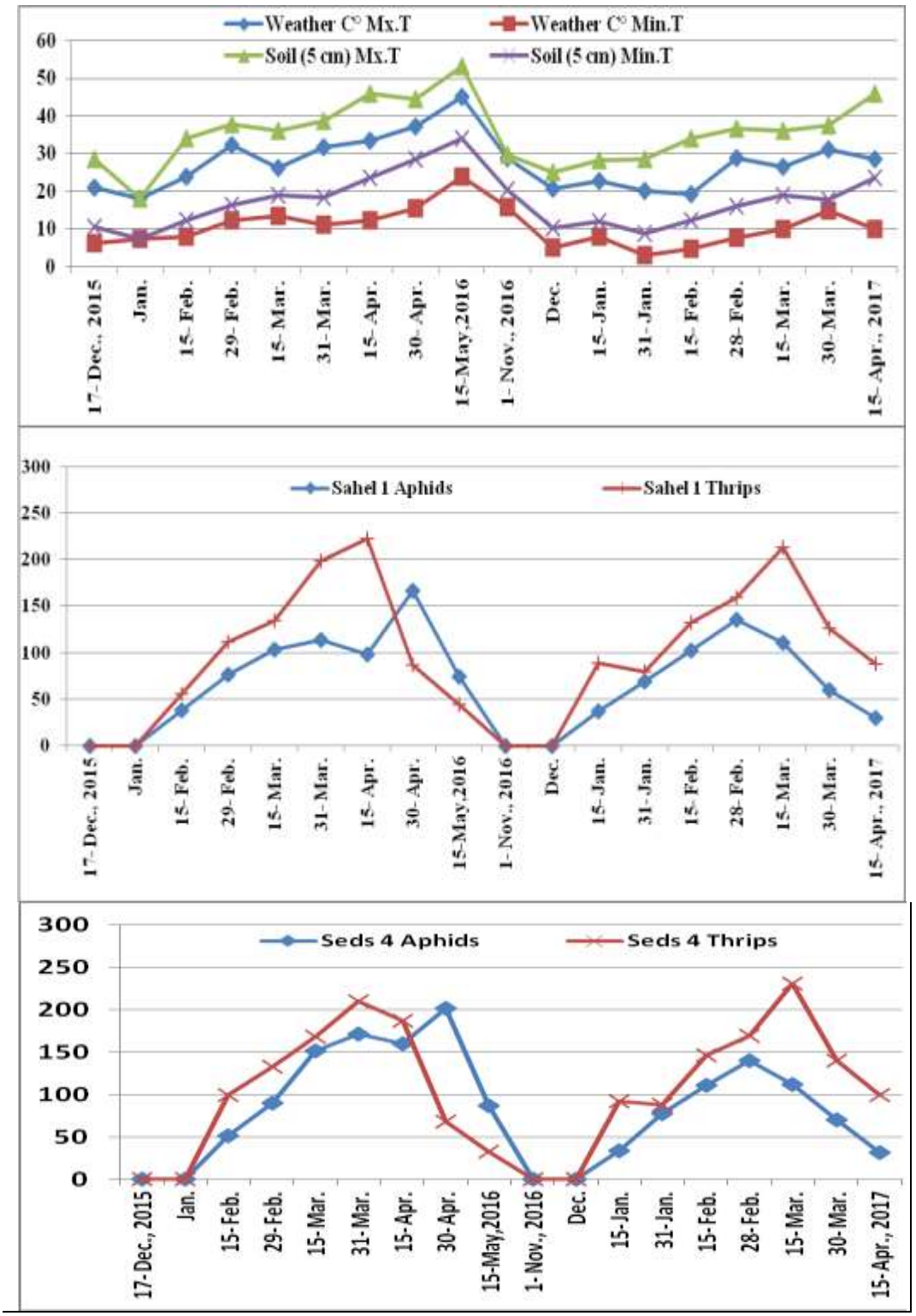

Figure 1. Seasonal fluctuation of aphids and thrips on various wheat cultivars and the considerable meteorological data under drought and irrigation conditions during (2015/16 and 2016/17) at the Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt**.**

