Argo-physiological evaluation and hot pepper and quinoa's saponin extract applications effects on some barley cultivars infestation by aphid insect

Abstract

Barley (*Hordeum vulgare* L.) is one of the most important food and feed crops in the world, which infested with several insect pests, the main economic pest is aphid which causes direct damage and indirect damage in barley production. The integrated pest management (IPM) programs are requirement to reduce aphids' damages, by using chemical substances extracts obtained from plants as an alternative to synthetic chemical control for its satisfactory effectiveness in pest control. The insecticidal effect of the aqueous extract of hot pepper and quinoa's saponin on aphids controlling were evaluated on ten Egyptian barley cultivars to determine their susptability and resistance to aphids' infestation through studying their agro-phycological behavior for aphids' infestation under Malawi station, during two growing seasons 2021/2022 and 2022/2023. The results showed that Giza 137 had the lowest percentage infestation of aphids was 29.638%/plant with lowest cultivar in Chlorophyll content (ChLa &Chl b) with values (4.17 and 1.65 µg ml^{-1}), with highest values for flavonoids and total phenolic with values were (2.37 and 79.82) and high grain yield was 19.17 ard fad^{1}. whereas Giza 136 was the highest cultivar that infested by high No. of aphids (33.167 insects/tiller) with highest percentage infestation with aphids which was 71.833%/plant, which displayed highest ChLa and ChL b with values (7.54 and 3.04 µg ml^{-1}), and had lowest values for flavonoids and total phenolic content with values (0.14 and 44.04). The low aphids' infestation cultivars under Malawi station were Giza 123, Giza 133, Giza 134 and Giza 130 which were (35.027, 39.111, 39.388 and 40.834%/plant according their physiological behavior after infestation. The Pearson correlation coefficients showed that high aphid insect infestation had high positive and significantly correlated with cha and ChL b, while had had high negative and significantly correlated with T-phenol and flavonoids The results showed that the first and second principal components PCA1= 63.00 % + PCA2 =15.3 % accounted 78.3% of the total changeability, which PCA2 clarified 15.3 % of the total variability influenced by T-phenol and flavonoids which placed in the left side (negative) of the horizontal axis according to its negative significant correlations with other characters. Treated barley plants by hot pepper and quinoa extract due to decreasing the aphid's infestation percentage on all cultivars after

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spray, the results showed that Giza 136 which was recorded the highest infested percentage 71.87 % was reduce to 35% after treated.

Keywords: ***Hordeum vulgar, aphids' infestation, agro-physiological behavior, hot pepper and quinoa extra application and IPM***

Introduction

Barley (*Hordeum vulgare* L.) is one of the most important food and feed crops in the world. In recent years, barley was employed as a staple diet. In addition, its ability to resist adverse environmental conditions such as drought stress, salinity, and poor fertility, etc. **[1]**.

In Egypt, barley is importance crop which it grown in area is not feasible for other strategic crops such as wheat and get high yield since its tolerance for a biotic such as drought, salinity and poor soil fertility **[2],** along with its resistance to biotic stress **[3, 4]** also using in making bread by mixing their flour with wheat flour which the produced bread had good morphology and nutritional quality, **[5].**

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Barley as the other cereal crops is infested with several insect pests, the main economic pest is aphid. Aphid causes direct damage (sieve drain and plant reaction) and indirect damage (often the most important, due to virus transmission) **[6]**. Cereal crops are hosts for many aphid species, which are important pests like *Sitobion avenae*, *Rhopalosiphum padi*, *Schizaphis graminum*, *Metopolophium dirhodum* and others **[7]**.

These aphids are accountable for transmitting *Barley/Cereal yellow dwarf virus* (B/CYDV) one of the most important cereal viruses in the world **[7]**. Four species of aphids infest barley in Egypt, Rhopalosiphum padi L. (bird cherry oat aphid), Schizaphis graminurn Rond. (greenbug), Rhopalosiphum maidis Fitch (Corn leaf aphid) and Sitobium avenae F. (Engishgrain aphid) **[8]**. In Egypt the most economic of them is Rhopalosiphum maidis Fitch (Corn leaf aphid) **[9]**.

On the other hand, **[10]** reported that aphids have fast multiplication rate and have potential to affect crop development within few days, and the yield losses can be up to 7.9 to 34.2%.

The integrated pest management (IPM) programs is requirement to reduce aphids damages, So chemical control was applied with recommended rates which based on a population density threshold **[11]**. Synthetic chemical control causes a lot of problems for human and environment. These products can promote the emergence of new resistant populations, cause mortality of natural enemies present in the environment, the intoxication of the surrounding fauna, and pollution of water bodies **[12]**. As an alternative to synthetic chemical control, research related to the use of extracts and substances obtained from plants has demonstrated satisfactory effectiveness in pest control. (**[13,12,14,3, 2]**.

