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The Relationship between the Biochemical Leaf Components and the Population Density of the Onion Thrips and Land Snails Attacking some Vegetable Crops

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ABSTRACT

Field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh governorate during 2013/14, 2014/15 and 2015/16 seasons, to study host preference and the population densities of *Thrips tabaci* Lind. and *Monacha* spp. in lettuce (Roman), onion (Giza red) and garlic (sids 40 and balady cultivars) plantations. Also, the relationship between the biochemical leaf components (Chlorophyll, moisture, potassium (K), nitrogen (N) and phosphorus (P), protein, total carbohydrates mg/kg and phenols) and pest population density. The population density of *T. tabaci* were detected in lettuce, onion, garlic (sids 40 and balady) plantations by late January. The population density of *T. tabaci* progressively increased to reached its peaks during February and March. No land snails were detected on balady garlic. Snail populations in lettuce, onion, garlic (sids 40), were low or moderate until mid February, and then gradually increased to maximal peaks in February and March. The highest population density of thrips was observed in onion followed by garlic when compared with lettuce, while *Monacha* spp. was opposite. Garlic (sids 40) had higher chlorophyll content followed by balady garlic than lettuce. Almost, K, N, P, protein, total carbohydrates and total phenols significantly varied among vegetable crops ($p \leq 0.05$). In addition, there is a positive correlation between the population density of *T. tabaci* with each of chlorophyll content, moisture, P and total phenols, while relationship between the population density and K, N, protein and total carbohydrates were negative. There is a negative correlation between land snails and chlorophyll content but it was positive with each of moisture, N, protein and total phenols and positive significant with K ($p \leq 0.05$).

Keywords: Onion, garlic, lettuce, population, thrips, land snail, leaf biochemical components.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most popular and important vegetables consumption with world production exceeding 58.11 million tones (FAO, 2012). Garlic (*Allium sativum* L.) is an important crop for Egyptian local market and exportation (Hamma *et al.,* 2013). Common lettuce, *Lactuca sativa* L. is native to the Mediterranean area and was domesticated in Egypt around 4,500 B.C. (Kerns *et al*., 2001).

Onion and garlic suffer from *Thrips tabaci* Lind. (Thysanoptera: Thripidae) infestations causing direct and indirect damage which result in yield reduction (Zsofia and Adam, 2012, Paibomesai and McDonald-Muck 2013 and Zereabruk, 2017). Onion thrips consume mesophyll cells, which eventually results in a loss of chlorophyll and reduced photosynthetic efficiency (Boateng *et al.,* 2014). Workman *et al.* (2007) and EL-Fakharany and Hendawy (2012) found that *Thrips tabaci* was the dominant thrips species on lettuce, they concluded that the low numbers of thrips on lettuce. Abd El-Wahed (2014) and Samy *et al.* (2015) mentioned that land snails, *Monacha* spp. (Gastropoda: Hygromiidae) attack lettuce and onion plants.

Hatem (2014), Khan *et al.* (2015), Kharbangar *et al.* (2015) and Shah *et al.* (2016) revealed that correlation of biochemical leaf components and sucking pests infestation were positive or negative in different crops.

The objective of this study was to investigate host preference, population density and relationship between the biochemical leaf components in lettuce, onion, garlic (sids 40 and balady) leaves and the population density of *Thrips tabaci* and *Monacha* spp. were determinated.

MATERIALS AND METHODS

1. The population density of thrips and land snails in certain vegetable crops

A field experiments were conducted at the experimental farm belonging to Sakha Agricultural Research Station, Kafr El-Sheikh governorate during three successive seasons, 2013/14, 2014/15and 2015/16, that has a latitude of 31° 05'.12" N and a longitude 30° 56' 56.66"E, to study host preference and relationship between the population densities of *T. tabaci* and *Monacha* spp. in lettuce, onion and garlic (sids 40 and balady cultivars) plantations and the biochemical leaf components. The lettuce, *Lactuca sativa* L. cultivar, Roman, onion (*Allium cepa* L.) cultivar, Giza red and garlic (*Allium sativum* L.) cultivars, (sids 40) and balady. The experimental area was about 1/2 feddan divided into four plots, each crop was represented by four replicates arranged in a randomized complete block design and weekly inspected randomly. Garlic lobes were sown on October, 20, onion seedlings were planted on December, 7 and lettuce seedlings were transplanted on December, 27. Inspection started on January, 17 and continued weekly till March, 28 of each season. Number of thrips were counted 10 plants/replicate, while land snails were counted $3m^2$/replicate in the field.