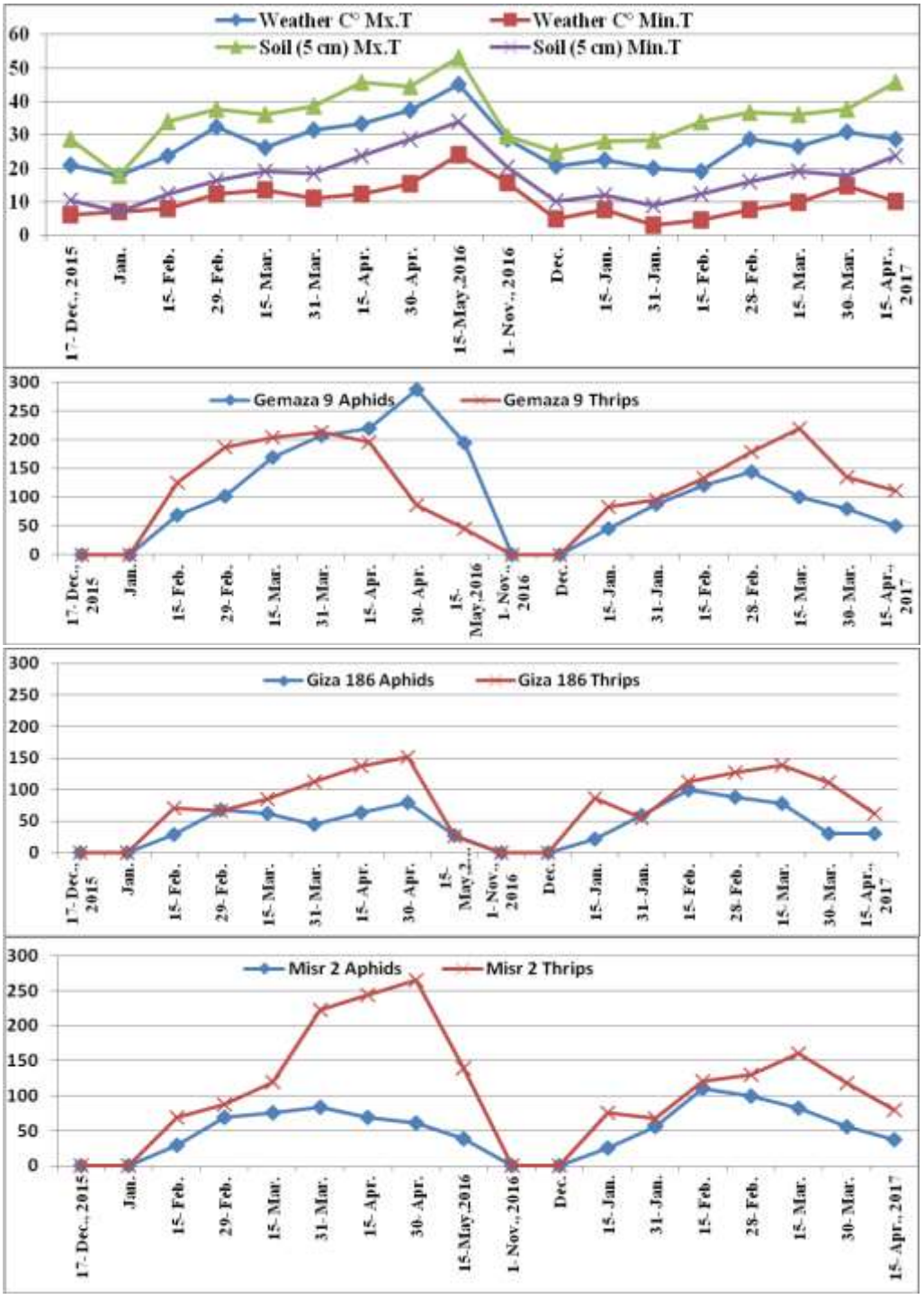

Figure 2. Seasonal fluctuation of aphids and thrips on various wheat cultivars and the considerable meteorological data under drought and irrigation conditions during (2015/16 and 2016/17) at the Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt**.**

Fluctuation of aphid species under drought conditions the second season

The population of aphids **(Fig. 1 and 2)** were in moderate levels during the middle and the end of January for all selected wheat cultivars on all selected cultivars.

The highest levels of abundance were occurred during the middle, end of February and middle of March (avgs. 102.00, 135.56, 110.34; 110.44, 139.78,

111.45, 120.23, 144.30, 99.45; 99.99, 87.90, 77.79; 110.00, 99.80, 82.30 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Seds4, Gemaza9, Giza186, and Misr2).

The population sharply dropped at the end of the season during the end of March and the end of the season in the middle of April on all cultivars.

The highest grand total of aphids population was occurred on Gemaza9 (625.36 individuals/ season) and the lowest was on Giza186 (407.25 individuals/ season).

Fluctuation of aphid species under irrigation conditions during the second season

Aphid's population was gradually fluctuated in little numbers during the middle and the end of January on all selected cultivars **(Fig. 1 and 2)**. Afterwards, the densities highly increased during the middle, and end of February on Sahel1, Seds 4, Giza186, and Misr2. However, the population took the same trend of high densities for Gemaza9 in the same previous months till the end of March.

The peaks of the population occurred on all selected cultivars during the end of February (avgs. 199.00; 249.00; 278.00; 169.00; 152.00 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Seds4, Gemaza9, Giza186, and Misr2). Afterwards, the population shapely decreased in the end of the season during the middle of April for all cultivars.

The maximum grand totals of aphids was noticed on Seds4 (1219 individuals/ season) and the minimum one on Giza186 (677 individuals/ season).