The efficiency of the aqueous extract of the fruits of chili pepper Capsicum frutescens (Solanaceae) was recorded in the management of the pink hibiscus mealybug by **[15].** The treatments consisted of five extract concentrations: 0.0, 2.5, 5.0, 7.5, and 10% (weight/volume). The mortality of mealybugs increased with the increase in extract concentrations, with mortalities greater than 70% from the lowest concentration. Also, hot pepper and lemon grass extracts were highly effective in controlling aphids, thrips, and other sucking insects. These extracts have properties that disrupt the pests' feeding behavior and damage their digestive systems, making them an excellent natural deterrent **[16]**. However, Saponins were characterized by a bitter taste and were considered toxic in high concentrations. They were present throughout the quinoa plant **[17]**. Saponins exhibit several physicochemical and biological properties **[18]**. These include antioxidant, analgesic, immunostimulant, antimicrobial, antiviral, and cytotoxic activities, and anti-inflammatory and hemolyticeects. **[19] and [20]. Woldemichael and Wink**

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[21] reported the antifungal activity of a crude saponin extract from C. quinoa. The extract inhibited the growth of C. albicans at the concentration of 50 ug/mL.

Thus, this work aimed to determine the ability of various barley varieties for the infestation with aphids spp. And to evaluate the insecticidal effect of the aqueous extract of hot pepper and quinoa'saponin on aphids controlling.

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2- Materials and Methods

2-1 Barley cultivars and Field Experimental design

Ten Egyptian barley were used in this study; their names, types, pedigree, years of released and reference were shown in (Table1). Barley cultivars were kindly provided by Malawi Agriculture Research Station Dep., Field Crops Research Institute, and Agricultural Research Center, Egypt.

The cultivars were grown at Malawi station, locating in Minya governorate with Latitude: 27° 43' 53.04" N Longitude: 30° 50' 29.94" E during two growing seasons 2021/2022 and 2022/2023.

The ten genotypes were planted in a randomized complete block design (RCBD) with three replicates each plot consisted of a cultivar, which were planted in plots of six rows m long and 20 cm apart (plot area =3.6 m^2) to evaluated the effect of aphid insects on the agronomical traits of the ten barley.

Table 1: Name, type, row and pedigree of ten barley genotypes used in this study

No.	Name	Pedigree
1	**Giza 123**	Giza 117/FAO 86
2	**Giza 130**	Comp.cross"229//Bco.Mr./DZ02391/3/Deir Alla 106
3	**Giza 131**	CM67B/CENTENO//CAMB/3/ROW906.73/4/GLORIABAR/ COME-B/5/FALCON BAR/6/LINO
4	**Giza 132**	Rihane-05//AS 46/Aths*2Athe/ Lignee 686
5	**Giza 133**	ICB91-0343-0AP-0AP-0AP-281AP-0AP
6	**Giza 134**	ICB91-0343-0AP-0AP-0AP-289AP-0AP
7	**Giza 135**	ZARZA/BERMEJO/4/DS4931//GLORIABAR/COPAL/3/SEN/5/AYAROS
8	**Giza 136**	Plaisant/7/Cln-B/Ligee640/3/S.P-B//Gloriaar/ Come B/5/Falconbar/6/Linocln-B/A/S.P/Lignee640/3/S.P-B//Gloria-Bar/Come B/5/Falconbar/6/Lino
9	**Giza 137**	Giza 118 /4/Rhn-03/3/Mr25-//Att//Mari/Aths*3-02
10	**Giza 138**	Acsad1164/3/Mari/Aths*2//M-Att-73-337-1/5/Aths/ lignee686 /3/Deir Alla 106//Sv.Asa/ Attiki /4/Cen/Bglo."S")

2-2 Agro- meteorological data

The average month maximum and minimum temperatures (C°) and relative humidity (RH.,%), were recorded for weather station belonging to Mallawi Station, Egypt during two growing winter seasons 2021/2022 and 2022/2023 were shown in (Table 2)

Season	Month	Medium temperature			Relative humidity,
		Max.	Min	Mean	RH %
Season 2021/2022	Dec.	20.7	9.15	14.93	64.83
	Jan.	18.7	6.13	12.42	64.83
	Feb.	22.7	9.82	16.26	61.81
	Marc.	28.7	14.2	**21.45**	61.19
	Apr.	32.53	17.1	24.82	53.46
	seasonal	**24.6**	**11.8**	**17.9**	**61.2**
Season 2022/2023	Dec.	25	14	19.5	54.56
	Jan.	24.5	12.5	18.5	54.54
	Feb.	23.5	9.71	16.61	54.2
	Marc.	29.3	13.9	**21.6**	52.35
	Apr.	31	14.6	22.8	45.51
	Seasonal	**26.6**	**12.9**	**19.8**	**52.23**

2-3. Studied traits

2-3-1. Agro- phycological traits

At the heading stage, days to heading were recoded and ten plants from each plot were randomly taken to determine photosynthetic pigments assay Chlorophyll content a&b (Cha &b), leaf sample was extracted in N-N-dimethylformamid. The concentration of the different pigment was determined by using the spectrophotometric according to **[22]**, total phenolic content of leaves (mg/g dry weight) was carried out according to the method described by **[23]** and the total flavonoid content was determined using [**24**] method.

