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Biological and Chemical Control of Powdery Mildew (*Sphaerotheca pannosa* (Wallr.) var. *persicae*) in Apricot

Mabrouk S.S. Hassan[1]; Gehan A. Monir[1] and Tahsin Shoala[2]

[1]Plant Pathology Research Institute, Agricultural Research Center, 12619, Giza, Egypt.

[2]Environmental Biotechnology Department, College of Biotechnology, Misr University for Science and Technology, 6th of October City, Egypt.

Abstract

During the two successive growing seasons 2017 and 2018, powdery mildew (*Sphaerotheca pannosa* (Wallr.) var. *persicae*) was recorded on apricot (*Prunus armeniaca* L.), cv. Canino in four governorates Qaliobia, Menoufia, Beheira and Giza, Beheira governorate recorded the highest percentage in disease incidence followed by Menoufia, Qaliobia and Giza, respectively. The pathogenicity of *Sphaerotheca pannosa* (Wallr.) var. *persicae* in inoculated seedlings at 5 days after inoculation confirmed the pathogenicity of the fungus on Amal, Hayed, and El-Amar cvs. The fungicides *i.e.*, Microvit, Topas, Topsin M70, Amistar Top, Bellis and Eminent, as well as the bio-fungicides, AQ10 and Bio Zeid, meanwhile calcium carbonate and sodium bicarbonates were evaluated to control the powdery mildew on apricot *in vitro*, greenhouse and field conditions. All the tested treatments inhibited conidial germination and the highest efficiency was found for the treatment with Amistar, Bellis and Eminent followed by Topas (100), AQ10 and Bio Zeid, while treatment with Microvit KZ showed lower efficiency. In the greenhouse and under field conditions during the two successive growing seasons 2017 and 2018 at El-Qanater El-Khayria Horticulture Research Station, Agricultural Research Center, Qaliobia governorate, Egypt, to control the powdery mildew (*Sphaerotheca pannosa* (Wallr.) var. *persicae*) all the tested fungicides, bio-fungicides and calcium carbonate and sodium bicarbonates significantly reduced the percentages of disease severity compared with the untreated control. highest efficiency was found for the treatment with Amistar, Bellis and Eminent followed by Topas (100), Topsin M70, AQ10 and Bio Zeid, as well as calcium carbonate and sodium bicarbonates

Keywords: Apricot; Powdery mildew; Biological and Chemical Control.

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Introduction

Apricot (*Prunus armeniaca* L.) is considered one of the major and the most delectable, important popular and favorite deciduous fruit trees cultivated in Egypt a long time ago. Since, it has an excellent flavor, nice taste and high nutritional value. Additionally, apricot is considered either as fresh ripe fruits or after industrial process. Increasing and improving both yield and fruit quality as well as reducing both the production costs, control diseases and environmental pollution are the vital and important aims of investigators (**Kabeel *et al.*, 2017**). According to FAO its total cultured area in Egypt is 6677 hectares in 2016 produced about 16.88 Tons/ hectare with total production of 102247 Tons (**Satuor *et al.*, 2019**). Apricot "Canino" cultivar is an introduced cultivar producing high yield in newly reclaimed lands (**Kelany *et al.*, 2009**).

Powdery mildew, caused by the fungus *Sphaerotheca pannosa* (Wallr.) var. *persicae*, is one of the most important diseases in apricot production areas. Circular white spots on leaves, shoots and fruits are characteristic symptoms of a powdery mildew attack, which may also induce necrosis, deformations and premature fruit drop, leading to serious economic loss (**Watkin and Brown, 1956; Marboutie *et al.*, 1980** and **Salazar *et al.*, 2016**).

