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CONTROL OF PEPPER POWDERY MILDEW DISEASE

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ABSTRACT: *Pepper (Capsicum annuum L.) is one of the most important vegetable crops in Egypt and many countries. The total cultivated area of pepper in Egypt reached more than 62 870 Feddan yielded 438915 tons in both nili and summer seasons during 2012. Powdery mildew disease is considered a serious disease of pepper plants in Egypt, caused by Leveillula taurica. Cabrio Top was the most effective fungicide in controlling the disease and perecentage of infection, where the lowest powdery mildew infection was noticed, followed by Bellis fungicide on pepper plants cv. Pasodoble during 2012 and 2013 seasons under natural infection. Yield of 10 plants in kg were raised by fungicide application and compatable with decreasing the disease incidence. Cabrio Top fungicide at (recommended dose) resulted the last disease severity, perecentage of infection and highest yield kg of 10 plants. Calcium carbonate with both used concentrations was the most effective salt in decreasing disease parameters,and wereasing the yield to reach ito maximum followd by calcium chloride, followed by Oxalic acid.werw effective in decreasing powdery mildew disease parameters and increasing fruit yield comparing to the control treatment.*

Key words: *Pepper, Leveillula taurica, control, fungicides, salts and antioxidants.*

INTRODUCTION

Pepper is cultivated in the regions with tropical climate. Pepper fruits occur in a wide usage have spread all over the world, variety of shapes, sizes, colors and different degrees of pungency, based on the type of pepper/ spices and the manner in which they are prepared and used.

Beever, *et al.,* (1989) Mahajan *et al.,* (1991) stated that, Triforine was compared with Sulphur W.P 0.25% for the control of *L. taurica*. Triforine at 0.2% was more effective than other treatments in controlling *L. taurica* and gave the highest yield of chilli *Capsicum annuum* c.v Jwala.

Fallik *et al.,* (1997) mentioned that bicarbonate solutions control powdery mildew (*Leveillula taurica*) on sweet red pepper and reduce the development of postharvest fruit rotting defoliation and fruit sunscald rating were significantly reduced by foliar applications of sodium or potassium bicarbonate solution, compared with water or penconazole.

Reuveni R. and Reuveni M. (1998) recorded that local and systemic control of powdery mildew on pepper plants by foliar spray of mono-potassoim phosphate. A foliar spray of 1% (w/v) solution of mon-potassium phosphate (mkp) on the upper surfaces of lower leaves of greenhouse grown.

Smith *et al.,* (1999) reported that several fungicides control powdery mildew in peppers. Sulfur is most effective as a preventive fungicide in variety trials.

(Babu, *et al.,* 2002). The capsaicinoid compounds, used widely for diverse medicinal applications. Powdery mildew can be a serious disease of peppers in warm, arid, and semiarid growing regions. Infection of powdery mildew leads to defoliation, which can lead to severe losses of pepper crops. Diseased crops give lower yield and fruit quality, and a reduced harvested period. Indirect losses include a rise in production costs as a result of the use of fungicides, and direct losses are caused by fruit sunburn. Increasing resistance to fungicides by pathogens has greatly increased pre and post harvest losses.

Tsror *et al.,* (2004) observed that control of powdery mildew on organic pepper with inorganic management sulfur-containing agents efficiently control the disease.

Mansour (2005) stated that the antioxidants were significantly better

improving disease control and fruit yield production of strawberry than the control. Salicylic acid and ascorbic acid were the most effective antioxidants on wilt disease and increasing the yield.

Zayan and Rahman (2009) recorded that inducing resistance in sweet pepper against powdery mildew using some chemical inducers and micro elements under greenhouse and field condition worldwide, including Egypt.

Bazanboor (2010) selected four antioxidants i.e., Ascorbic acid, Hydroquinone, Salicylic acid and Sodium benzoate. Each antioxidant was applied in five concentrations i.e., 12.5, 25, 50, 100 and 200 ppm. They were applied as soil drenching and seed soaking on cucumber and cantaloupe plants. He found that treating cucumber seeds by soaking in antioxidants solutions at their concentrations greatly affected charcoal rot symptoms as well as survival plants.

Cerkauskas *et al.* (2011) mentioned that in field plots, best disease control was achieved with applications of myclobutanil and the fermented milk byproduct + surfactant in 2006 whereas in 2007, citrus oil + borax and potassium bicarbonate were most effective. There were no significant differences in pepper yield among the treatments in field plots. In vitro survival studies showed that the fungus was able to survive in infected pepper leaves after exposure to temperatures of -10 degrees C for 2 months.

