Zagazig J. Agric. Res., Vol. 51 No. (2) 2024 289-302

Plant Protection and Pathology Research

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

INTEGRATED CONTROL PROGRAM FOR PEACH AND APPLE POWDERY MILDEW USING SOME FUNGICIDES, ESSENTIAL OILS AND FERTILIZERS, IN EGYPT

Sahar S. Abdahlla[1] *, H.A. Mohamed[2], M. Munir[3], T.N. Maklad[4], T.A. Abdel-Rahman[5], Shereen E.M. El-Nahas[6] and M.S. Flefel [6]

1. Fruit Diseases Res. Dept., Plant Pathol. Res. Inst., Agric. Res. Cent., 9 Gamaa Street, Egypt
2. Seed Pathol. Res. Dept., Plant Pathol. Res. Inst., Agric. Res. Cent., Giza 58312, Egypt. Date Palm Res. Cent. Ex., King Faisal Univ., Al-Ahsa 31982, Saudi Arabia
3. Frontier Agric., SOYL Precision Crop Prod. Div., Newbury, United Kingdom. Date Palm Res. Cent. Ex., King Faisal Univ., Al-Ahsa 31982, Saudi Arabia
4. Tropical Fruits Res. Dept., Hort. Res. Inst., Agric. Res. Cen.
5. Cent. Agric. Pest. Lab., ARC, Dokki, Giza, Egypt
6. Integrated Control Res. Dept., Plant Pathol. Res. Inst., Agric. Res. Cent., 9 Gamaa Street, Giza-12619, Egypt

Received: 06/03/2024; Accepted: 22/04/2024

ABSTRACT: An integrated control program for peaches and apples powdery mildew was evaluatedboth Burg Al-Arab and South of Tahreer regions. In the first season, the efficiency of the program's fungicides were tested in terms of the number of sprays and the most appropriate time to repeat the sprays, as well as the best effective fungicides. It was found that they all treatments were effective in controlling the disease. The best time to repeat spraying was from seven up to 10 days. In the second season, the chosen fungicides were evaluated compared with the farm fungicides individually, and the general control (sprayed with water only). On the other hand, evaluation of essential oils and fertilizers were done individually. The results showed the efficiency of systemic fungicide (Scor), copper and sulfur (preventive fungicides) and cinnamon oil and chitosan as Eco - friendly alternatives in controlling the disease. In the third season all tested fungicides used at the dormancy stage of trees at first January before buds swelling , data showed that all fungicides indicate high effect in decreasing the disease comparing with control at the in first of May compared to the control (100% disease severity). The tested fungicides gave 2.9% and 3.3% in case of peach at Borg Al-Arab and South of Tahreer respectively and 6%, 8.6% in apple at Borg Al-Arab and South of Tahreer respectively. At the fourth season all treatments combined in the integrated program were done at beginning spray (at 8 January while dormancy stage of trees) on apple. The tested program showed significant reduction on peach and apple powdery mildew compared to the control (100% disease severity) at the end of tested program comparing with the farm of tested program in case of peach and apple at Borg Al-Arab and South of Tahreer respectively, in May before harvest. In the fifth season the same tested program applied at t at the first of November during the winter tree service. The tested program was effective in control peach and apple powdery disease in locations.

Key words: Powdery mildew, Apple, Peach, Fungicides, Chitosan and Essential oils.

INTRODUCTION

Peach (*Prunu spersica*) is one of the stone fruit family, which includes apricots, plums, and cherries (**Ravi Kant *et al*., 2018)**. The peach fruit is rich in vitamins and minerals like vitamin C, vitamin A, potassium, and fiber. Egypt produces different types of peaches, including the yellow flesh and white flesh varieties. The country has developed effective methods

*** Corresponding author: Tel. :**+201001794288
E-mail address: Sharkawyahmed054@gmail.com

for growing these peaches, including careful selection of the planting site, regular pruning of the trees and pest control measures (**Zheng *et al*., 2014**). Egypt is producing 0.34 million tons of the world peach production), (**FAOSTAT, 2020**). Apple (*Malus domestica*) considered of the most widely consumed fruits in the world. Apple trees are deciduous and grow in most countries of the moderate regions and in some tropical areas (**Ferree and Warrington, 2003**). Apple trees, are attacked by various pathogens in Egypt and worldwide.

Peach powdery mildew caused by the fungus *Podosphaera pannosa* (**Grove, 1995**). It overwinters on infected twigs, shoots, and buds of peach. A similar symptom with rusty spots on fruits may be caused by *Podosphaera leucotricha* the causal agent of apple powdery mildew, thus eradicating adjacent fruits can reduce rusty spot in peach orchards (**Urbanietz and Dunemann, 2005**). Powdery mildew primarily damages the skin of green fruit but can also occur on leaves and young shoots. This disease may cause serious damage during years with cold and humid springs, followed by hot, dry summers. Signs start as a powdery white coating on infected surfaces that transition into a brown color with age. Young fruits develop white, spherical spots that may enlarge, then turn orange-tan and appear rusty. Symptoms usually occur on green fruits and disappear as the fruit develops **(El-Moslimany *et al.*, 2020**; **Xu and Madden, 2002)**.

