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THE EFFECT VENTILATION ON THE RATE OF DOWNY MILDEW INFECTION AND THE RESIDUES OF ELITE FUNGICIDE ON CUCUMBER CULTIVATED IN GREENHOUSE.

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ABSTRACT

The study was conducted at the Dujail region, north of Baghdad, during the spring season of 2022, to identify the rate of downy mildew infection and the residues of Elite (fungicide) on the cucumber cultivated in the regular greenhouses compared to the greenhouse with three ventilation openings. The regular greenhouse was sprayed with Elite pesticide, twice; the 1st treatment sprays was after 7 days of infection onset, and the 2nd spray was 30 days after the 1st treatment. The residuals of Elite were, then, estimated. In regards to the 2nd greenhouse, three ventilation openings were made after the first observation of the disease. The average temperature and a relative humidity (8˚C and 97%, respectively) were reported from the onset of the downy mildew infection on the cucumber. After 2 months, the average of the infection percentage was reported in the regular greenhouse was 1.95%, with a significant difference from the average of percentage the infection in the house of three ventilation openings, which was 1.28%. The average of the Elite residues after three days of spraying was 50, 40 and 28 mg/kg of the cucumber varieties; Mustaqbal, Jamila and Faris, respectively. On the 7th day of spraying, the average of the Eilit residue was 11mg/kg of the three cucumber varieties. The total production rate of cucumber fruits at the regular greenhouse was 1800 kg, for five times harvest, while it was 3000 kg at the greenhouse with three ventilation openings. The authors concluded that the performance of three ventilation holes into the greenhouse at the time infection onset considered a natural control strategy on the downy mildew disease of cucumber. while in the regular greenhouse sprayed with Elite fungicide, the cucumber crop can be harvested after 3d of spraying, when Elite residues were below the allowable limit (60 mg / kg of cucumber fruits).

Key words: powdery mildew, Elite residues, Ventilation openings, Greenhouse, The infection.

[*] **The article is taken from the master's thesis of the first researcher.**

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تاثير عملية تهوية البيت البلاستيكي في معدل نسبة اصابة نباتات الخيار بمرض البياض الزغبي ومتبقيات مبيد ايليت في الثمار.

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الخلاصة

اجريت الدراسة في منطقة الدجيل شمال بغداد للموسم الربيعي لعام 2022 بهدف المقارنة بين معدل نسبة الاصابة بمرض البياض الزغبي ومتبقيات مبيد الايليت في نوعين من البيوت البلاستيكية، البيت البلاستيكي الاعتيادي والبيت البلاستيكي ذو ثلاث فتحات تهويه. تم رش البيت البلاستيكي الاعتيادي بمبيد ايليت رشتين الاولى رشة علاجية بعد 7 ايام من ظهور المرض والرشة الثانية بعد 30 يوما من الرشة الاولى وفيها تم تقدير بقايا المبيد ايليت. اما البيت الثاني فتم عمل ثلاث فتحات تهويه بعد اول تسجيل للمرض. رافق تسجيل مرض البياض الزغبي على نباتات الخيار تسجيل معدل درجات الحرارة التي بلغت 8مْ والرطوبة النسبية بلغت 97%،بعد شهرين من بداية الاصابة بلغ معدل نسبة الاصابة في البيت الاعتيادي 1,95% وباختلاف معنوي عن معدل نسبة الاصابة في البيت ذو ثلاث فتحات تهويه اذ سجلت 1,28% . بلغ معدل متبقيات مبيد الايليت بعد ثلاثة ايام من الرش 50و40 و28ملغم/كغم في الاصناف مستقبل وجميله وفارس على التتابع وفي اليوم السابع من الرش بلغ معدل متبقيات المبيد 11ملغم/كغم من الثمار في الاصناف الثلاثة . بلغ اجمالي معدل انتاج ثمار الخيار لخمس جنيات في البيت البلاستيكي الاعتيادي هو 1800 كغم في حين سجل 3000كغم في البيت البلاستيكي ذو ثلاث فتحات تهويه. نستنتج من هذه الدراسة ان عمل ثلاث فتحات تهويه في البيت البلاستيكي بمجرد ظهور المرض على النباتات ممكن ان تكون معاملة مكافحه طبيعية لمرض البياض الزغبي اما في البيت البلاستيكي الاعتيادي الذي كوفح في المرض برش مبيد ايليت فيمكن جني المحصول بعد ثلاثة ايام من الرش لوصول متبقيات مبيد ايليت دون الحد المسموح به وهو 60 ملغم /كغم من ثمار الخيار.

