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ROLE OF GROWTH REGULATORS IN MINIMIZING POWDERY AND DOWNY MILDEW INFECTION ON CUCUMBER PLANTS AND THEIR RELATION WITH ENDOGENOUS PHYTOHORMONES

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ABSTRACT

This study aimed to reduce the use of fungicides and environmental pollution using the alternative methods for minimizing powdery and downy mildew infection on cucumber by spraying the plants with low rates of some plant growth regulators i.e. Ethephon, Cycocyl, Terpal and Morphactin and their influence on the endogenous phytohormones contents.

Treating cucumber plants with plant growth regulators reduced disease severity of powdery and downy mildew and consequently increased protection of different cucumber cultivars under both greenhouse and field conditions. Morphactin and Ethephon were the highest effective growth regulators in minimizing the infection as well as protecting cucumber plants from both diseases. Increasing the concentration of tested growth regulators increased gradually the protection percentages with superiority to the highest tested concentration in this concern. On the other hand, cucumber cultivars were varied in their responsibility to the tested growth regulators and their concentrations. Also, treating cucumber plants (cv. Beit Alpha) with some growth regulators affected greatly on the endogenous phytohormones contents where, they decreased the gibberellins (GA) contents in the healthy and infected cucumber leaves with either *Sphaerotheca fuliginea* or *Pseudoperonospora cubensis* infection comparing with the check untreated plants. The highest reduction in GA contents in healthy and infected cucumber leaves was recorded with different concentrations of Cycocel treatment against powdery or downy mildew pathogens. Also, a great discrepancy was recorded in indole acetic acid (IAA) contents in leaves of cucumber due to treating them with different growth regulators comparing with the un-treated check plants. Moreover, treating cucumber plants with different concentrations of all growth regulators increased cytokinins and abscisic acid (ABA) contents in the healthy leaves of cucumber plants than those of artificially infected with powdery or downy mildew pathogens compared with the *untreated* check. Meanwhile, Morphactin treatment was the highest in reducing ABA contents in cucumber leaves in case of powdery mildew infection. The application of these growth regulators can be of a great practical importance in minimizing the effect of powdery and downy mildew infection on cucumber in both greenhouse and open fields.

Key words: Cucumber, *Cucumis sativus*, powdery mildew, downy mildew, *S. fuliginea*, *P. cubensis*, plant growth regulators, endogenous phytohormones.

INTRODUCTION

Powdery and downy mildew diseases on cucumber (*Cucumis sativus* L.) caused by *Sphaerotheca fuliginea* (Schlectnd: Fr.) Pollacci, and *Pseudoperonospora cubensis* (Berk. & Curts.) Rostow, respectively, are considered the most economically important and widespread diseases occur throughout the world in both greenhouse and in open fields (Sitterly, 1978, Brunelli and Davi, 1987). They cause variety of changes in the development and metabolism in cucumber. One of the characteristics and most obvious symptoms of infection is the typical growth reduction of the host. Growth abnormalities are a frequently encountered phenomenon in diseased plants where they attracted the attention of plant pathologists and physiologists. In various host-pathogen systems altered growth patterns could be related to interference with the plants phytohormone system and in many cases, changes in the level of a particular phytohormone could be attributed to disease symptoms (Sequira, 1963 and 1973).

Consequently, there is a growing need to develop alternative approaches for controlling plant diseases such as the use of plant growth regulators as well as chemical inducers and/or bioactive substances in this respect (Matta and Gullino, 1998; Nielsen *et al.*, 2002; Abd El-Kareem *et al.*, 2002). Many investigators used plant growth regulators as abiotic inducers on cucumber plants against powdery and downy mildews. In this respect, Omar *et al.*, (1985b) mentioned that application of Terpal minimized the destructive effect of powdery mildew on barley. Suh and Chung (1986) increased the tolerance to infection with downy mildew by applying paclobutrazol as a gibberellin inhibitor. Also, spraying cucumber leaves with abiotic inducers 2-chloroethylphosphate (Ethephon) reduced the diseased area caused by *P. cubensis* as well as, increased the efficacy of induced systemic resistance (Okuno *et al.*, 1991). Song *et al.* (1992) reported that spraying cucumber plants with 100 or 200 ppm paclobutrazol increased significantly the levels of tolerance to powdery and downy mildew infection than those of check plants. In similar study on apple, applying growth retardants at different concentrations and timings prior to inoculation with *Venturia inaequalis* gave different effects in incidence of scab (Costa *et al.*, 2004).

Growth regulators have been used for increasing the productivity of some vegetables as well as controlling a wide range of physiological process in higher plants. In this respect, several reports showed various actions for different phytohormones on host-pathogen relation where, the ABA suppressed the hypersensitivity of some incompatible plant-pathogen interaction on potato against *Phytophthora infestans* (Henfling *et. al.*, 1980). Also, Edwards (1983) revealed the effect of kinetin and ABA on host–parasite relation of barley inoculated with *Erysiphe graminis* f. sp. *hordei*. In addition, plant growth regulators affect on the activity of enzymes and cytokinin/ABA ratio on squash plants in relation to powdery mildew disease (Omar *et al.*, 1985a). Also, growth regulator Terpal reduced IAA and ABA while these contents increased in powdery mildew infected barley plants (Omar *et al.* 1985b). Similar studies concerned the role of growth regulators on reducing the disease incidence in relation to the endogenous phytohormones were recorded by Salt *et al.* (1986) on

tobacco against *Peronospora tabacina*, Li and Heath, (1990) on bean as well as, Galal, (1996) on sunflower against rust infection and Maksimov, *et al.* (2004) on wheat calluses to bunt pathogen, *Tilletia caries*.