Several fungicides are registered to use on fruit trees, and each may be very effective against some diseases. Most fungicides are effective primarily as protectant fungicides; which must be applied before infection occurs to prevent damage. Some fungicides are locally systemic and have curative activity which provides certain control of infections that have already started. The Developing a fungicide spray program for fruit trees must be include rates, and proper the application times. There are several group of fungicides that had a positive and significant effect on reducing disease parameters and increasing yield *i.e.,* Punch (**Heman*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**) Penconazole, Myclobutanil, and Tetraconazole (**Reuveni *et al*., 2018**).

In recent years, there is increase interest in the use of essential oil combinations to improve their natural antimicrobial and anti-fungal activities. **Fu *et al*. (2007 and** El-Moslimany Rabab, et al, 2020**)** noticed an increase of anti-fungal effects caused by combinations of essential oils; the antimicrobial properties of clove oil (from *Syzygium aromaticum* L.) and rosemary oil (from *Rosmarin sofficinalis* L.) (**Dafererа*et al*., 2000; Angioni*et al*., 2004; Jirovetz*et al*., 2006**).

This research aims to highlight the efficacy of plant protection strategies based on natural products. In order to decrease the use of synthetic fungicides, based on essential oils, and fertilizers, have been tested against powdery mildew.

MATERIAL AND METHODS

The present investigation was carried out during five successive growing seasons on peach cultivar Sporting (*Prunus persica* L.), grown in a private orchard and apple cultivar Anna106 at Borg Al-Arab region, Alexandria governorate and South of Tahreer, Behiera governorate Egypt. The soil was sandy and well drained, and the trees were under dripping irrigation. The experiment trees were performed on 8-years-old, three replicates for each treatment was used. The trees were treated with a group of fungicides (systemic and protective), and essential oils and asome fertilizers in controlling powdery mildew in both peaches and apples.

In the first season, different fungicides (Score, Nimrod, Topas, Punch, Akoby, Funga-pro, Leader, Alpha Captan and Divora) were applied and their doses were mentioned in Table 1. In the second season, sex fungicides from the experimental control program (Score, Nimrod, Topas, Punch, Akoby, Funga-pro and Leader), plus three fungicides that were applied under farm programmer, Topas, Bleise, Amestar top and Topsen m 70%) (Under farm condition, they applied control program of the powdery meldow disease both on peach and apple but that was

less effective to impact the disease after some seasons. In this respect, the strains of pathogenic fungi are either have acquired immunity to the fungicides which were applied under farm program or there are new strains of the pathogen that have developed more immunity to the pesticides used. So, in this study, the suggested control program was been compared with farm program and both of two programs were compered with general control which was sprayed with water only compared with untreated trees as general control. Also, essential oils (Clove, Cinnamon, Camphor Thyme, Neem and Anise oil) and fertilizers (Chitosan, Potassium and Calcium chloride, Potassium, Calcium silicate and NPK+Mg Macro elements) were evaluated. All treatments were evaluated individually compared with the program of fungicides' farm. In the third season, the fungicides of the experimental program were compared with the farm program in a specific order, combined. On the other experimental organic program, which were been companied with fertilizers minerals salts ,oils and copper and micron sulfur were applied as the rest of the treatments were also combined with the fungicides in another experiment, as shown in Tables 7 and 8, and all of suggested, farm and organic programmers compared with untreated trees as general control. In the fourth season both of programs suggested combined with fertilizers and oils farm's integrated best management programs, and the application was started at first of January compared with untreated control (Table 9). Finally, in the fifth season the same two programs were tested at early during the winter tree service period (Table 10).

Disease Severity Assessment

Disease severity was assessed by evaluating the percentage of infected area, using grated of five classes:

0 = no powdery mildew;
1 = 0–1% of leaf area affected;
2 = 1–5% of leaf area affected;
3 = 5–20% of leaf area affected;
4 = 20–40% of leaf area affected;
5 = > 40% of leaf area affected.

(**European and Mediterranean Plant Protection Organization, EPPO Standards, 1996**).

The obtained results were processed by the Mc-Kinney's formula (**McKinney, 1923**), which generates a numeric disease index:

DI of severity of attack: $DI = (\Sigma vn)/(NV)\times 100$.

Where: v represents the numeric value of the class; n is the number of plants assigned to the class; N is the total number of the plants in the replication and V is the numeric value of the highest class.

Statistical Analysis

Data were subjected to one-way analysis of variance (ANOVA) and differences in the least significant differences (LSD) test. Statistical procedures were performed using the statistical analysis system software STATGRA PHICS® PLUS (Manugistics Inc., Maryland, USA). The significant level was selected at $P \leq 0.05$.

RESULTS

Data presented in Table 2 shows the effect of nine fungicides (Score, Nimrod, Topas, Punch, Leader and Akoby) used separately as systemic and protectant on reducing the disease severity of powdery mildew on apple and peach at two locations (Borgalarab and South of Tahreer) at the first season.

Evaluation of the fungicides was done at zero time, then after one hour post spray, 5, 7 and 10 days of post spraying.

Data show that all of fungicides reduced the disease significantly especially systemic fungicides and after 7 days from spraying.

Data in Table 3 recorded the lowest values of disease severity after three days then after 10 and t 15 days compared with untreated control.

Generally, Data in Table 3 indicate that, spraying fungicides every 3, 10, 15 and 21 days effectively reduced the powdery mildew the average percentage of disease severity of each of peach and apple at Borg Al-Arab and South of Tahreer at first season . The results showed clear significant differences between the treatments, where the best time to re-spray was after 10 days where the percentage of disease severity on the trees was decreased, compared to 15 days, 21 days and the control.

