Control of downy mildew disease on cucumber caused by the fungus *Psuedoperonospora cubensis* by using environmentally friendly materials

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Abstract

This study aimed to evaluate the efficacy of different agents in controlling downy mildew disease on *Cucumis sativus* L caused by Pseudoperonaspora cubensis using environmentally friendly treatments.The experiment was conducted in the field in Balad District / Salah al-Din province during the spring season 2020 under greenhouse conditions. The treatments included chemical agents with physical effect (casio3, k2sio3), plant extracts (garlic and neem) and biological control agents (T. harzianum and P. fluorescence) in a way. Solitary and successive in controlling the epidemiological infection of Downy mildew. The effect of treatments on the incidence and severity of disease and growth and production parameters of cucumber crop under greenhouse conditions compared to the fungicide Consento was evaluated. The results showed that the single and successive treatments with silicates prevented the disease completely, with an infection rate of 0.00%. This was followed by the highest reduction in the incidence and severity of infection in the garlic extract and fungicide treatments, which did not differ between them, followed by the treatment of garlic extract with a significant difference and the treatment of biological bacteria at a rate of 10.81% for each, then the treatment of successive spraying with biological control agents, which did not differ from the rate of infection rate in the treatment of the biological fungus T. harzianum compared with the highest rate of infection in the untreated infected control treatment (72.95%), which differed significantly from All treatments.The highest reduction in the severity of infection was recorded in the treatment of the fungicide Consento, which reduced the severity of infection to 1%, followed by the treatment of neem with a significant difference and severity of infection 12.47% and then significantly different from all other treatments under study. In general, all treatments significantly reduced the severity of the infection from what it is in the control treatment (71.12%). In the pesticide treatment (1637.6 g) (843.3) g.

Keywords: Downy mildew, cucumber, Trichederma, Pseudomonas, Cosento

مكافحة مرض البياض الزغبي على الخيار المتسبب عن شبه الفطر ***Psuedoperonospora cubensis*** باستعمال مواد صديقة للبيئة

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المستخلص

هدفت هذه الدراسة الى تقييم كفاءة عوامل مختلفة في السيطرة على مرض البياض الزغبي على الخيار *Cucumis sativus* L المتسبب عن *Pseudoperonaspora cubensis* باستخدام معاملات صديقة للبيئة. تم تنفيذ التجربة حقلياً في قضاء بلد/ محافظة صلاح الدين خلال الموسم الربيعي 2020 تحت ظروف البيت البلاستيكي وتضمنت المعاملات عوامل كيمايئية ذات تاثير

فيزيائي(k2sio , 3casio3) مستخلصات نباتية (الثوم والنيم) وعوامل مكافحة احيائية (*T. harzianum* و *P. fluorescence*) بشكل انفرادي ومتعاقب في السيطرة على الإصابة الوبائية بمرض البياض الزغبي. تم تقييم تاثير المعاملات في نسبة وشدة الإصابة بالمرض ومعايير النمو والانتاج لمحصول الخيار تحت ظروف البيت البلاستيكي مقارنة بالمبيد الفطري Consento. بينت النتائج ان المعاملات المفردة والمتعاقبة بالسيليكات قد منعت الإصابة بالمرض نهائيا و بمعدل نسبة إصابة بلغ 0.00%. ويتبعها اعلى خفض في نسبة وشدة الإصابة في معاملتي مستخلص الثوم و المبيد الفطري اللذان لم يختلفان فيما بينهما تلتهما في ذلك وباختلتف معنوي معاملة مستخلص الثوم و معاملة البكتيريا الاحيائية بمعدل 10.81% لكل منهما ثم معاملة الرش المتعاقب بعوامل المكافحة الاحيائية والتي لم تختلف عن معدل نسبة الاصابة في معاملة الفطر الاحيائي *T. harzianum* بالمقارنة مع أعلى معدل لنسبة الإصابة في معاملة السيطرة المصابة غير المعاملة (72.95%) والذي اختلف معنويا عن جميع المعاملات. اعلى خفض في شدة الإصابة تم تسجيله في معاملة المبيد الفطري Consento التي خفضت شدة الاصابة الى 1% تلتها معاملة النيم وبفرق معنوي وبشدة اصابة 12.47% ثم وباختلاف معنويا عن جميع المعاملات الاخرى قيد الدراسة. عموما ادت جميع المعاملات الى خفض شدة الاصابة معنويا عن ما هو عليه في معاملة المقارنة (71.12%). في معاملة المبيد (1637.6 غم) (843.3) غم .