At the harvest stage ten guarded plants were randomly taken from each plot to measure plant height cm, spike length, 1000 grain weight and grain yield was determined using the full plot area (3.6 m^{-2}).

2-3-2. Insect infestation traits

The population density of the insect was calculated by taking five plants of each replicate and taking three tiller from them randomly and placed in nylon bags and brought to the laboratory, Insects were collected from plants with a soft brush and placed in glass dishes. They were examined under a binocular and the readings were recorded once a week from the beginning of the appearance of the aphids until their disappearance.

The percentage of aphid infestation on the barley crop in the field was calculated randomly by taking 60 plants per variety and 10 plants per replicate. Two samples were taken from the four corners of each replicate and its middle using a wooden square with a side length of 1 meter **[25]** according to the number of infected to determine the rate of infection according to the following equation:

$$\text{Infestation rate} = \frac{\text{The number of infested plants}}{\text{The number of total plants}} \times 100$$

After aphid infestation were recorded, barley plants were sprayed with mixture of (hot pepper extract at 10% and quinoa's saponin at 5%) two times at two week intervals.

2.4. Aqueous extract preparation:

2.4.1. Hot pepper extraction:

(*Capsicum annuum*): Hot pepper extraction was prepared according to the method described by **[16]** with some modification, 500gm of hot pepper was crushed with electric blender. The ground pepper powder was soaked in 1liter of distilled water and stirred with a magnetic stirrer for 15 minutes. The mixture was left overnight, then was filtered through

Whatman's filter paper NO.1.and was considered as stock solution. Stock solution was kept in refrigerator (5C°) for 15-30days.

2.4.2. Saponin extraction from quinoa seeds

(Chenopodium quinoa Willd.): Quinoa'saponin extraction was prepared according to the method described by **[26]** with some modification, 500gm of quinoa seeds were soaked in 1liter of distilled water for two hours. After the recommended time seeds were washed in this water till the foam of saponin appeared, then was filtered through Whatman's filter paper NO.1.and was considered as stock solution. Stock solution was kept in refrigerator (5C°) for 15-30days.

The population density and percentage of aphid infestation were recorded once a week at the last same methods.

2-4. Statistical analysis:

The results from the two seasons were homogeneity and statistically analyzed as the completely randomized design (RCBD) model using the SPSS software. There is no significant interaction was found between year and treatment, thus, results were pooled across years **[27]**. Fischer's protected least significant difference (LSD) at the 5% level of significance was used for treatment means. Pearson's correlation test was performed using the SPSS 22.0 version (SPPS Inc., Chicago, IL) to determine the relationship between every two studied traits. Principal Component Analysis (PCA) were performed using Minitab 18.1 statistical software (Minitab Inc., Coventry, UK) according to **[28]** To study the differences and interrelations between genotypes with respect to measured phenotypic traits and insect infestation**.**

3-1 Results and Discussion

3-1. **Analysis of variance and means performance of agro- physiological**

The combined analysis of variance was conducted for all Agro-physiological studied traits with homogeneous variance across the two seasons as shown in (Table 3). The results of variance of combined analysis showed

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significant and highly significant for all traits with high differences genetic variation among all ten studied Egyptians barley cultivars.

The results showed that all the Egyptian barley cultivars had highly significant genotypic differences for days to heading, which Giza 138 and Giza 137 were earlier cultivar with (79.67 and 81.0 days) respectively, with average 84.90 days as shown in (Table3). For plant height also both of the two Egyptian cultivars Giza 137 and Giza 138 showed highest cultivars among other cultivars with (103.3 and 101.67 cm). About the spike length and 1000 weight all the Egyptian barley cultivars highly significant genotypic differences with average 8.63 cm and 51.5 g respectively. For grain yield, Giza 137 got the maximum grain yield value was 19.17 ard Fad[1] while Giza 133 showed the minimum grain yield value was (15.28.) as showed in (Table3). The results were in agreements with **Mariey et al. [29]** which they recognized a high significant for the agronomical traits with high differences genetic variation under Malawi station which the results indicated that Egyptian barley cultivars had great potential to use in breeding programs for many and different environmental stresses.