Table 1. List of fungicides with their descriptions, chemical name trade name, and rate of application recommended (M.A.), List of essential oils and fertilizers used in program with their applications rate

Fungicides	Rate/100 liter water	Active ingredient	Essential oils and fertilizers	Rate/L
Score 25%EC	150 ml	Difenconazole	Clove oil	2 ml +3%Tween80
Nimrod 25%EC	70 ml	Buprmate	Cinnamon	2 ml +3%Tween80
Topas10 % EC	25 ml	Penconazole	Camphor	2 ml +3%Tween80
Punch	6 ml	Flusilazole	Thyme oil	2 ml +3%Tween80
Akoby 50% wp	250 gm	Kresoxim-Methyl	Neem oil	2 ml +3%Tween80
Fungi-pro45 EW	75 ml	Prochloraz	Anise oil	2 ml +3%Tween80
Leader45% EC	75 ml	Prochloraz	Chitosan	0.5gm
Alphacaptan 80%WG	200 gm	Phthalimide	Calcium Silicate	2 gm
Praiz 54%SC	250 g	Chlorothalonil	Potassium Silicate	2 gm
Divora 40% SC	70 ml	Cyproconazole	(NPK+MG) Macro element	1 gm
Micronit KZ WP 80%	250 g	Sulfur	Calcium Chloride	2 gm
Copper sulphate	100 g	Copper	Potassium Chloride	0.5gm
Amistar top 32.5%SC	75 ml	Azoxystrobin, Difenoconazole	Control (Water)	
Topsin M 70%wp	65 gm	Chlorothalonil methyl		

Table 2. Effect of first spray fungicide at at five times (zero, after 1 hour, 5, 7 and 10 days) post applications an disease severity of powdery mildew of peach and apple at two locations in the first season (2019)

Treatments	After one hour				5 days post application				7 days post application				10 days post application			
	Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer	
	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple
Zero time	10	14	4	12												
Score	10	14	4	12	14	12	8	6	20	32	14	32	22	42	20	36
Nimrod	10	14	4	12	22	22	6	16	26	32	18	26	30	38	24	30
Topas	10	14	4	12	22	24	12	18	26	38	20	30	38	48	36	36
Punch	10	14	4	12	22	16	26	26	26	26	20	30	28	38	24	40
Akoby	10	14	4	12	32	34	24	32	34	34	26	30	48	52	38	48
Fungi pro	10	14	4	12	22	34	20	32	38	36	32	36	44	52	32	46
Leader	10	14	4	12	18	30	16	28	28	34	22	30	42	44	38	46
Alpha captan	10	14	4	12	22	24	22	20	36	38	32	34	52	58	54	54
Divora	10	14	4	12	30	28	24	26	34	38	30	34	40	48	38	36
Control	10	14	4	12	48	52.0	44	44	62	68	60	70	67.5	85	65	65
LSD 0.05	n.s	n.s	n.s	9.9	8.67	7.79	10.6	10.7	12.4	11.12	10.79	11.75	9.42	9.97	8.36	10.66

Table 3. Effect of second spray fungicides four times (3, 10.15 and 21 days) after application on average of percentage disease severity of peach and apple powdery mildew at two locations in the first season in the first season (2019)

Treatments	3 days after application				10 days post application				15 days post application				21 days post application			
	Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer		Borg Al-Arab		South of Tahreer	
	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple	Peach	Apple
Score	10	22	10	18	20	36	16	26	32	38	32	44	59	64	48	62
Nimrod	30	30	16	24	26	36	22	30	32	42	30	38	50	56	50	58
Topas	22	38	18	22	32	44	24	34	40	54	26	44	52	76	48	60
Punch	18	30	22	30	22	34	24	34	36	44	24	38	54	60	50	56
Akoby	30	34	32	32	38	50	38	40	40	56	42	48	62	64	60	58
Fungi pro	26	28	26	30	30	38	26	38	38	52	42	50	48	78	46	60
Leader	28	36	22	30	32	40	30	36	50	44	46	40	66	54	58	52
Alpha captan	24	26	22	20	36	32	32	28	52	54	56	54	70	72	70	72
Divora	28	36	20	24	40	44	32	38	52	54	58	50	70	78	72	80
Control	82	86	84	86	92	98	92	88	100	100	100	100	100	100	100	100
LSD 0.05	10.6	9.8	8.6	12.7	9.7	9.4	12.4	9.7	8.2	8.2	7.3	11.2	10.73	12.34	9.79	10.77

Data in Tables 4, 5 and 6 indicate the evaluation of fungicides, essential oils and fertilizers separately at the second season in two locations on percentage of disease severity. At the second season Table 4 showed that fungicides of tested program and farm fungicides separately at the beginning of spray on 20 February in the dormancy stage of the trees. All fungicides gave significant differences, Scor and Topas, were the most effective ones in contrast Leader and Fungi-pro were the least effective ones. In case of essential oils in Table 5 the high effect in decreasing disease was cinnamon oil and the least effective on disease was anise oil. While, Data in Table 6 indicated that the application of fertilizers early at first February, chitosan gave high effect in decreasing the disease severity comparing with control. Fertilizers the least effect were macro (NPK + MG) elements and calcium silicate.

