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Integrated Management Of Grapes Powdery Mildew (*Uncinula necator*), In Nubaria Locations, And Its Effect On The Grapes Yield

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ABSTRACT

This study was conducted over four seasons (2019-2022), and its main objective was to control powdery mildew disease in grapes caused by the Uncinula necator. The control was carried out through a chemical control program, using agricultural fertilizers to reduce the number of fungicide sprays and completely control the disease.

In the first season (2019), 11 different effective fungicides were tested after a single spray application, whether systemic or preventive, and their effect on disease severity % and crop characteristics of the plant was studied.

In this respect, the results showed that at the Al Noubaria location, the beginning of the disease on the different grapevine varieties (Flame, Superior, Thompson) was five days after spraying. Generally, Amistar-Top (azoxystrobin+ difenoconazole) showed the best reduction of disease severity % on Flame variety (15 %), while Prodizole and Flusilazole were the most efficient fungicides in controlling the disease after 10 days of spraying and the best reduction of powdery mildew disease severity % on all varieties. Pradizole *and flusilazole recorded disease severity% of (30 & 30), (30 & 45), and (50 & 50) in Flame, Superior, and Thompson, respectively. In the second season (2020), 17 fungicides were tested after three foliar spray applications, with a 10-day interval between each application. Nimrod followed by Delata-Dom 25% EC gave the highest weight of cluster (68.3 and 63.3 gm/cluster), respectively. When testing agricultural fertilizers without fungicides, the best ones were chitosan and potassium sulfate. In the third season (2021), a chemical program was designed in comparison with the farm program and proved its efficiency in reducing disease and raising crop characteristics. In the last season (2021/2022), the final program was applied, which combines preventive and systemic fungicides and agricultural fertilizers, and it proved its high efficiency in reducing disease severity compared to the farm program and general control.*

***Conclusively,** the results showed that, under the conditions of the Al-Noubaria region, powdery mildew disease appeared in the different grape varieties (Flame, Superior, and Thompson) five days after foliar spraying. The three varieties exhibited differences in their susceptibility to powdery mildew and their responses to treatments with fungicides or fertilizers. In general, Amistar-Top (azoxystrobin + difenoconazole) showed the best reduction in disease severity % on the Flame variety (15%). While chitosan and potassium phosphate were the best efficiency as alternative fungicides. The final program was applied in the dormant stage, which has proven highly efficient in reducing the severity of the disease compared to the agricultural program and general control.*

Keywords: Powdery mildew, grapes, fertilizers, fungicides and pest management.

INTRODUCTION

Grapevine powdery mildew is caused by the fungus *Uncinula necator* . This fungus infects green grapevine tissue including leaves, stems, and berries (Calonnec, *et.al.*, 2006). As the fungus grows, and especially when it produces spores, it gives infected tissue an ash-grey powdery appearance Pertot *et.al* (2017). Powdery mildew infection distorts the growth of rapidly expanding leaves, which may become cupped. Old sites of powdery mildew infection on shoots are indicated by a red-brown to black staining on dormant canes. Grapevine powdery mildew only grows on cultivated grapevines and very closely related ornamental grapes. There are numerous species of powdery mildew fungi, affecting a wide range of plants. It is important to note that *Uncinula necator* is the only one that grows on grapevines Wilcox, *et al.* (2015). The disease-susceptible Grapevine when planted in areas having high pathogen stress causes greater economic loss (Mueen Uddin *et al.*2022). In such a situation, the use of a fungicide is the only option to control the disease (Sônego *et al.*, 2022). Generally, fungicides are used at a stipulated time to get the plant surface covered as a preventive tool. Sometimes, several fungicides are repeatedly sprayed concerning the time in the production cycle of a crop. The efficacy of fungicide is decreased when sprayed too early or late when the disease is in epidemic form. Powdery mildew affects grapes tremendously and non-commercial varieties have less resistance against this pathogen that requires 6 or more fungicide sprays for effective control (Pearson and Gadoury1992) and (Stark-Urnau and Kast, 1999). It has been reported that one week before bunches of theses with berries size of 2 mm is a highly susceptible stage to disease attack (Gadoury *et al.*, 2003).

Managing powdery mildew with fungicides for best results, fungicide treatments should begin before the overwintering fungus can infect new growth. The first few treatments are the most important and should be applied at appropriate intervals, starting at bud break or early shoot growth (Mueen Uddin *et al*., 2023).To decrease the inoculum potential, a disease management program must be undertaken early in the season which is imperative to reduce late-season disease problems. Because, without early control of the infection of powdery mildew, often leads to severe problems in the late season (Bettiga, 2017 and Sadek *et al*., 2022). The objective of this work is the optimal time of application of chemical fungicides, the optimum dose, and the period between sprays. In addition to some suggested solutions of using nutrients as inducers of resistance within plants.

Therefore, we reduce the indiscriminate use of pesticides. Designing a control program that includes agricultural fertilizers, and fungicides in a specific order and specific doses and intervening at the correct time to obtain the highest control efficiency.