The objectives of this study were to identify useful chemical fungicides and reduced risk materials for control of powdery mildew on greenhouse and field peppers, as well as study the effect of chemical salts and some antioxidants compounds on control of powdery mildew disease incidence.

MATERIALS AND METHODS

These experiments were carried out at 2012 and 2013 seasons. Seedlings of Pasodoble RZ, the highly susceptible cultivar were transplanted in these studies. The experiments were done to study the effect of Fungicides, Calcium salts, antioxidants treatments on powdery mildew disease incidence, and yield. These experiments were done under field conditions at the farm of the Faculty of Agriculture, Minufiya University, Shebin El-Kom, Minufiya Governorate, Egypt.

Fungicidal effect: Seven fungicides listed in Table (3) were tested to study their efficacy in controlling powdery mildew disease of pepper. Fungicides were applied four times, starting just at the early stage of powdery mildew symptoms and repeated every two weeks. Control treatment was sprayed with water as foliar application. These experiments were distributed in completely randomized block design with four replicates in plots (1/400 of feddan). Data of disease incidence and yield were recorded.

Calcium salts effect: Four calcium salts i.e., calcium sulphate, calcium chloride, calcium phosphate and calcium carbonate in two concentrations (200 and 400 ppm) were applied for controlling powdery mildew disease incidence in pots under field conditions. In this respect, 200 and 400 ppm solutions of the prepared calcium salts were sprayed as foliar application calcium salts were applied four times, starting just at the early stage of powdery mildew symptoms and repeated with tap water as foliar application. Data of disease incidence and yield were recorded.

Organic acids effect: antioxidants were applied in various concentrations on pepper plants as foliar spray for four times starting just at the early stage of powdery mildew symptoms and repeated every 2 weeks intervals. Antioxidans used in this trials were, ascorbic acid, Citric acid, Magnesium citrate and Oxalic acid at Two concentrations (100 and 200 ppm) for controlling powdery mildew disease on pepper plants under field conditions.

Disease assessment: All tested pepper cultivars were evaluated for their resistance or susceptibility against *Leveillula taurica* using a modified scale according to Kremer and Unterstahofer (1967) as follows:

Table (1): Commercial name, active ingredient and mobility in the plant and dose of used fungicides .

Commercial names	Active ingredient	Concentration formulation type	Mobility in the plant	Dose/ 100 L
Bellis	Pyraclostrobin + Boscalid	38% WG	Systemic	50 g
Kumulus-s	Sulphur	80% WG	Contact	250 g
Amistar Top	Difenoconazole + Azoxystribin	32.5% sC	Systemic	50 CC
Sumi Eight	Diniconazole	5% EC	Systemic + Contact	35 ml
Rubegan	Fenarimol	12% EC	Systemic + Contact	10 ml
Atrazole	Penconazole	100% EC	Systemic	15 ml
Cabrio Top	Penconazole Metriram	60% WG	Systemic	100 g

Table (2): Reaction of pepper plants to powdery mildew infection caused by *Leveillula taurica* .

Grade	Description	Reaction
0	Powdery mildew free	Resistent (R)
1	10% of the leaf surface infected	least susceptible (L.S.)
2	11-25% of the leaf surface infected	Moderately susceptible(M.S.)
3	26-50% of the leaf surface infected	Susceptible (S.)
4	51.100% of the leaf surface infected	Highly susceptible (H.S.)

The disease severty was calculated using the disease index formula as follows:

$$R = \frac{(a \times b)}{N \times K} \times 100$$ where :

R = Intensity of the disease or (disease index).**a** = Number of infected leaves in each category.**b** = Numerical value of each category.**N** = Total number of leaves on the plant.**K** = The highest degree of infection in category.

RESULTS AND DISCUSSION:

Data in Tables (3 and 4) indicate that, powdery mildew on pepper plants grow under natural infection could be decreased by spraying the plants with any of the tested fungicides in both growing seasons 2012 and 2013 compared to untreated plants (control). There were clear significant differences between each of systemic and contact fungicides and untreated control.As for the systemic fungicide Cabrio Top, it was the most effective fungicide in reducing disease severity and % of infection, followed by Bellis fungicide. The least effective fungicide for controlling powdery mildew disease on pepper plants cv. Pasodoble was kumulus-s, followed by Altrazole during 2012 season under natural infection. Also, application of half of the recommended dose of any of the tested fungicides decreased the effectiveness of the tested fungicides on disease incidence, while application of double of the recommended dose of all of

