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Egyptian barley cultivars infestation by *rhyzopertha dominica* (f.) As influenced by seed biochemical and chemical composition

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ABSTRACT

Barley is an important food crop particularly for animal feeding but in Egypt, there is a shortage in barley supplies. Unfortunately, this crop is infested by several stored product insects, including *Rhyzopertha dominica*(F.). These insect pests are usually controlled by chemical application. However, developing barley cultivars resistant to insects is an important approach. Therefore, relationships between chemical traits of fifteen barley cultivars and infestation by *R. dominica*(F.) were investigated. The results showed that covert barley (Giza123,Giza125,Giza134 and Giza2000) were the lowest infested cultivars by *R. dominica*. It produced the least numbers of adult progeny (32, 39, 36 and 51.3 insects) from thirty gram grains sample, the least reduction of weight loss (6.3, 5.3, 5.3 and 6.9%) and the least of infested grains percentages (9.1, 6.9 and 11.6% respectively). The highest insect infestation were recorded in naked barley(Giza131, Giza135 and Giza136) where the number of adult progeny were 210, 169 and 201 insects, the weight loss were 33.3, 23.3 and 31.4% and the infested grains percentages were 60.7, 45.0 and 63.6%, respectively. Results of chemical component analysis showed that the lowest infestations were in cultivars of low protein content and high content of phenol, fiber and ash, while, the highest infestations in naked barley were in cultivars of high content of protein and low content of phenol, fiber and ash. Results of SDS-PAGE in soluble protein revealed a total number of 13 bands, two common bands were monomorphic and the others were polymorphic, and there were three specific bands found in naked barley which were higher infested than covert barley. Therefore, it should be taken into consideration to select a line with high yield, good quality, more tolerant to insect infestation to avoid insecticide usage.

Keywords: *Hordeum vulgare*, SDS-PAGE , grain chemical composition, *Rhzopetha dominica*, infestation.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is a cereal crop that is grown in most countries, and is ranked as fifth in world crop production. It is considered a major daily animal feed in the world and represents the most important source of required carbohydrates (Neelhirajan *et al*., 2007). Barley, like all crops, is attacked by many insect pests including stored grain insects. The infestation by insects causes several direct and indirect damage. These injuries might change color and appearance, bad odors, high in temperature and humidity, holes and dark spots on grains. Insects might also kill grain embryos; produce not required flour and powdered products leading to deterioration and contamination of grains (Al-Momany and Al-Antary, 2008).During storing, the barley is attacked by several pests, particularly insects. Seeds stored for more than six weeks must be protected against insect damage (Armitage *et al*., 1994). Seeds should only be stored when dried. High temperature reduces the efficacy of barley protectants, encouraging insects to increase. Direct feeding damage results in reductions in weight, nutritional value, germination and market value (Pears, 2015). Post harvest losses are caused by bad storage conditions, insects, rodents and microorganisms which account for more than 10% losses out of the total food grain. Stored-grain insects are divided into primary pests that attack whole kernels and secondary pests that feed on broken or cracked grains (Agriculture Knowledge Center, 2015)and (Bromley, 2015). Studies were performed to estimate the quantitative losses in different barley varieties against *Tribolium castaneum* (Herbst) which is commonly known as red flour beetle. Quantitative parameters like damaged grain percentage, frass weight (broken grains debris and insect exuviae), number of adult emergence and percentage weight loss were determined at three different incubation temperatures i.e., 28^{o}C, 32^{o}C and 35^{o}C. Results revealed that maximum damaged grains percentage and frass weight production with maximum number of adult emergence occurred at 32^{o}C, while minimum occurred at 35^{o}C and 28^{o}C. Maximum percentage weight loss was recorded in susceptible variety and minimum percentage weight loss was recorded in resistant variety (Javed *et al*., 2016). The plants possessing biochemical insect-resistant properties are nutritionally incomplete for the insects that become unable to complete their life cycles (Relf, 1996).

The present study was undertaken to evaluate the relationship between some chemicals traits of seed barley cultivars, and the resistance to the lesser grain borer, *Rhyzopertha dominica* (F.).