الكلمات المفتاحية: البياض الزغبي ،متبقيات المبيدات ،فتحات التهوية ،البيت البلاستيكي ،نسبة الاصابة.

INTRODUCTION

A cucumber (*Cucumbis sativus* L.) is one of the important crops that is widely cultivated in the opened and protected (greenhouses) fields around the world. It belongs to the Cucurbitaceae (**AL-Rakabi & Hussian 2006; Abdul-Karim, 2021**). Cucumber is grown in Iraq in two seasons; spring and autumn. It is considered one of the important greenhouse cultivation crops (**Abdul Razzaq, 2017).** Cucumber is used to control the nervous disorders, headaches relieve and as detoxicant agent. It also maintains skin health and reduces blood pressure (**AL-Azzawi & AL-Ibadi, 2017; Kareem *et al*., 2020).** The quantity and quality of cucumber crop cultivated in the open and greenhouse, are affected by infection with the pathogenic microbes, including; fungi, bacteria, and viruses, an eventually, the produced crops are uneconomic (**Othman & Kakey, 2020; Hateem & Khazal, 2020**). According to the publications, the downy mildew is an important infection of the cucumber crop caused by *Pseudoperonospora cubensis*, a pathogenic fungi of cucumber at different ages, especially at the production stage. The infection is associated with the huge economic losses, when the infection rate in greenhouse ranges from 30 to 80% **(EL-Nagga &Abd EL-Tawab., 2012; Abdul-Karim, 2021)**. It was noticed that the incidence of downy mildew infection of cucumber reaches 30.81%, when appropriate conditions are available, as the natural climate conditions of Iraq (**Khudhair & Aljarah, 2023**). The intensive chemical control operations, which may reach to several sprays to prevent various economically important pests and diseases , enhanced the emergence of pesticide-resistant strains. Therefore, it was urgent to find appropriate pesticides (**Al-Dahwi *at al,* 2005).** The pesticide residues is defined as any compound or mixture of chemical compounds existed in the food or feed due to prior use of a pesticide, including the derivatives resulting from the decomposition processes or the reaction

products of these ingredients (**Book, 2014**). To protect the cucumber crop, several fungicides are used frequently, including Elite (the active ingredient is Fosetyl–Aluminum 80%). Such ingredients causing a pollution of the crop, in addition to the harmful side effect on the human health and environment, due to the overlapping of the crop harvest (two days) with the pesticide-spraying. Despite of the protective effect of using of pesticides to control plant diseases (including downy mildew), their residues on the fruits is problematic issue. In cucumber fruits, the safety period ranges from 5-7 days. Elite pesticide is consider as a treatment controlling the symptoms of downy mildew caused by *Pseudoperonospora cubensis* which is capable of continuously developing resistance to the chemical pesticides (**Purohit *et al*., 2019; Liu *et al*., 2022**). According to the company's instructions, the permissible quantity of the pesticide residues on the cucumber fruits is 60 mg/kg, and the safety period of the pesticide is 5 days National Committee of Pesticides Registration & Approval 2017-2022(NCPRA). The mechanism of pesticide action is inhibiting of microbial growth and preventing the growth of fungal mycelium It is easily absorbed by the leaves and competed with the phosphates exists in the plant as an allosteric regulator of many enzymes (**Pandey *et al*. 2017). Sun *et al*. (2022)** indicated that the pesticide stimulates (directly or indirectly) the production of proteins-associated infection, leading to induction of plant defense mechanisms against fungal or bacterial pathogens, can induce resistance through many mechanisms including the increase in the formation of some compounds, including terpenoids and phenols (**AL. Awabid & Yass 2023; Mousa &Hassan 2023).** The QUECHERS method was followed to estimate the residues of pesticide on the treated fruits or plants. This is a new method used for analyzing and identifying pesticide residues in plants. The name of this method is an abbreviation of several words: Quick, Easy to apply, Cheap, Effective, accurate results (Rugged), and Safe. This method characterized by (i) the pesticide recovery rate is more than 85%, (ii) a 10-20 samples can be completed within 30-40 minutes with (iii) very little amounts of solvents and harmful ingredients are used (iv) without using of chlorinated solvents , (v) this method does not need a large space, the work can be done in a mobile laboratory with use of simple laboratory tools, (vi) the consistency of the results and (vii) the analysis can also be done by one person only, in addition to (viii) the low level of exposure to pesticides. This study aimed to shed the light on effect of the natural alternative strategy, the ventilation of greenhouse, to control the negative effects of pesticide residues and the incidence of downy mildew infection of the cucumber fruits, in comparison to the regular green house (without ventilation), before and after treatment, using the QUECHERS method.