2. leaf components

- Chlorophyll

Chlorophyll content of leaves was assessed on 27 of January, February and March using SPAD portable leaf chlorophyll meter (Minolta) (Marquard and Timpton, 1987) on the recently fully expanded leaf. The mean of the three chlorophyll measurements was used.

- Moisture

The moisture content was measured in investigated samples for the two pests, on February 27 in vegetable crops. The samples were taken from mature leaves, and four replicates, represented by 80 leaves for each vegetable crop. The samples were dried at 70^o C for 72 hours to a constant weight and dried samples were weighed. Moisture content (%) was calculated.

- Percentage of the chemical components at leaves

Chemical analyses of lettuce, onion and garlic (sids 40 and balady) leaves were conducted at Laboratory of Plant Nutrition Department, Soils, Water and Environment Research Institute, Sakha Agricultural Research station. Leaf samples were taken on February, 27 in 2014/15 and 2015/16 seasons, dried, crushed thoroughly and wet

digested using sulphuric+ salicylic acid method (Cottenie *et al.*1982). Nitrogen in the digested leaves was determined by micro-kjeldahl method (Jackson 1967).

Phosphorous (P) was determined colorimetrieally (Peterburgski 1968). Potassium (K) was determined by flame photometry (Jackson 1967). Total carbohydrates were estimated using the method (Dubosis *et al.* 1956) and total phenol content was assessed using the AOAC method (Anonymous, 1970) at Central Biotechnology Laboratory at Sakha Agricultural Research, Station.

-Statistical analysis

Pests and leaf chemistry variable were evaluated for differences between vegetable crops using analysis of variance (ANOVA). Significant differences between the means of these crops were calculated by Duncan's Multiple Rang Test (Duncan 1955). Correlation coefficients were calculated for the relationships between chemical contents of crop leaves and population densities of the thrips and snails using the SPSS statistical software package 16.0 (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

1. Population density

The onion thrips, *Thrips tabaci* Lind.

Population density of *T. tabaci* on lettuce, onion and garlic (sids 40 and balady) plants at Kafr El-Sheikh governorate in 2013/14, 2014/15 and 2015/16 seasons are shown in (Fig.1). The highest population density of this pest was recorded on February, 28 and March 14 in lettuce and garlic (sids and balady) plantations, while it was recorded on March 7 and 21 on onion plants in the three seasons. The highest peak value of *T. tabaci* on lettuce was recorded on February, 28 represented by 59, 108 and 93 individual/10 plants during three successive seasons, 2014, 2015 and 2016, respectively, while it was recorded on March, 14 on garlic (sids 40) by 123, 191 and 230 and on balady garlic by 132, 310 and 307 in the three seasons, respectively. These peaks were recorded on March, 21 on onion plants by 391, 500 and 499 in the three seasons, respectively (Fig.1).

The land snails, *Monacha* spp.

Monacha spp. were not found on balady garlic during all three seasons. In 2014 and 2015 seasons, the highest population density of *Monacha* spp. were noticed on February, 28 and March, 14 on lettuce plants, while the peaks were recorded on February, 14 and March, 7 in 2016 (Fig.2). On onion, and garlic (sids 40), *Monacha* spp. peaks were recorded on February, 28 in three seasons. Data revealed that the peaks *Monacha* spp. were obtained with onion on March, 21 in 2015 and 2016 seasons, while garlic (sids 40) on February, 14 in 2015 season (Fig. 2).The highest peak value of *Monacha* spp. on lettuce was recorded on March, 14, while it was recorded on February, 28 for onion and garlic (sids 40) by 975, 94.5 and 199.5 individual/3m^2, respectively in 2014 season. Also, the highest peak value on lettuce, onion and garlic (sids 40) were recorded on February, 28 represented by 176.25, 13.5 and 21.75 in 2015 season, respectively. These peaks were recorded on February, 14 on lettuce, while it was recorded on February, 28 on onion and garlic (sids 40) plants with 398.25, 31.5 and 111 in 2016, respectively (Fig.2).

