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Efficacy of some Chemical Structure of Pesticides on Yield, Fruit Quality and Infection with some Diseases of "Anna" Apple Trees

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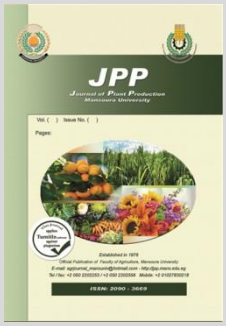

ABSTRACT

This experiment was carried out during the two successive seasons2018 and2019 on nine years old "Anna" apple trees (*Malus domestica*, Borkh) budded on Malus rootstock, planted at 3×4meters apart (350trees/fed.) in clay soil under drip irrigation system in a private orchard located at El-Gharbia governorate, Egypt to study the efficacy of some chemical structure of pesticides on yield, fruit quality and infection with fungal diseases (scab and powdery mildew diseases). The used chemical structure were: Carbendazim 80%, Captan 50%, Captan 80%, Sulfur 95%, Thiophanate methyl 70%, Kresomix methyl50%, Difenoconazole25%, Cyproconazole40%, Copper oxide56.35%, Dondine 40%, Epoxiconazole12.5%, Metalaxy-m +azoxystrobin39%, Difenoconazole + propiconazole30%, Thifluzamide + difenoconazole27.5%, each of this chemical structure were sprayed 4times; before flowering in mid-February, mid-March, after full bloom in the end of March and once after fruit set in mid-May. The main results can be summarized as follows:Apple trees sprayed with Carbendazim , Captan 50%, Captan80%, Sulfur95%, Thiophanat methyl,Copper oxide, Dondine, Metalaxy-m +Azoxystrobin, Epoxiconazole, Difenoconazole + Propiconazole and Thifluzamide+ difenoconazole.Gave the best results in fighting the infection of powdery mildew and improved vegetative growth and gave better results in the total number of flowers and fruit set percentage. Spraying one of the following chemical compounds with the same previous vehicles reduced infection with powdery mildew and apple scabies on trees, which led to improved and increased yield, number and weight of fruits, also improved the quality of the fruits; increasing TSS, coloration, as well as the percentage of the anthocyanin in the peel of the fruit and decreasing acidity.

Keywords: Anna apple, fungicides, apple scab, powdery mildew, vegetative growth, flowering, fruit set and fruit quality.

INTRODUCTION

Anna apple (*Malus domestica*, L. Borkh) belongs to family Rosaceae, its low chilling requirements, spreading in many tropic and sub-tropic areas including Egypt (Potter *et al.*, 2007). Apples are rich in vitamins, minerals, carbohydrates and dietary fiber content (Slavin and Lloyd 2012). Apples are regularly subjected to infection through filamentous fungi and their infection results in severe losses of production and fruit quality. Apple scab, caused by the fungal pathogen *Venturia inaequalis* (Cooke) Winter Hedwigia is one of the most devastating diseases of apples in temperate zones with humid growing seasons (Gonzalez-Dominguez *et al.*, 2017). Apple powdery mildew caused by the fungal pathogen *Podosphaera leucotricha* (Ellis & Everh.) E.S. Salmon is another fungal disease with great impact on fungicide use (Holb and Kunz 2016). Its primary effect is reduction of the quality of the infected fruits, scab also reduces fruit size or causing premature fruit drop, defoliation and poor fruit bud development of the next year, and it reduces the length of time to infected fruit can be kept in storage (Marku *et al.*, 2014). Most of apple cultivars are susceptible to fungal diseases, such as scab and powdery mildew, and growers have to apply fungicides many times per season. Prevention and control of these diseases is often very difficult, especially due to increasing resistance of pathogens to chemicals used (Ishii 2006). There are a considerable number of chemicals used and recommended in preventing and control these diseases, some effective, others less. In order to protect apple trees from the apple scab and powdery mildew, a wide spectrum of chemical substances have been used that belong to different chemical groups with different modes of action (preventative, preventative-curative and curative), and they are often combined in order to enhance their effectiveness or avoid the development of resistance (Aleksic1 *et al.*, 2014). Most commercial apple grown cultivars are very sensitive to scab, so that in a commercial apple orchard, very frequent fungicide applications are applied in order to control apple scab, depending on weather conditions, disease pressure and cultivar susceptibility (Holb *et al.*, 2005). Intensive apple production can ensure high yields and fruit quality, but it also requires high investments, largely in chemical control, which is performed for the purpose of suppressing some economically most significant diseases, such as scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*). In Egypt, a large number of fungicides having different mode of action have been reported to control apple diseases, a wide

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number of fungicide treatments against apple diseases were used, the whole program of chemical control for apple trees is focused on scab disease and powdery mildew (Azmy and El-Fakhrani, 2015).

The aim of this study was to identify the efficacy of the best group of fungicides to scab and powdery mildew in the collection group fungicides. The basic aims of selection efforts is to marker the best group fungicide against the most significant pathogens *V. inaequalis* and *P. leucotricha* with high yield and fruit quality.

