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THE NATURE OF RESISTANCE OF SOME PEPPER CULTIVARS TO POWDERY MILDEW DISEASE CAUSED BY *Leveillula taurica* (LEV.) ARN. UNDER GREENHOUSE CONDITIONS

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ABSTRACT

This work was carried out under green house conditions at Tokh and Sakha during 2007and 2008. All tested pepper cultivars differed in their response to *Leveillula taurica* infection at Tokh and Sakha locations .Gedeon F_1 cv. was very susceptible (71.93 %),while Parma cv. was the least susceptible one (9.78 %). The highest values of the area under disease progress curve (AUDPC) and rate of powdery mildew increase (r-value) were recorded with the highly susceptible cultivars Gedeon F_1followed by panta F_1, while the lowest values in this respect were in the least susceptible Maro and Parma cv. In addition, Parma cv . was found superior to all cultivars with respect to fresh weight (612.1 & 634.5 g/plnt), dry eight 129.7&132.6 g/plant) and fruit yield (65.8 & 68.6 kg/polt) at Tokh and Sakha .A positive correlation was found between pepper susceptibility to the infection with *L. taurica* and the number of stomata on both leaf surface. Gedeon F1 cv. with an average (181.72 & 385.74stomat/cm^2) on upper and lower leaf surfaces was found highly susceptible. Parma cv. was less susceptible and showed (24.15 &131.26 stomat / cm^2) . Both chlorophyll a , b and carotene contents in healthy of the least susceptible Parma cv. was higher than that of the highly susceptible Gedeon F1 cv. *L.taurica* infection decreased the content of chlorophyll and carotene in both cultivars and total sugars and free amino acids were higher in the healthy plants of the least susceptible cultivar than that in the highly susceptible one, *L. taurica* infection reduced the total sugars and free amino acids in both cultivars. The total phenols was higher in leaves of the highly susceptible cultivar than that in the least susceptible one. The activity of oxidative enzymes peroxidase, polyphenoloxidase and catalase increased in the least susceptible Parma cv. than in the highly susceptible Gedeon F1 cv. *L. taurica* infection lead to an increase in the levels of oxidative enzymes in the infected leaves as compared to with the healthy ones.

INTRODUCTION

The powdery mildew disease of pepper is widely distributed all over the world and its range includes a very large number of plant families(Natour *et al.,*1971).The causal organism *Leveillula taurica* (Lev.)Arnaud is considered one of the most important disease of pepper and attacking plants in open fields and under greenhouses. It causes severe damage to the host and losses in yield.(Schickedanz1989&Amelung1990).Mones *et al*.(1989) found that 4 pepper cultivars, inoculated under greenhouse conditions and 7 in the field under plastic tunnels were susceptible to *L. taurica.* Muneem *et al.* (2002) evaluated 150 indogenous and exotic capsicum collection against *L. taurica*. They found that 13 collections were free from powdery mildew infection and 19 were susceptible. Disease incidence was directly correlated to stomatal numbers, being greater in the susceptible cultivars, whereas the number of stomata on upper and lower surface of the leaves were higher.

(El-Kafrawy *et al*., 2000).Wood (1976) found that infection caused by obligate parasites was often accompanied by striking changes in amount and distribution of photosynthetic pigments. Loss of such pigments occurs in most disease, oftenly on early stage. A part of the photosynthesis probably depends on the losses of chlorophyll. Mohamed (1994) reported that, the least susceptible cultivars contained higher amount of total sugars and free amino acids in healthy leaves than the highly susceptible cv. *L. taurica* infection decreased the amount of total sugars and free amino acids in both cultivars. El-Shanawani *et al.* (1990) found that, the infection with powdery mildew increased total phenols.This increase was more in highly susceptible cv. compared with the least susceptible one. Abd El Karim (2002) and El-Kafrawy (2006) reported that,oxidative enzymes activity peroxidase, polyphenoloxidase and catalase enzymes increased in the least susceptible cv. than in highly susceptible ones. It was found that powdery mildew infection increases the levels of oxidative enzymes in the infected leaves comparing with the healthy one.

The objective of this study was to investigate the behaviour of different pepper cultivars to powdery mildew disease caused by *L taurica* in relation to vegetative growth, yield and physiological activities under greenhouse conditions.

