Resistance Induction in some tomato cultivars against Whiteflies *Bemisia tabaci* (Gennadius) by applying of salicylic acid

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Abstract

A field study was conducted to know the effect of salicylic acid spraying and different cultivars of tomato plants infested with the whitefly Bemisia tabaci Gennadius in one of the greenhouses at the research station of the College of Agriculture, University of Basra for the agricultural season 2019-2020. And that by spraying three cultivars of tomato plants Wijdan, Randy and Newton with four concentrations of salicylic acid 0, 0.5, 0.75 and 1 mmol, and two sprays,The first spray was applied to the field experiment plants after 60 days of sowing the seeds on 24/11/2019, while the second spray was carried out 21 days after the first spray.The studied cultivars differed in the characteristics of biochemical resistance and the percentages of containing the metabolic compounds, and through the study of the correlation it was possible to evaluate the occurrence of the induction in the resistance of the plant cultivar by the effect of spraying with salicylic acid by studying the relationship between increasing or decreasing the concentrations of salicylic acid and its relationship to reducing the population density of the insect.A negative correlation was found between the content of the leaves of carbohydrates, proteins, and phenols and the intensity of the insect roles in the vegetative growth stage.The tomato cultivars have a clear effect on the resistance of the whitefly during the vegetative growth period, where it was found that the two cultivars Wejdan (resistance to laying eggs) and Newton (resistance to nymphs), which contains the highest content of chlorophyll and phenol,They are the two cultivars that are resistance to laying eggs and the development of nymphs, which is represented by the low density of eggs laid on the leaves of those plants, the population density of nymphs, while the variety Randy, in which the content of carbohydrates and proteins increases, was found from the cultivars resistance to insects, which decreased the population density of the adult.It is possible to conclude from this study the important role of salicylic acid in inducing resistance against whitefly infection during the vegetative growth period.As spraying the tomato crop with a concentration of salicylic acid 0.75 mmol achieved the best increase in the chemical compounds in the treated plant in general, which have a role in inducing systemic resistance in the plant to prevent egg laying and reduce the population density of nymphs.The tomato cultivars have a clear effect on the resistance of the whitefly during the vegetative growth period, where it was found that the two cultivars Wejdan (resistance to laying eggs) and Newton (resistance to nymphs), which contains the highest content of chlorophyll and phenol,They are the two cultivars that are resistance to laying eggs and the development of nymphs, which is represented by the low density of eggs laid on the leaves of those plants, the population density of nymphs, while the variety Randy, in which the content of carbohydrates and proteins increases, was found from the cultivars resistance to insects, which decreased the population density of the adult.It is possible to conclude from this study the important role of salicylic acid in inducing resistance against whitefly infection during the vegetative growth period. As spraying the tomato crop with a concentration of salicylic acid 0.75 mmol achieved the best increase in the chemical compounds in the treated plant in general, which have a role in inducing systemic resistance in the plant to prevent egg laying and reduce the population density of nymphs.

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استحثاث المقاومة الجهازية لبعض اصناف الطماطة ضد الإصابة بحشرة الذبابة البيضاء (***Bemisia tabaci*** **(Gennadius** باستخدام حامض السالسلك

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الخلاصة

اجريت دراسة حقلية لمعرفة تأثير رش حامض السالسلك واختلاف اصناف نباتات الطماطة للإصابة بحشرة الذبابة البيضاء *Bemisia tabaci* Gennadius في احدى البيوت البلاستيكية في محطة البحوث التابعة الى كلية الزراعة جامعه البصرة للموسم الزراعي 2019-2020. وذلك برش ثلاث اصناف لنباتات الطماطة وجدان ، راندي ونيوتن بأربعة تراكيز من حامض السالسلك 0 ،0.5 ،0.75 و1 ملي مول، وبواقع رشتين، اذ طبقت الرشة الاولى على نباتات التجربة الحقلية بعد 60 يوم من الزراعة البذور بتاريخ 24\11\2019، اما الرشة الثانية فنفذت بعد مرور 21 يوم من الرشة الاولى.

قد تمايزت الاصناف المدروسة في صفات المقاومة البيوكيماوية ونسب احتوائها على المركبات الايضية، ومن خلال دراسة الأرتباط مكن تقييم حدوث الاستحثاث في مقاومة الصنف النباتي بتأثير الرش بحامض السالسلك عن طريق دراسة العلاقة بين زيادة او خفض تراكيز حامض السالسلك وعلاقتة بخفض الكثافة السكانية للحشرة.اذ وجدت علاقة ارتباط سالبة بين محتوى الاوراق من الكربوهيدرات والبروتينات والفينولات وكثافة ادوار الحشرة في مرحلة النمو الخضري،اذ سجل الصنف وجدان باحتوائه على اعلى مستويات من بعض المركبات الايضية المقاومة للحشرة.

ان لأصناف الطماطة تأثير واضح في مقاومة حشرة الذبابة البيضاء خلال فترة النمو الخضري، اذ وجد ان الصنفان وجدان (مقاوم لوضع البيض) و نيوتن (مقاوم للحوريات) والذي يحتوى على اعلى محتوى من الكلوروفيل والفينول ، هما الصنفان المقاومان لوضع البيض وتطور الحوريات ، والمتمثل بقلة الكثافة العددية للبيض الموضوع على اوراق تلك النباتات الكثافة السكانية للحوريات ، في حين وجد الصنف راندي الذي تزداد فيه محتوى الكاربوهيدرات والبروتينات من الاصناف المقاومة لبالغات الحشرة، والذي انخفضت علية الكثافة السكانية للبالغة .

ممكن الاستنتاج من هذه الدراسة الدور الهام لحامض السالسلك في استحثاث المقاومة ضد الاصابة بحشرة الذبابة البيضاء خلال فترة النمو الخضري ، اذ ان رش محصول الطماطة بالتركيز حامض السالسلك 0.75 ملي مول قد حقق افضل زيادة في المركبات الكيميائية في النبات المعاملة بصورة عامة ، والتي لها دورا في استحثاث المقاومة الجهازية في النبات لمنع وضع البيض و خفض الكثافة السكانية للحوريات.

Introduction:

The *Lycopersicon esculentum Mill* crop is considered one of the strategic crops in Basra province, where the area planted with this crop reached 8850.0 kg / dunum, with a production average of 239808 tons in the agricultural season 2018/2019, (8) and the crop is affected by many agricultural pests, the most important of which is the whitefly Bemisia tabaci (Aleyrodidae (Hemiptera (5)), which was characterized by characteristics and capabilities that made it a major pest on many crops, especially those grown in greenhouses such as tomato and cucumbers, through direct or indirect damage caused to the crop, as feeding the insect causes a decrease in the growth average and early leaf fall (9).The different roles of the insect, except for the eggs and the role of the virgin, feed on the plant juice in the bark of infected plants, and absorb a large amount of carbohydrate, which are disposed of in the form of a honeycomb that is secreted on the upper surface of the affected plant parts, Which is a suitable environment for the growth of fungi that impede the process of breathing and