In the third season (2021) all fungicides of suggested program and fungicides of farm combined (Table 7), started and used at the dormancy stage of trees (in first January before swelling buds) with contact fungicides (sulfur and copper) and in February with systemic fungicides. Tops in M Fungicide was stopped spraying because of flowering, then resumption spraying was done in first March with Punch fungi, Tops in M and Akoby (systemic fungicides). All fungicides used proved to be high effective in decreasing the disease compared with control (100% disease severity) at the first May Generally, less significant difference between both of chemical programs, either suggested or farm chemical control program, and the general control treatment which sprayed with only water, (LSD 5%), gave 2.9% and 3.3% in case of peach at Borg Al-Arab and South of Tahreer respectively and 3.2%, and 3.7% apple Borg Al-Arab and South of Tahreer, respectively (Table 7). However, the suggest program was more effective than farm chemical control program. In this respect, suggested program recorded 0 % and 2% diseases severity of peach powdery mildew, while in case of apple gave 1 and 2.5% disease severity compared with farm chemical control program which gave 4.3 and 6.3% disease severity of peach powdery mildew and 6.0 and 8.6% disease severity of apple powdery mildew, respectively (Table 7).

Data in Table 8 indicate that the suggested fertilizers and oils complained together as organic suggested was more effective than untreated general control treatment which recorded (62.3 and 57.3%) diseases severity %

Table 4. Evaluated tested fungicides and farm fungicides separately at two locations on decreasing average of disease severity percentage peach and apple powdery mildew in the second season (2020)

Treatments	Application time	Time of final result	Borg Al-Arab		South of Tahreer	
Zero time	20/2: 4/4	19/4	Peach	Apple	Peach	Apple
			7	10.3	3.6	7
Suggest program fungicides			**Suggest program fungicides**			
Score	20/2(3 Sprays)		32.3	37	31.6	39.6
Nimrod			37.3	48.3	35	42
Topas			33.3	49.6	39.6	32.3
Punch			41	39.6	39.6	34.6
Fungi-pro			44.3	53.3	41	47
Leader			51.3	35.3	46.3	32.3
(farm fungicides)	(farm fungicides)			(farm fungicides)		
Topas (farm fungicides)	20/2(3 Sprays)		31.6	37.6	29.3	33
Amistar top			38.6	36.6	32	33.6
Topsin M			52.6	60	45.6	50.3
Control	(Water)		80.6	86.3	71	72.6
LSD 0.05			3.34	4.93	4.80	2.63

Table 5. Evaluated tested essential oils separately at two locations for decreasing average of disease severity percentage powdery mildew of peach and apple in the second season (2020)

Treatments	Application time	Borg Al-Arab		South of Tahreer	
Zero time	15/2	Peach	Apple	Peach	Apple
		7.3	10	3	7
Clove oil	15/2(12 Sprays)/twice a week	76	60	75.3	60.6
Cinnamon		64	62	55	61.3
Camphor		86.3	66.6	79.6	65.6
Thyme oil		72	73	68	69.3
Neem oil		80.6	80	78	73.3
Anise oil		88.3	87.6	87.6	83
Control	(Water)	97.3	98.3	93.3	88.6
LSD 0.05		5.36	6.299	5.61	4.47

Table 6. Effect of tested fertilizers separately at two locations on the average of disease severity percentage powdery mildew in peach and apple in the second season (2020)

Treatments	Application time	Borg Al-Arab		South of Tahreer	
Zero time	1/February: 5/17	Peach	Apple	Peach	Apple
		0	2	0	0
Chitosan	1/2 (10 Sprays)/one every	58.3	58.3	47.3	51.6
Calcium silicate	10 days	63.3	65.3	53.6	59.3
Potassium silicate		60.6	63.3	52.6	58.3
Macro elements		74	77	62.3	66
Calcium chloride		59.6	64	55	54.6
Potassium chloride		62	51.3	53.3	50
Control	(Water)	100	100	96.3	90
LSD 0.05		5.31	5.09	6.07	5.29

Table 7. Effect of combining fungicides on the average of disease severity percentage of powdery mildew of peach and apple at two locations in the third season (2021)

