

**STUDIES ON CUCUMBER POWDERY MILDEW CAUSED BY
Sphaerotheca fuliginea UNDER COMMERCIAL PLASTIC
HOUSE CONDITIONS IN EGYPT**

**1- DISEASE SURVEY, PATHOGEN IDENTIFICATION AND
RESPONSE OF COMMON CUCUMBER HYBRIDS TO INFECTION**

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ABSTRACT: *Survey of cucumber powdery mildew disease was carried-out through cucumber commercial plastic houses in different localities during Spring season (2000) indicated the importance of this disease which has caused serious damage and moderate to very high disease aculty level to indoor cucumbers due to the conditions of the surveyed localities. The highest disease infection percentage and severity were recorded in El-Bostan region (Behera gover-norate) followed by El-Haram(Giza)and Kaha (Kaluebia) regions. El-Dokki (Giza) and Rafah (North of Sinai) were the latter most. The same tendency was recognized when the affected leaf area % due to infection was calculated in all surveyed regions.*

*The true causal organism of cucumber powdery mildew was identified as Sphaerotheca fuliginea (Schlecht ex Fr .) Poll. according to the morphological and dlnagnotical criteria of the pathogen on the both surfaces of the collected cucumber leaves , but not *Erysiphe cichoracearum* Dc ex Mart. All the patho types obtained from the five localities caused the typical symptoms of the disease. Behira patho type was the most virulent followed by types of El-Haram, El-Dokki, Kaluebia and North of Sinal .*

*Fourteen cucumber hybrids latterly common used in plastic houses were evaluated against *S. fuliginea* under greenhouse condltions using five disease assessment parameters . The most susceptible hybs. were Hana, Anas, Sweet-crunch, Nile-EZ, Salma, Magdy and Beit-alpha. Peto star, Delta-star, Thamin, Marmar and Hoki were moderately susceptible, whilst Hende-R2 and Primo were the lowest susceptible hybs.*

Consequently, it could be suggested that all highly susceptible hybs. must be dislodged from Spring season , contrarily , the encouragement of plantation of the moderate to lowest susceptible hybs. in this season besides the incorporation of these hybs. in breeding programs as further resistance sources , must be followed .

Key words: *Cucumber, powdery mildew, Sphaerotheca fuliginea*

INTRODUCTION

Cucumber powdery mildew is a widely distributed and destructive disease causing severe damage on greenhouses during relatively dry warm seasons (El-Kazzaz , 1981 ; El-Desouky ,1989 ;Reuveni *et al* ,1995 and Awad, 2000).

In past and as yet this disease has commonly been controlled by fungicides and how the widespread usage of fungicides led to many problems, pertaining with the interaction of their residues with the biological system in the environment (El-Desouky,1989 and Awad *et al.*,1990).

To control any plant disease successfully all conditions connected with this disease should be known such as the true causal organism,disease distribution , the optimum environmental conditions , the economical losses and the reaction of the hybrids and cultivars of the host against the causal pathogen. Subsequently, many investigators recorded that any disease could be quietly and justly managed. (Ballantyne,1975);ElKazzaz 1981; El-Ammari and Khan,1983 ; Reifschneider *et al*,1985; Pranzanti and Brunelli,1992;Kabitarani ,*et al*,1997 and Abdel-Sayed,2000) .

Planting of resistant hybrids or cultivars at suitable time is considered one of the most important method for controlling most diseases mainly in greenhouse conditions far away environmental polluting.(Schlosser,1979; Nikulenkova,1984 ; Aalbersberg and Stolk , 1995 and El-Desouky and El-Deweny,2001) .

The objective of this study aimed to survey cucumber powdery mildew disease in some Egyptian localities,identify the true causal organism, evaluating the virulence of the patho types of the pathogen and testing the response of different cucumber hybrids , which commonly cultivated in commercial plastic houses , against the disease in order to select the most resistant cucumber hybs. or cvs. for cultivation at the proper time as well as incorporating these hosts in breeding programmes in future.

MATERIALS AND METHODS

Survey of cucumber to powdery mildew:

This survey was carried out on commercial plastic houses grown cucumbers during Spring season,2000at the most productive provinces [North of Sinai (Rafah),Beheira (El-Bostan region),Kaluebia(Kaha),and Giza (ElHaram & El-Dokki)] . Samples of cucumber leaves were collected from five hundreds and sixty five plastic houses distributed all over the abovementioned governorates and localities to identify the true pathogen and calculate the percentages of disease infection and severity (depending on infected leaf area) and suggested by Townsend and Heuberger (1943). Affected leaf area percent was also determined.

