European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 5 No. 07 July 2024
ISSN: 2660-5643

EFFECT OF AZOTOBACTER CHROOCOCCUM AND SPRAYING WITH PLANT EXTRACTS ON GROWTH AND YIELD OF CUCUMBER PLANTS IN PLASTIC HOUSE

Hussain Alwan Mana[1]
1Department of Pathological Analytics Science, College of Applied Medical Science, Shatrah University, Thi-Qar, 64001, Iraq
husseinalwan@shu.edu.iq

Article history:
Received: 14th April 2024
Accepted: 10th May2024

Abstract:
This experiment was conducted in the plastic house condition at the agricultural research station/college of Agriculture/Al-Muthanna University/Al-Bandar region during the winter season of 2023-2024 to assess the response of Sahara cucumber (Cucumis sativus L.) to bio fertiliser and plant extract spraying. Yeast suspension and licorice extract were the two factors included in the study. The control treatment was T0, which was without addition. The other two treatments were T1 and T2, which were administered at a concentration of 5 g L-1 and 10 g L-1, respectively. The second factor is the addition of Azotobacter chroococcum, with two levels: M0 (Control treatment) and M1: 5 g of Azotobacter chroococcum Plant-1. At a probability level of 0.05, the means were compared using the L.S.D. test. A randomised complete block design (R.C.B.D.) with three replications was employed to conduct a factorial experiment.

In general, the results showed a significant effects for all factors whether for individual or interactions understudy with superiority for the interaction (T2M1) treatments in Plant eight , Number of leaves ,leaf area, Vegetative dry weight , fruit numbers and early yield reached (221.93cm , 36.12 leaf , 40.72dcm^2 ,117.49g, 34.26fruits and 4.44g per plant) respectively.

Keywords: *Azotobacter chroococcum* ; Yeast suspension and licorice extract ; cucumber

INTRODUCTION:

One of the significant vegetables in the cucurbitaceae family is the cucumber plant (Cucumis sativus L.). It is one of the oldest vegetables cultivated by humans and comes in second rank after tomato plant in Europe. The native of the cucumber was India In addition to some \ wild varieties there that are often sour and not suitable for human consumption . India also exports large quantities of cucumbers, especially the types with very small fruits, which are used in pickling (Eifediyi and Remison, 2010). Many names of cucurbits, including cucumber, were mentioned in the records of the Sumerians and Babylonians before about 3000. year BC, which indicates the interest of the ancient Iraqis in cultivating these crops, and the nutritional importance value of this plant comes from containing carbohydrates, protein, oils, and vitamins B2, B1, and C, as well as mineral salts, especially iron, calcium, and phosphorus (Al-Tahafy et al., 2013).

According to (FAO,2022) statistics, the cultivated area of this crop has reached 95,281 dunums in 2020, with a production of 242,614 tons.

As a result of the increase in population which requires providing them with adequate food , it has become important to improve the efficiency of the use of chemical fertilizers and find methods As an alternative to improving yields and their quality. Many developed countries have turned to organic agriculture and reduced the use of chemical compounds as much as possible because one of the aims of organic agriculture is to produce plants free of the toxic effects of chemical fertilizers . Organic agriculture also has long-term positive effects on agricultural ecosystems to produce organic foods while ensuring an environmental balance to avoid problems of soil fertility and pests. By adding organic waste to the soil to increase its fertility, provide nutrients, increase ion exchange and water storage capacity (Badran , 2007 ; Al-Jubouri *et al.*, 2017).

The research aims to investigate the possibility of using *Azotobacter chroococcum* and yeast suspension with licorice extract, and effect each of them separately and their interaction on growth and yield of cucumber under plastic house conditions.

MATERIALS AND WORK METHODS:

During the winter season of 2023-2024, this investigation was conducted in the plastic houses with dimensions of 9 * 56 m that were located at the Agricultural Research and Experimentation Station in Al Bandar, Iraq. The station was affiliated with the Faculty of Agriculture at Al-Muthanna University. The soil's physical and chemical characteristics are detailed in Table 1.