The present work aimed to study the effect of some plant growth regulators on minimizing powdery and downy mildew infection on cucumber and their influence on the endogenous phytohormones contents.

MATERIALS AND METHODS

Greenhouse experiment:

Three cucumber cultivars i.e. Amira II, Medina and Beit Alpha which differed in their reaction to both powdery and downy mildews were sown in plastic pots (25 cm ϕ, each one contained 5 kg of sandy clay soil) under greenhouse conditions (20 ± 4°C). Five seeds were sown in each pot and each treatment comprised five replicates.

Plant growth regulators:

The tested growth regulators i.e. Ethephon (2-chloroethyl phosphonic acid), Cycocel (2-chloroethyl trimethyl ammonium chloride) and Terpal (1,1-dimethyl-piperidinum chloride and 2-chloroethyl phosphonic acid) were used at rate 25, 50 and 100 ppm while, Morphactin (methyl, 2-cloro -9- hydroxy fluran - 9- carboxylate) was used at rate 2.5, 5 and 10 ppm. The different concentrations of tested plant growth regulators were prepared according to the method described by Li and Heath, (1990). The surfactant was added to the prepared concentrations of growth regulators before using in form of commercial product Super film at rate 0.3%. The prepared solutions of plant growth regulators were sprayed on plants at the second and third true leaf as well as at the beginning of early formation of flowers using hand atomizer (5 ml solution/plant).

Pathogens inoculation:

The treated plants were divided into four separated groups, each one of them served in a separate adjacent chamber in the greenhouse as follows:

1- The first group was inoculated with *Sphearotheca fuliginea* the causal agent of powdery mildew at rate of $3x10^4$ conidia/ml after three days from the first spray with growth regulators as described by Floris and Alvarez (1991).
2- The second group included plants protected from natural infection with powdery mildew by spraying them two times at 2 weeks intervals with Sumi-eight (Diniconazole) with the recommended dose (35 ml/100 L water).
3- The third group of plants was inoculated with *Pseudoperonospora cubensis* the causal agent of downy mildew at rate $5x10^3$ sporangia/ml after three days post the first spray of growth regulators according to Thomas *et al.* (1987).
4- The fourth group included plants protected from natural infection with downy mildew by spraying them two times at 2 weeks intervals with Acrobat cupper (Dimethimorph + cupper oxychloride) with the recommended dose (250 g/100 L water).

Determination of the endogenous phytohormones:

Plant material:

After two weeks from the last spray, twenty-gram of cucumber leaves samples of cv. Beit Alpha, grown under greenhouse conditions were taken from each treatment to determine the endogenous phytohormones.

Extraction:

Ten grams of fresh tissue per sample was homogenized with 70% methanol and stirred overnight at 4°C. The extract was filtered through a Whatman filter and the methanol evaporated in vacuo. The aqueous phase was adjusted to pH 8.5 with a 0.1 M phosphate buffer and then partitioned three times with ethyl acetate. After removal of the ethyl acetate phase, the aqueous phase was adjusted to pH 2.5 with 1 N HC1. The solution was partitioned three times with diethyl ether and then, passed through waterless sodium sulphate. After the diethyl ether was evaporated in vacuo, the dry residue containing hormones was dissolved in methanol and stored in vials at 4°C (Chen, 1990).

Thin-layer chromatography:

Thin layer chromatography (TLC) was used for separation and purification of the extracts containing endogenous phytohormones which dissolved in methanol as described by Chen, (1990). Then the resulted endogenous phytohormones (GA, IAA, ABA and cytokinin) based on their different Rf bands were dissolved in grade methanol for use in HPLC analysis.

HPLC analysis:

HPLC analysis was used to study growth hormones in extracts dissolved in 1 ml grade methanol. Analyses of GA, IAA, ABA and cytokinin were performed on a Model Varian 606 HPLC equipped with UV detector. Separations and determinations were performed on a nukleosil C18 column (4.6 mm x 150 mm). Total run time for the separations was approximately 5 min at a flow rate of 1 ml/min (Wurst *et al.*, 1984 and Chen, 1990).

Field experiment:

Field experiments were conducted at a private field at Shibin El-Kom (Minufiya governorate) during two successive autumn seasons of 2003 and 2004. Seeds of the susceptible cucumber cv. Beit Alpha were sown in experimental plots (each one contains three rows, 1 m apart and 7 m length). Four seeds were sown in each hill at 50 cm apart then the emerged seedlings were thinned at two plants/hill.

Plants were left to natural infection with powdery or downy mildews then, the plants were sprayed with growth regulators at the second and third true leaf as well as at the beginning of early formation of flowering stage using Knapsack sprayer. Check plants were sprayed with water containing only the wetting agent and protected from both diseases by the specific fungicides. Treated plants were divided into two groups, in downy mildew group plants were protected from natural infection of powdery mildew with Sumi-eight and in

powdery mildew group; plants were protected from natural infection of downy mildew with Acrobat cupper as mentioned above.

Disease assessment:

Severity of powdery and downy mildews were assessed and scored using 0 to 9 rating scale based on the percentage of leaf area affected as described by Warkentin *et al.* (1996), where: 0 = no infection, 1=1%, 2 = 1-5 %, 3 = 5-10 %, 4 = 10-20 %, 5=20-40 %, 6=40-80 %, 7 = 60-80 %, 8= 80-90 %, 9= > 90 % of leaf area affected. Percentage of protection was expressed as (Check-treatment/Check) x 100.

