

## MANAGEMENT OF CUCUMBER DOWNY MILDEW DISEASE BY SOME PLANT WATER EXTRACTS AND PLANT ESSENTIAL OILS

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**ABSTRACT:** The efficacy of three water plant extracts ie; Mint (*Mentha villosa*), Basil (*Ocimum basilicum*) and Aloe vera (*Aloe barbadensis*) with three concentrations (2, 4 and 6 ml/L) and plant essential oils of three plants Castor (*Ricinus communis*), Thyme (*Thymus vulgaris*) and Mint (*Mentha villosa*) with three concentrations (2.5, 3.5 and 4.5 ml/L) were studied under greenhouse conditions during two successive seasons (2019-2020 and 2020-2021) on cucumber downy mildew disease management. The obtained results indicated that, application of plant extracts and essential oils significantly reduced the disease severity and increase the yield production (number of fruits / plant and average fruit yield production / plant). For the water plant extracts the Alo vera (6 ml/L concentration) was the best treatment, while the Basil (2 ml/L concentration) showed the lowest effect. For the essential oils, Castor oil (4.5 ml/L) gave the highest effect on decrease the disease severity and increase the yield while the Mint oil (3.5 ml/L) showed the minimum effect.

**Key words:** Downy mildew, plant extracts, essential oils.

### INTRODUCTION

Cucumber (*Cucumis sativus* L.) is very important vegetable crop in Egypt and all over the world after tomato and watermelon. Cucumber is cultivated more broadly than any other vegetable and also very popular in kitchen garden.

Downy mildew caused by *Pseudoperonospora cubensis* (Berk and Curt) Rostow, is one of the most important and wide spread disease attacking cucurbits in Egypt and other countries. It appears in all the provinces where cucurbits are planted and cause great damage and crop loss. The pathogen attacks cotyledons and adult plants especially when the environmental conditions are favorable for disease occurrence resulting in significant economic losses, Zhanbin *et al.* (2022). The fungus is easily carried by wind currents, rain splash, farm implements, or the hands and clothes of farm workers.

In spite of the introduction of highly effective systemic fungicides control for this disease remains elusive. So, alternative methods to chemical management should be used. Recently,

attention has been paid towards exploitation of higher plant products as novel methods in plant protection. The popularity of botanical pesticides are increasing and some plant products are being used globally as green pesticides Malkhan *et al.* (2012). Some plant extracts are toxic to some plant pathogens. Moreover, they are generally less phytotoxic, may be systemic, are easily biodegradable and can stimulate host metabolism Stephane *et al.* (2005). Afifi and Sahar (2009) and Ahmed *et al.* (2016) reported that, under field condition experiment using six medicinal plant species i.e. leaves of Eucalyptus, Lemon grass, Mint leaves, Rosmary, Marjoram and Sweet basil were effective in controlling cucumber downy mildew disease. According to Deepak *et al.* (2007) the crude extracts of 12 species (*Agave americana*, *Aloe vera*, *Artemisia parviflora*, *Citrus limon*, *Citrus sinensis*, *Eucalyptus globosus*, *Euphorbia hirta*, *Leucas aspera*, *Murraya koenigi*, *Ocimum sanctum*, *Santalum album* and *Zingiber officinale*) completely inhibited the zoosporangium formation of *Sclerospora graminicola* (Sacc.) Schroet., the causative agent of pearl millet downy mildew.

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Moreover, scientific research has focused on the essential oils (EOs) as natural sources of antimicrobial and antioxidant compounds Sagdic *et al.* (2003). However EOs are volatile, natural, complex compounds characterized by a strong odour and are formed by aromatic plants as secondary metabolites Bakkali *et al.* (2008). Under greenhouse conditions Ahmed *et al.* (2016) stated that, application of *Bacillus subtilis*, *B. pumilus*, zinc oxide nanoparticles, castor and clove oils, as well as recommended fungicide (famoxadone + cymoxanil) reduced significantly cucumber downy mildew disease and improve (chlorophyll content, peroxidase, and polyphenoloxidase) as well as growth and yield characters (plant height, fruit number / plant, and fruit yield) of the cucumber plants in relation to control.

Hyeong *et al.* (2009) tested 7 plant essential oils (soybean, castor, canola, sunflower, safflower, olive and corn) against powdery and downy mildew of cucumber in filed experiment. The results showed that all tested oils inhibited the disease severity of both diseases; significantly. Canola oil found to be the most effective treatment. Ammar *et al.* (2018) proved that water extracts of castor, oleander and mint in addition to the oils of castor, thyme and mint significantly reduced the disease severity of grape downy mildew and increased the number of clusters, clusters length and yield production / plant.

Therefore, the objective of this work aimed to study the effect of some plant water extracts and essential oils on cucumber downy mildew disease and yield production.

## MATERIALS AND METHODS

### 1- Plant water extracts

Two hundred grams of Mint, Basil and Aloe vera leaves were separately boiled in enough amount of distilled water for half an hour, then filtered through filter paper and completed to be 1 L. It was placed in small containers inside the refrigerator until use. The concentrations of 2, 4 and 6 ml / L were prepared.