the tested fungicides gave 0.0 infection of the powdery mildew disease on pepper plants. Results indicate also that, the yield of 10 plants in kg were raised by fungicide applications and compatable with decreasing the disease incidence. Cabrio Top fungicide with normal recommended dose gave the least disease severity, % of infection and the maximum yield kg of 10 plants (13.0,5% 5.0% and 30.0, respectively).Data in Table (4) indicate that the obtained results of the seven fungicides in 2013 season were also at the same trend of the results obtained in 2012 season. Cabrio Top fungicide was the most effective fungicide on disease incidence (severity and % of infection), followed by Bellis. The least effective fungicide was Kumulus-s, followed by altrazole in recommended dose. It is important to notifiy, the systemic fungicides were more effective than the contact ones in controlling pepper powdery mildew, the reduction in infection due to the fungicidal action was correlated by substantial increase in the yield. In regard to percentage of powdery mildew infection in treated and non treated plants, it could be concluded that, each spray led to highly significant decrease in powdery mildew infection. These results are in accordance with those obtained by Smith *et al.,* (1999) Tsror *et al.,* (2004), Reuveni and Reuveni, (1998), Zayan and Rahman (2009) and Cerkauskas *et al.,* (2011).

Table (3): Effect of some fungicides on powdery mildew disease and yield production of pepper during 2012 season.

Fungicide	Conc. g/100L	Disease severity %	% of infection	Yield kg/10 plant
Bellis	25	20.0	11.0	19.0
	50	14.0	5.5	27.0
	100	00.0	00.0	29.0
Kumulus-s	125	37.5	22.0	21.5
	250	25.0	17.0	23.0
	500	00.0	00.0	20.0
Amistar Top	25	26.0	12.5	21.5
	50	18.0	8.5	25.0
	100	00.0	00.0	26.7
RubeGan	5	33.0	15.0	21.0
	10	19.0	12.0	23.0
	20	00.0	00.0	25.0
Atrazole	7.5	38.0	24.0	20.5
	15	23.5	17.0	22.0
	30	00.0	00.0	25.0
Cabrio Top	50	25.0	10.5	25.0
	100	13.0	5.0	30.0
	200	00.0	00.0	33.0
Control		50.5	20.0	18.5

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Table (4): Effect of some fungicides on powdery mildew disease incidence and yield production of pepper plants during 2013 season.

Fungicide	Conc. gm/100L	Disease severity %	% of infection	Yield kg/10 plant
Bellis	25	20.5	12.5	18.3
	50	15.0	6.0	26.0
	100	00.0	00.0	29.0
Kumulus-s	125	38.5	22.5	20.0
	250	25.5	18.0	22.5
	500	00.0	00.0	23.0
Amistar Top	25	25.0	12.0	22.5
	50	17.0	8.0	26.0
	100	00.0	00.0	28.0
Sumi-Eight	17.5	32.0	16.0	20.0
	35	20.5	10.0	23.5
	75	00.0	00.0	25.0
RubeGan	5	32.0	14.5	21.5
	10	19.0	11.0	23.4
	20	00.0	00.0	24.0
Atrazole	7.5	38.5	25.0	20.0
	15	24.0	17.7	22.5
	30	00.0	00.0	24.8
Cabrio Top	50	22.5	10.0	27.0
	100	11.0	4.5	33.0
	200	00.0	00.0	37.5
Control		62.0	28.0	20.0

Calcium salts with both tested concentrations affected disease parameters and yield production. Calcium carbonate was the most effective salt in decreasing disease parameters in both 200 and 400 ppm. followed by calcium chloride, while the least effective calcium salt was calcium sulphate, in both growing seasons 2012 and

2013. Calcium carbonate with both used concentrations was the most effective salt in decreasing disease parameters 21.0, 14.0 and 14.0, 11.0 for disease severity and % of infection in both 200 and 400 ppm, respectively. (Table 5). The results in the second season (Table 6) confirmed these obtained in the first season (2012 season). Calcium carbonate followed by Calcium chloride were the most effective salts in decreasing disease parameters and increasing yield production also. Generally, Calcium salts great affecting powdery mildew disease incidence and disease parameters in comparing to control treatment (about ½ disease parameters as well as double results in yield production) in both tested seasons.Similar results were obtained by Fallik *et al.,* (1997), Reuveni (1998) and Cerkauskas *et al.* (2011). Data in Table (7) indicate that spraying of pepper plants with both concentrations of each antioxidant salt affected disease severity of powdery mildew and percentage of infection during 2012 season. The most effective antioxidant was Ascorbic acid (in both 200 and 400 ppm concentration). Disease severity were 34.5 and 27.0, % of infection were 22.5 and 20.0%, in 200 and 400 ppm, respectively, followed by Oxalic acid that resulted 35.0 and 28.0, 22.0 and 20.5, respectively. The least effective antioxidant was Citricric acid in both applied concentrations, it resulted 38.0 and 26.0 for disease severity and 23.0, 19.5% of infection, respectively. Generally, antioxidants decreased disease parameters and increased fruit yield in comparing to control treatment that resulted disease severity 70.0 and percentage of infection 35.0%.Data in Table (8) illustrate the results of spraying pepper plants with antioxidants solutions during 2013 season. The same trend of results that obtained during 2012 season was confirmed during 2013 season. Similar results were reported by Khalifa (2003), Abdou *et al.,* (2001) and Bazanboor (2010).