Data analysis:

Analysis of variance of the data was performed with a computerized program (MSTATC) using the method of Clarke and Kenpson (1997).

RESULTS

1-Disease severity and protection percentages under greenhouse conditions:

a- Powdery mildew:

Data in Table (1a) reveal that the three tested cucumber cultivars were differed significantly in their susceptibility to powdery mildew infection. In this respect, Amira II cv was the least infected one with powdery mildew disease followed by Medina cv while, cv. Beit Alpha was the highest infected one with powdery mildew where its recorded disease severity was 49.2%. As for treating with growth regulators, results indicate also that all tested plant growth regulators reduced disease severity of powdery mildew and consequently increased protection of the three treated cucumber cultivars under greenhouse conditions where, they gave protection more than 50% in many cases with clear significant differences between most growth regulators treatments in relation to infection with *S. fuliginea*. In this respect, the highest protection percentage was recorded in case of treating cucumber cv. Beit Alpha with Morphactin at rate 10 ppm where it gave 58.3% followed by Amira II (56.5%) when sprayed with the same growth regulator at 5 and 10 ppm. It is clear also that treating cucumber plants (cv. Amira II) with Ethephon at rate 50 and 100 ppm protected the plants to values reached 54.8 and 54.2 % respectively. All tested concentrations of growth regulators increased protection and decreased consequently the severity of cucumber plants against powdery mildew where increasing the concentration increased gradually the protection with superiority to the highest tested concentration in this field. On the other hand, cucumber cultivars were varied in their responsibility to the tested growth regulators and their concentrations.

b- Downy mildew:

Data in Table (1b) show that the three tested cultivars were susceptible to downy mildew, but they differed in their values of disease severity.

The results indicated also that all tested plant growth regulators reduced disease severity of downy mildew and consequently increased protection of the three treated cucumber cultivars where, they gave protection more than 50% in

many cases with significant differences between different growth regulators treatments in relation to infection with *P. cubensis*. In this respect, the highest protection was recorded in case of treating cucumber cv. Amira II with Morphactin at rates 10, 5 and 2.5 ppm where it gave 59.1, 56.0 and 53.5%, respectively as well as at rates 10, 5 on cv. Beit Alpha followed by Cycocel at rates 100 and 50 ppm on cv. AmiraII where they showed protection reached to 51.6%. Terpal showed two cases of protection reached more than 50% at rate 100 ppm (56.0% on cv Beit Alpha and 53.0% on cv. Amira II).

Table (1a): Effect of treating cucumber plants with some plant growth regulators on powdery mildew severity and protection under greenhouse conditions.

Growth regulators	Cucumber cultivars					
	Amira II		Medina		Beit Alpha	
	Severity %	Protectio n%	Severity %	Protectio n %	Severity %	Protectio n %
Ethephon						
25	18.2	47.2	38.9	08.0	41.5	15.7
50	15.6	54.8	34.5	18.4	40.3	18.1
100	15.8	54.2	31.2	26.2	38.6	21.5
Cycocel						
25	20.6	40.3	30.6	27.7	39.2	20.3
50	18.6	46.1	28.2	33.3	32.4	34.1
100	16.4	52.5	22.5	46.8	26.7	45.7
Terpal						
25	16.4	43.5	33.6	20.6	46.0	06.5
50	15.0	44.6	26.2	38.1	33.6	31.7
100	15.0	45.5	31.2	26.2	22.8	53.7
Morphactin						
2.5	16.4	52.5	39.7	06.1	42.7	13.2
5	15.0	56.5	32.2	23.9	34.0	31.0
10	15.0	56.5	27.8	34.3	20.5	58.3
Check	34.5		42.3		49.2	
L.S.D. at 5% for	Growth regulators (Gr)		Cultivars (cvs)		GrXcvs	
	3.2		6.7		11.4	

Data revealed that all tested concentrations of growth regulators decreased disease severity and consequently increased protection and of cucumber plants against downy mildew where increasing the concentration increased gradually the protection with superiority to the high concentration. On the other hand, cucumber cultivars were varied in their responsibility to the tested growth regulators and their concentrations.

Table (1b): Effect of treating plants of three cucumber cultivars with some plant growth regulators on downy mildew severity and protection under greenhouse conditions.

Growth regulators	Amira II		Medina		Beit Alpha	
	Severity %	Protection %	Severity %	Protection %	Severity %	Protection %
Ethephon						
25	28.3	34.1	39.0	19.3	42.0	19.7
50	22.1	48.6	35.7	26.1	31.2	40.3
100	20.0	53.5	26.5	45.1	29.0	44.6
Cycocel						
25	26.9	37.4	40.0	17.2	39.2	25.0
50	20.8	51.6	36.5	24.4	33.2	36.5
100	20.8	51.6	25.3	47.6	25.0	52.1
Terpal						
25	24.5	43.7	34.7	28.2	39.7	24.1
50	21.8	49.3	28.6	40.8	27.5	47.4
100	20.2	53.0	23.0	52.4	23.0	56.0
Morphactin						
2.5	20.0	53.5	38.5	20.3	35.6	31.9
5	18.9	56.0	31.8	34.2	24.5	53.2
10	17.6	59.1	22.3	53.8	22.3	57.4
Check	43.0		48.3		52.3	
L.S.D. at 5% for	Growth regulators (Gr)		Cultivars (cvs)		GrXcvs	
	2.4		5.3		8.9	

2- Changes in endogenous phytohormones due to treating cucumber plants (cv. Beit Alpha) under greenhouse conditions:

a- Gibberellins:

Data in Fig. (1a & b) indicate that treating cucumber plants (cv. Beit Alpha) with the high concentration of different growth regulators decreased the gibberellins (GA) content in the healthy leaves as well as in inoculated leaves either with *S. fuliginea* or *P. cubensis* comparing with the check plants (untreated). The reduction of GA contents in healthy and infected cucumber leaves with either powdery or downy mildew were more pronounced by treating them with different rates of Cycocel comparing to other tested growth regulators. Also, treating cucumber plants with Ethephon at 100 ppm reduced GA contents in healthy and mildewed cucumber leaves. In addition, application of Terpal and Morphactin with different concentrations affected negatively on GA contents in the infected cucumber leaves with either powdery or downy mildew while, GA contents in the healthy leaves of cucumber were less affected in this respect. It is obvious from the obtained data that the high concentrations (100 &10 ppm) of all tested growth regulators decreased the GA contents in cucumber leaves (Beit Alpha) comparing with the other tested concentrations which revealed that the concentrations 25 and 2.5 ppm were the least effective ones in this respect.

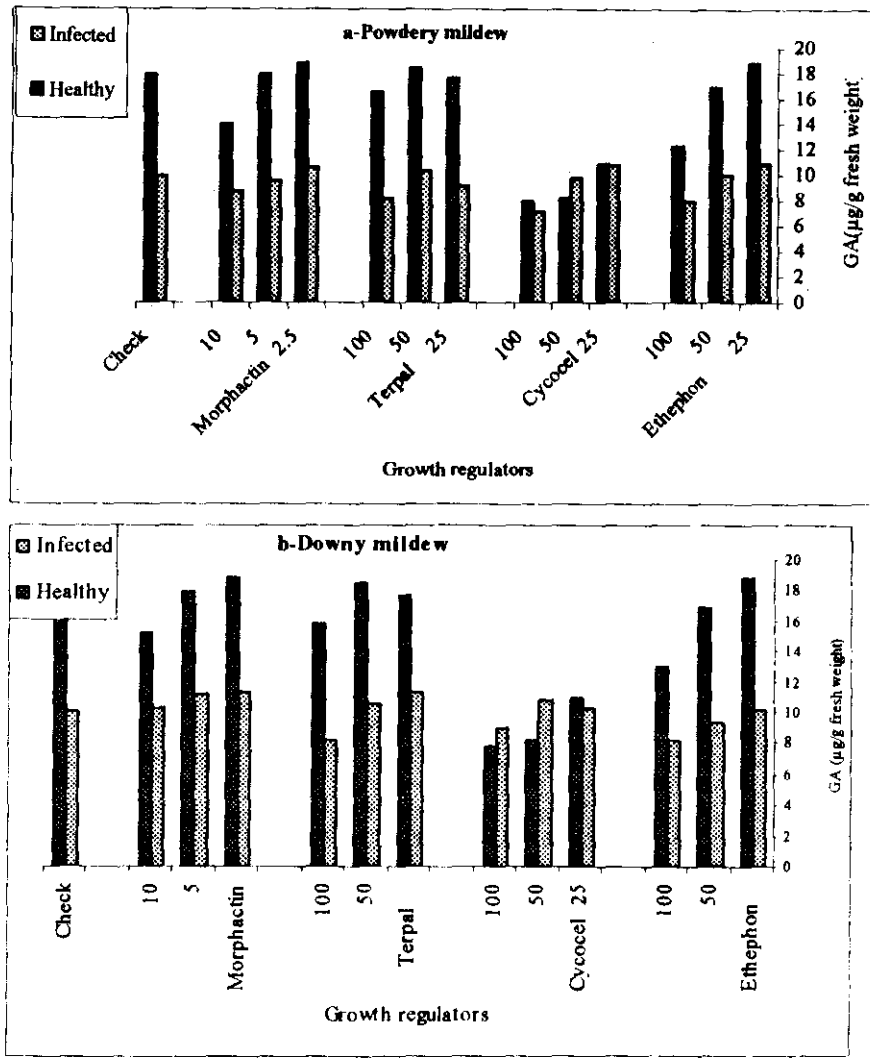

Fig. (1a&b): Changes in gibberellins (GA) contents due to treating cucumber plants (cv. Beit Alpha) with different growth regulators in relation to powdery and downy mildew infection.

b- Indole acetic acid contents:

Data presented in Fig. (2a&b) showed a great discrepancy in indole acetic acid (IAA) contents in leaves of cucumber (cv. Beit Alpha) due to treating them with different growth regulators comparing with the non-treated plants (check). The reduction of IAA contents in healthy and infected cucumber leaves with either powdery or downy mildew were more pronounced by treating them with different rates of Morphactin comparing to other tested growth regulators. Also, treating cucumber plants with Ethephon at 100 ppm reduced IAA contents only in the mildewed cucumber leaves. Meanwhile, all rates of Cycocel increased

IAA in plants infected with powdery mildew. Application of Cycocel and Terpal with different rates affected negatively on IAA contents in the infected cucumber leaves with powdery mildew while, IAA contents in the healthy leaves of cucumber were less affected in this respect. Moreover, all rates of Cycocel, Terpal and Ethephon affected negatively on IAA contents in the healthy and infected cucumber leaves with downy mildew.