MATERIALS AND METHODS

This experiment was carried out during the two successive seasons 2016 and 2017 on nine years old "Anna" apple trees (*Malus domestica*, Borkh), budded on Malus rootstock, planted at 3×4 meters apart (350 trees/fed.) in clay soil under drip irrigation system in a private orchard located at El-Ghabria governorate, Egypt. Forty eight trees uniform in growth, vigour and productivity were selected, and subjected to the same cultural practices commonly adopted on this region. The trees were arranged in a randomized complete block design, each treatment replicated three times with one tree per replicate. Fifteen pesticides and control were chosen to investigate their effect on apple scab and powdery mildew as well as evaluate their effect on growth, yield and fruit quality of Anna apple trees. Thus, the experiment involved sixteen treatments (pesticides + control) as shown in Table (1). Trees were sprayed with each of used fungicides 4 times, twice before flowering in mid-February and mid-March and once after full bloom in the end of March and once after fruit set in mid-May.

Table 1. The tested treatment against apple powdery mildew and scab

No.	Active ingredient	Concentration	Formula	Application rate
1	Carbendazim	80%	WP	40 g/100 L
2	Captan	50%	WP	200 g/100 L
3	Captan	80%	WG	125 g/100 L
4	Sulfur	80%	WP	250 g/100 L
5	Sulfur	95%	WP	10k g/100 L
6	Thiophanate methyl	70%	WP	65 g/100 L
7	Kresomix methyl	50%	WG	10 g/100 L
8	Difenoconazole	25%	EC	50 ml/100 L
9	Cyproconazole	40%	SC	30 ml/100 L
10	Copper oxide	56.35%	WP	250 g/100 L
11	Dondine	40%	SC	140 ml/100 L
12	Epoxiconazole	12.5%	SC	60 ml/100 L
13	Metalaxy-m +azoxystrobin	39%	SC	40 ml/100 L
14	Difenoconazole + propiconazole	30%	EC	40 ml/100 L
15	Thifluzamide + difenoconazole	27.5%	SC	75 ml/100 L

Control (sprayed with tap uneter only)

The following data was recorded:

Four branches on each tree were selected and tagged in four directions for measuring and determination the following parameters:

Vegetative growth:

At the end of each growing seasons, shoots formed in branches were measured for the average of shoot number/branch, shoot length (cm), shoot thickness (cm) and leaf area (cm^2) was measured by using a leaf area meter Model Li 3100 area- meter.

Leaf chlorophyll content (mg/cm^2 fresh leaves):

Chlorophyll a, b and its total were determining by using N, N dimethyl formamide according to the methods described by Moran and Porath (1980).

Flowering:

At flowering stage, flower number/shoot, flower/branch, average flower number/ spurs and spurs number/branch were counted in both seasons. After then fruit set was calculated according to equation:

$$\text{Fruit set percentage} = \frac{\text{Number of developing fruitlets}}{\text{Total number of flowers}} \times 100$$

Fruit yield:

At harvest time (3rd week of June) yield of each replicate was determined as number and weight (kg) of fruits/tree, and total yield as ton/feddan.

Fruit quality:

Ten fruit samples were taken at random from each replicate to determine fruit quality as follow: fruit weight (g), fruit length (cm), fruit diameter (cm), fruit shape index (fruit length /fruit diameter ratio), total soluble solids (TSS) were determined using a hand refractometer, percentage of titratable acidity in fruit juice (%) was determined according to A.O.A.C., (1995), and anthocynins were determined at the stage of coloration (µg/cm^2 peel) according to the method described by (Rabino *et al.*, 1977).

Observation and measurements of scab and powdery mildew diseases:

Each year, disease assessments on the leaves were recorded. For leaf severity assessments, 10shoots per tree were recorded about 10 days after spraying. Observations were made on 10 older leaves per shoot. Visual observations in the field were made on the intensity and frequency attack of apple scab and apple powdery mildew on leaves (Yoder, *et al.*, 1997).

Reduction in diseases severity calculated as:

$$\text{reduction \%} = \frac{\text{disease severity of untreated control} - \text{disease severity of treatment}}{\text{untreated control}} \times 100$$

Statistical analysis:

The obtained data were subjected to analysis of variance (ANOVA) according to the method described by Snedecor and Cochran, (1980). The differences among treatment means were compared with Duncan multiple range test (DMRT) at 5% .

RESULTS AND DISCUSSION

Effectiveness of some fungicides for controlling apple scab and powdery mildew:

Results of this study indicate a significant difference (P=0.05) in the effectiveness of fungicides to control apple scab and powdery mildew for two seasons of the study. At the first season (Table 2) fungicides containing Epoxiconazole; Captan 80%; Kresomix methyl and Copper oxide were the most effective in reducing apple scab disease severity by 84.23 and 78.68%, respectively. Application of Metalaxy-m + azoxystrobin completely inhibited powdery mildew disease (100%). At the same time fungicides containing Carbendazim ; Captan 50%; Captan 80%; Sulfur 95%; Epoxiconazole;

Difenoconazole + propiconazole and Thifluzamide + difenoconazole were able to reduce the severity of powdery mildew by percentage ranged from 81.97 – 90.71% . However, the fungicides Captan 80% and Epoxiconazole exhibited effectiveness to control apple scab and powdery mildew for this season.

At the second season(Table3) in order to control apple scab, fungicides containing Captan 50%; Thiophanate methyl; Copper oxide ; Difenoconazole + propiconazole and Thifluzamide + difenoconazole were the most effective in controlling apple scab with potential to reduce apple scab severity ranged from 80.18 – 87.56 % (Table 2). For the second season too, the fungicide containing Metalaxy-m + azoxystrobin completely inhibited powdery mildew disease (100%). When fungicides containing Captan 50%; Thiophanate methyl; Sulfur 95%; Dondine and Difenoconazole + propiconazole exhibit lower disease severity for powdery mildew, reduction percent ranged from 80.24 to 89.82%. Captan 50%; Thiophanate methyl and Difenoconazole + propiconazole exhibited effectiveness to control apple scab and powdery mildew for this season.