Table (5): Effect of some Calcium salts on powdery mildew disease incidence and pepper yield production during 2012 season.

Calcium salt	Conc. (ppm)	Disease severity%	% of infection	Yield kg/10 plant
Calcium phosphate	200	27.5	15.0	20.0
	400	23.0	12.0	21.0
Calcium chloride	200	26.5	15.5	19.5
	400	21.0	13.0	21.0
Calcium sulphate	200	28.5	17.0	17.5
	400	24.0	13.5	19.0
Calcium carbonate	200	21.0	14.0	20.5
	400	14.0	11.0	22.0
Control		50.0	25.0	11.0

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Table (6): Effect of some Calcium salts on powdery mildew disease incidence and pepper yield production during 2013 season.

Calcium salt	Conc. (ppm)	Disease severity%	% of infection	Yield kg/10 plant
Calcium phosphate	200	28.0	16.5	19.0
	400	24.0	13.0	21.0
Calcium chloride	200	27.0	16.0	20.5
	400	22.5	13.0	21.5
Calcium sulphate	200	29.0	17.5	17.0
	400	25.0	14.0	18.0
Calcium carbonate	200	22.0	15.0	21.0
	400	15.0	12.5	22.5
Control		60.0	30.0	12.0

Table (7): Effect of some Organic acids on powdery mildew disease incidence and pepper yield production during 2012 season.

Organic acids& Mineral salt	Conc. (ppm)	Disease severity %	% of infection	Yield kg/10 plant
Ascorbic acid	100	34.5	22.5	21.0
	200	27.0	20.0	21.5
Citric acid	100	38.0	23.0	19.0
	200	26.0	19.5	17.5
Magnesium citrate	100	37.0	22.5	19.5
	200	29.0	21.0	21.5
Oxalic acid	100	35.0	22.0	20.5
	200	28.0	20.5	21.0
Control		70.0	35.0	8.0

Table (8): Effect of some Organic acids on powdery mildew disease incidence and pepper yield production during 2013 season.

Organic acids& Mineral salt	Conc. (ppm)	Disease severity %	% of infection	Yield kg/10 plant
Ascorbic acid	100	34.0	22.0	19.0
	200	26.0	20.0	20.0
Citric acid	100	37.5	23.5	19.5
	200	25.5	19.0	18.0
Magnesium citrate	100	37.5	23.0	18.0
	200	30.0	22.0	18.5
Oxalic acid	100	36.0	22.0	15.0
	200	27.0	20.0	17.5
Control		75.0	40.0	7.5

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مكافحه مرض البياض الدقيقى فى الفلفل

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الملخص العربى

يعتبر الفلفل واحدا من أهم محاصيل الخضر الثمرية فى مصر وفى العديد من بلدان العالم حيث تتعدى المساحة المنزرعه بالفلفل فى مصر 62870 فدان تنتج حوالى 438915 طن فى الموسم (2012) . يصاب الفلفل بالعديد من الأمراض ، ويعتبر مرض البياض الدقيقى من أخطر الأمراض الفطرية على الفلفل فى مصر والذى يسببه الفطر *Leveillula taurica* . وقد تم رش النباتات تحت ظروف العدوى الطبيعية فى الحقل بجرعات متباينه طبقا للموصى بها من سبعة مبيدات متخصصه للمرض حيث أظهر المبيد كابريو توب كفاءه عالية فى تقليل نسبة وشدة الإصابة بالمرض فى موسمين متتاليين 2012 ، 2013 وبالتالى زيادة معنوية فى كمية المحصول ، تلاه فى المقاومة المبيد بيليز . كذلك فقد ثبت من التجارب الحقلية أن الرش بمحلول كربونات الكالسيوم كان الأعلى كفاءه بين أملاح الكالسيوم المختبرهحيث قلل القياسات المرضيه وزاد من كمية المحصول وتلاه فى التأثير ملح الكالسيوم كلوريد . أما الاحماض العضويه فقد أظهرت النتائج ان الرش ب حمض الأسكوربيك بتركيزى 200 ، 400 جزء فى المليون كان الأكثر فعالية فى مقاومة البياض الدقيقى على النباتات مع زيادة معنوية فى كمية المحصول تلاه حمض الأوكساليك .