### 2- Plant essential oils

Essential oils of Mint, Thyme and Caster were obtained from EL Gomhouria Company for Oils and Pharmaceutical Industries, Cairo, Egypt. The oils were emulsified with 3 % Tween 20. The concentrations of 2.5 , 3.5 and 4.5 ml / L were prepared.

### 3- Greenhouse Experiments

The following experiments were conducted under greenhouse and natural infection conditions at El-Deresa district, Giza governorate, Egypt during 2019-2020 and 2020-2021 growing seasons.

Baracoda cucumber cultivar was cultivated at November 2019 and 2020 growing seasons. The plants were subjected to different individual treatments in order to control cucumber downy mildew disease. A complete randomized block design system with three replicates per each treatment was carried out. Cucumber plants were grown in 40 cm space. Drip irrigation system and the recommended fertilization were applied. Three weeks later of seeding, the plants were treated every 10 days (six times) with the following plant extract treatments {Mint (*Mentha villosa*), Basil (*Ocimum basilicum*) and Aloe vera (*Aloe barbadensis*)} using three concentrations (2 , 4 and 6 ml/ L) and plant essential oils of three plants Castor ( *Ricinus communis*), Thyme ( *Thymus vulgaris*) and Mint (*Mentha villosa*) using three concentrations of each ( 2.5 , 3.5 and 4.5 ml/L) .

### Data recorded

The results of percentage of infection (P.I.), Disease severity (D.S.), yield production and its components (number of fruits / plant and average fruit yield / plant) ; as affected with the different treatments were estimated as following :

### Percentage of infection (P. I.)

Percentage of infection was recorded four times after 10 days of the treatment application. Plants showed any downy mildew symptoms considered diseased.

### Disease severity (D.S.)

Disease severity was determined four times using the scale of 0 -9 according to the area of the leaves covered with the disease symptoms where (0: healthy plants and 9; up to 100% infection).

The formula of Soliman *et al.* (1988); were used for this estimation as follow:

$$\text{Severity of infection} = (axb)/(NxK) \times 100$$

Where;

a= Number of the diseased plants.

b=Infection rate.

N=Total number of the plants / plot.

K=Total infection rates.

### Statistical analysis

Data were subjected to analysis of variance (ANOVA). The mean differences were evaluated for their significant level by Duncans Multiple Range Test (DMRT). The analysis of data was done by using Costat software.

### Results

Results present in Tables (1) and Figs (1&2) clear that spraying of the tested plant water extracts on cucumber Baracoda cultivar reduced the disease severity compared to control. *Aloe vera* plant extract with (6 ml / L) was the best effective treatment in reducing the disease, followed by Basil (6ml /L) by 24.91 and 27.9 disease severity, respectively compared to control by 78.6.

Mint plant extract showed the least efficiency. In this respect generally, increasing the concentration of any tested extract (2 , 4 , 6 ml/L) resulted significant efficiency in reducing the disease up to 10 weeks of planting.

Yield production was also increased, significantly; in response to the plant extract applications compared to control treatment.

Results of the second season (2020-2021) were nearly same results (Table 2) and Figs (3 & 4)

**Table (1) : Average severity of infection estimated 4-10 weeks of Baracoda cultivar and the average yield / plant collected through the growing, season 2019/2020 as affected by spraying plant extracts .**

Plant extract	conc. ml/l	Average severity infection weeks after sowing				yield	
		4	6	8	10	Av.No.of fruits/ plant	Av.fruit yield kg/ pl.
Aloe vera	2	14.3	18.9	24.2	33.1	19	3.84
	4	11.11	17.2	10.2	27.21	21	4.33
	6	9.6	14.87	18.1	24.91	21	4.38
Basil	2	13.1	20.1	25	35.81	20	2.57
	4	12.7	18.9	23.5	29.81	21	3.16
	6	11.4	16.19	22.9	27.9	21	3.64
Mint	2	16.2	20.9	28.21	34.76	18	2.29
	4	15.2	20.1	26.4	33.8	18	2.92
	6	13.9	18.1	23	32.1	19	3.38
CONTROL		33.2	44.8	60.1	78.6	16	1.84
LSD 5 %		1.9	1.5	2.4	3.6		

