DISEASES OF BIRD OF PARADISE (*STRELITIZIA REGINAE* BANKS) IN EGYPT ROOT AND FLOWER ROTS

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Abstract

Isolation trials were carried out on rotted roots, buds and flowers as well as necrotic spots on flower stalks and seeds yielded 13 fungi on PDA. *Fusarium* spp. were the most frequent showing 70.9, 38.2, 67.2 and 45.1 percent of occurrence, repectively. *F.oxysporum, F.solani* and *Alternaria* spp. were isolated from all plant organs and seeds, while *Botryodiplodia* spp., *Nigrospora* spp., *Pythium* sp. and *Rhizoctonia solani* from roots and *Botrytis cinerea* from rooted buds and flowers. *Pestalotia* sp. was also isolated from infected roots and seeds.

Pathogenicity tests proved that *Pythium* sp., *R.solani, F .solani, F. scripi, F.oxysporum, F.semitectum* and *F.moniliforme* were pathogenic to plant roots and the first four fungi were the most virulent. On the other hand, *B. cinerea* was the most destructive fungus on flower buds followed by *F.oxysporum* and *F.solani* .

With the exception of *F.moniliforme*, the fungi isolated from roots and seeds, in addition to *Alternaria* spp. isolated from flower buds and the resulting diseases were reported for the first time in Egypt.

Control studies indicated that Rizolex T and Topsin M at the rate of 2g/L water as root dip for one hour and soil drench before and one month after transplanting in infested soil, respectively, gave sufficient control against root-rots. Disease severity on plant roots and foliages was significantly decreased than the control. On the other hand, Topsin M (lg/L water) followed by Ridomil plus (2.5 g/L water) were effective against bud and flower rots in the field when they were used four times at 14-day intervals.

INTRODUCTION

Bird of paradise (*Strelitzia reginae* Banks) is grown commercially for cut flowers to produce all year round exotic cut flowers of relatively long keeping quality. It is considered one of the most promising ornamental export crops.

Considerable losses often occurred on plant stand and flower production ascribed to root and flower rots in different countries (Garibaldi, 1964; Grasso and Cutuli 1972; Orlikoski, 1977 a and b; Lorenzini, 1983; Davino, 1984). These diseases are mainly caused by several species of fusaria, *Cylindrocarpon destructans*, *Armillaria mellea* and *Botrytis cinerea*.

During the last ten years, Egyptian growers are annually faced with great losses resulting from rot diseases on roots, flower buds and flowers. Root rotted plants stunted with wilted leaves commonly appeared all year round, whereas the majority of flower rots during certain months only (October to March). Very few researchers studied these diseases and their control under Egyptian conditions (Assawah, 1969; El-Goorani; Abo-El-Dahab, 1973; Mahdy, 1992).

The present investigation was conducted to identify the causal pathogens of root-rots, bud and flower rots in order to determine their pathogenic capabilities and to evaluate certain fungicides as effective control means.

MATERIALS AND METHODS

I. Isolation and identification of causal fungal pathogens

Rotted roots and buds and flowers as well as seeds were collected from several plantations in Cairo, Giza, Qalubia and Dakahlia Governorates during the three successive seasons 1993-1995. Infected tissues were plated on PDA medium for 7 days at 25°C. The developed colonies were counted and frequency of each fungus was recorded. Pure culture were identified according to Barnett (1960), Booth (1971) and Domsch et al. (1980).

II. Pathogenicity studies

A. On seedlings (6 months-old)

Fungal inocula needed for soil infestation were prepared by growing each fungus on milet seed-sand medium at 25°C for 25 days. Soil was infested at the rate of 1% , i.e. fungal growth : formalin-sterilized soil, (w/w). Twenty seven healthy

seedlings were planted in 27 formalin-sterilized pots (25 cm diam.) per each treatment. A set of 9 seedlings were considered as a replicate of each treatment. Percentages of infection were recorded 7 times, at monthly intervals. Growing plant was considered a diseased one when wilt symptoms appeared on plant leaf (leaves). Severity was also calculated on plant foliage as follows:

$$\text{Severity} = \frac{\text{No. of wilted leaves on each plant X 100}}{\text{Total No. of leaves}}$$

As for root-rot, severity was recorded after 3,5 and 7 months from planting according to Salt (1982) as follows:

	Category No.	Conditions
Roots more white than black	0	Healthy-most roots white.
	1	Many more white than black.
	2	Slightly more white than black.
Roots more black than white	3	Slightly more black than white.
	4	Many more black than white.
	5	Most black. Plants moribund or dead.