Fluctuation of thrips under drought conditions during the second season

The fluctuation of individuals **(Fig. 1 and 2)** were in moderate levels in the middle and the end of January on all cultivars. The highest mean numbers of population recorded during the middle, end of February and March on the following cultivars Sahel1, Seds4, Gemaza9, Giza186, and Misr2 (avgs. 132.70, 159.45, 212.65, 125.87; 146.45, 169.67, 230.65, 139.98; 133.45, 178.54, 219.45, 134.40; 112.00, 127.00, 139.00, 111.00; 121.00, 130.00, 160.30, 118.00 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Seds 4, Gemaza9, Giza186, and Misr2).The peaks represented in the middle of March on all selected cultivars.

The density of the population slightly decreased at the end of the season in the middle of April with averages of (87.37; 99.45; 111.23; 62.40; 79.50 individuals/ 3 plants/ replicate/ cultivar; respectively on Sahel1, Seds 4, Gemaza9, Giza186, and Misr2).

The highest grand total of thrips population was occurred on Seds 4 (965.76 individuals/ season) and the lowest was on Giza186 (693.40 individuals/ season).

Fluctuation of thrips under irrigation conditions during the second season

Aphids population **(Fig. 1 and 2)** showed that the fluctuation were slightly during the middle of January on Sahel1, Seds 4 (avgs. 178.00 and 177.00 individuals/ 3 plants/ replicate/ cultivar; respectively on), but the slight fluctuation occurred on the other three cultivars (avgs. 138.00, 199.00; 152.00, 170.00; and 130.00, 152.00 individuals/ 3 plants/ replicate/ cultivar; respectively on Gemaza9, Giza186, and Misr2).

The peaks were occurred on all selected cultivars in the end of February. But, in general the highest densities of population were occurred during the end of January, middle and the end of April, and the middle of March on Sahel1 and Seds4. Then, the population decreased gradually till the end of season. But, the densities of population reached to the maximum for the rest of cultivars in the middle and the end of February, middle and the end of March on Gemaza9, Giza186, and Misr2 afterwards, the population fluctuation decreased till the end of the season. The thrips population reached to the highest numbers of individuals on Sahel1 (**1411.00** individuals/ season) and the lower numbers of population occurred on Giza186 (**1127** individuals/ season).

Efficiency of certain biotic and abiotic factors on the population dynamics of aphids and thrips under drought and irrigation conditions during (2015/ 16- 2016/ 17)

The gradual representative efficiency of each selected variable among the biotic and abiotic factors on the population dynamics of aphids and *T. tabaci* were investigated by dropping one of each variable, step by step from the input analysed data in drought and irrigation conditions **(Table 2 and 3)**.

Population under drought conditions during (2015/16- 2016/17)

The results showed that all factors were responsible together (R^2) for the changes on the population abundance of aphids by 47.16%, and 56.19% for thrips in all of wheat cultivars.

Table 2. Multiple regression analysis between the population of aphids and thri*ps* with certain biotic and abiotic factors in certain wheat varieties under drought and irrigation conditions during (2015/16- 2016/17) at The Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

	Variable removed	a	b	R^2 × 100	Efficiency (%)	a	b	R^2 × 100	Efficiency (%)
		Aphids				*Thrips*			
					Drought				
Sahel 1, Seds 4, Gemaza 9, Giza 168, and Misr 2	None	------	0.686	47.16	------	------	0.7496	56.19	------
	Max. T	0.638**	0.6597	43.53	12.4471	0.661**	0.7375	54.40	15.852
	Min. T	0.520**	0.6425	41.29	20.1336	0.495*	0.7308	53.40	24.617
					Irrigation				
	None	------	0.8584	73.69	------	------	0.889	79.04	------
	N.E.	0.707**	0.8002	64.03	20.7009	0.802**	0.8451	71.42	34.6279
	S. Max. T	0.716**	0.8168	66.72	14.9459	0.645**	0.8887	78.98	0.2328
	Chlo. (A+B)	0.669**	0.8340	69.56	8.8475	0.762**	0.8649	74.80	19.255

a, b correlation coefficient.
R^2 = Coefficient of determination.
N.E. = Natural enemies.
* Significant at 5 % level of probability.
** Significant at 1 % level of probability.

The minimum temperature was the most efficient factor and the maximum temperature recorded the second effective factor on the population changes of aphids and thrips. They were participated in aphids population by 20.13% and 12.44% out of 47.16% (r= 0.520** and 0.638**), and for thrips 24.61% and 15.85% out 56.19% (r= 0.495* and 0.661**); respectively for minimum and maximum temperatures for aphids and thrips in all wheat cultivars.

Irrigation conditions during (2015/16- 2016/17)

The R^2 of the selected factors in relation to the changes of aphids and thrips population were 73.69% for aphids and 79.04% for thrips **(Table 2)**.