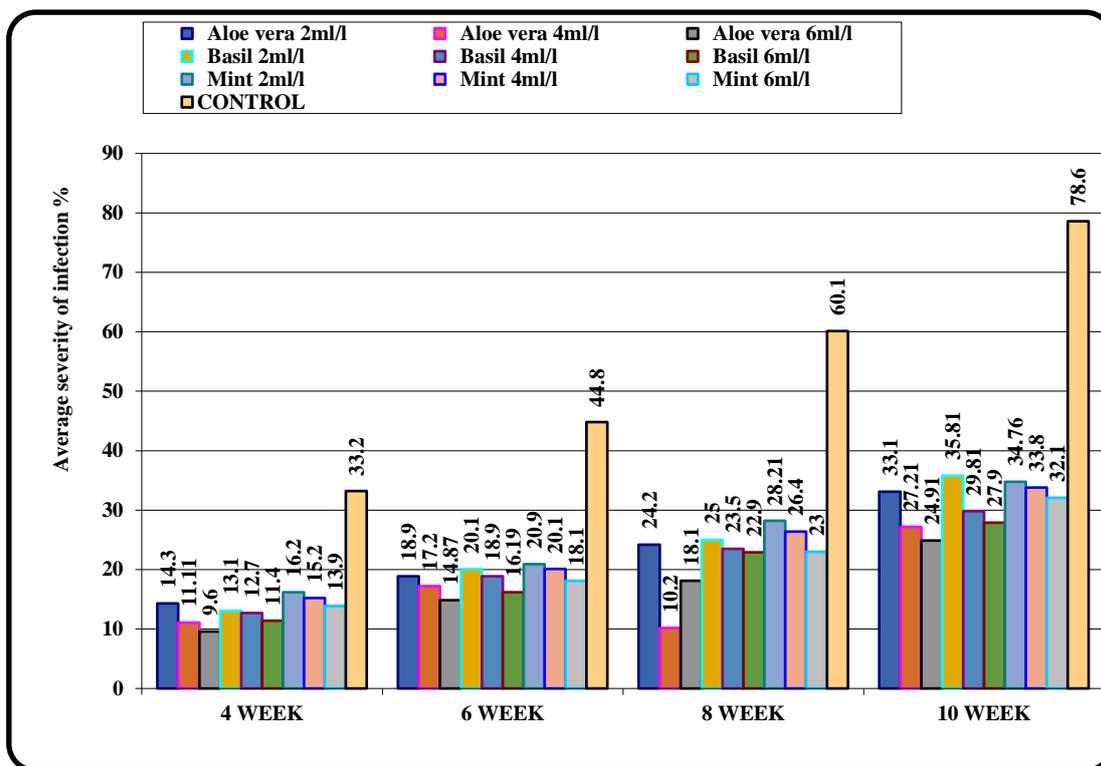


Figure (1): Average severity of infection estimated 4-10 weeks of Baracoda cultivar as affected by plant extracts treatment during season 2019\2020 .