الكلمات المفتاحية: البياض الزغبي, الخيار, **Trichederma , Pseudomonas , Cosento**

Introduction

Cucumber is the most important crop of the Cucurbitaceae family in Iraq and the world, and it is grown in Iraq in large areas in open cultivation and in protected environments such as greenhouses. The area cultivated with this crop in Iraq for the winter season reached 14531 dunums, with a production average of 3214 kg/dunum. The downy mildew disease caused by Pseudoperonospora cubensis is one of the most widespread and deadly diseases in cucumber plants grown under protected conditions (1 and 2). Providing appropriate environmental conditions accelerates the development of downy mildew on cucumbers in a short period (3). It causes losses in protected agriculture from 30 to 80% (4 and 2). Although it is possible to combat downy mildew disease by using chemical pesticides, the use of these pesticides continuously and in large quantities exacerbates the problem of environmental pollution on the one hand and leads to the emergence of resistant strains on the other another (5).Biological control methods for powdery mildew and downy mildew in protected crops have been successful using bacterial and fungal biological agents (6). The fungus *Trichoderma harzianum* is one of the most important fungal biological resistance factors that has proven successful against a number of pathogens on plants, especially the strain T. harzianum T39, which led to a reduction in its treatment as a spray or as a soil treatment (7) T. harzianum also proved effective against the cause of downy mildew on cucumbers P.cubensis under greenhouse conditions.The bacteria Pseudomonas sp. One of the most successful factors in combating fungal and bacterial pathogens, which inhibits spore germination and impedes the growth of germination tubes and mycelium (8).A number of studies have indicated the possibility of using Pseudomonas fluorescens with high efficiency in controlling powdery and downy mildew on cucumbers grown under protected conditions (9, 10 and 11).on the other hand, the use of plant extracts in plant disease control programs is considered one of the environmentally friendly and effective methods that are acceptable, especially in sustainable farming patterns in developing countries and countries with low resources.On this basis, attention was paid to the extract of the neem plant, neem oil and its other components that were produced on a commercial level, especially in countries where neem cultivation thrives. Garlic extract, *Allium sativum*, has also demonstrated a high efficiency in resisting plant diseases, and this efficiency is due to the effectiveness of its active substance, allicin, in the laboratory and in the field against many bacterial and fungal pathogens on the plant (12) and it has recently proven the

possibility of using silica salts as a spray treatment on the vegetative system or a soil treatment, not only as plant nutrients and stimulating growth and increasing production, but also as inducing materials for plant resistance against a wide range of plant pathogens (13).In view of the lack of studies conducted in Iraq on the use of safe substances in the control of downy mildew disease on cucumbers with the aim of providing effective and safe alternatives to the dangerous, prohibited and long-staying pesticides currently used.This study was conducted to evaluate the possibility of using a combination of natural plant nutrients with some fungal and bacterial vital factors and the organic extract of both neem and garlic plants and employing the promising inputs from them in an integrated program to manage this disease of great economic and health importance.Therefore, the research aimed to study the effect of potassium and calcium silicate salts, Trichoderma harzianum, Pseudomonas fluorescens, neem plant extract and garlic oil extract individually or sequentially and compared them with the pesticide Concento on the germination and growth of pathogenic fungi under greenhouse conditions.

Materials and methods

The experiment was conducted in one of the private farms in Balad District / Salah al-Din province for the period from 1/2/2020 to 15/6/2020 in a plastic house 51 meters long and 9 meters wide. 5% formalin solution.It was covered immediately after spraying with transparent nylon, 80 microns thick, 35 meters long, and 10 meters wide, where the ends of the nylon were tightly buried. After 10 days, the nylon cover was lifted and the soil was left for seven days before planting. *Cucomis sativus* (Sayff F1) cucumber seeds were used, with a germination rate of 95% and purity of 99%, produced by the German company Bayer. The greenhouse has been prepared for cultivation after completing the sterilization process during the 2020 season.Where the iron structure was covered with transparent nylon with a thickness of 200 microns, a distance of 90 cm was left from both sides of the plastic house, and five planting lines were identified at a distance of 80 cm between one line and another, and the width of one line was 80 cm.. The seedlings were planted with a distance of 40 cm between one plant and another within the same line, and the experimental transactions were randomly distributed within one replicate, with three replications for each treatment, according to the Randomized Complete Block Design (RCBD) with 15 plants per experimental unit, leaving a distance of 1 m between one treatment and another. All crop service operations were carried out according to the recommendations of the cucumber crop in Iraq (Agricultural Bulletin 2017).The experiment included testing the effect of single or successive spraying of three chemical agents with physical effect, including Leafdrip sil 21 potassium silicate solution from (FRARMPEX) French company and Silicato de calico solution from (Cosmocel) Mexican company. Plant extracts represented by neem seed extract (neem seed oil) at a concentration of 5% and garlic bulb extract by the same concentration.