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Concerning, the photosynthetic pigments (ChLa and ChLb contents) and flavonoids and total phenolic content, the results showed that all the Egyptian barley cultivars had highly significant genotypic differences for all the physiological traits, which the Egyptian cultivars Giza 136 showed the highest ChLa and ChLb with values (7.54 and 3.04 µg ml^{-1}), while showed the lowest values for flavonoids and total phenolic with values (0.14 and 44.04) respectively as shown in Table 3 . However, the Egyptian cultivars Giza 137 display the lowest cultivars in ChLa and ChLb with values (4.17 and 1.65 µg ml^{-1}), with highest values for flavonoids and total phenolic with values were (2.37 and 79.82) respectively. Photosynthetic pigments (ChLa and ChLb) are an important factor of

plant photosynthetic capacity, the results showed that Giza 137 had low Cha and ChLb. Similar results obtained with **Mariey et al. [29]**

Table 3. Mean values of agro-physiological studied characters (Combined data of two years)

Egyptian Cultivars	Heading Data days	Plant Hight cm	1000 weight (g)	Spike Length Cm	Grain Yield ard/F	Chl a µg ml-1	Chl b µg ml-1	Flavonoids	T-Phenolic
Giza 123	83.67	91.67	31.80	7.07	17.36	5.60	1.82	1.04	73.97
Giza 130	83.33	93.33	68.53	8.20	15.97	5.64	1.99	0.78	71.97
Giza 131	88.67	93.33	41.17	8.53	17.78	6.13	2.63	0.75	44.10
Giza 132	88.00	98.33	64.93	9.40	15.47	5.03	1.83	0.72	64.68
Giza 133	82.67	95.00	43.90	8.07	15.28	2.98	1.08	0.29	61.93
Giza 134	86.67	91.67	47.43	7.80	19.15	4.24	1.76	0.32	62.58
Giza 135	88.67	98.33	53.07	9.53	18.33	5.77	2.28	0.28	50.20
Giza 136	86.67	100.0	56.37	9.27	18.47	7.54	3.04	0.14	44.04
Giza 137	81.00	103.3	53.27	9.33	19.17	4.17	1.65	2.37	79.82
Giza 138	79.67	101.6	54.50	9.13	19.03	5.87	2.00	0.24	57.60
Mean	84.90	96.67	51.50	8.63	17.60	5.30	2.01	0.69	61.09
Ftest	*	*	**	**	**	*	*	*	*
LSD	1.27	13.29	4.07	0.68	0.60	0.21	0.65	0.07	1.96
Std. error	1.03	1.34	3.46	0.26	0.48	0.40	0.17	0.21	3.89
Stand. Dev	3.26	4.23	10.94	0.83	0.27	1.26	0.54	0.66	13.96
Stand. Dev	3.26	4.23	10.94	0.83	1.52	1.26	0.54	0.66	12.30
Coeff. Var	3.84	4.38	21.25	9.60	8.65	23.81	26.99	95.32	20.13

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3-2. Susceptibility of barley cultivars to aphid insect infestation analysis

Results in (Table 4) showed significant for population density of aphids/tiller for all tested barley cultivars with different percentages with high differences genetic variation among them. The results showed that the barley cultivars, Giza 137, Giza 123,Giza 133, Giza 134 and Giza 130 were lower cultivars that infested by aphid insect, which had least number of aphid insect were (9.78, 12.17, 13.69, 16.72 and 18.99 insects/tiller), respectivley.

The results showed that Giza 136 was the highest cultivar that infested by aphids (33.17 insects/tiller) followed by Giza 131, Giza 135, Giza 138 and Giza 132 which had the mean number of aphid insect were (27.97, 27.57, 23.22 and 22.01 insects/tiller), respectivley. As shown in Table 4

Table (4) Population density of aphids/tiller on barley plants for ten cultivars.

Genotypes	1st week	2nd week	3rd week	4th week	Average
Giza 123	8.444	2.667	21.333	16.222	12.167
Giza 130	17.889	19.500	13.556	25.000	18.986
Giza 131	22.331	28.778	38.332	22.444	27.971
Giza 132	14.000	14.500	41.333	18.222	22.014
Giza 133	14.667	12.333	11.667	16.111	13.694
Giza 134	6.000	28.222	17.000	18.667	16.722
Giza 135	55.332	16.722	20.778	17.444	27.569
Giza 136	83.111	12.889	20.778	15.889	33.167
Giza 137	10.889	6.778	19.666	1.778	9.777
Giza 138	40.333	15.444	15.444	21.667	23.222
Average	**27.300**	**15.783**	**21.989**	**17.344**	
F.Test	**	*	**	**	
LSD	19.100	5.500	15.340	5.040	
Std. error	0.877	6.633	7.676	6.710	
Stand. Dev	2.908	20.976	24.273	21.220	

About the percentage infestation of aphids on barley plants the results showed a significant differences in the percentage infestation of aphids on barley plants, as shown in (Table 5) Which he lowest percentage infestation of aphids was indicated in Giza 137 cultivar which was 29.64%/plant followed by Giza 123, Giza 133, Giza 134 and Giza 130 which were (35.03, 39.11, 39.39 and 40.83%/plant), respectively as showed in (Table 5 & Fig1) . However, Giza 136 was the highest cultivar in percentage infestation with aphids which was 71.83%/plant, followed by Giza 131, Giza 135, Giza 138 and Giza 132), which were (57.22, 53.33, 48.75 and 41.89 %/ plant), respectively. These results are in agreement with those **Bakroune et al. [30]** who reported that both wheat and barley were infected with two spices of aphids such as R. maidis and R. Padi with high values in January, February and March. Also, the results which obtained by **Atris [31]** indicated that barley was infected with many types of aphids. This infection was more server in barley than wheat and in the following types of corn tusk camel, American Badri, sugar, Giza Baladi and seventy. However, the mean total numbers of aphids/ tiller on barley variety Giza 125 were (5.52, 4.64 and 2.75, respectively) in the first