MATERIALS AND METHODS

Five pepper cultivars namely, Gedeon F1,Capri, Parma, Maro and Panta F1 obtained from Horticulture Research Institute ARC were used in this study. The experiment were carried out under greenhouse conditions at Tokh and Sakha of the protected agriculture locations during two successive seasons (2007 and 2008). Seedling 30 days old were transplanted at spacing of 50 cm using double row on each ridge. The plot was 7m length and 1.5m width. Each plot had 28 plants. The treatment were arranged in complete randomized blocks designed in four replicates. Cultural practices were carried out as usual. The disease severity was assessed weekly (7days) starting from symptoms appearance till the end of the growing period. The area under disease progress curve (AUDPC) and the rate of increase(r-value) was also assessed. In addition, plant growth characters were recorded after 65 days from transplanting using five plants from each treatment / plot, fresh weight , dry weight (gm/plant) and the fruit yield(kg/plot) were also calculated.

Disease assessment :

The disease was determined using the following equation developed by Kremer and Unterstahofer,(1967).

$$R = \frac{\sum (axb)}{N - X\,K} \times 100$$

Where :-

R = disease index

a = number of leaves within infection grade.

b = numerical value of each grade.

N = total number of leaves.
K=The highest degree of infection in category

Tested cultivars were also classified according to the next scale (Table 1) as follow .

Table (1): The scale used to estimate the degree of infection of the different powdery mildew sample.

Numerical value or infection category	Infection	Mildew response
0	Mildew free	R
1	10% of the leaf surface was infected .	LS
2	11– 25% of the leaf surface was infected	MS
3	26 – 50% of the leaf surface was infected .	S
4	51-100% of the leaf surface was infected	HS

R = Resistance. **S = Susceptible.**
LS = Least Susceptible . **HS = Highly Susceptible.**
MS = Moderately Susceptible .

The area under disease progress curve (AUDPC) was estimated to compare different responses of the tested cultivars using the following equation(Pandey *et al*., 1989) :

$$AUDPC = D[\tfrac{1}{2}(Y_1 + Y_k) + Y_2 + Y_3 + \text{----------} Y_{k-1}]$$

Where :
D = days between reading.
Y_1 = first disease recording .
Y_k = last disease recording .

Rate of powdery mildew increase (r-value) was estimated using the following formula outlined by Van der plank (1963):

$$\text{r-value} = \frac{1}{t_2 - t_1}\left(\log_e \frac{X_2}{1 - X_2} - \log_e \frac{X_1}{1 - X_1}\right)$$

Where :
X_1 = The proportion of the susceptible infected tissue (disease severity) at dates t_1 .
X_2 = The proportion of the susceptible infected tissue (disease severity) at dates t_2 .
$T_2 - t_1$ = the intervals in days between these dates .

Number of stomata;

Leaf samples from the highly and the least susceptible pepper cultivars were collected on both leaf surfaces using the following formula adopted by (Kreeb,1990). Stomata frequency / cm^2 = $\frac{\text{No. of stomata at40 X}}{0.00086}$

Physiological studies :-

Apparently healthy and mildewed fresh leaves of the least and highly susceptible pepper cvs. were collected after appearance of infection with *L.taurica* for the following determinations.

1 – Chlorophyll and caroten contents :-

Chlorophyll content in pepper leaves were determined in the fifth leaf from the growing tip of 10 plants by a spectrophotometer by using N . N-Dimethyl formaide according to the methods Moran (1982).

2 – Sugar, total free amino acids and phenols contents :-

Apparently healthy and mildewed leaves of the least and highly susceptible pepper cvs. were oven dried at 60˚c till constant weight. The dried materials were grinded to fine powder. The extraction were obtained individually using Soxhlet units till the percolate was coloureless (10-12 hrs) using 75% ethanol as an extraction.

a)Reducing and total soluble sugars were determined colourimetricully with picric acid method as described by Thomas and Dutcher (1924). The non-reducing sugars were then calculated.The sugar content was calculated as glucose from standard curve prepared for glucose

b)Quantity of total free –amino acids was determined in leaf extracts colourimetrically according to the buffer acetate methods described by Rosen(1957). The amount of total free amino acids was calculated from prepared standard curve as glycine.

c)Total free phenols were determined by using colourimetrically methods of Folin and Denis as described by Snell and Snell (1953). The conjugated phenols were then calculated. Phenolic compound were determined as mg catechol/g dry weight based on the standard curve for catechol.