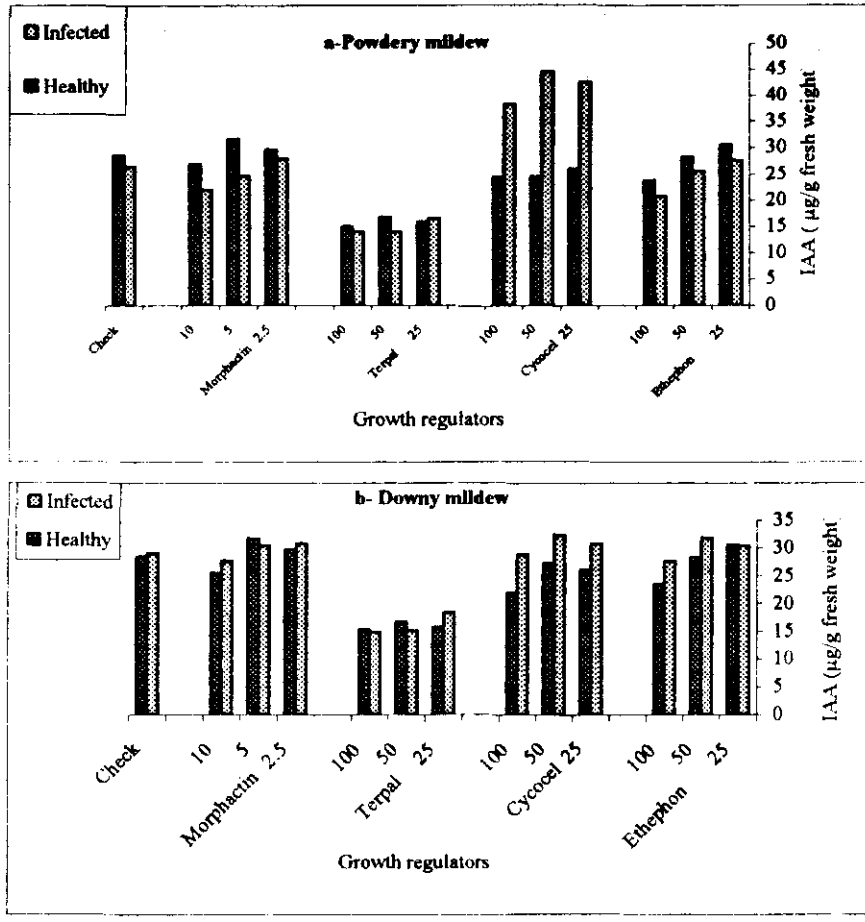

Fig. (2a&b): Changes in indole acetic acid (IAA) contents due to treating cucumber plants (cv. Beit Alpha) with different growth regulators in relation to powdery and downy mildew infection.

c- Cytokinins contents:

Data presented in Fig. (3a&b) indicate that treating cucumber plants with different concentrations of Ethephon, Cycocel, Morphactin and Terpal showed an increase in cytokinins contents in the healthy leaves of cucumber plants than those in the artificially infected with powdery or downy mildew

compared with the untreated check. In this respect, Ethophon treatment followed by Morphactin at all tested concentrations increased cytokinins contents in the healthy and inoculated leaves of cucumber plants with powdery and downy mildew pathogens than other tested growth regulators. Application of all tested growth regulators show slight increase in the amount of cytokinins content in the infected plants with both the diseases.

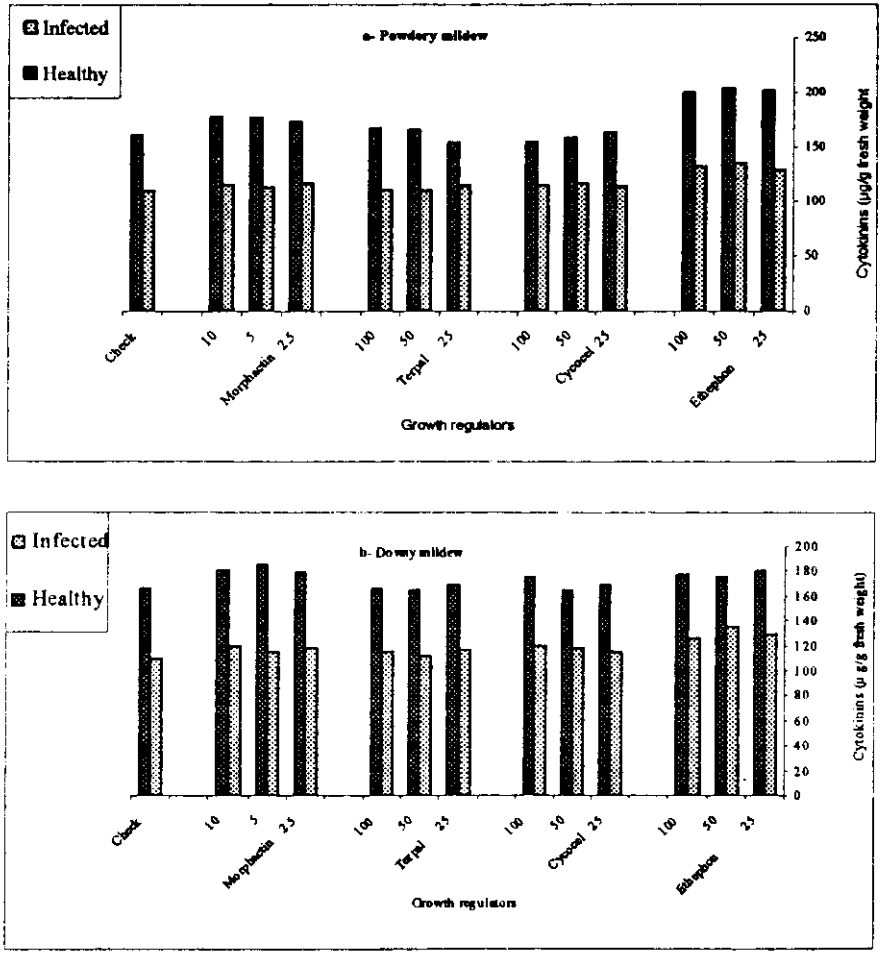

Fig. (3a & b): Changes in cytokinin contents due to treating cucumber plants (cv. Beit Alpha) with different growth regulators in relation to powdery and downy mildew infection.