The results of the current study indicate that fungicides, which used for effective management of apple scab reduced it over 50% reduction, except Cyproconazole. Whereas, all of them reduced powdery mildew by percent ranged from 59.36 to 100%. From the fungicides in our experiment Carbendazim ; Captan 50% ; Captan 80%; Sulfur 95%; Thiophanate methyl; Copper oxide; Dondine; Metalaxy-m +Azoxystrobin; Epoxiconazole; Difenoconazole + Propiconazole and Thifluzamide + difenoconazole recorded over 60% reduction in two diseases.

Most commercial apple orchard grown cultivars are very sensitive to scab and powdery mildew. So, it is obvious from data in Tables (1, 2 and fig. 1) that these orchard, very frequently applied the fungicide in order to control apple scab and powdery mildew diseases, depending on weather conditions, disease pressure and cultivar susceptibility (*Holb et al*., 2005). In Egypt the very susceptible apple cultivars, are treated regularly with fungicides for control of powdery mildew and apple scab. The fungicides most commonly used for powdery mildew are sulfur and Thiophanate-methyl (*Holb and Kunz*, 2016). In organic apple growing, just a few approved chemical products are available for disease control, mainly based on sulphur and copper (*Holb*, 2008 and Jamar et al, 2010). A large number of fungicides having different mode of action have been reported to control apple diseases. Diniconazole is a conazole fungicide with systemic, curative and protective action. This study compares the activities of some fungicides against scab and mildew of apple plants and evaluates which of them had a broad-spectrum against the two diseases at the same time. In our study the most promising fungicides groups for control of powdery mildew and scab of apple are Carbendazim ; Captan 50% ; Captan 80%; Sulfur 95%; Thiophanate methyl; Copper oxide; Dondine; Metalaxy-m +azoxystrobin; Epoxiconazole; Difenoconazole + propiconazole and Thifluzamide + difenoconazole, which recorded over 60% reduction in two diseases. It's grouped to register for the control of these diseases in Egypt. Fungicides containing metalazyl and macozeb were found to be effective at controlling apple scab, while fungicides containing tebuconazole were more effective in the control of powdery mildew with potential to reduce the disease severity *(Byarugaba et al*. 2013).

Table 2. Average of apple scab and powdery mildew disease severity percentage reduction in the disease severity, for the 2018 season as influenced by different fungicides

Fungicides	Scab		Powdery mildew	
	Disease severity	Reduction %	Disease severity	Reduction %
Carbendazim	10.0 de	68.45	3.3 c	81.97
Captan 50%	13.3 de	58.04	3.3 c	81.97
Captan 80%	6.7 fg	78.68	1.7 c	90.71
Sulfur 80%	18.3 bc	42.27	8.3 b	54.65
Sulfur 95%	10.0 de	68.45	1.7 c	90.71
Thiophanate methyl	15.0 cd	52.68	5.0 bc	72.68
Kresomix methyl	6.7 fg	78.86	6.7 bc	63.39
Difenoconazole	11.7 de	63.09	8.3 b	54.65
Cyproconazole	21.7 b	31.55	6.7 bc	63.39
Copper oxide	6.7 fg	78.68	5.3 bc	71.04
Dondine	8.3 ef	73.81	6.7 bc	63.39
Epoxiconazole	5.0 g	84.23	1.7 c	90.71
Metalaxy-m + azoxystrobin	8.3 ef	73.81	0.0 d	100.0
Difenoconazole + propiconazole	11.7 de	63.09	2.7 c	85.25
Thifluzamide + difenoconazole	11.7 de	63.09	3.3 c	81.97
Control	31.7 a	-----	18.3 a	-----

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

Table 3. Average of apple scab and powdery mildew disease severity percentage reduction in the disease severity, for the 2019 season as influenced by different fungicides

Fungicides	Scab		Powdery mildew	
	Disease Severity	reduction %	Disease severity	Reduction %
Carbendazim	6.7 cd	69.13	7.0 bc	58.08
Captan 50%	2.7 d	87.56	3.3 de	80.24
Captan 80%	5.0 cd	76.96	5.0 bc	70.06
Sulfur 80%	8.3 bc	61.75	6.3 bc	62.28
Sulfur 95%	10.0 bc	53.92	1.7 gh	89.82
Thiophanate methyl	3.3 d	84.79	3.0 ef	82.04
Kresomix methyl	8.3 bc	61.75	8.0 b	52.10
Difenoconazole	5.7 cd	73.73	6.0 bc	64.07
Cyproconazole	13.3 b	38.71	5.0 bc	70.06
Copper oxide	4.3 cd	80.18	5.0 bc	70.05
Dondine	8.3 bc	61.75	1.7 gh	89.82
Epoxiconazole	6.0 cd	72.35	6.3 bc	62.28
Metalaxy-m + azoxystrobin	8.3 bc	61.75	0.0 h	100.0
Difenoconazole + propiconazole	3.7 d	82.95	2.0 fg	88.02
Thifluzamide + difenoconazole	4.3 cd	80.18	4.7 cd	71.86
Control	21.7 a		16.7 a	

