

Host Range And Survival Of Powdery Mildew Of Cucumber In Ghor El-Safi Area, Jordan

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Abstract

The objective of this study was to determine the host range and inoculum sources of cucumber powdery mildew in Ghor El-Safi area, Jordan, using artificial inoculation on 15 selected cultivated crops and weed species. Survival of the pathogen was also assessed on cultivated crops and weed species commonly found in the area.

Erysiphe cichoracearum and *Sphaerotheca fuliginea* are identified in the area, where the second pathogen is reported for the first time in Jordan. It seems that *E. cichoracearum* is adapted to Jordan University campus while *S. fuliginea* is adapted to Ghor El-Safi area.

Though no perfect stage of these fungi was found in this study, the imperfect stage (conidia) of powdery mildew was present throughout the year on cultivated crops and/or weed species in fields or in plastic houses ensuring inoculum supply during the year. Out of 15 plant species tested for host range, *E. cichoracearum* was able to produce disease symptoms on 7 of the species. *S. fuliginea* was also able to cause the disease on 8 out of 11 plant species tested. While both pathogens failed to infect loofa and snapdragon, they were able to incite the disease on squash and cucumber but differ in their reaction towards the rest of the species tested.

Keywords: Host range, survival, powdery mildew, *Sphaerotheca fuliginea*, *Erysiphe cichoracearum*, Jordan.

الملخص

هدفت هذه الدراسة إلى معرفة المجال العائلي ومصادر العدوى الأولية لمرض البياض الدقيقي على الخيار بمنطقة غور الصافي في الأردن، وذلك عن طريق العدوى الاصطناعية لخمسة عشر عائلاً من المحاصيل الإقتصادية والأعشاب المتواجدة في المنطقة.

حددت ممرضات البياض الدقيقي على الخيار باستخدام عينات نباتات مصابة وفحصها مجهرياً للدراسة خصائصها التركيبية وانبثاق أبواغها الكونيدية، وسجل الفطر *Sphaerotheca fuliginea* لأول مرة في الأردن بمنطقة غور الصافي، كما حدد الفطر المستوطن *Erysiphe cichoracearum* من مزرعة الجامعة الأردنية. أظهرت النتائج تواجد أمراض البياض الدقيقي في معظم أشهر السنة على المحاصيل المزروعة في الحقل أو الدفيئة البلاستيكية، مشكلة مصدر عدوى بأبواغها الكونيدية على مدار السنة، بينما لم تظهر العينات المدروسة وجود الطور الجنسي. وعند إجراء العدوى الاصطناعية لخمسة عشر نوعاً نباتياً بالفطر *E. cichoracearum* ظهرت الإصابة على 7 منها، كما أصيبت 8 أنواع من أصل 11 نباتاً معدياً بالفطر *S. fuliginea*. فشل الفطران في إصابة نباتي اللوف وعرف الديك، إلا أنهما أصابا نباتات كل من الكوسا والخيار وتبين أن إصابة بقية النباتات المدروسة.

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Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important cash crops grown under plastic house conditions in Jordan. In 2000, the total area grown under cucumber was 1176 ha, with a total production of 87,311 tons.

Among the diseases associated with cucurbits, powdery and downy mildews are of common occurrence in commercial cucurbit plantings. The former, which is caused by the fungi *Sphaerotheca fuliginea* (Schlecht.) Pollacci and *Erysiphe cichoracearum* DC, is much more prevalent on cucurbits than the latter, especially under dry and hot conditions (Langston, 1999). The disease affects plants on a worldwide scale (Morgan, 2001).

This disease is characterized by a white or brownish mealy growth, found on upper and lower sides of the leaves and on young stems. If plants are severely attacked, the leaves and young stems may wither and die. In less severe cases, the plant may be weakened or stunted. Early defoliation, resulting from the disease, may cause premature ripening or sunscald (Langston, 1999). However, *S. fuliginea*, which causes the rusty brown-colored powder symptoms, is less common under field conditions compared to the other fungus (Hazelrigg, 2001).

Powdery mildew attacks many cucurbits, such as squash, cucumber, gourds, pumpkins, cantaloupes, and watermelons (Hazelrigg, 2001), sunflower (Gill *et al*, 2001), vine crops citron, vegetable marrow, West Indian gherkin, and other seldom-grown vegetables (Eastburn and Ortiz-Ribbing, 2001).