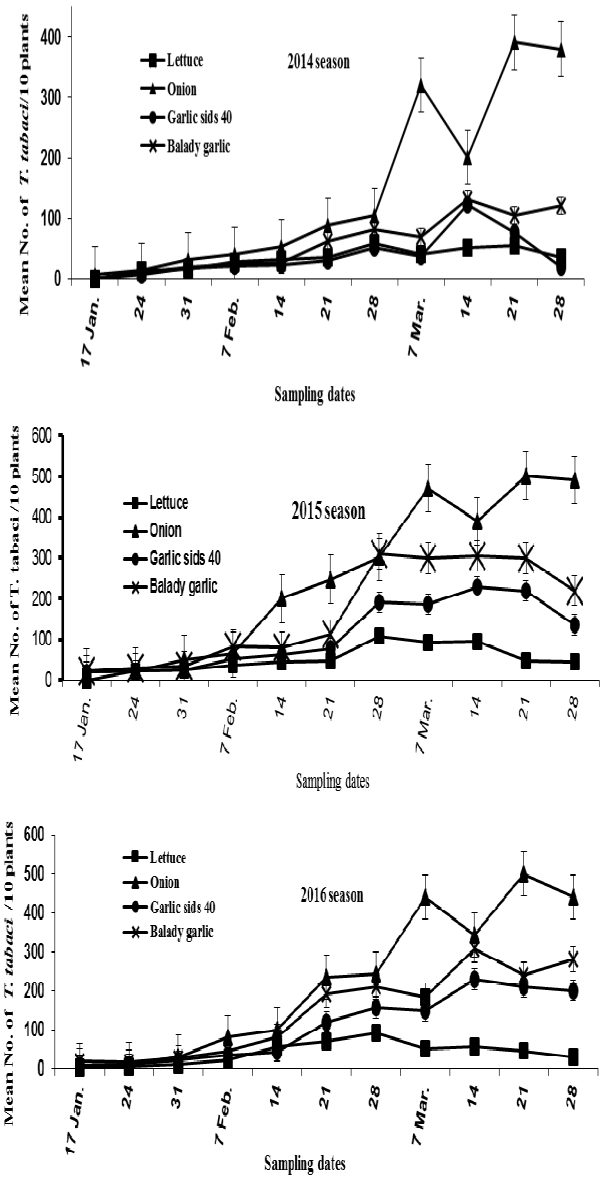

Fig. 1. Population density of *Thrips tabaci* in certain vegetable crops during the three successive seasons 2014, 2015 and 2016 at Kafr El-Sheikh governorate

These findings agreed with those obtained by Workman *et al.* (2007) they found that thrips populations peaked in December to February with greatest numbers in February on lettuce. Hendawy *et al.* (2011) found that the population density of *T. tabaci* peaked in February, March and April on onion plants. EL-Fakharany and Hendawy (2012) found that *T. tabaci* was lower in October plantation than those of January plantation on lettuce. El-Fakharany *et al.* (2012) found that the population density of *T. tabaci* reached a maximum abundance at the second, third and fourth weeks of March on garlic plants. Khan *et al.* (2017) found that *T. tabaci* was the dominant pests species in onion plantations. Zereabruk (2017) found that population density of thrips on onion plants was low in December and progressively increased to reach maximum in March.

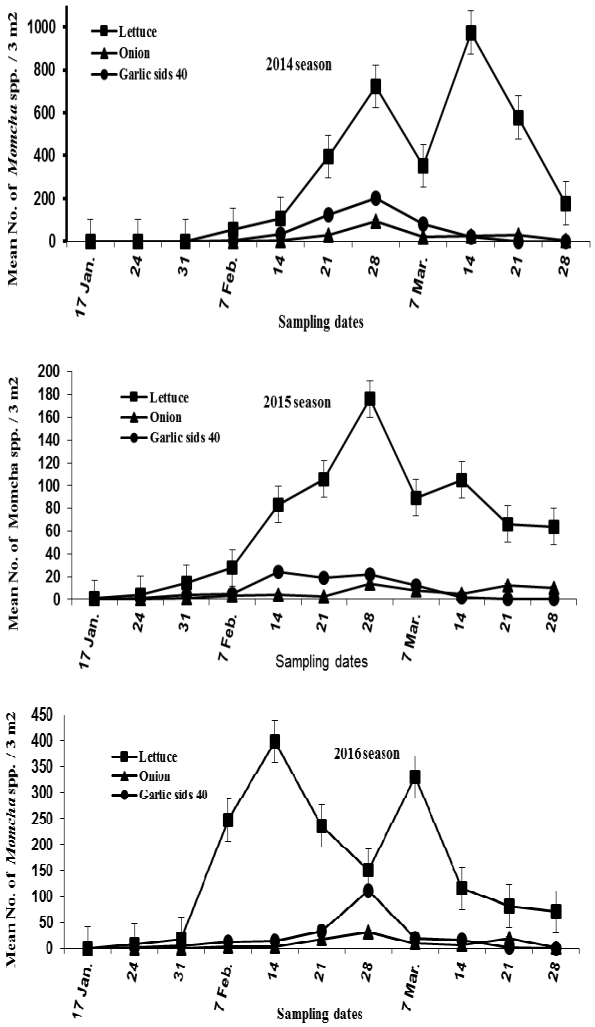

Fig. 2. Population density of *Monacha* spp. in certain vegetable crops during the three successive seasons 2014, 2015 and 2016 at Kafr El-Sheikh governorate