MATERIALS AND METHODS

The present investigation was carried out at the Plant Breeding and Biotechnology laboratory. of Barley Res., Dept. Sakha Agricultural Station, Field Crops Res. Inst, and Dept. of Stored Product Pests, Plant Protection Res. Inst., Agric Res. Center. Fifteen barley (*Hordeum vulgare* L.) genotypes were used in this study during 2014-2015 seasons, obtained from Barley Res. Dept., Field Crops Res. Inst., five were naked barley and ten were covert, the genotypes and their pedigree are shown in Table (1).

Grain samples were taken randomizely from each cultivar, cleaned by excluding foreign grains and raw materials, and divided into two groups, the first group was used to assess their resistance to *Rhyzopertha dominica*, while, the second one was subjected to chemical tests along with investigating biochemical traits.

1- **Insect infestation:** Tested grains were sterilized by heating at 50^{o}C for one hour to get rid of any insect infestation and its moisture content was determined according to the method of A.O.A.C (2000). The target insect (Lesser grain borer, *Rhyzopertha dominica* F.) adults, used in this study, were obtained from Stored Product Pests Department at Sakha, Plant Protection Research Institute, A.R.C., Dokki. This standard insect culture is maintained without exposure to insecticides for several years. Newly emerged adults (1-5 days old) were used in the experiments. Three replicates of 30 g-grain samples of each cultivar were placed in small plastic jars(6 cm diameter and 10 cm height). Thirty unsexed newly emerging of *R. dominica* adults were released in each jar and allowed to lay their eggs. The jars were kept in the laboratory at constant conditions (30 $\pm$ 2^{o}C, 70 $\pm$ 5% r.h.). After 180 days from storage under previous conditions, number of adult progeny, damage (number of infested grains/ jar) and the loss in grain weight were recorded.

Table (1): Barley genotypes and their type

Name	Row type	
Giza 123	covert	6 row
Giza 124	covert	6 row
Giza 125	covert	6 row
Giza 126	naked	6 row
Giza 127	naked	2 row
Giza 128	covert	2 row
Giza 129	naked	6 row
Giza 130	naked	6 row
Giza 131	naked	6 row
Giza 132	covert	6 row
Giza 133	covert	6 row
Giza 134	covert	6 row
Giza 135	naked	6 row
Giza 136	naked	6 row
Giza 2000	covert	6 row

2- **Chemical analysis:** Tested grains were ground to a fine powder to pass through 2 mm mesh for chemical analysis, crude protein (CP), oil , crude fiber (CF), ash , sugar and starch that were determined according to the procedures outlined in A.O.A.C. (2000). Total phenols were determined using folin-Denis reagent according to the method of Swain and Hilis (1959).

3- **SDS-Protein electrophoresis :** Sodium dodecyl sulphate –polyacylamide gel electrophoresis (SDS-PAGE) was used to study the banding patterns of treatments under study according to the method of Leammli (1970) as modified by Studier (1973).

4-Statistical analysis: The obtained data were statistically analyzed, utilizing a computer software package and differences among means were tested using the method of multiple range test outlined by Duncan (1955).

RESULTS AND DISCUSSION

1-Insect infestation:

Rhyzopertha dominica adults infested all tested barley cultivars with different percentages. Data in Table (2) showed that Giza123, Giza125, Giza134 and Giza2000, as the covered cultivars, were the lowest infested barley cultivars by *R. dominica*. They produced the least number of adult progeny (32, 39, 36 and 51.3 insects) from thirty gram grains sample, also they had the least reduction of weight loss (6.3, 5.3, 5.3 and 6.9%) and had the least percentage of grain infestation (9.1, 8.5, 6.9 and 11.6%, respectively). The second rank of the insect infestation was occupied by Giza124, Giza126, Giza127, Giza132 and Giza133 as their corresponding values were 95, 69,65,60 and 69 insects, for number of adult progeny, the weight losses were 24, 17.3,16.4,13.7 and 13.0% and the infested grains percentages were 22.8, 21.5,16.8,13.6 and 18.3%, respectively. The moderate insect infestations were recorded in Giza128, Giza129 and Giza130 where the numbers of adult progeny were 120, 125 and 120 insects, the weight losses were 22.1, 32.7 and 29% and the infested grains percentage was 26.3, 29.4 and 25.3%, respectively. However, the highest insect infestation was recorded in Giza131, Giza135 and Giza136 as the naked cultivars, where the numbers of adult progeny were 210, 169 and 201 insects, the weight losses were 33.3, 23.3 and 31.4% and the infested grain percentages were 60.7, 45.0 and 63.6%, respectively. These results are in agreement with those Gharib and El-Lakwah (2005) who found that the naked cultivars were more susceptible to *Sitophilus oryzae* L. infestation compared to the covered varieties. These findings are also in agreement with results obtained by Raffea and Gharib (2005) who found that the naked varieties (Giza 129, Giza 130 and Giza 131) were more susceptible to *Trogodrma granarium* than the covered varieties(Giza 123, Giza 124, Giza 126 and Giza 2000), they also found that the insect growth was of significantly shorter duration in the naked varieties than in the covered varieties. Also, more progeny number emerged from all naked varieties.