Environmentally friendly treatments used in research:

The experiment includes the use of Biocont fertilizer containing T. harzianum (19 * 107 spores / 1 g) of *T. harzianum* as a seed treatment before planting and a spraying treatment on the vegetative group during the growing season at a rate of 2.5 g / L.and the commercially produced P. fluorescens Bactvipe (International Panacea LTD) containing (2 * 108 CFU/ml) with the same treatment and method with the fungus. A potassium silicate solution obtained as an imported product under the trade name Leafdrip sil 21 from the French company (FRARMPEX) was used as a spray on the plant at a rate of 75 ml / L.Whereas, the obtained calcium silicate solution was used as an imported product under

the trade name Silicato de calico from the Mexican company (Cosmocel). As for the treatments of plant extracts (neem and garlic), they were prepared locally using a special pressing machine for this purpose, as they were used as a spray on the vegetative total at a concentration of 5%.The pesticide Consento SC 450 (Bayer Co.) containing Propamocarp hydrochloride 375g/L and Fenamidone 75g/L was used as a positive comparison treatment in addition to the negative comparison treatment (spraying with distilled water).

Results and discussion :

4.1 Diagnosis of the pathogen:

The pathogen that causes downy mildew on cucumbers was diagnosed with the help of Prof. Abdullah Abdul-Karim in the Laboratory of Advanced Plant Diseases - Plant Protection Department / College of Agriculture - Tikrit University based on the taxonomic key (15) The effect of different treatments on the percentage of infestation of cucumber plants with downy mildew under greenhouse conditions:

The results in Table (1) showed that all the treatments under study were significantly different in the percentage of infection from the untreated infected control treatment. It also showed that treatment with potassium silicate or calcium silicate, single or successively among them, led to the prevention of disease completely, with an infection rate of (0.00%). The lowest infection rate was recorded in plants treated with neem extract, followed by the treatment of the fungicide Consento, without significant difference. In general, all treatments led to a significant reduction in the infection average compared to the untreated infected control treatment, 72.95%. It is noted that the treatment of successive spraying with the two biological control agents was more efficient in reducing the percentage of infection (13.00%) compared to the treatment of the biological fungus T. harzianum 17.14% with a significant difference between them, but at the same time it was less efficient compared to the treatment with the biological control bacteria P. fluorescence which recorded 10 .81%. This indicates the existence of a conflict between the activities of the two bio-resistance factors.The results (Table 1) show that the highest infection rate was recorded in the second week, with an average of 16.72%, while the lowest rate of infection was recorded in the seventh (last) week, at a rate of 11.34%, with a significant difference. The last week also recorded the highest average of infection in the positive control treatment. which amounted to 99.67%.with regard to the interaction between the different treatments under study and the time periods during which the development of infection was followed up, it is noted that the highest rate of infection rate (25.00%) was recorded in the first week on plants successively treated with the biological resistance fungus T. harzianum and the biological resistance bacteria *P. fluorescens* and that The lowest average(0.67%) was recorded in the sixth week on plants treated with the fungicide Consento, if we exclude the treatments of single and successive spraying with silicates that prevented infection completely over the seven weeks of the study. As for the normal development of the percentage of infection with the pathogenic fungus P.cubensis, which can be assessed by following the development of the disease in the control treatment (infected and untreated), the disease recorded an increase in the infection rate over the seven weeks of the study, except for the fifth week, which recorded 72.95% A significant decrease from the infection rate in the fourth week, 79.00%. to develop

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Table (1): The effect of different treatments on the percentage of infection of cucumber plants with downy mildew disease caused by P.cubensis under greenhouse conditions