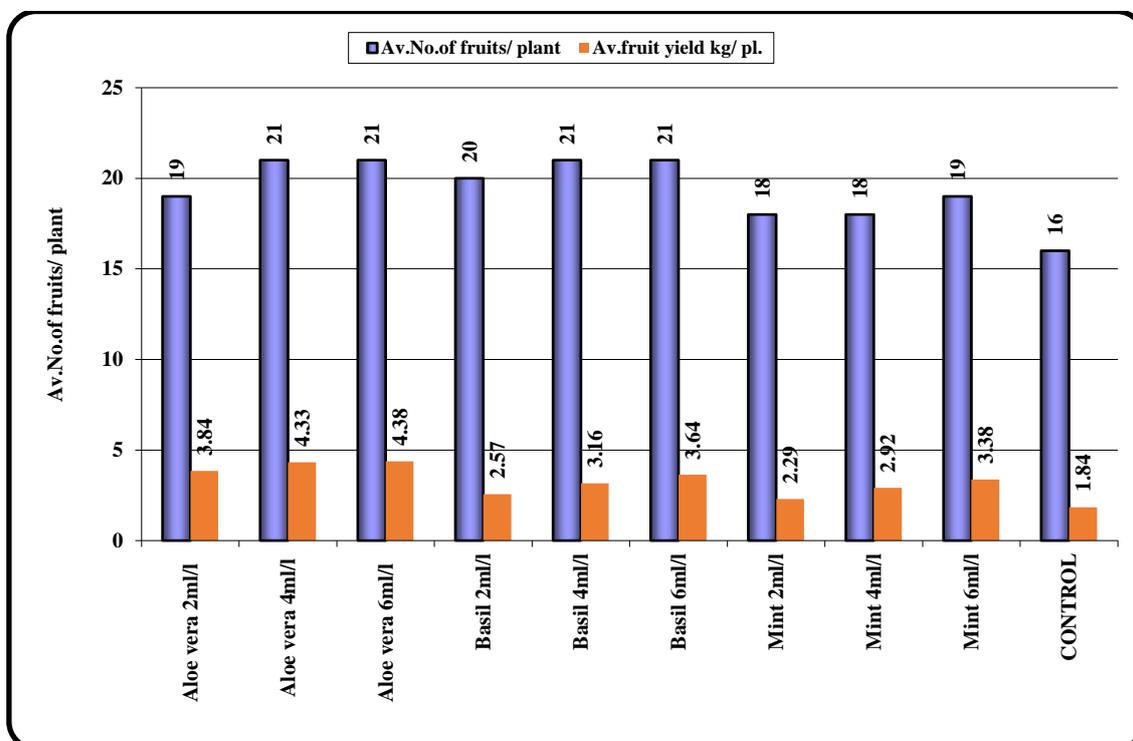
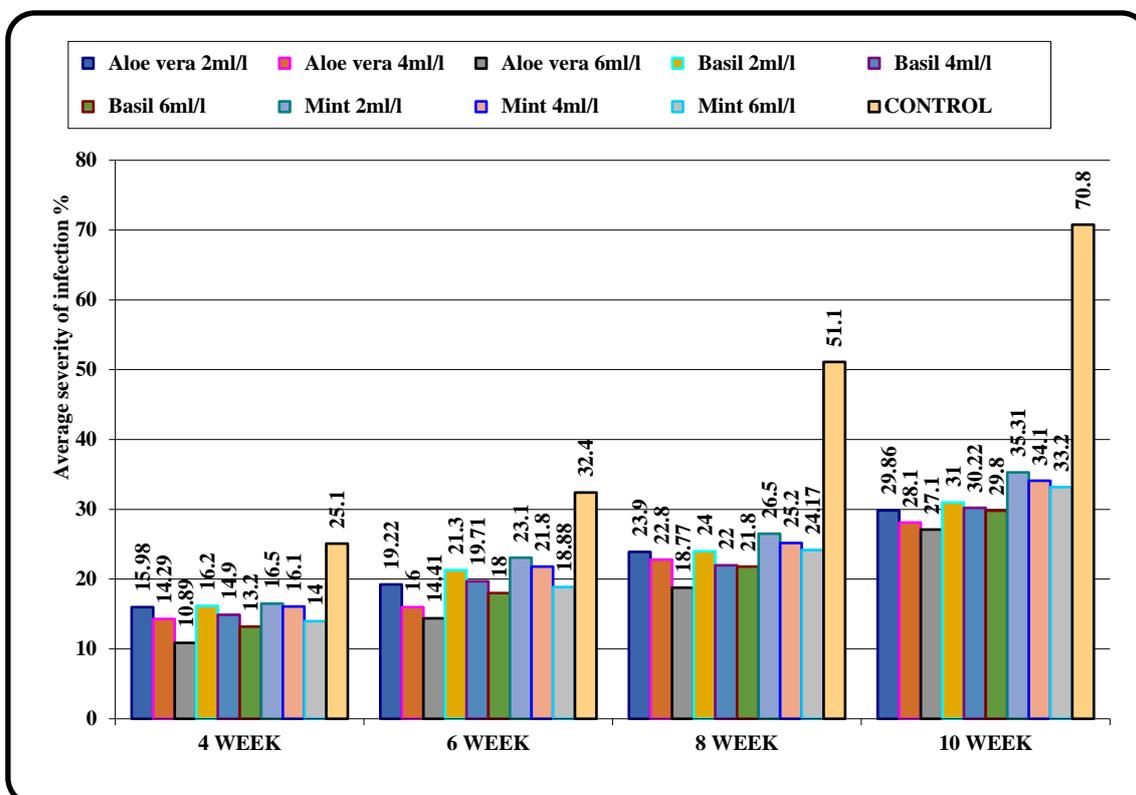


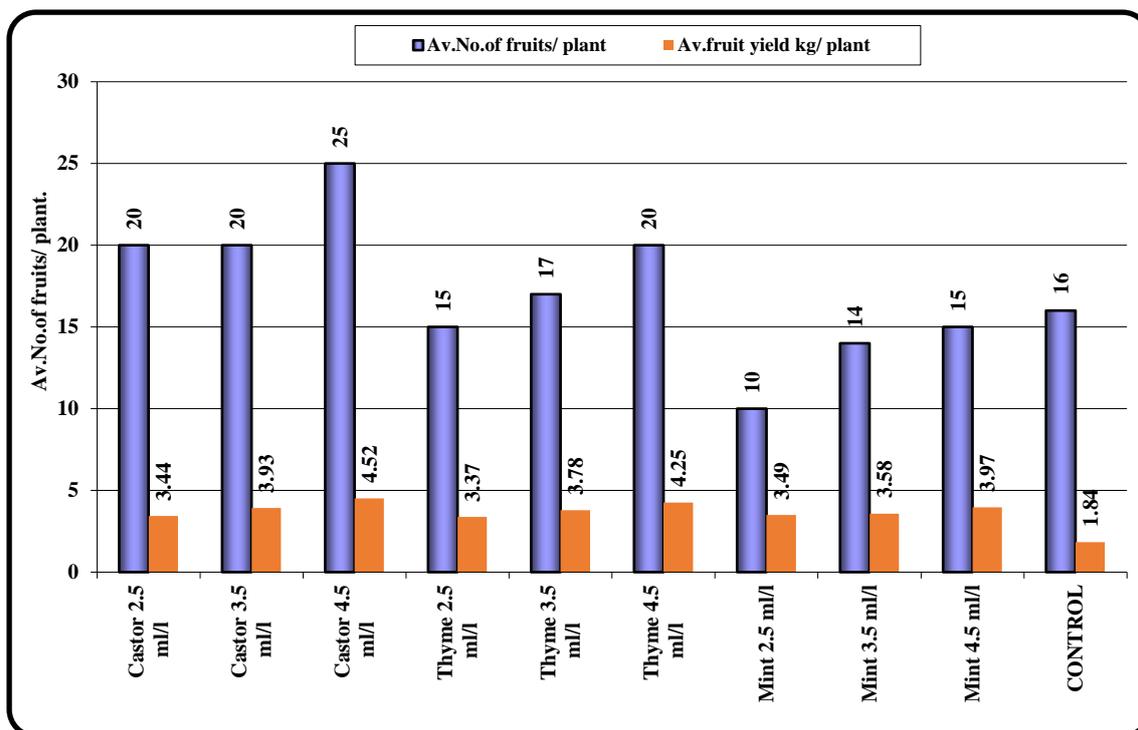
Figure (2): Average yield (kg/plant) estimated through the growing as affected by plant extracts treatment during season 2019\2020 .