Powdery mildew fungi cause significant diseases on a wide range of crops, and different species of fungi are involved depending on the plant affected (**Kristkova *et al.*, 2009**). They are important plant pathogens, which are obligate parasitic on the surface of leaves, stems, fruits, and flowers of a wide range of angiosperms (**Takamatsu *et al.*, 1998**). Powdery mildew, caused by the fungus *Sphaerotheca pannosa* (Wallr.) var. *persicae*, is one of the most important diseases in apricot production areas. Circular white spots on leaves, shoots and fruits are characteristic symptoms of a powdery mildew attack, which may also induce necrosis, deformations and premature fruit drop, leading to serious economic loss (**Marboutie *et al.*, 1980**). Powdery mildew of apricot and peach is found in most peach-growing areas of the world. It may be a problem when weather conditions are favorable for infection. Cultivars differ in their susceptibility to infection (**Burchill, 1978**). First infections occur chiefly on the apricot fruit, with the inoculum originating from the diseased dormant shoots and buds of the previous season. Apricot fruits are susceptible to powdery mildew when young but become resistant with maturity. Infected fruit usually are deformed, with slightly depressed or raised areas. Fruit lesions may become necrotic and cause surface cracking, and infected areas turn brown or remain green (**Grove, 1995**). Such fruits are worthless; losses in yield are generally due to culling of the blemished fruit at harvest (**Burchill, 1978**). Crop losses resulting from

fruit infections may reach 50% on Japanese plums, apricots, nectarines and peaches (**Grove, 1995**). Serious outbreaks of powdery mildew have also been reported in the Cape province of South Africa (**Burchill, 1978**). In Egypt, a few research investigated the powdery mildew on apricot. Powdery mildew fungi usually do not require moist conditions and their asexual spores can germinate and infect in the absence of water, moreover moisture reduces the viability of their conidia. Therefore, they are more prevalent than many other diseases under dry summer conditions in great number of countries (**Carlile *et al.*, 2001**). Elemental sulfur was one of the first fungicides to be introduced and is still used to prevent commercially important powdery mildew infections (**Carlile *et al.*, 2001**). However, fungicide resistant strains of the pathogen have developed (**Zahavi *et al.*, 2001**). Therefore, the importance of biological methods for plant protection has increased today (**Rankovic, 1997**). Fungi of the genus Ampelomyces are well known hyperparasites and are widely distributed on the powdery mildews (**Rankovic, 1997**).

Chemical control is highly recommended that the powdery mildew is an aggressive and destructive disease and satisfactory control without the use of fungicides is unlikely. The role of fungicides in reducing the disease is well known (**McGrath, 2001; 2004**). The chemical fungicides have been used as the main strategy for control of powdery mildew disease and subsequently increases yield production (**Abdel Moneim *et al.*, 1980**; **Keinath and DuBose, 2004**; **Wolf and Verreet, 2008**).

Several fungicides significantly controlled powdery mildew and increased fruit yield *i.e*., Punch (**Hemant *et al.*, 2012**), Flusilazole or Pyrazophos (**Lonsdale and Kotze, 1991**), Topas (**Haq *et al.*, 1994**), Thiophanat-methyl and sulfur (**Akhtar *et al.*,1998**), Hexaconazol, Amistar 25 SC (**Fugro *et al.*, 2012**) and Penconazole, Myclobutanil, Tetraconazole (**Reuveni *et al.*, 2018**). Repeated application one mode action of the different fungicides often results in the selection of pathogen strains that are a challenge with the fungicides (**Brooks, 1991**). Unfortunately, the current and indiscriminate use of the fungicides posed a serious threat to human health, environment and production of fungicide resistant pathogen strains (**Fernandez, 2000**). The great efforts by agro-scientists are carried out to search and development of nontoxic alternative to chemical fungicides would be useful in reducing the undesirable effects to uses for management plant disease, for example biofungicides and salts.

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This study was conducted to evaluate the potential effects of the fungicides *i.e.*, Microvit, Topas, Topsin M70, Amistar Top, Bellis and Eminent, as well as the bio-fungicides, AQ10 and Bio Zeid, meanwhile calcium carbonate and sodium bicarbonates to control powdery mildew on apricot *in vitro* and *in vivo* conditions.

MATERIALS AND METHODS.

1. Survey for apricot powdery mildew disease:

Survey of apricot powdery mildew disease incidence and severity has been carried out in four governorates in Egypt (Qaliobia, Menoufia, Beheira and Giza) from March until May of both successive growing seasons 2017 and 2018. The locations of each governorate were selected and taken into consideration to detect the disease incidence and its severity symptoms on the different plant parts leaves and fruit.

