DISTRIBUTION OF EPIDEMIC DISEASES OF CUCUMBER UNDER PROTECTIVE PLASTIC HOUSES IN EGYPT

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Abstract. Survey on cucumber plants at four Governorates in Egypt, revealed, root rot, gray mould blight and downy mildew a epidemic diseases. High incidence of root rot disease syndromes on cucumber plants in Kafr El- Sheickh (81.4%) followed by El - Giza (40%) Governorates, the common fungi associated were *Fusarium solani* and *Fusarium oxysporum* with high frequency of *F. solani* (84.2%) in Kafr El- Sheickh followed by *F. oxysporum* (75.0%) in El- Giza Governorates. Gray mould disease incidence of immature cucumber fruits was (35%) mainly caused by fungal of *Botrytis cinerea* with high frequency (90%) in El-Gharbeia Governorate. Downy mildew disease incidence of cucumber plants caused by *Pseudoperonospora cubensis* was epidemic in El-Gharbeia Governorate (80.0%) with high disease severity. On the other hand, the minor diseases occurrence were powdery mildew caused by *Podosphaera fusca*, moderately recorded at El-Giza followed Kafr El- Sheickh Governorates and white stem rot caused by fungi of *Sclerotinia sclerotiorum* in El-Beheira and El-Gharbeia Governorates respectively. So, the alternative fungicides such as biocontrol agents, chemicals non fungicides *i.e.,* antioxidants, essential oils, and nanoparticles as eco-friendly agents will be consideration in integrated programme for avoiding diseases development to epidemic case, for improving yield quality and quantity.

Key word: *Cucumis sativus*; root rot; downy mildew; powdery mildew; gray mould; white rot; *Fusarium* spp.; *Pseudopernospora cubensis*; *Podosphaera fusca*; *Sclerotinia sclerotiorum*; *Botrytis cinerea.*

INTRODUCTION

Cucumber plants (*Cucumis sativus* L.) is an important economic vegetable crop of family cucurbitaceae grown under protective greenhouses conditions in the world [7]. In Egypt, the area cultivation of cucumber are increasing year after year in recently reclaimed lands in the open field and greenhouses for production enough quantity according to human population development [5].Worldwide cucumber fruits are used as fresh food diet, industrial and medical purposes due to health properties, high content of water (95%), carbohydrates (3.6%), protein (0.65%), free cholesterol, free sugar, low calories, rich of minerals calcium, in each (mg/ kg^{-1}), vitamin C (0.28), magnesium (1.3), beta carotene, pantothenic acid (0.026), antioxidants, anticancer and anti-inflammatory [23, 24]. Egypt ranks in 13^{th} place with regard to cucumber productivity across the world [20].

Cucumber plants are attacked by several fungal diseases causing considerable reduction of quantity and quality on cucumber fruit yields by soil borne fungi causing damping off, root rot and wilt diseases, several fungal genera, *F. oxysporum*, *F. solani*, *Rhizoctona solani*, *Sclerotium rolfsii*, *Macrophomina phaseolina* and *Sclerotinia* spp. [4, 8, 9, 18, 19, 44, 47] in addition, *Fusarium oxysporum* f. sp. *cucumerinum* [42]. This diseases were management of cucumber by chemical fungicides, inducer antioxidants agents such as salicylic acid, biocontrol agents such as *Trichoderma harzianum,* green macroalgae essential oils such as peppermint and clove, compost as well as nanoparticles of silver and copper as seed soaking, coating and soil drench [4, 18, 19, 22, 25, 44, 48].

Downy mildew caused by *Pseudoperonospora cubensis* [(Berck and Curts) Rostow], the obligate of Oomycetes fungi, is the still common destructive on cucumber worldwide, in Egypt [2, 16, 32, 33] and in Romania [28, 29], in Pakistan [34, 36] and in India [24, 40]. The highest disease severity of downy mildew on cucumber plants as the result of lowest average of temperature, 23.8°C and high relative humidity, 53.3% yield losses of cucumber fruit were (70-100%) recorded before in Egypt [16]. So, resistance cultivars of cucumber were used for supressive downy mildew incidence and reduction the losses in fruit yield production [16, 34, 32], chemical fungicides and resistance inducer were used for management downy mildew [2, 26, 39], biocontrol agents of *Bacillus* spp., essential oils and nanoparticles [33].

Powdery mildew causing by *Podosphaera fusca* (synonym *Podosphaera xanthii*) [15, 21, 35, 38], worldwide disrtibution [15, 21, 30, 31], its managemnt mainly by fungicides plant inducer agents such as salicylic, and oxalic acid which activation resistance enzymes in plants such as peroxidase and polyphenol oxidase enzymes [1, 26], microelement [35]. Biological induce resistance by isolate of tobaco mosaic virus (TMV) [21] commerical natural products of lemon oil, garlic oil, ginger oil, spirulina of algae and blight stop of biocontrol agent as well as fungicide of Score 25% EC [15].

Gray mould of cucumber caused by *Botrytis cinerea*, causing considerable reduction of quantity and quality of cucumber fruit yield [6, 40, 45, 47, 49] , during development young and immature fruits of cucumber. The disease was controlling by several chemical of fungicides, antioxidants [39, 46]. In this respect, foliar application of cucumber plants with essential oils nano formulation of clove and black seed (2:1) by the rate 1% significantly reduced gray mould on cucumber [49].

White rot caused by *Sclerotinia sclerotiorum* [3, 17] was management by biocontrol agents of *Trichoderma* spp. and bacterial isolates [3, 17].