MATERIALS AND METHODS

Field experiment:

Mature, field-grown grapevines (*Vitis vinifera* L.) of the 8-year-old Flame, Superior and Thompson varieties were used during the fourth growing season. The experimental vineyards are located in Al-Nubaria (Behara Governorate).

The fungicides common names, active ingredient and the rate of applications of all studied fungicides are tabulated in Table (1).

In the first season of 2019, at Al-Nubaria region, application of 11 fungicides (a single application only) were been tested for their efficiency on

Table (1): The tested fungicides used and rate of application

Common name	Rate (ml or gm) / 100-liter water	Active ingredient
Eco pro 25% EC	20	Propconazole
Eurozol 25% EC	50	Difenoconazole
Delata-Dom 25% EC	50	Difenoconazole
Topas 10 % EC	10	Penconazole
Prodizole, 30% EC	50	Difenoconazole +Propiconazole
Mycobutanil, 25% EC	25	Mycobutanil 25% Ec
Amistar top 32.5%SC	75	Azoxystrobin+ Difenoconazole
Curve25% EC	50	Difenoconazole
Flusilazole 40% EC	3.0	Flusilazole
Akoby 50% SC	10	Kresoxim-Methyl
Topsin M 70% WP	80	Thiophanate – methyl
Eminent 12.5% EW	35	Tetraconazole
Bellis 38% WG	50	Boscalid + Pyraclostrobin
Nimrod 25%EC	70	Bupirimate
Switch 62.5% WG	50	Cyprodinil+Fludioxonil
Carbendazim 80%WP	50	Carbendazim
Lepra12.5%EW	25	Tetraconazle

disease severity % on three varieties of grapevine, (Flame, Superior, and Thompson). The disease severity % was recorded at zero time and after 5 days, 10, 21 days, and 28 days by applying the recommended dose.

In the second season (2020) at Al-Nubaria regions, seventeen fungicides were been applied 3 times and the interval between the application and the following one was every 10 days on three varieties of grapevine, (Flame, Superior, and Thompson). The disease severity % of powdery mildew was recorded, when the trees were 25% flowering, the beginning of spraying in the three varieties of grapes. Also, yield characteristics including number of clusters, number of shoulders, length of cluster, and weight of cluster, were assessed at harvest time.

On the other hand, the alternative fungicides program was initiated on the first of January, Micronics sulfur, and Champion (Copper hydroxide) were sprayed once every two weeks. Then, the application of Potassium phosphate, Chitosan, Calcium nitrate, Potassium sulfate, Magnesium sulfate, Manganese sulfate, Ferrous sulfate and Mico- elements (Zinc and Iodine) were applied once every week, separately .

Table (2). Fertilizers treatments:

Treatments	Rate alone/ L as (cm or g)
Microvet-KZ 80% sulfur 80%	2,5
Champion (Copper hydroxide)	2,5
Potassium phosphate (Mono)	1.0
Chitosan	0.5
Calcium nitrate	1.0
Potassium sulphate	1.0
Magnesium sulphate	0.5
Manganese sulphate	0.5
Ferrous sulphate	0.3
Micro elements (Zinc+ Iodine)	0.001 Mm (Mile molar)

Also, the effect of the alternative fungicide program on the yield characteristics (*i.e.* Number of clusters, Number of shoulders, length of the cluster, and weight of cluster), was recorded at harvest time.

In the third season (2021), at Al-Nubaria regions, on three varieties of grapevine, (Flame, Superior, and Thompson), chemical program only either suggested program or farm chemical fungicides program that were been applied compared with the control treatment which sprayed water only. Each application was been done once every 10 days, both of farm and tested programs were been compared with the general treatment control, which was been sprayed with water only as general control. The efficiency of the three programs on disease severity % was recorded, two weeks after the last application.

In the fourth season (2021/2022) at Al-Nubaria regions, three varieties of grapevine, (Flame, Superior, and Thompson), started on the first of November (2021) during the dormancy stage until harvest time at (2022). The tested program applied chemical fungicides and fertilizers (Tested) in comparison with the farm program (Farm) and both of them compared with the general treatment control which was been sprayed with water only as general control. In this respect, the effect of the tested program or farm program on the yield was been recorded at the harvest time.

***Disease severity assessment*:**

To assess the severity of the disease depending on the devised scale 0-4 by Lonsdale and Kotze (1993), Where:

0= No diseases present

1= 15-25% leaf area and berries infected, 2 =26%-50% leaf area and berries infested, 3 =51%-75% leaf area and berries infected, 4= More than 75% of leaf area and berries infected.

Percent Index (PDI) is calculated by following formulae. The severity of the disease was calculated using the following formula:

Disease severity % 100

Σ = ´(n x v)/ 4Nx100

Where:

n = Number of the infected inflorescence in each category, v = Numerical values of each category, N = Total number of the examined inflorescence.