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season and (40.71, 23.46 and 13.68, respectively) in the second season **[9]**. On the other hand, these results are related to those results obtained by **Mariey et al. [32]** who found that the all of barley cultivars (Giza 123, Giza 125, Giza 134 and Giza 2000) were the lowest infested cultivars by R. dominica whereas, (Giza 131, Giza 135 and Giza 136) were the highest infested cultivars by this insect

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Table (5) Infestation percentage (%) of aphids on ten barley cultivars.

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Genotypes	1st week	2nd week	3rd week	4th week	Average
Giza 123	33.443	66.667	40.000	0.000	35.027
Giza 130	83.335	0.000	35.000	45.000	40.834
Giza 131	88.888	10.000	85.000	45.000	57.222
Giza 132	77.555	15.000	65.000	10.000	41.888
Giza 133	66.443	15.000	35.000	40.000	39.111
Giza 134	77.555	5.000	55.000	20.000	39.388
Giza 135	100.000	48.333	30.000	35.000	53.333
Giza 136	77.333	50.000	100.000	60.000	71.833
Giza 137	33.553	55.000	30.000	0.000	29.638
Giza 138	100.000	25.000	60.000	10.000	48.750
Average	**73.811**	**29.000**	**53.500**	**26.500**	
F. Test	**	*	***	**	
LSD 0.05	29.450	37.950	19.150	25.650	
Std. error	7.480	7.525	7.676	6.710	
Stand. Dev	23.654	23.795	24.273	21.220	

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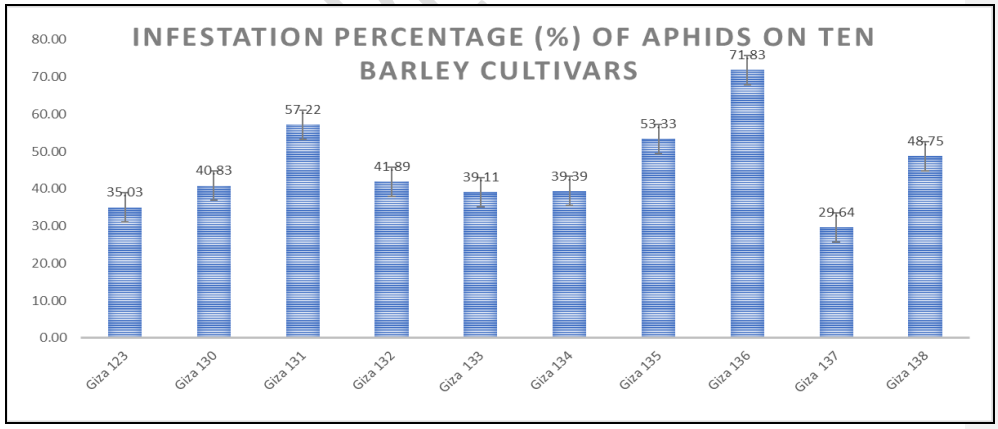

Fig 1. Infestation percentage % of aphids insect infestation on ten barley cultivars

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3-3. Relationships among barley cultivars based on studied Traits

In the direction of understanding the relationships among the agro-physiological studied and the aphids insect infestation on barley cultivars, both Pearson correlation coefficients and Principal component analysis (PCA) were analyzed.

3-3-1. Pearson Correlation coefficients

Pearson correlation coefficient among all studied phenotypic traits through the aphid insect infestation were done to understand the relationships among all studied traits, Data indicated clearly that the Pearson correlation coefficients showed that high aphid insect infestation had high positive and significantly correlated with cha and chb, while that had high negative and significantly correlated with T-phenol and flavonoids1 as shown in (Fig 2)