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

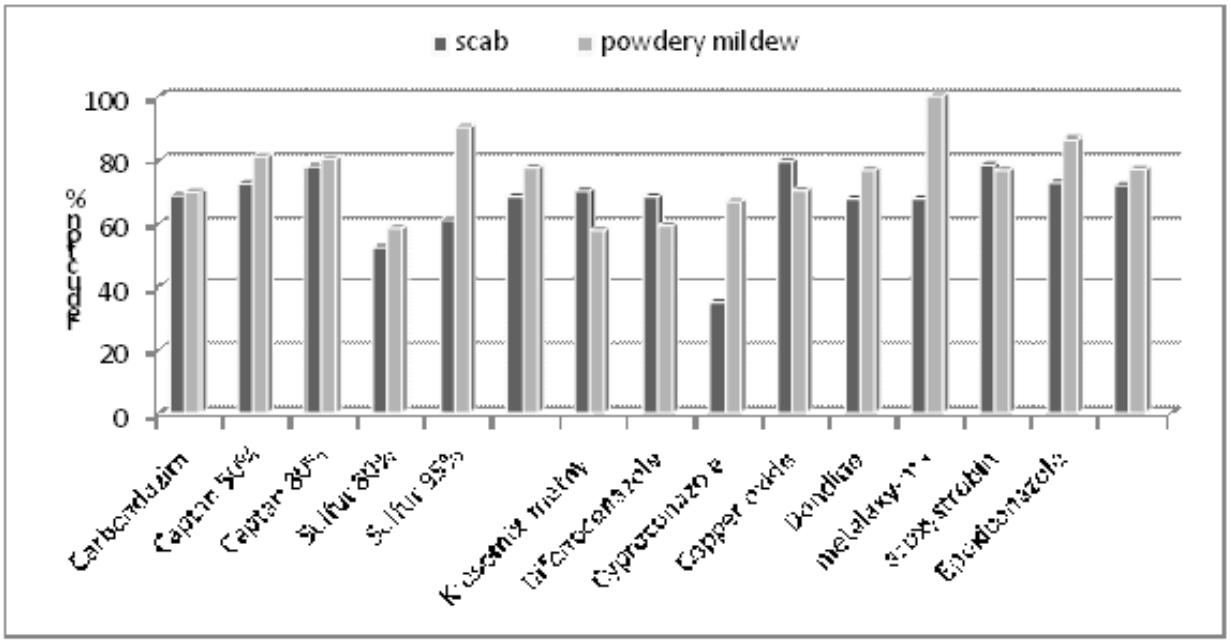

Fig. 1. Average of two season reduction percent of apple scab and powdery mildew disease severity as activity of different fungicides

Vegetative growth:

The results in Table (4) show that, all fungicides application had positively affected on vegetative growth parameters of Anna apple trees in both seasons. The highest shoot length, shoot thicknesses, shoot number/ branch and leaf area were obtained from fungicides containing Kresomix methyl, Difenoconazole, Epoxiconazole and Captan 80%; compared to the control and other tested fungicides. In this respect, Kresomix methyl, Difenoconazole and Epoxiconazole were the most effective in increasing vegetative growth of apple trees in both seasons, respectively. These results were similar to those obtained by *Radwan and Darwesh* (2018), who cleared that, application of Microvit, Punch and Topas as program against powdery mildew showed remarkable increase in vegetative growth in terms of shoot length, leaves number/shoot and leaf area of Anna apple trees.

Table 4. Effect of some fungicides against powdery mildew and scab on vegetative growth of Anna apple trees during 2018 and 2019 seasons

Fungicides	Shoot length (cm.)		Shoot thickness (cm.)		Number of shoot\branch		Leaf area (.cm ^{2})	
	2018	2019	2018	2019	2018	2019	2018	2019
Carbendazim	59.4a	59.2a	1.46a	156a	48.2a	48.3a	23.38a	23.70a
Captan 50%	58.3b	58.4b	1.44b	1.54b	47.3b	47.3b	21.07c	21.08c
Captan 80%	57.5c	58.5b	1.40c	1.43c	46.2c	46.6c	23.38a	23.31a
Sulfur80%	55.4f	54.3f	1.39d	1.19g	42.7g	42.3g	18.17g	18.12g
Sulfur 95%	57.5d	58.4c	1.09g	1.39d	45.7d	45.6d	20.18d	20.09d
Thiophanate methyl	57.5d	57.2d	1.39d	1.40d	45.4d	45.6d	20.71d	20.51d
Kresomix methyl	56.5e	55.1e	1.06h	1.09h	43.5e	43.3e	18.03h	18.09h
Difenoconazole	53.5g	53.2g	1.11f	1.11f	41.3h	41.1h	18.09f	18.13f
Cyproconazole	53.5g	53.3g	1.09g	1.09h	43.3f	43.7f	18.19e	18.19e
Copper oxide	58.5b	58,3b	1.44b	1.54b	47.2b	47.2b	22.37b	22.43b
Dondine	58.5b	58.2d	138d	1.41d	45.4d	45.3d	20.16d	20.15d
Epoxiconazole	57.6c	56,5c	1.40c	1.43c	46.3c	47.3b	23.17a	23.53a
Metalaxy-m +Azo.	58.5b	58.6b	1.44b	1.54b	48.1a	47.3b	21.13c	20.63d
Difenoconazole +Pr.	57.5c	58.1b	141c	1.42c	47.3b	47.5b	21.17c	22.43b
Thifluzamide + Dif.	57.3d	58.3c	1.39d	1.40d	47.2b	46.7c	22.45b	22.57b
Control	51.4h	50.4h	1.01i	1.00i	40.1i	40.0i	16.17i	16.15i