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photosynthesis, thus decreasing the quality of crops and decreasing their marketing value.As well as the occurrence of spotting and discoloration of leaves as a result of feeding by the insect, which leads to a reduction in the production of infected crops (31,28). Several chemical pesticides have proven effective in resistance ling whitefly on tomato, including: Abamectin, Polo500SC, Confidor200SL, Endosulfan35EC, Pyriproxyfenf, Buprofezen, Pymetrozine, Imidacloprid and Diafenthiuron ((51,36,29,27).. However, the use of these chemical pesticides had negative side effects in many environmental aspects of water, soil, and air, where the pesticides affect non-target organisms in the soil (18).In view of the negative effects of the use of insecticides in combating the whitefly and the economic losses this insect causes on the farmed tomato plants in tunnels and greenhouses, represented by its ability to transmit the TYLCV virus, and for the purpose of reducing infection with this virus inside these greenhouses, Many non-chemical methods of resistance were used as part of the integrated pest management programs, such as the use of resistance plant cultivars, which gave protection to the plant from infection with the virus in addition to delaying the onset of symptoms (5).The method of inducing plant resistance is one of the most important methods of agricultural pest resistance , which occurs either naturally when plants are infected with plant pathogens or attacked by insect pests, or by using chemical stimuli such as spraying with salicylic acid or jasmonic acid (52).There are many studies that confirm that treating plants with these hormones by an exogenous application, such as spraying on the vegetative total of plants, may provide some defensive features for treated plants, which contributes to inducing resistance against insect pests (56), as it was found that spraying a plant Cotton after 21 days of cultivation with salicylic acid at a concentration of 0.02%,It led to a reduction in the number of Bemisia tabaci by 1,422 whiteflies/leaf compared with the resistance treatment, which numbered 11,244 insects/leaf (10), so this study was conducted to show the effect of resistance of tomato cultivars and the role of salicylic acid in inducing resistance against whitefly infection.

Materials and methods:

The cultivars of tomato and concentrations of salicylic acid used in the experiment:

To study the resistance of plant cultivars against whitefly, the following cultivars of tomato were used:

Table (1) of the tomato plant cultivars used in the study

Cultivars name	Producing company	importing company
Randy	**Huizer germany**	**Alard**
Newton	**Switzerland SG**	**Alawrad**
Wijdan	**Siimnis**	**Alard**

Salicylic acid concentrations were prepared 0, 0.75 and 1 mmol, and in two sprays, where the first spray was applied to the field experiment plants after 60 days of sowing the seeds on 24/11/2019, while the second spray was conducted 21 days after the first spray on 15\ 12/2019 .

Experiment location

The experiment was conducted in one of the greenhouses in the research station of the College of Agriculture of Basra University - Iraq during the agricultural season 2019-2020, as the soil was prepared for cultivation after tillage and leveling and dividing it into five lines 50 m long, 40 cm wide, 20 cm high, and 100 cm

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between each line, it also left a distance of one meter on the sides and front of the house, and organic manure was used before planting operations. The seedlings were transferred to the greenhouse on October 29, 2019. The planting lines were divided into experimental units that were 2.5 m long, and a distance of one meter was left between each experimental unit and another without planting, and 12 seedlings were planted for each experimental unit with a distance of 40 cm Between one plant and another and on both sides of the line,All service operations were conducted for all treatments equally. The plants were watered as needed and the continuous fertilization program of urea and foliar fertilizers was followed by one spray every 10 days after 10 days of planting the seedlings.

Effect of salicylic acid on some biochemical traits of some tomato cultivars

The fourth leaf was taken from the upper part of the plant two days after the date of the second spray with salicylic acid. The samples were placed in paper bags.Written on it were the concentration information, the sector number, the experimental unit number, and the date of taking the sample. The samples were transferred to the Entomology Laboratory at the College of Agriculture for the purpose of conducting chemical analyzes. The total chlorophyll pigment in green leaves was estimated according to the method (25). The total soluble carbohydrate content of the leaves was also estimated using the phenol and Sulfuric acid center method (17).

As for proteins, the method of digestion of plant samples was followed as mentioned (15), and the total nitrogen in the digested paper samples was estimated using a steam distillation device (Kildal) based on the method (47).The free amino acids were estimated from leaf tissues using the standard leucine curve (58,50). As for phenols, they were estimated using FolinDenis reagent (57).

Study of the effect of salicylic acid on the population density of whitefly on some tomato cultivars:

The seasonal presence and numerical density of the whitefly was studied weekly on the cultivars Newton and Randy Wejdan, during the vegetative growth period, starting from the second week of December 11/12/2019 until the first week of February 1/2/2020, as samples were taken randomly By taking three plant leaves of three levels (upper, middle and lower) from one plant from each experimental unit for each treatment respectively,The leaves were kept in a plastic bag, on which the date of sampling and the cultivars was fixed, and then they were transferred to the Entomology Laboratory at the College of Agriculture, the University of Basra for the purpose of tests under a light microscope at a resolution of X^{10}The number density of nymphs and eggs was calculated in an area of square inches per leaf in the samples from each experimental unit for each treatment, and the population density of the whole whitefly was calculated in the field in the plastic house in the early morning around seven in the morning by turning the paper quietly and counting the number of adult insects on its lower surface (2) .

statistical analysis:

The randomized complete block design was used in the field experiment with five replications, while the completely randomized design was used to analyze the results of the laboratory study using the Genstat program, and the results were analyzed using ANOVA, and to compare the averages, the choice of the least significant difference was used. LSD - at 5% probability level (4).

Results and discussion:

Effect of salicylic acid on some biochemical characteristics of some tomato cultivars:

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The results showed the effect of spraying some cultivars of tomato with different concentrations of salicylic acid on the total chlorophyll pigment shown in Tables 1.As the amount of total chlorophyll in Newton cultivar increased by increasing the acid concentration to a concentration of 0.75 mmol, as the total chlorophyll recorded an average concentration of 5.80 mg/100 g fresh weight at a concentration of 0.0, and it increased to 7.19 mg/100 g fresh weight at a concentration of 0.75 mmol. While the percentage of total chlorophyll decreased in Randy variety after treatment with salicylic acid, it recorded a percentage of 7.17 when treating the resistance , and the percentage decreased to 5.69 mg / 100 g fresh weight at a concentration of 0.75 mmol of salicylic acid, and no change was recorded in the percentages of total chlorophyll in The cultivar Wejdan laboratories with different concentrations of salicylic acid.

Table (1) Average concentration of total chlorophyll in different cultivars of tomato treated with different concentrations of salicylic acid

Cultivars	Average total chlorophyll concentration (mg/100gm fresh weight ± SE)				Cultivars average
	Salicylic acid concentration				
	0.0	**0.5**	**0.75**	**1**	
Randy	±7.17 0.26	±6.21 0.35	5.69± 0.26	5.85± 0.06	6.23
Newton	±5.80 0.44	6.51± 0.14	7.19± 0.42	6.79± 0.12	6.58
Wijdan	6.56± 0.45	6.27± 0.03	6.80± 0.08	6.39± 0.37	6.50
concentration average	6.51	6.33	6.56	6.35	
LSD	NS				NS

As for the effect of salicylic acid concentrations in the carbohydrate of tomato cultivars , the results recorded in Table 2 that there were significant differences between the concentrations of the acid used, where the concentration of 0.75 mmol recorded the highest average in raising the carbohydrate content in the tested cultivars at a average of 51.14 mg/100 g dry weight, Compared to the other concentrations of 0.5 and 1 mmol, which recorded an increase in carbohydrate content as well, at an average of 45.37 and 45.19 mg/100 g dry weight, respectively, compared to the resistance treatment, which was 36.20 mg/100 g dry weight.The cultivar Randy showed the highest response to the concentrations of salicylic acid and the average carbohydrate content was 48.95 mg/100g dry weight, while the other cultivars did not differ among themselves in the carbohydrate content. It was also noted that the carbohydrate content differed between the cultivars according to the acid concentration, where the interaction between the cultivar and the treated concentration was significant, and it was found that the highest carbohydrate content was in the cultivar Randy treated with a concentration of 0.75 mmol at average of 61.54 mg/100 g dry weight, compared to the other treated concentrations. In the same cultivar and in the rest of the other cultivars, the Wejdan cultivar recorded the lowest carbohydrate content at concentration 0.50 and at an average of 40.08 mg/100 g dry weight, compared to the resistance treatments of 43.45, 31.96 and 33.18 mg/100 g dry weight in the cultivars Randy, Newton and Wejdan, respectively. .