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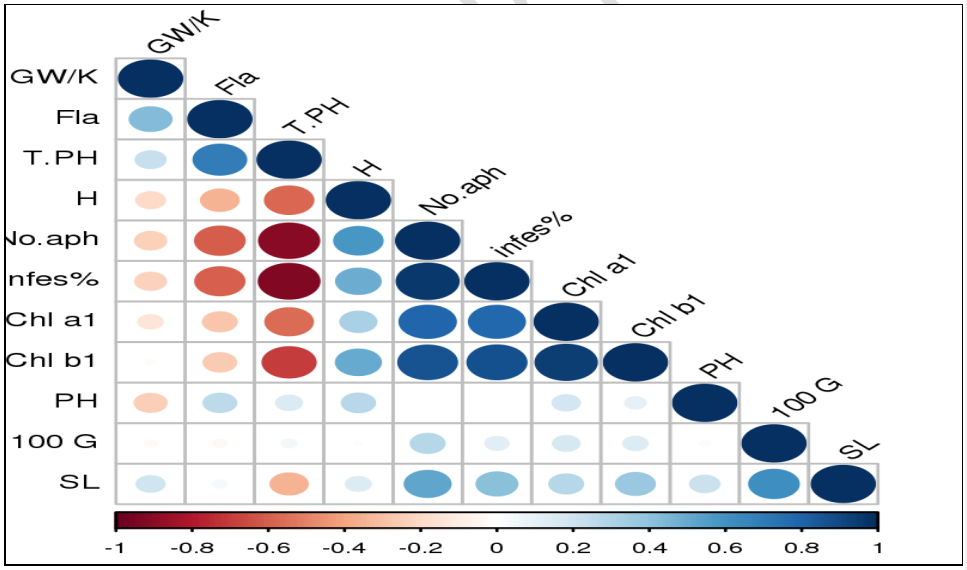

Figure (2). Pearson correlation coefficient heatmap between both of no. of aphid (No. aph) and aphid insect infestation (infes %) and chlorophyll a (cha), chlorophyll b (chb) , total phenolic(TPH) , flavonoids (FLA) , days of heading (HD) , plant height (PH) ,) and thousand kernel weight TKW and grain Yield (GY) . which red circle indicted negative correlation, blue circle indicted positive correlation, smaller circle indicted lesser significance; bigger circle indicted greater significance. The size of the circle is total to the correlation coefficients.

Principal component analysis (PCA)

Loading PCA, plot was achieved using distance matrix accessible in the horizontal axis designated the direction of relationship among all the nine Morpho-physiological and insect infestation studied characters was showing in (Figure 3). The results showed that the first and second principal components PCA1= 63.00 % + PCA2 =15.3 % accounted 78.3% of the total changeability. PCA1 illuminated 63 % of total variation unfair by HD, PH, cha , Chb , GY, No. of aph , infestion %, 1000 G/ W and SL characters were located in positive direction (right side) of the horizontal axis according to their positive significant correlations with other characters under study. The second PCA2 clarified 15.3 % of the total variability influenced by T-phenol and flavonoids which placed in the left side (negative) of the horizontal axis according to its negative significant correlations with other characters under this study. these results were in agreement with (**Naser *et al.*, 2018 [33], [5, 29]**) which They confirmed that using Correlation and PCA analysis were necessary to know the information about the relationship between different traits to get high yield in breeding programs

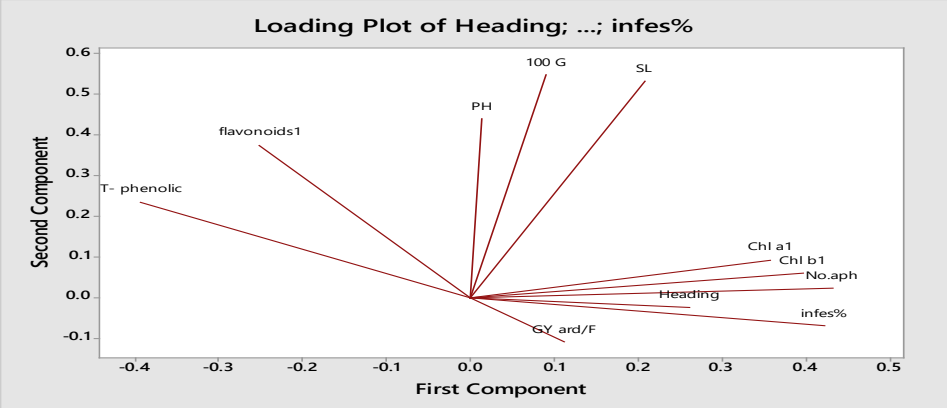

Figure (3). Loading plot graph, showing the first two principal components (PCA) of the correlation matrix among the studied characters which no. of aphid (No. aph) and aphid insect infestation (infes %) and chlorophyll a (cha), chlorophyll b (chb) , total phenolic(TPH) , flavonoids (FLA) , days of heading (HD) , plant height (PH) ,) and thousand kernel weight TKW and grain Yield (GY) .

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3.4. Effect of hot pepper and quinoa extract on aphid controlling:

Aphids' infestation percentage on treated barley plants of ten studied cultivars were recorded in Table (6 & Fig 4). The results showed that aphids infestation percentage on all cultivars were decreased with different percentage. The lowest infested percentage was indicated in Giza 123 which ranged from 29.638 % before spray to 5.0 % by highest reduction was (85.73%) also Giza 137 had lowest infested percentage which ranged from 29.638 % before spray to 5.0 % after spray by high reduction (83.13 %) . However, Giza 136 was recorded the highest infested percentage (66.67% - 35%) by lowest reduction was (51.28%)

Similarly, as shown in Table (7) number of aphids decreased in treated cultivars and the lowest number of aphids was found on Giza 137 (2.92 insect/tiller The highest number of aphids was showed on Giza 136 followed with Giza 131, respectively which had 11.86 and 10.39 insect/tiller, respectively.