The current results revealed that the damage in grains (number of holes) was significantly different among tested cultivars. These results are also in agreement with those of Antary and Thalji (2015), who found that the number of holes caused by the storage pests in all seeds was significantly different between tested barley cultivars. Also, they found that the most common insects in the barley seed samples of all cultivars were *Rhyzopertha dominica*, followed by *Sitophilus granarius, Tribolium confusum* and *Oryzaephilus surinamensis*.

Javed *et al*., (2016) studied the red flour beetle, *Tribolium castaneum* infestation against some barley varieties. They found that the maximum damaged grain percentage, frass weight (broken grains debris and insect exuviae), number of adult emergence and percentage weight loss were recorded in susceptible variety while minimum in resistant variety.

2- Chemical composition

The chemical components of tested barley grains were determined in order to check for possible differences and to investigate the relationship between chemical composition and the insect infestation . The results of chemical analysis of fifteen barley cultivars are shown in Table (3). The highly infested cultivars by *R. dominica* (Giza 131, Giza 135 and Giza 136) had high content of protein and low content of phenol, fiber and ash. The lowest infested cultivars (Giza 123, Giza 125, Giza 134 and Giza 2000) had low content of protein and high content of phenol, fiber and ash. These results are in agreement with those of Astuti *et al*.(2013) who suggested that protein, fat, ash carbohydrate, phenolic content and hardness are important characteristics to determine the resistance to insects of stored products. Also, our results are in agreement with those of El-Aidy *et al* (2008) who found negative correlations between insect infestation and each of crude fiber, phenol, tannins and thickness of hull of faba bean seeds.

Table (2): Adult progeny of *Rhyzopertha dominica* and damage parameters of barley cultivars after artificial infestation