This investigation aimed to survey of the common diseases incidence on cucumber cultivation under protective greenhouse in Egypt.

MATERIALS AND METHODS

Survey of cucumber diseases incidence

Survey of root and foliar diseases on cucumber during, growing winter season 2016-2017 at 1, 2 and 3 months after sowing during December 2016 to February 2017 at vegetative stage, begining flowering stage and during fruting stage respectively. Randomly five greenhouses 9x25 m^2, each one was included 8 rows with 50 plants / row with 50 cm distance between each two plants of Baracoda cultivar in El- Giza, El-Beheira, Kafr and El -Shieckh as well as Golden cultivar in El- Gharbeia, Governorates, Egypt. Soil different in locations in this study, its loam in El-Giza, sandy in El-Beheira, clay in El-Gharbeia and Kafr El – Shieckh, in addition the location in El-Gharbeia first time cultivation with cucumber under greenhouses rather than other locations mentioned before, the relative humidity high in Kafr El -Shieckh followed by El- Gharbeia, then in El- Beheira and El- Giza respectively and vice-versa with temperature degrees, Root rot, gray mould, powdery mildew, downy mildew, stem white rot diseases incidence were calculated of 100 plants of cucumber as the percentage of diseased plants and their severity was determined by linear scale of syndromes development of each disease were described below according to the following formulation [41]:

$$\text{Disease severity} = \Sigma (n \times r) \times 100/N$$

where: n= Number of infected leaves plant in each numerical disease grade, r = Number of the disease grade and N= Total number of plant multiplied by the maximum numerical disease grade.

Root rot disease incidence

Root rot disease of cucumber plant percentage of wilt and root rot syndromes of cucumber plants were recorded according to formulations mentioned before. Root rot severity on shoot system were determined according linear scale (0 - 4) according to [13] as following

0 = healthy plant.
1 = intial signs of wilting of aerial parts.
2 = up to 25% of plant wilted.
3 = up to 50% of plant.
4 = dead plant.

Powdery and downy mildew incidence

Percentage of powdery and downy mildew diseases of cucumber were calculated as formula mentioned before and disease severity was determined based on leaf area diseased according to linear scale (0-4) according to [38] as following

0 = no mildew
1 = mildew coverd 1-10% of leaf area.
2 = mildew coverd 11-25% of leaf area.
3 = mildew coverd 26-50% of leaf area.
4 = mildew coverd more than 50% of leaf area.

Stem white rot disease

Percentage of stem white rot during growing cucumber plants was determined 1, 2 and 3 months after sowing and disease severity was assessment as a percentage of rotten tissue of cucumber stem as follows [17]:

0 = healthy stem.
1 = 1 - 5 cm white rot of stem 25% wilt of shoot.
2 = 10 - 15 cm white rot of stem 50% wilt of shoot.
3 = 20 - 30 cm white rot of stem 75% wilt of shoot.
4 = more than 35 cm white rot of stem 100% wilt of shoot.

Gray mould of cucumber fruit

Percentage of diseased gray mould was determined on cucumber fruits during growing season. Disease severity was assessment as a percentage of discoloration and rotten of cucumber fruits as follows linear scale (0–5) according to [46,48] as follows:

0 = no symptoms.
1 = yellowish 50% of fruit.
2 = yellowish 100% of fruit.
3 = gray mould 50% of fruit.
4 = gray mould 50% + soften 50% of fruit.
5 = soften 100% of fruit.

Isolation of causal diseases of cucumber

Samples tissue of twenty five diseased cucumber plants of root rot, stem white rot and immature fruit rot with gray mould from randomly five greenhouses of each Governorate. Five pieces of each five each plant were washed several time individually with tap water.The sample tissue cut into small pieces and rinsed with (5%) chlorox (sodium hypochlorite) for 3 minutes and then cultured on potato dextrose agar (PDA) medium. Five specimens of diseased plant tissue placed in each Petri dish. Plates incubated at 25°C for five days. Different fungal colonies were purified using the single spore and hyphal tip techniques according to Booth 1971 [12]. While, the obligate parasites of powdery and downy mildews fungi were collected randomly from diseased plants in each location then dried under laboratory conditions according [27]. Frequency of isolated fungi will recorded using the following formula:

Fungal frequency % = Total fungal colonies of each sample/ total fungi colonies of each location x 100.

Identification of causal organisms

Isolated species of fungal genera facultative saprophytes were identification depends on characterizations of cultural and morphological based on the keys of [10, 12]. In addition, several isolated were confirmed identification with molecular biological tools and their pathogenicity tested were tested in previous research work [9, 50]. Meanwhile, the isolates of powdery and downy mildews were microscopy examination leaf surfaces [27] and confirmed view by Scanning Electron Microscope (SEM) after fixing piceses (4 mm), of cucumber leaf affected with powdery and downy mildews infection in buffer it in osmium tetroxide, Dehydration by a graded ethanol series from 25 to 100% then coated with gold then eximination by Scanning Electron Microscope (SEM) at National Research Centre Unit, Egypt.

Statistical analysis

At the (LSD) least significant difference ($P < 0.05$), the means of data collected from five replicates of each study were statistically analysis of variance (ANOVA) [37].