Activity of oxidative enzymes :-

Apparently healthy and mildewed leaves of pepper plants were collected after appearance of infection with *L.taurica* . Fresh leaves of both cultivars were cut at the base level for determining the activity of oxidative enzymes. Enzymes extraction were prepared as recommended by Maxwell and Bateman (1967). The methods described by Allam and Hollis (1972), Broesch (1954) and Colowick & Kaplan (1955) were used to determine peroxidase, polyphenoloxidase and catalase activies.

RESULTS AND DISCUSSION

Data presented in Table (2) indicated that, all the tested pepper cultivars differed in their response to powdery mildew infection in both growing seasons 2007 and 2008. Gedeon F1 cv. exhibited the highest percentage of disease severity 71.93%, while the lowest infection was observed on Parma cv. 9.78%. The different between these two cvs. was highly significant . In addition, the other tested cultivars were in between. The results obtained at Tokh location were more than those at Sakha location. Spencer (1978) stated that inheritance of resistance to pepper powdery mildew was show to be polygenic resistance mechanism restricted both colonization and sporulation by the pathogen. Mones *et al.* (1989) found variation in powdery mildew resistance between pepper cultivars as the

highest disease on Gedeon F1 and Red north, while the lowest disease severity was obtained on Atol pepper cultivar. .Muneem *et al*. (2002) studied the reaction of different pepper varieties to *Leveillula taurica*. All the tested varieties differed in their reaction to the disease.

Table (2): Response of some pepper cultivars to *L. taurica* under greenhouse conditions at Tokh and Sakha locations during 2007 – 2008 seasons.

Cultivars	Powdery mildew infection (%)						General mean	Powdery mildew response
	Tokh			Sakha				
	2007	2008	Mean	2007	2008	Mean		
Gedeon F1	70.18	76.24	73.21	69.16	72.14	70.65	71.93	HS
Capri	37.48	39.32	38.40	33.53	35.91	34.72	36.56	S
Parma	9.51	12.45	10.98	8.14	9.02	8.58	9.78	LS
Maro	17.82	21.92	19.87	16.02	18.12	17.07	18.47	MS
Panta F1	64.97	71.13	68.05	55.58	61.32	58.45	63.25	HS
L.S.D at 5 %	8.05	9.65	-	7.81	8.08	-	-	-

Data in Table(3) revealed that the cultivars Gedeon F1 and Panta F1 exhibited the highest values of AUDPC (955.6)and(798.5) ,followed by Capri (475.9) and Maro(253.3),respectively while Parma cultivar exhibited low levels of AUDPC(121.6) in both seasons. In addition to the differences in means of AUDPC among the two locations Tokh and Sakha, were clearly higher at Tokh than that at Sakha.

Table (3): Values of area under disease progressive curve (AUDPC) for spread of *L. taurica* on five pepper cultivars under greenhouse conditions at TOkh and Sakha locations during 2007 – 2008 seasons.

Cultivars	Area under disease progressive curve (AUDPC)						General mean
	Tokh			Sakha			
	2007	2008	Mean	2007	2008	Mean	
Gedeon F1	982.1	1035.5	1008.8	884.3	920.5	902.4	955.6
Capri	502.7	530.5	516.6	426.8	443.6	435.2	475.9
Parma	128.4	141.2	134.8	99.5	117.3	108.4	121.6
Maro	246.0	270.0	258.0	229.7	267.5	248.6	253.3
Panta F1	795.6	830.2	812.9	763.5	804.7	784.1	798.5

Concerning the mean rate of disease increase, data in Table(4) showed that Parma cv. showed low levels of (r–value) whereas , the cultivars Gedeon F1 and Panta F1 showed high values of r-value followed by Capri and Maro cultivars in both seasons. These results are in agreement with those obtained by EL-Desouky(1996) who found that the rate of disease increase (r-value) was higher on the highly susceptible variety (Beta Alpha) ,while it was low on the moderately resistant variety (Sweet Crunch).

Table (4): Development of powdery mildew expressed as rate of disease increase (r-value) on five pepper cultivars under greenhouse conditions at Tokh and Sakha locations during 2007 – 2008 seasons.

