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### The Relationship between Aphid and Leafhopper Infestations and Chemical Constituents of three Wheat Varieties

Ola I. M. Hegab\*

Plant Prot. Dept., Fac. Agric., Zagazig Univ., Egypt

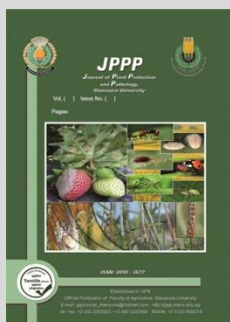


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#### ABSTRACT

Chemical analysis of ( carbohydrates ,protein, pH and amino acids) in three tested varieties of wheat plant( Sakha94,Giza168 and Balady) on the rate of infestation of some homopterous insects i.e. aphid insects (*Rhopalosiphum maidis* and *R. padi*) and leafhopper insects(*Balclutha hortensis*, *Empoasca decipiens* and *E decedens*) was studied in order to clarify the importance of these chemical constituents on the rate of infestation and subsequently the effect on the quality of yield of these plants. These results showed that these were differences between the tested wheat varieties and the number of these insects. The Balady variety showed the highest infestation with the aforementioned insects ,while the Sakha94 was infested with the lowest number of the insects .There were significant difference between the aforementioned of all three varieties and the infestation with the tested insects. Chemical analysis results recorded a positive relationship between protein , carbohydrate contents, and amino acid and infestation ,while a reverse relation was recorded with pH values. Large differences were found between amino acids concentration in the three wheat varieties especially Proline, Serine , Aspartic acid and Alanine which were obviously between Balady variety and Sakha 94 variety. Highly significant positive correlation between aforementioned insects and free amino acids except Methionine , Cysteine and Phenylalanine the correlation was non-significant. Although, the total amount of amino acids present in phloem sap was low but they were a limiting factor for aphids and leafhoppers growth . Preliminary data on present work highlights a dependent .relation between plant quality and aphid and leafhopper number on three wheat varieties .

**Keywords:** wheat , aphid population, leafhopper population ,amino acids, plant chemical composition



#### INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the main food foods in the world; according to FAO (2010), aphid and leafhoppers insects cause large losses of wheat crop. The aphid attacked starts from emergence and continues till maturity Niehoff and Staeblein (1998); Hansen (1999); Riedell, W.E and T. M. Blackmer (1999) and Shea *et al.* ,( 2000) . Aphids are very specialized and important group from insects that are feed on phloem sap ( mainly sugar and amino acids) of their host plants Holman(1974) Jedeliza *et al.*, (2013) . Phloem sap is characterized by 0.8-4.5% amino acid content Sandstrom & Moran,(1999), the amino acid composition of the phloem is the factor that shapes the nutritional quality of plants for aphids Karley *et al.*, (2002), Silva & Varanda (2005 )and Sempruch *et al.*, (2011).

Wheat varieties are differed in their chemical composition and their level of tolerance to the insect infestations Schotzko, N. and Bosque-Perez *et al.*, (2002) and Hegab (2001)

Therefore, these escapements were conducted to study the relationship between the variation in the populations of aphids *Rhopalosiphum maidis* and *R. padi* and leafhoppers, *Balclutha hortensis*, *Empoasca decipiens* and *E decedens* and the variation in the amino acids

concentration , protein ,carbohydrate and pH value in three Wheat varieties.

#### MATERIALS AND METHODS

Field experiments were carried out at Diarb-Nigm district, Sharkia Governorate, Egypt during seasons 2016/17 and 2017/18 .The experimental area were 720 m<sup>2</sup> divided to 12 replicates and each replicate was 60m<sup>2</sup> .Three wheat varieties Sakha94,Giza168 and Balady were cultivated in the third week of November during two successive seasons. Each wheat variety was cultivated in four replicates .

##### Aphids

The following procedure of collect sampling were used:

**Plant samples :** The sampling started when the age of wheat plants reached about 30 days continued at weekly intervals throughout the period from the mid-December till the mid – April. weekly samples of 25 plants were taken randomly, the infested leaves and tassels were placed in paper bags until counted in the laboratory according to Wratten *et al.*, (1979) and Lykouress (1984).