Leaves and fruit were rated on a scale of 0-4 for the disease severity using the following scale described by **Lonsdale and Kotze (1993)**.

$$\textbf{\% Disease severity} = \frac{\Sigma\, n \times v}{4N} \times 100$$

Where:

n = Number of the infected leaves or fruit in each category.

v = Numerical values of each category.

N = Total number of the examined leaves or fruit.

0 = Leaves or fruits free of disease.

1 = 1 - 25 % infection.

2 = 26 - 50% infection.

3 = 51-75% infection.

4 = More than 75% infection.

Disease incidence calculated using the following equations:

$$\textbf{\% Disease incidence} = \frac{\textbf{No. of diseased plants}}{\textbf{Total No. of examined plants}} \times 100$$

Inspected diseased samples of apricot leaves were collected carefully and placed in paper bags. Bags were tied carefully, labeled and carried to Plant Pathol. Lab., to use in *in vitro* experiments.

2. Disease symptoms and morphological study:

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Typical symptoms of powdery mildew on apricot leaves and fruits were observed in the field and photographed. The microscopic characteristics of fresh white powder fungal materials stripped from the leaves or fruits surfaces with a clear adhesive tape were observed by light microscopy 400×.

3. Pathogenicity tests:

Pathogenicity test was confirmed by using dusting conidia from apricot (*Prunus armeniaca* L.) cv. Canino on healthy seedlings and non-inoculated seedlings served as controls. A sterile brush was used to transfer conidia from the affected leaves to fully expanded leaves of healthy seedlings. A plastic bag was placed around each seedling for three days and then removed. Non-inoculated seedlings (control) were stroked with a sterile brush, placed in a plastic bag and kept separate in the greenhouse. This experiment was carried out at El-Qanater El Khayria Horticulture Research Station, Agricultural Research Center, throughout 2017 growing season, in Plant Pathology Greenhouse.

4. Virulence test:

Diseased leaves and or fruits of apricot cv. Canino were collected and gently pressed onto new leaves of one year old of three cultivars Amal, Hayed and El-Amar to confirm the pathogenicity of the fungus Sphaerotheca *pannosa* (Wallr.) var. *persicae* infected cv. Canino on other cultivars. The negative control consisted of non-inoculated new leaves from one year old of the same cultivars. Disease process was observed and the symptoms on the inoculated leaves were compared to that on the naturally infected leaves. The inoculation experiment was performed with ten apricot seedlings in separated pots were used as replicates for each particular cultivar and each one contained five new leaves. Inoculated and non-inoculated seedlings were incubated in Plant Pathology greenhouse at 20-25°C with 60% -70% humidity at El-Qanater El-Khayria Horticulture Research Station, Agriculture Research Center, Qaliobia governorate, Egypt, throughout 2018 growing season.

5. *In vitro* experiment:

Six fungicides, two biofungicides and two salts were tested *in vitro* by spore germination inhibition method. This experiment was carried out in the Laboratory of the Department of Plant Pathology, El-Qanater El-Khayria Horticulture Research Station, Agricultural Research Center, Qaliobia governorate, Egypt. Conidial spores of *Sphaerotheca pannosa* (Wallr.) var. *persicae* were obtained from young sporulating lesions cv. Canino, the lesions were softly shaken by glass bar and new conidia were dropped on glass slides according to **Nair and Ellingboe (1962)**. Slides were previously cleaned by ethyl alcohol and air dried before

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covering with thin smears of 2% water agar contain of the tested treatment show in Table 1. Slides were placed on V-shaped glass rods in sterilized Petri-dishes, containing several layers of water-moistened filter papers. Slides with conidia were incubated at 25°C under continuous light (**Reifschneider *et al*., 1985**). Conidia were considered to have germinated if a germ tube at least as long as the width was produced **(Menzies *et al*., 1991)**. Percentages of germination were calculated for 100 conidia on slides. Five slides were examined for each treatment. Slides contain 2% water agar free from tested treatment were used as a control. The readings on germination of conidia were recorded after 24 and 48 hrs. by placing slides under light microscope and percent inhibition in germination of each treatment was calculated by adopting the formula:

$$\% \text{ Efficiency} = \frac{\text{Germination in control- Germination in treatment}}{\text{Germination in control}} \times 100$$

Table (1): Trade names, active ingredients and application rates of compounds.