Genotype	Number of adult progeny (insect)	Grains weight after infestation (g)	Weight loss (%)	Damage (No. of exit holes)	Number of initial grains /30g (grain)	Number of infested grains /30g (grain)	Infested grains (%)
Giza123	32.0 ^{g}	28.1 ^{a}	6.3 ^{g}	61.0 ^{jk}	525.7 ^{gh}	48.0 ^{j}	9.1 ^{i}
Giza 124	95.0 ^{d}	22.8 ^{e}	24.0 ^{c}	132.7 ^{g}	530.7 ^{g}	121.0 ^{g}	22.8 ^{f}
Giza 125	39.0 ^{g}	28.4 ^{a}	5.3 ^{g}	50.0 ^{k}	515.3 ^{i}	44.0 ^{j}	8.5 ^{i}
Giza126	69.0 ^{e}	24.8 ^{d}	17.3 ^{d}	201.0 ^{e}	725.0 ^{b}	156.0 ^{f}	21.5 ^{f}
Giza 127	65.0 ^{e}	25.1 ^{cd}	16.4 ^{de}	122.0 ^{gh}	662.3 ^{d}	111.0 ^{g}	16.8 ^{g}
Giza 128	120.0 ^{c}	23.4 ^{e}	22.1 ^{c}	165.0 ^{f}	593.3 ^{e}	156.0 ^{f}	26.3 ^{e}
Giza 129	125.0 ^{c}	20.3 ^{g}	32.7 ^{a}	240.0 ^{d}	732.3 ^{b}	215.0 ^{d}	29.4 ^{d}
Giza 130	120.0 ^{c}	21.3 ^{f}	29.0 ^{b}	230.3 ^{d}	750.3 ^{a}	190.0 ^{e}	25.3 ^{e}
Giza 131	210.0 ^{a}	20.0 ^{g}	33.3 ^{a}	620.0 ^{a}	687.3 ^{c}	417.0 ^{a}	60.7 ^{b}
Giza 132	60.0 ^{ef}	25.9 ^{bc}	13.7 ^{ef}	82.0 ^{i}	552.7 ^{f}	75.0 ^{i}	13.6 ^{h}
Giza 133	69.0 ^{e}	26.1 ^{b}	13.0 ^{f}	109.0 ^{h}	520.0 ^{gh}	95.0 ^{h}	18.3 ^{g}
Giza 134	36.0 ^{g}	28.4 ^{a}	5.3 ^{g}	65.0 ^{ijk}	650.0 ^{d}	45.0 ^{j}	6.9 ^{i}
Giza 135	169.0 ^{b}	23.0 ^{e}	23.3 ^{c}	360.0 ^{c}	694.7 ^{c}	315.0 ^{c}	45.0 ^{c}
Giza 136	201.0 ^{a}	20.6 ^{fg}	31.4 ^{ab}	400.0 ^{b}	550.0 ^{f}	350.0 ^{b}	63.6 ^{a}
G 2000	51.3 ^{f}	27.9 ^{a}	6.9 ^{g}	72.0 ^{ij}	562.0 ^{f}	65.0 ^{i}	11.6 ^{h}

Means followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test(1955)

Table (3):Chemical composition of barley grain varieties on dry matter basic

Genotypes	Phenol mg/100g	Ash %	Starch%	Sugar%	Protein%	Fiber %	oil %	Moisture%
Giza123	71.4 ^{b}	2.6^{abc}	40.7^{hf}	1.9^{q}	10.98^{e}	4.9^{d}	2.1^{e}	9.7^{f}
Giza 124	67.7 ^{d}	2.44^{bcd}	44.6^{e}	1.0^{h}	11.77^{cd}	4.8^{de}	2.5^{bcd}	13.3^{a}
Giza 125	73.8 ^{b}	٢.٤ ^{cf}	٤٤.٠^{f}	٠.٩^{hi}	١٠.٨٨^{ef}	٥.٣^{bcd}	1.7^{f}	١٢.٩^{b}
Giza126	68.3 ^{d}	2.7 ^{ab}	45.3^{d}	1.7^{def}	10.60^{fg}	5.8^{b}	3.1^{a}	10.7^{d}
Giza 127	69.6 ^{c}	2.23^{ag}	47.6^{b}	0.9^{hi}	10.76^{ef}	7.1^{a}	2.2^{de}	12.8^{b}
Giza 128	68.1 ^{d}	2.31^{dg}	46.8^{c}	1.4^{g}	11.04^{e}	3.3^{f}	2.1^{e}	13.1^{a}
Giza 129	54.7 ^{h}	٢.١^{efg}	٤٦.٣^{c}	١.٥^{fg}	١١.٨2^{c}	٢.١^{g}	٢.٤^{bce}	١٠.٦^{d}
Giza 130	50.4 ^{i}	٢.١^{efg}	٤٩.٦^{a}	٢.٥^{a}	11.90^{c}	١.٣^{h}	٢.٧^{b}	١١.٥^{c}
Giza 131	47.8 ^{i}	٢.١^{efg}	40.3^{i}	1.9^{cde}	12.13^{b}	1.8^{gh}	2.4^{bce}	10.3^{de}
Giza 132	60.9 ^{b}	2.9^{a}	41.9^{g}	1.1^{h}	11.12d^{e}	5.5^{bc}	2.6^{bc}	10.4^{de}
Giza 133	66.9^{e}	2.7^{ab}	41.1^{h}	0.7^{i}	11.42^{cd}	5.0^{cd}	2.4^{be}	10.7^{d}
Giza 134	71.6 ^{b}	2.4^{be}	40.4^{i}	2.2^{b}	10.24^{g}	4.3^{e}	2.3^{cde}	10.6^{d}
Giza 135	37.3^{c}	2.0^{g}	40.3^{i}	2.7^{a}	15.24^{a}	1.3h	2.1^{e}	10.1^{ef}
Giza 136	54.8 ^{h}	2.1^{efg}	43.5^{f}	1.6^{efg}	12.22^{b}	1.5^{gh}	2.2^{de}	10.6^{d}
Giza 2000	77.4 ^{a}	2.4^{be}	39.4^{j}	2.0^{bc}	10.18^{g}	3.7^{f}	3.4^{a}	13.1^{ab}