RESULTS

Root rot disease incidence

During winter season of cucumber growing cultivations, 2016 and 2017, cucumbers were grown as shown in (Fig. 1) chlorosis of lower to apical leaves, turned to yellowish, stunting of plant hight, wilting of shoot system, soften of root tissues and stem base were observed as well as lysis, soften and discoloration on root system tissue have been observed on cucumber plants in plastic green houses, in El- Giza, Kafr El-Shieckh, and El- Gharbeia, Governorates in Egypt. Data illustrated in (Fig. 2), indicated that, wilt, root rot syndromes of cucumber shoot system and their severity were progress increased with increasing cucumber growth. High percentage of wilting and severity recoded 3 months after sowing. Epidemic incidence of root rot on cucumber plants in, Kafr El- Shieckh (81.4%) followed by El- Giza (40.0%). On the other hand, lowest incidence of root rot disease in El-Beheira followed by El- Gharbeia Governorates. In this manner, the root rot pathogens on cucumber were illustrated in Figs. 3 and 4 show that three fungal genera are associated with root rot diseased tissue of

Figure 1. Wilt symptoms of shoot system associated with root rot disease of cucumber plant at Kafr El- Sheickh (A) shown epidemic stunt of major diseased plant. Meanwhile, in El-Giza Governorate (B) shown various root rot symptoms of plants included, chlorosis, yellowish and wilt on shoot system

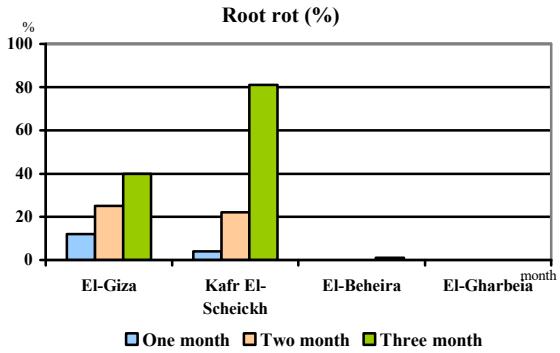

Figure 2. Incidence root rot disease on cucumber plants grown in plastic greenhouses conditions

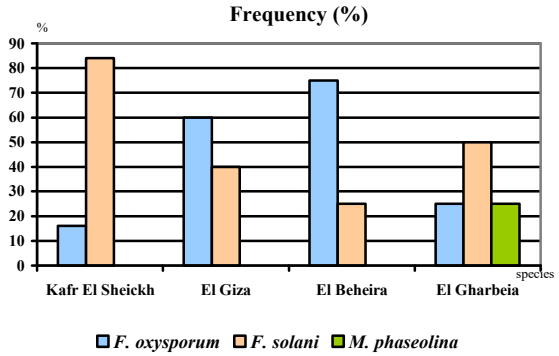

Figure 3. Frequency of fungi associated with root rot disease of cucumber plants at four Governorates in Egypt

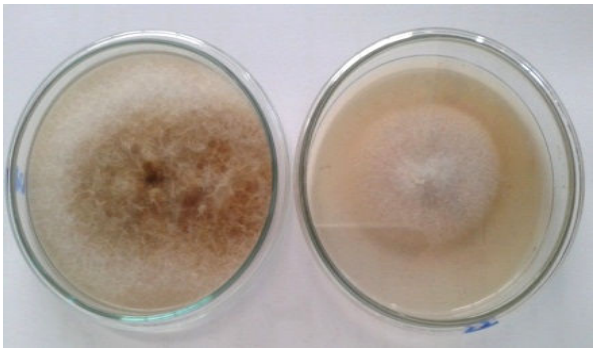

Figure 4. Cultures of fungi isolates of *F. solani* shown white to brown mycelial growth isolated from Kafr El-Sheickh (left) and *F. oxysporum* shown white cottony color of mycelial growth with purple pigment isolated from El-Beheira (right), Governorates, Egypt

cucumber plants i.e., *Fusarium oxysporum*, *Fusarium solani,* and *Macrophomina phaseolina,* in addition *F. oxysporum* and *F. solani* were the most common fungi associated with diseased plants in all locations in this study. High frequency of *F. oxysporum* in El- Beheira (75.0%) then El- Giza (60.0 %). Meanwhile, the lowest frequency in Kafr El- Shieckh (15.8%). The high frequency of *F. solani* (84.2%) was recorded in Kafr El- Sheickh followed in El- Giza (40%), then (50 %) in El- Gharbeia Governorates. *M. phaseolina* with frequncey (25%) was recorded only in El- Gharbeia. In this manner, root rot disease caused by pathogenic soil borne fungi more epidemic distribution of cucumber plant during growing season in greenhouse cultivation

in El- Giza and Kafr El-Shieckh Governorates regarding limitation and continuously cultivation the same area by cucumber which increasing population of pathogenic fungi.

Powdery mildew and downy mildew incidence

Data shown in (Table 1) indicated that powdery mildew caused by fungi of *Podosphaera xanthii* of cucumber plants during winter growing season 2016-2017 with high incidence at vegatative stage the first month after sowing in El- Giza Govermorate, moderate incidence in Kafr El-Sheickh Governorates with no observation in El- Beheira and El-Gharbeia Governorates. On the other hand, data in Table 1 and Fig. 5 show that downy mildew disease as epidemic by progress increased of percentage and severity on cucumber plants by the fungus of *Pseudoperonospora cubensis* in El- Gharbeia and lowest incidence in El Beheira ,with no observation of downy mildew in El-Giza and Kafr El-Sheickh Governorates. As shown in Fig. 6 indicated that view by scanning electron microscopy (SEM) of *Pseudoperonospora cubensis* is the causal pathogen of downy mildew and powdery mildew of cucumber plants, were observed El-Gharbeia and in El- Beheria Governorates.