Treatments	Application time	Borg Al-Arab		South of Tahreer	
		Peach	Apple	Peach	Apple
Micron Sulfur suggest program	1/1 :15/1 (2 Sprays onece a week)	0	0	0	0
Micron Sulfur farm programs	1/1 :15/1 (2 Sprays onece a week)	0	0	0	0
General Control	No: Spray only water	0	0	0	0
Copper Oxychloride suggest program	16/1 : 31/1(2 Sprays onece a week)	0	0	0	0
Copper Oxychloride farm programs	16/1 : 31/1 (2 Sprays onece a week)	0	0	0	0
General Control	No: Spray only water	0	0	0	0
Topas suggest program	1/2 : 15/2(One spray/15 days)	0	0	0	0
Copper Sulphate farm programs	1/2 : 15/2 (One spray/15 days)	0	0	7	1
General Control	No: Spray only water	5.3	7	9.7	13.3
Topas suggest program	15/2 : 28/2	15.6	19.3	17.6	19
Topsin M farm programs	15/2 : 28/2	17.6	23.3	23	27.3
General Control	No: Spray only water	22.6	17.6	32.6	36
Namroud suggest program	1/3 :10/3The second one from 11/3: 21/3 (two sprays once /10days	7.6	13.3	14.6	17
Topsin M farm programs	1/3 :10/3The second one from 11/3: 21/3 (two sprays once /10days	15.3	16.3	16	20
General Control	No: Spray only water	37.3	44.6	47.6	50.6
Score suggest program	22/3 :2/4The second one from 2/4: 12/4 (two sprays once /10days	8.3	10	10.3	13.6
Bleze farm programs	22/3 :2/4The second one from 2/4: 12/4 (two sprays once /10days	11.3	12.6	15	17
General Control	No: Spray only water	57	63	64.6	68
Punch suggest program	12/4 :22/4The second one from 22/4: 2/5 (two sprays once /10days	5	5.3	9	12.6
Amistar top farm programs	12/4 :22/4The second one from 22/4: 2/5 (two sprays once /10days	7	7	9.6	11.6
General Control	No: Spray only water	78.3	84	91.6	96.6
Leader suggest program	3/5 :13/5The second one from 13/5: 23/5 (two sprays once /10days	0	1	2	2.5
Topsin M farm programs	3/5 :13/5The second one from 13/5: 23/5 (two sprays once /10days)	4.3	6	6.3	8.6
General Control	No: Spray only water	100	100	100	100
LSD 0.05		2.942	3.145	3.324	3.675

Table 8. Effect of combining contact fungicides, essential oils and fertilizers on the average of disease severity percentage of peach and apple powdery mildew at two locations in the third season (2021)

Treatments	Application time	Borg Al-Arab		South of Tahreer	
		Peach	Apple	Peach	Apple
Micron sulfur	8/1:15/1(one Spray onece a week)	0	0	0	0
General control	No: Spray only water	0	0	0	0
Copper Oxychloride	16/1 :23/1 one spray	0	0	0	0
General Control	No: Spray only water	0	0	0	0
Clove oil	24/1:31/1twice a week	0	0	0	0
General control	No: Spray only water	0	0	0	0
Cinnamon oil	1-8/2 twice a week	0	0	0	0
General control	No: Spray only water	3.5	5.3	1.3	2.3
Thyme oil	9/2 : 16/2twice a week	9.6	10.3	2.6	5.6
general control	No: Spray only water	15.6	19.3	6	13
Chitosan	17/2: 3/3 (One spray/7 days)	15.6	15	5	8.3
General control	No: Spray only water	26.3	30	25	27.3
Potassium chloride	4/3 : 19/3 (two sprays once /week)	16.3	26.3	13.6	20.3
Control	No: Spray only water	37.6	44	40	36.6
Calcium chloride	20/3 :4/4 (two sprays once /7days	36.3	40.3	36	26
General control	No: Spray only water	52.3	59	47	57.6
Macro elemants (NPK+Mg)	5/4: 20/4 Two sprays once/week	52	51	42	44.3
General control	No Spray only water	78.3	79	73.6	72.3
Potassium silicate	21/4 :6/5 Two sprays once/week	39.6	59.6	50.6	55
General control	No: Spray only water	91.6	93.3	87.6	90
Calcium silicate	6/5 : 21/5 Two sprays once/week	62.3	64	57.3	58
Control	No: Spray only water	100	100	100	100
LSD 0.05		3.169	4.213	3.329	2.468

of peach powdery mildew and (64.0 and 58.0%) disease severity of apple, compared with general control treatment which sprayed with only water, (100 and 100%) diseases severity of peach or apple powdery mildew at both of two locations .

Results indicate a significant difference between treatments and control. Where average of disease severity percentage was 100% in control and 62.3% and 57.3% in case of peach at Borg Al-Arab and South of Tahreer respectively and 64%, 58% apple in Borg Al-Arab and South of Tahreer, respectively, in May.

In the fourth season (2022) application of the tested program compares with farm program as the integrated control program at two locations with specific order both of them compared with general control which sprayed with water only. Data in Table 9 revealed that beginning spray in first January (for both of tested program or farm program), were been starting with contact fungicides while dormancy stage of trees and followed essential oils and fertilizers until half February and then stopped spray because of flowering after that we sprayed systemic fungicides with fertilizers, when we closed to harvest we applied protectant fungicides avoiding the residual effect on fruits before harvesting in May. Generally, the tested program gave excellent results in controlling powdery mildew on peach and apple, more than farm program. However, both of two programs were decreasing disease severity %, either peach or apple treated and also of both of two locations where the control was 100% disease severity the tested program was 7% and 0% in case of peach at Borg Al-Arab and South of Tahreer, respectively and 7%, 5% in apple Borg Al-Arab and South of Tahreer, respectively, in May before harvest.

Table 10 in the fifth season the same program was applied as in Table 9, but the difference is that the beginning of spraying was in the first of November during the winter tree service. It is clear from the results that at the end application all locations of peach and apple were 0% disease severity while control was 100%.