The sexual cleistothecia (perfect state) of *S. fuliginea* are rarely seen (Roberts and Boothroyd, 1984), but conidia formed asexually, are born in long chains. These conidia contain distinct fibrosion bodies, which are absent in *E. cichoracearum*. Conidia of *S. fuliginea* are ellipsoidal to barrel shaped and measure 25-37 μ to 14-25 μ (Boesewinke, 1980). During spore germination, the germ tubes produced by *E. cichoracearum* are simple while those formed by *S. fuliginea* are forked (Sitterly, 1978).

In the tropics as well as in areas where winter is not very severe, the powdery mildew can act over winter as active mycelium on a variety of volunteer plants and cultivated cucurbits (Jhooty, 1971). Butt (1978) indicated that powdery mildew caused by *S. fuliginea* recurs during the vegetative growth in the seasons. Between growing seasons fungi are less

active and survive in a perfect state as cleistothecia or remain in the form of active conidia in plant debris.

S. fuliginea is serious under plastic houses and spreads easily where hosts are available throughout the year (Sitterly, 1978). In Iraq, Sami (1985) reported that this pathogen is considered as a major problem in plastic houses, inducing heavy damage to cucumber when disease severity and incidence reach 72% and 100%, respectively.

Powdery mildew epidemics show that their population starts from an initial inoculum and then increases during their successive cycles throughout the growing season (Zadoks and Shein, 1979). Spores produced on over-wintering crop debris or weeds could cause primary infections, but major source of infections could come from the wind borne spores blown in from earlier produced crops. Afterwards, the disease can spread rapidly throughout the field by windborne spores (Hazelrigg, 2001).

During warm and humid weather, the powdery mildew fungus may produce over 2 million microscopic spores (conidia) from a square inch of infected leaf surface, within a week or ten days (Eastburn and Ortiz-Ribbing, 2001). These spores are then spread into nearby fields by wind and from plant to plant by wind, rain, insects, and human means. The disease severity depends upon environmental conditions, where infection increases as relative humidity increases. However, the fungus can cause a lot of damage under hot and dry conditions because it does not require free water for spreading (Hazelrigg, 2001).

The importance of ascospores as a primary inoculum is enhanced in the case of non-specific species of powdery mildew because of the wide host range (Sitterly, 1978). In this respect, Dinnor (1974) studied *Xanthium* sp. and *Papaver* sp. as a source of epidemic for *S. fuliginea* on cucurbits. El-ammari and Khan (1983), and Khan (1983) reported that, in addition to cucurbits, *Leucantha* sp., *Luffa cylindrica* and *Calandulla* sp. serve as inoculum sources of *S. fuliginea*.

Information on host range as well as source of inoculum of a disease is vital for planning future disease control strategies. This information on powdery mildew of cucurbits in Ghor El-Safi area has not been adequately studied. Hence, this research was conducted to study the source of inoculum

and host range of the powdery mildew pathogen in Ghor El-Safi area, Jordan.

Materials and Methods

a-Identification of the causal agent

Conidia of powdery mildew collected from different hosts and cucumber leaves of different ages, are brushed on clean glass slides and treated with 3% aqueous potassium hydroxide solution for one minute. Spores are then examined under light microscope to detect presence or absence of fibrosion bodies on their outer wall (Kable and Ballantyne, 1963). Conidia collected from Ghor El-Safi and Jordan University campus are dusted on dry clean slides, placed on glass rod triangle and kept in Petri dishes containing moistened filter paper. Petri dishes are inoculated in the dark at room temperature at 25°C for 36 hours. The morphology of germ tubes in germinated conidia are then studied.

Thirty conidia of each infected leaf samples were collected from *Cucumis sativus* and *Cucurbita pepo* (at Ghor El-Safi area) and from *C. sativus* and *Sonchus oleraceus* (at Jordan University campus). Fifty conidia per sample were measured, using the Boesewinke (1980) technique.

b-Source of inoculum and host range

The sources of conidia used for the artificial inoculation in host range testing were collected from cultivated cucumber plants at Ghor El-Safi Agricultural Station and from cucumber plants and the common weed *Sonchus oleraceus*, at the Jordan University Campus.

Fifteen cultivated and weed species were artificially inoculated with Ghor El-Safi and/or Jordan University Campus isolates of powdery mildew (Table 1).