Table 1. Powdery and downy mildews incidence on cucumber plants

Location	Mildew diseases incidence of cucumber plants (month) after sowing					
	Disease name	1		2		3
		December 2016		January 2017		February 2017
		%	D. S	%	D.S	%	D.S
El- Giza	Powdery	52.1	1.1	5.0	0.2	0.0	0.0
	Downy	0.0	0.0	0.0	0.0	0.0	0.0
Kafr El- Sheickh	Powdery	26.5	1.0	0.0	0.0	0.0	0.0
	Downy	0.0	0.0	0.0	0.0	0.0	0.0
El- Beheira	Powdery	0.0	0.0	0.0	0.0	0.0	0.0
	Downy	2.0	1.0	10.0	2.0	0.0	0.0
El –Gharbeia	Powdery	0.0	0.0	0.0	0.0	0.0	0.0
	Downy	33.0	1.7	55.0	2.1	90.0	3.0

D.S = disease severity

Figure 5. Epidemic incidence of downy mildew of cucumber plants shown chlorosis, necrosis spots in upper leaf surface (left) and black growth of fungal pathogen in lower leaf surface (right) in El- Gharbeia Governorate, Egypt

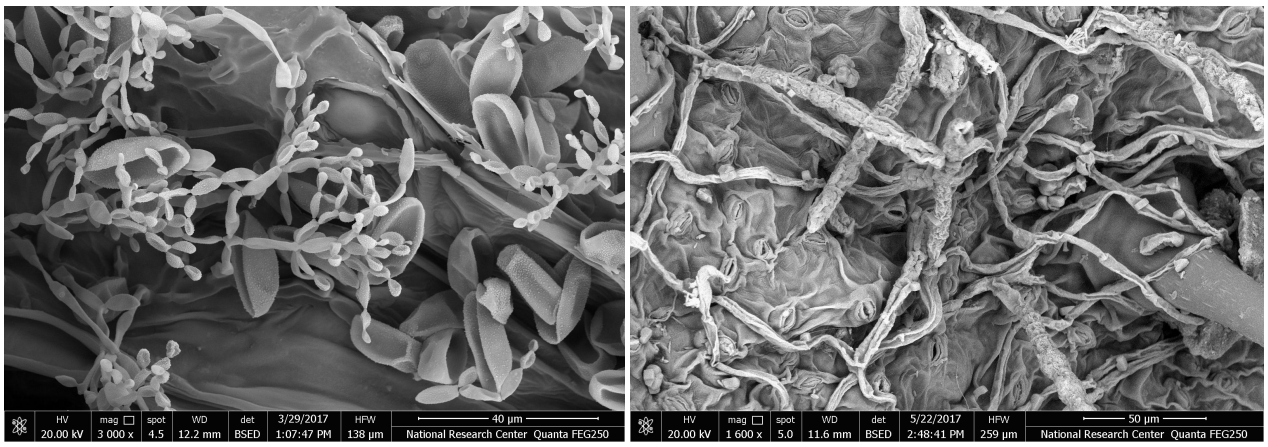

Figure 6. Morphology of pathogens of cucumber, downy mildew pathogen, *Pseudoperonospora cubensis*, shown sporangia and sporangiophore (left), and powdery mildew pathogen, *Podosphaera fusca*, shown conidiophores (right)

Gray mould and stem white rot of cucumber plant

Data in Table 2 and Figs. 7 and 8 show that fruit blight (gray mould) caused by fungus of *Botrytis cinerea* during development growth of young and immature fruits of cucumber plant during growing season in El- Gharbeia Governorate, which progress increased their percentage incidence and severity on cucumber fruits by increasing growth age of cucumber plants which reach to 35 % through third month, while the lower incidence of gray mould on cucumber fruits in El- Beheira followed by El- Beheira Governorates with no observation on gray mould on cucumber fruit in Kafr El- Shecikh. On the other hand, stem white rot of cucumber plant caused by fungus of *Sclerotinia sclerotiorum* in El-Beheria and El-Gharbeia Governorates respectively as the minor epidemic diseases in this investigation. with no observation of stem white rot of cucumber plants at El-Giza and Kafr El-Sheickh Governorates.

At the same manner, as shown in Table 3 and Fig. 8 data indicated fungus of *Botrytis cinerea* is the common causal pathogen of fruit blight of cucumber with high frequency (80.0%) in El-Gharbeia Governorate followed by (38.0 %) in El-Beheria Governorate, with no observation in Kafr El- Sheickh Governorate. *Botrytis cinerea* fungal colonies isolated from El- Gharbeia Governorates was grown on potato dextrose agar medium (PDA) at 25°C initially produced white mycelial turned grey to dark grey after incubation at 3-5 days, as shown in (Fig. 8) numerous of hard, small, irregular and blackish sclerotia were formation of mycelium accumulation in old culture 10-15 days. Meanwhile, *Sclerotinia sclerotiorum* the common causal pathogen frequency of stem white rot of cucumber plant (100 and 75.0%) in El-Beheria and El-Gharbeia Governorates respectively. In addition, *Alternaria alternata*. was associated with fruit gray mould (blight) disease in El-Beheria and El-Gharbeia Governorates. In addition *Sclerotinia sclerotiorum* the common causal pathogen of stem white rot disease of cucumber plant with high frequency (100 and 75.0%) in El-Beheria and El-Gharbeia Governorates respectively, with no observation of stem white rot on cucumber plants at El-Giza and Kafr El-Sheickh Governorates.