MATERIALS AND METHODS

The recommended dose of using pesticide is 200-250 g/100 liters that manufactured by the Spanish company (Proplan). Two greenhouses, 56 m length, 9 m width, and 3 m high, were planted on January 10th, 2022 at the Dujail, north of Baghdad, with three registered varieties of cucumber crops; Mostaqbal, Jamila, and Faris, which are hybrid varieties. The Mostaqbal was produced by Dr. Enad Dhaher Abood (an Iraqi product), Jamila belongs to the American company (US Agresed), while Faris is a Germany product. Each greenhouse was divided into three sectors, each sector contains five double terraces. Each greenhouse represents a separate treatment. The cucumber was cultivated and irrigated, hoeing and breeding. A digital device DATA LOGGER GM 1365 (Chinese origin) was used to calculate and save the reading of the relative humidity and temperature every single hour at each greenhouse. The two greenhouses

were left for the natural infection with downy mildew disease. The onset of the disease was monitored daily. After the first observation of the infection, and an increase in the incidence of the disease which was noticed on March 26th, 2022, the regular greenhouse was treated (sprayed) with the Elite pesticide at a rate of 250 g/100 liters of water 7 days after the disease was noticed, i.e April 3rd, 2022. In the second greenhouse, three ventilation openings were made at the time of disease onset (without pesticide spraying). The width of each opening was 50 cm, distributed at the equal distances, and covered with the saran. The percentage of infection was calculated weekly in the two varieties of greenhouses based on the data of 10 randomly selected plants of 40 plants /varieties / sector / house, according to the following equation:

$$Infection\ per\ each\ plant\ \% = \frac{(\text{number of infected leaves})}{(\text{The total numbereach of leaves per each plant})} \times 100$$

In order to estimate the residues of the Elite fungicide on the cucumber fruits, the standard curve of the Fostil aluminum pesticide was prepared as follows:

A stock solution of Fostile Aluminum (100ppm) was prepared using Acitonitral astic asid (ACN)as a solvent. Then, a series of dilutions (0, 10, 25, 35, 50 and 75 ppm) were made. From each dilution, 2 ml of was injected into the HPLC device. The peak of the standard ingredient appeared l at a wavelength 298 nm, at a retention time of 4.2 seconds. After that, the straight-line equation of the standard Fostel aluminum was calculated in order to calculate the concentration of the pesticide on the samples, as in Figure 1. Where y represents the amount of absorbance (nm), x represents the concentration (ppm) of the pesticide in the sample.