Cultivars	Rate of disease						General mean
	Tokh			Sakha			
	2007	2008	mean	2007	2008	mean	
Gedeon F1	0.196	0.216	0.206	0.179	0.201	0.190	0.198
Capri	0.150	0.166	0.158	0.128	0.140	0.134	0.146
Parma	0.037	0.051	0.044	0.030	0.038	0.034	0.039
Maro	0.061	0.079	0.070	0.055	0.069	0.054	0.062
Panta F1	0.182	0.198	0.190	0.163	0.181	0.172	0.181

Results presented in Table (5) indicated that, all pepper cultivars differed in their growth parameters., fresh ,dry weight and fruit yield were responded to powdery mildew infection.The effect was significant in both growing seasons 2007 and 2008. Parma cv. was found to be superior with respect to great fresh weight (612.1 gm/plant), dry weight(129.7gm/plant) and it gave the highest fruit yield (65.8 kg/polt), while Gedeon F1 cv. was the minimum in fresh weight (389.4gm/plant), dry weight (75.8gm/plant)and the lowest fruit yield(37.6 kg/polt).). The other tested cultivars fall in between. The results at Tokh location were in the same range to those at Sakha location. These results might be due to correlation between pepper cultivars sensitivity to powdery mildew infection and the plant characters. The disease severity of powdery mildew was negatively correlated with all vegetative growth characteristics (they were increased as disease severity decreased). These results are in accordance with those obtained by Amelung(1990)) who reported that, powdery mildew of some pepper cultivars is an important disease and often is a limiting factor in the production of pepper crops. El-Kafrawy (2006) found that the least susceptible cv. was found superior to all other cvs. with respect to highly, fresh and dry weight.

Table (5): Effect of powdery mildew on fresh&dry weight (gm/plant)and furit yield (kg/plot) of five pepper cultivars under greenhouse conditions at Tokh and Sakha locations during 2007 – 2008 season.

Cultivars	Tokh			Sakha		
	Mean of 2007 - 2008			Mean of 2007 - 2008		
	Fresh weigh gm/plant	Dry weight Gm/plant	Yield kg/plot	Fresh weight gm/plant	Dry weight gm/plant	Yield Kg/plot
Gedeon F1	389.4	75.8	37.6	394.7	78.2	39.9
Capri	462.7	102.3	55.8	481.8	108.3	57.9
Parma	612.1	129.7	65.8	634.5	132.6	68.6
Maro	430.6	97.6	63.1	448.7	100.1	65.8
Panta F1	505.2	114.6	42.5	525.6	117.8	44.1
L.S.D at 5%	30.5	15.2	3.4	41.4	16.7	4.6

Data presented in Table(6) revealed that , a positive correlation was noticed between pepper plant susceptibility and the number of stomata on both leaf surface .This may explain the highly and least susceptibility of

Gedeon F1 vc.(385.74&181.72 stomata/cm^2) and Parma vc.(131.26&24.15 stomata/cm^2) to powdery mildew infection . These results agreed with those obtained by Ammar *et al*.(1986) found that disease incidence was directly related to stomatal numbers , which were least in resistance and higher in the susceptible cultivars, whereas the number of stomata were greater on the lower surface than the upper surface epidermis .

Table (6): The mean number of stomata/ cm^2 on leaves of five pepper cultivars in relation to powdery mildew infection%

Cultivars	Powdery mildew infection%	Mean No. of stomata/ cm^2	
		Upper surface	Lower surface
Gedeon F1	71.93	181.72	385.74
Capri	36.56	81.12	174.25
Parma	9.78	24.15	131.26
Maro	18.47	51.19	159.23
Panta F1	63.25	152.28	264.44

Data in Table (7) indicate that, in healthy plants chlorophyll a and b was higher in the least susceptible cultivars Parma (10.38 & 7.12mg/g) than in the highly susceptible cultivars Gedeon F1 (HS) (10.15 & 6.98mg/g). It can be concluded that *L.taurica* infection decreased chlorophyll a & b in both cultivars . Total chlorophyll and carotene contents were higher in Parma cv. (LS) (17.40 & 3.19mg/g) than Gedeon F1 cv (17.03 & 2.08mg). Generally, *L.taurica* infection decreased total chlorophyll and carotene contents in both cultivars. These results are in accordance with those obtained by Wood(1976) who found that, infection caused by obligate parasites was often accompanied by striking changes in the amount and distribution of photosynthetic pigments. Loss of such pigments occurs in the most diseases, oftenly in early stage. A part of the fall phytosynthesis probably depends on the losses of chlorophyll .El-shanawani *et al.* (1990) and El-Kafrawy(2000) pointed out that, the infection decreased the amount of total chlorophyll and carotene contents. Loss of such pigments occurs in most disease caused by obligate parasites.