DISCUSSION

The survey during growing season of cucumber plants in plastic greenhouses 2016-2017 years on the common foliar and soil borne fungal diseases, mainly, for detection distribution of cucumber diseases under naturally infestation by pathogens for preparation the suitable management agents against epidemic diseases in each location. Root rot an epidemic incidence of root rot on cucumber plants in, Kafr El- Sheickh followed by El- Giza, while, lowest in El- Beheira followed by El- Gharbeia Governorates. The pathogens were the fungal genera i.e., *F. oxysporum*, *F. solani,* were the most common fungi associated with diseased plants in all locations in this study. High frequency of *F. oxysporum* in El- Beheira, El- Giza Governorates while, the high frequency of *Fusarium solani* recorded in Kafr El- Sheickh then in El- Giza Governorates. The lowest occurrence of *Macrophomina phaseolina* was recorded only in El- Gharbeia Governorate. The

Table 2. Fruit blight, leaf spot and stem white rot diseases of cucumber

Location	Gray mould and stem white rot of cucumber plants (month) after sowing						
	Disease name	1		2		3	
		December 2016		January 2017		February 2017	
		%	D.S	%	D.S	%	D.S
El –Giza	Gray mould	0.5	3.0	0.25	2.0	0.0	0.0
	Stem white rot	0.0	0.0	0.0	0.0	0.0	0.0
Kafr El –Sheickh	Gray mould	0.0	0.0	0.0	0.0	0.0	0.0
	Stem white rot	0.0	0.0	0.0	0.0	0.0	0.0
El –Beheira	Gray mould	0.0	0.0	0.0	0.0	2.0	3.0
	Stem white rot	1.0	0.2	2.0	0.3	5.0	4.0
El –Gharbeia	Gray blight	1.0	1.0	25.0	1.1	35.0	2.0
	Stem white rot	0.0	0.0	0.5	2.0	1.0	3.0

D.S = disease severity

Table 3. Fungi associated with foliar diseases of cucumber plants

Location	Disease name	Fungal name	Frequencey %
El- Giza	Gray mould	0.0	0.0 g
	Stem white rot	0.0	0.0 g
Kafr El-Sheickh	Gray mould	0.0	0.0 g
	Stem white rot	0.0	0.0 g
El- Beheira	Gray mould	*B. cinerea*	38.0 d
	Stem white rot	*S. sclerotiorum*	100.0 a
El- Gharbeia	Gray mould	*B. cinerea*	80.0 b
		A. alternata	20.0 f
	Stem white rot	*S. sclerotiorum*	75.0 c
		F. oxysporum	25.0 e

Values in each column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's multiple range test.

Figure 7. Gray mould of cucumber fruits in El-Gharbeia (left) and stem white rot (right) in El-Beheira Governorates, Egypt

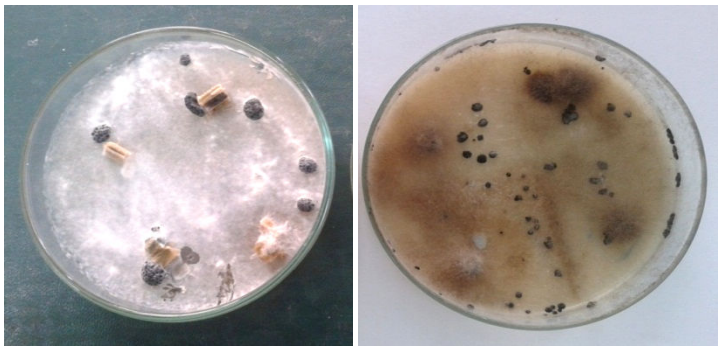

Figure 8. Cultures of *Sclerotinia sclerotiorum* with white mycelium and large black sclerotia (left) and *Botrytis cinerea* with dark mycelium and small sclerotia (right) on potato dextrose agar medium

epidemic distribution of root rot on cucumber plant during growing season in greenhouse cultivation in Kafr El- Shieckh followed by El- Giza Governorates regarding limitation and continuously cultivation the same area by cucumber which increasing population of pathogenic fungi [9, 19, 22, 44, 48]. This disease was controlling on cucumber in greenhouses by soaking cucumber seeds in 2% peppermint extract and enhance seedlings growth [22]. Seed soaking of cucumber in suspension of salicylic acid (4 mM), for 12 hrs before sowing followed by coating with *Trichoderma harzianum* and soil amemded with (2 ton/fed) of compost significantly reduced root rot and wilt diseases caused by some fungi [19]. Recently, silver nanoparticles was controlling seed rot, pre and post emergency damping-off of cucumber seedlings by of soaking cucumber seeds in silver nanoparticles (20 ppm) for 60 minutes before sowing in potted soil artificially infested by each pathogenic fungi [48]. Recently, for minimization fungicides used in management root rot of cucumber, green macroalgae, *Ulva fasciata,* and *Enteromorpha flexuosa* were used *in vitro* and *in vivo* to suppress causal pathogens of *M. phaseolina, F. solani* and their root rot incidence on cucumber plants [18], copper oxide nanoparticles was suppress myelial growth of *Fusarium solani* the causal of root rot of cucumber and their ability for induce root rot disease in cucumber as well as enhancing growth and yield of ccumber [25].

