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POWDERY MILDEW OF GRAPEVINE IN EGYPT: PREVALENCE, TEMPERATURE, HUMIDITY, CULTIVARS AND CHEMICAL AND BIOLOGICAL CONTROL

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ABSTRACT: *Field studies were conducted to clarify the period of the disease appearance and its successive development. Thompson seedless, Crimson seedless, Red Roomy and Flame seedless cultivars in four Egyptian governorates, i.e. Kalyoubia, Gharbia, Beheira and Minia were examined during 2012 and 2013seasons to calculate the disease severity %.The disease occurrence was more prevailing during the season 2013 than 2012. Flame seedless was the least susceptible cultivar, Thompson seedless, Red roomy and Crimson seedless were very susceptible under field conditions. In the contrary, the highest disease severity was recorded in Gharbia on Red Roomy and Crimson seedless but the lowest was on Thompson seedless and Flame seedless. The highest disease severity percentage was recorded in Minia governorate with all cultivars, followed by Beheira and Kalyoubia, while Gharbia governorate recorded the lowest occurrence. The temperatures which were correlated with the intensity of powdery mildew indicating that as temperatures increase, the intensity increased. The pathogenic activity of the fungus began when the temperature was 22°C with a relative humidity more than 50%.The temperature of 25.0-32.0°C, relative humidity of 55-90% were the most favourable conditions for the peak incidence of the disease. Interestingly, the disease severity subsided with the increasing the temperature degree above32°C. The fungicides and biocides were sprayed 5 times at 15-day intervals at two programmes on grapevine cv. Thompson seedless in Nobaria-Beheira . All treatments in early spraying programme which started with three protective sprays of sulfur after bud break were more effective on leaves and bunches as compared with treatments were used in late spraying programme which started after the appearance of disease symptoms. Topas, Bayfidan and Punch were the most effective treatments, followed by Topsin M and AQ10. On the contrary, Bio Arc, Bio Zeid and Micronized soreil were the least in minimizing the incidence of powdery mildew.The efficiency of sulfur declined when the pressure of the disease was high.*

Key words: *Grapevine, Cultivars, Powdery mildew,Uncinula necator, Fungicides,Biocides.*

INTRODUCTION

Grapevine (*Vitis vinifera*) is considered one of the most important fruits around the world (Pearson and Goheen, 1998) and Egypt (Anon., 2013). In fact, grape responds on the request of the local market and give off a surplus intended to the exportation. Recently, grape crops have recognized a considerable development with a steadily expansion of the surface and the number of farms, thereby, strenuous efforts have always been exerted to increase its production through a better using of suitable cultivars and good control. Powdery mildew (*Uncinula necator)* is one of the most important and destructive diseases of grape in many countries of the world. It can cause serious damages and loses to grape production in conducible environmental. The effects of disease on grape production are found throughout the records of viticulture. Disease affect production, harvesting, processing, marketing and consumption, reduce quality and yield and increase the costs of production. Disease debilitate and kill vines and destroy vineyards not only locally but also over larges areas and regions (Odile *et al.* 2006; Sall,1980 and Eichmann and Hückelhoven, 2008).*Uncinula necator* survived as mycelium and Fungal cleistothecia in the dormant buds of the grapes during winter season (Hajjeh *et al.* 2008). First disease symptoms on the leaves were observed on late April. Yield losses of grapevine under Minia conditions resulted in a decrease of the grapevine cultivated area (Hanaa and Galal,2012).The pathogenic activity of the fungus began when the temperature was 22°C with a relative humidity more than 50%. The optimum temperature and relative humidity for developing of *U. necator* was 25-32°C and 55-90%, respectively.The disease severity subsided with the increasing the temperature degree above32°C. Results of epidemiology studies of *U. necator* may be of national and international interests for the management of powdery mildew disease which is one of the most destructive diseases around the world including Egypt (Fathi and Karbalaei Khiavi ,2012).