Means followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test(1955)

3- Correlation matrix:

To better assess of obtained results, an analysis of correlation matrix between the chemical parameters of tested barley varieties and biological parameters of *R. dominica* was performed and presented in Table (4). The correlation matrix showed no significant correlations between starch, moisture and oil percentages with number of adult progeny, weight grains loss and infested grains. In contrast, there were highly significant negative correlations between each of crude fiber, phenol and ash with insect infestation. This may be explained by the fact that fiber and ash increase hardness and toughness of the coat, thus the grain coat resists larval penetration and reduces the degree of insect infestation (El-Aidy *et al*, 1995). These findings are in full agreement with those of El-Aidy *et al* (2000) who recorded highly significant negative correlation between crude fiber content of 20 rice varieties with hardness of *S. oryzae* infestation. Chunni and Singh (1996) evaluated 64 wheat varieties for resistance to the rice weevil, *S. oryzae* using no-choice progeny tests. They found that susceptibility to the rice weevil is negatively correlated with hardness, crude fiber and crude protein contents of the grains.

Table (4): Correlation coefficient values among chemical traits of barley varieties and *Rhyzopertha dominica* infestation

Chemical trait	No. of adult progeny	Weight Loss %	Infested grains (%)	Damage (No. of holes)
Moisture %	- 0.095	-0.022	-0.092	-0.054
oil %	- 0.247	-0155	-0.312	-0.353
Crude protein%	0.623*	0.472*	0.607*	0.622*
Crude fiber%	- 0.761***	-0.668**	-0.698**	-0.717**
Ash %	- 0.703**	- 0.668	-0.648**	-0.672**
starch%	- 0.127	0.210	- 0.261	-0.171
sugar%	0.304	0.162	0.262	0.361
Phenol mg/100g	- 0.254*	- 0.377*	- 0.162*	- 0.216*

*** Significant at 0.05**
**** Highly significant at 0.01**

In contrast, the current results revealed significant positively correlation between each of protein and sugars contents with insect infestation. Such results are explained by the fact that these nutrients could be the major source of energy and encourages insect development inside the grain during storage period (Elzun *et al.*, 2015)

4-SDS-PAGE soluble protein

Electrophoretic techniques for protein polymorphism have been used as identification and quantization methods, which provide association between the altered expression of specific genes and environmental stress. These changes in expression of genes would be involved in adaptation and could be used as molecular markers for insect stress.

Electrophoretic analysis was carried out on water-soluble SDS-protein fraction for fifteen barley genotypes before and after infestation. Banding patterns of protein extract of barley seeds (Fig.1 & Table 5) showed that the band pattern indicates into wide differences among the tested seeds in number and position of the bands the presence and absence of bands were assessed (+) and (-), respectively. The maximum number of bands was 13, which were not necessarily exhibited in all genotypes. The electrophoretic patterns revealed marked variations in the occurrence, distribution, intensity and density of bands.

Table (5). Summary of densitomtric analysis for water soluble protein profiles of thirty barley cultivars before and after infestation

Lane No.	MW KDa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	240.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	+	+	+	+	+	+	+	+
2	140.00	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	+	-	+	+	+	+	+	+
3	100.00	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+
4	70.00	-	-	-	-	-	-	-	-	-	+	-	-	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+
5	64.00	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6	47.50	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
7	35.00	-	-	-	+	+	-	-	-	-	+	-	-	+	+	+	-	-	-	+	+	+	+	+	-	+	+	+	+	+	-
8	25.00	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9	21.50	+	+	+	-	-	+	-	-	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10	20.00	+	+	+	-	-	-	-	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	18.32	+	+	+	-	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+
12	15.00	+	+	+	-	-	-	-	-	-	-	+	+	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	-
13	10.00	+	+	+	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Total		8	8	8	5	5	5	3	2	2	8	8	8	9	11	10	9	12	12	12	9	10	10	13	8	13	13	13	13	13	11