Azo. : Azoxystrobin, Pr.: Propiconazole, Dif.: Difenoconazole
Means followed by the same letter within a column are not significantly different using DMRT at P ≤0.05

Leaf chlorophyll content (mg/cm^2):

Regarding the effect of fungicides application on leaf chlorophyll content of Anna apple trees, results in Table (5) clearly show that, chlorophyll a, b and its total content were significantly improved with Kresomix methyl, Copper oxide and Epoxiconazole applications in both seasons. Anna apple trees treated with Kresomix methyl and Copper oxide recorded the highest values of chlorophyll a, b and its total content in both seasons. On the other hand, application of Sulfur80% and Dondine recorded the least values of leaf chlorophyll content in both seasons. Whereas, control and other applications gave intermediate values in this respect. These results are similar to those of Mohamed *et al.,* (2016) who showed a significant effect of *Bacillus subtilus, Bacillus pumilus,* zinc oxide, castor and clove oils against powdery mildew

on chlorophyll content, peroxidase, and polyphenol oxidase of cucumber plants.

Flowering:

From data in Table (6), it can be noticed that the flowering of Anna apple trees were responded significantly to treated with fungicides against powdery mildew and scab under study during the two seasons. Data indicated that spraying Anna apple trees with fungicides against powdery mildew and scab gave the highest flowering, while the least one was recorded by the control. Also, it's quite evident from data that trees sprayed with Captan 80% followed by Copper oxide, Epoxiconazole and Kresomix methyl were the most effective treatments and resulted the highest ratio of flowering, Moreover the other investigated fungicides were in between the above mentioned the two extents. Powdery mildew and Scab is common diseases on apples in most areas of its cultivation and it also causes massive losses in some years, where flowering buds are affected by this diseases until they fail to form flowers and thus the fruit set is forbidden thus, the good control of these diseases improves the flowering of Anna apple trees. These results are agreement with those reperted by *George Sundin and Amy Irish-Brown*, (2010) and *Marine et al.,*. (2010).

Table 5. Effect of some fungicides against powdery mildew and scab on leaf chlorophyll content of Anna apple trees during 2018 and 2019 seasons

Fungicides	Leaf chlorophyll content (mg.cm^2)					
	A		B		Total	
	2018	2019	2018	2019	2018	2019
Carbendazim	4.77b	4.85d	2.40d	2.43d	7.17d	7.28d
Captan 50%	4.71d	4.89b	2.71a	2.62b	7.42b	7.54b
Captan 80%	5.34a	5.77a	2.59b	2.73a	7.39b	8.50a
Sulfur80%	4.23g	4.22g	1.06g	1.08g	5.29g	5.30g
Sulfur 95%	4.73c	4.74c	1.47c	2.24c	6.20c	6.98c
Thiophanate methyl	4.71d	4.71d	2.71b	2.71b	7.42b	7.42b
Kresomix methyl	4.34e	4.33e	1.12e	1.22e	5.46e	5.55e
Difenoconazole	4.32f	4.30f	1.11f	1.11f	5.43f	5.41f
Cyproconazole	4.20h	4.19h	1.04h	1.03h	5.24h	5.22h
Copper oxide	5.71a	5.91a	2.71a	2.77a	8.42a	7.96a
Dondine	4.71d	4.72d	2.45d	2.55d	7.31d	7.27d
Epoxiconazole	5.77a	5.88a	2.68b	2.68c	8.45a	8.56a
Metalaxy-m + azoxystrobin	4.73c	4.74c	2.66b	2.65b	7.39b	7.39c
Difenoconazole +Propiconazole	4.76b	4.77b	2.71a	2.74a	7.47a	7.24b
Thifluzamide +Difenoconazole	4.77b	4.78b	2.72a	2.72a	7.49a	7.50a
Control	4.11i	4.10i	1.02i	1.01i	5.13i	5.11i

Means followed by the same letter within a column are not significantly different using DMRT at P ≤0.05

Table 6. Effect of some fungicides against powdery mildew and scab on Flowering and fruit set of Anna apple trees during 2018 and 2019 season.