2- Pathogen identification:

The method described by Kable and Barbara,1963 which distinguish the fibrosin bodies inside the conidia of *Sphaerotheca fuliginea* (Schl.ex Fr.) Poll. but not *Erysiphe cichoracearum* Dc ex Mart. was followed.

The conidia were mounted in 3% aqueous solution of potassium hydroxide and were microscopically examined. Likewise, the morphology of germ tube and site of its germination were observed by dusting conidia on dry clean slides kept on glass rods inside Petri dishes and surrounded by 100 % relative humidity atmosphere and 25 °C for 24 h (Boesewinkel ,1977).

3-Virulence tests:

The infected leaf samples collected from abovementioned provinces (5 locations) were separately used in infecting detached leaves of Beit alpha cv. (highly susceptible) in Petri dishes inside laminar flowhood to multiply conidia .(Warkentin *et al*/1995) . Set of Peit-alpha seedlings (at third or fourth true leaf stage) were sprayed with the purified and multiplied conidia at the rate of 3×10^6 conidia / ml of each of *S. fuliginea* five isolates.(Reuveni *et al* 1995). Ten days later,disease percent, average colony's number /leaf and disease severity (according to Townsend and Heuberger, 1943) were determined.

4 – Reaction of fourteen cucumber hybrids to the disease:

Plantation:

Fourteen cucumber hybrids (Beit-alpha ,Primo, Sweet crunch ,Thamin, Nile-EZ, Hende-R2, Delta-star-R2, Hoki, Hana, Anas, Peto star, Salma, Marmar and Magdy were evaluated against *S.fuliginea* under greenhouse condtions. (Seeds were obtained from Peto seed Co. andVeg. Res. Depart Hort. Res. Inst. Dokki, Giza). Four pots (25 cm in diameter) were devoted for each hybrid and each pot receivd four seeds . Cultivation was carried out in sandy - clay soil (1:1) All pots were kept under greenhouse conditions at $26 \text{ }^\circ\text{C} \pm 2$.

Inoculation:

Typical powdery mildewed Beit - alpha leaves were collected from El-Bostan region (Beheira province). The leaves were shaken for 24 h before conidial harvest to dislodge the old conidia and ensure the inoculum viability. The colonies were brushed in distilled water and immediately were used in inoculating the previous cucumber hybrid at the third or fourth leaf stage (Ferriere and Molot,1988) at the rate of 3×10^6 conidia / ml (Reuveni *et al* ,1995). Other group of pots of all evaluated cucumber hybrids were kept without inoculation as check.

Disease assessment:

Five measurement parameters [disease percent, disease severity percent, av. colony's diameter (cm), av. colony's number / leaf and av. number of conidia/leaf(million)] were used for determining the disease ten days later of inoculation (Townsend and Heuberger, 1943; Gyongyver, 1987; Floris and Alvarez, 1991; Menzies *et al*, 1991; Haberle and Schlosser, 1993 and Bolteux *et al*, 1995).

RESULTS

1- Survey of cucumber to powdery mildew:

Data of the survey study revealed that powdery mildew disease caused severe damage on commercial plastic house grown cucumbers in all surveyed provinces.(Table-1).

The highest disease percentage was recorded inside the plastic houses of Beheira (El-Bostan-300 plastic houses), followed by Kaluebia (Kaha -100 plastic houses), Giza (El-Haram - 92 plastic houses) , North of Sinai (Rafah - 35 plastic houses) then Giza (El- Dokki-38 plastic houses) . The highest disease severity was in Beheira then respectively decreased in Giza (El-Haram),Kaluebia, Giza (El-Dokki) and North of Sinai (Rafah).

It is also clear from (Table -1) that the highest affected leaf area % was recorded in Beheira (72.06 %) and the lowest was in El-Dokki (36.09%) . In the rest surveyed provinces , the percent ranged from 41.04 to 56.37 %.

2- Identification of causal Pathogen:

The causal pathogen of cucumber powdery mildew disease was identified according to its morphological and diagnostic criteria as *Sphaerotheca fuliginea*(Schlecht ex Fr.)Poll.These criteria were:The markedly swollen conidia in long chains, particularly the three or four upper conidia. The oval to barrel shape of swollen conidia .The fibrosin bodies inside the conidia .The lateral germination of conidia. The occasionally formation of forked conidial germ tube .