Leafhoppers Sweeping net, (35 cm diameter and 60 cm deep) was used and each sample consisted of 50 double strokes taken randomly of the field. Caught leafhoppers were transferred to plastic Sacs containing pieces of cotton

\* Corresponding author.  
E-mail address: [drolahegab@gmail.com](mailto:drolahegab@gmail.com)  
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saturated with ether for anesthetizing the collected insects. The plastic Sacs were tied by rubber bands and taken to the laboratory for inspection and identification according to the work of Nielson (1968) and Hegab *et al.*, (1987)

Chemical analysis of wheat varieties were carried out in Central Laboratory ,Faculty of Agriculture ,Zagazig University .plant leaves and tassels were taken at random from each replicate at start of the expulsion of the ears of different wheat varieties for the two studied seasons to determine the total protein and carbohydrate contents according to Bremner and Mulvaney (1982) and Dubois *et al.*, (1956) and estimated pH values in the plants sap by using pH meter

**Amino acid assay**

Free amino acids were extracted from plant material freeze-dried with 80% ethanol and purified on the ion-exchange column (Amberlit IR - 120 [H+]) according to Lasheen *et al.*, (1970) method. The samples were analyzed with using of the amino acids analyser T-339 (Microtechna, Praha).

**Statistics**

All chemical analyses were assayed in three independent replicates

All data were analyzed by statistically analysis of variance using least significant differences ( L.S.D) The acceptance level of statistical significance was ≤ 0.05. Also the correlation between the mean number of aphids and leafhoppers and the chemical constituents of wheat varieties were investigated by calculating Pearson's correlation . according to SPSS16.0 computer program.

**RESULTS AND DISCUSSION**

**Aphid**

The obtained results arranged in Table (1) showed that the highest average number of aphids *R maidis* and *R padi* were recorded on wheat variety Baldy during the two seasons (2016/17 and 2017/18) and represented by (517.3 and 538.0 indiv.) and (290.0 and 340.0 indiv.),respectively .Meanwhile, the lowest average number for the two aphid species during the two seasons were recorded on Sakha94 and presented by (232.7 and 253.0 indiv.) and (152.3 and 206.3 indiv.),respectively.

According to the average number of the leafhoppers *E. decipiens* ,*E decedens* and *B.hortensis*,the wheat variety Balady attractive the highest average number during the two successive seasons and presented by (38.3 and 41.3 indiv.), (41.3 and 43.7 indiv.) and (40.0 and 42.0 indiv.), respectively . while , the lowest average number of the three leafhoppers, *E. decipiens* ,*E decedens* and *B.hortensis* were recorded on the wheat variety and represented by (19.7 and 27.3 indiv.), (22.3 and 29.7 indiv.) and (29.0 and 40.3 indiv.) respectively.

Statistical analysis revealed that, a significant differences were recorded between the average number for the aforementioned aphids and leafhoppers species and the tested wheat varieties during the two successive seasons 2016/17 and 2017/18 at Diarb –Nigm Sharkia Governorate . These results are in agreement with the finding of Abdel-Hafez and El-Hagag (1999), Hegab (2001) , Muhammed *et al.*, (2004), Abd-Elsamed (2006) and El –Khyat *et al.*,(2016) who mentioned that there were significant differences

between wheat varieties and cereal aphids and leafhoppers infestation .

**Chemical constituents of three wheat varieties**

The obtained data illustrated in Table (2) showed the chemical constituents on the three tested wheat varieties .It can be noticed that ,the mean of total protein percentage , the mean of total carbohydrate percentage ,pH value and the mean of the total amino acids percentage were recorded significantly differences on the three tested wheat varieties .

These results are in agreement with those of Narang *et al.*, (1997) who found that total amino acids and soluble proteins were responsible for susceptibility of the plants, Telang *et al.*, (1999) who determined that, the whether *D. noxia* feeding damage results in higher concentrations of essential amino acids , Nasir (2001) who mentioned that the protein content, carbohydrates and amino acids in wheat plant and found significantly different in all the varieties of wheat and found a significant positive effect of amino acids on the population of aphids , Karley *et al.*, (2002), Eleftherianos *et al.*,( 2006),Chiozza *et al.*, (2010) and M. S. HILLWIG *et al.*,(2016)who showed that , the amino acid composition of the phloem is the one factor that shapes the nutritional quality of plants for aphids.

**Table 1. The average number of aphids and leafhoppers species on different wheat varieties during the two successive seasons 2016/17 and 2017/ 18.**

Wheat varieties		Sakha 94	Giza 168	Balady	F test	L.S.D
<i>R. maidis</i>	A	232.7	354.7	517.3	**	3.147
	B	253.0	410.0	538.0	**	5.698
<i>R.padi</i>	A	152.3	244.0	290.0	**	5.777
	B	206.3	291.3	340.0	**	6.801
<i>E.decipiens</i>	A	19.7	31.7	38.3	**	2.127
	B	27.3	37.7	41.3	**	1.999
<i>E.decedens</i>	A	22.3	33.0	41.3	**	1.115
	B	29.7	41.3	43.7	**	1.329
<i>B.hortensis</i>	A	29.0	33.7	40.0	**	0.895
	B	40.3	35.7	42.0	**	1.051

A .The first season 2016/17

B .The second season 2017/18

**Table 2. Mean values of Chemical constituents of the three wheat varieties during the two successive seasons 2016/17 and 2017/ 18.**

Chemical components	Wheat varieties			F.test	L.S.D
	Sakha94	Giza168	Balady		
Mean of total protein	11.2	12.9	13.9	**	.492
Mean of total carbohydrate	25.3	37.5	48.5	**	.137
pH value	4.6	5.1	5.4	**	.062
Mean of total amino acids	3.9829	7.7064	9.2541	**	.033

The obtained results arranged in Table (3) showed the correlation between the average number of aphids and leafhopper species and the chemical constituent of the three tested wheat varieties .It can be noticed that , the correlation between aphid and leafhopper species in one hand and the protein percentage, the carbohydrate percentage and pH value on the other hand were positively highly significant differences.