The aim of the experimental studies in four Egyptian governorates, on four cultivars were to find the least susceptible cultivars to infection by powdery mildew.The effect of temperature and humidity on the prevalence of the disease were also studied .Fungicidal and biocidal treatments were evaluated in the field during two successive seasons to obtain the best time of the application for controlling the disease

MATERIALS AND METHODS

1- Survey of powdery mildew incidence and susceptibility to infection in grape orchards:

A disease survey during two growing seasons (2012 and 2013) was carried out in different grapevine orchards in four Egyptian governorates, *i.e.* Kalyoubia, Gharbia, Beheira and Minia to clarify the period of the disease appearance and its successive development.Choosing the least susceptible cultivars is also important in reducing the impact of powdery mildew. The vineyard experiments were arranged in a randomized complete block design with twenty trees as four replicates of four cultivars namely Thompson seedless, Crimson seedless, Red Roomy and Flame seedless, were marked and were examined regularly at 15 day-intervals from late April to August in two seasons. Disease severity % on leaves and bunches was calculated after the first disease symptoms were observed according to the modified scale of Wicks and Davies (1999) as follows:

D.S. = Σ n x V ÷ 5 N where:

n = The number of diseased leaves and bunches in each infected category.

V= Numerical value of the grade as follows: 0 = No infection, 1 = 1.0 - 10 % infection, 2 = 10.1 - 25% infection, 3 = 25.1 – 50 % infection, 4 = 50.1 – 75 % infection, 5 = 75.1 – 100 infection.

N = Total number of the leaves and bunches inspected.

5 = Maximum disease severity grade.

2-Epidemiological studies:

Studying the effect of temperature and humidity on the prevalence of powdery mildew on Thompson seedless cultivar in four governorates during two growing seasons (2012 and 2013) was very important to forecast the prevalence period of the disease. The outcomes and findings of this study may therefore be used effectively in formulation of management strategies to combat and overcome the disease problem.

3. Disease control:

Effect of two spray programmes using some fungicides and biocides on disease severity%:

Five fungicides namely Micronized soreil 70%WP (sulfur), Punch 40%EC (flusilazole), Topsin M70% (Thiophanate-methyl), Topas 10% EC (penconazole), Bayfidan 25% EC (triadimenol) and three biocides namely Bio Zied (*Trichoderma album*), Bio Arc (*Bacillus megaterium*) and AQ10(*Ampelomyces quisqualis*) were evaluated in field experiment in Nobaria region, Beheira governorate during 2012 and 2013 seasons for their efficiency against powdery mildew on plants at ten years old of Thompson seedless cultivar. The vines were planted in a light calcareous sandy soil and placed at 1.5 m (between vines in the row) x 2.75 m (between rows). All vines received the same agricultural practices already applied in the vineyard. Also, the effect of times of application on the effectiveness of fungicides and biocides for controlling powdery mildew were recorded. The two spraying programmes were applied at two different periods, *i.e.* early spraying was applied with three sprays of sulfur at 15 day-intervals started after bud break at the second week of March, at 2 weeks after bud burst (shoots are approx.10cm), at 4 weeks after bud burst (shoots are approx.20-30cm) until the first disease symptoms appears on the fourth week of April as a protective control and complete the programme with each treatment alone ,late spraying starting at the initial appearance of the symptoms with each treatment alone as a curative control .The two programmes received five treatments from the fourth week of April to the fourth week of June. Control vines were sprayed with only water. The vineyard experiments were arranged in a randomized complete block design, twenty trees of Thompson seedless cultivar as four replicates were marked and were sprayed regularly at 15 day-intervals and disease severity % on leaves and bunches was calculated until 15 days from the last treatment .Efficiency% was calculated as follows: efficiency of treatment = (control-treatment/control) x 100 according to Mousa, *et al*. 2006.

Statistical analysis:

Data of the experiments were statistically analyzed using ANOVA Table and New L.S.D test at 5% level of probability to verify the difference between the treatments as described by Snedecor and Cochran (1999).

RESULTS

1-Survey of powdery mildew incidence and susceptibility to infection in grape orchards:

During 2012 and 2013 growing seasons a survey results (Tables 1 and 2) show that the first disease symptoms appeared approximately at the same time every year. Disease severity was more pronounced in season 2013 than 2012. The highest percentage in disease severity was recorded in Minia governorate in all varieties, followed by Beheira and Kalyoubia, while Gharbia governorate recorded the lowest disease occurrence.Due to the high cost and toxicity associated with fungicide applications, developing the least susceptible cultivars could be an efficient, economic, and environmentally friendly strategy to reduce the threat of the disease.On the basis of disease severity, flame seedless was the least susceptible cultivar to the disease but Thompson seedless, Red roomy and Crimson seedless were very susceptible under field conditions. In the contrary, the highest disease severity was recorded in Gharbia with Red Roomy and Crimson seedless but the lowest disease severity was recorded on Thompson seedless and Flame seedless.