2- Virulence tests:

It is clear from(Table-2) that all the patho types of *S.fuliginea* caused typical symptoms of powdery mildew disease but in different degrees. Beheira(El-Bostan isolate),was significantly the most virulent,followed by Giza (El-Haram and El-Dokki isolates), Kaluebia (Kaha), and North of Sinai (Rafah) isolates.

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Table (1): Powdery mildew incidence in commercial plastic houses surveyed during spring season, 2000.

Provinces and localities	Powdery mildew incidence				
	No. of plastic-houses	Av. mean of disease%	Av. mean of disease severity %	Affected leaf area %	Disease severity's level
1.North of Sinai (Rafah)	35	69.8	58.8	41.04	Moderate
2. Beheira (El-Bostan)	300	91.1	79.1	72.06	Very high
3- Kaluebia (Kaha)	100	80.6	68.8	55.45	High
4- Giza (El – haram)	92	79.5	70.9	56.37	High
5- Giza (el dokki)	38	53.7	67.2	36.09	Moderate
L.S.D at 0.05 level			1.3		

* Affected leaf area % = Disease % × Disease sever

Table(2): Pathogenicity test of *Sphaerotheca fuliginea* patho types on cucumber Beit alpha hybrid under greenhouse conditions

Source of patho types used in infection	Powdery mildew incidence		Fungus occurrence
	Disease %	Disease severity %	Av. Colonies number/leaf
North of Sinai (Rafah)	90	42.80	46
Beheira (El-Bostan)	95	18.00	107
Kaluebia (Kaha)	75	21.10	51
Giza (El-Haram)	80	31.30	96
Giza (El- Dokki)	80	24.70	101
Check	5	2.30	2
L.S.D.at 5% level		2.11	

3- Reaction of fourteen cucumber hybrids against the disease:

All tested cucumber hybrids (Table-3) were susceptible to *S.fuliginea* with different levels. Beit-alpha, Sweet-crunch, Nile-EZ, Hoki, Hana, Anas Salma and Magdy showed the highest percentages of infection whereas Thamin, Delta-star, Peto-star, and Marmar showed moderate percent of infection. The least percent of infection was shown by Primo and Hende. Moreover, it is known that the disease severity is the most important indication to differentiate whether the host is resistant or susceptible.

Table (3): Reaction of 14 cucumber hybrids against powdery mildew disease under artificial inoculation in greenhouse conditions

Cucumber Hybrids	Disease assessments				
	Av. of disease %	Av. of disease severity %	Av. colony's diameter (cm)	Av. colony's number / leaf	Av. conidia / leaf (million)
Beit alpha	100	50.2	0.5	99	69
Primo	50	20.9	0.2	41	45
Sweet crunch	100	55.1	0.4	93	61
Thamin	70	35.8	0.3	125	157
Nile-EZ	100	55.1	0.4	85	65
Hende-R2	50	25.5	0.3	56	53
Delta-star-R2	65	36.2	0.4	96	53
Hoki	100	35.1	0.2	80	55
Hana	100	60.4	0.6	93	81
Anas	100	60.4	0.7	109	89
Peto-star	75	39.3	0.4	85	59
Salma	100	55.1	0.4	96	65
Marmar	75	35.8	0.3	102	91
Magdy	100	50.2	0.4	56	61
L.S.D.at 5% level		9.8			

In this respect, significant differences between cucumber hybrids were recorded. The highly susceptible hybs. were Hana, Anas, Sweet crunch, Nile-EZ, Salma, Magdy and Beit-alpha. Peto-star, delta-Star-R2, Thamin, Marmar and Hoki showed moderate susceptibility. Hende-R2, and Primo were the least susceptible hybs. The highly susceptible hybs.

Hana and Anas showed by the highest diameters of the fungal colonies and likewise as for the colonies number /leaf and conidia /leaf. In general, data in (Table-3) prove that Hana and Anas hybs. are high susceptible while Primo and Hende-R2 are tolerant (low susceptible).

DISCUSSION

The survey of cucumber powdery mildew disease carried out in commercial plastic houses during season 2000 indicated the importance of this disease and how it causes serious damage inside plastic houses at all localities surveyed. Many investigators recorded the importance of this disease. Ballantyne (1975) found 150 collections from watermelon, melon and cucumber, all resembled the imperfect state of *Sphaerotheca fuliginea* in conidial characters. El -Ammari and Khan(1983) revealed that the pathogen *Levellula taurica* caused serious damage to greenhouse grown cucumbers. Branzanti and Brunelli (1992) demonstrated the epidemiology of *Erysiphe cichoracearum* and *S. fuliginea* on marrow melon, and cucumber under field and greenhouse conditions .