The sums of the natural enemies presented the highest effective factor on aphids and thrips population with efficiency 20.70% out of 73.69% for aphids, and 34.62% out of 79.04% for thrips. The second efficient one for aphids was the soil maximum temperature 14.945% out of 73.69% and showed the highest correlation (r=0.716**) and for thrips the chlorophyll showed the second effective factor for regulating thrips population with efficiency 19.25% out of 79.04%, (r= 0.762**).

DISCUSSION

General overview of aphids and thrips fluctuation during (2015/ 16 and 2016/ 17) under drought and irrigation conditions

The population fluctuations of the individuals of both pests in the beginning of the season under drought and irrigation conditions **(Fig. 1 and 2)** were in zero numbers during the first two months, because the non-sampling processes due to the shortage of the vegetative growths of all wheat cultivars in the beginning of the first two months throughout the seasons of the study. Afterwards, the population of each insect pest was recorded the same pattern under drought and irrigation conditions; separately with respect to the differences between the numbers in each condition. The irrigation conditions showed higher population of both pests than drought conditions. These results could be attributed to the earlier stages of non-vegetable growth of all cultivars, which could be take about one month and half from sowing time to be matured enough to attract insect pests, especially with aphids and thrips which mainly prefer the vegetable parts to infest. Additionally, there were obvious differences between the spatial distributions of aphids and thrips under drought and irrigation conditions. The fluctuations under irrigation conditions showed higher mean numbers of individuals for both pests (Grand means= 5134.00 for aphids, and 5117.67 for thrips individuals/ season)

than drought conditions (Grand means= 403.44 and 4601.00 individuals/ season; respectively for aphids and thrips), and eternally the same trend of high densities of individuals were occurred under irrigation condition compared to drought conditions on all cultivars. These results could be related to the irrigation conditions which enhance the production of the vegetative growths of wheat cultivars to be in freshly and greenly condition to attract more aphids and thrips compared to drought conditions. The higher numbers of thrips than aphids might be related to the symptoms of infestation, because thrips females individuals prefer to invade the fresh leaves which were more available under irrigation than drought condition to complete their life cycle by inserting the eggs into the fresh leaves tissue and the emerged nymphs and adults stages rasp the tender parts and leaf epidermal tissue by the rasping-sucking mouth parts to suck the sap of the cells which lose their coloration, causing dispersal silvery spots on the leaves (Ahmed, 2015).

The differences between the numbers of aphid's or thrips individuals among the selected cultivars under each condition might be occurred due to the variation of wheat plantations in the chemical composition which mainly responsible for the resistant of cultivars which might be play an important role in aphid's resistance. These results were in the same findings of Wheeler *et al.* (1995) who noticed that there were cultivars free from insect pest's infestations which have the insecticidal properties due to the chemical content in the growing young leaves. This chemical composition content varies from tissue to tissue inside the same cultivar from 8-12% in actively growing shoots, from 4-6% in young leaves. These mounts of chemical composition enable cultivars to show different levels of resistance (Norton *et al.*, 1995; Shelton and Jones, 1995).

population fluctuations of aphids under drought and irrigation conditions during the seasons of the study (2015/ 16 and 2016/ 17)

Under drought conditions, the gradual increase and decrease of the population abundance of the individuals under drought and irrigation conditions were observed in parallel to the vegetative growth curve. Results declared that fluctuations which could be occurred due to the effect of maximum and minimum temperatures, as the minimum temperatures **(Fig. 1 and 2)** ranked the most efficient factor in regulating the population (20.133% out of 47.16%), and the maximum ranked the second factor (12.44% out of 47.16%). These results were similar to the findings of Rustamani *et al.* (1999) who noted that the first infestations of aphids were observed during the third week of February on certain wheat varieties, besides the results of Hussein, (1993) who found that the fluctuation of aphid's population was in low densities on wheat plantations during February and increased to moderate levels on March and the highest densities occurred at the beginning of flowering stage. The same results of Aheer *et al.* (2008) who noted that the population of aphids decrease when maximum and minimum temperatures reached to the optimum degrees (i.e., 24.30 C° and 9.57 C°).

On the other hand, under irrigation condition, the previous mentioned fluctuation during the seasons of the study might be occurred due to the performance of the natural enemies and soil maximum temperatures; respectively were participated with efficiency of 20.70 % and 14.94 % out of 73.67%). These results of the natural enemies are in the same line with Symondson *et al.* (2002) who found that the specialist natural enemies such as parasitic wasps and predators such as Coccinellidae and Araneae differ in their capacity for aphid control and help to suppress aphid's population. However, the soil temperatures have a great impact due to their effects on nymph and adult stages when they escape from sun heat to the soil which might be killed due to the soil stored temperatures.

Population fluctuations of thrips under drought and irrigation conditions during the seasons of the study (2015/ 16 and 2016/ 17)

Thrips patterns under both conditions were in low fluctuations during the middle of February. Afterwards, it increased to moderate levels at the end of February and middle of March. The peaks recorded on three cultivars at the end of March, the middle, and end of April on Sahel1, Seds 4, and Gemaza9, but during the same periods the fluctuations were slight on Giza186 and Misr2.