2-Epidemiological studies:

Data presented in Tables (3 and 4) show that there was correlation between the occurrence of powdery mildew disease and temperature degree during the period of study. First disease symptoms were observed on the leaves on late April. Subsequent increase in the degree of disease severity was associated with a parallel rise of the temperature degree. Thus the means of daily temperature increases from April to July led to rapid in disease severity in two seasons. The pathogenic activity of the fungus began when the temperature was 22°C with a relative humidity more than 50%. The optimum temperature and relative humidity for developing of *U. necator* was 25-32 °C and 55-90%, respectively. Interestingly, the disease severity subsided with increasing temperature degree above 32°C.

Effect of two spray programmes using some fungicides and biocides on disease severity%:

Powdery mildew fungus overwinters either within infected buds as mycelium or conidia, which germinate in the spring; or as minute fruiting bodies (cleistothecia) that lodge in the bark on the vine. Then they release unique spores (ascospores) to infect new foliage and young clusters in the spring. Of course, any programme that provides good disease control on the foliage and fruit during a growing season will limit the infection in the following spring. The

Table (1): Powdery mildew severity % on leaves and bunches of four grapevine cultivars in four governorates during 2012 season.

Dates	Disease severity % on grapevine cultivars in four governorates																				Mean
	Kalyoubia					Gharbia					Beheira					Minia					
	T	C	R	F	M	T	C	R	F	M	T	C	R	F	M	T	C	R	F	M	
26/4/2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.90	3.42	5.07	0.00	3.34	9.85	5.52	7.00	2.87	6.31	2.41
10/5/2012	4.62	6.15	7.17	3.10	5.26	2.50	3.00	5.40	2.42	3.33	12.67	7.01	10.15	4.07	8.47	20.10	14.32	19.27	5.02	14.67	8.18
24/5/2012	13.12	11.07	13.42	7.32	11.23	9.75	11.03	14.70	4.07	9.88	17.35	14.52	16.10	7.15	13.78	30.67	21.67	32.77	9.62	23.68	14.64
8/6/2012	22.37	21.07	23.27	13.67	20.09	13.70	16.01	20.05	8.75	14.62	26.40	22.80	26.01	15.10	22.57	36.37	32.01	38.02	24.02	32.60	22.47
22/6/2012	28.47	24.05	27.00	16.75	24.06	16.40	18.60	25.22	11.42	17.91	33.15	28.12	30.35	19.05	27.66	26.12	21.80	28.52	15.30	22.93	23.14
6/7/2012	30.50	28.07	28.05	18.02	26.16	21.35	24.02	27.67	17.95	22.74	22.45	20.30	20.02	11.01	18.44	10.40	8.75	12.97	5.20	9.33	19.16
20/7/2012	18.67	16.60	19.37	11.15	16.44	10.02	8.12	13.15	5.05	9.08	11.50	9.70	12.40	4.37	9.49	0.00	0.00	0.00	0.00	0.00	8.75
4/8/2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	14.71	13.37	14.78	8.75	12.90	9.21	10.09	13.27	6.20	9.69	16.05	13.23	15.01	7.59	12.96	16.68	13.00	17.31	7.75	13.69	12.34

T= Thompson seedless C= Crimson seedless R= Red Roomy F= Flame seedless M=mean of disease severity to four cultivars
LSD at5% for:
Governorates (G) = 0.52 Cultivars (C) = 0.52 Dates (D) = 0.73 G x C x D = 7.54

Table (2): Powdery mildew severity % on leaves and bunches of four grapevine cultivars in four governorates during 2013season.