Disease rating (D.R.) was calculated according to the following equation :

$$\text{D.R.} = \frac{\text{Sum of (category X number of plants in that category) X 100}}{\text{5 X total number of plants}}$$

B. On flower buds

The tested five fungi were grown on PDA at 22°C for 15 days. The developed spores were gently collected using distilled water and a hair brush. Spore suspensions (10^5 spores/ml water) were mixed with carborundum powder and applied to the surface of healthy buds by means of a hair brush, then covered with plastic bags for 24 hours. Ten buds were used as a replicate for each treatment. Percentages of infection were recorded 20 days after inoculation.

III. Chemical control

A. Root rots

The fungicides used in this study were Ridomil MZ, Rizolex T and Topsin M. Seedling roots were dipped in fungicide suspension (2g commercial product/one liter

of water) for one hour. Then, they were planted in non-infested or infested soil. A set of nine seedlings (one seedling/pot) were considered as a replicate for soil drenched with each fungicide (2g/liter of water) at the rate of 0.5 liter of fungicide suspension per each pot (25 cm. diam.).

Percentages and severity of infection were recorded similar to those previously described in pathogenicity tests.

B. Rots of flower buds and flowers

Efficacy of the fungicides Daconil 2787 (2.5g/L water), Ridomil plus (2.5g/L water) and Topsin M (1g/L water) were tested against flower and flower bud rots under field conditions. The experiments were carried out on plants (3-years-old) grown at Embaba, Giza Governorate during the two successive seasons, 1995 and 1996. Each experiment was conducted in a complete randomized block design with four replicates. Each replicate consisted of 25 plants. Fungicides spraying started on 25/9/1996. Four applications at 14-day intervals were used per each experimental season.

Percentages of infected flower buds and/or flowers were recorded 14 days after the last spray.

RESULTS AND DISCUSSION

I. Isolation and identification of the causal fungal pathogens

Data in Table (1) show that twelve fungi were isolated from rotted roots. The highest percentage of occurrence was recorded for fusaria (70.9%), i.e. *F.oxysporum* (28.7), *F. moniliforme* (17.3%), *F. solani* (10.7%), *F.semitectum* (8.2%) and *F.scirpi* (6.0%). Whereas, *Pythium* sp. and *R. solani* occurred at 9.1% and 4.1%, respectively.

In Egypt, only Assawah (1969) and El-Goorani and Abo-El-Dahab (1973) reported incidence of root rot diseases caused by *F.moniliforme* and *Erwinia carotovora*, respectively. Therefore, all the isolated fungi in this study, except *F.moniliforme*, were reported on bird of paradise for the first time in Egypt. Whereas, *Cylindrocarpon destructans* and *F.solani* (Grasso and Cutuli, 1977b), and *Armillaria mellea* (Davino, 1984) were found to be the causal pathogens of root rots in other nations, *Alternaria* spp. *Helminthosporium* spp., *F.oxysporum, F. solani* and *Botrytis cinerea* were isolated form rotted tissues of flower buds and flowers. On the other hand, the first four fungi in addition to *F.moniliforme, F.scirpi* and *F.semitectum* were isolated from necrotic lesions on flower stalks. As for seeds,

Alternaria spp., *F.moniliforme*, *F.oxysporum*, *F.solani* and *Pestalotia* sp. appeared in the isolation trials.

Occurrence of the isolated *Fusaria* recorded the highest percentages similar to that reported by Orlikowski (1977a). *B.cinerea*, *F.oxysporum* and *F.Solani* were also isolated from flower buds and flowers by Mahdy (1992). On the other hand, *F.moniliforme* (El-Mokadem, 1991) and *F. Moniliforme*, *F.oxysporum* and *F.solani* (Orlikowski, 1977 a and b) were isolated from infested flower stalks and seeds as indicated in our study.

According to the available literature, *Alternaria* spp. and *Helminthosporium* spp. isolated from buds and flowers and all fungi from seeds were recorded for the first time in Egypt.

Table 1. Percentage occurrence of fungi isolated from different plant organs.