Under drought condition, the previous pattern might be occurred due to the effect of weather temperatures which could be affected the number of generations; the maximum temperatures with efficiency (15.85 out of 56.19, r= 0.66), and then the minimum temperatures (efficiency 24.61 out of 56.19; r= 0.495); respectively. These results are in the same findings of John and Andrew (2016) as they stated that the length of the life cycle depends on environmental conditions and around 30°C, the life cycle can be completed in less than 2 weeks. The same species at 20°C might take 3 weeks to complete the lifecycle.

Under irrigation condition pattern, was determined due to the effect of the natural enemies (efficiency 34.62 out of 79.04, r= 0.802; P< 0.02). These results are in the same line of Muhammad *et al.* (2016) whom stated that there were highly positive

correlation between thrips and natural enemies population (r^2= 0.83) which means that any increase in thrips numbers was followed by increase in natural enemies population. Afterwards, the chlorophyll ranked the 2nd efficient factor (efficiency 19.25 out of 79.04, r= 0.762; P< 0.02). The obtained results could be occurred due to the behaviour of thrips symptoms of infestation, as thrips females tend to infest the young greenly leaves to insert their eggs into leaves tissues, the emerged nymphs and adult stages rasp the tender parts of leaves tissues by piercing leaf epidermal tissues and sucking the sap of the cells which lose their own coloration, causing dispersal silvery spots on leaves surfaces. These results are similar to the findings of Asni *et al.* (2016) whom measured chlorophyll levels in the leaves before and after treatment and found that chlorophyll content of infested leaves by thrips were lower than non-infected leaves, because thrips stick the leaf tissue and suck the liquid epidermis, palisade containing chlorophyll and mesophyll cells as the same results of Kirk (1997). Additionally, Kolb *et al.* (1991) confinement five adult thrips per bud which succeeded in causing chlorosis, and the infested leaves reduced the rate of photosynthesis.

CONCLUSION

Aphids and thrips populations under irrigation condition were higher than drought conditions during both seasons. But, the numbers of thrips were higher than aphids in each season under each condition. The infestations of both pests were started in February during 1st season and January for 2nd season in all replicates. The aphid's peaks which occurred in the middle of 2nd month to the following month from sampling date; and for thrips were in the 2nd month to the half of 3rd month from sampling date under both conditions.

The fluctuation patterns of both pests under drought conditions were regulated by the daily maximum temperature, then the minimum temperature; respectively with positive significant correlations on all selected cultivars. However, under irrigation conditions the sums of natural enemies ranked the most efficient factor, followed by the chlorophyll AB, and the plant age recorded the third efficient factor; respectively with positive significant correlations on all selected cultivars.

Yield data indicated that all wheat cultivars under irrigation conditions produced the higher yields than cultivars in drought conditions. The top yields under both conditions were recorded from Giza186, Misr2, and Sahel1; respectively during seasons of the study, except Gemeza9 under irrigation condition in 1st season ranked the 3rd yield.

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REFERENCES

Aheer, G.M., Ali A., Ahmad, M. 2008. Abiotic factors effect on population fluctuation of alate aphids in wheat. Journal Agricultural Research, 46: 367-371.

Akhtar, I.H., Khaliq, A. 2003. Impact of plant phenology and Coccinellid predators on the population dynamic of rose aphid *Macrosiphum rosaeiformis* Das (Aphididae: Homoptera) on rose. Asian Journal of Plant Sciences, 2: 119- 122.

Asni, J., Siti, H., Chandra, I., Yulia, P. 2016. Phenomenon of Thrips (Thysanoptera) Attack on Chili Plant (*Capsicum annuum* L.). American Journal of Agricultural and Biological Sciences, 11 (3): 103.109.

Atta, H.A. 1989. Survey and taxonomic studies on certain aphid species. M. Sc. thesis of Economic Entomology, Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Blackman, R.L., Eastop, V.F. 1984. Aphids on the world crops. Chichester: John Wiley and Sons. 466 p.

Bospucperez, N.A., Schotzko, J.D.J. 2000. Wheat genotypes, early plant growth stage and infestation density effects on Russain wheat aphid (Homoptera: Aphidae) population increase and plant damage. Journal Entomological Science, 35: 22-38. https://doi.org/10.18474/0749-8004-35.1.22

Cochran, W.G.1977. Sampling Techniques. John Wiley & Sons, New York. Crank, J., 1975. The Mathematics of Diffusion, 2nd ed. Oxford University Press, Oxford.

Dedryver, C.A., Le Ralec, A., Fabre, F. 2010. The conflicting relationships between aphids and men: A review of aphid damage and control strategies. Comptes Rendus Biologies 333:539–553. https://doi.org/10.1016/j.crvi.2010.03.009

Dixon, A.F.G.1987. Cereal aphids as an applied problem. Agricultural Zoology Review 2: 1–57.