Table 9. Effect of an integrated control program in the fourth season (2022), on peaches and apples powdery mildew disease severity % at two locations

Treatments	Application time	Borg Al-Arab		South of Tahreer	
		Peach	Apple	Peach	Apple
Copper Sulphate suggest program	1/1: 8/1 (One spray once a week)	0	0	0	0
Copper Oxychloride farm program	1/1: 8/1 (one spray once a week)	0	0	0	0
General control	dormancy stage	0	0	0	0
Chitosan suggest program	9/1:16/1/ once a week	0	0	0	0
Copper Oxychloride farm program	9/1:/16/1 once a week	0	0	0	0
General control	dormancy stage	0	0	0	0
Cinnamon oil suggest program	17/1:23/1 twice a week	0	0	0	0
Micron sulfur farm program	17/1:23/1 once a week	0	0	0	0
General control	swelling buds	0	0	0	0
Clove oil suggest program	24/1 : 31/1 twice a week	0	0	0	0
Micron Sulfur farm program	24/1 : 31/1 once a week	0	0	0	0
General control	swelling buds	0	0	0	0
Potassium Silicate	1/2: 8/2	0	0	0	0
Suggest program	(one spray/a week)				
Topas farm program	uncover the buds1/2: 8/2	0	0	0	0
General control	only water	11	11.3	4.6	7.6
Potassium chloride Suggest program	9/2: 16/2 once a week	0	0	0	0
Topas farm program	9/2: 16/2 (one spray)	11	11.3	7	12.3
General control	Water	18.3	20	13.6	17
Topas uggest program	17/2 :23/2 once spray	2.3	2.6	1.3	2.6
No treatment farm program	23/2: 2/3flowering	22.3	25.3	24.3	23.3
General control	Water	31	35.6	30	33.3
Calcium chloride	3/3: 17/3two sprays once a week	10.6	16.6	13.6	15.3
Suggest program					
Topas farm program	3/3: 17/3once/two week	17	22.3	16.6	14.3
General control	3/3: 17/3	40.6	49	42.3	46.3
Nimrod suggest program	18/3: 4/3 once/two week	9.6	11.6	7.3	8.3
Topas farm program	18/3: 3/4 once/two week	13.6	18.3	12.6	13.6
General control	18/3: ¾	55.6	62.3	55.3	61
Calcium silicate Suggest program	4/4: 14 Two spray , once /5 days	12.6	15.6	8.6	11.6
Bleiz farm program	4/4: 14 Two spray , once /5 days	10.6	16	6.3	9.6
General control	14/4	72	74	66.6	75.3
Score suggest program	15/4: 25/4 once/ 10 days	9.6	11.3	4.3	5
Bleiz farm program	15/4: 25/4 once/ 10 days	9	8.6	3.3	5
General control	15/4: 25/4	89	89.3	84.6	86
Micro elements suggest program	26/4 : 9/5 two sprays/ once a week	9	11.3	5	11.3
Amistar top farm program	26/4 : 9/5 once/ 15 days	8.3	7	2.3	6
General control	26/4 : 9/5	100	100	93.3	96.6
Leader suggest program	10/5: 25/5 -once/15 days	1	2	0	0
Topsin M farm program	10/5: 25/5 -once/15 days	7	7	0	5
General control	25/510/5: 25/5	100	100	100	100
LSD 0.05		3.459	3.502	5.052	5.022

Table 10. Effect of an integrated control program in the fifth season (2023) on peaches and apples powdery mildew at two locations

Treatments	Spring time	Borg Al-Arab		South of Tahreer	
		Peach	Apple	Peach	Apple
Zero time	**0**	**0**	**0**	**0**	**0**
Copper Sulphate suggest program	1/11 (one two Sprayers/ ONECE A WEEK)	0	0	0	0
Copper Oxychloride farm program	1/11two Sprayers/ ONECE A WEEK)	0	0	0	0
General control	dormancy stage	0	0	0	0
	15/11: 22/11 once a week	0	0	0	0
Micron Sulfur farm program	15/11: 22/11 once a week	0	0	0	0
General control	dormancy stage	0	0	0	0
Chitosan suggest program	23/11: 30/11 once a week	0	0	0	0
Micron sulfur farm program	23/11: 30/11 once a week	0	0	0	0
General control	dormancy stage	0	0	0	0
Potassium silicate suggest program	1/12 : 8/12once a week	0	0	0	0
Copper Oxychloride farm program	1/12:8/12 once a week	0	0	0	0
General control	1/12:8/12once a week	0	0	0	0
Calcium Silicate suggest program	9/12: 15/12 once a week	0	0	0	0
Copper Oxychloride farm program	9/12: 15/12once a week	0	0	0	0
General control	only water	0	0	0	0
Micro elements suggest program	16/12:23once a week	0	0	0	0
Chitosan farm program	16/12:23once a week	0	0	0	0
General control	16/12:23only water	0	0	0	0
Potassium Chloride suggest program	24/12: 31/12once a week	0	0	0	0
Chitosan farm program	24/12 : 31/12once a week	0	0	0	0
General control	only water	0	0	0	0
Calcium Chloride Suggest program	1/1: 8/1 once a week	0	0	0	0
Potassium Phosphate Farm program	1/1: 8/1 (one spray)	0	0	0	0
General control	1/1: 8/1water	0	0	0	0
Topas Suggest program	9/1 :19/1once spray/ 10 days	0	0	0	0
Pendazim Farm program	9/1 :19/1 once spray/ 10 days	0	0	0	0
General control	9/1 :19/1 water	0	0	0	0
Cinnamon oil Suggest program	20/1: 27/1 two sprays once a week	0	0	0	0
Chitosan Farm program	20/1 :27/1 once/two week	0	0	0	0
General control	20/1only water	0	0	0	0
Clove oil	28/1: 3/2 two sprays once a week	0	0	0	0