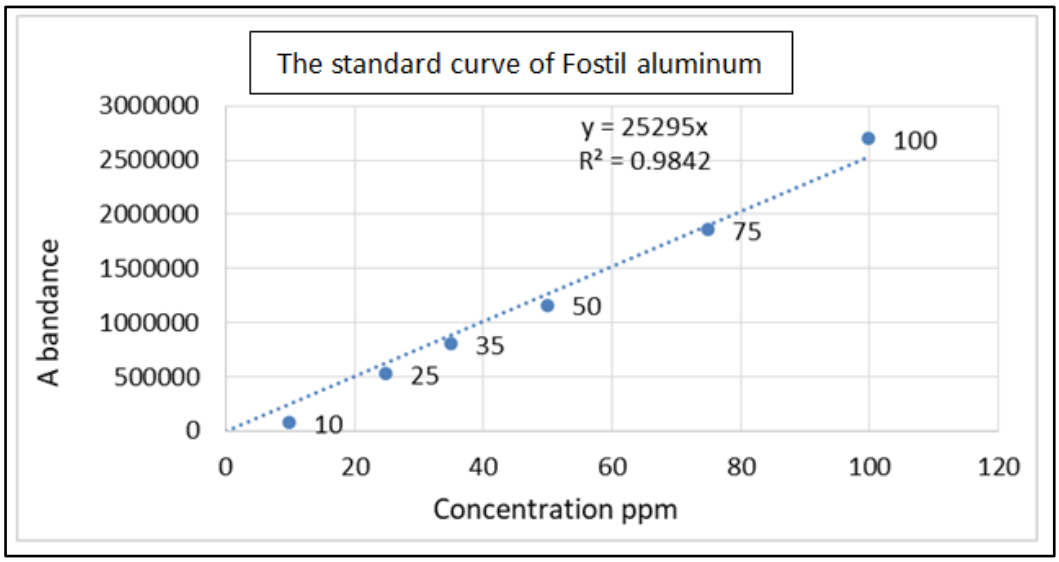

Figure (1): The standard curve of the active ingredient of Fostil aluminum in the Elite pesticide that used for controlling downy mildew disease of cucumbers in the regular greenhouse.

In order to estimate the residuals of the Elite on the three varieties of cucumber fruits, the following steps were followed according to the QUCHERS method:

1. Samples weighing 10gm were collected from each varieties of cucumber fruits without treatment, which represent a control groups.
2. From each varieties ,a sample of cucumber fruits was collected separately after 1 hour of treatment with the Elite (the active ingredient is Fostil Aluminum). A 10gm of cucumber peels was weighed and 15 ml of acetonitrile was added to it, and crushed well.
3. A 4 gm of $MgSO_4$ was added to each sample separately (to draw the water from each sample), and at the same time, 1gm of NaCl was applied to explode the plant cells and eliminate their water content due to the high osmotic pressure.
4. Each sample was placed for 3 minutes in a cooled centrifuge at 5000 cycles/min.
5. A 3 ml from each sample was taken and mixed with 75 mg of PSA (priamarey scindry amen) (to purifying the sample from water) and placed in the centrifuge for 5 minutes at 5000 cycle / minute.
6. A 2ml of the filtrate was withdrawn and injected into the HPLC device. The peak appeared, which indicated the sensitivity of the device, at the same concentration as the standard Fostile aluminum sample, at a retention time of 4.2 seconds.

Samples were prepared again following the same strategy for the three varieties of the cucumber fruits; Mostaqbal, Jamila, and Faris, after 3, 5, 7, 10, 14, and 21 days of spraying. The samples were injected in the high-performance liquid chromatography (HPLC) to calculate the peak area at a retention time of 4.2 seconds, which is used to calculate the amount of pesticide in unknown field samples **(Hens *et al*., 2018)**

RESULTS AND DISCUSSION

Calculation the percentage of downy mildew infection

The results from table (1) showed that there were no significant differences in the triple interference treatment; the two varieties of greenhouse, the time of results reporting, and the cucumber varieties. In general, there were significant differences between the percentages of infection of the 3 varieties; Mustaqbal, Faris and Jamila which were 1.17, 1.21, 1.47% at the three ventilation openings-greenhouse, with the infection of the same cucumber varieties 2.30, 1.67 and 1.86%, respectively in the greenhouse treated with Elite. The highest incidence of the infection was reported in the Mustaqbal varieties (treated group) 2.30%, compared to the Faris and Jamila varieties (1.67 and 1.86% respectively), with significant differences. Also, the highest infection was identified in the Mustaqbal varieties, was 1.47%, while in the Jamila and Faris the infection was 1.17 and 1.21%, respectively when ventilation treatment are applied. It can be noted that there are significant differences in infection % between the ventilation treatment (it reached 1.28%) and the regular treatment (treated with two time spraying of Elite fungicide), it was 1.95%. In regards to the average of infection in three varieties, there were significant differences between the infection in the 3 varieties of cucumber. The highest the infection was noticed in the Mustaqbal varieties (1.89%), followed by the Jamila and Faris varieties 1.54, and 1.42%, respectively. For the ventilation treatment, the highest infection was 2.36% reported in the Mustaqbal varieties on March 26th, 2022, while the highest infection% was 1.95 and 2.10% for the Faris and Jamila varieties, respectively observed on April 3rd, 2022.