Statistical analysis

This experiment was arranged as a complete randomized block design with four replicates, three vines per each one. Data were subjected to analysis of variance (ANOVA) using Costat Statistical Software (1986). Means of all data were compared by LSD method at 5% according to Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Evaluate the effect of 11 fungicides on disease severity % of powdery mildew on three varieties of grapes using the recommended dose at different intervals (Zero time, 5 days, 10 days, 21 days, and 28 days):

In general, the results in (Table 3) showed under Al-Noubaria location the beginning of the disease in the different varieties of grapevine (Flame, Superior, Thompson) was five days after spraying. The efficiency of fungicides in controlling the disease after five days of spraying and ten days of spraying was not significant, so there is no need to repeat spraying after five days. All fungicides showed significant differences in controlling the disease compared to the control. In this respect, after 5 days Amistar Top recorded the lowest disease severity % on Flame variety at the first seasons (15%). Myclobutanil and curve 25% Ec showed (10%) disease severity % at the first season on superior variety and Eurozol 25% Ec showed (25%) disease severity, five days after application on Thompson variety. However, the results 10 days post application showed that Perozole, Flusilazole, and Akoby 50% SC were the most efficient reduced disease severity on Flame variety in the first season recording (30, 30, 30 %) disease severity, respectively. Whatever, both Perozole and Delata-Dom 25% Ec and Topsin M70 gave (30,30 and 30%) decreased severity on Superior variety, 10 days post application. Perozol, Myclobutanil, Flusilazole, and Akoby50%SC decreased disease severity of powdery mildew on Thompson variety (50, 50, 50, and 50%), 10 days post

Table 3: Evaluate the effect of 11 fungicides on disease severity% of powdery mildew on three varieties of grapes using the recommended rate at different intervals (5, 10, and 21 days post-application) in Frist season (2019), at the Al-Nubaria location

Treatments	Disease severity%											
	Time	Flame	Superior	Thomson	Time	Flame	Superior	Thomson	Time	Flame	Superior	Thomson
Eco pro 25%EC	5 Days	45.00	50.00	50.00	10 Days	50	50	60	21 Days	70	70	80
Eurozol 25% EC		20.00	40.00	25.00		40	50	55		70	70	80
Delata-Dom 25% EC		40.00	30.00	50.00		45	30	55		60	60	70
Topas 10% EC		40.00	40.00	50.00		50.00	50.00	60.00		60.00	60.00	70.00
Prodizole 30% EC		35.00	30.00	40.00		30.00	30.00	50.00		50.00	60.00	50.00
Myclobutanil 25% EC		40.00	10.00	50.00		45.00	40.00	50.00		60.00	60.00	60.00
Amistar top 32.5%SC		15.00	15.00	30.00		40.00	40.00	55.00		70.00	50.00	60.00
Curve 25% EC		20.00	10.00	30.00		35.00	40.00	55.00		45.00	50.00	65.00
Flusilazole 40% EC		30.00	20.00	40.00		30.00	45.00	50.00		60.00	60.00	50.00
Akoby 50%SC		30.00	40.00	45.00		30.00	55.00	50.00		60.00	50.00	70.00
Topsin 70% WP		40.00	20.00	50.00		40.00	30.00	60.00		70.00	60.00	60.00
Control		50.00	50.00	60.00		65.00	65.00	70.00		100.00	100.00	100.00
LSD 0.05		6.23	6.40	7.72		2.40	3.70	2.40		3.60	8.40	6.10

application. After 28 days of application, the effectiveness of the fungicides in controlling was completely, as the disease severity rate in all treatments was 100%. That results was agreement with Abdelhak *et al.* (2021) and (Lior Gur, *et al*, 2023). In this respected, Wong and Wilcox (2002) found that two hundred fifty-six single-conidial chain isolates of *Uncinula necator* were assayed for their sensitivity to azoxystrobin and myclobutanil. Mean coefficients of variance for a leaf disk assay used to test fungicide sensitivities were 31% for azoxystrobin and 41% for myclobutanil. Baseline ED50 values ranged from 0.0037 to 0.028 µg/ml (mean 0.0097 µg/ml) for azoxystrobin and from 0.0049 to 0.69 µg/ml (mean 0.075 µg/ml) for myclobutanil. Tests with three other strobilurin fungicides (kresoxim-methyl, pyraclostrobin, and trifloxystrobin) indicate clear differences in the intrinsic activity of these compounds against *U. necator*, and the applicability of the methods developed with azoxystrobin for assays with pyraclostrobin and trifloxystrobin.

In the second season (2020), data in Table (4) represented the effect of seventeen on fungicides disease severity %of powdery mildew on three varsities of grapes at Al-Nubaria region in the first season after 10 days, the percentage of disease severity decreased significantly for all fungicides compared to control, the best of them were Prodizole-EC 30 %, was the most decreased powdery mildew disease severity on Flame and Thompson varieties that recording (48.6 and 50.6 %) respectively. While, Delata-Dom 25%Ec was the highest efficiency on Superior variety, 10 days post application, that recording (42%) disease severity. These results were harmony with, (Miles *et.al.,* 2012), Grove (2000) and Deliere (2010). In this respect, Semcheddine *et al.* (2018) reported that the repeated use of fungicides mainly Boscalid has resulted in the emergence of resistant microorganisms such as Botrytis cinerea. However, Boscalid resistance was never observed in *E. necator*. A large-scale survey of French grapevine field populations of *E. necator* revealed many field populations with low sensitivity to Boscalid. Single spore strains originating from collected resistant populations showed Half maximal effective concentration (EC50) values greater than 100 mg L-1, and strains originating from Boscalid-sensitive populations showed EC50 values lower than 1 mg L-1. The complete nucleotide sequences of the EnSdhB succinate dehydrogenase of sensitive and resistant single spore strains revealed that H242R and H242Y substitutions in the EnSdhB succinate dehydrogenase subunit conferred *E. necator* resistance to Boscalid. No cross-resistance of *E. necator* strains bearing H242R and H242Y substitutions in EnSdhB succinate dehydrogenase to Fluxapyroxad and Fluopyram was noticed.