**Amino acids**

Data illustrated in Table 3 showed that amino acids differences between three wheat varieties were highly significant. On the other hand the correlation between amino

acids and the insect pests were highly significant except Cysteine , methionine and phenyl alanine ,the correlation was non-significant . These results are in agreement with those of Ciepiela and Sempruch (1999) and Sempruch *et al.*, (2007) who recorded that a wheat cultivar resistant to *Sitobion avenae* was positively correlated with specific protein and non protein amino acids .

From the aforementioned results there were positive relationship between protein content, carbohydrates , pH value, and mean number of tested insects of three wheat varieties .From obtained results aforementioned chemical compounds differences were significant between three wheat varieties .

**Table 3. The correlation between the mean number of aphids and leafhoppers and the chemical constituents of wheat varieties at Diarb-Nigm district, Sharkia Governorate during 2017/18 season**

chemical constituents	Insects				
	<i>R.maidis</i>	<i>R.padi</i>	<i>B.hortensis</i>	<i>E.decipiens</i>	<i>E.decedens</i>
Protein%	0.999**	0.991**	0.990**	0.981**	0.942**
Carbohydrate%	0.983**	0.975**	0.975**	0.960**	0.929**
pH	0.996**	0.996**	0.974**	0.986**	0.964**
Aspartic acids	0.955**	0.977**	0.900**	0.973**	0.995**
Threonine	0.962**	0.932**	0.988**	0.918**	0.838**
Serine	0.961**	0.931**	0.987**	0.916**	0.835**
Glutamic acid	0.981**	0.957**	0.996**	0.944**	0.877**
Proline	0.948**	0.913**	0.981**	0.899**	0.810**
Glycine	0.798**	0.847**	0.717**	0.861**	0.913**
Alanine	0.920**	0.879**	0.964**	0.865**	0.761**
Cysteine	0.154	0.192	0.103	0.199	0.263
Valine	0.999**	0.996**	0.982**	0.987**	0.959**
Methionine	0.573	-0.497	-0.672	-0.477	-0.324
Isoleucine	0.999**	0.996**	0.982**	0.988**	0.960**
Leucine	0.892**	0.929**	0.815**	0.928**	0.981**
Tyrosine	0.901**	0.855**	0.950**	0.840**	0.730**
Phenylalanine	0.282	0.370	0.140	0.384	0.549
Histidine	0.957**	0.924**	0.988**	0.910**	0.825**
Lysine	0.995**	0.995**	0.972**	0.985**	0.968**
Arginine	0.638	0.707*	0.519	0.714*	0.833**

\*\* indicates highly significant correlation at 0.01% level of probability.

\* indicates significant correlation at 0.05% level of probability.

The obtained results in Table(4) illustrated that the concentration of amino acids differed in the three wheat varieties, proline recorded the highest concentration in the three wheat varieties (0.7014,0.9351 and 1.5722) followed by Serine (0.3854, 0.7136 and 1.0462),Aspartic acid(0.4851, 0.4851 and 0.9620) and Alanine (0.5296, 0.6070 and 0.9302) in Sakha94 ,Giza 168 and Balady, respectively , while the concentration of amino acids Methionine (0.346,0.0404 and 0.0244) followed by, cysteine (0.0318,0.0340 and 0.0323),Glycine (0.1096,0.1320 and 0.1282) , lysine (0.0367,0.1234 and 0.1767) and Histidine (0.1356, 0.1505 and 0.1857) in aforementioned wheat varieties respectively were the lowest concentration. On the other hand 17 amino acids showed significant differences between three wheat varieties ,which were obviously between Balady variety and Sakha 94 variety .Also table 4 showed that Sakha 94 was the lowest wheat varieties in total amino acids with ( 3.9829) followed by Giza168 (7.7064) while Balady variety was the highest in total amino acids (9.2541)

These results agree with the findings of Gao Chong sheng *et al.*, (1998) who mentioned that the next amino acids , leucine, isoleucine, valine, proline, phenylalanine, glutamine and alanine were the most abundant at resistant

varieties of wheat and Chiozza *et al.*, (2010) who showed that the aphid-resistant line had a lower concentrations of glutamic acid and histidine, than the aphid-susceptible line.