Pseudoperonospora cubensis is the causal agent of downy mildew of cucumber diseased was observed only in El- Gharbeia and El- Beheria Governorates. High incidence of downy mildew in El- Gharbeia followed in El Beheira with no observation in El-Giza and Kafr El-Sheickh Governorates, mainly regarding to the different conditions inside plastic house like, inoculium rate, temperature degrees, density of plants, amount and irrigation intervals, aireation, amounts and types of fertilizers specially nitrogen, cultivars, relative humidity. In addition, downy mildew on cucumber is the most serious problem in the greenhouse, where warm wet weather promotes disease development, severely infected leaves may die in 10 to 14 days [24, 36]. The epidemic distribution of downy mildew on cucumber plants by pathogen, *Pseudoperonospora cubensis* due to wide host range which attacking several cucurbit plants such as *Cucumis sativus, C. melo, Cucurbita pepo, C. maxima,* and *Citrullus lanatus* recorded in Romania [28, 29]. So, several researcher were development integrated agents for reducing epidemic distribution of downy mildew on cucumber for enhancing plant growth and yield production by cultivation resistance cultivars in Egypt [32], biocontrol agents of *Bacillus subtilis* and *B. pumilus*, nanoparticles of clove and caster essential oils [33]. Recently, in Egypt some fungicides of, Profiler, Previcur Energy, Previcur N, Infinito and Veulet were applicable to control downy mildew on cucumber plants [2]. In Egypt, the promising effective fungicides

of Flent, Score, Topas, Thiovit and Actamyl as well as resistance inducer chemicals of KNO_3 and K_2HPO_4 were used for suppress the development incidence powdery mildew [1].

Powdery mildew disease on cucumber, caused by *Podosphaera fusca* are is the minor distribution during this investigation it was recorded before in Egypt [15, 21, 30, 31, 38]. This disease was management plant inducer agents such as salicylic, and oxalic acids as well as yeast extract which activation resistance enzymes in plants such as peroxidase and polyphenol oxidase enzymes [26]. Essential oils, commercial natural products of algae spirulina (*Arthrospira platensis*), blight stop (*Trichoderma harzianum* and *Bacillus subtilis*) and Score 25% EC were high efficacy suppressive powdery mildew of cucumber, with trivial toxicity of natural material [15,38].

Epidemic spread of *Botrytis cinerea* under favourable environmental conditions specially temperature and high relatively humidity during growing season in December and February in El-Gharbeia Governorate with highly significantly lossess of the total number of young and immature cucumber fruits during developing growth [11, 14, 39, 40]. Grey mould of cucumber fruit caused by air borne fungi of *Botrytis cinerea* Pers. (*Botryotinia fuckeliana*) quickly develop distribution in a greenhouses regarding to high humidity [14], wide host range of more than 200 plant species worldwide [43], the common symptoms on developing gray mould rotten on cucumber fruit are yellowish followed by browning [6, 11]. In this respect, gray mould of cucumber fruits was controlling by several chemical of fungicides, antioxidants [39, 46]. In addition, foliar application of cucumber plants during growing by essential oils nano formulations of clove and black seed essential oils with ratio respectively (2:1) by the rate 1% significantly reduced gray mould on cucumber [49].

White stem rot caused by *Sclerotinia sclerotiorum* was management by biocontrol agents of *Trichoderma* spp. and bacterial isolates [3, 17]. In this contex, biocontrol agents treatments as individual and in combinations were reduction lytic enzyme activities of chitinase and β 1,3-glucanase and enhancing enzyme related resistance such as peroxidase (PO), polyphenoloxidase (PPO) and phenylalanine ammonia lyase (PAL**)** as well as and increased yield of cucumber fruits up to 2.5 kg/plant [3].

So, new strategies for management epidemic diseases of cucumber depends of various agricultural practical, climatic conditions, applicable biotic and abiotic agents for suppress pathogens growth for enhancing healthy production of cucumber fruit with no observation of phytotoxicity syndromes on cucumber plants.

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REFERENCES

[1] Abd-Elsayed, M.H.F., Sarhan, E.A.D., Ebrahiem, A.M.Y., (2019): Management of cucumber powdery mildew disease caused by *Podosphaera xanthii* by some fungicides and resistance inducing chemicals. Current Science International, 8(4): 820-828.

[2] Ahmed, M.I., El-Hassawy, M.M., (2021): Effect of temperature, relative humidity and some systemic fungicides on cucumber downy mildew and certain crop parameters. Egyptian Journal of Phytopathology, 49(1): 63-74.

[3] Ahmed, G., Makhlouf A.H., Selim, M.E., (2021): Efficacy of compost and some biocontrol agents in controlling cucumber white mould disease under protected house conditions. Alexandria Science Exchange Journal, 42(2): 495-507.

[4] Al-Ameiri, N.S., (2014): Control of cucumber damping – off in the field by the bio-agent *Trichoderma harzianum*. International Journal of Agriculture and Foresty, 4(2): 112-117.

[5] Ali, S.A., (2012): Modeling of some solar radiation available at different orientations of greenhouses. Misr Journal of Agricultural Engineering, 29(3): 1181-1196.

[6] Al-Sadi, A.M., Al-Said, F.A., Al-Kaabi, S.M., Mohammed, S., Al-quraini, S.M., Al-Mazroui, S.S., Al-Mahmooli I. H., Deadman, L. D., (2011): Occurrence, characterization and management of fruit rot of immature cucumbers under greenhouse conditions in Oman. Phytopathologia Mediterranea, 50: 421-429.

[7] Alsadon, A., Al-Helal, I., Ibrahim, A., Abdel-Ghany, A., Al-Zaharani, S., Ashour, T., (2016): The effects of plastic greenhouse covering on cucumber (*Cucumis sativus* L.) growth. Ecological Engineering, 87: 305-312.

[8] Al-Tuwaijri, M.M.Y., (2015): Studies on Fusarium wilt disease of cucumber. Journal of Applied Pharmaceutical Science, 5(2): 110-119.