d- Abscisic acid content:

Data in Fig. (4a&b) show that all growth regulators treatments increased abscisic acid (ABA) contents in the infected cucumber leaves than those in the healthy plants compared with the untreated check. Meanwhile, Morphactin treatment at all tested concentrations reduced the content of ABA in inoculated

cucumber leaves with powdery mildew pathogen more than other tested growth regulators while, Terpal gave the highest content of ABA at 100 ppm. In contrary, all tested growth regulators at all tested concentrations recorded clear increase in ABA contents in infected leaves with downy mildew pathogen more than healthy ones.

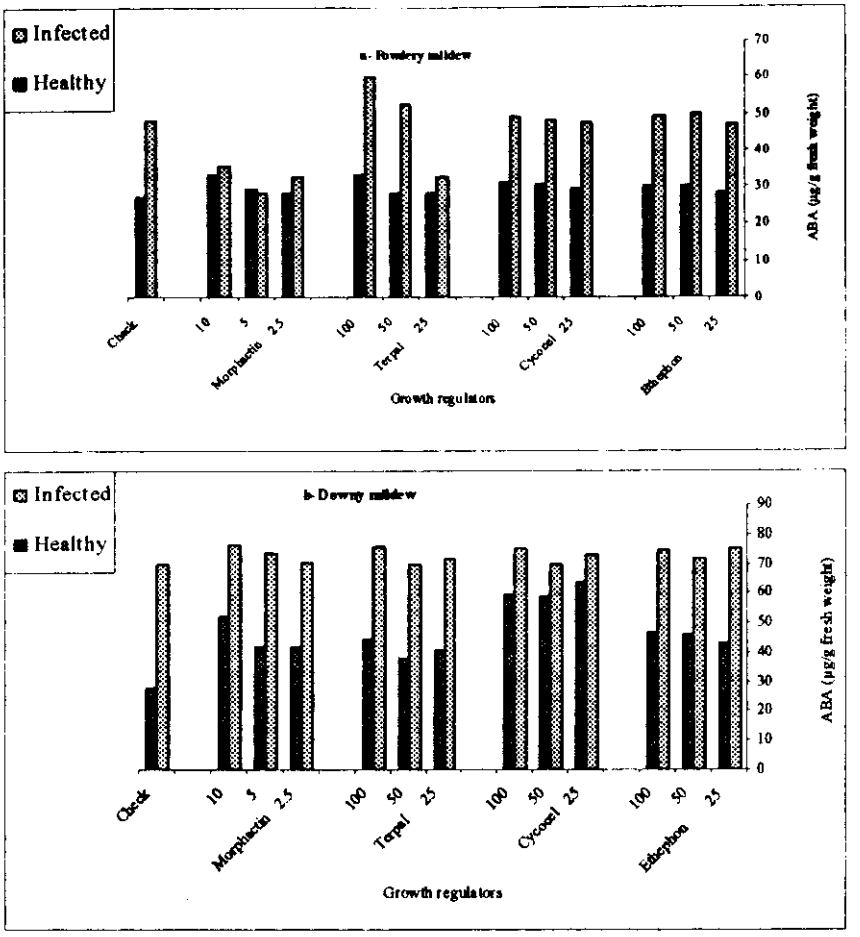

Fig. (4a&b): Changes in absicsic acid (ABA) contents due to treating cucumber plants (cv. Beit Alpha) with different growth regulators in relation to powdery and downy mildew infection.

3-Disease severity and protection percentages under field conditions:

Data in Table (2a&b) reveal the effect of treating cucumber plants (cv. Beit Alpha) with growth regulators on powdery and downy mildews severities under natural infection in open field during two successive autumn seasons 2003 and 2004 at Shibin El-Kom (Minufiya).

a- Powdery mildew:

Data in Table (2a) indicate that, all tested plant growth regulators reduced powdery mildew severity and consequently increased protection of cucumber cultivars cv. (Beit Alpha) during two autumn seasons of 2003 and 2004 under field conditions. In this respect, clear significant differences were obtained between check plants and those treated with plant growth regulators before inoculation with *S. fuliginea*. Low concentrations of tested growth regulators decreased powdery mildew severity with slight increase in the protection percentage of the tested plants. The high concentrations of all tested growth regulators raised the percentage of protection against powdery mildew infection to values more than 50% in some cases. Moreover, the effect of tested growth regulators on infection severity was differed clearly during the two seasons. In this respect, it is obvious that Morphactin followed by Terpal gave the higher degrees of protection against powdery mildew disease meanwhile, Ethephon and Cycocel were the least effective one in this concern.

Table (2a): Effect of treating cucumber plants (cv. Beit alpha) with some plant growth regulators on powdery mildew severity and protection under field conditions.