Therefore, the present results highlight the emergence of resistance to Boscalid activity in French vineyards and warrant the need for the implementation of risk assessment strategies to maintain effective grapevine protection against powdery mildew.

Effect of seventeen fungicides sprayed every 10 days on yield characteristics of three varsities of grapes at Al-Nubaria.

Data in Table (5) obtained Amistar–top recording the highest Flame cluster weight (185.0 g/ flame cluster), Delata-Dom 25% Ec, and Lepra produced the highest Superior cluster weight (135.00 and 135.00 g / superior cluster). That was agreement with (David *et al.,* 2001). While, (Abdelhak Rhouma et.,al. 2001) found that the pathogen can differentially attack leaves and grapes, and is currently controlled with repeated applications of fungicides, under field conditions.

Table 4: Effect of seventeen fungicides on disease severity% of powdery mildew in three varieties of grapes at the Al-Nubaria in second (2020) season.

Treatment	Original fungicides treatment	Time	Disease severity%		
		Every 10 Days	Flame	Superior	Thompson
Zero Time			15.3	7.6	7.00
Eco pro 25% EC	Powdery mildew of mango		47.3	54.3	70.00
Eurozol 25% EC	(Farm treatment)		44.3	58.6	51.6
Delata-Dom 25%EC	Powdery mildew of grape		53.3	42.00	54.6
Topas 10% EC	Powdery mildew of apple (Farm treatment)		45.6	52.3	70.00
Prodizole 30% EC	Leaf spot of crops		48.6	49.3	50.6
Mycobutanil, 25% EC	Rust of peach		68.6	43.3	68.6
Amistar top 32.5%SC	Leaf spot of guava + Blight of Mango (Farm treatment)		53.00	43.3	64.6
Curve 25% EC	Leave spots of crop, vegetables and powdery mildew of stone fruits and pome		54.00	53.6	67.3
Flusilazole40% EC	Powdery mildew of mango		51.00	49.00	59.00
Akoby 50% SC	Scab of apple		53.6	44.00	54.3
Topsin M 70% WP	Powdery mildew of grape (Farm treatment)		50.00	46.00	66.6
Emenent **12.5% EW**	Powdery mildew of apricot		60.00	73.6	77.6
Bellis 38% WG	Fruit rot and powdery mildew of grape (Farm treatment)		58.6	62.00	65.6
Nimrod 25%EC	powdery mildew in apples, stone fruit, and mangoes		53.3	45.00	58.00
Switch 62.5% WG	Fruit rot of grape		52.6	60.00	70.3
Carbendazim 80%WP	(Farm treatment)		52.00	50.00	65.00
Lepra 12.5%EW	Powdery mildew of apricot		41.00	42.00	65.00
Control			100.0	100.0	100.0
LSD0.05			4.28	3.64	9.64

Table 5: Effect of seventeen fungicides after sprayed every 10 days on yield characteristics of three varieties of grapes at Al-Nubaria in season (2020).