Treatments	weeks							
	first week	second week	third week	fourth week	fifth week	sixth week	Seventh week	average
K2SiO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaSiO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KSiO3/CaSiO 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neem	21.00	18.33	10.33	4.72	9.15	2.8	1.6	6.38
Garlic	20.67	19.00	13.67	12.33	11.25	4.2	2.2	10.81
Neem/Garlic	23.67	20.00	16.00	11.67	13.28	5.7	3.33	10.86
T.h	24.00	22.00	18.00	17.67	17.14	13.33	11.00	17.14
P.fluo	22.67	19.33	15.00	8.67	10.81	3.67	2.33	10.81
T.h/P. flu.	25.00	21.67	14.67	10.33	13.00	5.00	3.33	13.00
Consento	22.00	20.00	9.00	2.00	7.95	0.67	1.33	7.95
control treatment	24.00	43.67	72.33	79.00	72.95	99.00	99.67	72.95
average	16.63	16.72	15.36	13.30	14.13	12.21	11.34	16.63
L.S.D.(P≤0.05)	Interaction=5.193		Weeks=1.566		Treatments=1.963			

The disease in this treatment was significantly different between all weeks of the study, except for the last week (seventh), which recorded an average infection rate of 99.99%, with a slight difference from the sixth week (99%).

The effect of different treatments on the severity of infection of cucumber plants with downy mildew disease caused by P.cubensis under greenhouse conditions:

The results in Table (2) showed that all treatments were significantly different in the percentage of infection severity from the comparison treatment. Treatments of potassium silicate and calcium silicate alone or successively led to complete prevention of infection. For the rest of the treatments, the lowest rate of infection severity was recorded in Consento (9.51%) treatment, followed by a significant difference with the neem extract (12.47%)and if we exclude the untreated infected control treatment, which recorded 71.12%, the highest rate of infection severity among the treatments was in the treatment of the live fungus T. harzianum, which amounted to 16.32%. It is also noted from the table that the treatment of successive spraying with the two biological control agents was more efficient in

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reducing the percentage rate of infection severity as it recorded 13.00% compared to the treatment of the biological fungus T. harzianum alone with 16.32% and a significant difference between them, but at the same time it was less efficient compared to the treatment with the control bacteria The biological P. fluorescence alone recorded a higher infection severity rate of 14.37%.This indicates the negative impact of the presence of the aforementioned fungus on the performance of bacteria for this purpose. When comparing the weeks of the experiment, it turns out that the highest rate of infection severity was recorded in the first week, with a rate of 22.8%.As for the lowest average infection rate, it was recorded in the seventh (last) week, at a rate of 11.7%, with a highly significant difference between them, while this week recorded the highest average of development of the percentage of infection severity in the treatment of the untreated infected control, reaching 95.00%.With regard to the interaction between the different treatments and the time periods to follow the development of infection, it is noted that the highest rate of infection severity (34.7%) was recorded in the first week on plants treated with neem extract, and the lowest average (0.72%) was in the seventh week on plants treated with the fungicide Consento ,we exclude the treatments single and successive spraying with silicates prevented infection completely over the seven weeks of the study.In general, the disease recorded a clear escalation in the severity of infection over the seven weeks of the study, with the exception of the fifth week (62.00%), which recorded a significant decrease from the infection rate in the fourth week of 81.70%. It is noted from the results of the rate and severity of infection that the successive spraying treatments with the biological control agents were relatively more efficient in reducing the severity of the infection than it is in the treatment of the biological fungus T. harzianum and without a significant difference, but at the same time it was almost equal and slightly lower than the efficiency of the control bacteria