2. Host preference and population density of *Thrips tabaci* and *Monacha* spp.

The onion thrips, *Thrips tabaci*

The obtained results in Table (1) showed that, the highest average number of *T. tabaci* recorded in onion plantations by 148.20, 250.75 and 220.98 individual/10 plants during the three seasons, respectively. On the other hand, balady garlic came in second category (59.16, 163.27 and 145.52) followed by garlic (sids 40) were 44.89, 110.68 and 107.91 during the three seasons, respectively. Lettuce plants ranked the least category by 33.18, 51.48 and 40.66 during the three seasons, respectively. Statistical analysis revealed that, a significant differences between the different host plants during the three seasons and the average number of *T. tabaci* ($p \leq 0.05$). Results revealed that, onion plants attracted the highest average number of thrips followed by balady garlic, garlic (sids 40) and lettuce.

The land snail, *Monacha* spp.

Also, in Table (1) showed that, the highest average number of *Monacha* spp. recorded in lettuce plantations represented by 305.32, 67.07 and 150.32 individual/3m^2 during the three seasons, respectively. On the other hand, garlic (sids 40) came in second category represented by 42.0, 8.05 and 19.43 during the three seasons, respectively. Moreover, onion plants ranked the least category by 17.89, 5.23 and 8.48 during the three seasons, respectively. It is obvious that, no land snails were detected on balady garlic. Statistical analysis revealed that, a significant differences between the different host plants during the three seasons and the average number of land snails ($p \leq 0.05$). Results revealed that, lettuce plants attracted the highest average number of *Monacha* spp. followed by garlic (sids 40) and onion.

Table 1. Host preference and population density of thrips and land snails

Crop	Mean No. of *Thrips tabaci* / 10 plants ± SE*		
	2013/14	2014/15	2015/16
Lettuce	33.18^{c} ± 5.28	51.48^{d} ±9.66	40.66^{d} ±8.29
Onion	148.20^{a} ± 12.89	250.75^{a} ±55.47	220.98^{a} ±53.65
Garlic (sids 40)	44.89^{bc} ± 11.80	110.68^{c} ±23.84	107.91^{c} ±24.78
Balady garlic	59.16^{b} ± 13.34	163.27^{b} ±35.42	145.52^{b} ±31.83
Mean No. of *Monacha* spp. / 3m^2 ± SE			
Lettuce	305.32^{a} ± 95.58	67.07^{a} ±15.26	150.32^{a} ±38.85
Onion	17.89^{bc} ±8.02	5.23^{bc} ±1.37	8.48^{b} ±2.98
Garlic (sids 40)	42.0^{b} ±19.09	8.05^{b} ±2.70	19.43^{b} ±9.21
Balady garlic	0.0^{c} ±0.0	0.0^{c} ±0.0	0.0^{c} ±0.0

In a column, means followed by the same letter are not significantly different at the 5% level by Duncan (1955)
***Standard error**

These results are in agreement with those of Shetaia *et al*. (2009) who found that population dynamics of *M. cartusiana* was high at the tested winter crops (egyptian clover, faba bean, pea, lettuce and cabbage) during spring months as compared with winter or autumn months. Abd El-Wahed (2014) encountered high population density of *Monacha* spp. on pea, lettuce and cabbage plantations than in potatoes and carrot. Samy *et al.* (2015) found that population densities of *Monacha* spp. were lower in onion plantation than in lettuce and cabbage plantations.

3.Chemical components in leaves of certain vegetable crops

Data presented in Table (2) show that garlic (sids 40) had high significant of chlorophyll content than of balady garlic and onion while lettuce was lower (28.6, 27.83 and 27.22) in three seasons, respectively, this may be due to the nature leaf shading of lettuce growth compared to the other crops which decrease chlorophyll content.