Fungi	% frequency			
	Root rot	Flower bud & flower rots	Flower stalk necrotic lesions	Seeds
Alternaria spp.	5.4	332.4	330.0	41.0
Botryodiplodia spp.	2.1	0.0	0.0	0.0
Botrytis cinerea	0.0	28.7	0.0	0.0
Helminthosporium sp.	1.4	2.7	2.8	0.0
Fusarium moniliforme	17.3*	0.0	23.6*	11.6*
F.oxysporum	28.7*	25.3*	27.8*	31.1*
F.scirpi	6.0*	0.0	3.5*	0.0
F.semitectum	8.2*	0.0	5.9*	0.0
F. solani	10.7*	12.9*	6.4*	2.4*
Nigrospora spp.	2.2	0.0	0.0	0.0
Pestalotia spp.	4.8	0.0	0.0	13.9
Pythium spp.	9.1	0.0	0.0	0.0
Rhizoctonia solani	4.1	0.0	0.0	0.0
* % Occurrence of fusaria per each plant organs and seeds	70.9	38.2	67.2	45.1

II. Pathogenicity studies

A. On seedlings

Data presented in Table (2, 3 and 4) reveal that all the tested fungi were pathogenic since percentages of plants with wilted leaves and disease severity on foliages and roots were significantly higher than the control. Wilting symptoms on plant foliages were observed during the first month in case of *F.solani*, *Pythium* sp.

and *R.solani* and in the presence of all fusaria and all fungi. However, this reaction on foliages, which appeared as a result of roots infection started on the second, third and fifth month with *F.semitectum, F.moniliforme* and *F.oxysporum*, respectively. Disease severity on plant foliages and root gradually increased from one month to another to reach the maximum in the seventh month, i.e, the plants began to show complete decay in roots accompained with complete wilting in the stunted foliages (Fig. 1 and 2).

The symptoms which appeared on the vegetative growth of the plants (stunted foliage and wilted leaves) as a result of root infection, were similar to those previously described in Italy (Grasso and Cutuli, 1972) and Poland (Orlikowshi, 1977a). Also, *F.moniliforme, F.oxysporum* and *F.solani* were among the root rotting organisms in Italy and Poland as also found in this study.

According to the available literature, *F.oxysporum, F.scirpi, F.semitectum, F.solani, Pythium sp.* and *R.solani* are now recorded as root rot pathogens on bird of paradise for the first time in Egypt as well as *F.moniliforme* (Assawah 1969) and *Erwinia carotovora* (El-Goorani and Abo-El-Dahab, 1973).

B. On flower buds

All the isolated fungi (Table 5), except *Helminthosporium* sp. were pathogenic to flower buds causing rot disease. *B.cinerea* was the most destructive fungus causing 86.7% disease incidence, followed by *F.oxysporum* (36.7%) and *F.solani* (20.0%), whereas *Alternaria* sp. (13.3%) was the least. Inoculation with inoculum containing all the tested fungi gave 100 percent of disease incidence.

Most of the infected buds showed a complete gray rot (*B.cinerea*), light brown rot (*F.solani*) and dark brown rot (*F.oxysporum*), while others, including those inoculated with *Alternaria* sp., gave partial rots which allowed to produce weak or malformed florets with necrotic spots on flower petals. Isolation trials on PDA from tissues of rotted buds and necrotic petals yielded the same tested fungi. Artificial infection symptoms were, however, similar to those exhibited under natural infection (Figs. 3 and 4).

Data on bud flower rots and their causal fungal pathogens in Egypt, except those of *Altherharia* sp., were similar to the results of Mahdy (1992) who reported that *B.cinerea* was the most destructive fungus on buds and flowers in Egypt, followed by *F.tabacinum* and *F.oxysporum*. On the other hand, *B.cinerea* and several species of fusaria were responsible for rot diseases on buds and flowers in other countries (Garibaldi 1964; Orlikowski 1977; Lorenzini et al., 1983).

III. Chemical control

A. Root rots

Results in Tables (6 and 7) demonstrate that all the tested fungicides were ef-

Fig. 1. Naturally infected plant roots.