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Table (2) Average carbohydrate content of different tomato cultivars treated with different concentrations of salicylic acid

Cultivars	Average carbohydrate content (mg/100g dry weight ± SE)				Cultivars average
	Salicylic acid concentration				
	0.0	**0.5**	**0.75**	**1**	
Randy	±43.45 2.18	±45.98 1.39	61.54 ±0.79	44.83 ±3.19	48.95
Newton	31.96 ±0.33	±50.04 2.39	42.76 ±3.11	44.14 3.41±	42.22
Wijdan	33.18± 1.80	40.08±4.63	49.12± 0.57	±46.59 2.45	42.24
concentration average	36.20	45.37	51.14	45.19	
LSD	4.23				3.67

As for the effect of salicylic acid concentrations in the proteins of tomato cultivars, the results of Table 3 showed that there were significant differences in the protein content as a result of treatment with different acid concentrations, where the concentration of 0.75 mmol recorded the highest average of increase in the protein content, with an average of 36.84%, compared to other concentrations of 0.5 and 1 mmol, which did not record an increase in the protein content of 32.66 and 31.66% compared to the resistance treatment, which amounted to 31.67%, while there were no significant differences in the levels of protein content between the tested tomato cultivars. The protein content of the cultivars differed according to the concentration of the acid. The interaction between the cultivar and the concentration of salicylic acid-treated had significant differences. It was found that the concentrations of the acid led to an increase in the protein content in the cultivar Randy from 31.72% in the resistance treatment to 40.25% in the leaves treated with the concentration. 1 mmol, While the highest increase in proteins was recorded by 37.33% in the Newton cultivar when treated with a concentration of 0.75 mmol, compared to the resistance treatment, which amounted to 29.46%. As for the cultivar Wijdan, the increase in the concentration of salicylic acid treated with leaves did not affect the protein content down to the concentration of 0.75 mmol, where the levels of proteins did not differ significantly between concentrations 0.0, 0.5 and 0.75 mmol, and their averages were 33.83, 35.14 and 37.54%, and then the level decreased Proteins when spraying with concentration 1 and at a average of 22.81%.

As for the effect of salicylic acid on free amino acids in some tomato cultivars, the results recorded in Table 4 that there were significant differences in the levels of amino acids in plants treated with the concentrations of the acid used, as concentrations of 0.75 and 1 mmol caused the highest average of increase in the content of free amino acids. Its average was 2.49 and 2.85 mg/100g compared with the concentration of 0.5 mmol, which did not record an increase in the content of free amino acids compared with the concentration of the resistance treatment of 2.25 mg/100g.The Newton cultivar showed the highest response to salicylic acid concentrations with an average free amino acid content of 2.60 mg/100gm, while the other cultivars did not differ among themselves in the free amino acid content. As for the effect of spraying salicylic acid on the phenol content of tomato cultivars

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treated with different concentrations, the results showed in Table 5 that there were significant differences in the phenol content between the cultivars. The other cultivars differ significantly among themselves in terms of their content of phenols, as the average phenols in the two cultivars, Randy and Newton reached 114.5 and 100.0 mg/100 g dry weight, respectively. No significant differences were recorded for salicylic acid concentrations and their interaction with tomato cultivars.

Table (3) Average protein content in different tomato cultivars treated with different concentrations of salicylic acid

Cultivars	Average protein content (percentage ± SE)				Cultivars average
	Salicylic acid concentration				
	0.0	**0.5**	**0.75**	**1**	
Randy	±31.72 1.49	28.64± 1.60	35.64± 1.99	±40.25 2.20	34.06
Newton	±29.46 0.77	±34.19 1.37	37.33 ±1.26	±31.91 1.28	33.22
Wijdan	33.83± 1.54	±35.14 1.13	37.54±1.31	22.81± 1.31	32.33
concentration average	31.67	32.66	36.84	31.66	
LSD	2.43				2.10

Table (4) Average content of amino acids in different tomato cultivars treated with different concentrations of salicylic acid

Cultivars	Total amino acids (mg/100g ± SE)				Cultivars average
	Salicylic acid concentration				
	0.0	**0.5**	**0.75**	**1**	
Randy	2.22 2.14±	2.21 2.13±	2.31 2.38±	3.02 2.67±	2.44
Newton	2.41 2.41±	2.34 2.34±	2.78 2.78±	2.86 2.86±	2.60
Wijdan	2.14 2.22±	2.13 2.21±	2.38 2.31±	2.67 3.02±	2.33
concentration average	2.25	2.23	2.49	2.85	
LSD	0.026				0.13

LSD value (at the 0.05 probability level) for the cultivars interaction *concentration = NS, SE (standard error)

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Table (5) Average content of phenols in different tomato cultivars treated with different concentrations of salicylic acid

Cultivars	Concentration average of phenols (mg/100g dry weight ± SE) Salicylic acid concentration				Cultivars average
	0.0	**0.5**	**0.75**	**1**	
Randy	88.6 ±3.17	118.0± 14.42	±127.4 16.59	±124.1 13.16	114.5
Newton	97.8± 10.31	98.9 5.39 ±	91.8 6.41 ±	±111.4 9.29	100.0
Wijdan	±122.4 2.15	131.2 16.35±	151.0± 10.17	±122.2 15.91	131.7
concentration average	102.9	116.0	123.4	119.5	
LSD	NS				16.63

Several studies have indicated the important role of salicylic acid in increasing the plant's chemical content, which has a role in increasing the plant's defenses against insect pests, as some studies have shown the effectiveness of salicylic acid in increasing the chlorophyll pigment.(7) indicated an increase in the concentration of chlorophyll in the bean plant as a result of spraying with salicylic acid, and (37) confirmed the increase in the concentration of chlorophyll in the cucumber plant after treatment with different concentrations of salicylic acid from 10 - 500 µm.As for the role of acid in influencing the carbohydrate content of plants, (6) indicated an increase in the amount of carbohydrate in the tomato plant after spraying it with salicylic acid (aspirin), as the concentration recorded 150 mg / L^{-1}, and the research results agree with (7) in Increasing the carbohydrate content of the bean plant. As for the role of salicylic acid in increasing the proportion of protein in the tomato plant, it showed 14,40) (that the prior spraying of tomato plants with salicylic acid has a significant role in increasing the proportion of protein in the plant.There was also a role for salicylic acid in increasing the proportion of amino acids in the tomato plant, as the concentration of 0.75 mmol recorded the highest average of increase of amino acids. Salicylic acid, as mentioned (23) that spraying salicylic acid on the leaves of basil plant at concentrations 10^{-3}, 10^{-4} and 10^{-5} mol, led to an increase in the level of total amino acids in the plant compared to the resistance sample. The increase of some important mineral elements in the plant may be due to the effective role of salicylic acid in improving the characteristics of the plant if an increase in the leaf area of the plant is recorded, which in turn contributes significantly to an increase in photosynthesis processes in the plant, which leads to an increase in chlorophyll, carbohydrate, acids and proteins (34).