Treatments	Spring time	Borg Al-Arab		South of Tahreer	
		Peach	Apple	Peach	Apple
Zero time	**0**	**0**	**0**	**0**	**0**
Suggest program					
Pendazim	28/1: 3/2	0	0	0	0
Farm program	once/two week				
General control	28/1: 3/2	0	0	0	0
	only water				
Topas	4/2: 14/2once / 10 days	0	0	0	0
Suggest program					
Potassium Phosphate	4/2 :14/2once/ 10 days	0	0	0	0
Farm program					
General control	4/2 :14/2	4.3	7.3	2.3	5.3
Calcium chloride	15/2 :25/2once/ 10 days	0	0	0	0
Suggest program					
Topas	15/2 :25/2once/ 10 days	0	0	0	0
Farm program					
General control	15/2 :25/2only water	14.6	16.6	14.6	15.3
Chitosan	26/2: 8/3once/ 10 days	0	0	0	0
Suggest program					
Topas	26/2: 8/3once/ 10 days	6.3	12.3	8.6	7.3
Farm program					
General control	26/2: 8/3only water	23	23	22	25
Score	9/3 : 19/3	0	0	0	0
Suggest program	The first sprayonce/ 10 days				
Potassium phosphate	9/3: 19/3once/ 10days	16.6	16	18	23.6
Farm program					
General control	9/3: 19/3only water	33.6	40	34	37.6
Score	20/3: 30/3 the second spray	5.3	8.6	3.6	5.3
Suggest program	/10days				
Bleize	20/3: 30/3once/ 10days	9	10.3	8	8
Farm program					
General control	20/3: 30/3only water	57	67.3	55.6	61.3
Nimrod	31/3: 10/4once /10 days	5	3.6	2	2.3
Suggest program					
Amistar top	31/3/ : 10/4once /10 days	4	5.6	2	2.6
Farm program					
General control	31/3: 10/4only water	75.3	80	73.6	82.6
Leader	11/4 : 21/4 once /10days	0	0	0	0
Suggest program					
Amistar top	11/411/4 : 21/4once/10 days	1	3.3	0	0
Farm program					
General control	11/4 : 21/4only water	88.3	93.3	89.6	94.3
Micro elements	22/4: 2/5	0	0	0	0
Suggest program	once/10 days				
Topsin M	22/4: 2/5once/10days	0	0	0	0
Farm program					
General control	22/4 : 2/5only water	100	100	100	100
Stopping for harvest					
LSD 0.05	3.459 3.502 5.052			5.022	

DISCUSSION

Powdery mildew fungi (Erysiphales) are among the most common and important plant fungal pathogens. These fungi are obligate biotrophic parasites that attack nearly 10,000 species of major field crops, and trees. Chemical control, including the use of fungicides from multiple chemical groups, is the most effective tool for managing powdery mildew (**Fernández *et al*., 2020** and El-Moslimany Rabab, et al, 2020). The aims of these five seasons were to evaluate the effectiveness of essential oils and fertilizers as alternative organic products with fungicide, alone or in combination on powdery mildew of peach and apple at two locations. In the first season nine fungicides were evaluated. Systemic fungicides and multisite fungicides belonging to the group's flusilazol, penoconazol, chlorothalonil gave high effect in controlling the disease. These results are harmony with **Radwan and Darwesh, (2018)**. Fungicide resistance in powdery mildew is an important problem that causes economically important losses to growers around the world every year, especially when site-specific fungicides are used (**Brent *et al*., 2007; Oliver *et al*., 2014**). Therefore, in the first season, the period between fungicide sprays and the extent of its where efficiency in reducing the disease was tested to avoid the phenomenon of resistance. This was also taken into concentration when designing the integrated control program by spraying fungicides in a specific order according to their effect on the disease, period between each spryer and the followed spryer, and also the number of specific sprays. In the second season, the best 6 fungicides were selected were and with 3 farm fungicides which already in the farms, essential oils and fertilizers were evaluated alone to select the best essential oil and fertilizers in controlling the disease to add them in the program and it was found that the best effect was cinnamon oil which decrease antifungal activity percentage. It was the most fungitoxic and also, these were mentioned by **Fialho *et al*. (2016)**. Chitisan indicate high effect in comparing with other fertilizers (**Oliveira *et al*., 2004**). Due to its fungistatic or fungicidal potential, chitosan, a high molecular-weight polymer that is non-toxicand biodegradable, has become an alternative to conventional fungicides. **Nascimento *et al*. (2007)** explored the fungicidal effect of chitosan on some of the most important grapevine wood fungi, such as *Botryosphaeria* sp. (dieback and cane blight), *Phomopsis* sp. (*Phomopsis* cane and leaf spot), *Eutypalata* (eutypa dieback), *Neonectrialiriodendri* (black foot disease), *Phaeomoniel lachlamydospora* (Petri disease) and *Fomitiporia* sp. In the third season, all either suggested chemical fungicides program were applied, which compared with farm fungicides treatments and general control that was treated with water only. On the other hand, oils and fertilizers companied were evaluate their efficiency on controlling the disease also decreasing the number of sprayers of fungicides in addition of that were designed as integrated control program including contact fungicides ,systemic fungicides, essential oil and fertilizers according to specific order and the most important also was the time of beginning of spray. This was obvious when applied the program in the fifth season early in dormancy stage and winter services in November hence the average of percentage of disease severity before harvest in May was 0%.