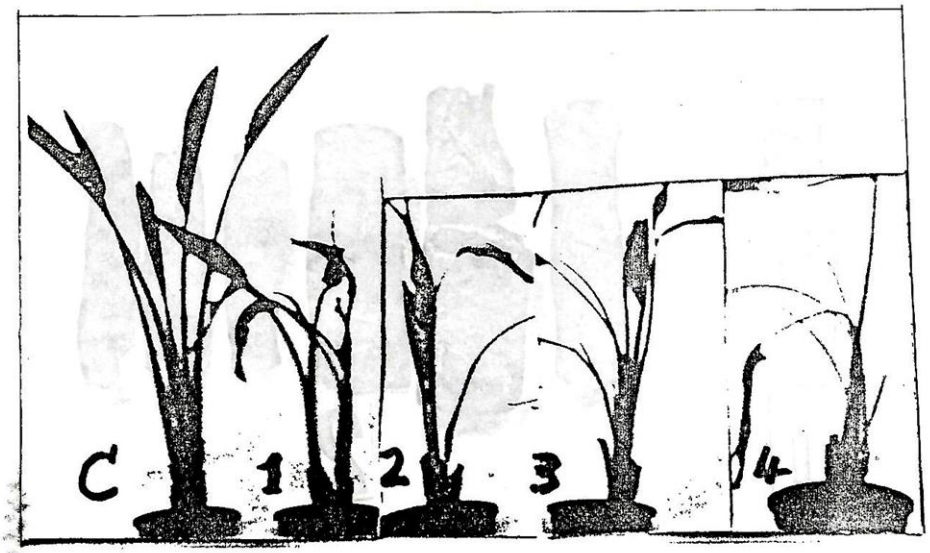

Fig. 2. Plants artificially infected with *F.oxysporum* (1), *R.solani* (2), *F.moniliforme* (3) and *Pythium* sp. (4), showing stunted foliages and wilted leaves.

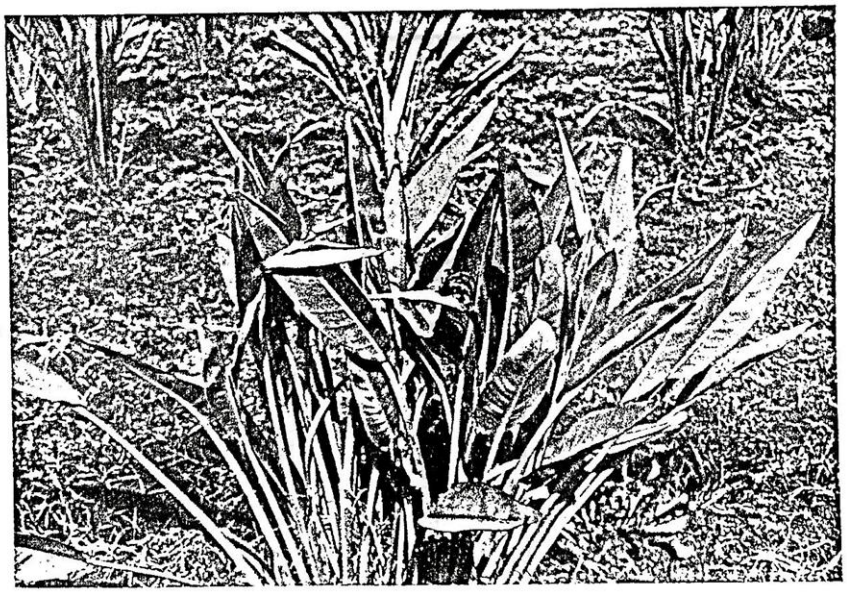

Fig. 3. Plants with healthy and rotted flowers in the field.