Commercial name	Active ingredient	Dose/ L of water
Microvit KZ 80% WP	Sulfur	2.5 g
Topas (100) 10% EC	Penconazole	0.25ml
Topsin M70 WP	Thiophanate methyl	0.6 g
Amistar Top 32.5%	Azoxystrobin - Difenoconazole	0.6 ml
Bellis 38% WG	Pyraclostrobin – Boscalid	0.3g
Eminent 12.5% Ec	Tetraconazole	0.25ml
AQ10 58% WGD	*Ampelomyces quisqualis*	5g
Bio Zeid 2.5% WP	*Trichoderma album*	2.5 g
Calcium carbonate	CaCO3	2g
Sodium bicarbonates	NaHCO3	2g

6. Greenhouse experiment:

The fungal inoculum of *Sphaerotheca pannosa* (Wallr.) var. *persicae* used here was obtained from apricot cv. Canino naturally infected with powdery mildew in 2018 growing seasons at an experimental farm at El-Qanater El-Khayria Horticulture Research Station, Agricultural Research Center, Qaliobia governorate, Egypt. Conidia from leaves or fruits were gently brushed with distilled water (100 ml) containing five drops of Tween-80 and the spore was adjusted to 5×10^5/ml **Abdu-Allah and Abo-Elyousr (2017).** Fresh new leaves of cv. Canino were placed in Petri dishes on wet filter papers. Leaves were sprayed with 2 ml of a $5x10^5$ conidia/ml suspension and then sprayed with individually ten treatments tabulated in Table 1. Sterile water was used as a control treatment. Fifteen leaves were included in a replicate. The dishes were incubated at 25°C in darkness for 48 hrs. The disease severity was

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assessed following the scale described by **Lonsdale and Kotze (1993)** as mentioned above. The efficiency of treatments in controlling the disease was calculated according to the following formula mentioned by **Abo Rehab *et al*. (2014):**

$$\% \text{ Efficiency} = \frac{\% \text{ Disease severity in control} - \% \text{ Disease severity in treatment}}{\% \text{ Disease severity in control}} \times 100$$

7. Field experiment:

Field experiment was carried out during two successive seasons of 2017 and 2018 at an experimental farm at El-Qanater El-Khayria Horticulture Research Station, Agricultural Research Center, Qaliobia governorate, Egypt on Canino cultivar 15-years. The selected trees were uniform in vigor as possible. The fertilization program and other agricultural practices were the same for all trees. The trees left to the natural infection by powdery mildew and distributed in a complete randomized design, three replicated (two trees per each replication). Spraying individually with ten compounds tabulated in Table 1. Foliar spraying application has been carried out at the end of March then repeated three times 15-days intervals, the same number of trees was sprayed with water as a control. Disease severity percentage and efficiency assessed randomly one week after each spraying and averaged. Disease severity was assessed following the scale described by Lonsdale and Kotze (1993) as mentioned above. The efficiency of treatments in controlling the disease was calculated according to the following formula mentioned by **Abo Rehab *et al*. (2014)** as mentioned above.

8. Statistical analysis:

Data that obtained during 2017 and 2018 growing seasons were subjected to analysis of variance method according to **Snedecor and Cochran (1990)** to assess the program effects. Duncan's Multiple Range tested (**Duncan, 1955**) were used to compare differences among means.

Results

1. Survey for apricot powdery mildew disease:

A survey results during 2017 and 2018 growing seasons in Table 2 show that the highest percentage in disease incidence and severity were recorded in Beheira governorate (20.50, 16.50 and 17.00, 12.50 %) on leaves in the two seasons and (23.50, 18.50, 20.00 and 14.50) on fruits in the two seasons respectively, followed by Menoufia governorate (17.50, 12.50 and 15.66, 10.25 %) on leaves in the two seasons and (20.30, 14.20, 18.66 and 12.25) on fruits in the two seasons respectively, while Giza governorate recorded the lowest disease occurrence.