For the control group, the highest the infection was 3.78, 2.69 and 2.57% for the Mustaqbal, Faris and Jamila, respectively, identified on April 3rd and May 3rd, 2022. There were no significant differences in the infection of the three varieties of cucumber during the weeks from March 26th to May 18th.

Table (1): Average of downy mildew the infection of cucumber planted at the Dujail region on 2022 using; a) the regular greenhouse, and b) the greenhouse with three ventilation openings.

Treatments	Varieties	Cucumber infection % during weeks (on 2022)									% of infection in treatment × varieties
		10 (Mar.21st)	11 (Mar.26th)	12 Apr.3th)	13 (Apr.12 th)	14 (Apr.19 th)	15 (Apr. 26th)	16 (May 3rd)	17 (May 10th)	18 (May 18th)	
Greenhouse with three ventilation openings	Mustaqbal	**0.00**	**2.36**	**1.95**	**1.58**	**0.61**	**2.29**	**1.95**	**1.86**	**0.61**	**1.47**
	Faris	**0.00**	**1.18**	**1.95**	**1.57**	**0.55**	**1.18**	**1.91**	**1.60**	**0.56**	**1.17**
	Jamila	**0.00**	**1.11**	**2.10**	**1.74**	**1.33**	**1.11**	**0.34**	**1.82**	**1.33**	**1.21**
Regular greenhouse (spraying with Elite)	Mustaqbal	**0.00**	**1.91**	**3.78**	**3.05**	**2.13**	**0.91**	**3.78**	**3.05**	**2.13**	**2.30**
	Faris	**0.00**	**1.00**	**2.69**	**2.18**	**1.65**	**1.00**	**2.69**	**2.18**	**1.65**	**1.67**
	Jamila	**0.00**	**2.11**	**2.57**	**2.14**	**1.57**	**2.11**	**2.57**	**2.14**	**1.57**	**1.86**
Treatment		Treatment × Weeks									Median of Treatments
Greenhouse with three ventilation openings		**0.00**	**1.55**	**2.00**	**1.63**	**0.83**	**1.53**	**1.40**	**1.76**	**0.83**	**0.30**
Regular greenhouse (spraying)		**0.00**	**1.67**	**3.01**	**2.46**	**1.78**	**1.34**	**3.01**	**2.46**	**1.78**	**6.73**
Varieties		Varieties × Weeks									Median of Varieties' median
Mustaqbal		**0.00**	**2.14**	**2.87**	**2.32**	**1.37**	**1.60**	**2.87**	**2.46**	**1.37**	**1.89**
Faris		**0.00**	**1.09**	**2.32**	**1.88**	**1.10**	**1.09**	**2.30**	**1.89**	**1.11**	**1.42**
Jamila		**0.00**	**1.61**	**2.34**	**1.94**	**1.45**	**1.61**	**1.46**	**1.98**	**1.45**	**1.54**
Median of weeks		**0.00**	**1.61**	**2.51**	**2.04**	**1.31**	**1.43**	**2.21**	**2.11**	**1.31**	
Factors	Treatment	Varieties	Weeks	Treatment × Varieties		Treatment × Weeks		Varieties × Weeks		Triple interactions	
LSD5%	**0.37****	**0.46****	**0.80****	**0.65****		**1.36****		**1.39**		**1.96**	

The number of varieties = 3, the number of replicates=3, the total number of plants =40 of each replicate, the number of plants whose data were reported = 10 of each replicate, the number of sectors=5 for each varieties, each number is an average of 10 readings. 1. The ventilation treatment, included three ventilation openings with a width of 50 cm covered with saran, the distance between each two openings was 14 m. The dimensions of the greenhouse were 56× 9×3 m, 2. The regular greenhouse treatment which was sprayed with Elite fungicide. The results was analyzed statistically according to CRBD.