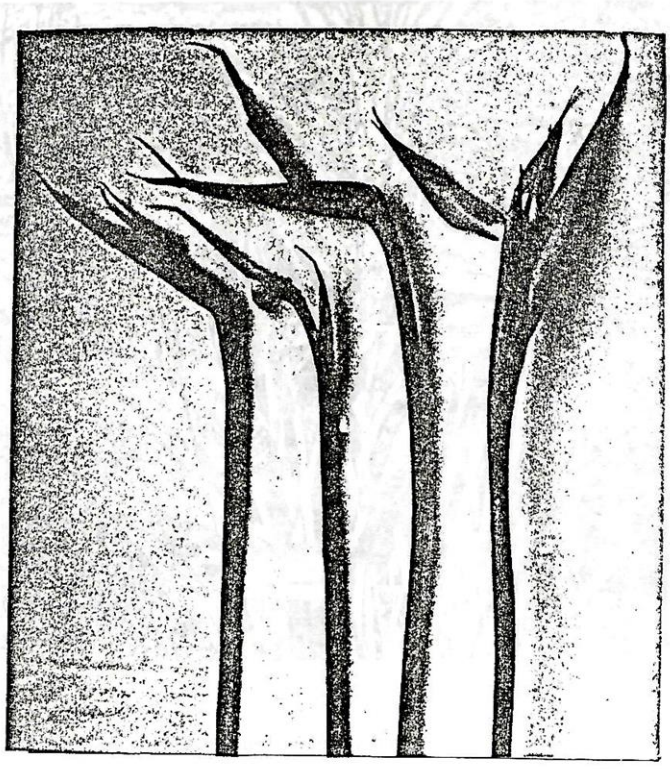

Fig. 4. Naturally rotted bud and flowers of bird of paradise.

Table 2. Percentages of infested plants grown in artificially infested soil during seven months after planting.

Fungi	Months after planting						
	1	2	3	4	5	6	7
Fusarium moniliforme	0.0	0.0	33.3*	55.6	66.7	66.7	100.0
F.oxysporum	0.0	0.0	0.0	0.0	11.1	33.3	44.4
F.scirpi	0.0	22.2	33.3	66.7	66.7	66.7	100.0
F.semitectum	0.0	11.1	33.3	33.3	55.6	66.7	100.0
F. solani	22.2	22.2	33.3	33.3	33.3	66.7	100.0
Pythium sp.	33.3	33.3	44.4	66.7	66.7	77.8	100.0
Rhizoctonia solani	33.3	33.3	33.3	55.6	66.7	66.7	66.7
All fusaria	33.3	33.3	33.3	66.7	66.7	77.8	100.0
All fungi	33.3	66.7	66.7	66.7	77.8	88.9	100.0
Control (without fungi)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D. at 5%	-	-	-	-	-	-	-

*% of infection = $\frac{\text{No of plants showing wilted leaf (leaves) X 100}}{\text{Total No. of grown plants}}$

Table 3. Disease severity on foliage of plants grown in artificially infested soil during seven months after planting.

Fungi	Months after planting						
	1	2	3	4	5	6	7
Fusarium moniliforme	0.0	0.0	11.1*	20.4	33.1	36.4	40.7
F.oxysporum	0.0	0.0	00.0	0.0	5.6	9.6	33.3
F.scirpi	0.0	8.3	16.7	16.7	27.0	38.1	50.0
F.semitectum	0.0	5.6	5.6	16.7	20.4	22.2	46.3
F. solani	5.6	11.1	19.7	27.0	38.1	42.9	73.8
Pythium sp.	8.3	12.5	25.0	33.3	40.7	50.0	100.0
Rhizoctonia solani	8.3	10.0	17.8	20.0	35.8	36.5	61.9
All fusaria	12.5	16.7	20.0	33.3	37.5	40.7	70.8
All fungi	20.0	25.0	33.3	40.7	50.0	66.7	100.0
Control (without fungi)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D. at 5%	-	-	-	-	-	-	34.8

* Disease severity on plant foliage = $\frac{\text{No of wilted plant leaves X 100}}{\text{Total No. of plants leaves}}$

Table 4. Percentages of infested plants grown in artifically infested soil during seven months after planting.

Fungi	Months after planting			Mean
	3	5	7	
Fusarium moniliforme	0.0	0.0	33.3*	1.8
F.oxysporum	0.0	0.0	0.0	2.0
F.scirpi	0.0	22.2	33.3	2.3
F.semitectum	0.0	11.1	33.3	1.4
F. solani	22.2	22.2	33.3	2.7
Pythium sp.	33.3	33.3	44.4	3.4
Rhizoctonia solani	33.3	33.3	33.3	2.7
All fusaria	33.3	33.3	33.3	3.5
All fungi	33.3	66.7	66.7	3.9
Control (without fungi)	0.0	0.0	0.0	-
L.S.D. at 5%	-	-	-	-

Table 5. Pathogenicity tests of some fungi to bird of paradise flower buds, 20 days after inoculation .