**Table (2): Average severity of infection estimated 4-10 weeks of Baracoda cultivar and the average yield / plant collected through the growing season, 2020 / 2021**

Plant extract	conc. ml/l	Average severity infection weeks after sowing				Yield	
		4	6	8	10	Av.No.of fruits/ plant	Av.fruit yield kg/ plant
Aloe vera	2	15.98	19.22	23.9	29.86	20	3.74
	4	14.29	16	22.8	28.1	22	4.18
	6	10.89	14.41	18.77	27.1	22	4.43
Basil	2	16.2	21.3	24	31	19	2.72
	4	14.9	19.71	22	30.22	20	3.9
	6	13.2	18	21.8	29.8	22	3.63
Mint	2	16.5	23.1	26.5	35.31	17	2.42
	4	16.1	21.8	25.2	34.1	17	2.65
	6	14	18.88	24.17	33.2	18	2.81
CONTROL		25.1	32.4	51.1	70.8	15	2.11
LSD 5 %		1.4	1.8	2.6	3.4		



**Figure (3): Average severity of infection estimated 4-10 weeks of Baracoda cultivars as affected by plant extracts treatment during season 2020\2021.**



**Figure (4): Average yield (kg/plant) estimated through the growing as affected by plant extracts treatment during season 2020\2021.**

For essential oils experiment, results given in Table (3) and Figs (5& 6) indicated that application of tested essential oils to cucumber plants at (2019-2020) season reduced significantly the disease severity in comparison with control. Castor oil showed the best efficiency where the severity of infection after 10 weeks recorded 20.1 %, while it was 78.6 % at the same time in the untreated control plants.

In this respect, thyme essential oil came in the second rank and mint oil was the least effective one recorded 26.0% compared with control 78.6 % .

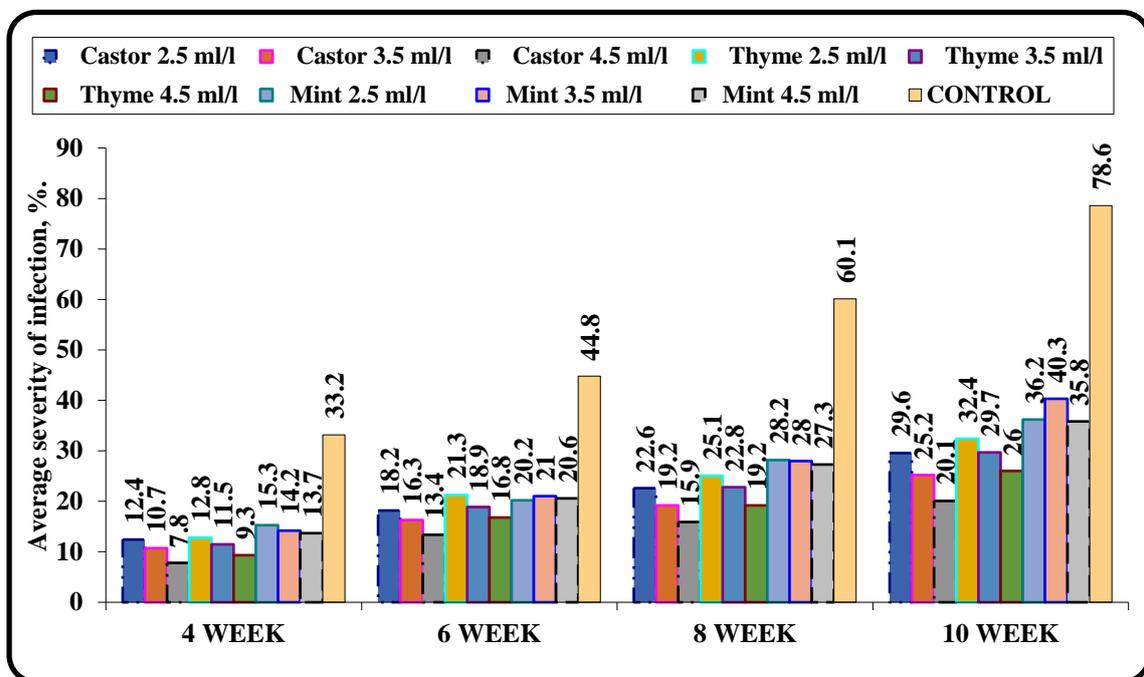
Increasing the concentration of the tested oils gave significant reduction of the disease incidence.