Treatment	Yield characteristics											
	Flame				Superior				Thompson			
	N.C.	N.Sh	L.C.	W.C	N.C	N.Sh.	L.C.	W.C	N.C.	N.Sh.	L.C.	W.C
Eco pro 25% EC	3.0	1.0	12.3	25.0	0.0	0.0	0.0	0.0	2.0	1.0	14.0	43.3
Eurozol 25% EC	11.0	6.0	13.0	175.0	1.0	1.0	9.0	10.0	1.0	1.0	11.0	35.0
Delata-Dom25%EC	2.0	4.0	7.0	31.6	1.0	3.0	14.0	135.0	1.5	1.5	12.6	63.3
Topas10% EC	2.0	1.0	5.0	40.0	0.0	0.0	0.0	0.0	2.0	1.0	13.3	35.0
Prodizole30% EC	2.0	5.0	13.0	90.0	1.0	2.0	12.0	78.3	1.0	1.0	9.0	50.0
Mycobutanil, 25% EC	2.0	3.0	5.6	48.3	6.0	2.0	13.0	113.0	1.0	1.0	5.0	46.6
Amistar top32.5%SC	12.0	2.0	12.0	185.0	5.0	2.0	13.0	85.0	1.0	1.0	5.0	35.0
Curve 25% EC	2.0	1.0	10.0	40.0	1.0	1.00	4.0	15.0	2.0	1.0	10.0	36.6
Flusilazole40% EC	6.0	5.0	13.0	122.0	2.0	1.0	12.0	40.0	1.0	1.0	9.6	30.0
Akoby 50% SC	10.0	4.0	11.0	133.0	5.0	2.0	13.3	93.3	0.00	0.0	0.0	0.0
Topsin M 70% WP	4.0	2.0	13.0	76.6	3.0	1.0	14.0	53.3	1.0	1.5	6.0	63.3
Emenent 12.5% EW	8.0	1.3	9.3	148.0	6.0	1.0	8.0	45.0	2.0	2.0	11.0	53.3
Bellis 38% WG	4.6	3.0	13.0	140.0	1.0	1.0	4.0	10.0	1.0	1.0	4.0	35.0
Nimrod 25%EC	7.0	4.0	15.0	121.0	4.0	2.0	14.0	93.3	1.0	2.0	13.0	68.3
Switch 62.5% WG	1.0	1.0	8.0	38.3	1.0	1.0	3.6	9.0	3.0	1.0	15.6	103
Carbendazim 80%WP	0.0	0.0	0.0	0.0	1.0	1.0	8.3	25.0	1.0	1.0	6.0	45.0
Lepra 12.5%EW	1.0	2.0	9.0	50.0	6.0	3.0	13.0	135.0	2.0	1.0	15.0	50.0
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSD0.05	2.82	2.72	N.S	57.8	2.8	1.16	5.87	44.2	1.8	N.S	N.S	N.S

N.C: Number of clusters, N.Sh: Number of shoulders, L.C: length of cluster, W.C: Weight of cluster

In the second season (2020) of the experiment, alternative fungicides were applied in the form of agricultural fertilizers beginning in January in Al-Nubaria. Generally, results in Table 6 showed that the most efficient fertilizer in reducing the percentage of disease severity was chitosan which gave (52,42.6 and 50) disease severity % under Al-Nubaria locations that were on Flame, Superior, and Thompson grape varieties, followed by Potassium sulfate which gave (53.6,49 and 51%) disease severity on the same three grape verities under Al-Nubaria location, respectively.

Table 6: Effect of alternative fungicides on disease severity % of powdery mildew on three varieties of grapes at the Al-Nubaria locations in second season (2020).

Treatments	Sprays	Time	Disease severity%		
			Flame	Superior	Thompson
Micronics sulfur	Two	1st January to15	0	0	0
Shampion (Copper hydroxide)	Two	15-30 January	0	0	0
Zero time	Every week	1st –February-28/ 3 5 APRIL	0	0	0
Potassium phosphate(Mono)			55.3	54.3	58
Chitosan			52	42.6	50
Calcium nitrate			59	55.6	64
Potassium sulfate			53.6	49	51
Magnesium sulphate			67.6	64.6	62
Manganese sulphate			74	61.6	74
Ferrous sulphate			75.3	70.3	74.3
Zinc			70.3	62.3	61
Small elements			58.6	54	54
Control			86	78.3	79
LSD. 0.05			7.4	3.7	4.3

However, the results of nutrients applied alone without fungicides were in harmony with Lior Gur *et al.* (2022) found that in field experiments the foliar application of the potassium phosphate fertilizer as Top-KP + (1-50-33 NPK) reduced disease incidence on leaves and clusters by 15–65% and severity by 75–90%, compared to untreated vines. Top-KP+ mixed with Nanovatz (containing the micronutrients boron and zinc) or with TruPhos Platinum (a mixture containing N, P2O5, K2O, Zn, B, Mg, Fe, Mn, Cu, Mo, and (CO) further reduced disease incidence by 30–90% and disease severity by 85–95%. These fertilizers were as effective as the fungicide tebuconazole.

Tank mixtures of fertilizers and tebuconazole further enhanced control efficacy in the vineyards. The modes of action of fertilizers in disease control were elucidated via tests with grape seedlings, microscopy, and berry metabolomics. Fertilizers applied preventively to the foliage of grape seedlings inhibited powdery mildew development. Application on to existing mildew colonies plasmolysis mycelia and conidia and arrested the development of the disease. Berries treated with fertilizers or with a fungicide showed a significant increase in anti-fungal and antioxidant metabolites (Ram *et al.,* 2017).

In terms of crop characteristics, as shown in Table 7, under Al-Nubaria location chitosan and potassium phosphate were among the best treatments as alternative fungicides. Whenever Chitosan gave the highest cluster average number on Flame, Superior and Thomas varieties (7, 8 and 3 cluster/ tree), respectively and it gave the best average weight (250, 201.6 and 51.6 gm/cluster), respectively, followed by potassium phosphate which gave average number cluster (7, 3 and 3 cluster/ tree), (185, 186.6 and 48.3 gm./cluster) m respectively.

In this respect, Chitosan is one of the nutrients that grapes were treated with, and it has shown a significant reduction in the % severity of powdery mildew disease. It is one of the DE acetylated chitin derivatives, as it sends signals to the plant to defend against plant pathogens as well as some viral diseases. It is safe for the plant, as it is considered an environmentally friendly alternative to fungicides, and these are the results compatible with, (Iriti *et al.,* 2011).