These results are in agreement with those **Marchiori et al. [15]**, who invested that the aqueous extract of the fruits of chili pepper was used in the management of the pink hibiscus mealybug. The mortality of mealybugs increased with the increase in extract concentrations. The mortalities were greater than 70% from the lowest concentration. Also, hot pepper and lemon grass extracts were highl effective in controlling aphids, thrips, and other sucking insects. These extracts have properties that disrupt the pests' feeding behavior and damage their digestive systems, making them an excellent natural deterrent **[16]**. On the other hand **EL-Hazzam et al.** [17] reported that Saponins quinoa were characterized by a bitter taste and were considered toxic in high concentrations. Quinoa-derived extract had the highest toxicity (LC50 36.6 ppm) against *Aphis craccivora* adults indirect spray method than leaf dipping method (LC50 34.6 ppm), accompanied by (LC50 35.2 ppm) against nymph indirect spray method than (LC50 32.2 ppm) in

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leaf dipping method. The maximum mortality was obtained after 72 hours of exposure to the saponin extract at a concentration of 66 ppm in the leaf dipping process, causing 76 ± 0.2% and 72±0.2% for nymphs and adults respectively. However, the maximum mortality was recorded after 72 hours at a concentration of 66 ppm in the saponin extract, resulting in 88 ± 0.2% and 88 ± 0.2% for nymphs and adults, respectively **[34].**

Table (6) Efficacy of hot pepper and quinoa extract on infestation percentage (%) of aphids in ten barley cultivars.

Barley Cultivars	Before Spray	1st spray		Second spray	Average
		1 st week	2nd week	3rd week	
Giza 123	35.027	0.00	15.00	0.00	5.00
Giza 130	40.834	0.00	25.00	15.00	13.33
Giza 131	57.222	20.00	40.00	5.00	21.67
Giza 132	41.888	20.00	25.00	5.00	16.67
Giza 133	39.111	0.00	20.00	0.00	6.67
Giza 134	39.388	20.00	10.00	0.00	10.00
Giza 135	53.333	45.00	15.00	0.00	20.00
Giza 136	71.833	25.00	45.00	35.00	35.00
Giza 137	29.638	0.00	15.00	0.00	5.00
Giza 138	48.750	25.00	10.00	15.00	16.67
Ftest	**	**	**	**	**
LSD	**73.811**	**2.72**	**4.95**	**5.7**	**1.92**
Std. error	29.450	**4.798727**	**3.815174**	**3.593976**	**2.929248**
Stand. Dev	7.480	**15.17491**	**12.06464**	**11.36515**	**9.263096**

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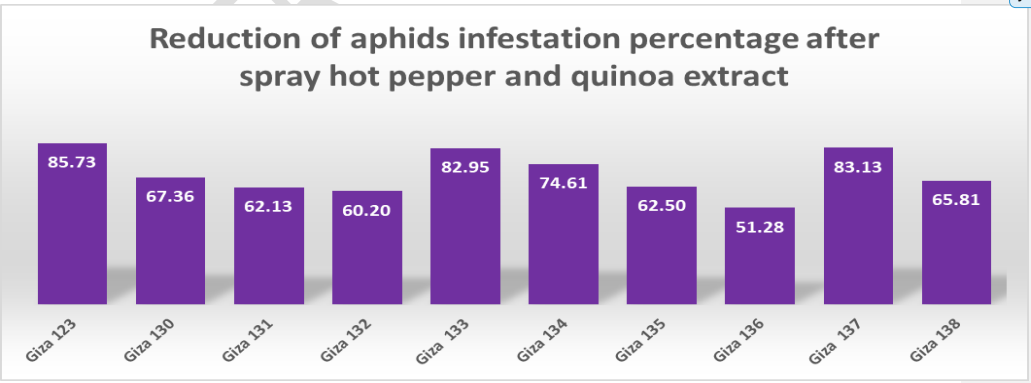

Fig 4: effect of hot pepper and quinoa extract on infestation percentage (%) of aphids in ten barley cultivars.

Table (7) Efficacy of hot pepper and quinoa extract on population density of aphids/tiller in barley plants for ten cultivars.