Table 2. Chlorophyll and moisture contents in leaves ± SE of certain vegetable crops

Crop	Season	Chlorophyll content* SPAD	Moisture (%)
Lettuce	2013/14	28.6^{c} ± 1.69	93.39^{a} ±0.94
Onion		53.91^{b} ±0.78	92.74^{a} ±1.42
Garlic(sids 40)		69.22^{a} ±4.04	86.14^{a} ±0.94
Balady garlic		56.12^{ab} ±2.26	86.84^{a} ±1.42
Lettuce	2014/15	27.83^{c} ±0.63	93.86^{a} ±1.42
Onion		55.03^{b} ±0.67	93.47^{a} ±0.93
Garlic (sids 40)		68.44^{a} ±3.72	85.37^{a} ±1.40
Balady garlic		54.32^{b} ±2.32	86.04^{a} ±0.93
Lettuce	2015/16	27.22^{c} ±1.17	94.0^{a} ±1.42
Onion		55.86^{b} ±1.53	93.63^{a} ±1.40
Garlic (sids 40)		68.16^{a} ±3.45	85.28^{a} ±1.76
Balady garlic		52.78^{b} ±1.54	85.93^{a} ±1.45

***= Average from thee reading on27of January,February and March**

Table 3. The relationships between chemical components percentages in leaves± SE of certain vegetable crops

Crop	Season	Macro-elements %			Protein%	%Total carbohydrates	%Total phenols
		K	N	P			
Lettuce	2014/15	5.88^{a} ±0.47	3.09^{a} ±0.05	0.46^{a}±0.02	17.61^{a}±0.94	20.0^{b}±1.42	0.30^{a}±0.01
Onion		2.4^{b} ±0.19	2.0^{b} ±0.12	0.47^{a}±0.01	11.4^{b}±0.71	20.0^{b}±1.89	0.32^{a}±0.03
Garlic (sids 40)		2.23^{b} ±0.11	1.86^{b} ±0.05	0.29^{b}±0.02	10.6^{b}±0.93	21.0^{ab}±1.42	0.14^{b}±0.01
Balady garlic		2.75^{b} ±0.12	2.29^{ab} ±.09	0.40^{a}±0.02	13.05^{b}±0.80	25.2^{a}±1.46	0.31^{a}±0.02
Lettuce	2015/16	5.38^{a} ±0.29	3.09^{a}±0.01	0.42^{b}±0.01	17.61^{a}±0.80	21.8^{ab}±1.51	0.26^{a}±0.01
Onion		2.55^{b} ±0.07	2.13^{b} ±0.01	0.51^{a}±0.01	12.14^{b}±0.80	17.83^{b}±0.85	0.28^{a}±0.02
Garlic (sids 40)		2.43^{b} ±0.06	2.03^{b} ±0.02	0.25^{c}±0.02	11.57^{b}±0.62	25.56^{a}±0.76	0.13^{b}±0.01
Balady garlic		2.8^{b} ±0.09	2.33^{b} ±0.02	0.51^{a}±0.02	13.28^{b}±0.68	22.30^{ab}±1.89	0.27^{a}±0.02

In a column, means followed by the same letter are not significantly different at the 5% level by Duncan (1955) Protein= N*5.7

Moisture content was higher in lettuce and onion than in the garlic (sids 40 and balady)**.** There was no significant differences between the moisture content of crops leaves.

Almost, each of potassium, phosphorus, nitrogen, protein, total carbohydrates and total phenols differed significantly among vegetable crops ($p \leq 0.05$)(Table 3).

4. The relationship between the population density of *Thrips tabaci, Monacha* spp. and leaf component

Correlations between number of *T. tabaci* and chlorophyll content, moisture, phosphorus and total phenols were positive. While, correlations were negative in cases of nitrogen, potassium, protein and total carbohydrates (Tables 4 and 5).