[9] Attallah, A.G., Ziedan, E.H., Sahab, A.F., (2019): Molecular characterization and pathogenicity of *Fusarium* species causing root rot disease of cucumber in greenhouse in Egypt. Plant Archives, 19: 1301-1307.

[10] Barnett, H.L., Hunter, B.B., (1998): Illustrated genera of imperfect fungi 4th edition APS Press st. Paul. Minnesota, USA, 218 pp.

[11] Blancard, D., Lecoq, H., Pitrat M., (2005): A colour atlas of cucurbit diseases: observation, identification and control. Manson Publishing, London, 2005 p.

[12] Booth, C., (1971): The genus *Fusarium*. Commonwealth Mycological Institute, Kew, Surrey, 237 p.

[13] Carver, C.E., Pitt, D., Rhodes, D.J., (1996): Aetiology and biological control of Fusarium wilt of Pinks (*Dianthus caryophyllus*) using *Trichoderma aureoviride.* Plant Pathololoy, 45: 618-630.

[14] Elad, Y., Vivier, M., Fillinger, S., (2016): Botrytis, the good, the bad and the ugly. In: Fillinger S, Elad Y (eds) Botrytis-the Fungus, the Pathogen and its Management in Agricultural Systems. Springer International Publishing Switzerland, pp 1.

[15] Elagamey, E., Abdellatef, M.A., Haridy, M.S., Abd El-aziz, E.A., (2023): Evaluation of natural products and chemical compounds to improve the control strategy against cucumber powdery mildew. European Journal of Plant Pathology, 165: 385-400.

[16] El-Hafaz, A., El-Din, B., El-Doweny, H.H., Awad, M.M.W., (1990): Inheritance of downy mildew resistance and its nature of resistance in cucumber.

Annals of Agricultural Science Moshtohor, 28: 1681-1697.

[17] EL-Kafrawy, A.A., (2008): Biological control of white rot of cucumber caused by *Sclerotinia sclerotiorum* under greenhouse conditions. Journal of Agricultural Research, 86(2): 427-439.

[18] El-Sheekh, M.M., Ahmed, A.Y., Soliman, A.S., Abdel-Ghafour, S.E., Sobhy, H.M., (2021): Biological control of soil borne cucumber diseases using green marine macroalgae. Egypt Journal of Biological Pest Control, 31: 72.

[19] Elwakil, M.A., El-Metwally, M.A., Elsherbiny, A., Eisa, K.N.M., (2015): Enhancing systemic acquired resistance in cucumber to control root rot and wilt diseases with reference to yield and quality. Plant Pathology Journal, 14(4): 223-233.

[20] FAOSTAT, (2018): Retrieved 2020-02-15. Countries-Select All; Regions-World + (Total); Elements-Production Quantity; Items-Cucumbers and Gherkins. FAOSTAT; Rome, Italy.

[21] Farrag, E.S.H., Ziedan, E.H., Mahmoud, S.Y.M., (2007): Systemic aquired resistance induced in cucumber plants against powdery mildew disease by pre-inoculation with tobacco necrosis virus. Plant Pathology Journal, 6(1): 44-50.

[22] Farrag, E.S.H., Moharam, M.H.A. , Ziedan, E.H., (2013): Effect of plant extracts on morphological and pathological potential of seed-borne fungi on cucumber seeds. International Journal of Agricultural Technology, 9(1): 141-149.

[23] Hao, J., Li, Q., Yu, H., Wang, H., Chai, L., Miao, T., Jiang, W., (2020): Comparative proteomic analysis of cucumber fruits under nitrogen deficiency at the fruiting stage. Horticulture Plant Journal, 7: 59-72.

[24] Hembram, S., Dutta, S., Bhattacharya, I., Saha, A., Majumder, D., (2014): Influence of weather variables on morphological structures of *Pseudoperonospora cubensis* in cucumber. Journal of Agrometeorology,16(2): 219-221.

[25] Kamel, S.M., Elgobashy, S.F., Omara, R.I., Derbalah, A.S., Abdelfatah, M., El-Shaer, A., Al-Askar, A.A., Abdelkhalek, A., Abd-Elsalam, K.A., Essa, T., Kamran, M., Elsharkawy, M.M., (2022): Antifungal activity of copper oxide nanoparticles against root rot disease in cucumber. Journal of Fungi (Basel), 8(9): 911.

[26] Khalil, M.E., Ashmawy, E.M.A., (2019): Induction of systemic disease resistance in cucumber plants treated by the spray of some biotic and abiotic agents to control downy mildew disease. Egypt Journal Agriculture Research, 97(1): 19-37.

[27] Křístková, E., Lebeda, A., Sedláková, B., (2009): Species spectra, distribution and host range of cucurbit powdery mildews in the Czech Republic, and in some other European and Middle Eastern countries. Phytoparasitica, 37: 337-350.

[28] Lebeda, A., Cohen, Y., (2011): Cucurbit downy mildew (*Pseudoperonospora cubensis*) – biology ecology, epidemiology, host-pathogen interaction and control. European Journal of Plant Pathology, 129: 157-192.

[29] Lebeda, A., Cohen, Y., (2012): Fungicide resistance in *Pseudoperonospora cubensis*, the causal pathogen of cucurbit downy mildew, Chapter 4. In: Thind, T.S. (Ed.): Fungicide Resistance in Crop Protection. Risk and Management. CABI, Wallingford, UK, pp. 44-63.

[30] Lebeda, A., McGrath, M.T., Sedláková, B., (2010): Fungicide resistance in cucurbit powdery mildew fungi; Chapter 11, pp. 221-246. In: Carisse, O. (Ed.): Fungicides. InTech PublishersRijeka, Croatia, 538 p.