Dates	Disease severity % on grapevine cultivars in four governorates																				Mean
	Kalyoubia					Gharbia					Beheira					Minia					
	T	C	R	F	M	T	C	R	F	M	T	C	R	F	M	T	C	R	F	M	
26/4/2013	7.62	5.47	5.10	0.00	4.54	0.00	0.00	0.00	0.00	0.00	7.42	5.15	6.05	0.00	4.65	11.02	8.07	9.25	4.85	8.29	4.37
10/5/2013	11.60	9.57	11.52	4.20	9.22	4.67	6.55	9.02	4.02	6.06	15.01	9.65	13.25	5.27	10.79	25.17	19.00	25.22	9.30	19.67	11.43
24/5/2013	21.15	17.02	19.95	8.45	16.64	13.35	16.02	19.67	7.02	14.01	23.95	20.70	18.75	10.77	18.54	36.22	28.27	34.02	14.77	28.32	19.37
8/6/2013	23.42	21.32	23.70	14.47	20.72	16.12	19.27	23.17	11.01	17.39	31.35	30.45	29.32	17.20	27.08	41.87	35.50	39.02	28.52	36.22	25.35
22/6/2013	27.67	22.82	25.07	17.02	23.14	20.05	24.35	28.22	15.37	21.99	38.01	34.45	36.67	21.01	32.53	27.22	25.10	27.10	18.02	24.36	25.50
6/7/2013	33.05	29.02	31.01	20.07	28.28	24.62	28.07	33.01	20.60	26.57	27.20	28.75	24.15	12.00	23.02	17.37	11.67	15.25	7.30	12.89	22.69
20/7/2013	21.00	18.15	19.00	11.02	17.29	15.15	11.22	19.65	7.17	13.29	11.02	13.01	11.00	4.47	9.87	0.00	0.00	0.00	0.00	0.00	10.11
4/8/2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	18.18	15.42	16.91	9.40	14.97	11.74	13.18	16.59	8.14	12.41	19.24	17.77	17.39	8.84	15.81	19.85	15.95	18.73	10.34	16.21	14.85

T= Thompson seedless C= Crimson seedless R= Red Roomy F=Flame seedless M=mean of disease severity to four cultivars
LSD at5% for:
Governorates (G) = 0.41 Cultivars (C) = 0.41 Dates (D) = 0.59 G x C x D = 6.93

Table (3): The relations between powdery mildew incidence and environmental factors (temperature and humidity) on Thompson seedless cultivar in four governorates during 2012 season.

Dates	Kalyoubia			Gharbia			Beheira			Minia		
	S	T	H	S	T	H	S	T	H	S	T	H
26/4/2012	0.00	21	80	0.00	21	85	4.90	22	70	9.85	23	55
10/5/2012	4.62	23	82	2.50	23	87	12.67	24	72	20.10	26	56
24/5/2012	13.12	25	83	9.75	25	89	17.35	27	73	30.67	29	57
8/6/2012	22.37	27	85	13.70	26	90	26.40	29	75	36.37	32	58
22/6/2012	28.47	31	85	16.40	30	87	33.15	32	72	26.12	34	50
6/7/2012	30.50	33	86	21.35	32	87	22.45	34	74	10.40	36	52
20/7/2012	18.67	36	86	10.02	34	89	11.50	36	74	0.00	38	53
4/8/2012	0.00	37	87	0.00	37	90	0.00	38	71	0.00	39	48
Mean	14.71	-	-	9.21	-	-	16.05	-	-	16.68	-	-

S= severity T=temperature H= humidity

Table (4): The relations between powdery mildew incidence and environmental factors (temperature and humidity) on Thompson seedless cultivar in four governorates during 2013 season.

Dates	Qalyoubia			Gharbia			Beheira			Minia		
	S	T	H	S	T	H	S	T	H	S	T	H
26/4/2012	7.62	22	80	0.00	21	85	7.42	22	70	11.02	23	55
10/5/2012	11.60	25	82	4.67	23	87	15.01	23	72	25.17	27	56
24/5/2012	21.15	27	83	13.35	25	89	23.95	25	73	36.22	31	57
8/6/2012	23.42	30	85	16.12	26	90	31.35	27	75	41.87	32	58
22/6/2012	27.67	32	85	20.05	30	87	38.01	32	72	27.22	34	50
6/7/2012	33.05	33	86	24.62	32	87	27.20	34	74	17.37	36	52
20/7/2012	21.00	36	86	15.15	34	89	11.02	36	74	0.00	38	53
4/8/2012	0.00	37	87	0.00	37	90	0.00	37	71	0.00	39	48
Mean	18.18	-	-	11.74	-	-	19.24	-	-	19.85	-	-