Seeds were sown in two replicates of pots (15 cm in diameter) filled with peat moss and kept under plastic cages of 70x90x40 cm in the glass house. At cotyledon stage, all seedlings were inoculated by sweeping the healthy leaves with infected leaf, and then covered with plastic sheets for 36 hrs in order to raise the humidity (Joseph, 1988). Plants were examined for powdery mildew symptoms 12 days after inoculation.

To assess sources of endogenous inoculum, infected plants from cultivated cucurbits, weeds and ornamental plants that were found in the experimental site and in the nearby fields were collected every two weeks and examined for the presence of powdery mildew fungus.

Results

Conidia harvested from cucumber, inoculated with the cucumber isolates from Ghor El-Safi, measured in average of 27.22 and 17.37 μ . The length/width index was 1.57 and a length: width ratio of about 3:2, which gives the conidia nearly a spherical shape. Nevertheless, those conidia originated from *Sonchus oleraceus* isolates measured 29.98 and 15.05 μ with length/width index of 2.00 and length: width ratio of 2:1, giving an elliptical shape characteristic to this type of conidia. These two types of conidia gave also two different types of germ tubes when germinated, forked and sampled, respectively.

Also, fibrosion bodies were observed inside conidia of Ghor El-Safi isolates but not in the University campus isolates.

Host range of powdery mildew

Isolates collected from cucumber at Ghor El-Safi were virulent and produced disease symptoms on 7 out of the 15 plant species tested (Table 1), whereas *S. oleraceus* isolates were able to develop such symptoms on 8 out of 11 tested species (Table 1). This table shows that unlike cucumber isolates, *S. oleraceus* isolates incited the powdery mildew disease on common sow thistle, tobacco, dwarf chicory, okra, prickly lettuce and chrysanthemum but not on *Citrullus colocynthus*. However, both isolates failed to attack snapdragon and loofa as well.

Table (1): Reaction of selected host species under artificial inoculation to powdery mildew pathogens collected from cucumber and *S. oleraceus* grown under glass house conditions, Jordan, 1999.

Host	Source of Isolate	
	<i>C. sativus</i>	<i>S. oleraceus</i>
Cucumber (<i>C. sativus</i>)	+	+
Squash (<i>Cucurbita pepo</i>)	+	+
Watermelon (<i>Citrullus vulgaris</i>)	+	Nt
Muskmelon (<i>Cucumis melo</i>)	+	Nt
Muskmelon (<i>C. melo</i> var <i>flexuosus</i>)	+	Nt
Pumpkin (<i>Cucurbita maxima</i>)	+	Nt
<i>Citrullus colocynthis</i>	+	-
Common sow thistle (<i>Sonchus oleraceus</i>)	-	+
Tobacco (<i>Nicotiana glutanosia</i>)	-	+
Dwarf chicory (<i>Cichorium intybus</i>)	-	+
Okra (<i>Hibiscus esculantum</i>)	-	+
Snapdragon (<i>Antirrhinum orontium</i>)	-	-
Loofa (<i>Luffa cylindrica</i>)	-	-
Prickly lettuce (<i>Lactuca serriola</i>)	-	+
Chrysanthemum (<i>Chrysanthemum segetum</i>)	-	+

+ = Positive reaction - = Negative reaction Nt = Not tested

Sources of inoculum of powdery mildew

Powdery mildew disease was found on all surveyed samples of cucurbit crops, except on January, July and August. The growing period of the cucurbits covers most of the year except the period mid-March – May, (Fig.1). Besides, out of nineteen species of plants surveyed for the presence of powdery mildew, seven of them are found infected with powdery mildew during their respective growing period. These plant species were available throughout the year (except August) and could serve as possible sources of inoculum for powdery mildew, (Table 2).

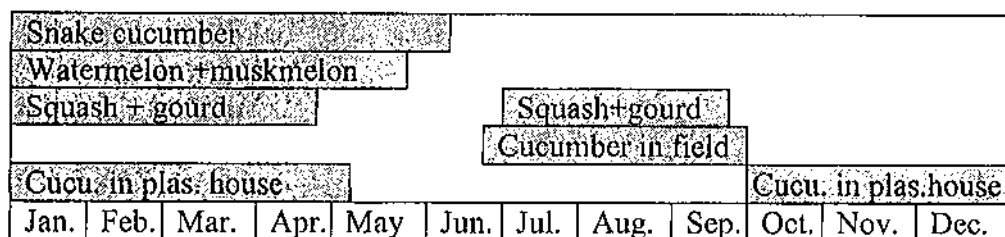


Figure (1): Occurrence of cultivated cucurbits during the year in Ghor El-Safi area, Jordan.