Based on the above mentioned data, we concluded that the results of the ventilation treatment were equivalent to the treatment of spraying plants with the Elite pesticide, twice during the season. The study was correlated with the findings of (**Al-Dahwi *et al.*, 2005**) who stated that the downy mildew is an risky-epidemiological disease inhibit all the stages of plant growth and causes economic losses, ranging from 60-70% of crops production. The authors elucidated that the ventilation has a major role in reducing the development of downy mildew infection reported in on cucumber that grown in the greenhouses. The data of this study was coincided with the study of **Goldenhar & Hausbeck (2019**) who referred to the major importance of pesticides and their role in controlling the development of downy mildew disease inside the greenhouses. Figure 2 indicated that the first onset of the disease was reported on March 26th, 2022 in both greenhouses, when the average of relative humidity and

temperatures were 97% and 8 C, respectively. When the three ventilation openings were made in the second greenhouse, the relative humidity decreased to 80% on April 3rd and , then, 70% on April 26th, 2022. At the same time, the infection ranged between 0.55 and 3.78%, with significant differences. Making three ventilation openings inside the greenhouse played an important role in controlling the relative humidity, and eventually led to a reduction in the infection. The average of relative humidity elevated again to 92% from April 26th, to May 10th, 2022. This was accompanied by an increase in the average temperatures to 20 °C on May 10th, and continued to increase until it reached 30 °C on May 18th, 2022. Regarding the incidence of the disease during time, It ranged between 0.83 and 2.46%, with significant differences. Re-elevation of the relative humidity inside the greenhouse could be related to the crop irrigation, in addition to closing the doors of the green houses at night, to avoid the effect of winds and dust. Moreover, the reduction of The infection on May 18th, 2022, is associated with the reduction in the relative humidity, due to leaving the front and back doors opened at the day and night time, when the temperatures increases, These data referred to the impact of controlling relative humidity, compared to the effect of temperatures, in reducingThe infection, at that time.

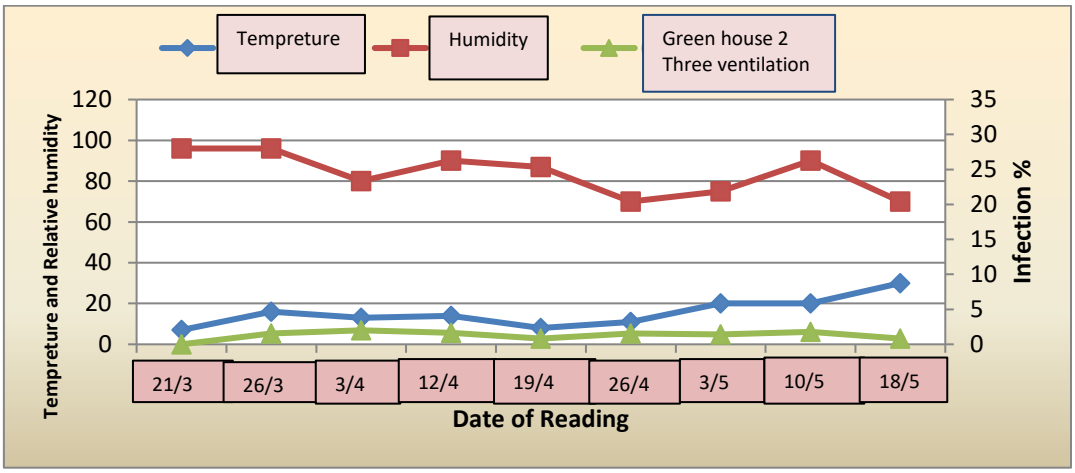

Figure (2): The average temperature, relative humidity and infection percentage in the greenhouse of three ventilation openings

In the Regular greenhouse which was sprayed with the Elite, the highest average of downy mildew infection percentage was 3.01% on April 3rd and May 3rd, 2022. At the same period, the average (fig 3) temperature and relative humidity inside the greenhouse were 12 °C, 97% and 22 °C, and 78%, respectively. At this the percentage, the cucumber plants were sprayed with Elite pesticide, leading to a significant decrease in the rate of infection %, it was 1.34 and 1.78% on April 26th and May 18th, 2022, respectively Fig. 3. Our results were a confirmatory of work performed by(**EL-Nagga & Abd El-Tawab, 2012**) who indicated that the downy mildew infection of cucumber caused by *Pseudoperonospora cubensis* led to large economic losses (between 30 and 80% of crops in the greenhouses), as it infects the plants at the different stages of growth, especially, the production stage and cause a reducing in the quality and quantity of the crops.