The average yield production which collected through the growing season (2019-2020) was highly increased in response to the oil treatment. Castor oil was the best effective one followed by thyme essential oil.

Results of the second season (2020 - 2021) confirm the above-mentioned results Table (4) and Figs (7 & 8)

**Table (3): Average severity of infection estimated 4-10 weeks from planting on Baracoda cultivar and the average yield / plant through the growing season , 2019/2020**

Essential oil	conc. ml/l	Avarage severity infection weeks after sowing				Yield	
		4	6	8	10	Av. No. of fruits/ plant	Av. fruit yield kg/ plant
Castor	2.5	12.4	18.2	22.6	29.6	20	3.44
	3.5	10.7	16.3	19.2	25.2	20	3.93
	4.5	7.8	13.4	15.9	20.1	25	4.52
Thyme	2.5	12.8	21.3	25.1	32.4	15	3.37
	3.5	11.5	18.9	22.8	29.7	17	3.78
	4.5	9.3	16.8	19.2	26	20	4.25
Mint	2.5	15.3	20.2	28.2	36.2	10	3.49
	3.5	14.2	21	28	40.3	14	3.58
	4.5	13.7	20.6	27.3	35.8	15	3.97
CONTROL		33.2	44.8	60.1	78.6	16	1.84
LSD 5 %		1.6	1.5	2.6	7.6		



**Figure (5) Average severity of infection estimated 4-10 weeks from planting of Baracoda cultivar as affected by essential oils treatment during Season 2019\2020 .**

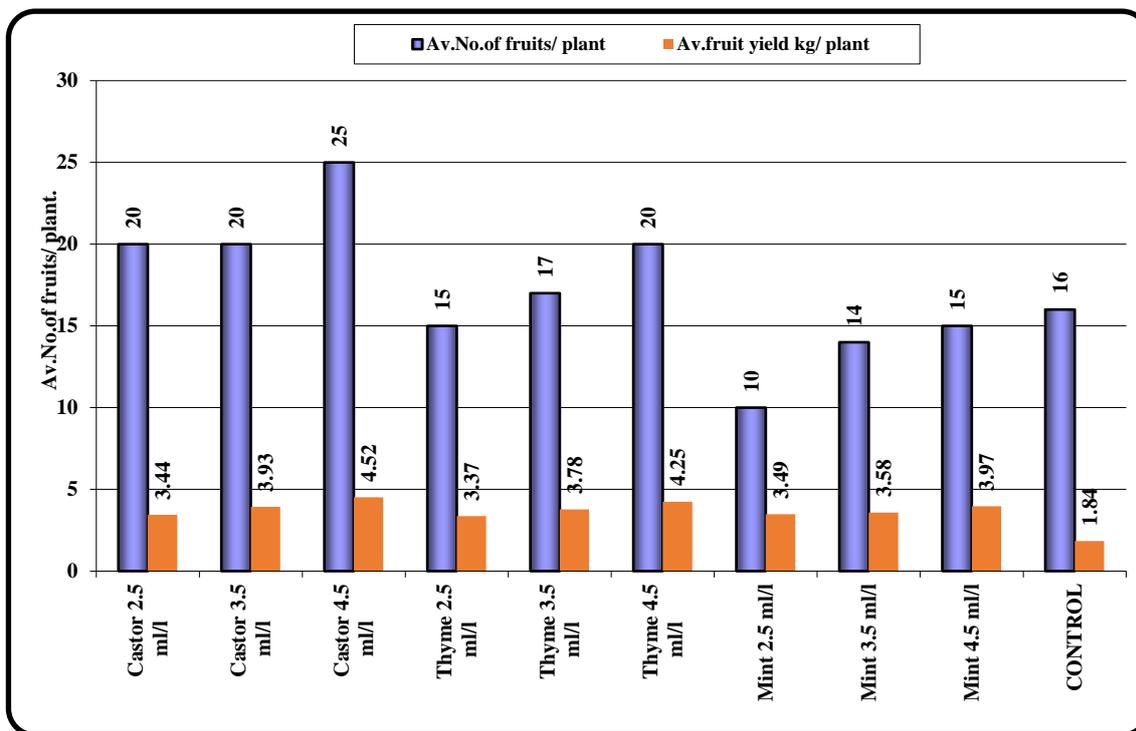


Figure (6): Average yield (kg/plant) estimated through the growing as affected by essential oils treatment during season 2019/2020.

Table (4): Average severity of infection estimated 4-10 weeks from planting of on baracoda cultivar and the average yield / plant collected through the growing, as affected by spraing different essential oils season 2020/2021.