Biological P. fluorescence to reduce the severity of infection. This may be due to the existence of a conflict in the activity of both biological fungi and biological bacteria when they are present together in the same place. It was concluded (16) that the bio-resistors T. harzianum and P. fluorescence produce many enzymes such as (4 glucanase, 3 glucanase B-1, B-1), and that some P. fluorescence isolates produce secondary metabolites such as 2,4 -Diacetyl(2,4-DAPG) This compound is responsible for the antifungal properties of some. In another study, between (17) that the bacteria Pseudomonas sp. They had a synergistic effect with *T. harzianum* in reducing the incidence and severity of urticaria on rice, while they had an antagonistic effect on Bacterial leaf blight. The antibacterial effect of Pseudomonas fluorescence against *Trichoderma harzianum* was confirmed in the laboratory, where the study showed that the bacteria had an inhibitory effect on the fungus on food media, as the percentage of inhibition ranged 8.59% when the medium was inoculated with the fungus first and then the bacteria after 24 hours, while the percentage of The inhibition was 59.44% when the inoculation process was reversed (18).It was also observed that the neem extract was relatively more efficient in reducing the severity of the infection and the rate of infection compared to garlic extract and the successive spraying treatment with them. The positive effect of the neem plant extract is due to the presence of its active substance, Azadirachtin, in addition to the sulfur element between (19). Sulfur and Azadirachtin are among the most active substances of this extract. Similar results were reported from (20) to the fact that neem extract was more efficient as a fungicide rather than a bacterial, and that the active substances (azadirachtin, nimbin and salanin) had no antibacterial effect on Bacillus mycoides. While it had a fungistatic effect against the causative agent of black sheath disease (Take all) on wheat caused by

Gaeumannomyces graminis, it also reduced the germination of conidia causing powdery mildew on cucurbits Sphaerotheca (Podosphaera) fuliginea by 11%.On the other hand, the efficiency of garlic extract was relatively low in reducing infestation and spore germination causing downy mildew on Plasmopara viticola grapes compared to the Bordeaux mixture and the standard pesticide Mancozep (21). The neem extract was also more effective than garlic extract in reducing the incidence and severity of early and late leaf spot disease on field pistachios caused by *Cercospora arachidicola* (22). This may be due to the neem extract maintaining its efficacy as a single treatment due to the continuous weekly enhancement of its concentration as it is one of the environmentally friendly phytochemicals with a quick effect and at the same time fast degrading after 14 days of treatment (23).Thus, the treatment of garlic extract in the following week in the successive spraying treatment may have reduced the effectiveness of the active neem residues from the previous week, or the effectiveness of the neem extract decreased due to the decomposition of the remaining active substances due to weather conditions or were consumed by the plant.

Table (2): The effect of different treatments on the percentage of infection severity of cucumber plants with downy mildew caused by P.cubensis under greenhouse conditions:

Treatments	weeks							
	first week	second week	third week	fourth week	fifth week	sixth week	Seventh week	average
K2SiO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaSiO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KSiO3/CaSiO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neem	34.7	26	14	3.3	8.7	2.7	1.2	12.94
Garlic	24	18	22	11.3	16.7	11.3	5.7	15.57
Neem/Garlic	28	16.7	15.7	13.3	13.3	9.3	5.3	14.51
T.h	32.42	16.33	18.3	14.82	12.7	12	7.7	16.32
P.fluo	37	20	14.3	8.3	9	6	6	14.37
T.h/P. flu.	26.7	20.3	15.7	14.3	14.3	12	7.4	15.81
Consento	29.3	15.2	9	6.5	3.66	2.2	0.72	9.51
control treatment	38.3	64	72.22	81.7	62.3	84.3	95	71.12
average	22.8	17.9	16.5	14.0	12.8	12.7	11.7	
L.S.D.(P≤0.05)	17.1	14.4	19.2	23.6	28.3	29.4	24.6	
L.S.D.(P≤0.05)	Interaction=5.193		Weeks=**6.421**		**Treatments=7.853**			

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Indicators of growth and yield

With regard to the effect of different treatments on plant height, the results showed that the highest plant height was recorded in the chemical pesticide Consento SC 450 (157.6 cm), which did not differ significantly from the single or successive treatments of potassium silicate and calcium silicate, in which the average plant height ranged from 155.3 - 157.4 cm, which in turn differed significantly from the average plant height in the other treatments.The rates of plant heights were close in the successive spraying treatments with biological control agents (T.harzianum and P.fluoresence), which ranged between 145.3 and 148.6 cm, respectively, which in turn did not differ from the single or successive treatments of neem and garlic, which had plant lengths between 145 and 148 cm. Also, the latter differed slightly from the control treatment (spraying with water only), which recorded the lowest rate (143.33 cm). As for the fresh weight of the vegetative group , the highest average was in the treatment of Consento SC 450, which amounted to 437 g, with a significant difference from the nearest fresh weight in the treatment of calcium silicate 405 g, which in turn did not differ from most of the other treatments, which ranged between 401 g - 396 g, and with a slight difference For T. harizianum single treatment, which differed significantly from the control treatment with the lowest average of 302 gm (Fig. 3). All treatments differed with a significant increase from the control treatment, which recorded the lowest dry weight of the vegetative growth, which was 54.4 g. The highest average dry weight of the vegetative (77.9 g) was recorded in the chemical pesticide treatment, followed by the single and successive calcium silicate and potassium silicate treatments that did not differ from the single and successive treatment of garlic and neem and the treatment with the biological resistance bacteria P.fluoresence, but at the same time it differed significantly from the treatment of the biological resistance fungus T.harzianum, which recorded 66.5 g, while the average dry weight of the vegetative total of the other treatments ranged between 69.5 and 72.23 g.