S= severity T=temperature H= humidity

efficiency of fungicides and biocides were determined under natural conditions in two programmes in two seasons. Data in Tables (5, 6, 7 and 8) show that in the majority of cases the disease often appeared on grapes at late April, and these treatments with sulfur which were given before this date made early spray programme more efficiency than late spray programme. All treatments significantly reduced disease incidence compared to the untreated control. In vineyards, three applications of sulfur at 250 g/100 L water after bud break made the early programme provided good protection at an important level against the disease infection on leaves and bunches of Thompson seedless cultivar as compared with control and the late programme. Sulfur also controlled early attacks by powdery mildew fungus, this was true in early programme during the two tested seasons compared to untreated trees. For instance, Topas, Bayfidan and Punch had (94.92% and 89.87), (91.88% and 89.01) and (89.82%and 87.58) efficiency, respectively when they applied in early programme, but they had (86. 39% and 84.96), (86.22% and 83.32%) and (83.84%and 81.71%) efficiency, respectively when they applied in late programme during the two seasons, followed by Topsin M and AQ10which recorded (86.71% and 85.46%) and (84.93% and 82.09%) efficiency, respectively in early programme and (82.60% and 78.85%) and (78.33% and 75.25%)) efficiency, respectively in late programme. On the contrary, BioArc, Bio Zeid and Micronized soreil were the least in minimizing the incidence of the disease during the two tested seasons .The efficiency of sulfur declined when the pressure of the disease was high. When disease pressure was high, spray programme which started with three protective sprays of sulfur after bud break and a demethylation inhibiting (DMI) fungicides Bayfidan and Topas provided better disease control than continuous spray with sulfur. Recently, search for biocides have been initiated. Regarding the biocides, AQ10 recorded good efficiency for controlling the disease.

Table (5): Effect of early spraying with sulfur after bud break until the first disease symptoms appears and complete the programme with each treatment alone on Thompson seedless powdery mildew during 2012 season .

Treatments	Efficiency % at different dates					Mean
	10/5/2012	24/5/2012	8/6/2012	22/6/2012	6/7/2012	
Micronized soreil 70%WP	89.42	83.22	79.39	76.22	83.11	82.27
Punch 40%EC	93.84	90.77	89.16	86.36	88.99	89.82
Topsin M70%WP	90.44	87.78	86.17	83.86	85.31	86.71
Topas 10% EC	97.31	94.12	91.96	89.77	92.45	94.92
Bayfidan 25%EC	95.73	92.91	90.94	88.80	91.04	91.88
Bio Zied	85.55	78.32	74.58	71.85	80.84	78.22
Bio Arc	83.10	76.19	72.80	70.25	79.95	76.45
AQ10	90.21	85.01	84.24	80.69	84.54	84.93
Control (water)	4.62	13.12	22.37	28.47	30.50	19.82

LSD at5% for:
Dates (D) = 0.23 Treatments (T) = 0.30 D x T = 0.68

Table (6): Effect of late spraying after the first disease symptoms appears with each treatment alone on Thompson seedless powdery mildew during 2012 season.

Treatments	Efficiency % at different dates					Mean
	10/5/2012	24/5/2012	8/6/2012	22/6/2012	67/2012	
Micronized soreil 70%WP	84.37	77.23	73.06	70.10	78.57	76.66
Punch 40%EC	87.84	84.26	82.00	80.27	84.85	83.84
Topsin M70%WP	88.55	83.17	79.84	78.37	83.07	82.60
Topas 10%EC	89.34	87.66	86.25	82.05	86.68	86.39
Bayfidan 25%EC	88.95	86.45	86.02	81.81	87.88	86.22
Bio Zied	76.87	74.81	68.33	62.59	66.85	69.89
Bio Arc	74.26	73.48	66.25	61.65	63.07	67.74
AQ10	86.74	78.15	75.03	72.18	79.55	78.33
Control (water)	4.62	13.12	22.37	28.47	30.50	19.82

LSD at5% for:
Dates (D) = 0.40 Treatments (T) = 0.36 D x T = 0.80

Table (7): Effect of early spraying with sulfur after bud break until the first disease symptoms appears and complete the programme with each treatment alone on Thompson seedless powdery mildew during 2013 season .