Table (7): Effect of powdery mildew infection on chlorophyll and carotene contents on Leaves of both pepper cultivars, Gedeon F1 and Parma as mg/gm dry weight

Cholophyll and carotene contents	Gedeon F1 (HS)		Parma (LS)	
	Mg/gm dry weight		mg/gm dry weight	
	Healthy	Infected	Healthy	Infected
Cholorophlly a	10.15	6.02	10.38	6.54
Cholorophyll b	6.98	4.72	7.12	5.49
Cholorophyll a + b	17.03	10.74	17.40	12.03
Caroten	3.08	2.14	3.19	2.88

HS. = Highly susceptible **LS. = Least susceptible**

Data presented in Table (8) show that, total sugars, free amino acids and phenols were highest in the healthy leaves of Parma cv.(LS) these were12.26, 3.89 and 18.84mg, respectively. While these values were 11.45, 3.02 and 17.92mg in Gedeon F1cv., respectively. *L. taurica* infection reduced total sugars of leaves in both cultivars.

The decrease in total sugars was more pronounced in the highly susceptible(Gedeon cv.) These results are in accordance with those obtained by Mohamed *et al*.(1994) who found that the least susceptible variety contained higher amount of total sugars in healthy leaves than the highly susceptible ones*. L.taurica* infection decreased the amount of total sugars in both varieties. The obligate parasites consume much quantity of sugars(Spencer1978). Total free amino acids and phenols were higher in the leaves of Parma cv. (LS) than Gedeon cv.(HS). *L.taurica* infection increased total free amino acid and phenols in both cultivars, but the increase was more pronounced in the highly susceptible cultivar Gedeon F1. Similar results have been reported by Beihn *et al*.(1968) who revealed the accumulation of phenols in resistant plant- Fungi interaction and concluded that the increase in rate of phenols synthesis occurring in response to fungal inoculation was a result of an alternation of plant metabolism similar to the occurring by mechanical injury. In many cases a correlation may exist between the degree of resistance and phenols levels in healthy tissues. El-Kafrawy(1997) found that,the highly susceptible California Wonder cv. contained high amount of total free amino acid in healthy leaves of the least susceptible Cayenne Long cv. Powdery mildew infection increased the total free amino acids in both cultivars. Increased of the total free amino acids was more pronounced in the highly susceptible cv.

Table (8): Effect of powdery mildew infection on total sugars, phenols and free amino acids of both cultivars, Gedeon F1 (HS) Parma (LS).

Chemical analysis	Gedeon F1 (HS)		Parma (LS)	
	Healthy	Infected	Healthy	Infected
Total sugars*	11.45	8.96	12.26	1182
Total free amino acids**	3.02	5.98	3.89	4.99
Total phenols***	17.92	23.56	18.84	21.09

*** Expressed as mg glucose/g dry weight** **(HS) = Highly susceptible**
**** Expressed as mg glycine/g dry weigh**
***** Expressed as mg caticole /g dry weigh** **(LS) = least susceptible**

The results in Table (9) show that, the determined oxidative enzymes “peroxidase, polyphenoloxidase and catalase were higher in healthy leaves of Parma cv. (LS) (0.74, 0.26 and 4.75mg) than Gedeon F1 cv. (HS) (0.68, 022 and 3.98mg),while *L.taurica* infection increased peroxidase, polyphenoloxidase and catalase in both infected leaves , but the increase was more pronounced in Gedeon cv.(0.99, 0.54 and 7.91mg), than Parma cv.(0.85,0.39 and 6.68mg) respectively. The results are in agreement with those obtained by. Abd El Karim(2002) andEl-Kafrrawy(2006) stated that the oxidative enzymes peroxidase, polyphenoloxidase and catalase enzymes increased in the least susceptible cultivars than in the susceptible ones. It can be concluded that downy mildew infection lead to an increase in the levels of oxidative enzymes in the infected levels comparing with the healthy ones.

Table (9): Effect of powdery mildew infection on the activity of peroxidase, polyphenoloxidase and catalase enzymes in both cultivars leaves of Gedeon F1 (HS) Parma (LS).