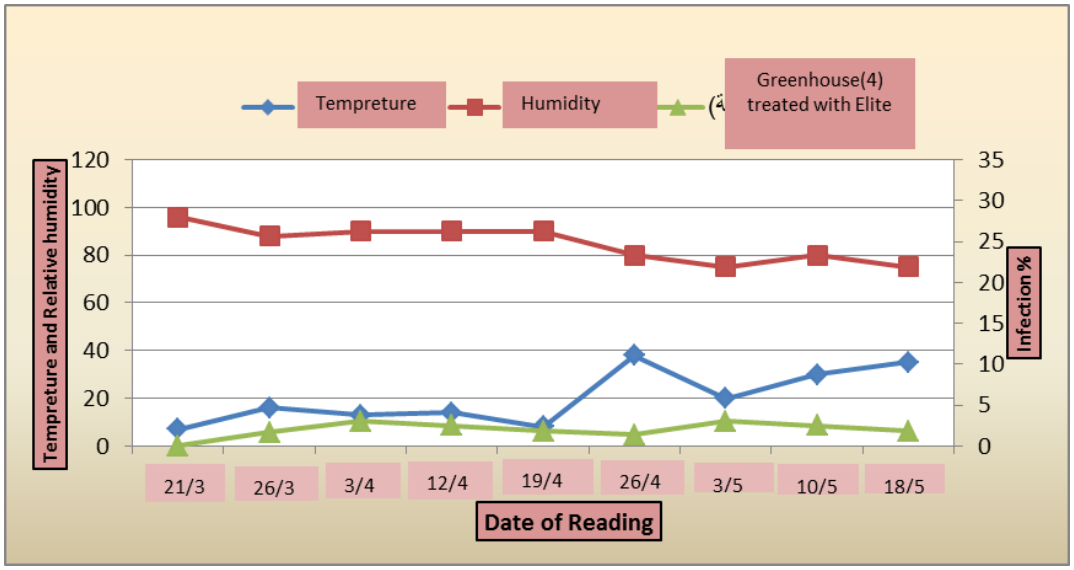

Figure (3): The average of downy mildew infection % in the regular greenhouse (spraying with Elite).

Figure 4. referred to data of Elite fungicide residues (Fostil aluminum) on the cucumber fruits. On the 1st day of spraying, the fungicide concentration on the cucumber was 72, 75 and 40 mg / of the three varieties; Al-Mustaqbal, Jamila and Faris respectively. On the 3rd day, the concentration of the Elite fungicide residues was 50, 40 and 28 mg / kg, while on the 5th day, it was reduced to 20, 15 and 15 mg / kg of the same varieties; Mostaqbal, Jamilah, and Faris, respectively. Furthermore, the Elite residues concentration on the 7th day, was 11 mg/kg, while it decreased on the 10th day of spraying to10 mg/kg in the three varieties of cucumber. Based on above mentioned data, the concentration of pesticide residues reached the permissible value (60 mg/kg or less), according to the recommendations of the National Committee for Pesticides Registration and Approval (2017-2022) since the 3rd day after spraying. The findings of this study were correlated with **Soliman (2021**) who indicated that the spraying of most fungicides should be a 7th days before the harvesting time. The pesticide residues are affected by several factors; (i) the most importantly is the nature of the active ingredient, (ii) the method of preparation, (iii) the pre-harvest period, and (iv) the environmental conditions during spraying pesticide, as well as (v) the oxidation factors present in cucumber plants (**Soliman, 2021**). the results of this study were consistent with what **Pandey *et al*, (2017**) who mentioned that the safety period of the pesticide is 5 days. The authors explained that the Elite pesticide competes with phosphate as an allosteric regulator of many enzymes, enhancing the direct or indirect production of infection-related proteins, which lead to stimulate defense mechanisms against fungal or bacterial pathogens. The percentage of downy mildew infection in cucumber plants reachs 30.81%, when the appropriate conditions are available at the regular greenhouse which was left for natural infection in Iraq. If the decision of spraying pesticides in a timely manner is delayed, the plants can be destroyed within 1 month from the onset of infection (**Khudhair & Aljarah, 2023).** In regard to the greenhouse with three ventilation openings, where the plants were not sprayed with the Elite pesticide, the infection was 1.28%, which was significantly lower than the infection in the regular greenhouse sprayed with Elite pesticide twice during the