In present research, the cucumber powdery mildew was severe in the greenhouses of El-Bostan region (El-Beheira province) and the least disease severity was recorded in the greenhouses of North of Sinai Rafah meanwhile intermediate severities were recorded within the greenhouses at El-Kaluebia and Giza provinces(Kaha -El-Haram & El-Dokky regions). Also, the highest affected leaf area percent due to the disease was occurred at El-Beheira governorate and proportionally paralleled with the disease severity in the greenhouses of the rest provinces. These results are in agreement with those recorded by Al-Raddad (1993) who found that the yield was negatively correlated with the severity of the disease and sharply dropped when the disease severity reached 45% or more. Similar results were also obtained by Arimoto and Homma (1995) .

Because of the absence of perfect stage of the causal organism of cucumber powdery mildew disease, the identification was depended on the criteria of the conidial stage as the swollen shape of conidia (formed in long chains) particularly the apical three or four conidia , the oval or barrel shape of the swollen conidia, the fibrosin bodies within the conidia as well as the occasional conidial lateral germination and the forked shape of the conidial germ tube . According to these criteria, the pathogen of cucumber powdery mildew was identified as *Sphaerotheca fuliginea* but not *Erysiphe cichoracearum* . The same criteria were also followed by Kable and Barbara(

1963), El-Kazzaz (1981), Mazzanti de Castanon et al(1987), Gyjetkovic et al (1988), El-Mahjoub and Romdhani 1991), Khan and Sharma (1995), Kabitarani et al (1997) and Abd-El-Sayed (2000). Ballantyne (1975) demonstrated that 150 collections of powdery mildew pathogen on numerous cucurbits including watermelon, melon and cucumber resembled the imperfect state of *S.fuliginea* in conidial characters. Before 1958 *Erysiphe cichoracearum* was assumed to be the most common powdery mildew pathogen on cucurbits but Ballantyne investigation indicated that conidial *S.fuliginea* is predominant. Also, the present results are in accordance with those reported by Kontaxis (1979), El-Kazzaz (1981), Abul-Hayja and Trabulsi (1981), Reifschneider et al (1985), Khan and El-Ammari (1987) and Konstantinidou-Doltsinis and Schmitt (1998) and Awad (2000) that microscopic investigations revealed that *S.fuliginea* is the main causal pathogen of the cucumber powdery mildew disease .

As for virulence tests, the experiments exhibited existence of five different isolates of *S. fuliginea*. All isolates caused typical symptoms of the disease with different virulence degrees. Behira isolate was significantly the most virulent, followed by the two isolates of Giza , Kaluebia isolate and finally the isolate of North of Sinai. Such variations in virulence was the main reason of disease reaction on the tested cucumber hybrids and therefore these isolates were considered as patho types. Thomas (1978) recorded the existence of a new biological race of *S.fuliginea*, designated as a race-3. Also, these results are in harmony with those obtained by El-Desouky and El-Deweny (2001). They found that the isolates collected from Cairo and Giza were highly virulent on most of the tested hybrids.

The reaction of fourteen cucumber hybrids with the most virulent isolate of *S.fuliginea* was determined by many disease assessment (disease percentage, percent of disease severity, number of colonies / leaf, number of conidia / leaf and the colony's diameter . In this regard, Gyongyver (1987) used the number of mildewed spots only, Floris and Alvarez (1991) depended on the percentage of diseased tissues and the counts of conidia , Haberle and Schlosser (1993) counted the numbers of colonies /leaf, colony's diameter and the number of conidia /colony and Boiteux et al(1995) who used spore production and disease severity score.

The fourteen tested cucumber hybrids differed in their reactions against *S.fuliginea* .Hana, Anas, Sweet-crunch, Nile-Ez, Salma, Beit-alpha and Magdy were the most susceptible followed by the moderate susceptible hybs. Peto-star, Delta-star, Thamin and Hoki whereas Primo and Hende were the least susceptible hybs. In this respect, Schlosser (1979) found all 12 greenhouse cucumber cvs. were susceptible to *E.cichoracearum* and *S.fuliginen*. Nikulenkova (1984) screened 180 cucumber lines against natural *S. fuliginea* infection under cover and recommended Kobus mix, Nimbustol, hybrids 2343, 3219, N1133 and MP1 for their resistance. Also the

results of present hybrids are in harmony with the results of Angelov (1979), Aalbersberg and Stolk (1995). Also similar results were recorded by Awad (2000) and El-Desouky and El-Deweny (2001). They found that Beit-alpha was the most susceptible hybrid to *S. fuliginea*.