Food and Agriculture Organisation. 2011. Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production. [Accessed 19 May 2018]. Available from: http:// www.fao.org/docrep/014/i2215e/i2215e.pdf.

Gaston, K.J, Lawton, J.H. 1988. Patterns in the distribution and abundance of insect populations. Nature 331: 709–712.

Geza, K. 2000. Aphid flight and change in abundance of winter wheat pests. Archives Phytopatholgy and Plant Protection, 33: 361-373. DOI : 10.1080/03235400009383356

Hallqvist, H. 1991. Bekampningstosklar for havrebladlus (*Rhopalsiphum padi*) I varsad resultat fran Mellansvergie. In: 32nd Swedish Crop Protection Conference. Swedish University of Agricultural Science, Uppsala, pp. 197-205.

John, D., Andrew, M. 2016. Thrips A Pest Management Plan for Production Nurseries. [Accessed: 10 June 2018]. Available from: https://horticulture.com.au/wp-content/uploads/2017/02/Thrips-pest-management-plan.pdf.

Kiechefer, R.W., Gellener, J.L. 1992. Yield losses in winter caused by low density cereal aphid's populations. Agronomy Journal, 84: 180-183. doi:10.2134/agronj1992.00021962008400020011x

Kindler, S.D., Springer, T.L., Jensen, K.B.L. 1995. Detection and characterization of the mechanisms resistance to Russian wheat aphid (Homoptera: Aphididae) in tall wheat grass. Journal Economic Entomology, 88: 1503-1509. https://doi.org/10.1093/jee/88.5.1503

Kirk, W.D.J. 1997. Feeding. In: Thrips as Crops Pest, Lewis, T. (Ed.), CAB International, Wallingford, U.K. pp. 119-162.

Kolb, T.E., McCormick, L.H., Shumway, D.L. 1991. Physiological responses of pear thrips-damaged sugar maples to light and water stress. Tree Physiol., 9: 401-413. DOI: 10.1093/treephys/9.3.401.

Lewis, W.J., van, L.J.C., Phatak, S.C., Tumlinson, J.H. 1997. A total system approach to sustainable pest management. Proceedings of the National Academy of Sciences of the United States of America 94:12243–12248. https://doi.org/10.1073/pnas.94.23.12243

Lichtenthater, H.K.1987. Chlorophylls and carotinoids: Pigments of photosynthetic Biomembranes. In Methods in Enzymology. Academic press, Orlando, Fl., USA. Vol. 148, pp. 183- 350

Muhammad, S.K., Tajwar, S.S., Shagufta, R., Ghulam, H.A., Muhammad, S., Sajjad, A., Muhammad, S., Adeel, A.P., Su, W., Azmat, H.A. 2016. Occurrence and abundance of thrips, whitefly and their natural enemy, Geocoris Spp. on cotton crop at various localities of Sindh, Pakistan. Journal of Entomology and Zoology Studies 2016; 4(1): 509-515.

Nancy, D.E., Morrill, W.L., Mankin, R.W. 2008. Traps for Capturing Insects. USDA/ARS, Subtropical Horticulture Research Station, Miami, FL, USA. pp. 3887-3901.

Norton, B.M., Lowry, B., Mcsweeny, C. 1995. Leucaena - opportunities and limitations In: Shelton H.M., Piggin, C.M., Brewbaker, J.L. (eds.). The Nutritive Value of Leucaena Species. Proceedings of workshop held in Bogor, Indonesia. ACIAR Proceedings No. 57. pp. 103-108.

Palumbo, J.C. 2000. Management of Aphids and Thrips on Leafy Vegetables. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. [Accessed: 22 June 2018]. Available from URL: http://cals.arizona.edu/crops/vegetables/insects/aphid/aphidsandthrips.html

Qamar, Z., Hayat, B., Hussain, A., Ruidar, A., Mahwish, R. 2011. Population of aphids on different varieties/ lines of wheat and their effect on yield and thousands grainweight. Entomology Section, Agricultural Research Institute, Tarnab, Peshawar – Pakistan. Sarhad JournalAgriculture. 27(3)*:* 443-450.

Rossing, W.A.H., Daaman, R.A., Jansen, M.J.W. 1994. Uncertainty analysis applied to supervised control of aphids and brown rust in winter wheat. Part 2. Relative importance of different compound of uncertainty. Agricultural. Systems. 44: 449-460. https://doi.org/10.1016/0308-521X(94)90197-N

Rustamani, M.A., Sheikh, S.A., Memon, N., Laghari, M.H., Dhaunroo, M.H. 1999. Impact of wheat plant phenology on the development

of greenbug, Schizaphis *graminum* R. Pakistan Journal of Zoology., 31: 245–8.