Fungicides	No. of flowers \ shoot		No. of flowers\ branch		No. of flowers \ spur		No. of Total Flowers	
	2018	2019	2018	2019	2018	2019	2018	2019
Carbendazim	81.2h	79.3k	561.2e	552.3e	3.23j	3.11h	642.4g	631.6i
Captan 50%	100.2e	101.2e	621.3d	613.2c	4.o2d	4.01d	721.5f	714.4f
Captan 80%	116.7a	117.3a	787.1a	798.2a	5.01a	5.31a	868.4a	864.7a
Sulfur80%	80.2i	81.2i	403.6l	716.2b	3.31i	4.21c	483.8n	696.3j
Sulfur 95%	96.2f	96.5f	515.2g	518.3f	4.02c	5.12a	611.4i	714.8e
Thiophanate methyl	80.1j	77.3l	413.2h	561.2d	3.11k	3.35f	493.3m	638.5h
Kresomix methyl	114.5b	115.6b	701.6b	717.2b	5.01a	5.11b	806.1c	813.8d
Difenoconazole	77.3k	81.3h	501.2i	511.2g	4.01d	4.11d	578.5k	592.5k
Cyproconazole	80.1j	80.1j	408.3k	428.2j	4.21b	4.21c	497.50	487.9o
Copper oxide	113.4c	113.4d	723.1a	751.3a	5.01a	5.01b	836.5b	834.5b
Dondine	83.7g	83.7g	555.2f	561.2d	3.32h	3.23g	634.9h	644.9g
Epoxiconazole	113.3d	113.7c	751.7a	716.2b	5.01a	5.01b	899.4d	829.9c
Metalaxy-m + Azo.	68.9m	69.1	513.2h	513.2h	3.71e	3.71e	582.1j	582.3l
Difenoconazole+ Pr.	71.2l	77.2m	533.1j	532.1i	3.61f	3.06i	494.3l	509.3m
Thifluzamide+Dif.	63.7n	76.3n	706.1c	618.2l	3.40g	3.14.h	786.2e	494.5n
Control	59.2o	59.7p	401.3m	403.6k	3.01l	2.01j	465.0p	484.8p

Azo. : Azoxystrobin, Pr.: Propiconazole, Dif.: Difenoconazole

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

Fruit set and yield:

Table (7) illustrates effect of some fungicides against powdery mildew and scab on fruit set, fruit number |tree and yield in 2018 and 2019 seasons. All sprayed trees with fungicides against powdery mildew and scab under investigation were mostly significantly in increasing fruit set, fruit number | tree and yield compared to the control in the two growing seasons. Among to the used fungicides, the sprayed trees with Captan 80% recorded the highest fruit set percentage, fruit number |tree and yield followed by Kresomix methyl, Epoxiconazole and copper oxide as compared to the other fungicides. As mentioned above, the flower buds are affected by fungal diseases that are the subject of the study until they fail to form flowers and thus the fruit set decreases, but if the fruits are attacked with fungi while they are in their first stages of growth, they will continue to be small, atrophied and deformed. The injury leads to falling leaves, which leads to reducing the amount of the crop. Annual yield loss caused by apple scab would be about 80% in orchards with susceptible cultivars and without fungicide treatments, under favourable climatic conditions *(Holb* 2000). Great numbers of fungicide treatments (10–20) are required for efficient disease control in order to produce high quality and quantity apples (*Alston,* 1989, *Borovinova* ,1994a, *Grauslund and Bertelsen* 1996).

Fruit quality:

Fruit physical characters:

Data in Table (8) show the effect of spray some fungicides against powdery mildew and scab on fruit physical characters in terms of fruit weight, length, and diameter and fruit index of Anna apple trees in both seasons. It's quite clear that, fruit weight, fruit length, fruit diameter and fruit index were responded significantly to spray with fungicides under study during the two seasons. Data indicated that under copper oxide spraying, the highest values of the above measurements were achieved followed by Epoxiconazole, Captan 80%, and Kresomix methyl, respectively, since the reverse was detected with unsprayed trees which exhibited statistically the least values of these measurements. Moreover, the other investigated fungicides were in between the above mentioned the two extents. Under the humid climatic conditions, the most dangerous for apple trees is apple scab (*Venturia inaequalis* Cke. Wint). It can cause a significant reduction in fruit yield and fruit quality (*MacHardy,* 1996; *Raudonis et al.,* 2007; *Brun et al.,* 2008). Another important disease of apple trees is powdery mildew (*Podosphaera leucotricha*). This disease does not cause such great losses in fruit yield as apple scab does, but occurring every year it weakens trees and reduces their resistance to frost, and may cause russeting on fruit (*Bryk & Broniarek-Niemiec,* 2008), therefore, good control of these diseases improves the quality of apple fruits

Table 7. Effect of some fungicides against powdery mildew and scab on yield of Anna apple trees during 2018 and 2019 seasons

Fungicides	Fruit set %		Fruit number/tree		Yield/tree (kg)		Yield ton/fed	
	2018	2019	2018	2019	2018	2019	2018	2019
Carbendazim	22.7l	22.7l	291.1j	257.1j	25.06l	30.01l	14.77e	15.44c
Captan 50%	25.7f	26.7d	398.1f	389.2f	47.94f	52.58f	16.77c	16.32d
Captan 80%	29.8a	30.1a	410.1a	409.2a	56.96a	57.04a	19.93a	18.54b
Sulfur80%	24.8g	23.1g	303.1m	302.5m	22.61e	23.47g	7.93i	7.43i
Sulfur 95%	26.7e	26.2e	377.1e	397.1e	48.72g	53.70e	17.05b	17.47d
Thiophanate methyl	24.5h	23.5h	312.1i	302.1i	33.86k	35.61k	11.85g	11.45g
Kresomix methyl	29.7b	29.3b	405.1d	400.1d	55.33d	56.43d	15.36d	15.22c
Difenoconazole	22.8k	23.1k	301.5h	302.5h	36.33i	36.51i	12.71f	12.65f
Cyproconazole	23.2i	23.3i	301.1k	300.1k	26.93j	35.86j	9.42h	8.54h
Copper oxide	28.3c	29.1cf	405.6b	408.2b	56.83b	56.66c	19.88a	19.37a
Dondine	23.7i	24.1f	228.1k	228.1k	27.98i	27.62m	17.34b	17.64b
Epoxiconazole	29.7b	28.5b	407.1c	407.1c	56.47c	56.79b	19.85a	19.51a
Metalaxy-m + Azo.	21.1n	28.6b	203.5n	201.1n	23.47h	23.62n	16.30c	17.44d
Difenoconazole +Pro.	21.6m	20.7m	201.3l	211.1l	22.47j	22.20o	15.21c	5.78c
Thifluzamide +Dif.	27.3d	20.5n	363.2g	371.3g	37.8h	38.89h	1726b	19.31a
Control	20.3o	20.1o	198.1o	188.1o	18.84k	20.02p	6.59j	7.22j