Effect of plant cultivars and salicylic acid on whitefly resistance on tomato crop:

Effect of tomato cultivars on whitefly population density

The results of Figure (1) showed that there were significant differences in the densities of eggs on the studied cultivars during the vegetative growth period, and the most resistant cultivar to laying eggs was Wijdan, The lowest

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density of eggs was recorded at a average of 1.50 eggs/inch ^{2} compared to the cultivars Randy and Newton, and with a average of 1.83 eggs/inch^{2} for laid eggs, respectively.While Newton was the most resistant cultivar to nymphs during the vegetative growth period, it recorded the lowest density of nymphs at a average of 2.07 nymphs/ inch^{2} compared to the two cultivars Jedan and Randi at a average of 2.67 and 3.02 nymphs/ inch^{2} respectively. Figure (2).No significant differences were recorded between the cultivars Randy, Newton and Wejdan in reducing the number of adults during the vegetative growth stage (Fig. 3).

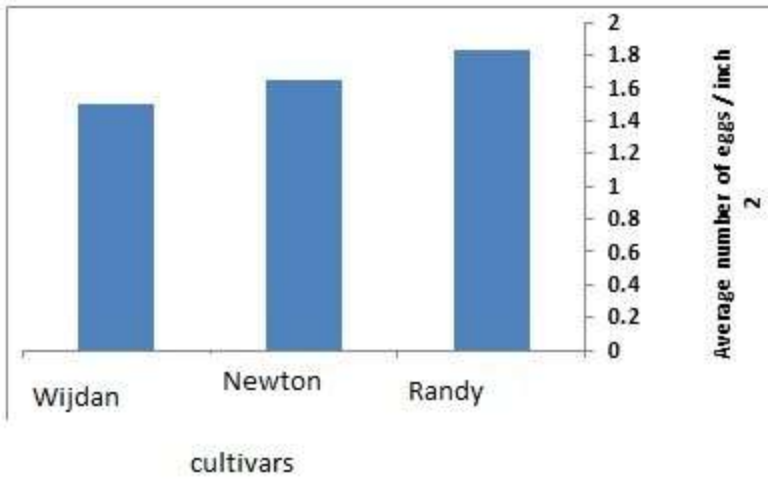

Figure (1) Effect of tomato cultivars on the number of eggs laid by whitefly females during the vegetative stage of plant growth, LSD value (at the 0.05 probability level) = 0.28.

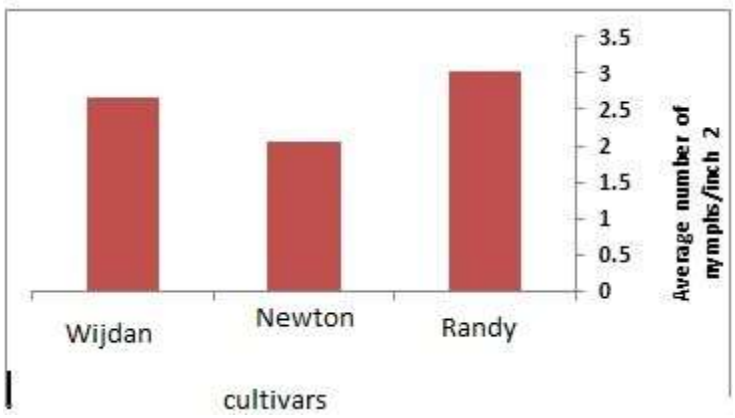

Figure (2) Effect of tomato cultivars on the number of whitefly nymphs during the vegetative growth stage, LSD value (at the probability level of 0.05) = 0.44.

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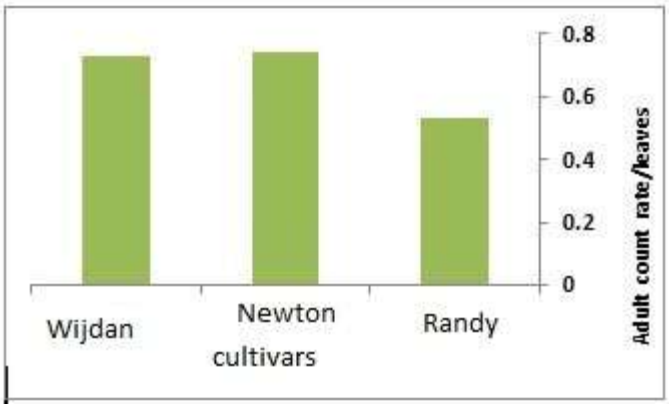

Figure (3) Effect of tomato cultivars on the number of whitefly adults during the vegetative stage of plant growth, LSD value (at the probability level of 0.05) = NS (not significant)

The resistance tomato cultivars have a clear role in influencing the life of the whitefly insect, where a difference was recorded in the cultivars ' resistance to the different roles of the whitefly, and the cultivar Wejdan was the most resistance cultivar to laying eggs, while the cultivar Newton was the most resistance cultivar represented by reducing the density of the number of nymphs in the growth stage. vegetative.Tomato cultivars differ according to the mechanism of plant cultivar to insects, as some cultivars recorded resistance through the mechanism of pests not favoring those cultivars, as LA716, PL134418 and LA444-1 were identified as resistance cultivars among the 17 tested cultivars due to the lack of preference by the whitefly. In contrast to the sensitive cultivars Santa Clara and nav1062, which were more preferred by the insect (46), as mentioned (33)The tomato cultivar Vybhav was superior to the rest of the cultivars in its resistance to the whitefly due to the insect's lack of preference for this cultivar, unlike the sensitive cultivars PTR6 and TR4, which were the most preferred cultivars. Also, some plant cultivars are classified as resistance cultivars based on the antibiosis characteristic of these cultivars, as some cultivars contain metabolic substances that affect the physiological activities of insects. It was found that the resistance tomato cultivars GS reduces the number of egg laying rates for the whitefly, unlike the cultivars (StrainB), which is one of the sensitive cultivars that recorded the highest average number of eggs on the plant 42)). Usually, resistant tomato cultivars affect the numerical density of the whitefly, as these densities increase on sensitive cultivars and density levels decrease when fed on resistance cultivars (59).The resistance tomato cultivars have a clear role in influencing the life of the whitefly insect, where a difference was recorded in the cultivars ' resistance to the different roles of the whitefly, and the cultivar Wejdan was the most resistance cultivar to laying eggs, while the cultivar Newton was the most resistance cultivar represented by reducing the density of the number of nymphs in the growth stage. vegetative.Tomato cultivars differ according to the mechanism of plant cultivar to insects, as some cultivars recorded resistance through the mechanism of pests not favoring those cultivars, as LA716, PL134418 and LA444-1 were identified as resistance cultivars among the 17 tested cultivars due to the lack of preference by the whitefly. In contrast to the sensitive cultivars Santa Clara and nav1062, which were more preferred by the insect (46), as mentioned (33)The tomato cultivar Vybhav was excelled on the rest of the cultivars in its resistance to the whitefly due to the insect's lack of preference for this cultivar, unlike the sensitive cultivars PTR6 and TR4, which were the most preferred cultivars.

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Also, some plant cultivars are classified as resistance cultivars based on the antibiosis characteristic of these cultivars, as some cultivars contain metabolic substances that affect the physiological activities of insects.It was found that the resistance tomato cultivars GS reduces the number of egg laying rates for the whitefly, unlike the cultivars (StrainB), which is one of the sensitive cultivars that recorded the highest average number of eggs on the plant 42)). Usually, resistant tomato cultivars affect the numerical density of the whitefly, as these densities increase on sensitive cultivars and density levels decrease when fed on resistance cultivars (59).The variation of tomato cultivars in their resistance to infection with the whitefly B.tabaci may be due to many characteristics of physiological and biochemical resistance , where the morphological characteristics of leaves represented by the length and thickness of the leaf plate, leaf color and the density of glandular hairs Trichomes have an important role in reducing the numbers of whiteflies (26).), as well as the variation of those hairs in their secretion of metabolic compounds, including sugar esters (45. As for the reasons for cultivar resistance , according to the mechanism of non-preference for cultivars by the white fly, it may be due to their high levels of (AS) (asylsugars), which have an insect repellent action (43,16). The characteristics of plant resistance are usually due to the possession of these cultivars by special genetic genes (44).