Table (3). Effect of different treatments on vegetative growth indicators and yield (number and weight of fruits of three harvests) of cucumber plants grown in greenhouse conditions.

Treatments	The yield of three harvests		Vegetative weight (g)		plant length (cm)
	Yield weight (g)	fruits number	Dry	Fresh	
K2SiO3	1581.33	21.60	70.97	398.67	156.67
CaSiO3	1502.00	20.00	72.23	405.00	157.43
KSiO3/CaSiO3	1484.00	20.33	71.33	398.33	155.33
Neem	1413.00	19.33	70.80	395.67	145.00
Garlic	1505.33	20.60	72.23	401.00	146.00
Neem/Garlic	1493.00	20.33	69.50	393.40	148.00
T.h	1450.00	21.00	66.50	370.67	145.33
P.fluo	1451.67	19.67	70.87	395.00	146.33
T.h/P. fluo.	1565.67	21.33	70.83	396.00	148.67
Fungicide	1637.67	22.33	77.90	437.00	157.67
Control	843.33	15.33	54.40	302.00	143.33

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When comparing the effect of different treatments on the average number of cucumber fruits for three crops, the results (Table 3) showed that the highest rate of the number of fruits was in the pesticide treatment (22.33 fruits/plant), which did not differ from potassium silicate (21.60 fruits/plant) and successive spraying of T.harizianum factors. and P.fluorescens (21.33 fruits/plant) The treatment of T.harizianum (21 fruits/plant) was equal with the average number of fruits in most of the other treatments, which ranged between 19.33 fruits/plant in the single neem treatment and 20.60 in the single garlic treatment, which differed significantly from the lowest average number of fruits in the control treatment, which amounted to 15.33 fruits. / plants .As for the weight of the cucumber yield, the highest mean yield of the plant was for three crops in the Consento SC 450 treatment (1637.6 g), which did not differ from the treatment of single or successive potassium silicate with calcium silicate (1581.3 g) and the successive treatment of biological control agents (1565.6 g), with a very slight difference. About garlic treatment Calcium silicate single, whose yield weight reached 1505.3 g and 1502 g, respectively, while all other treatments were less and without significant difference, and the weights of yield for three pions ranged between 1413 g in the treatment of neem and 1493 g in the treatment of successive spraying of biological resistance factors and that all treatments It differed significantly from the control treatment treated with water only, which recorded the lowest average yield weight of 843.3 g. The results of the study showed that the single or successive physical treatment (vegetative spraying) with potassium silicate and calcium silicate did not record any infection with the disease when treating plants early before the onset of infection. This may be due to the ability of silicate salts to increase the mechanical strength of the plant in general, especially for the outer protective layers (24 and 25). Complex compounds in the epidermal cell layer and cell walls. The presence of such protective layers inhibits the penetration of pathogens and makes plant cells less sensitive to the degrading enzymes secreted by pathogenic fungi (13).The noticeable decrease in infection in plants treated with silicates may also be due to the role of these compounds in stimulating plant resistance against pathogenic fungi (26). (27) indicates that the silicate salts stimulated the physiological and biochemical resistance of the cucumber plant against fusarium wilt on the cucumber caused by the fungus Fusarium f.sp.cucumereinum. The addition of silicon to cucumber plants also reduced the incidence of powdery mildew caused by the fungus Spharotheca sp. and Podosphaera sp (28). On the other hand, the noticeable improvement in growth indicators and yield of cucumber plants treated with silicates under experiment is due not only to the role of silicates in reducing the infection of pathogenic fungi, but also to its role in enhancing growth and production in general (29).As for the effect of the neem extract in the fight against the pathogen P. cubensis, this effect is mostly due to the effect of the active substance of neem, Azadirachtin, which has anti-bacterial and anti-microbial properties (30).This is consistent with the results of previous studies on the effect of neem extract and neem oil at low concentrations on fungal pathogens (31). The efficacy of neem leaf extract has also been confirmed against many pathogens of fungal and bacterial diseases on bananas (32), powdery mildew on cucumbers (33) and downy mildew on sunflowers (34). The use of garlic extract as a spray on the shoot reduced the incidence and severity of downy mildew on cucumber with an efficiency comparable to that of using the fungicide Consento SC 450. The results agreed with what was found by (35) that 50 micrograms ml^{-1} of allicin present in garlic juice was sufficient to inhibit Spore and sporangia germination and subsequent germ tube growth in Phytophthora infestans in vitro and on leaf surface in the field and led to reducing the severity of the disease in