In conclusion, the susceptibility or resistibility of the tested cucumber hybrids may be due to weakness of the host mechanical structures, some host exudates may encourage the fungal penetration and disease development or other host exudates may contain inhibitory substances to fungal penetration or connected with plant resistance as phytoalexins and phenols. The abovementioned conclusive results confirm that all hybrids showed resistance must be recommended as suitable hybrids to be cultivated indoor cucumbers particularly in spring season or to be used in breeding programmes.

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دراسات على مرض البياض الدقيقى على الخيار والمتسبب عن الفطر
Sphaerotheca fuliginea تحت ظروف الصوب فى مصر
١- حصر المرض و تعريف الكائن الممرض ورد فعل هجن الخيار الشائعة
للإصابة بالمرض

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الملخص العربى

أكد حصر مرض البياض الدقيقى على الخيار الغرض الذى أجرى من اجله حيث أكد الحصر اهمية وخطورة هذا المرض وكيف يسبب اضرارا بالغة الخطورة لنباتات الخيار داخل صوب الانتاج البلاستيكية فى محافظات البحيرة والقليوبية والجيزة وشمال سيناء فى ربيع عام ٢٠٠٠ .

سجلت اعلى نسبة و شدة اصابة بالمرض فى صوب محافظة البحيرة (موقع البستان) ثم تأتى فى المرتبة الثانية كل من صوب الهرم(جيزة) وصوب قها (قليوبية)، بينما سجلت صوب الدقى (الجيزة) وصوب رفح(شمال سيناء) اقل نسبة وشدة اصابة بالمرض.

تبين نفس ترتيب المحافظات عند تقدير الخسائر الناتجة عن المرض مما يؤكد مدى خطورة ذلك المرض داخل صوب الانتاج الأمر الذى يستوجب معه اتخاذ كافة التدابير للحيلولة دون ظهور هذا المرض باستخدام اتسب الوسائل دون اللجوء الى استخدام المبيدات الفطرية سواء كانت وقائية أو علاجية.

ولوضع افضل البرامج وامثل طرق الوقاية من المرض ومقاومته لابد من تحديد المسبب الحقيقى للمرض وفى هذا المجال وبعد الفحص المورفولوجى لجراثيم الفطر الكونيدية وكيفية انبثاقها تبين ان المسبب الحقيقى للمرض الفطر *Sphaerotheca fuliginea* وليس الفطر *Erysiphe cichoracearum* كما كان معروفا من قبل.

أكدت اختبارات القدرة المرضية قدرة طرز الفطر المرضية الخمسة التي عزلت من المحافظات التي تم حصر المرض فيها على أحداث الإصابة و ظهور الأعراض النموذجية للمرض بدرجات متفاوتة وكان طراز البحيرة المرضى أكثر الطرز ضراوة في أحداث المرض يليه طرازي الجيزة (الهرم و الدقى) وطراز القليوبية وأخيرا الطراز المرضى المنتشر في محافظة شمال سيناء.

اتضح من البحث ان ١٤ هجينا من الخيار (وهي تقريبا كل هجن الخيار الشائع زراعتها فى الآونة الأخيرة فى مصر تحت ظروف الصوب الانتاجية) أصيبت بالمرض بدرجات مختلفة معنوية وذلك باستخدام خمسة معايير مختلفة لتقدير المرض وقد صنفت هذه الهجن على النحو التالي:-

١- هجن عالية الإصابة بالمرض (هنا ، أنس ، سويت كراتش، نيل، سالمة، مجدى ، بيت الفا ويوصى باستبعاد تلك الهجن وعدم زراعتها فى العروة الربيعية داخل صوب الانتاج البلاستيكية.

٢- هجن متوسطة الإصابة بالمرض (بيتو ستار ، دلتا ستار ، ثامين ، مرمر ، هوكى) ولإمناح من استخدامها فى حالة عدم توفر الهجن المقاومة التالية.

٣- هجن مقاومة لحد بعيد (هند ، بريمو) وقد حققا هذين الهجينين أقل درجة إصابة بالمرض و يوصى بأستخدامها. كما يقترح ادخال هذين الهجينين فى برامج التربية كمصدرين اضافيين من مصادر المقاومة للمرض.