[31] Lebeda, A., Sedláková, B., Křístková, E., Widrlechner, M.P., Kosman, E., (2021): Understanding pathogen population structure and virulence variation for efficient resistance breeding to control cucurbit powdery mildews. Plant Pathology, 70: 1364-1377.

[32] Metwally, E.I., Rakha, M.T., (2015): Evaluation of selected *Cucumis sativus* accessions for resistance to *Pseudoperonospora cubensis* in Egypt. Czech Journal of Genetics Plant Breeding, 51: 68-74.

[33] Mohamed, A., Hamza, A., Derbalah,A.,(2016): Recent approaches for controlling downy mildew of cucumber under greenhouse conditions. Plant Protection Sciences, 52: 1-9.

[34] Muhammad, W., Imran, U.H., Khan, S.A., (2014): Farooq, A., Mudassir, I., Muhammad,S., Zia, U., (2014): Screening of cucumber varieties against downy mildew (*Pseudoperonospora cubensis*) and its chemical management. Pakistan Journal of Phytopathology, 26(1): 21-24.

[35] Reuveni, M.V., Agapo,V., Reuveni, R., (1997): Spray of microelement solution induce local and systemic protection against powdery mildew (*Sphaerotheca fuliginia*) in cucumber plants. European Journal of Plant Pathology, 103: 581-588.

[36] Shama, S.M., Amer M.A., El-Farnawany, M.A., (1998): Greenhouse evaluation of adjutants for effective control of downy mildew (*Pseudoperonospora cubensis*) of cucumber (*Cucumis sativus* L.) with fungicides. Crop Protection, 63: 1057-1066.

[37] Snedecor, G.W., Cochran, W.G., (1980): Statistical Methods. 7th Edn. Iowa State Univ. Press, Ames, 257 p.

[38] Soleimani H, Mostowfizadeh-Ghalamfarsa R, Ghanadian M, Karami A, Cacciola SO. (2023): Defense mechanisms induced by celery seed essential oil against powdery mildew incited by *Podosphaera fusca* in cucumber. Journal of Fungi (Basel). 10(1): 17. doi: 10.3390/jof10010017.

[39] Soliman, H.M., El Metwall, M.A., Elkahky, M.T., Badawi, W., (2015): Alternative to chemical control of grey mold disease on cucumber caused by *Botrytis cinerea* Pers. Asian Journal of Plant Pathology, 9(1): 1-15.

[40] Sujoy, S., Ashtekar, N.D., Rai, A.B., Sharma, M.A., Balaraman, A.K., (2017): Synergistic effect of Benalaxyl 8% and Mancozeb 65% WP in combating downy mildew of cucumber. Journal of Mycopathological Research, 55(3): 227-230.

[41] Waller, J.; Cannon, P. Fungi as Plant Pathogens. In Plant Pathologist's Pocketbook, 3rd ed.; CABI Publishing: Boston, MA, USA, 2002; p. 85.

[42] Wang, Hy., Li, Pf., Wang, Y., Chi, C.Y., Jin, XX., Ding, G.H., (2024): Overexpression of cucumber *CYP82D47* enhances resistance to powdery mildew and *Fusarium oxysporum* f. sp. *cucumerinum*. Functional & Integrative Genomics, 24(1): 14 https://doi.org/10.1007/s10142-024-01287-1

[43] Williamson, B., Tudzynski, B., Tudzynski, P., Van Kan, J.A., (2007): *Botrytis cinerea*: the cause of grey mould disease. Molecular Plant Pathology, 8(5): 561.

[44] Yousef, S.A., El-Metwally, M.M., Gabr, S.A., Al-Ghadir, A.H., (2013): New strategy for managing damping-off and root rot disease of cucumber caused by *Rhizoctonia solani* by seed soaking in formula of antioxidants with micronutrients. Journal of Plant Pathology& Microbiology, 4(9): 1000196.

[45] Yunis, H., Elad, Y., Mahrer, Y., (1990): Effects of air temperature, relative humidity and canopy wetness on gray mold of cucumbers in unheated greenhouses. Phytoparasitica, 18: 203-215.
[46] Yunis, H., Elad, Y., Mahrer, Y., (1991): Influence of fungicidal control of cucumber and tomato grey mould (*Botrytis cinerea*) on fruit yield. Pesticide Science, 31: 325-335.
[47] Ziedan, E.H., Khattab, A.A., Sahab, A.F., (2018): New fungi causing postharvest spoilage of cucumber fruits and their molecular characterization in Egypt. Journal of Plant Protection Research, 58(4): 362-371.
[48] Ziedan, E.H., Saad, M.M., (2016): Efficacy of nanoparticles on seed borne fungi and their pathological potential of cucumber. International Journal of Pharma Tech Research, 9(10): 16-24.
[49] Ziedan, E.H.E., Saad, M.M., El-Kafrawy, A.A., Sahab, A.F., Mossa, A.T., (2022): Evaluation of essential oils nanoemulsions formulations on *Botrytis cinerea* growth, pathology and gray mould incidence on cucumber fruits. Bulletin of the National Research Centre, 46(88): 2-9.
[50] Ziedan, E.H., Attallah, A.G., Abd-El-Aal, S.K., Sahab, A.F., (2018): Molecular identification and pathogenic potential of *Botrytis cinerea* isolates causing fruit blight of cucumber under protective greenhouse in Egypt. Plant Archives, 18(2): 1563-1569.

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