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tomato seedlings infected with *P.infestans* by 45-100% by spraying the leaves with garlic juice containing allicin at a concentration of 55-110 µg/ml. Similarly, in growth chamber experiments using concentrations of 50-1000 µg ml^{-1} allicin in garlic juice reduced the intensity of downy whiteness of cucumber caused by P.cubensis by about 50-100%. Garlic extract was effective against downy mildew on grapes, and it reduced the severity of the infection in the field and the rate of sporangium germination in the laboratory, which increased with increasing exposure period (21).The results of the study agreed with previous studies that treating plants with garlic cloves extract increases the vegetative growth indicators of the plant, develops root growth, encourages and increases nutrients, especially microelements, and this increases the plant's strength in general and reduces the severity of vegetative diseases (36). Generally, this effect is attributed to the volatile allicin (S-allyl-l-cysteine sulphoxide) that is produced in garlic when tissues are damaged and the allicin base (S-allyl-l-cysteine sulphoxide) mixes with the enzyme (alliin-lyase E.C.4.4.1.4). Allicin enters thiol-disulfide exchange reactions with free thiol groups in proteins that are believed to be the basis of the antimicrobial effect. The results of the research showed the efficiency of the bacteria P. fluorescence in reducing the incidence and severity of downy mildew infection on cucumber, almost equal to those results that appeared using garlic and neem extracts, but it is higher than the efficiency of the biological fungus T. harzianum on the other hand, treatment with biological bacteria in most cases led to the promotion of plant growth and increase in the indicators of cucumber yield. P. fluorescens preparations have been used on the shoot and seed treatment to increase the germination rate, reduce infection with many diseases and induce plant resistance to many pathogens (37). A previous study showed that testing the synergistic effect of *P. fluorescence* bacteria and *T. harzianum* on growth indicators and the plant content of active and defensive enzymes in cowpea plants. The results showed that different treatments had different effects on the indicators under study, so it was the treatment of the total interaction of animal manure + bacteria + The biological fungus with the highest effect on increasing the vegetative growth indicators compared to other treatments, followed by the treatment of animal manure, then the biological mushrooms on some indicators, and then bacteria (38).The results of the same study with regard to measuring the plant content of active and defensive enzymes also showed that bacteria in the presence of animal manure led to the highest values of plant contents of peroxidase and poly-phenol oxidase, while the highest value of catalase was in Single fertilizer treatment (38).another study also showed that using *P.fluorescence* efficiently against the fungus Pythium spp. In combating the death of tomato seedlings compared to the fungicide (39). Similar results showed that Pseudomonas can be a treatment for the control of downy mildew by treating seeds or spraying on the vegetative growth, but its efficiency in the control increased significantly when used together, that is, seed treatment and then spraying plants at an early age after emergence (40), The results agree with what was found (41) and (42) that the bio-resistance fungus *T. harzianum* was efficient in protecting plants and combating many diseases of the vegetative growth, and (43) that treatment with *T. harzianum* as a spray on the shoot led to a significant reduction in infection in white Peronospora antirrhini on the flowers of the seven throats (fish mouth). A previous study in testing the biological resistance factors Bacillus subtilis, Psuedomonas phloycenes, Derxia gummosa and T. harzianum in controlling downy and powdery mildew on cucumber under greenhouse conditions showed that spraying plants with the above agents reduced the severity of both diseases and increased the yield per plant compared to the control treatment. (44).

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