Treatments	Efficiency % at different dates					Mean
	10/5/2012	24/5/2012	8/6/2012	22/6/2012	6/7/2012	
Micronized soreil 70%WP	86.54	79.79	75.82	72.45	80.25	78.97
Punch 40%EC	90.87	88.72	87.59	83.45	87.31	87.58
Topsin M70%WP	88.07	86.26	85.55	80.83	87.38	85.46
Topas10%EC	93.13	91.60	89.31	86.02	89.30	89.87
Bayfidan 25%EC	91.33	90.73	88.89	85.84	88.30	89.01
Bio Zied	80.21	77.53	72.31	67.85	77.16	75.01
Bio Arc	77.81	73.44	70.71	67.45	75.47	72.97
AQ10	88.00	83.84	79.80	76.66	82.16	82. 09
Control (water)	11.60	21.15	23.42	27.67	33.05	23.38

LSD at5% for:
Dates (D) = 0.24 Treatments (T) = 0.32 D x T = 0.71

Table (8): Effect of late spraying after the first disease symptoms appears with each treatment alone on Thompson seedless powdery mildew during 2013 season.

Treatments	Efficiency % at different dates					Mean
	10/5/2012	24/5/2012	8/6/2012	22/6/2012	6/7/2012	
Micronized soreil 70%WP	77.48	73.56	70.55	67.56	75.33	72.89
Punch 40%EC	87.56	83.59	78.53	77.71	81.17	81.71
Topsin M70%WP	85.47	80.04	75.27	72.32	81.17	78.85
Topas10%EC	88.41	86.09	84.21	80.26	85.84	84.96
Bayfidan 25%EC	86.07	84.25	81.53	79.50	85.29	83.32
Bio Zied	73.48	71.44	66.12	60.08	63.45	66.91
Bio Arc	71.81	67.34	63.76	60.35	61.13	64.87
AQ10	80.34	76.49	71.74	68.79	78.89	75.25
Control (water)	11.60	21.15	23.42	27.67	33.05	23.38

LSD at5% for:
Dates (D) = 0.29 Treatments (T) = 0.39 D x T = 87

Discussion

Uncinula necator causes heavy yield losses because the warm and dry climate of Egypt allows the fungus to persist in the vineyards and is optimal for the development of epidemics. In this area, crop protection relies on an intense preventative usage of fungicides from bud break to version, or later in table-grape vineyards, to control late infections on rachis (Bob Emmett *et al.* 2003). Fungus overwinters as mycelium or conidia in dormant buds and/or as cleistothecia that lodge in the bark. They remained viable throughout the winter season, thus, becoming one of the overwintering stages of grapevine powdery mildew and a major inocula source of the fungus. The pathogen develops another type of spore, conidium within 6-8 days, if the temperature is between (20-32°C) (Hajjeh *et al.*2008). Cleistothecia are formed primarily on foliage, but also on berries, rachises or shoots (Pearson and Gadoury, 1987), once the disease severity has increased to a level at which pairing of compatible mating types on the same tissue becomes possible (Gadoury and Pearson, 1988).

According to the results, first disease symptoms occurred approximately at the same time every year. As about the disease attacks on grapes, Flame seedless proved to be the least susceptible cultivar in the four governorates at two seasons but Thompson seedless, Red Roomy and Crimson seedless were very susceptible under field conditions. In the contrary, the highest disease severity was recorded in Gharbia on Red Roomy and Crimson seedless but the lowest was recorded on Thompson seedless and Flame seedless. The highest percentage, however, was recorded in Minia governorate with all cultivars, followed by Beheira and Kalyoubia, while Gharbia recorded the lowest disease occurrence. Yield losses of grapevine under Minia conditions resulted in a decrease of the grapevine cultivated area (Hanaa and Galal, 2012).The optimal range for development symptoms of powdery mildew is (25-32°C) and temperatures above (33°C) have been reported to inhibit or kill colonies. High relative humidity (55%-90%) was conducive to the production of this pathogen. These conidia and fungal mycelia cause further spread of the pathogen. These findings and the previous reports (Fathi and Karbalaei Khiavi,2012) support the assumption that *U. necator* survived as mycelium in the dormant buds during winter. The pathogenic activity of the fungus began at 16-19°C with a relative humidity more than 50% and the optimum temperature and relative humidity for the sporulation was 20-30°C and 50-100%. They also showed that fungal cleistothecia were observed abundantly on the leaves, petioles and twigs at the end of season but they were not able to survive during winter. Formation of ascospores on young leaves was proved but their role as the primary inocula was not supported by the results of their study. Results on the biology and epidemiology of *U. necator* may be of national and international interests for the management of powdery mildew disease which is one of the most destructive diseases around the world (Sall, 1980).Where possible, the timing and number of sprays applied for its control should be adjusted to patterns of expected disease activity and weather-based disease forecasts, this should increase the efficiency of spray programmes.