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Table (2): Disease incidence and severity % of powdery mildew on apricot cv. Canino in the investigated governorate.

Governorate	% Disease incidence				% Disease severity			
	Season 2017		Season 2018		Season 2017		Season 2018	
	Leaves	Fruits	Leaves	Fruits	Leaves	Fruits	Leaves	Fruits
Qaliobia	115.60b	18.60b	10.50b	12.50b	14.00b	17.00b	10.30b	10.30b
Menoufia	17.50b	20.30b	12.50b	14.20b	15.66b	18.66b	10.25b	12.25b
Beheira	20.50a	23.50a	16.50a	18.50a	17.00a	20.00a	12.50a	14.50a
Giza	11.50c	15.50c	6.00c	8.00c	11.00b	15.00b	5.00c	6.00c

Mean numbers within columns followed by different letters are significantly different *at* $P < 0{:}05$ according to Duncan's Multiple Range Test.

2. Disease symptoms and morphological study:

Powdery mildew on apricot (*Prunus armeniaca* L.) caused by *Sphaerotheca pannosa* (Wallr.) var. *persicae* which is an external obligate parasite pathogen living intercellular in host tissues epidermis. The examined fungal vegetative parts under the light microscope in Fig. 1 show that fungus causing powdery mildew produces hyaline septate mycelium, which ramified over the surface of the host, forming a white dense short, un-septate, coating of branched hyphae consists of short conidiophore carrying chain of spores basipetally, the largest on the top and the smallest at the bottom. Symptoms on leaves, buds, green shoots and fruit are commonly infected by the powdery mildew fungus, but flower infections are rare. Symptoms include circular, white, web-like colonies that become powdery once masses of asexual conidia are produced in chains on all tissues. Leaves may then enroll, curl, or become stunted. Severe infections commonly cause leaf chlorosis, necrosis, and leaf drop. Infected leaves may be covered by fungal mycelium. This mildew may be a serious disease in the nursery by causing stunting and defoliation. On fruit, the disease usually appears as round whitish spots a few weeks after shuck fall. The spots will enlarge to cover much of the fruit. Later, the white mycelium sloughs off to reveal rusty colored round lesions.

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Fig. (1): Powdery mildew on apricot, symptoms on leaves (A), fruit (B) and examined fungal vegetative parts under light microscope (C).

3. Pathogenicity test

The pathogen signs were observed only in inoculated seedlings at 5 days after inoculation. Thin, white colonies were observed on leaves of with powdery mildew, whereas control seedlings remained healthy Fig. 2.

Fig. (2): Pathogenicity test, Observation of powdery mildew symptoms on apricot, Pathogen signs observed on inoculated seedlings cv. Canino (A) and control (B).

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4. Virulence test

Powdery mildew disease progress was visually observed on leaves of all inoculated cultivars (Amal, Hayed and El-Amar). At 5-7 days after inoculation, the disease symptoms were the same as those in naturally diseased leaves on Canino cultivar. The morphology of the reisolated conidia under light microscope was identical to that of the conidia of the inoculated fungus. No symptoms were observed on the control leaves on all un-inoculated cultivars.

Fig. (3): Observation of powdery mildew symptoms on apricot, Pathogen signs observed on inoculated leaves to confirm the pathogenicity of the fungus Sphaerotheca *pannosa* (Wallr.) var. *persicae* infected cv. Canino on other cultivars Amal (A), Hayed (B) and El-Amar (C).

5. Disease control.

***In vitro* experiment**:

Microscopic observation show that all treatments inhibited conidial germination of the fungus Sphaerotheca *pannosa* (Wallr.) var. *persicae* Table 3. The highest efficiency was found for the treatment with Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec (100%) followed by Topas (100) 10% EC, AQ10 58% WGD and Bio Zeid 2.5% WP (94.73%), while Calcium carbonate and Sodium bicarbonates gave the efficiency of conidial germination (86.84%) compared to other treatments. The treatment with Microvit KZ 80% WP shows lower efficiency (81.57%).