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تقييم برنامج مكافحة متكاملة للمبيدات الفطرية والزيوت العطرية والأسمدة لمرض البياض الدقيقي في الخوخ والتفاح في مصر

سحر شرقاوي عبدالله[1] - هشام عبد المنعم محمد[2] - محمد منير[3] - طه مقلد[4]
طارق عبد الرحمن[5] - شيرين السيد النحاس[6] - محمد صلاح الدين فليفل[6]

1. قسم أبحاث أمراض الفاكهة، معهد بحوث أمراض النبات، البحوث الزراعية، سنتر، 9 شارع الجامعة، مصر.
2. قسم أبحاث أمراض البذور، معهد بحوث أمراض النبات، مركز البحوث الزراعية، الجيزة 58312، مصر. مركز التميز لأبحاث أمراض النخيل، جامعة الملك فيصل، الأحساء 31982، المملكة العربية السعودية.
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4. قسم بحوث الفواكه الاستوائية، معهد بحوث البستنة، مركز البحوث الزراعية، قسم بحوث المكافحة المتكاملة، معهد بحوث أمراض النبات، البحوث الزراعية
5. سنتر، 9 شارع الجامعة، الجيزة-12619، مصر.
6. المعمل المركزى للمبيدات الزراعية، مركز البحوث الزراعية، الدقى، الجيزة، مصر

في هذه الدراسة تم تقييم برنامج مكافحة متكاملة لمرض البياض الدقيقي في كل من الخوخ والتفاح بمنطقتي برج العرب وجنوب التحرير. في الموسم الأول تم اختبار كفاءة المبيدات الفطرية الخاصة بالبرنامج والمبيدات المستخدمة في المزرعة من حيث عدد الرشات وانسب وقت لتكرار الرش وأيضًا أفضل المبيدات تأثيرًا وقد وجد أنها جميعهًا ذات كفاءه ما عدا الفاكابتانوديفوراكانا الاقل كفاءه في التحكم بالمرض على المدى الطويل بين الرشه والاخرى وأفضل وقت لتكرار الرش كان بين 7 إلى 10 أيام بين الرشة والأخرى. في الموسم الثاني تم تقييم المبيدات الفطرية التي تم اختيارها مقارنه مع مبيدات المزرعة منفرده وكذلك تقييم الزيوت العطرية والأسمدة منفردة. أما الكنترول العام كان معامل بالرش بالماء فقط للمقارنة بصفة عامة. وأظهرت النتائج كفاءة المبيدات الجهازية (سكور والتوباس) والنحاس والكبريت من المبيدات الوقائية وزيت القرفة هو الشيتوزان من البدائل الصديقة للبيئة. في الموسم الثالث قمنا بتطبيق جميع المبيدات الفطرية سواء مبيدات البرنامج أو مبيدات المزرعة منغرده مع تكرار الرش لكل مبيد 3 رشات بين الرشه والاخرى 15 يوم وفى المقابل ايضا تقييم المعاملات الصديقة للبيئه سواء كانت الزيوت اوالاغذيه السماديه كبرنامج يتبع المكافحةالحيويه على ان يراعى الفترة الزمنية بين كل رشه والاخرى .حيث انه فى حالة الرش بالزيوت العطريه تكون المعامله مرتين اسبوعيا بينما فى حالة الاسمده الغذائيه تكون مرة كل اسبوع .بدأنا في مرحلة سكون الأشجار في 8 يناير اثناء فترة السكون بالمبيدات الوقائيه بالملامسه (الكبريت والنحاس) وأظهرت البيانات أن جميع المبيدات الفطرية أعطت تأثيراً عالياً في تقليل المرض بالمقارنةمع الكنترول في أول مايو من هذا الموسم بلغت متوسط نسبة شدة المرض 100% وأعطى البرنامج 2.9% و3.3% في الخوخ عند بورجالعرب وجنوب التحرير على التوالي و6% و8.6% في التفاح ببرجالعرب وجنوب التحرير. على التوالي، قمنا في الموسم الرابع بتطبيق برنامج المكافحة المتكامل، حيث بدأ الرش في أول يناير أثناء مرحلة سكون الأشجار، وأعطى البرنامج نتائج ممتازة في مكافحة البياض الدقيقي على الخوخ والتفاح، حيث كانت شدة الاصابه بالمرض فى الكنترول العام 100%. شدة المرض بينما كانت شدة المرضية فى البرنامج المختبر (7 و7%) و(صفر وصفر %) مقارنه ببنامج المزرعة الذى سجل (7 وصفر) فى حالة الخوخ و (7 و5%) فى حالة التفاح فى كلا المنطقتين برج العرب و جنوب التحرير على التوالى في مايو قبل الحصاد. في الموسم الخامس تم تطبيق نفس البرنامج ولكن الفرق أن بداية الرش كانت في أول نوفمبر أثناء خدمة الشجرة الشتوية ففي نهاية تطبيق البرنامج في جميع المواقع على الخوخ والتفاح كانت شدة المرض 0% بينما كانت المقارنه العام 100%.

المحكمـــون:
1- أ.د. أحمد أحمد موســى أستاذ أمراض النبات- كلية الزراعة – جامعة عين شمس
2- أ.د. دولت أنور عبدالقادر أستاذ أمراض النبات- كلية الزراعة – جامعة الزقازيق.