Effect of salicylic acid in inducing systemic resistance against whitefly on tomato:

The results of the study of the effect of salicylic acid concentrations on the whitefly population density indicated the effective role of salicylic acid in inhibiting the egg-laying process and reducing the population density of whitefly nymphs on the studied tomato cultivars during the vegetative growth period. The results of the study showed in Figure (4) that there are high differences Significant in the densities of eggs laid on the leaves as a result of spraying with different concentrations of salicylic acid, All concentrations excelled the resistance treatment, and the best effective concentration in inhibiting the egg laying process of whiteflies was at a concentration of 1 mmol at a average of 1.37 eggs/in2, compared with concentrations of 0.5 and 0.75 mmol at a average of 1.64 and 1.57 eggs/in2 respectively.As for the effect of acid concentrations on reducing the population density of nymphs, the results of the study in Figure 5 showed that there were significant differences in the density of nymphs as a result of spraying salicylic acid concentrations, as all concentrations also excelled the resistance treatment in reducing the number of nymphs. The population density of nymphs decreased from 3.56 nymphs/in2 in distilled water to 2.35, 1.90 and 2.53 when salicylic acid was sprayed with concentrations of 0.5, 0.75 and 1 mmol, respectively. No significant differences were recorded between the concentrations of salicylic acid used to reduce the population density of whitefly adults in the vegetative growth stage of the plant (Fig.6).

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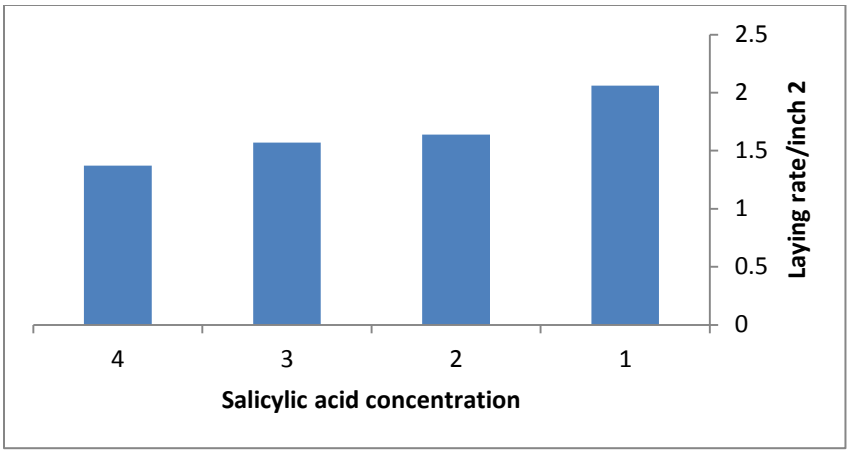

Figure (4) The effect of spraying with salicylic acid on the number of eggs laid by whitefly females during the vegetative growth stage, LSD value (at the probability level of 0.05) = 0.33.

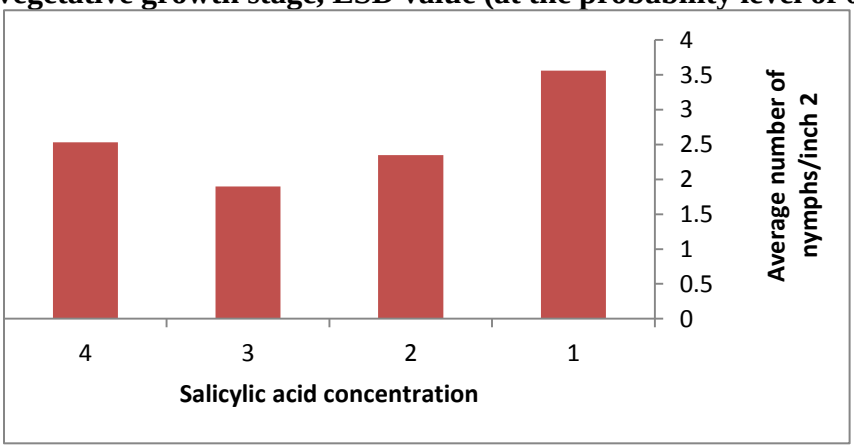

Figure (5) Effect of salicylic acid concentrations on the number density of whitefly nymphs in the vegetative growth stage, LSD value (at the probability level of 0.05) = 0.51

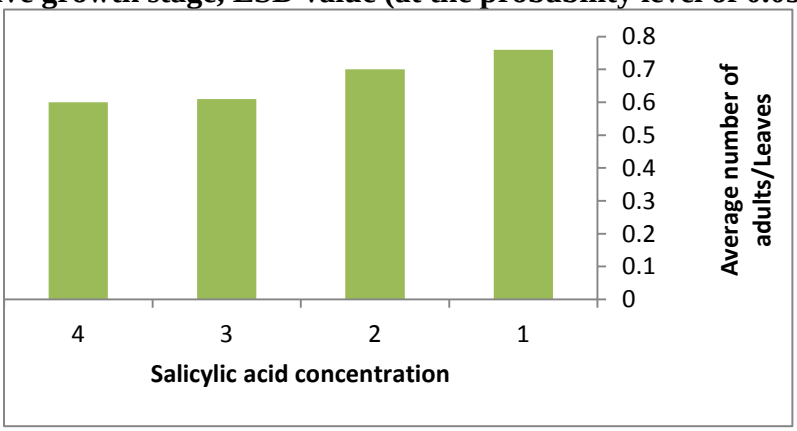

Figure (6) Effect of salicylic acid concentrations on the population density of whitefly adults in the vegetative growth stage. LSD value (at the probability level of 0.05) = NS (not significant).

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The presence of defensive metabolites stored in plants ineffectively, Inactive Forms may be induced as a result of infection with insect pests or pathogenic microbes (55), and these metabolites are plant hormones such as Salicylic acid, Jasmonic acid, and gibberellin, which have an important role in the resistance created in plants. (54,53,22).There are many studies that confirm that treating plants with these hormones in an exogenous application, such as spraying on the vegetative system of plants, may provide some defensive features in treated plants, which contributes to inducing resistance against insect pests (56).(52) indicated that the tomato plant treated with three concentrations of salicylic acid 0.01, 0.1 and 1 mmol had a role in releasing volatile substances Methyl salicylate and Limonene, which have an important role in reducing the fertility of the whitefly and the longevity of the insect, as well as reducing The insect's preference for the plant compared to the plants of the resistance treatment, and with the same resistance mechanism, salicylic acid was used against the whitefly insect on the plants of other crops.It was mentioned (10) that the application of salicylic acid to the cotton plant at a concentration of 0.02% significantly reduced the infestation of the whitefly insect compared to the resistance treatment. 0.1 mmol led to an increase in phenolic compounds and thus a decrease in the number of whiteflies, and the external application of salicylic acid also had an effective role in reducing the average number of aphids on wheat cultivars, as the concentration of 200 mg/L had the most effective effect (41).Salicylic acid also has a role in inducing resistance against other insect pests, as it was confirmed (30) that salicylic acid played a role in stimulating plant defenses, which in turn led to a decrease in the growth of tobacco worm larvae Tobacco hornworm and an increase in larvae dropping from infected tomato plants, which stimulated defense responses in Tomato plants by increasing H2O2 as it works to damage the alimentary canal and disrupt the absorption systems in the insect, which leads to the cessation of growth (48).