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Table (3): Effect of some treatments on spores' germination of *Sphaerotheca pannosa* (Wallr.) var. *persicae in vitro*.

Treatment	Germination (%)	Efficiency (%)
Microvit KZ	7	81.57
Topas (100)	2	94.73
Topsin M70	1	97.36
Amistar Top	0	100
Bellis 38%	0	100
Eminent	0	100
AQ10	2	94.73
Bio Zeid	2	94.73
Calcium carbonate	5	86.84
Sodium bicarbonates	5	86.84
Control	38	--

Greenhouse experiment:

Data presented in Table (4) and Fig. (4) show that all treatments caused significant efficiency in the severity of powdery mildew compared with the control. The highest efficiency levels of 100% were found after the treatment with Topas (100) 10% EC, Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec followed by Topsin M70 WP treatment (97.14%), while, Bio Zeid 2.5% WP, AQ10 58% WGD, Calcium carbonate and Sodium bicarbonates show the moderate efficiency level (92.85, 92.85, 85.71 and 85.71%) respectively, Microvit KZ 80% WP show the lowest efficiency level (71.42 %). No phytotoxicity on the apricot leaves were recorded at the tested doses of all tested compounds.

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Table 4. Efficiency % of ten treatments against powdery mildew on cv. Canino apricot leaves.

Treatments	%Disease severity	%Efficiency
Microvit KZ	20.00b	71.42
Topas (100)	0.00d	100
Topsin M70	2.00 c	97.14
Amistar Top	0.00 d	100
Bellis 38%	0.00 d	100
Eminent	0.00 d	100
AQ10	5.00 c	92.85
Bio Zeid	5.00 c	92.85
Calcium carbonate	10.00 bc	85.71
Sodium bicarbonates	10.00 bc	85.71
Control	70.00 a	--

Mean numbers within columns followed by different letters are significantly different *at* $P < 0:05$ according to Duncan's Multiple Range Test.