In addition to chitosan (Soares *et al*., 2023), potassium fertilization gave good results in reducing the disease rate results mentioned by (Bowen *et al.,* 1992) that foliar application of potassium salts reduced Powdery mildew on grape leaves (Reuveni *et al.,* 1997) and (Calzarano *et al.,* 2014) showed that the foliar application of phosphate salts controlled powdery mildew in cucumber, roses, mango, apple, nectarine, and grapes.

The proposed chemical control program was applied with the farm program at the beginning of January in Al-Nubaria

The results in Table, 8 showed that the results also showed the efficiency of the proposed program in decreasing the disease and reducing the percentage of disease severity provided that they were applied in the same order and timing. In the third season of the experiment, the proposed chemical control program was applied to the farm program at the beginning of January in Al-Nubaria. In the last season, the program was fully applied with agricultural fertilizers, but spraying began in November before the buds opened.

The program was fully applied with agricultural fertilizers, but spraying began in November before the buds opened (Table 9).

Results in Table 9 showed a delayed appearance of the disease, as it began to appear clearly in March in Al-Nubaria. The severity of the disease% decreased wonderfully, reaching the end of the disease. The season reached 5, 3 and 1.5 in Al-Nubaria the three varieties compared to the farm program.

Table 7: Effect of alternative fungicides on yield characteristics of three varieties of grape at the Al- Nubaria location in second season (2020).

Treatments	Yield characteristics											
	Flame				Superior				Thompson			
	N.C	N.Sh	L.C	W.C	N.C	N.Sh	L.C	W.C	N.C	N.Sh	L.C	W.C
Micronics sulfur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Champion (Copper hydroxide)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zero time	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium phosphate(Mono)	7.00	5.00	15.6	185.00	3.00	5.00	15.00	186.6	3.00	1.00	12.00	48.3
Chitosan	7.00	6.00	17.00	250.00	8.00	6.00	22.00	201.6	3.00	2.00	13.00	51.6
Calcium nitrate	4.00	4.00	14.6	191.6	3.00	2.00	20.00	103.3	3.00	1.00	12.00	33.3
Potassium sulphate	5.00	5.00	15.00	205.00	7.00	5.00	18.3	166.6	3.00	2.00	13.00	33.3
Magnesium sulphate	4.00	3.00	12.00	103.3	5.00	4.00	18.3	155.00	3.00	1.00	13.00	41.6
Manganese sulphate	1.00	2.00	12.00	73.3	2.00	2.00	12.00	60.00	1.00	1.00	7.00	15.00
Ferrous sulphate	1.00	1.00	4.00	25.00	1.00	1.00	7.00	25.00	1.00	1.00	6.00	16.00
Zinc	1.00	1.00	10.00	40.00	3.00	3.00	13.6	100.00	3.00	1.00	10.00	33.3
Micro elements	4.00	4.00	13.00	163.3	4.00	4.00	13.00	153.3	3.00	1.00	12.00	35.00
Control	2.00	1.00	6.00	26.6	2.00	1.00	4.00	15.00	1.00	0.00	4.00	9.00
LSD 0.05	2.008	1.64	5.13	52.7	2.99	2.14	5.38	46.85	2.48	1.04	5.25	22.8

N.C: Number of clusters, N.Sh: Number of shoulders, L.C: length of cluster, W.C: Weight of cluster

The results were also reflected in the crop characteristics of the plant, as shown in (Table 10), where the crop characteristics were significantly higher in the case of the proposed program compared to the farm program.

On the other hand, the tested chemical program was compared with the farm program in certain order to give the best management and the best time of spraying, in the fourth season integrated pest management was either tested or the farm program that contained the nutrients with chemical fungicides whether they were protective or systemic in certain order and beginning

Table 8: Effect of applying the chemical program on disease severity % of powdery mildew on three varieties of grapes at Al- Noubaria location in third season (2021)

Program	Treatments	Time between Intervals sprayer and followed	Time of application	Disease severity%		
				Flame	Superior	Thompson
Tested	Micronics sulfur	10 Days	1-21/Jan	0	0	0
Farm	Micronics sulfur		1-21/ Jan	0	0	0
*General control	None			0	0	0
Tested	Copper hydroxide (Shampion)		21/ Jan -15/Feb	0	0	0
Farm	Copper Oxycholoride		21/ Jan -15/Feb	0	0	0
Tested	Prodizole 30% EC		15-25/Feb	10	9	7
Farm control	Topas 10 % EC		15-25/Feb	19	15.6	14.6
General control	None			29.3	24	22
Tested	Mycobutanil, 25% EC		26/Feb-8/Mar	9.3	8	5
Farm control	Topas 10 % EC		26/Feb-8/Mar	25.3	25	22
General control	None			40.6	38.6	33.3
Tested	Akoby 50% SC		9-19/Mar	8.6	7	4
Farm	Bellis 38% WG		9-19/ Mar	33.3	30.3	28
General control	None		9-19/ Mar	52.3	49.3	45
Tested	Eurazol 25%EC			8	6	4
Farm	Bellis 38% WG		20-30/ Mar	45.6	42	38.6
General control	None		30/ Mar	73.3	66.3	64.3
Tested	Eco pro Ec25%		1-10/Apr.	6.3	4	2.6
Farm control	Amistar top 32.5%SC		10/ Apr.	55.3	51.6	59
General control	None			94.6	90	85
Tested	Curve25% EC		11-21/Apr.	3.3	3	1.6
Farm	Amistar top 32.5%SC		11/21/ Apr.	62.6	54.3	56.3
General control	None			100	100	100
Tested	Topsin M70% WP		22/Apr: 2/May	3	2.3	1
Farm	Topsin M 70% WP		3/-13/May	61.3	58.6	57.3
General control	None			100	100	100
Stop until harvest time						