Shah, A.K., Farmanullah, N., Hussain, A.U.R., Saljoqi, Y., Hayat, Sattar, S. 2006. Distribution pattern of the cereals aphids in the wheat growing areas of the province Khyber Pukhtunkhwa of Pakistan. Sarhad Journal Agriculture, 22: 655-959.

Shelton, H.M., Jones, R.J. 1995. Opportunities and limitations in leucaena. In: Shelton H.M., Piggin C.M., Brewbaker J.L. (eds.). Leucaena - Opportunities and Limitations pp. Proceedings of workshop held in Bogor, Indonesia. ACIAR Proceedings No. 57. Pp. 16-23.

Villani, M.G., Wright, R.J. 1990. Environmental Influences on Soil Macroarthropod Behavior in Agricultural Systems. 2010. Faculty Publications: Department of Entomology. 195. [Accessed: 22 June 2018]. Available from URL:http://digitalcommons.unl.edu/entomologyfacpub/195.

Wheeler, R.A., Norton, B.M., Shelton, H.M. 1995. Leucaena - opportunities and limitations. In: Shelton H.M., Piggin, C.M., Brewbaker, J.L. (eds.). Considered Tannins in Leucaena Species and Hybrids and Implications for nutritive Value. Proceedings of workshop held in Bogor, Indonesia. ACIAR Proceedings No. 57. pp. 112-116.

Supplementary material

Annex 1. Mean numbers of aphid species[#] and onion thrips^ on certain bread wheat cultivars* under drought and irrigation conditions during the first season (2015 - 2016) at The Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Treatment	Month	Mean numbers of individuals/ 3 plants/ replicate										Grand Means		Weather C°		Soil (5 cm)	
		Sahel1		Seds4		Gemaza9		Giza186		Misr2				Mx.T	Min.T	Mx.T	Min.T
		Aphids	*Thrips*	*Aphids*	*Thrips*	*Aphids*	*Thrips*	*Aphids*	*Thrips*	*Aphids*	*Thrips*	*Aphids*	*Thrips*				
Drought	17- Dec., 2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	15- Feb.	38.00	55.33	51.67	99.67	69.00	124.67	29.00	71.00	29.67	69.33	217.33	420.00	23.8	8	34	12.2
	29- Feb.	76.00	111.33	90.00	132.67	101.00	186.67	67.67	66.00	68.67	88.00	403.33	584.67	32.4	12.2	37.8	16.2
	15- Mar.	103.67	134.00	151.33	168.00	168.67	203.00	62.67	85.67	76.33	119.00	562.67	709.67	26.2	13.4	36	19
	31- Mar.	114.00	198.33	171.00	210.00	207.33	214.00	45.00	112.6	84.00	223.00	621.33	958.00	31.6	11	38.6	18.4
	15- Apr.	97.67	222.00	160.00	187.33	219.00	196.00	63.00	136.6	69.33	244.67	609.00	986.67	33.4	12.4	45.8	23.6
	30- Apr.	166.67	86.33	201.33	67.67	286.33	85.67	80.00	152.0	61.67	264.67	796.00	656.33	37.2	15.4	44.6	28.6
	15-May, 2016	74.00	44.00	87.00	32.33	195.00	44.33	27.33	25.33	38.00	139.67	421.33	285.67	45	24	53.2	34
	Grand total	670.00	851.33	912.33	897.67	1246.3	1054.3	374.6	649.3	427.6	1148.3	3631.0	4601.0	-----	-----	-----	-----
	Season g. mean	74.44	94.59	101.37	99.74	138.48	117.15	41.63	72.15	47.52	127.59	403.44	511.22	-----	-----	-----	-----
	The yield: GY/10	129.66		123.33		81.66		178.33		171.66		------	------	-----	-----	-----	-----
Irrigation	17- Dec., 2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	15- Feb.	66.33	138.67	84.33	155.33	46.33	126.67	26.33	120.3	22.67	113.33	246.00	654.33	23.8	8	34	12.2
	29- Feb.	88.33	192.33	99.67	212.00	81.00	187.67	63.00	106.0	29.33	105.00	361.33	803.00	32.4	12.2	37.8	16.2
	15- Mar.	162.00	215.00	218.33	213.00	152.00	192.00	98.00	167.3	88.33	143.33	719.33	930.67	26.2	13.4	36	19
	31- Mar.	165.33	231.67	219.00	247.00	153.67	221.33	132.6	205.0	116.0	200.00	786.00	1105.0	31.6	11	38.6	18.4
	15- Apr.	218.33	205.67	240.67	140.33	207.67	166.00	192.6	138.6	136.0	114.67	995.33	765.33	33.4	12.4	45.8	23.6
	30- Apr.	292.67	112.67	311.00	129.67	284.33	110.33	206.0	84.33	178.0	75.33	1272.0	512.33	37.2	15.4	44.6	28.6
	15-May, 2016	145.33	74.33	299.00	86.00	136.33	73.33	95.67	52.33	77.67	61.00	754.00	347.00	45	24	53.2	34
	Grand total	1138.3	1170.3	1472.0	1183.3	1061.3	1077.3	814.3	874.0	648.0	812.67	5134.0	5117.6	-----	-----	-----	-----
	Season g. mean	126.48	130.04	163.56	131.48	117.93	119.70	90.48	97.11	72.00	90.30	570.44	568.63	-----	-----	-----	-----
	The yield: GY/10	181.33		156.66		182.66		218		207.33		------	------	-----	-----	-----	-----