Barley Cultivars	Before Spray	1st spray		2nd spray	Average
		1 st week	2nd week	3rd week	
Giza 123	8.444	3.92	3.00	2.67	3.20
Giza 130	17.889	5.50	9.67	1.33	5.50
Giza 131	22.331	9.83	13.83	7.50	10.39
Giza 132	14.000	12.92	6.33	1.50	6.92
Giza 133	14.667	3.33	5.67	1.00	3.33
Giza 134	6.000	5.00	9.17	0.83	5.00
Giza 135	55.332	13.50	8.00	3.33	8.28
Giza 136	83.111	12.42	13.33	9.83	11.86
Giza 137	10.889	2.92	4.83	1.00	2.92
Giza 138	40.333	6.67	9.67	5.67	7.33
F.Test	**27.300**	**	**	**	**
LSD	**	**1.05**	**7.22**	**9.63**	**9.01**
Std. error	19.100	**1.320902**	**1.112486**	**0.99901**	**0.971216**
Stand. Dev	0.877	**4.177058**	**3.517989**	**3.159146**	**3.071254**

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For the effect hot pepper and quinoa extract on barley yield productively the results in Fig 5, showed that after spray hot pepper and quinoa extract on aphid controlling had a significant increasing grain yield of the ten barley cultivars as a result of effecting of spray hot pepper and quinoa extract on reducing aphids' infestation percentage and their number as showed in Table (6&7). The highest increasing in grain yield after spray was 3.72% as shown in Fig 5 found in Giza 133 which was 15.28 ard/fad before spray become 15.87 ard/fad after spray, followed by Giza 132 showing high increasing by 3.31% which gave 15.47 ard/fad before spray and gave 16.0 ard/fad after spray by hot pepper and quinoa extract. The lowest increasing were found in Giza 131 by 1.22% as a resulting of grain yield was ranged from 17.68 to 18.0 ard/fad before and after spray by hot pepper and quinoa extract respectively, followed by Giza 130 showing low increasing by 1.54 % which gave (15.47 and 16.22 ard/fad) before and after spray by hot pepper and quinoa extract respectively as shown in Fig 5.

For Giza 123 the resulting showing increasing in their grain yield by 2.96% which gave (17.36 and 17.89 ard/fad) before and after spray by hot pepper and quinoa extract respectively as shown in Fig 5, which showed highest reduction of infested percentage was (85.73%) as showing in Fig 4.

In contrary, Giza 137 had the same results which had increasing in their grain yield by 1.99 % which gave (19.17 and 19.56 ard/fad) before and after spray by hot pepper and quinoa extract respectively as shown in Fig 5 , which showing the highest grain yield among all the ten cultivar after spray as a resulting for using hot pepper and quinoa extract to reduce the aphids' infestation percentage and their number as showing in (Fig 4 & table 7).

Comparable, Giza 137 had the same results which had increasing in their grain yield by 1.99 % which gave (19.17 and 19.56 ard/fad) before and after spray by hot pepper and quinoa extract respectively as shown in Fig 5 , which showing the highest grain yield among all the ten cultivar after spray as a resulting for using hot pepper and quinoa extract to reduce the aphids' infestation percentage and their number as showing in (Fig 4 & Table 7).

Analogous, Giza 138 had increasing in their grain yield by 2.71 % (Fig 5) which gave (19.03 and 19.56 ard/fad) before and after spray by hot pepper and quinoa extract respectively as shown in Fig 5 , which display also highest grain yield (19,56 ard/fad) among all ten cultivar after spray as a resulting for using hot pepper and quinoa extract to reduce the aphids' infestation percentage and their number as showing in (Fig 4 & Table 7).

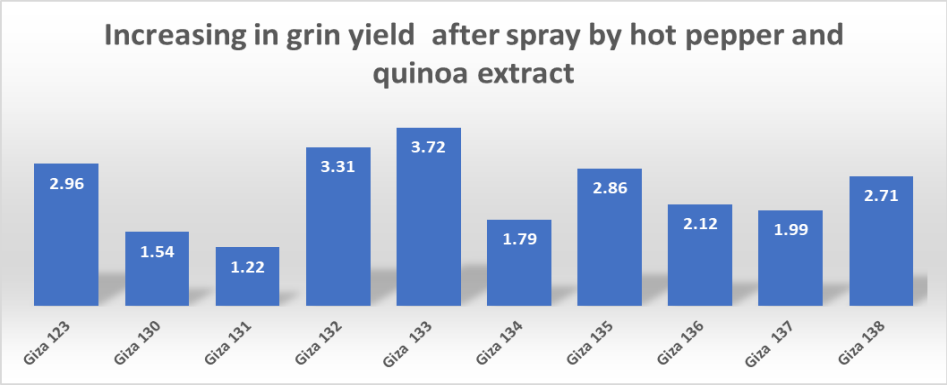

Fig 5: effect hot pepper and quinoa extract on barley yield productively after spray hot pepper and quinoa extract on aphid controlling

Conclusion:

Susceptibility of some Egyptian barley cultivars for aphid infestation are significant different percentages with high differences genetic variation among them. High aphid insect infestation had high positive and significantly correlated with cha and chb, while that had high negative and significantly correlated with T-phenol and flavonoids. Treated barley plants by hot pepper and quinoa extract due to decreasing the aphids infestation percentage on all cultivars after spray, which due to the insecticidal effect of hot pepper and quinoa's saponin aqua extract.

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