cucumber production season, it reached 1.95%. The 1st spraying was 7 days after the onset of infection, and the 2nd spray was a month after the first spraying.

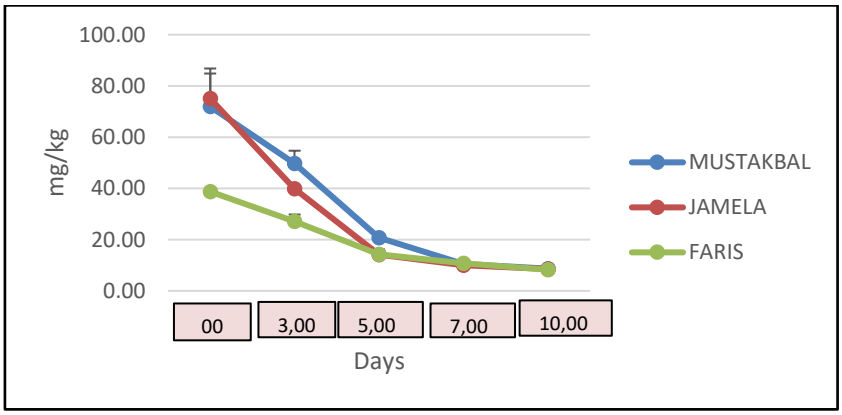

Figure (4): The curve of fungicide Elite (Fostil aluminum) disappearance of the cucumber varieties; Mustaqbal, Jamila and Faris under normal greenhouse conditions

Thus, it was possible to obtain fruits free of pesticides with making ventilation openings in the greenhouse as soon as the symptoms of the disease appeared on the plants.

(Table, 4) illustrated that the total costs of managing a regular greenhouse is 125,000 Iraqi dinar, while managing a greenhouse with three ventilation openings cost only 25,000 Iraqi dinar, which is the cost of the saran. In addition, the total production rate of cucumber fruits for five harvest in the regular greenhouse was 1800 kg, while it was 3000 kg in the greenhouse of three ventilation openings. These findings indicated the efficiency of the ventilation method for (i) controlling the downy mildew infection and (ii) reducing the cost of cucumber production, (iii) increasing the quantity of crops production which are free from the residues of the Elite pesticide.

Table (2): The monetary cost of managing the cucumber fruits production of in the regular greenhouse and in the house with three ventilation openings.

Factors	Regular greenhouse	Greenhouse with 3 ventilation openings
Pesticides	50000	…….
The fees of Spray's worker	75000	…….
The existence period of Elite pesticide residues	3 days	…….
Saran cost	……..	25000
Quantity of cucumber production of 5 harvest	1800 kg	3000 kg
Total (Iraqi dinars)	125000	28000

CONCLUSIONS

Based on the results observed in this study, we concluded that it is possible to control the development of downy mildew disease of cucumber cultivated at the Dujail region/north of Baghdad, through ventilation method, making three ventilation openings into the greenhouse when the symptoms of infection appeared. This method could be applied in the other regions

since the ventilation method played an important role in controlling of downy mildew disease through reducing of relative humidity, a key factor of the spread of the disease. Moreover, it was possible to harvest fruits free of pesticide residues. In regards to the regular greenhouses in which Elite pesticide was sprayed to combat the disease, the cucumbers can be harvested after 3 days of treatment. As a recommendation, farmers must be aware of using the correct strategy to apply fungicides, and follow all the instructions associated with doses, the timing of crop harvesting after treatment, and how to dispose the empty containers to protect the environment from pollution and produce a safe food.

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