*General control : sprayed water only

Table 9: Effect of applying integrated control program on disease severity % of powdery mildew on three varieties of grapes at the Al- Noubaria location in fourth season (2021/2022).

Program	Treatment	Time between Intervals sprayer and followed	Time of application	Disease severity		
				Flame	Superior	Thompson
Farm	Moronic sulfur	1-20/Nov.	10 Days	0	0	0
Tested	Copper sulphate	1-20/ Nov		0	0	0
Control	None			0	0	0
Tested	Chitosan	21/ Nov -1/Dec.		0	0	0
Farm	Moronic sulfur	21/ Nov -1/Dec.		0	0	0
Control	None			0	0	0
Tested	Shampion (Copper hydroxide)	2-12/Dec.		0	0	0
Farm	Copper oxychloride	2-12/Dec.		0	0	0
Control	None			0	0	0
Tested	Potassium sulphate	13-23/2-12/Dec.		0	0	0
Farm	Chitosan	13-23/2-12/Dec.		0	0	0
Control	None			0	0	0
Tested	Eminent 12.5% EW	24/Dec.-3/Jan.		0	0	0
Farm	Topas 10 % EC	24/Dec.-3/Jan.		0	0	0
Control	None			0	0	0
Tested	potassium phosphate	4-14/Jan.		0	0	0
Farm	Topas 10 % EC	4-14/ Jan		0	0	0
Control	None			0	0	0
Tested	Topsin M 70% WP	15-25/ Jan		0	0	0
Farm	Chitosan	15-25/ Jan		0	0	0
Control	None			0	0	0
Tested	Micro elements	26/ Jan -5/Feb.		0	0	0
Farm	potassium phosphate	26/ Jan -5/Feb.		0	0	0
Control	None			0	0	0
Tested	Nimrod 25%EC	6-16/Feb.		0	0	0
Farm	potassium phosphate	6-16/Feb.		0	0	0

Continue Table 9: Effect of applying integrated control program on disease severity % of powdery mildew on three varieties of grapes at the Al- Noubaria location in fourth season (2021/2022).

Program	Treatment	Time between Intervals sprayer and followed	Time of application	Disease severity		
				Flame	Superior	Thompson
Control	None		10 Days	0	0	0
Tested	Calcium nitrate	17-27/Feb		0	0	0
Farm	Chitosan	17-27/ Feb		0	0	0
Control	None			23	17.6	22.3
Tested	Lepra12.5%EW	28/ Feb -9/Mar		0	0	6
Farm	Bellis 38% WG	28/ Feb -9/ Mar		21	18.5	17.5
Control	None			35.6	33.6	33.6
Tested	Chitosan	10-20/ Mar 3		0	0	0
Farm	Bellis 38% WG	10-20/ Mar		27.3	24.3	23.6
Control	None			53.3	32.3	42.6
Tested	Bellis 38% WG	21/ Mar -1/Apr.		9.6	9	8
Farm	potassium phosphate	21/ Mar -1/ Apr.		20.3	24.6	22
Control	None			61.3	58	54
Tested	potassium sulphate	2-12/ Apr.		9	7	7
Farm	Amistar top 32.5%SC	2-12/ Apr.		26.3	26.3	23.6
Control	None			75.3	67.6	65
Tested	Amistar top 32.5%SC	12-22/ Apr.		7	5	4
Farm	Amistar top 32.5%SC	12-22/ Apr.		26	26.6	25
Control	None			85	81.6	75
Tested	Switch 62.5% WG	23/ Apr.-3/May		5	3	1.5
Farm	Topsin M 70% WP	23/ Apr.-3/ May		31.6	30.3	30.6
Control				100	100	96.6
Stop until harvest time						

Table 10: Effect of applying tested program on yield characteristics of three varieties of grapes at the Al- Noubaria location in fourth season (2022).

Program	Yield characteristics											
	Flame				Superior				Thompson			
	N.C	N.Sh	L.C	W.C	N.C	N.Sh	L.C	W.C	N.C	N.Sh	L.C	W.C
Tested	30	9	20	358	30	9	23	517	25	9	18	300
Farm	25	9	20	500	25	9	25	500	20	9	16	220
General control	0	0	0	0	0	0	0	0	0	0	0	0

N.C:Number of clusters, N.Sh: Number of shoulders, L.C: length of cluster, W.C: Weight of cluster

spraying early in November compared with general control treatment with sprayed with only water complete control of the disease, this results compatible with (Mueen Uddin *et al.*, 2022).