Essential Oil	Conc. ml/l	Average severity infection weeks after sowing				Yield	
		4	6	8	10	Av. No. of fruits/ plant	Av. fruit yield kg/ plant
Castor	2.5	14.3	17.3	23.9	27.2	18	3.29
	3.5	11.3	15.1	21	25.1	21	3.7
	4.5	7	13	16.1	22.3	21	4.27
Thyme	2.5	13.8	18.7	23	29.3	20	3.25
	3.5	12.8	17.8	20.1	26	21	3.53
	4.5	9	16.2	19.8	25.1	22	4.33
Mint	2.5	16	21.1	25.8	32.8	17	3.43
	3.5	14.8	19.2	23.7	29.7	18	3.62
	4.5	12.3	18.3	21.2	29	18	3.91
CONTROL		25.1	32.4	51.1	70.8	15	2.11
LSD 5 %		1.5	1.8	2.9	6.8		

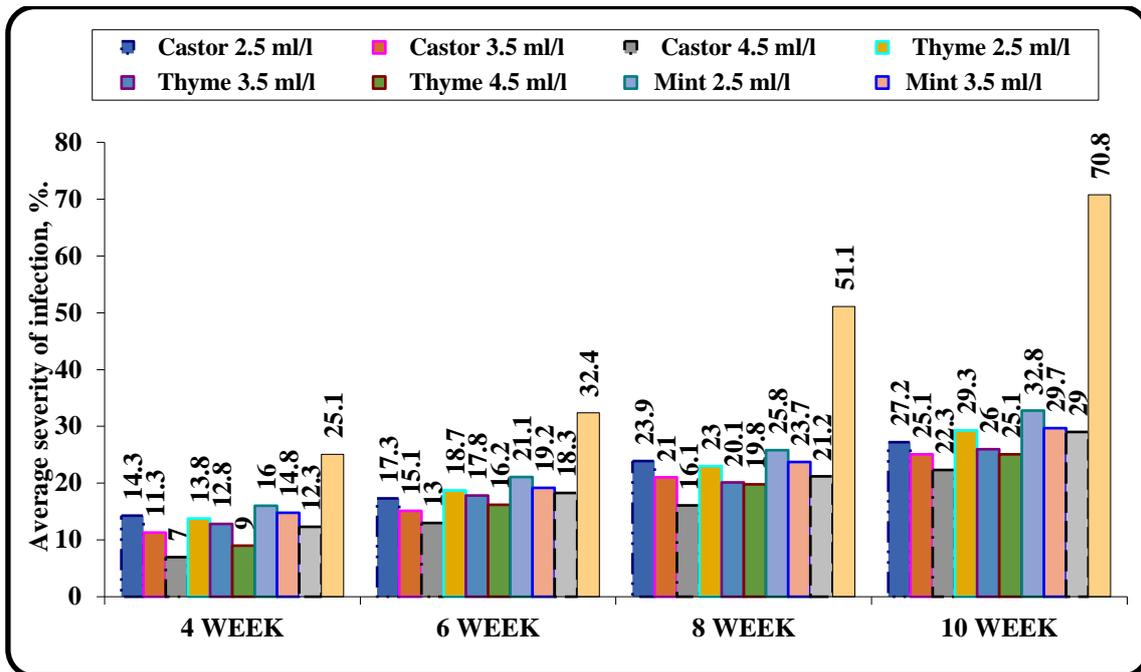


Figure (7): Average severity of infection estimated 4-10 weeks from planting of on Baracoda cultivar as affected by essential oil treatment during essential oil season 2020/2021 .