Growth regulators	Autumn 2003		Autumn 2004	
	Severity %	Protection %	Severity %	Protection %
Ethephon				
25	34.8	32.9	33.0	47.8
50	28.6	44.9	35.2	44.3
100	26.1	49.5	31.8	49.7
Cycocel				
25	43.5	16.2	42.1	33.4
50	34.2	34.1	40.2	36.4
100	27.8	46.4	31.9	49.5
Terpal				
25	42.9	17.3	50.0	20.9
50	35.4	31.8	51.2	19.0
100	25.2	51.4	41.1	35.0
Morphactin				
2.5	33.6	35.3	38.6	38.9
5	25.4	51.1	35.0	44.6
10	22.6	56.5	31.9	49.5
Check ——	51.9		63.2	
L.S.D. at 5% for	Growth regulators (Gr)		Cultivars (cvs)	GrXcvs
	2.9		5.7	8.8

b- Downy mildew:

Data in Table (2b) show that all tested plant growth regulators reduced disease severity of downy mildew and increased protection of the tested cucumber cultivars during two autumn seasons of 2003 and 2004 under field conditions. All tested plant growth regulators reduced downy mildew severity and

consequently increased protection of cucumber cultivars with clear significant differences between different treatments of plant growth regulators. The low concentrations of tested growth regulators decreased downy mildew severities as well as increased the protection percentages of tested plants. Also, the high concentration of all tested growth regulators raised the protection% to downy mildew infection to values more than 50% in few cases. Moreover, the effect of growth regulators on downy mildew infection (severity and protection) were differed clearly during the two seasons. Morphactin followed by Terpal gave the highest protection % against downy mildew while, Ethephon and Cycocel were the least effective ones in this concern.

Table (2b): Effect of treating cucumber plants (cv. Beit alpha) with some plant growth regulators on downy mildew severity and protection under field conditions.

Growth regulators	Autumn 2003		Autumn 2004	
	Severity %	Protection %	Severity %	Protection %
Ethephon				
25	35.8	20.4	32.8	42.6
50	41.0	08.9	35.1	38.5
100	29.4	34.7	28.9	49.4
Cycocel				
25	34.9	22.4	37.6	34.2
50	28.9	35.8	31.5	44.8
100	25.1	44.2	29.5	48.3
Terpal				
25	36.5	18.9	44.2	22.6
50	28.5	36.7	37.0	35.2
100	22.5	50.0	28.2	50.6
Morphactin				
2.5	24.3	46.0	38.5	32.6
5	21.5	52.2	32.3	43.4
10	19.9	55.8	29.0	49.2
Check —	45.0		57.1	
L.S.D. at 5% for	Growth regulators (Gr)		Cultivars (cvs)	GrXcvs
	3.1		8.1	9.6

DISCUSSION

The level of resistance or susceptibility of plants can be modified towards increased resistance by several heterogeneous compounds i.e. nutrients, growth regulators, amino acids, phenols, pesticides, organic acids and miscellaneous compounds of plants or microorganisms. Most of them caused profound metabolic changes with differences among plant taxa that are randomly associated with resistance to a restricted group of pathogens only (Matta and Gullino, 1998).

In this study, all tested plant growth regulators reduced disease severity of powdery and downy mildew and consequently increased protection of different cucumber cultivars under both greenhouse and field conditions. In this respect, Morphactin and Ethephon were the highest effective growth regulators in minimizing the infection as well as protecting cucumber plants from powdery and downy mildews. Increasing the concentration of tested growth regulators increased gradually the protection with superiority to the highest tested concentration in this field On the other hand, cucumber cultivars were varied in their responsibility to the tested growth regulators and their concentrations. These obtained results are in harmony with the findings of Suh and Chung, (1986) who mentioned that tolerance to infection with downy mildew was increased by applying paclobutrazol (gibberellin inhibitor) as a soil drench. Also, Okuno *et al.*, (1991) mentioned that spraying cucumber leaves with abiotic inducers 2-chloroethylphosphate (Ethephon) reduced the diseased area caused by *P. cubensis* as well as, the induced systemic resistance in cucumber plants by abiotic inducers was effective in controlling infection by *P. cubensis*. In addition, Song *et al.*, (1992) revealed that the levels of tolerance to infection by powdery mildew and downy mildew of cucumber plants sprayed with 100 or 200 ppm paclobutrazol were also significantly higher than those in controls.

Concerning the changes in endogenous phytohormones due to treating cucumber plants with different growth regulators, It is clear from the obtained results that treating cucumber plants (cv. Beit Alpha) with some growth regulators before the inoculation with *S. fuliginea* or *P. cubensis* affected greatly on the endogenous phytohormones contents like GA, IAA, cytokinins and ABA. In this respect, treating cucumber plants (cv. Beit Alpha) with growth regulators decreased the Gibberellin contents (GA) in the healthy and infected cucumber leaves with either *S. fuliginea* or *P. cubensis* infection comparing with the check untreated plants. The highest reduction in GA contents in healthy and infected cucumber leaves was recorded with different concentrations of Cycocel treatment against powdery or downy mildew pathogens. Also, a great discrepancy was recorded in indole acetic acid (IAA) contents in leaves of cucumber due to treating them with different growth regulators comparing with the un-treated check plants. Moreover, treating cucumber plants with different concentrations of all growth regulators increased Cytokinins and Abscisic acid contents (ABA) in the healthy leaves of cucumber plants than those in the artificially infected with powdery or downy mildew compared with the untreated check. Also, Morphactin treatment was the highest in reducing ABA contents in cucumber leaves in case of powdery mildew infection. These obtained results could be interpret in light the findings of Morris *et al.*, (1973), Benz and Spring (1995) and Niktane and Talieva (2001) whom showed that increasing ABA and cytokinins as a result of infection in treated and untreated leaves may affect as follows: a) Cytokinins are involved in the green islands effect and play an important role in the prolongation of photosynthetic activity in infected leaves. b) ABA increase may reflect water loss, which in turn leads to alteration in either auxin metabolism or transport. The destruction of IAA in infected leaves is closely correlated with the calculated increase of IAA oxidase and its activity. Also, the physiological resistance of some plants to the diseases in relation to the endogenous phytohormones was