The traditional method of controlling the disease on grapes, which depends on the application of fungicides and biocides after the appearance of symptoms, is less efficiency than application of fungicides and biocides before the appearance of symptoms. The first few treatments with sulfur are very important and should be applied starting at bud break or early shoot growth (Wicks *et al.* 2002). Sulfur is a low cost, multi-site fungicide that is widely used to control powdery mildew in all the world vineyards, using sulfur in spray programmes is important to prevent the development of resistance to other fungicides and ensure optimum control of powdery mildew. Protective fungicide treatments prevent infection by fungal spores. Good coverage is important (Tweedy, 1969). The results show that the time of application markedly affected the efficiency of the fungicides and biocides. Topas, Bayfidan and Punch were the most effective treatments, followed by Topsin M and AQ10. On the contrary, Bio Arc, Bio Zeid and Micronized soreil were the least treatments in minimizing the disease incidence at the two seasons .The efficiency of sulfur declined when the pressure of the disease was high. When the disease pressure was high, spray programme which started with three protective sprays of sulfur after bud break and a demethylation inhibiting (DMI) fungicide, *i.e.* Topas and Bayfidan provided better disease control than continuous spray with sulfur. Ergosterol biosynthesis inhibitor (ESBI), *i.e.* penconazole 10% EC (Topas), flusilazole 40 EC (Punch) were also the most effective fungicides. The DMI's and the sulphur fungicides have been the mainstay of the disease control in most grape areas of Australia (Wicks *et al*.2002). (Bob Emmett *et a*l. 2003) reported that in warm climate, many organic growers utilize sulfur products to control the disease starting at bud break. They need to be applied every seven days or reapplied whenever they are washed off by rain or irrigation, which may not be cost effective. Also they found that sprays of sulfur or alternative fungicides for powdery mildew control should be applied at 2 weeks after bud burst (when shoots are around 10cm with 5-6 separated leaves), at 4 weeks after bud burst (when shoots are around 20-30cm with 8-10 separated leaves), at 6-7 weeks after bud burst (at pre-flowering when shoots have 12-14 leaves) and/or at 8- 10 weeks after bud burst (at berry set or post flowering, when berries are around 2mm). (Tweedy, 1969; Pearson, 1988; Mametz and Raoul 2001and Mametz , 2003) reported that sulfur has been successfully used since the middle of the eighteenth century and is still considered to be an effective agent in the form of dusts or liquid formulations . However, such natural or organic-type treatments must be repeated frequently for adequate control. For this reason, synthetic fungicides with much longer effectiveness dominate in conventional viticulture. (Bob