The role of the biochemical resistance factors of plant cultivars in the population density of the whitefly insect:

By studying the correlation between the concentrations of these compounds in plant cultivars and the insect population density on those cultivars, it is possible to know the role of these chemical compounds in the cultivars' resistance to that pest. A negative correlation was found between the total chlorophyll content of leaves in plant cultivars with the number density of eggs and nymphs (-0.77 and -0.89), respectively.While the relationship was positive with the numerical density of female adults (0.98). As for carbohydrates, a strong direct correlation was observed between the carbohydrate content of the leaves and the numerical density of eggs and nymphs (0.89 and 0.78),While the relationship was negative with adults (-0.99). Also, a direct relationship was found between the protein content of the plant leaves with eggs (0.99) and an inverse relationship with the population density of adults (-0.83). As for phenols, a negative correlation was found with eggs (-0.49) and a positive correlation with nymphs (0.58). Thus, the two cultivars Wejdan (resistance to laying eggs and adults) and Newton (resistance to nymphs), which contain the highest content of chlorophyll and phenol (Table 3 and 7), are the two cultivars that are resistance to laying eggs and the development of nymphs, by inhibiting or preventing the egg-laying process by females, represented by By decreasing the number density of eggs laid on the leaves of those plants, and decreasing the population density of nymphs (Fig. 1 and 2 (20,3)),While Randy cultivar, which had an increased content of Table 4 carbohydrates and Table 5 proteins, was one of the cultivars resistance to adults, which is nutritionally unsuitable for these insects (Fig. 3 (13.6).

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The role of the biochemical resistance factors of plant cultivars treated with salicylic acid in the population density of the whitefly insect:

Salicylic acid with its different concentrations has an effective role in increasing the plant's content of special chemicals, where the results of chemical analysis of the leaves of plant cultivars during the vegetative growth stage indicated a clear increase in chlorophyll, carbohydrates, proteins and phenols.

As for the role of these chemical compounds in resistance ling the whitefly, it was noted that this effect was observed on the intensity of the roles of the whitefly insect on the tomato crop in varying proportions according to the concentrations of salicylic acid used.

It is possible to assess the occurrence of the induction in plant variety resistance by studying the relationship between increasing or decreasing the concentrations of chemical compounds in the tomato plant when the concentration of salicylic acid is increased and its relationship to reducing the population density of the insect.The results showed the effect of spraying with salicylic acid on the correlation between the chemical content in some tomato cultivars and the numerical densities of the roles of the whitefly insect on the tomato crop during the vegetative growth period (Table 8), as the spraying with salicylic acid had the effect on influencing the relationship between chemical content and numerical densities. For the insect, a weak positive correlation was observed between the chlorophyll content of the leaves and the numerical densities of eggs and nymphs of adults 0.45, 0.07 and 0.07, respectively,While it was observed that there was an inverse relationship between the level of carbohydrates and the density of insect roles, meaning that the increase in carbohydrates led to a decrease in the density of the insect during the vegetative growth stage, where the correlation appeared negative and significant between the level of carbohydrates in the vegetative growth phase and each of the densities of the role of eggs (-0.77). and nymphs (-0.99) and the role of adults (- 0.82). It also found a weak inverse correlation between proteins and numerical densities (eggs and adults), with a correlation coefficient of (-0.22 and -0.46).Whereas, there was a strong inverse correlation between proteins and nymph densities (-0.72). As for phenols, the results show that there is an important role for phenols represented in reducing the numerical density of insect roles (eggs, nymphs and adults) on plants treated with salicylic acid. They were represented by (-0.89, -0.96 and -0.92), respectively, which means that the numerical densities decrease with increasing concentrations of salicylic acid used in the experiment.The results showed a strong direct relationship between free amino acids and the numerical densities of the insect roles (eggs, nymphs and adults) represented by a correlation coefficient of (0.91, 0.92 and 0.80). Based on the above results, the role of salicylic acid in inducing resistance against whitefly infection was shown.It was found that spraying the tomato crop with a concentration of salicylic acid 0.75 mmol achieved the best increase in chemical compounds in the treated plant in general (Table 4-7), which has a role in inducing systemic resistance in the plant to prevent egg-laying. And reducing the population density of nymphs and adults of the insect during the vegetative growth stage (Fig. 5-6), which is the sensitive stage for infection with viral diseases that may be transmitted to the crop as a result of infection with the whitefly insect despite its low numerical density during this stage of plant growth. Several studies indicated the effect of increasing or decreasing the levels of plant metabolic compounds in resisting insect pests, as it was shown (12,11) that plants containing different percentages of carbohydrates may lead to changes in the feeding efficiency of many insects, By affecting

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the activity of the enzyme amylase in the digestive system.The reason for the decrease of Sit Obion venae insects on the weeds belonging to the plant cultivars Cocksfoot is due to the high percentage of water soluble carbohydrates (Wscs) water soluble carbohydrates, as mentioned (55) n the increase in carbohydrates had an effective role in contributing to plant defenses against insects .While it was shown (49) that the increase in carbohydrates in rice plant after infection with insect pests led to a contribution to stimulating plant defenses against them as a means of resistance of the host plant against invading pests. Several studies indicated that the increase in phenols and their importance in resistance ling insect infestation, (19) indicated an increase in the concentration of phenols in tomato after exposure for 48 and 96 hours to the white fly, and this proves its defensive role to discourage and reduce the insect's density.It also showed (24) that infestation of pea plant by aphids led to an increase in the content of phenol in the plant as a defense against the insect.It also agrees with (39,38) who indicated that there is a high inverse relationship between the percentage of phenols in the wheat plant and the rate of aphid density on it. Also, the different levels of chlorophyll in tomato cultivars had a role in reducing the intensity of some whitefly roles on the plant. An inverse relationship was recorded between the high level of chlorophyll and the density of eggs and nymphs, which amounted to -0.77 and -0.89, respectively.This is what agreed with (32) who indicated that the whitefly was more attracted to the yellow-colored leaves. As (3) indicated that there is an inverse relationship between the level of chlorophyll in the plant and the density of the whitefly, while (1) stated that the low concentration of chlorophyll pigment in the super marimond plant made it more preferred by the adults of the tobacco whitefly compared to other cultivars.Table (8) values of the simple correlation coefficient of the average chemical content of tomato leaves with the numerical density of the roles of the whitefly insect

Table (8) values of the simple correlation coefficient of the average chemical content of tomato leaves with the numerical density of the roles of the whitefly insect

Simple correlation coefficient values										instars
chlorophyll		amino acids		, phenols		Proteins		carbohydrate		
SA	**cultivars**	SA	**cultivars**	SA	**cultivars**	SA	**cultivars**	SA	**cultivars**	
0.45	0.77-	0.91	0.35	0.89-	0.49-	0.22-	0.99	0.77-	0.89	egg
0.07	0.89-	0.92	0.70-	0.96-	0.58	0.72-	0.34	0.99-	0.78	nymphs
0.07	0.98	0.80	0.14	0.92-	0.00	0.46-	0.83-	0.82-	0.99-	adults

References

1. Jabbar, Alaa Sobeih (2006). Different methods of resistance ling the tobacco whitefly Bemisia tabaci (Genn). on tomato yield. Basra Journal of Agricultural Sciences, No. 19 (2).

2. Al-Janabi, Suhaila Dawood Salman (1986). Biological study of the whitefly Bemisia tabaci (GENN) Aleyrodidae Homoptera in central Iraq. Master Thesis. College of Science - University of Baghdad. 106 pages.