Conclusively, the results showed that under the conditions of the Al-Noubaria region, powdery mildew disease showed on the different grape varieties (Flame, Superior, and Thompson) five days after spraying. There were differences in the three varieties in their susceptibility to powdery mildew or their response to treatments with fungicides or fertilizers. In general, Amistar-Top (azoxystrobin + difenoconazole) showed the best reduction in disease severity % on the Flame variety (15%).

Chitosan and potassium phosphate were the best efficiency as alternative fungicides. The final program was applied in the dormant stage, which has proven highly efficient in reducing the severity of the disease compared to the agricultural program and general control.

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المكافحة المتكاملة للبياض الدقيقي على العنب (*Uncinula necator*) في موقع النوبارية وتأثيرها على محصول العنب

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أجريت هذه الدراسة على مدار أربعة مواسم (2019- 2022) وكان الهدف الرئيسي منها هو مكافحة مرض البياض الدقيقي في العنب المتسبب عن الفطر *Uncinula necator*، على أن تتم المكافحة من خلال برنامج مكافحة كيميائي مع استخدام الأسمدة الزراعية في البرنامج من أجل تقليل عدد رشات مبيدات الفطريات وكذلك السيطرة الكاملة على المرض، في الموسم الأول (2019) تم اختبار تأثير ١١ مبيداً فطرياً فعالاً مختلفاً (مبيدات جهازيه او وقائية) بعد رشة واحدة فقط على النسبة المئوية لشدة المرض والصفات المحصولية.

وفي هذا الصدد أظهرت النتائج في منطقة النوبارية أنه قد تبين بداية ظهور المرض بعد خمسة ايام من المعاملة على أصناف العنب المختلفة (فليم، سوبيريور، طومسون). و بشكل عام أظهر الأميستارتوب (أزوكسي استروبيين + ديفينوكونازول) أفضل تخفيض في النسبة المئوية لشدة المرض على صنف الفيلم (١٥%) بينما بعد ١٠ أيام من رش المبيدات كان مبيد البروديزول و الفلوسيلازول الأكثر كفاءة في مكافحة و ذلك على جميع الأصناف. حيث انه سجل مبيد البروديزول والفلوسيلازول النسبه المئويه لشدة المرض (٣٠% ، ٣٠%)، (٣٠% ، ٤٥%) ، (٥٠% ، ٥٠%) في اصناف الفليم والسوبيريور وطومسون على التوالي. في الموسم الثاني(2020) تم اختبار ١٧ مبيد فطري بعد رش ٣ مرات متكررة كل ١٠

أيام بين الرشة والرشه التالية. وجد ان استخدام مبيد النمرود اعطى أعلى متوسط لأوزان العنقود علي صنف الفيلم يليه مبيد الدلتا دوم حيث انهم سجلوا (٦٨.٣ و ٦٣.٣ جم/عنقود) على التوالي. عند اختبار الأسمدة الزراعية منفرده دون استخدام المبيدات، فقد اعطي الشيتوزان وكبريتات البوتاسيوم افضل نتائج. وفي الموسم الثالث (٢٠٢١) تم تصميم برنامج كيميائي للمكافحه مقارنة ببرنامج المزرعة ووقد أثبت كفاءته في الحد من انتشار المرض وزيادة صفات المحصول. وفي الموسم الاخير (٢٠٢٢/٢٠٢١) تم تطبيق البرنامج النهائي الذي يجمع بين مبيدات الفطريات الوقائية والجهازية والأسمدة الزراعية وأثبت كفاءته العالية في تقليل شدة المرض مقارنة بالبرنامج المستخدم في المزرعه والمكافحة العامة (رشم بالماء فقط).

التوصية: أظهرت النتائج انه بعد خمسة ايام من المعاملة تحت ظروف منطقة النوباريه تم بداية ظهور المرض على أصناف العنب المختلفة (فلام، سوبيريور، طومسون). وقد وجد اختلافات في الأصناف الثلاثة من حيث قابليتها للإصابة بالبياض الدقيقي أو مدى استجابتها للمعاملات بالمبيدات أو الأسمدة .بشكل عام أظهر الأميستار-توب (أزوكسى يستروبيين + ديفينوكونازول) أفضل تخفيض في النسبة المئويه لشدة المرض على صنف الفيلم (١٥%). عند اختبار الأسمدة الزراعية كان أفضلها الشيتوزان وفوسفات البوتاسيوم. تم تطبيق البرنامج النهائي والذي يجمع بين مبيدات الفطريات الوقائية والجهازية والأسمدة الزراعية التي أثبتت كفاءتها العالية في تقليل شدة المرض مقارنة بالبرنامج المستخدم في المزرعه والمكافحة العامه (رش بالماء فقط)

الكلمات المفتاحية: البياض الدقيقي، العنب، الأسمدة، المبيدات الفطرية والمكافحة المتكاملة.