Emmett *et* al. 2003) explained that mode of action for Sulfur against powdery mildew is related to contact and vapour activity. Contact activity usually has a minor role in the efficacy of sulfur products. Contact activity is not temperature dependent (providing particles have not vaporized). Vapour activity is temperature dependent. Sulfur inhibits germination of the fungal spores ,although the mode of action is uncertain. Sulfur vapour may be absorbed into lipids in spores and metabolism by the fungus may lead to hydrogen sulfide (H2S) production and blocking of respiration. Sulfur has less efficacy against established mycelia of powdery mildew. Demethylation inhibiting (DMI) fungicides are superior to sulfur in this regard. Also this study have indicated that when micronized sulfur is applied to leaf surfaces 60% of sulfur is bound to lipids of cuticular waxes on leaves within 2 hours of application. Of this 60%, up to 10% is used in plant metabolism and incorporated into amino acids and other compounds; 20% of sulfur is vaporised within 2 hours; 10% remains on the leaf surface but is not fixed to lipids and is readily removed by washing; 20% does not usually reach the leaf surface and is deposited on the ground or elsewhere**.** Development of resistance in the pathogens, residual effects, and environmental pollution along of the cost of controlling diseases are problems associated with the use of these chemicals. Biological control is considered one of the most important methods to control plant diseases and reduce the requirement to fungicides to keep environment clean and to protect human health. Results clear that AQ10 recorded good efficiency in controlling powdery mildew on Thompson seedless cultivar. AQ-10 is a new biocide, which contains fungal spores of *A. quisqualis*, and controls powdery mildew by parasitizing and killing fungal organisms that cause the disease. AQ-10 is approved for biological control of powdery mildew. The initial application should begin before the symptoms appear and at the latest when three spots on 100 leaves or fruits have been observed (Sirca, 2001). Although the recent strategy of control plant disease is depended upon minimizing of fungicidal utilization to avoid environmental pollution and to keep human healthy, fungicides will be one of IPM weapons. It is vitally important that everyone use any pesticide in a judicious, timely manner.

It could be concluded that most of fungicides and biocides that were used in present experiments gave satisfactory control to powdery mildew when applied after three sprays of sulfur before the initial appearance of the disease symptoms. Chemical control is more effective than biological control but biological control may be used throughout integrated pest management (IPM) to keep environment clean and keep human health.

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البياض الدقيقى على العنب فى مصر: تفشى المرض، الحرارة، الرطوبة، الأصناف ومكافحتة كيماويا وبيولوجيا.

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الملخص العربى

أجريت دراسات حقلية على أربعه أصناف من العنب هى (البناتى ، كريمسون سيدلس ،الرومى الأحمر ،الفليم سيدلس) فى أربعه محافظات هى (القليوبيه، الغربيه، البحيرة، المنيا) وذلك بفحص هذه الأصناف خلال موسمى ٢٠١٢،٢٠١٣ لمعرفة بداية ظهور مرض البياض الدقيقى والتطور المتعاقب له. ولقد أوضحت النتائج أن المرض كان أكثر انتشارا فى موسم ٢٠١٣ وأن الصنف فليم سيدلس كان أقل الأصناف إصابه بالمرض، وأن الأصناف البناتى، الرومى الأحمر، الكريمسون سيدلس كانت أكثرها قابلية للإصابة ، ولقد ظهر عكس ذلك فى الغربيه حيث

كان الصنفين الرومى الأحمر والكريمسون سيدلس الأعلى إصابة أما البناتى والفليم سيدلس فكانتا أقل الأصناف إصابه. ولقد سجلت أعلى شدة إصابه على كل الأصناف فى محافظة المنيا يليها البحيرة والقليوبية بينما سجلت أقل شدة اصابة فى الغربية. ولقد وجد أن هناك علاقة بين درجات الحرارة و الرطوبه وشده الأصابة بالمرض حيث بدأ ظهور المرض عند درجه حرارة ٢٢ م ورطوبة أعلى من ٥٠% . وأن درجة الحرارة من ٢٥–٣٢ م والرطوبة من ٥٠–٩٠% كانت هى المفضلة لأنتشار وزيادة شدة الإصابة بالمرض ، ولقد هبطت شدة الاصابة عند زيادة درجة الحرارة عن ٣٢ م. تم رش خمس رشات بالمبيدات الفطرية والحيوية كل ١٥ يوم من خلال برنامجين هما الرش المبكر و الرش المتأخر. ولقد وجد أن جميع المعاملات التى تمت فى البرنامج المبكر الذى بدأ بالمعاملة الوقائية بثلاث رشات من الكبريت عند انتفاخ البراعم حتى ظهور المرض ثم الرش بكل مبيد على حدة أعطت أعلى كفاءة للمبيدات عن الرش الذى تم بعد ظهور المرض وأن المبيدات توباس ، بايفيدان ، بانش كانت أعلى المعاملات كفاءة فى مكافحة المرض يليها المعاملة بمبيدى توبسين ام ، أيه كيو –١٠وعلى العكس كان الرش بمبيدات بيوأرك، بيوزيد والكبريت الميكرونى أقل كفاءة فى مكافحه المرض. كما أن كفاءة الكبريت قد انخفضت بعد زيادة شدة الإصابة بالمرض.