 ISSN 2072-3875

3. Al-Dosari, Nasser Hamid Muhammad (2002). Study of the presence and spread of the tobacco white fly Bemisia tabaci (Genn) (Aleyrodidae: Homoptera) on some economic plants in Basra Governorate and comparison of the efficiency of some pesticides in their resistance . Master's thesis. College of Agriculture. University of Basra. 109 pages.

4. Al-Rawi, Khasha Mahmoud and Khalaf Allah, Abdel Aziz Muhammad (2000). Design and analysis of agricultural experiments. The second edition, Dar Al-Kutub for Printing and Publishing, University of Mosul, 488 pages.

5. Al-Samer, Russell Abdul-Amir Abboud (2014). Diagnostic and ecological study of whiteflies of the two species Bemisia tabaci and Aleurolobus marlatti (Aleyrodidae Homoptera:) with reference to their resistance in Basra Governorate. Master Thesis. Plant protection. faculty of Agriculture. Basra University.105 pages.

6. Al-Saadawi, Mortada Sarhan Muhalhal Hamad (2018). Effect of spraying with aspirin, ascorbic acid and spraying phase on the growth and yield of tomato plants grown in greenhouses. Master Thesis. faculty of Agriculture. Albasrah university. 110 pages.

7. Faisal, Hassan Abdul-Imam (2011). Effect of concentrations of salicylic and ascorbic acids and method of use on growth, flowering and green yield of Vicia fabaL. faculty of Agriculture. Basra University.95 pages.

8. The Iraqi Ministry of Planning, Agricultural Statistics Center (2019). The cultivated area of the tomato crop in Iraq. iq agri. plan@ mop. gov.

1. **Alemandri, V., Laguna, I. G., Pardina, P. R., Truol, G., and Pardina, R. (1998).** Plant pest factsheet *Bemisia tabaci*. 446–448. Http://Www.Nacaa.Com.
2. **Ali, S., Khan, M., Sahi, S., & Hassan, M. (2010).** Evaluation of plant extracts and salicylic acid against *Bemisia tabaci* and cotton leaf curl virus disease. *Pak J Phytopathol*, 22, 98-100.
3. **Alkhedir, H., Karlovsky, P., and Vidal, S. (2013).** Relationship between water soluble carbohydrate content, aphid endosymbionts and clonal performance of *Sitobion avenae* on cocksfoot cultivars. Plos One, 8(1), E54327.
4. **Borzoui, E., Bandani, A. R., Goldansaz, S. H., and Talaei-Hassanlouei, R. (2018).** Dietary protein and carbohydrate levels affect performance and digestive physiology of *Plodia* interpunctella (Lepidoptera: Pyralidae). *Journal of Economic Entomology*, 111(2), 942-949.
5. **Caldwell, E., Read, J., and Sanson,G.D.(2016).** Which leaf mechanical traits correlate with insect herbivory among feeding guilds. *Annals of botany*,117(2),349-361.
6. **Çanakci‘ S., and Dursun, B. (2012).** The effect of pre-application of salicylic acid on some physiological and biochemical characteristics of tomato seedling (*Lycopersicon esculentum* L) growing in cadmium containing media. *African Journal of Biotechnology*, 11(13), 3173-3178.
7. **Cresser, M. S., & Parsons, J. W. (1979).** Sulphuric—perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. *Analytica Chimica Acta*, 109(2), 431-436**.**
8. **Dias, D. M., Resende, J. T. V., Marodin, J. C., Matos, R., Lustosa, I. F., & Resende, N. C. V. (2016).** Acyl sugars and whitefly (*Bemisia tabaci*) resistance in segregating populations of

 ISSN 2072-3875

tomato genotypes. *Genetics and Molecular Research*, 15(2), 1-11.

9. **Dubois, M. K.; K. A. Crilles; J.K. Hamiltor; D.A. Rebers, and F.Smith (1956)**. Colorimetric method for determination of sugars and related substances. Anal .Chem. 28:350 – 365.
10. **Eisenhauer, N., Klier, M., Partsch, S., Sabais, A. C., Scherber, C., Weisser, W. W., and Scheu, S. (2009).** No interactive effects of pesticides and plant diversity on soil microbial biomass and respiration. *Applied Soil Ecology*, 42(1), 31-36.
11. **El-Meniawi, F. A., Rawash, I. A., El-Gayar, F. H., & Hussein, H. S. (2015)**. Plant response to *Bemisia tabaci* infestation. *Middle East Journal of Applied Sciences*, 5(4), 1164–1173.
12. **El-Sherbeni A, Khaleid Ms, Abdallah Saea, and Ali Osm (2019)**. Effect of some insecticides alone and in combination with salicylic acid against aphid, *Aphis Gossypii*, and whitefly *Bemisia tabaci* on the cotton field. *Bulletin Nati Res Centre* 43(1):57.
13. **El-Yazeid, A. A. (2011).** Effect of foliar application of salicylic acid and chelated zinc on growth and productivity of sweet pepper (*Capsicum annuum L.)* under autumn planting. *Research Journal of Agriculture and Biological Sciences*, 7(6), 423-433.
14. **Erb, M., Meldau, S., and Howe, G. A. (2012).** Role of phytohormones in insect-specific plant reactions. *Trends in plant science*, 17(5), 250-259.
15. **Gharib, F. A. (2006).** Effect of salicylic acid on the growth, metabolic activities and oil content of basil and marjoram. *Internationl Journal of Agriculture and Biology* 4, 485-492.
16. **Golawska, S., Kapusta, I., Lukasik, I., and Wojcicka, A. (2008).** Effect of phenolics on the pea aphid, acyrthosiphon pisum [harris] population on pisum sativum l.[Fabaceae]. Pestycydy, (3-4), 71-77.
17. **Goodwin،T.W.(1976).**Chemistry and biochemistry of plant pigment.2nd Ed. Academic press,London,N.Y,Sanfrancisco.373P.
18. **Hasanuzzaman, A. T. M., Islam, M. N., Zhang, Y., Zhang, C. Y., and Liu, T. X. (2016).**L eaf morphological characters can be a factor for intra-varietal preference of whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) among eggplant cultivars. Plos One, 11(4), https://doi.org/10.1371/journal.pone.0153880.
19. **He, Y., Zhao, J., Zheng, Y., Weng, Q., Biondi, A., Desneux, N., and Wu, K. (2013).** Assessment of potential sublethal effects of various insecticides on key biological traits of the tobacco whitefly, *Bemisia tabaci*. *International Journal of Biological Sciences*, 9(3), 246–255. Https://Doi.Org/10.7150/Ijbs.5762
20. **Horowitz, A.R., Antignus, Y., Gerlig ,D.(2011).**Management of *Bemisia tabaci* whiteflies .the whitefly, *Bemisia tabaci*(Homoptera:Aleyrodidea) interaction with Geminivirus. infected host plant, *Springer Dordrecht*,PP 293-322.
21. **Ishaaya, I., and Horowitz, A. R. (1992).** Novel phenoxy juvenile hormone analog (pyriproxyfen) suppresses embryogenesis and adult emergence of sweet potato whitefly (homoptera: aleyrodidae). *Journal of Economic Entomology*, 85(6), 2113–2117. Https://Doi.Org/10.1093/Jee/85.6.2113
22. **Iverson, A. L., Iverson, L. R., and Eshita, S. (2001).** The effects of surface-applied jasmonic and salicylic acids on caterpillar growth and damage to tomato plants. *Ohio Journal of Science*: Volume 101, Issue 5