From the previous results, we found that the three varieties of wheat plant differed in their susceptibility to infection of aphids and leaf hoppers, whereas the cultivar Sakha 94 was the least affected species, while the cultivar Balady was the most affected variety and may be due to the difference between the three varieties of wheat in the chemical composition of protein and carbohydrates as well as their contents of Amino acids, which showed positive correlation between them and the enumeration of the insects mentioned above and this may explain the difference in sensitivity of the varieties and the infection of insects .

**Table 4. Mean values of Amino acid concentrations on the three varieties during 2016/17 and 2017/18 seasons.**

Amino acids	Sakha94	Giza 168	Balady	L.S.D
Methionine	.0346±.00123	.0404±.00048	.0244±.00038	.003
Cysteine	.0318±.00030	.0340±.00132	.0323±.00098	.003
Lysine	.0367±.00064	.1234±.00005	.1767±.00346	.007
Glycine	.1096±.00049	.1320±.00231	.1282±.00072	.005
Histidine	.1356±.00056	.1505±.00040	.1857±.00058	.007
Phenylalanine	.1571±.00041	.2876±.00059	.1875±.00067	.002
Arginine	.1318±.00012	.3257±.00055	.2468±.00065	.002
Leucine	.1078±.00058	.3126±.00058	.3111±.00034	.002
Tyrosine	.1428±.00046	.3126±.00047	.4762±.00055	.002
Isoleucine	.2382±.00069	.4955±.0004	.6831±.00084	.002
Glutamic acid	.3854±.00066	.5037±.00053	.6921±.0035	.007
Valine	.3700±.00252	.5907±.00041	.7546±.00074	.005
Threonine	0.993±.000785	1.2605±.00178	.8448±.00117	.005
Alanine	.5296±.00075	.6070±.00361	.9302±.00066	.007
Aspartic acids	0.4851±.00069	0.8715±.0009	.9620±.00173	.004
Serine	.3854±.00049	.7236±.00069	1.0462±.00055	.002
Proline	0.7014±.00072	.9351±.00111	1.5722±.0035	.004
Total amino acids	3.9829	7.7064	9.2541	0.033

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## العلاقة بين الإصابة بحشرات المن ونشاطات الأوراق و المكونات الكيميائية لثلاثة أصناف من القمح

علا ابراهيم محمد حجاب

قسم وقاية النبات - كلية الزراعة - جامعة الزقازيق

دراسة التركيب الكيميائي (الكربوهيدرات ، البروتين ، الأس الهيدروجيني ، والأحماض الأمينية) للأصناف المختبرة من نبات القمح ( Sakha94 ، Giza168 و Balady) كانت مهمة للتأثير على معدل الإصابة ببعض الحشرات المتشابهة ، مثل حشرات المن (*Rhopalosiphum maidis* و *R. padi*) وحشرات نشاطات الأوراق (*Balclutha hortensis* و *Empoasca decipiens* و *E. decedens*). والتي تتغذى على الحاء الذي يحتوي على الكربوهيدرات والمركبات النيتروجينية ، يتحرك النيتروجين في الحاء بشكل أساسي في شكل أحماض أمينية حرة. أظهرت هذه النتائج وجود فروق بين أصناف القمح المختبرة وعدد هذه الحشرات. أظهر صنف البلدي أعلى نسبة إصابة بالحشرات السالفة الذكر ، في حين أصيبت Sakha94 بأقل عدد من الحشرات. وقد سجلت نتائج التحليل الكيميائي علاقة إيجابية بين محتويات البروتين والكربوهيدرات والأحماض الأمينية والإصابة بحشرات المن ونشاطات الأوراق ، في حين تم تسجيل علاقة عكسية بين تعداد الحشرات وبين قيم الأس الهيدروجيني. كما وجدت اختلافات كبيرة بين تركيز الأحماض الأمينية في أصناف القمح الثلاثة وخاصة البرولين ، السيرين ، الأسبارتيك أسيد و الانين والتي كانت واضحة بين صنف البلدي و صنف سخا 94. توجد علاقة إيجابية معنوية عالية بين الحشرات المذكورة أعلاه والأحماض الأمينية الحرة باستثناء الميثيونين والسيسيتين والفيل الانين كانت العلاقة غير معنوية. وعلى الرغم من أن كمية الأحماض الأمينية الموجودة في عصاره الحاء كانت منخفضة إلا أنها كانت عاملاً محدداً لنمو حشرات المن وحشرات نشاطات الأوراق. تسلط البيانات الأولية عن العمل الحالي الضوء على العلاقة بين التركيب الكيميائي للنبات وتعداد الحشرات على الثلاثة أنواع المختبرة من القمح.