(+)present (-) Absent

1 = Giza 123 before infestation **2= Giza 123 after infestation** **3 = Giza 124 before infestation**
4= Giza 124 after infestation **5 = Giza 125 before infestation** **6= Giza 125 after infestation**
7 = Giza 126 before infestation **8= Giza 126 after infestation** **9 = Giza 127 before infestation**
10= Giza 127 after infestation **11 = Giza 128 before infestation** **12= Giza 128 after infestation**
13 = Giza 129 before infestation **14= Giza 129 after infestation** **15 = Giza 130 before infestation**
16= Giza 130 after infestation **17 = Giza 131 before infestation** **18= Giza 131 after infestation**
19 = Giza 132 before infestation **20= Giza 132 after infestation** **21 = Giza 133 before infestation**
22= Giza 133 after infestation **23 = Giza 2000 before infestation** **24= Giza 2000 after infestation**
25= Giza 134 before infestation **26= Giza 134 after infestation** **27 = Giza 135 before infestation**
28= Giza 135 after infestation **29 = Giza 136 before infestation** **30= Giza 136 after infestation**

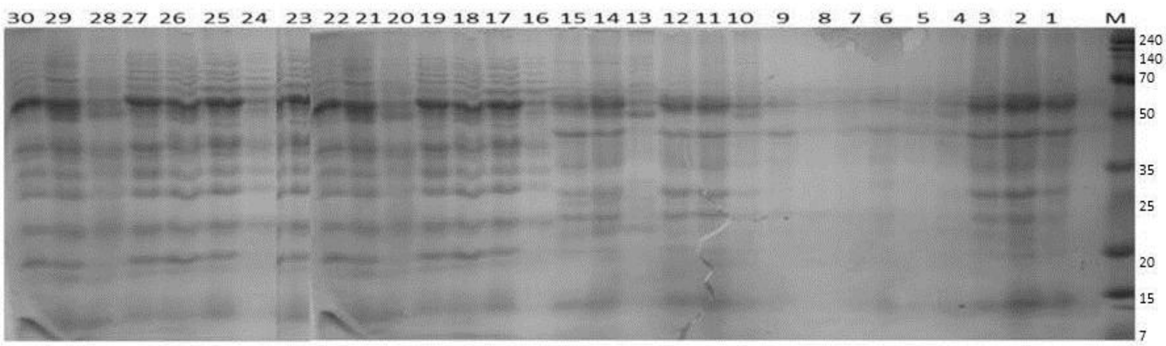

Fig (1) SDS-PAGE profiles of barley seed protein (Water-Soluble) for fifteen barley genotypes before and after infestation with protein standard

1 = Giza 123 before infestation **2= Giza 123 after infestation** **3 = Giza 124 before infestation**
4= Giza 124 after infestation **5 = Giza 125 before infestation** **6= Giza 125 after infestation**
7 = Giza 126 before infestation **8= Giza 126 after infestation** **9 = Giza 127 before infestation**
10= Giza 127 after infestation **11 = Giza 128 before infestation** **12= Giza 128 after infestation**
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16= Giza 130 after infestation **17 = Giza 131 before infestation** **18= Giza 131 after infestation**
19 = Giza 132 before infestation **20= Giza 132 after infestation** **21 = Giza 133 before infestation**
22= Giza 133 after infestation **23 = Giza 2000 before infestation** **24= Giza 2000 after infestation**
25= Giza 134 before infestation **26= Giza 134 after infestation** **27 = Giza 135 before infestation**
28= Giza 135 after infestation **29 = Giza 136 before infestation** **30= Giza 136 after infestation**

Data show the clear identification between the seed before infestation and after infestation, which indicates that there were two common bands (monomorphic) whereas other eleven bands wee polymorphic. Data show that there were three specific band with molecular size (140 KDa), (100 KDa) and (70 KDa) found for the naked barley cultivars, Giza 129,Giza 130, Giza 131, Giza 135 and Giza 136, these bands for all naked barley indicate that the naked barley cultivars were higher infested than covert barley. The naked barley had high number of bands ranged from thirteen bands found in Giza 135 to nine bands found in Giza 129 protein. Kasarda *et al* (1998) and Jaramillo *et al* (1999) reported that the SDS-PAGE was widely used to separate proteins related to genetic background and can be used to certify the genetics make –up of wild, cultivars, or newly derived cereal plants.