Table (2): Plant species occurred in Ghor El-Safi area and inspected for their reaction to powdery mildew under natural conditions in their habitat, Jordan, 1999.

Plant species	Host to powdery mildew	Season	Distribution
<i>Cichorium intybus</i>	No	Nov-May	Wide spread
<i>Lactuca serriola</i>	No	Nov-May	Wide spread
<i>Sonchus oleraceus</i>	No	Nov-May	Wide spread
Papaver rhoeas	No	Dec-Feb.	Wide spread
<i>Alhagi maurorum</i>	No	Dec-Aug	Wide spread
<i>Xanthium strumarum</i>	Yes	Jan-Mar	Water sources
<i>Polygonum sp.</i>	No	Jan-Jun	Nurseries
<i>Conyza bonariensis</i>	No	Mar-Sep	Nurseries
<i>Luffa cylindrica</i>	No	Perennial	Home gardens
<i>Chrysanthemum segetum</i>	No	Jan-Mar	Homes, nurseries
<i>Antirrhinum orontium</i>	No	Jan-Mar	Homes, nurseries
<i>Hibiscus esculantus</i>	No	Mar-Aug	Wide spread
<i>Raphanus sativum</i>	No	Dec-Mar	Wide spread
<i>Cucumis sativus</i>	Yes	Sep-Jul	Wide spread
Cucurbita pepo	Yes	Sep-Apr	Wide spread
<i>Citrullus vulgaris</i>	Yes	Mar-Jul	Wide spread
<i>Cucumis melo</i>	Yes	Mar-Jul	Wide spread
<i>Cucurbita maxima</i>	Yes	Sep-Apr	Wide spread
<i>Lagenaria siceraria</i>	Yes	Sep-Apr	Wide spread

Discussion

The presence of *S. fuliginea* on cucurbits in Ghor El-Safi is recorded by this study for the first time in Jordan. At Jordan University campus, *E. cichoracearum* was isolated from both cucumber and *S. oleraceus* plants, growing in the green houses.

Based on the morphological and host range test, the cucumber isolates collected from Ghor El-Safi area belong most probably to *S. fuliginea*, while those collected from the Jordan University campus are very similar to *E. cichoracearum* characteristics. These powdery mildew pathogen species seem to be adapted to cucumber plants in the former region, and to common sow thistle plants in the latter area, respectively.

It is obvious that conidial morphology and germination, fibrosion body, and host range tests could be used reliably to differentiate between these two powdery mildew species (*E. cichoracearum* and *S. fuliginea*), where the perfect stage of these two fungi is rare in nature.

The common sow thistle, dwarf chicory, prickly lettuce and anabsis showed, in this study, no powdery mildew infections throughout the season. However, it was reported that these plants have been found infected in other locations in Jordan where some of them developed the perfect stage of *E. cichoracearum* (Qasem and Abu-Blan, 1986).

None of the collected samples from cucurbits, weeds, and volunteer plants had yielded the perfect stage of the powdery mildew causal agent in this study. Similarly, Sitterly (1978), found that only 13% out of 515 tested samples have contained perithecia of *S. fuliginea*; such observation was also irregularly reported in some countries (Jhooty, 1971). Therefore, the ascospores or fungus survival in a perfect state plays no important role for disease and have no important role neither as a source of primary inoculum and fungal survival nor for disease initiation. Since *S. fuliginea* is an obligate parasite, it may survive as dormant mycelium on plant debris. A similar situation is also expected to occur in Ghor El-Safi area, where the perfect stage seems to have no role for disease initiation. Rather, the cultivation of cucurbits covers almost all year round, and the availability of host species in home gardens, field margins and vegetable nurseries (Table 2) seem to serve as the main source of primary inoculum for disease initiation in the area. This is true because the disease was found attacking

the above mentioned plant species, and occurred in protected cucurbits on early October. Also, in nearby adjacent areas, the disease was observed during the months of June and July, and the secondary infections continued till the end of the growing season. On open fields, powdery mildew appeared during September and October and the infection was observed as late as February. In adjacent fields powdery mildew appeared from May to June and remained till September and October, where the imperfect stage of both fungi were prevalent throughout the year. Similarly Jagger (1962) reported that powdery mildew fungi might persist in the vegetative form, while Yarwood (1957) pointed out that the over wintering stage of *S. fuliginea* is the conidial state.

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