Azo. : Azoxystrobin, Pr.: Propiconazole, Dif.: Difenoconazole

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

Table 8. Effect of some fungicides against powdery mildew and scab on physical fruit quality of Anna apple trees during 2018 and 2019 seasons

Fungicides	Fruit weight (gm)		Fruit length (cm.)		Fruit diameter (cm.)		Fruit index (L|D ratio)	
	2018	2019	2018	2019	2018	2019	2018	2019
Carbendazim	102.1g	103.1m	7.45l	7.54j	6.51f	6.55f	1.14c	1.15h
Captan 50%	123.2c	132.1d	7.66g	7.52k	6.53g	6.35g	1.17b	1.15h
Captan 80%	135.8b	139.1c	7.63h	7.91b	6.57c	6.59c	1.23a	1.23b
Sulfur80%	111.7f	115.6i	7.61j	7.61i	6.17m	6.56e	1.16bc	1.20c
Sulfur 95%	122.7c	121.2e	7.62i	7.81d	6.18l	6.23m	1.20ab	1.19f
Thiophanate methyl	112.1f	114.1j	7.61j	7.61i	6.31k	6.31l	1.20b	1.20c
Kresomix methyl	138.3a	139.1c	7.91b	7.87c	6.59b	6.60b	1.20b	1.19d
Difenoconazole	120.1cd	121.1f	7.82d	7.73e	6.55d	6.57d	1.18bc	1.17f
Cyproconazole	118.1d	119.1g	7.72e	7.62h	6.31j	6.38k	1.16bc	1.19d
Copper oxide	139.2a	139.7a	7.92a	7.92a	6.61a	6.61a	1.23a	125a
Dondine	122.7c	121.1f	7.33n	7.35l	6.51h	6.52h	1.14c	1.12j
Epoxiconazole	139.4a	139.5b	7.85c	7.26n	6.61d	6.61a	1.22a	1.23b
Metalaxy-m +Azo.	115.1e	116.1h	7.71f	7.71g	6.55d	6.52h	1.18bc	1.16g
Difenoconazole +Pro	111.2f	110.3k	7.35m	7.35l	6.65e	6.41j	1.15c	1.14i
Thifluzamide +Dif.	1oo.2g	107.1l	7.53k	7.33m	6.565c	6.50i	1.14c	1.12j
Control	97.5h	101.1n	7.16o	7.12f	6.13i	6.17n	1.07d	1.10k

Azo. : Azoxystrobin, Pr.: Propiconazole, Dif.: Difenoconazole

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

Fruit chemical characters:

Results in Table (9) show the effect of some fungicides against powdery mildew and scab on fruit chemical characters in terms of TSS %, acidity %, red color and peel Anthocyanin content of Anna apple trees in both seasons. Sprayed trees with Captan 80%, Copper oxide, Epoxiconazole and Kresomix methyl produced fruits had the highest TSS%, red color and peel Anthocyanin content and lowest acidity in both seasons. The highest values of acidity achieved by Dondine, Thiophanate methyl, Cyproconazole and control. The control gave the lowest values of TSS, while the least fruit

coloration and peel anthocyanin content appeared on trees sprayed with Difenoconazole + Propiconazole. Apple trees scabies infection may lead to a decline in the quality of the fruits and the quantity of the crop, which leads to losses of up to 70%, which constitutes a major threat to the profitability of apple producers. To limit the losses caused by this disease, farmers often combine preventive practices including good drainage and resistance breeding, with reactive measures, such as targeted fungicide or bio-control treatments, to prevent the incidence and spread of apple scab in their crops (*Jha, et. al*., 2009 and *Bowen, Joanna et. al*., 2011)

Table 9. Effect of some fungicides against powdery mildew and scab on chemical fruit quality of Anna apple trees during 2018 and 2019 seasons