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الصفات الكيماوية والبيوكيماوية لبعض أصناف الشعير المصرية واستجابتها للإصابة بحشرة ثاقبة الحبوب الصغرى

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يعتبر محصول الشعير من المحاصيل الهامة التي تستخدم لغذاء الحيوان في مصر. يتعرض هذا المحصول أثناء التخزين للإصابة بعدة أنواع من حشرات المنتجات المخزونة ومنها ثاقبة الحبوب الصغرى وعادة ما تتم مكافحة هذه الحشرات بالمبيدات التي لها آثار سلبية على الغذاء والبيئة. لذلك اتجهت الأبحاث الحديثة إلى إيجاد وسائل بديلة منها استنباط وإنتاج أصناف نباتية أكثر تحملاً ومقاومة لهذه الحشرات. استهدفت هذه الدراسة تقييم بعض الصفات الكيماوية لحبوب خمسة عشرة صنفاً من الشعير المصري وعلاقتها باستجابة حشرة ثاقبة الحبوب الصغرى لإصابة هذه الأصناف. أظهرت النتائج أن أصناف جيزة ١٢٣ وجيزة ١٢٥ وجيزة ١٣٤ وجيزة ٢٠٠٠ كانت أقل الأصناف إصابة بالحشرة حيث سجلت أقل عدد من حشرات الذرية (٣٢ و ٣٩ و ٣٦ و ٥٦ حشرة على التوالي) وكذلك كانت نسبة الفقد في وزن الحبوب هي ٦.٣ و٥.٣ و٥.٣ و٦.٩ % على التوالي وأيضاً كانت نسبة الحبوب المصابة ٩.١ و٨.٥ و٦.٩ و١١.٦ % على التوالي ، بينما كانت أصناف جيزة ١٣١ وجيزة ١٣٥ وجيزة ١٣٦ أعلى الأصناف إصابة بالحشرة حيث سجلت أعلى عدد من حشرات الذرية (٢١٠ و ١٦٩ و ٢٠١ حشرة على التوالي) كما كانت نسبة الفقد في وزن الحبوب ٣٣.٣ و٢٣.٣ و٣١.٤ % على التوالي وأيضاً كانت نسبة الحبوب المصابة ٦٠.٧ و٤٧.٠ و٦٣.٦ % على التوالي. كما أظهرت نتائج التحليل الكيماوي أن الأصناف الأقل إصابة بالحشرة سجلت أقل نسبة في محتوى البروتين وأعلى نسبة في محتوى الفينول والألياف والرماد ، بينما سجلت الأصناف الأعلى إصابة بالحشرة أعلى نسبة في محتوى البروتين وأقل نسبة في محتوى الفينول والألياف والرماد. أوضحت نتائج التفريد الكهربائي أن عدد الحزم ثلاث عشرة حزمة وجد منها حزمتان عامة لكل الأصناف وأيضا إحدى عشر متعدد الحزم كما وجدت ثلاث حزم مميزة و خاصة بالأصناف العارية حيث أنها عالية الإصابة لاحتوائها على نسبة من البروتين أعلى من الموجودة فى الاصناف المغطاة. وبصفة عامة نستنتج من هذه الدراسة أن هناك ارتباط معنوي سالب بين نسبة الإصابة الحشرية وبين نسبة الألياف والفينولات والرماد ، كما يوجد ارتباطاً معنوياً موجباً بين نسبة الإصابة الحشرية وبين نسبة البروتين لهذه الأصناف. وبهذا يمكن التوصية بالانتخاب للأصناف المحتوية على نسب عالية من الألياف والفينولات والرماد في برامج التربية لمقاومة الحشرات وفي برامج المكافحة المتكاملة للآفات بدلاً من استخدام الكيماويات الضارة.