23. **Johnson, M. W., Sylvester, E. S., Toscano, N. C., Kid, K., Reynolds, H. T., and Natwick, E. T. (1982).** Whiteflies cause problems for southern California growers. Carlifornia Agriculture, October, 24–26.
24. **Johnston, N., and Martini, X. (2020).** The influence of visual and olfactory cues in host selection for *Bemisia tabaci* biotype b in the presence or absence of tomato yellow leaf curl virus. Insects, 11(2), 115.
25. **Ketaki Chauhan, B.R.M. Vyas, Anamik K. Shah, Von Johnson. (2017).** Bioconversion of amino acids to α-keto acid by geotrichum candidum used for the treatment of chronic kidney disorders. *Internatinoal. Journal. Current. Microbiol. App. Sci*. 6(2): 988-996. Doi: Http://Dx.Doi.Org/10.20546/Ijcmas.2017.602.111
26. **Khodary, S. E. A. (2004).** Effect of salicylic acid on the growth, photosynthesis and carbohydrate metabolism in salt stressed maize plants. *International Journal of Agriculture & Biology*,, 6(1), 5-8.
27. **Kott, F. P. S., Weighting, C., and Samples, C. P. (2009).** Provided for non-commercial research and educational use only. Not for reproduction, distribution or commercial use. Sample Surveys: Inference and analysis, vol. 29b
28. **kumar, p., and poehling, h.-m. (2007).** Effects of azadirachtin, abamectin, and spinosad on sweet potato whitefly (Homoptera: Aleyrodidae) on tomato plants under laboratory and greenhouse conditions in the humid tropics. *Journal of Economic Entomology*, 100(2), 411–420. Https://Doi.Org/10.1093/Jee/100.2.411
29. **Kumar, S. P., Kumar, C. V., and Bandana, B. (2010).** Effects of salicylic acid on seedling growth and nitrogen metabolism in cucumber (cucumis sativus l.). *Journal of Stress Physiology & Biochemistry*, 6(3).
30. **Leszczyński, B., Warchoł, J., and Niraz, S. (1985).** The influence of phenolic compounds on the preference of winter wheat cultivars by cereal aphids. International Journal of Tropical Insect Science, 6(2), 157-158.
31. **leszczynski, b., wright, l. c., and bakowski, t. (1989).** Effect of secondary plant substances on winter wheat resistance to grain aphid. Entomologia Experimentalis et Applicata, 52(2), 135-139.
32. **Mady, M. A. (2009).** Effect of foliar application with salicylic acid and vitamin e on growth and productivity of tomato (*Lycopersicon Esculentum*, Mill.) Plant. J. Agric. Sci. Mansoura Univ, 34(6), 6735–6746.
33. **Mahmoud, F. M., and Mahfouz, H. M. (2015).** Effects of salicylic acid elicitor against aphids on wheat and detection of infestation using infrared thermal imaging technique in ismailia, egypt. Pesticidi I Fitomedicina, 30(2), 91-97.
34. **Mahmoud, Y. A., Ebadah, I. M. A. E. M., Attwa, W., Moawad, S., Omar, N., El-Wahab, T. E. A., and Sadek, H. (2020).** Susceptibility of different tomato, *Solanum Lycopersicum* l., cultivars to infestation with some insect pests in Egypt. Bulletin of the National Research Centre, 44, 1-5.
35. **Maluf, W. R., Maciel, G. M., Gomes, L. A. A., Cardoso, M. D. G., Gonçalves, L. D., Da Silva, E. C., and Knapp, M. (2010).** Broad-spectrum arthropod resistance in hybrids between high-and low-acylsugar tomato lines. Crop Science, 50(2), 439-450.
36. **Mcdaniel، T., Tosh, C.R., Gatehouse, A.M., George, D., Robson, M., and Brogan, B.(2016).** Novelresistance

mechanisms of a wild tomato against the glasshouse whitefly. Agronomy for sustainable development, 36(1),14.

37. **Nombela, G., and Muñiz, M. (2009).** Host plant resistance for the management of *Bemisia tabaci*: a multi-crop survey with emphasis on tomato. In Bemisia: Bionomics And Management Of A Global Pest (Pp. 357-383). Springer, Dordrecht.
38. **Oriani, M. A. D. G., and Vendramim, J. D. (2010).** Influence of trichomes on attractiveness and ovipositional preference of *Bemisia tabaci* (Genn.) B Biotype (Hemiptera: Aleyrodidae) on tomato genotypes. Neotropical Entomology, 39(6), 1002-1007.
39. **Page،A.L.;Miller, R.H. and Keeney,D.R.(1982).**M ethods of soil analysis. Part 2, 2nd Ed. Madison Son, Wisconson, USA:PP.1159.
40. **Peng, J., Deng, X., Jia, S., Huang, J., Miao, X., and Huang, Y. (2004).** Role of salicylic acid in tomato defense against cotton bollworm, *Helicoverpa armigera* Hubner. Zeitschrift Für Naturforschung C, 59(11-12), 856-862.
41. **Rani, P. U., and Jyothsna, Y. (2010).** Biochemical and enzymatic changes in rice plants as a mechanism of defense. acta physiologiae plantarum, 32(4), 695-701.
42. **Rosen, H., (1957).** Amodified ninhydrin colorimetric analysis for amino acids. Archives of Biochemstry and. Biophysics. 67, 10–15.
43. **Sciences, S., An, A., and Ba, H. (2008).** Comparative efficacy of insecticides against sucking insect pests of. Journal. Life Soc ,6, 140–142.
44. **Shi, X., Chen, G., Tian, L., Peng, Z., Xie, W., Wu, Q& Zhang, Y. (2016).** The salicylic acid-mediated release of plant volatiles affects the host choice of *Bemisia tabaci*. International Journal of Molecular Sciences, 17(7), 1048.
45. **Traw, M. B., and Bergelson, J. (2003).** Interactive effects of jasmonic acid, salicylic acid, and gibberellin on induction of trichomes in arabidopsis. Plant Physiology, 133(3), 1367-1375.
46. **War, A. R., Hussain, B., and Sharma, H. C. (2013).** Induced resistance in groundnut by jasmonic acid and salicylic acid through alteration of trichome density and oviposition by *Helicoverpa Armigera* (lepidoptera: noctuidae). AoBP *PLANTS*, Volume 5. https://doi.org/10.1093/aobpla/plt053
47. **War, A. R., Paulraj, M. G., Ahmad, T., Buhroo, A. A., Hussain, B., Ignacimuthu, S., and Sharma, H. C. (2012).** Mechanisms of plant defense against insect herbivores. Plant Signaling & Behavior, 7(10), 1306-1320.
48. **War, A. R., Paulraj, M. G., War, M. Y., and Ignacimuthu, S. (2011).** Jasmonic acid-mediated-induced resistance in groundnut (*Arachis Hypogaea* l.) against *Helicoverpa Armigera* (hubner)(lepidoptera: noctuidae). Journal of Plant Growth Regulation, 30(4), 512-523.
49. **Waterhouse, A. L. (2002).** Determination of total phenolics. Current protocols in food analytical chemistry, 6(1), I1-1.
50. **Winters, A. L., Lloyd, J. D., Jones, R., and Merry, R. J. (2002).** Evaluation of a rapid method for estimating free amino acids in silages. Animal Feed Science and Technology, 99(1-4), 177-187.
51. **Yassin, S. A., Arafat, N. F., and Baiomy, F. A. (2014).** Susceptibility of some tomato cultivars to some pests and predators. Egyptian Academic Journal of Biological Sciences. A, Entomology, 7(1), 1-10.