Enzymes activity	Gedeon F1 (HS)		Parma (LS)	
	Healthy	Infected	Healthy	Infected
Peroxidase*	0.68	0.99	0.74	0.85
Polyphenoloxidase*	0.22	0.54	0.26	0.39
Catalase**	3.98	7.91	4.75	6.68

*** Expressed as optical density** **(HS) = Highly susceptible**
**** Expressed as mg H_2O_2 reaction/time** **(LS) = least susceptible**

In conclusion , in this study , the tested pepper cultivars showed great differences in their response to powdery mildew infection ,Gedeon cv . was highly susceptible , while Parma was least susceptible and were differed in the plant growth parameters and physiological activities. Therefore breeding for resistance is the most reliable method for controlling powdery mildew disease on pepper.

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طبيعة المقاومة لبعض أصناف الفلفل ضد مرض البياض الدقيقى تحت ظروف الصوبة الزراعية

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يعتبر مرض البياض الدقيقى فى الفلفل والمتسبب عن فطر ليفيليولا اتوريكا من الامراض واسعه الانتشار فى مصر سواء فى الحقل او تحت ظروف الصوبة وقد اجرى هذا البحث لدراسة طبيعه المقاومه لبعض اصناف الفلفل والمحتوى الكيماوى لها .

ويمكن تلخيص نتائج البحث المتحصل عليها فيما يلى :-

1- اختلفت درجة أستجابة الاصناف لمرض البياض الدقيقى فكان الصنف جديون أكثر الاصناف قابلية للاصابة (٧١,٩٣%) . بينما كان الصنف بارما الأقل قابلية للاصابة (٧٨. ٩%) .

2- أعطت الأصناف جديون وبنتا ف١الأكثر قابلية للإصابة أعلي مساحة تحت منحني المرض(AUDPC) و أعلي معدل تطور المرض (r-value) , بينما الصنف بارما الأقل قابلية للاصابة أعطى أقل مساحة تحت منحنى المرض وأقل معدل تطور المرض .

٣-وجد ان سلوك الصنف بارما الاقل قابلية للاصابة كان الافضل حيث اعطى اعلى معدل للوزن الطازج (٦١٢.١- ٦٣٤.٥ جم/نبات) وايضا الوزن الجاف (١٢٩.٧ – ١٣٢,٦ جم/ نبات) . وايضا اعطى اعلى محصول من الثمار (٦٥.٨ – ٦٨.٦ كجم / بلوت) عن الصنف جديون الأكثر قابلية للاصابة

٤- وجد هناك علاقة وثيقة بين قابلية الاصابة بمرض البياض الدقيقى وعدد الثغور على كلا سطحى الورقة حيث ان الصنف جديون يحتوى على عدد اكثر من الثغور على كلا سطحى الورقة (١٧١.٤ – ٣٥٦. ٦ سم٢) و (١٦٨.٢ – ٣٤٣.٣ سم٢) على التوالى بينما الصنف بارما الاقل قابلية للاصابة يحتوى على عدد اقل من الثغور (٨١.٧ – ١٥٨. ٥ سم٢) و (٧٧.٦ – ١٥٢.٨ سم٢) على كلا سطحى الورقة العلوى والسفلى .

٥-كان محتوى الكلوروفيل والكاروتين اعلى فى الصنف (بارما) الأقل قابلية للاصابة عنة فى الصنف الاكثر قابلية للاصابة (جديون) وقد ادت الاصابة بالمرض الى نقص محتوى الكلوروفيل والكاروتين فى كلا الصنفين .

٦-كانت كمية السكريات الكلية اعلى فى النباتات السليمة للصنف الأقل قابلية للاصابة (بارما) عنة للصنف الاكثر قابلية للاصابة (جديون) وادت الاصابة بالبياض الدقيقى الى خفض نسبة السكريات الكلية فى كلا الصنفين .

٧-كانت كمية الفينولات والا حماض الامينية اعلى فى الصنف الأقل قابلية للاصابة (بارما) عنة فى الصنف الاكثر قابلية للاصابة (جديون) بينما ادت الاصابة الى زيادة كمية الفينولات الكلية والاحماض الامينية في كلا الصنفين وكانت الزيادة واضحة فى الصنف جديون.

٨- زاد النشاط الانزيمى (البيروكسيدير والبولى فينول اوكسيديز والكاتليز) في الصنف الأقل قابلية للاصابة (بارما) عنه فى الصنف الاكثر قابلية للاصابة (جديون) بينما ادت الاصابة بالبياض الدقيقى الى زيادة مستوى النشاط الأنزيمى في الأوراق المصابة عن الأوراق السليمة .