Table 4. Correlation coefficient values (r) among pest and leaf component

Pest	Season	Chlorophyll content SPAD	Moisture (%)
Thrips tabaci	2013/14	0.20	0.370
	2014/15	0.442	0.293
	2015/16	0.571	0.012
Monacha spp.	2013/14	-0.871	0.611
	2014/15	-0.887	0.609
	2015/16	-0.875	0.586

Table 5. Correlation coefficient values (r) among pest and leaves biochemical components

Pest	Season	Macro-elements %			Protein%	Total carbohydrates%	Total phenols%
		K	N	P			
Thrips tabaci	2014/15	-0.594	- 0.643	0.211	- 0.643	-0.395	0.354
	2015/16	-0.767	- 0.731	0.483	- 0.731	-0.610	0.297
Monacha spp.	2014/15	0.973*	0.906	0.397	0.906	- 0.497	0.442
	2015/16	0.976*	0.931	-0.114	0.932	0.039	0.140

***Significant, $p \leq 0.05$**

Tables (4 and 5) show a negative correlation between land snails and chlorophyll content, this may be due to mobility of snail depended on colour but it was positive with moisture, nitrogen, protein and total phenols this may be due to these factors causes leaf leanly. Correlations had significant positive effect in case of potassium ($p \leq 0.05$) which increase moisture in leaves. Correlations between phosphorus and land snails were positive in 2014/15, but it was negative in 2015/16 (Table, 4). A negative effect between land snails and carbohydrates in 2014/15 and positive in 2015/16, this may be due to presence of other factors. From the correlation matrices of the thrips and land snail densities with some biochemical characters, proved to have a contribution for resistance in lettuce, onion and garlic crops against these pests. The findings of this study may throw some light on the relationship between components of vegetable plants and infestation of thrips and snails.

These findings agreed with those obtained by Elanchezhyan *et al.* (2008) they found that total chlorophyll and moisture content were positively correlated with shoot damage while total phenols have negative correlation of aphid, leafhopper and whitefly of brinjal leaves. Hegab (2008) found that protein have positive relationship with aphids and leafhopper in the faba bean. Hatem (2014) reported that aphids and leafhoppers correlated negatively insignificant with total phenols and carbohydrates in leguminous plants. Khan *et al.* (2015) revealed that moisture content and protein had significant positive correlation with *Aphis gossypii* and cotton jassid, *Amrasca biguttula biguttula* of brinjal. Kharbangar *et al.* (2015) found that phenolic content was significant positive with thrips on rice leaves. Shah *et al.* (2016) revealed that correlation of protein and moisture with the grass hopper of maize was recorded positively significant, while the carbohydrate content was positively insignificant.

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العلاقة بين مكونات الأوراق البيوكيميائية و الكثافة العددية لتربس البصل *Thrips tabaci* Lindeman والقوقع الأرضى *Monacha* spp. التى تهاجم محاصيل الخضر

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[١] معهد بحوث وقاية النباتات

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أجريت تجارب حقلية بمحطة البحوث الزراعية بسخا-محافظة كفرالشيخ خلال ثلاث مواسم متتالية ٢٠١٣ / ١٤ ، ١٥/٢٠١٤ ، ١٦/٢٠١٥ لدراسة الكثافة العددية و التفضيل العوائلي لتربس البصل *Thrips tabaci* و القوقع الأرضى *Monacha* spp. على الخس (رومانى) و البصل (جيزة أحمر) والثوم (صنفان سدس ٤٠ والبلدى) وأيضا العلاقة بين بعض المكونات البيوكيميائية للأوراق ومستوى الإصابة. بدأ ظهور تربس البصل على الخس و البصل والثوم ابتداء من أواخر يناير و زادت الكثافة العددية لهذه الآفة تدريجيا إلى أن وصلت إلى ذروتها خلال شهرفبراير و مارس. أوضحت النتائج أن الكثافة العددية لتربس البصل كانت أعلى تواجدا فى زراعات البصل و الثوم (السدس ٤٠ و البلدى) عن الخس مع وجود اختلافات معنوية بينهم قد يرجع ذلك لزيادة محتوى الكلوروفيل فى الثوم السدس ٤٠ و الثوم البلدى و البصل بينما العكس مع القوقع الأرضى. وبينما لم يلاحظ وجود القوقع الأرضى فى زراعات الثوم البلدى.أظهرت أيضا نتائج التحليل وجود فروق معنوية فى محتوى الرطوبة فى الأوراق و البوتاسيوم و النيتروجين والفوسفور و البروتين والكربوهيدرات والفينولات بين محاصيل الخضر .ارتبطت الكثافة العددية لتربس البصل بعلاقة طردية مع محتوى الكلوروفيل و نسبة الرطوبة والفوسفوروالفينولات بينما كانت عكسية مع البوتاسيوم والنيتروجين والبروتين والكربوهيدرات.و كذلك ارتبطت الكثافة العددية للقوقع الأرضى بعلاقة عكسية مع محتوى الكلوروفيل بينما كانت طردية مع نسبة الرطوبة والنيتروجين و البروتين والفينولات والبوتاسيوم.