studied by many investigators. In this respect, Srivastava *et al.* (1962) indicated to the low content of auxin in brassica plants infected with Albugo, while Saxena (1983) found that Albugo-peronospora complex infection of *Eruca sativa* reduced indole-3-acetic acid (IAA) content and promoted the activity of IAA oxidase. On the other hand, El-Shanawani *et al.* (1990) mentioned that the healthy leaves of the resistant cucumber cultivar contained higher amount of cytokinins, GA and lower amount of ABA than the susceptible one, as well as, the infection with powdery mildew increased cytokinins and ABA meanwhile, it decreased GA and IAA in both susceptible and resistant cultivars. In addition, the malformed inflorescences in *Brassica juncea* and *B. campestris* varieties caused by *Albugo candida* showed lower levels of indole–3–acetic acid and higher level of gibberillic acid, zeatin and abscisic acid as compared with healthy inflorescences (Khangura and Sokhi, 1995).

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دور منظمات النمو فى تقليل الأصابه بمرضى البياض الدقيقى والزغبى على نباتات الخيار وعلاقتها بالهرمونات النباتية الداخلية

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أجرى هذا البحث بهدف تقليل استخدام المبيدات الفطريه ومنع التلوث البيئي وايجاد البدائل المناسبة لمقاومة مرضى البياض الدقيقى والزغبى على الخيار. حيث تم دراسة تأثير الرش بمعدلات منخفضة لبعض منظمات النمو النباتيـــة مثـــل الأثيفـــون، السيكوسيل، التيربال، المورفاكتين بغرض تقليل الأصابه وإعطاء حماية لنباتات الخيار ضد مرضى البياض الدقيقى والزغبى وعلاقة ذلـــك بالهرمونـــات النباتيـــة الطبيعيـــة الداخلية في النباتات.

وقد وجد عند معاملة نباتات الخيار بمنظمات النمو المختلفة أنها قللت من شدة الأصابه بكلا المرضين وبالتالى أعطت زيادة فى حماية أصناف الخيار المختبـــرة فـــي تجارب الأصص تحت ظروف الصوبه وكذلك فى تجارب الحقل فى مواسم الزراعـــة المختلفة (٢٠٠٣-٢٠٠٤). وقد أظهر المورفاكتين والأثيفون أعلى تـــأثير فـــى تقليـــل درجة الأصابه بكلا المرضين وأيضا إعطاء أعلى درجة حماية للنباتات. زادت درجـــة الحماية تدريجيا بزيادة تركيز منظمات النمو المستخدمة وكان أفضلها هو أعلى تركيز تم استخدامه لجميع منظمات النمو. ومن الناحية الأخرى فقد اختلفت أصـــناف الخيـــار تحت الدراسة فى استجابتها لمنظمات النمو المختبرة وكذلك لتركيزاتها المختلفة.

أيضا تم دراسة تأثيرا لرش بمنظمات النمو النباتية وعلاقة ذلك بالهرمونـــات النباتية الطبيعية في النباتات حيث ظهرت اختلافات واضحة فى المحتـــوى الهرمـــونى للنباتات المعاملة بمنظمات النمو المختلفة سواء كانت مصابة بالمرض أو سليمه مقارنة بالنباتات الغير معاملة. حيث أظهرت معاملة نباتات الخيار (صنف بيتا ألفا) بمنظمـــات النمو تأثيرا على المحتوى الهرمونى للنباتات المعاملة حيـــث قلـــل محتـــوى الأوراق السليمه أو المصابة بأى من المرضين من الجبريلينات مقارنة بالنباتات الغير معاملـــة بمنظمات النمو. وقد ظهر أعلى نقص فى محتـــوى الأوراق مـــن الجبريلينـــات عنـــد

المعاملة بالتركيزات المختلفة للسيكوسيل ضد كلا المرضين. . ظهر تناقض كبير فى محتوى أوراق نباتات الخيار من أندول حمض الخليك نتيجة ا لمعامله بمنظمات النمو النباتية المختبره مقارنة بمحتوى أوراق النباتات الغير معاملة. أظهرت معاملة نباتات الخيار بالتركيزات المختلفة من منظمات النمو زيادة واضحة فى محتوى الأوراق السليمة من السيتوكينينات وحمض الأبسيسيك عنها فى أوراق النباتات المصابه بأى من المرضين مقارنة بمحتوى أوراق النباتات الغير معاملة. وقد كان المورفاكتين هو الأعلى تأثيرا فى تقليل محتوى أوراق نباتات الخيار من حمض الأبسيسيك وذلك فى حالة الأصابه بالبياض الدقيقى.

يستنتج من هذا البحث أن استخدام منظمات النمو النباتية مثل الأثيفون، السيكوسيل، التيربال، المورفاكتين (المأمونة على الصحة العامة) بالتركيزات المنخفضة يفيد فى تقليل الأصابه بمرضى البياض الدقيقى والزغبى على نباتات الخيار تحت ظروف الصوبه أو الحقل كذلك زيادة الحماية عن طريق زيادة تحمل النباتات لتلك الأمراض.