Fungi	% infection	symptoms
Alternaria sp.	13.3	Black rot
Botrytis cinerea	86.7	Gray rot
Fusarium moniliforme	20.0	light brown rot
F.oxysporum	36.7	Dark brown rot
Helminthosporium sp.	0.0	-
All fungi	100.0	Gray to black rot
Control (without fungi)	0.0	-
L.S.D. at 5%	11.5	-

fective in controlling root rots since they significantly decreased disease severity on plant foliages and roots compared with the control. There was no significant differences between them. Rizolex T was generally the most effective fungicide in this respect, followed by Topsin M and Ridomil MZ. As for disease severity on roots, Topsin M and Ridomil MZ were the most effective fungicides against *F.solani* and *Pythium* sp., respectively, while Rizolex T was effective against *R.solani* and in the presence of all fusaria and other fungi.

In this respect, drenching soil with Topsin M greatly decreased carnation plant rot caused by *R.solani* (Shehata et al., 1982). Also, using Rizolex as root dip and soil drench treatments before and after planting, respectively, gave good control of *R.solani* infection on carnation plants (Aloj and Garibaldi, 1982). On the other hand, soil borne diseases affecting geranium (*Pelargonium graveolens*) were controlled when cuttings were dipped in Topsin M before planting in infested soil (Hilal, 1985).

B. Rots of flower buds and flowers

Incidence of rot diseases in flower buds and flowers was significantly decreased than in the control with any of the tested fungicides (Table 8). Topsin M was the best fungicide since it gave more than four and two times reduction in disease incidence than the control in 1995 and 1996, respectively. Also, Topsin M significantly decreased the incidence of the disease compared with other fungicides.

Fungicidal sprays are the most common control means against plant foliage diseases. Fletcher (1984) reported that fungicidal sprays with one of the benzimidazole fungicides gave effective control against chrysanthemum flower damping off disease caused by *B.cinerea* or *Alternaria* sp. The results of Mahdy (1992) concerning chemical control of bud and flower rots of bird of paradise revealed that spraying with Topsin M and other fungicides were effective means in reducing incidence of these diseases.

Table 6. Efficacy of three fungicides on disease severity on foliages of plants grown in artificially infested soil, 3.5 and 7 months after planting.

Fungi	Months after planting											
	3				5				7			
	Control	Ridomil MZ	Ridomil T	Topsin M	Control	Ridomil MZ	Ridomil T	Topsin M	Control	Ridomil MZ	Ridomil T	Topsin M
Fusarium solani	9.0	0.0	0.0	0.0	17.5	2.3	5.1	2.0	46.9	5.7	7.5	4.3
Pythium sp.	25.0	4.2	10.0	5.6	40.7	6.7	17.2	33.3	100.0	24.2	38.9	40.7
Rhizoctonia solani	7.8	0.0	0.0	0.0	15.6	0.0	1.6	7.6	40.2	7.6	3.5	6.2
All fusaria	20.0	0.0	0.0	0.0	37.5	17.2	16.1	16.7	70.8	39.1	27.1	38.9
All fungi	33.3	9.5	12.5	0.9	50.0	42.2	20.0	36.1	100.0	41.7	40.0	51.1
Mean	19.0	2.7	4.5	1.3	32.3	10.1	12.0	19.1	71.6	23.6	23.4	28.2

L.S.D. at 5% for : Fungicide (F) = 11.3
Fungi (Fu) = 12.6
F X Fu = 25.3

Table 7. Efficacy of three fungicides on disease severity on roots of plants grown in artificially infested soil, 3,5 and 7 months after planting.

Fungi	Months after plantin											
	3				5				7			
	Control	Ridomil MZ	Ridomil T	Topsin M	Control	Ridomil MZ	Ridomil T	Topsin M	Control	Ridomil MZ	Ridomil T	Topsin M
Fusarium solani	1.3	0.0	0.2	0.0	2.5	1.0	0.6	0.5	4.3	2.3	2.4	1.9
Pythium sp.	1.7	0.0	0.5	0.9	3.6	0.8	2.6	2.9	5.0	2.7	3.0	3.2
Rhizoctonia solani	1.2	0.0	0.0	0.0	2.9	1.6	0.3	1.1	4.1	3.0	0.8	1.7
All fusaria	1.9	0.3	0.2	0.1	4.0	1.0	0.9	0.6	4.8	3.0	2.0	2.7
All fungi	2.2	0.9	0.5	1.0	4.6	2.7	1.6	3.0	5.0	4.3	2.1	4.3
Mean	1.7	0.2	0.3	0.4	3.5	1.4	1.2	1.6	4.6	3.1	2.1	2.8

L.S.D. at 5% for : Fungicide (F) = 0.4
Fungi (Fu) = 0.5
F X Fu = 1.0

Table 4. Percentages of infested plants grown in artifically infested soil during seven months after planting.