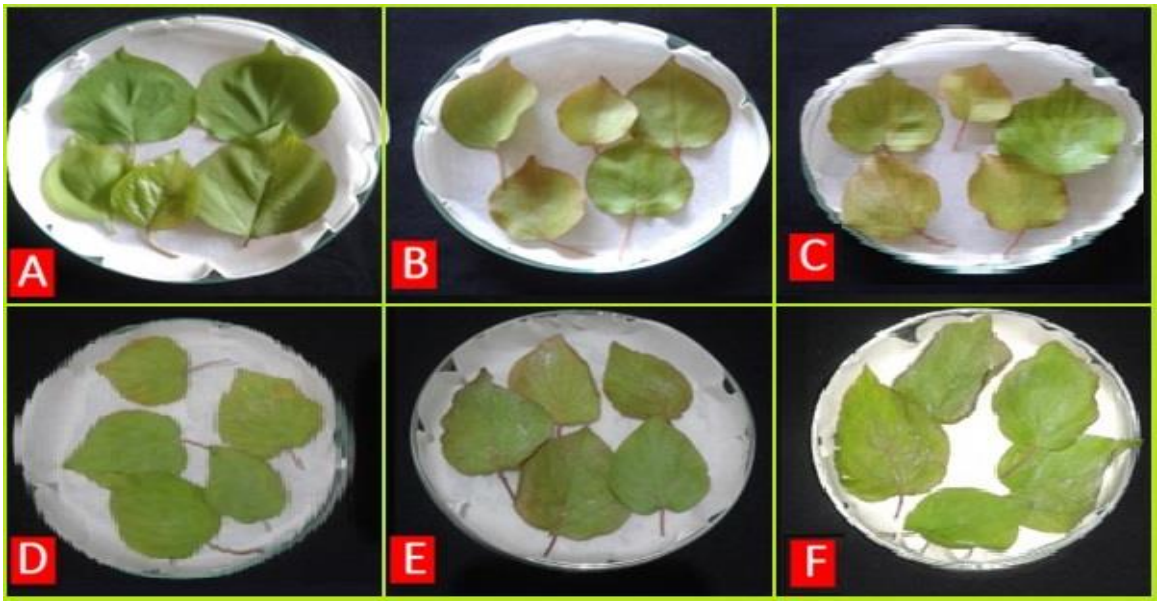

Fig. (4): The disease severity on apricot leaves after inoculated with *Sphaerotheca pannosa* (Wallr.) var. *persicae* using Topas (100), Amistar Top, Bellis and Eminent (A), Topsin M70 (B), AQ10 and Bio Zeid (C), Calcium carbonate and Sodium bicarbonates (D), Microvit (E) and control (F).

Field experiment:

The Efficiency of the tested ten treatments under natural conditions was determined in 2017 and 2018 seasons. Data presented in Table 5 show that all tested treatments reduced the severity of powdery mildew compared with control treatment. The highest efficiency levels of were found using the treatment Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec

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followed by Topsin M70 WP and Topas (100) 10% EC Microvit KZ 80% WP show the lowest efficiency.

Table (5): Efficiency% of ten treatments against powdery mildew in Canino apricot under naturally infection in the orchard.

Treatments	Season 2017				Season 2018			
	%Disease severity		%Efficiency		%Disease severity		%Efficiency	
	Leaves	Fruits	Leaves	Fruits	Leaves	Fruits	Leaves	Fruits
Microvit KZ	10.00b	12.00b	40.00	33.33	7.00b	8.00b	30.00	46.66
Topas (100)	5.00c	10.00b	64.28	44.44	5.00c	5.00b	50.00	66.66
Topsin M70	5.00c	10.00b	64.28	44.44	5.00c	6.00b	50.00	60.00
Amistar Top	2.00d	5.00c	85.71	72.22	2.00d	5.00c	80.00	66.66
Bellis 38%	2.00d	5.00c	85.71	72.22	2.00d	5.00c	80.00	66.66
Eminent	2.00d	5.00c	85.71	72.22	2.00d	5.00c	80.00	66.66
AQ10	6.00d	10.00b	57.14	44.44	5.00c	6.00b	50.00	60.00
Bio Zeid	8.00b	10.00b	42.85	44.44	6.00b	5.00c	40.00	66.66
Calcium carbonate	8.00b	10.00b	42.85	44.44	6.00b	8.00b	40.00	46.66
Sodium bicarbonates	8.00b	10.00b	42.85	44.44	6.00b	6.00b	40.00	60.00
Control	14.00a	18.00a	- -	- -	10.00a	15.30a	- -	- -

Mean numbers within columns followed by different letters are significantly different *at P* < 0:05 according to Duncan's Multiple Range Test.

DISCUSSION

Powdery mildew, caused by *Sphaerotheca pannosa* var. *persicae*, is one of the most important diseases in apricot production areas around the world. This work was planned to test Biological and chemical control on powdery mildew of apricot under *in vitro* and *in vivo* as well as field conditions. Survey was conducted after the first disease symptoms were observed during 2017 and 2018 seasons on Canino apricot trees. The highest percentage in disease incidence and severity were recorded in Beheira governorate, followed by Menoufia governorate, while Giza governorate recorded the lowest disease occurrence. The pathogen signs were observed only in inoculated seedlings at 5 days after inoculation on cv. Canino and 5-7 days after inoculation cvs. Amal, Hayed, and El-Amar confirm the pathogenicity of the fungus Sphaerotheca *pannosa* (Wallr.) var. *persicae* on this cultivar. All treatments inhibited conidial germination. The highest efficiency was found for the treatment with Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec followed by Topas (100) 10% EC, AQ10 58% WGD and Bio Zeid 2.5% WP, while treatment with Microvit KZ 80% WP showed lower efficiency. *In vivo* experiment the highest efficiency levels were observed after the treatment with Topas (100) 10% EC, Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec while