[#] = *Mayzus persicae*, *Brivecoryne brassicae*, and *Rhopalosiphum padi* ^= *Thrips tabaci* lindeman *= Sahel 1, Seds 4, Gemaza 9, Giza 168, and Misr 2

Annex 2. Mean numbers of aphid species# and onion thrips^ on certain bread wheat cultivars * under drought and irrigation conditions during the second season (2016 - 2017) at The Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Treatment	Month	Mean numbers of individuals/ 3 plants/ replicate										Grand Means		Weather C°		Soil T (5 cm)	
		Sahel1		Seds4		Gemaza9		Giza186		Misr2				Mx. T	Min. T	Mx.T	Min. T
		Aphids	Thrips	Aphids	Thrips	Aphids	Thrips	Aphids	Thrips	Aphids	Thrips	Aphids	Thrips				
Drought	1- Nov., 2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	15- Jan.	36.44	88.55	33.54	92.00	45.54	82.00	21.90	87.00	25.65	75.40	163.07	424.95	22.6	7.8	28.2	12
	31- Jan.	69.42	79.34	77.86	87.56	87.86	95.92	59.00	55.00	55.92	68.40	350.06	386.22	20	3	28.4	8.8
	15- Feb.	102.00	132.70	110.44	146.45	120.23	133.45	99.99	112.00	110.00	121.00	542.66	645.60	19.2	4.6	34	12.2
	28- Feb.	135.56	159.45	139.78	169.67	144.30	178.54	87.90	127.00	99.80	130.00	607.34	764.66	28.8	7.6	36.6	16
	15- Mar.	110.34	212.65	111.45	230.65	99.45	219.45	77.79	139.00	82.30	160.30	481.33	962.05	26.4	9.8	36	19
	30- Mar.	59.56	125.87	69.77	139.98	78.98	134.40	30.68	111.00	55.50	118.00	294.49	629.25	31	14.8	37.6	17.8
	15- Apr., 2017	29.42	87.37	31.45	99.45	49.00	111.23	29.99	62.40	36.80	79.50	176.66	439.95	28.6	10	45.8	23.6
	Grand total	542.74	885.93	574.29	965.76	625.36	954.99	407.25	693.40	465.97	752.60	2615.61	4252.68	------	------	------	------
	Season g. mean	60.30	98.44	63.81	107.31	69.48	106.11	45.25	77.04	51.77	83.62	290.62	472.52	------	------	------	------
	The yield: GY/10 plants	138.25		128.7		95.13		162.39		160.29		------	------	------	------	------	------
Irrigation	1- Nov., 2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
	15- Jan.	79.00	178.00	112.00	177.00	88.00	138.00	41.00	152.00	44.00	130.00	364.00	775.00	22.6	7.8	28.2	12
	31- Jan.	102.00	202.00	99.00	199.00	95.00	199.00	88.00	170.00	63.00	152.00	447.00	922.00	20	3	28.4	8.8
	15- Feb.	170.00	219.00	226.00	146.00	230.00	202.00	120.00	188.00	112.00	166.00	858.00	921.00	19.2	4.6	34	12.2
	28- Feb.	199.00	255.00	249.00	222.00	278.00	250.00	169.00	220.00	152.00	228.00	1047.00	1175.00	28.8	7.6	36.6	16
	15- Mar.	108.00	260.00	222.00	249.00	220.00	288.00	112.00	209.00	128.00	246.00	790.00	1252.00	26.4	9.8	36	19
	30- Mar.	99.90	199.00	199.00	139.00	199.00	220.00	99.00	110.00	111.00	125.00	707.90	793.00	31	14.8	37.6	17.8
	15- Apr., 2017	78.00	98.00	112.00	99.00	80.00	91.20	48.00	78.00	87.00	100.00	405.00	466.20	28.6	10	45.8	23.6
	Grand total	835.90	1411.00	1219	1231	1190	1388.2	677	1127	697	1147	4618.9	6304.2	------	------	------	------
	Season g. mean	92.88	156.78	135.44	136.78	132.22	154.24	75.22	125.22	77.44	127.44	513.21	700.47	------	------	------	------
	The yield: GY/10 plants	192.76		182.23		132.03		213.43		198.76		------	------	------	------	------	------

= *Mayzus persicae*, *Brivecoryne brassicae*, and *Rhopalosiphum padi* ^= *Thrips tabaci* lindeman *= Sahel 1, Seds 4, Gemaza 9, Giza 168, and Misr 2