PHYSIOLOGICAL STUDIES ON THE NATURE OF RESISTANCE TO POWDERY MILDEW IN CUCUMBER

By

R.M.* Helal, M.S.** Zaki and F.A. FADL***

ABSTRACT

The resistant "Poinsett' and the susceptible cucumber cultivar 'Beit Alpha' were used in studying the nature of resistance to Erysiphe cichoracearum. Physiological studies on 'Poinsett' and 'Beit Alpha' plants showed that resistance is due to : (a) a high level of Preformed phenols which hinder fungal infection and (b) a low level of total soluble sugars which prevents further establishment of the pathogen within host tissues. Anatomical studies showed that the cuticle and the cell wall in leaf sections of 'Poinsett' were more thicker than those of 'Beit Alpha'.

* Fac. of Agric. Ain Shams University.

** Fac. of Agric. Sci. Moshtohor, Zagazig University.

*** Res. Inst. of Plant pathology, Ministry of Agric.

INTRODUCTION

Powdery mildew is one of the principle diseases that causes the greatest damage for vegetable crops grown in warm areas. The causal fungus Erysiphe cichoracearum, attacks the leaves and stems of cucumber and other cucurbits (Whitaker and Glen, 1962). The most promising method of controlling the disease lies in the development of resistant cultivars by plant breeders. Among resistant cultivars 'Puerto Rico No. 37' (Whitaker and Glen, 1962), 'Poinsett' (Abou Bakr, 1971; Sitterly, 1972).

Resistance to different fungi may be due to biochemical properties or anatomical characters of host tissues (Wingard, 1953). Schnathorst (1955) found that resistance to Erysiphe cichoracearum in lettuce cultivars was due to physiological rather than morphological factors and a physiochemical resistance was involved. Scott et al. (1957) and Barnes (1961) showed that resistance of barley to powdery mildew was due to a phenolic compound with a marked fungistatic properties present before infection. Hare (1966) mentioned also that resistance of lima beans to downy mildew Phytopthora phaseoli was related to a greater amounts of toxic phenols and their oxidation products.

Data on the relation between total soluble sugars and the resistance to powdery mildew are meager. Allen (1942) found that resistance to powdery mildew of wheat was correlated with a low sugar content in leaves of resistant cultivars. Moreover, powdery mildew was found to be a high sugar disease (Horsfall and Dimond, 1957).

The object of this work was to study the nature of resistance to powdery mildew in cucumber.

MATERIAL AND METHODS

A preliminary test was conducted in a green house at the Research Institute of Plant Pathology in Giza during two successive seasons 1977 and 1978, to study the effect of infection with Erysiphe cichoracearum on two cucumber cultivars namely "Poinsett" and "Beit Alpha". Thirty 25 cm clay pots of each genotype were used in each season for this purpose. Ten seeds were sown in each pot at the 20th of March in 1977 and 1978 seasons. Fourty days later, plants were tested to infection by conidial spores obtained from nature infected leaves. The percentages of infection were recorded weekly for five weeks.

Physiological and anatomical studies were made using a split plot design with four replicates. The two genotypes were assigned to the main plots. Split plots were infected vs non infected plants. Each experimental plot consisted of four pots. Artificial infection was made 40 days from seed sowing. One week later, the third and the fourth true leaves were taken, cleaned and chopped into fine pieces. Two representative samples (5-10 gm) from each treatment were analytically weighed. The first sample was dried in an oven at 70°C for dry matter determination. The other sample was used for chemical analysis.

Total phenols:

Extraction of total phenols was made using 80% ethanol. The ethanolic extract was evaporated to dryness at 45°C in an oven and the residue was redissolved with boiling distilled water. The Foelin-Dense method of the determination of total phenols was used as described in A.O.A.C. (1970).

Total soluble sugars:

Quantitative analysis of total soluble sugars was based on the colour density of the sugar-phenol

H_2SO_4 reaction. The colour of solution was measured at 490 mu using Karl size colorimeter as reported by Dubois et al (1956).

Anatiomical studies:

The artificially infected leaves of cucumber plants in each cultivar were taken for anatomical studies. Portions of leaf spots of the infected leaves were fixed in F.A.A. for 24 hours, dehydrated through increasing the value of ethyl alcohol, filterated and embded in paraffin wax. Sections of 12μ to 14μ thickness were cut. These sections were stained with safranin and light green for microscopic examination as described by Sass (1961).

RESULTS AND DISCUSSION

It is clear from Table 1. that "Poinsett" showed a high degree of resistance regradless of the method of infection. These results are in agreement with those of Abou Bakr (1971) and Sitterly (1972). Results indicated also that percentage of infection began to increase ten days after infection. The highest disease development was noticed 38 days after infection.

Table 1; Effect of infection with Erysiphe cichoracearum on the development of powdery mildew in "Poinsett" and Beit Alpha" leaves during the 1977 and 1978 seasons.