Fungi	1995		1996	
	% Disease incidence	% Disease*	% Disease incidence	% Disease*
Daconil 2787	6.5	232.3	9.3	82.8
Ridomil plus	8.9	142.7	7.7	120.8
Topsin M	3.	478.9	5.5	209.1
Control (without fungi)	21.6	-	17.0	-
L.S.D. at 5%	0.6	-	0.9	-

$$*\%\ \text{Decrease} = \frac{\text{control treatment - fungicide treatment}}{\text{fungicide treatment}} \times 100$$

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أمراض عصفور الجنة فى مصر
أعفان الجذور والأزهار

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قسم بحوث أمراض نباتات الزينة والطبية والعطرية- معهد بحوث أمراض النباتات مركز البحوث الزراعية - الجيزة .

أجرى العزل المعملى للمسببات المرضية من البذور والنباتات المتفزمة وذات الأوراق الذابلة. وعزلت عدة فطريات على بيئة البطاطس والدكستروز من الجذور المتعفنة، البراعم والأزهار وكذا من التبقعات على سوق الأزهار والبذور. ولقد كان الفطر فيوزاريوم اكثر الفطريات تكرارا فى العزل حيث تم عزله بنسبة ٧٠,٩ ، ٣٨,٢ ، ٧٦,٢ ، ٤٥,١٪ على الترتيب من الجذور، البراعم والأزهار، سوق الأزهار، البذور. كما عزلت الفطريات : فيوزاريوم اوكسيسبورم ، فيوزاريوم سولانى، والترناريا من كل الأعضاء النباتية المصابة وكذلك البذور. وعزلت الفطريات : بترووديبلوديا ، نجروسبورا، بيثيم، ريزوكتونيا سولانى من الجذور والفطر بوترايتس سيناريا من البراعم والأزهار المتعفنة. كما عزل الفطر بستالوشيا من الجذور والبذور المصابة.

ولقد أثبتت إختبارات العدوى الصناعية قدرة الفطريات : بيثيم، ريزوكتونيا سولانى، فيوزاريوم سولانى، فيوزاريوم إسكيربى، فيوزاريوم أوكسيسبورم ، فيوزاريوم وفيوزاريوم مونيليفورم على إصابة جذور النباتات وكانت الفطريات الأربعة الأولى أكثر الفطريات قدرة على إحداث العدوى. ومن ناحية أخرى فان الفطر بوترايتس سيناريا كان أكثر الفطريات قدرة على إحداث العدوى على البراعم الزهرية يليه الفطرين فيوزاريوم أوكسيسبورم وفيوزاريوم سولانى.

ولقد سجلت كل الفطريات التى تم عزلها من الجذور والبذور وأمراضها بالإضافة الى فطر الترناريا من البراعم الزهرية المصابة لأول مرة فى مصر ماعدا الفطر فيوزاريوم مونيليفورم الذى سبق عزله من الجذور.

ولقد أظهرت الدراسات التى أجريت لبحث إمكانية مقاومة أمراض عصفور الجنة باستخدام المبيدات الفطرية أن المبيدين ريزولكس تى أو توبسين م بمعدل ٢جم / لتر ماء لهما القدرة على المقاومة الفعالة لأعفان الجذور عند غمر الجذور فيها لمدة ساعة قبل الزراعة، ثم رى التربة بمحلولهما بعد شهر من زراعة الشتلات. ولقد خفضت المبيدات من شدة الإصابة على المجموع الخضرى والجذور. كما ثبت أن الرش بأى من المبيدين: توبسين م (١ جم / لتر ماء) أو ريدوميل بلاس (٢,٥ جم / لتر ماء) يعتبر وسيلة فعالة فى مقاومة أعفان البراعم والأزهار فى الحقل عند استخدامهما كل ١٤ يوما بمعدل أربعة رشات متتالية.