Microvit KZ 80% WP showed the lowest efficiency. Under natural conditions, all the tested treatments reduced the severity of powdery mildew compared with control treatment. The highest efficiency levels of were found using the treatment Amistar Top 32.5%, Bellis 38% WG and Eminent 12.5% Ec followed by Topsin M70 WP and Topas (100) 10% EC Microvit KZ 80% WP show the lowest efficiency. All biological and chemical control showed high potential effect on disease reduction. My results agree with the results reported by **Abdu-Allah and Abo-Elyousr (2017)** Laboratory study showed that all the tested plant extracts and fungicides significantly reduced germination of conidia of the causal pathogen Uncinula necator (Schlecht.) caused powdery mildew disease of Grapevines. Spraying of the extracts on vine trees significantly ($p < 0.05$) decreased the disease severity (D.S. %) compared with infected control. The tested plant extracts as well as fungicide have high effect in disease reduction; no significant differences ($p < 0.05$) in the disease reduction were found in the effect of the extracts between tested compounds in both tested seasons.

The field reduction results were compatible with the high inhibition in germination spore in *R. sachalinensis* extract as well as azoxystrobin + difenoconazole (systemic fungicide). *R. sachalinensis* extract showed high field efficacy and also it exhibited high spore germination inhibition of *Sphaerotheca fuliginea* **(Seddon and Schmitt 1999)**. Chemical control alternative for powdery mildews disease by biological ways is environmentally friendly. In recent years, the development and resistance of pathogen cause of less effective of fungicides beside pollution and potentially undesirable effects of the chemical fungicides on human and environment (**Manandhar *et al.*, 1988**). Successful biological control under greenhouse conditions on foliar diseases has been achieved by several researchers using fungal or bacterial bio-against (**Hussein *et al.*, 2007**). **Gilardi *et al.*, (2008)** evaluated the activity of two bio agents mainly *B. subtilis* and *A. quisqualis* alone and in combination with the two fungicides penconazole and azoxystrobin against *Podosphaera xanthii* on zucchini (*Cucurbita pepo* L.) under controlled conditions. **Abdel-Kader *et al.*, (2012)** reported that *Trichoderma viride*, *T. harzianum*, *P. fluorescens*, and *B. subtilis* reduced disease incidence of powdery and downy mildews of cucumber than the control. Use of bio-agents is safely and easily applied and cost-effective control treatment against plant foliar diseases. Trichoderma isolates have strong antagonistic and mycoparasitic effects against phytopathogens. Therefore, they are able to reduce disease severity in plants (**Viterbo and Horwitz 2010**; **Elsharkawy *et al.*, 2013 and Sarhan *et al.*, 2018**). Salts are inexpensive, easily accepted by consumers, non-toxic, with minor environmental impact at the effective concentrations and usually used in the food

industry. Potassium, Sodium and Calcium salts have been shown to be effective as growth inhibitors of *Botrytis cinerea* (**Soltan *et al.*, 2006**; **Gabler and Smilanick, 2001; Fallik *et al.*, 1997** and **Palmar *et al.*, 1997**). Different kinds of potassium and calcium salts sprayed three weeks before harvest on Thompson seedless grapevines showed highly reduction of disease severity with *B. cinerea* comparing with the control grapes under field and storage condition at 0-1^{o}C (**Rushed**, **2001**). **Nigro *et al.*, (2006)** reported that several salts could reduce the growth of *B. cinerea* under lab. conditions but under greenhouse conditions, calcium chloride, sodium bicarbonate and sodium carbonate significantly reduced the incidence of grey mold on small table grape bunches. **Hafez *et al.*, (2018)** found that the bio-agents (*Bacillus spp*. and *Trichoderma spp*.) reduce significant disease severity of squash powdery mildew (*Podosphaera xanthii*). However, the bio-agent role could be attributed to upregulation of defense-related enzymes catalase, peroxidase, and polyphenol oxidase, which stimulate growth and yield characteristics to control. The fungicide Topas-100 one of systemic fungicides is more efficient in management of cucumber powdery and downy mildews (**Abada *et al.*, 2009)**. Disease severity of squash powdery mildew was reduced with an average of 10.34% when used the fungicide Topas-100 at recommended dose (**El-Ghanam *et al.*, 2018**).

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