Days after infection	Percentage of infection							
	1977				1978			
	Poinsett		Beit Alpha		Poinsett		Beit Alpha	
	N	A	N	A	N	A	N	A
10	1	1	20	20	0	1	15	20
17	2	2	30	30	1	2	28	35
24	2	2	35	40	2	2	42	48
31	3	3	60	65	3	4	60	70
38	5	5	80	85	5	5	75	85

N = Nature infection A = Artificial infection

Total phenols:

Results obtained from determination of total phenols in leaves extracts of resistant "Poinsett" and susceptible "Beit Alpha" are presented in Table 2. It is evident that leaves of "Poinsett" contained more phenols than that of "Beit Alpha". There was a tendency towards increasing

total phenols in "Poinsett" leaves following infection but this increase was not significant. On the contrary, total phenols of infected "Beit Alpha" plants decreased as a result of infection. Such reduction was statistically significant only in the 1977 season. These findings suggest an association between resistance and the high level of preformed phenols in the resistant genotype "Poinsett". These phenols remain at a high level in resistant genotypes following infection but decrease in susceptible genotypes. The reduction may be due to a parasitic action leading to a breakdown in these phenols. These results are inaccordance with those of Scott et al. (1957), Barnes (1961 and Hare (1966).

Table 2: Effect of infection with Erysiphe cichoracearum on the total phenolic content of "Poinsett" and "Beit Alpha" leaves during the 1977 and 1978 seasons*

Genotype	Percent total phenols				Mean
	Non infected		Infected		
		1977 Season			
"Poinsett"	0.0500	Bb	0.0516	Bb	0.0508^{B}
"Beit Alpha"	0.0372	Ab	0.0113	Aa	0.0243^{A}
		1978 Season			
"Poinsett"	0.0637	Bb	0.0698	Bb	0.0668^{B}
"Beit Alpha"	0.0331	Aa	0.0250	Aa	0.0291^{A}

* Data of each season were analized separately. Values followed by the same letter do not differ significantly from each other. Capital letters are used in comparing values in columns, while small letters are used in comparing values in rows at the 5% level.

Total soluble sugars:

It is clear from Table 3 that leaves of "Poinsett" contained small amount of total soluble sugars compared with that of "Beit Alpha". These results show that there is a correlation between the low level of total soluble sugars in leaves and the resistance to powdery mildew. It is suggested that this low sugar content inhibit the development of the fungus within host tissues. The low sugar content of leaves has been previously reported as contributing factor in resistance to powdery mildew of wheat (Allen, 1942). Infection with the studied fungus leads to an increase in total soluble sugars of both cultivars during both seasons. Such increase was significant only in "Beit Alpha" during the 1977 seasons. From these data, it could be suggested that powdery mildew is a high sugar disease as mentioned by Horsfall and Dimond, (1957).

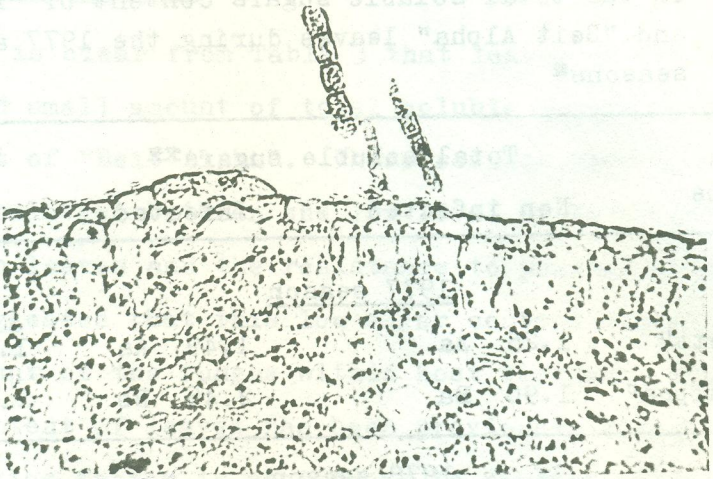
Table 3: Effect of infection with Erysiphe cichoracearum on the total soluble sugars content of "Poinsett" and "Beit Alpha" leaves during the 1977 and 1978 seasons*

Genotype	Total soluble sugars** Non infected		Infected		Mean	
			1977 season			
"Poinsett"	1.25	Aa	1.49	Aa	1.37	A
"Beit Alpha"	1.90	Ba	2.46	Bb	2.18	B
			1978 season			
"Poinsett"	1.32	Aa	1.38	Aa	1.35	A
"Beit Alpha"	1.72	Bb	1.89	Bb	1.81	B

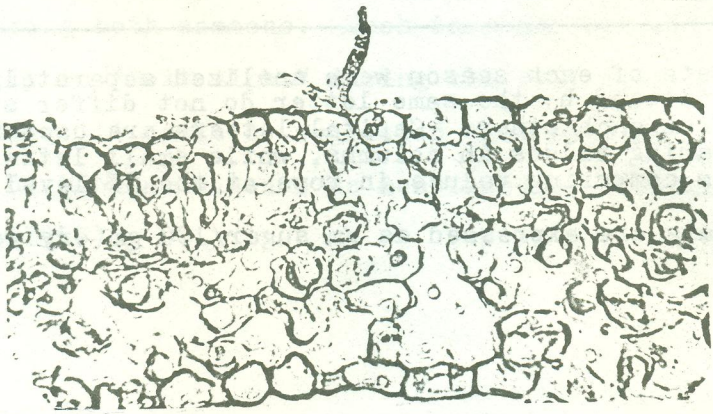
* Data of each season were analized separately. Values followed by the same letter do not differ significantly from each other. Capital letters are used in comparing values in columns, while small letters are used in comparing values in rows at the 5% level.