Fungicides	T.S.S %		Total acidity %		Red color		Peel Anthocyanin content (µg. cm.^{2})	
	2018	2019	2018	2019	2018	2019	2018	2019
Carbendazim	11.21i	11.31j	0.71f	0.71f	69.1g	69.2g	20.34a	20.71a
Captan 50%	11.31g	11.51g	0.73e	0.73e	69.3f	69.3f	16.81d	16.71c
Captan 80%	12.17a	12.53a	0.70g	0.70g	77.9a	77.8a	17.86b	17.87b
Sulfur80%	11.51f	11.18l	0.80d	0.80d	68.7k	68.5k	15.72h	15.72i
Sulfur 95%	11.51f	11.53f	0.71f	0.71f	69.9d	69.7d	17.71b	20.61a
Thiophanate methyl	11.18j	11.17m	0.82b	0.82b	68.8j	68.7j	15.71i	15.32l
Kresomix methyl	12.15c	12.51b	0.71f	0.71f	77.9a	77.9a	17.37b	16.38d
Difenoconazole	11.64e	11.46h	0.81c	0.81c	69.7e	69.7e	15.82g	15.77h
Cyproconazole	11.71d	11.71e	0.82b	0.82b	69.3f	69.7c	14.31m	14.32k
Copper oxide	12.17a	12.38c	0.71f	0.71f	77.3c	77.9a	17.38c	17.62c
Dondine	11.25h	11.21k	0.82a	0.83a	68.9i	68.7i	17.61c	16.61k
Epoxiconazole	12.16b	12.22d	0.71f	0.71f	77.8b	77.8a	17.76b	17.87b
Metalaxy-m +Azo.	11.16k	11.18l	0.81c	0.81c	68.70k	77.4b	16.17l	17.17b
Difenoconazole +Pro.	11.13m	11.20b	0.81c	0.81c	76.3b	75.2d	16.31m	16.31c
Thifluzamide +Dif.	11.15l	11.42i	0.81c	0.81c	69.03h	68.7h	17.30n	17.82b
Control	10.07n	10.6n	0.82b	0.82b	61.3i	61.3i	12.21o	11.31o

Azo. : Azoxystrobin, Pr.: Propiconazole, Dif.: Difenoconazole

Means followed by the same letter within the same column are not significantly different using DMRT at P ≤0.05

CONCLUSION

Powdery mildew(*Podosphaera leucotricha*) and apple scab (*Venturia inaequalis* Cke. Wint) are fungal diseases that affect apples, and symptoms appear on flowers, fruits and vegetative groups, and cause great losses in yield and fruit quality. Therefore, apple farmers resort to fighting these fungal diseases in various ways, including chemical resistance. The chemical compounds used in this study gave positive results in different proportions in controlling these diseases compared to the control, but the most promising fungicides groups for control of powdery mildew and scab of apple are Carbendazim ; Captan 50% ; Captan 80%; Sulfur 95%; Thiophanate methyl; Copper oxide; Dondine; Metalaxy-m +azoxystrobin; Epoxiconazole; Difenoconazole + propiconazole and Thifluzamide + difenoconazole which recorded over 60% reduction in two diseases.

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فاعلية بعض التراكيب الكيماوية للمبيدات علي المحصول والجوده وبعض الامراض علي اشجارالتفاح صنف "أنا"

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اجريت هذه الدراسة خلال موسمي ٢٠١٨،٢٠١٩ علي اشجار التفاح المزروعه بمزرعه خاصه بمحافظة الغربية – مصر . بهدف دراسة فاعلية بعض التراكيب الكيماوية للمبيدات علي المحصول والجوده وبعض الامراض علي اشجار التفاح صنف "انا" حيث تم رش الاشجار ببعض المركبات الكيميائية وهي كربن ديزيم٨٠% -كبتان ٥٠% - كبتان ٨٠%- كبريت ٨٠%- كبريت٩٥%- سيفونات ميثيل ٧٠%- كريسوميكس ميثيل٥٠%- ديفينو كونازول ٢٥%- سيبروكونازول ٤٠%- اكسيد النحاس ٣٥و٦٥%- دون داين ٤٠%- ايبوكس كونازول ٥و١٢%- ميتالاكس+ازوكسي ستروبين ٣٩% - ديفينو كونازول+بروبي كونازول ٣٠%- سيفلو زي مايد+ديفينوكونازول ٥و٢٧%. بالاضافه الي معاملة الكنترول (ماء فقط) وتم دراسة تأثير هذه المركبات علي بعض الامراض الفطريه مثل البياض الدقيقي وجرب التفاح وكذلك تأثيرها علي نمو وانتاجية وجودة الثمار لأشجار التفاح صنف "أنا" .اشارت النتائج الي ان:- الرش بأحد المركبات مثل كربن ديزيم ٨٠%او كبتان٥٠%او كبتان ٨٠% اوكبريت ٩٥% او كريسوميكس ميثيل ٥٠%او اكسيد النحاس ٣٥و٦٥% او سفونات ميثيل ٧٠% او دون داين ٤٠%او ازوكسي ستروبين +ميتا-لاكس ٣٩% او بروبي كونازول +ديفينو كونازول ٣٠% او سيفلو زي مايد + ديفينو كونازول٥و٢٧% اعطت هذه المركبات افضل النتائج في علاج البياض الدقيقي وحسنت النمو الخضري والمساحه الورقيه ونسبة الكلورفيل في الاوراق خلال موسمي الدراسه.الرش بأحد هذة المركبات السابقه اعطت افضل نتائج للتزهير وادت الي زيادة نسبة العقد بصوره ملحوظه مقارنة بالكنترول خلال موسمي الدراسه.ايضا الرش بأحد المركبات السابقة ادت الي تقليل الاصابه بمرض البياض الدقيقي وجرب التفاح علي الاشجاربصورة ملحوظة مقارنة بالكنترول كما ادت الي تحسين الصفات الفيزيائية والكيمائية للثمارولذلك توصي الدراسه باستعمال احد هذه المركبات التي لها تأثير علي تقليل الاصابه ببعض الامراض الفطريه مثل ا لبياض الدقيقي وجرب التفاح علي اشجار التفاح صنف "أنا" وذلك للحد من استخدام مبيدات غير متخصصه والتي تؤدي الي زيادة تكاليف الانتاج وتلوث البيئه.