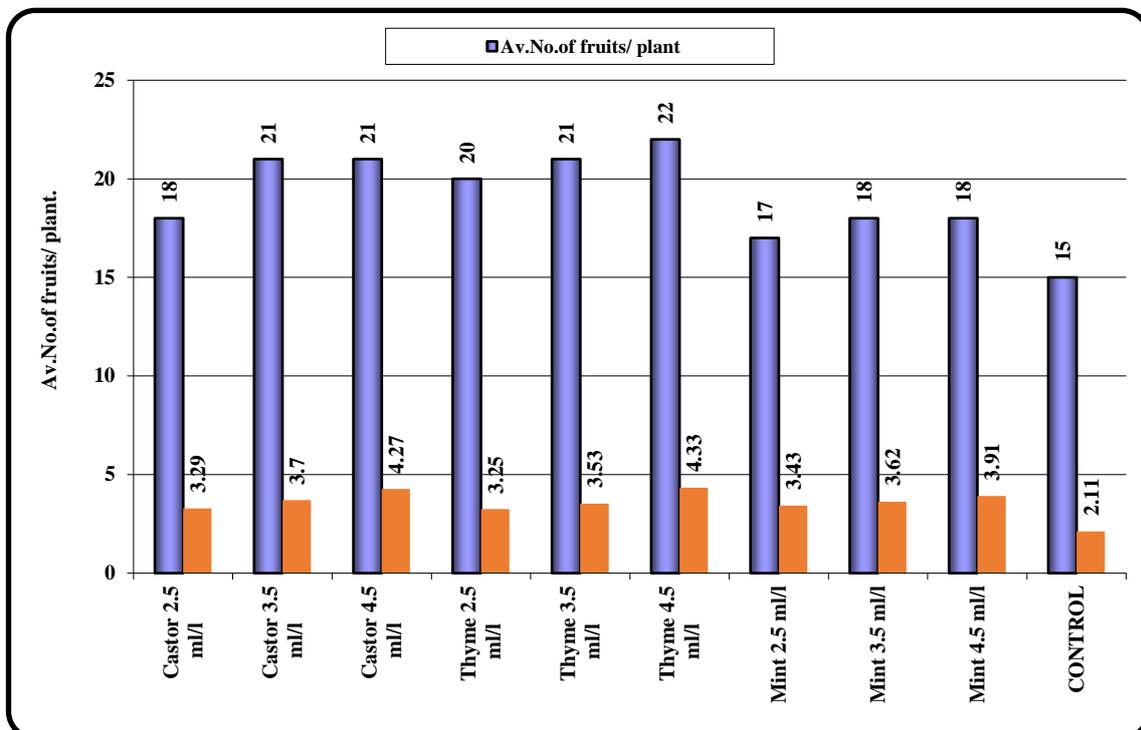


Figure (8): Average yield (kg/plant) estimated through the growing as affected by essential oil treatment during season 2020\2021 .

## Discussion

The cucumber downy mildew disease caused *Pseudoperonospora cubensis* is an important pathogen that causes serious annual losses. The extensive use of fungicides to manage diseases has undesirable effects on human health and the environment. Different strategies are employed to control the disease worldwide to reduce fungicides application. One important approach is using plant extracts and essential oils. The use of watery extracts of plants in agricultural practices has advantages. The technology of preparation of watery extracts easy to transfer to the farmers and thus to promote sustained millet production. They can be formulated on-farm like herbal tea, moreover, the extracts do not need further bioremediation and are immediately suitable as a foliar spray.

Spraying the tested plant water extracts and application of essential oils on cucumber plants reduced the severity of downy mildew disease and improved yield production. Similar results were also obtained by Afifi and Sahar (2009), Adriano- Anaya *et al.* (2018), Islam *et al.* (2019), Deweer *et al.* (2017) and Fialho *et al.* (2017).

Application of either plant water extracts or plant oils showed significant reduction the grape downy mildew disease. These results may be referring to the effect of chemical composition of the oils and extracts on the structure of epidermis cells and stomatal opening and closer. Ammar *et al.* (2018). According to Ahmed *et al.* (2016) activity of castor and clove oils on reducing powdery and downy mildew on cucumber could be due to the drastic effect of fatty acids and their derivatives on the causal pathogen. Fatty acids, as well as their corresponding salts, have been reported to display an antimicrobial activity Skřivanova *et al.* (2005)

In general, the mode of action of phytochemicals against mycotoxigenic fungi is facilitated through the following mechanisms; disruption of the fungal cell membrane, inhibition of ergosterol biosynthesis, a major sterol that regulates plasma membrane biogenesis and production of reactive oxygen

species (ROS), which results in oxidative stress Xu *et al.* (2021).

## CONCLUSION

Overall, application of water plant extracts Mint (*Mentha villosa*), Basil (*Ocimum basilicum*) and Aloe vera (*Aloe barbadensis*) and plant essential oils of three plants Castor (*Ricinus communis*), Thyme (*Thymus vulgaris*) and Mint (*Mentha villosa*) can be regarded as a promising treatment for controlling downy mildew disease and increase the quality and yield production of cucumber without causing harm.

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## مكافحه مرض البياض الزغبي في الخيار باستخدام بعض المستخلصات النباتية والزيوت العطرية

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### الملخص العربي

تم دراسته استخدام المستخلصات النباتية المائية لنباتات النعناع، الريحان، الصبار بثلاثة تركيزات ( ٢ ، ٤ ، ٦ مللي / لتر) وثلاثة زيوت عطرية لنباتات الخروع ، الزعتر ، النعناع بتركيزات ٢,٥ ، ٣,٥ ، ٤,٥ مللي / لتر ) لمكافحه مرض البياض الزغبي في الخيار تحت ظروف الصوبة والعدوي الطبيعية في موسمي الزراعة ٢٠١٩ - ٢٠٢٠ ، ٢٠٢٠ - ٢٠٢١ . واطهرت النتائج ان استخدام اي من المستخلصات النباتية او الزيوت العطرية ادي إلى اختزال حدوث شدة الاصابة بالمرض بصورة معنوية وإلي زيادة انتاج المحصول ومكوناته ( عدد الثمار لكل نبات و متوسط انتاج المحصول / نبات ) . وكان افضل المستخلصات النباتية المستخدمة في هذا الصدد هو مستخلص الصبار بتركيز ( ٦ مللي / لتر) في حين كان مستخلص نبات الريحان ( ٢ مللي / لتر ) هو الأقل فعالية. هذا وقد اظهر نبات الخروع بتركيز (٤,٥ مللي / لتر ) أفضل تأثير علي اختزال شدة الاصابة بالمرض وزيادة انتاجية المحصول في حين كان زيت النعناع بتركيز ( ٣,٥ مللي / لتر ) هو الأقل فعالية.