** Data are expressed as gm sugar/100 gm dry weight.

Figure 1: Photographs showing sections of infected cucumber leaves.



A. Belt Alpha leaf section showing cuticle and cell wall thickness. The infection is shown with conidiophore and conidiospores of the fungus (X 650).



B. Poinsett leaf section showing cuticle and cell wall thickness. The infection is shown with conidiophore and conidiospores of the fungus (X 650).

Anatomical studies:

Anatomical studies in infected leaf sections of both cultivars (Fig. 1A and B) showed no differences except that the cuticle and the cell wall of "Poinsett" cells are more thicker than those of "Beit Alpha". This character could be a factor of plant defense mechanism against the pathogen.

It could be concluded from the previous data that resistance to Erysiphe cichoracearum is due to physiological rather than morphological factors.

REFERENCES

Abou-Bakr, M.A. 1971. (Evaluation of some american cultivars and hybrids of cucumber for resistance to powdery mildew under local conditions) (In Arabic). The third scientific reasearch conference, Alexandria p. 53.

Allen, P.J. 1942. Changes in the metabolism of wheat leaves induced by infection with powdery mildew. Amer. Jour. Bot. 29: 425-435.

A.O.A.C. 1970. Association of official agriculture chemists, Washington D.C. 11th edition.

Barnes, W.C. 1961. Multiple disease resistant cucumbers. Proc. Amer. Soc. Hort. Sci.; 71: 417-423.

Dubois, M., Gillesk. A., Hamilton, J.K.; Rebers.P.A. and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Anal. Chem. 28 : 350-356.

Hare, R.C. 1966. Physiology of resistance to fungal diseases in plants. Bot. Rev. 32 : 95-137.

Horsfall, J .G. and A.E. Dimond, 1957. Interactions of tissue sugar, growth substances and disease susceptibility, A.E.Z. Pflkr. Pflschutz, 64: 415-421.

Sass, J.E. 1961. Elements of Botanical Microtechnique. McGraw-Hill Book Co. Inc. New York.

Schnathorst, W.C. 1955. Resistance to powdery mildew related to osmotic value. Phytopathology. 49: 562-571.

Scott, K., Millerd A. and N.H. White. 1957. Mechanism of resistance in barley varieties to powdery mildew disease. Austar. Jour. Sci. 19: 207-208.

Sitterly, W.R. 1972. Breeding for disease resistance in cucurbits. Ann. Rev. Phytopathol. 10: 471-490.

Whitaker, T.W. and N.D. Glen. 1962. Cucurbits. Interscience publishers, New York. 250 p.

Wingard, S.A. 1953. The nature of resistance to disease. In plant Diseases, the year book of Agriculture; p. 165-173. U.S.D.A. Washington, D.C.

دراسات فسيولوجية على طبيعة المقاومة لمرض البيـــاض الدقيقى فى الخيـــار

رفعت محمد هـــلال ، محمد السعيد زكى ، فهمى عبد المنعـــم فضـــل
كلية الزراعـــة جامعة عين شمس ، كلية العلوم الزراعيـــة بمشتهـــر
ومعهد بحوث أمراض النباتات بوزارة الزراعـــــة

أستخدم فى هذه الدراسة صنفين من الخيار أحدهما مقاوم (بونست) والاخـــر قابل للاصابة (بيت ألفا) لدراسة طبيعة المقاومة لمرض البيـــاض الدقيقى المتسبب عـــن الفطر (أريسايف شيكوراسيرم) فى الخيار .

وقد أوضحت الدراسات الفسيولوجية على نباتات الصنفين أن المقاومة ترجع الى :-

أ - وجود مستوى عالى من الفينولات الكلية الموجودة فى النباتات المقاومة قبل العـــدوى ، هذه الفينولات تعطل من حدوث الأصابـــة .

ب - وجود مستوى منخفض من السكريات الذائبة الكلية فى أنسجة النباتات المقاومـــة قبل وبعد العدوى وهذه تثبط من نمو الفـــطر وتحد من أنتشاره وتغلغله داخـــل أنسجة العائـــل .

كما أوضحت الدراسات التشريحية على أوراق الصنفين بعد عدواها بالفطر أن طبقـــة الكيوتيكل والجدار الخلوى لخلايا أوراق النباتات المقاومة كانت أكثر سمكا عن تلك فـــى أوراق النباتات القابلة للاصابـــة .