Table (1): The physical and chemical properties of field soil .

Feature	Value	Unit
Soil interaction(pH)	7.6	_____
Soil electrical (ECe) conductivity	6.2	ds m^{-1}
Available Nitrogen	28.4	mg kg^{-1} soil
Available Phosphorous	17.5	mg kg^{-1} soil
Available Potassium	181	mg kg^{-1} soil
Organic matter	0.7	%
Bulk density	1.5	g. cm^3
Particle density	2.7	g. cm^3
Porosity	32.3	%
Soil texture	_____	Clay
Clay	52.18	%
Sand	17.39	%
Silt	30.42	%

The seeds of cucumber hybrid F1 (Sahara variety) were used in this experiment. The soil in plastic house was divided into 6 rows, 50 m long, and the distance between one row and another was 75 cm. Each two rows represented one replicate with 21 experimental units. The distance between each experimental unit and another was 75 cm and the distance between each plant 30 cm. Each experimental unit contains 6 cultivated cucumber plants. The seeds of cucumber were planted in peat moss on (26/9/2023). A drip irrigation system was used, the rows were covered with polyethylene layer (mulching) to keep soil moisture and prevent the weeds growth , reducing water wasting , evaporation and accumulation of salts in soil .

The experiment encompassed the examination of two variables: yeast suspension and licorice extract. T0 represents the control treatment (no addition), T1 is 5 g L-1, and T2 is 10 g L-1. and the addition of Azotobacter chroococcum treatments M,: M0 - No addition (Control treatment) and M1 : 5 g Plant-1. A factorial experiment was conducted using a randomised complete block design, with three replications and 12 experimental units. The vegetative attributes and yield were measured and analysed, and the averages of the parameters were compared at the lowest level of the L.S.D test at a probability level of 0.05.

RESULT AND DISCUSSION :

Plant height :

The results of Table 2 demonstrate that there were substantial differences in the plant height characteristics of the study variables. The T2 treatment, which consisted of 10 g of yeast suspension with licorice extract L-1, achieved the highest plant height (206.31 cm), which was significantly higher than the other treatments, T0 and T1, which reached (181.9 and 194.52 cm), respectively, with an increase rate of (13.41, 6.06 %). Additionally, it was observed that there were significant differences between the treatments that included Azotobacter chroococcum. The M1 treatment (208.62 cm) outperformed the control treatments M0 (179.86 cm), with a 15% increase rate. From the Table 2 below, the results showed that there were significant differences in interactions between yeast suspension with licorice extract and adding *Azotobacter chroococcum* on plant height . Perhaps the reason is that the *A.chroococcum* bacteria and the organic matter present in the soil were positively reflected in the growth of cucumber plants, in terms of the height plant, number and area of the leaves(Tab.2,3 and 4), this is consistent with Sohail *et al.,* (2010) . The highest value was in the T2M1 treatment with 221.93 cm, while the lowest leaf area value was recorded in the T0M0 treatment with 167.75cm . The reason for this may be due to the hormonal nature of the extract and the fact that licorice and yeast contain substances similar in their effect

to growth regulators (auxin) and enzymes, especially by increasing Mg and K and their role in that, and then increasing the division of cells of the growing shoot, which has a positive effect on the height of the plant. This is consistent with Issa and Herby (2017).

Table (2) Effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* on plant height (cm) :

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	167.75	181.15	190.7	179.86
M1	196.05	207.9	221.93	208.62
Mean of Extracts	181.9	194.52	206.31	
L.S.D.0.05	T=9.984	M= 8.371	TM= 15.430	

Number of leaves (Leaf Plant^{-1})

It was evident from Table (3) that the study variables exhibited substantial variations in the number of leaves, which is a characteristic of the plant. The T2 treatment demonstrated a considerably higher rate of leaf production (34.18 leaf plant-1) than the other treatments. It was also observed that the M1 treatment (33.29 leaf plant-1) was considerably superior to the control treatments, and there were significant differences between the addition of Azotobacter chroococcum treatments. It was evident from the table below that the binary interactions between yeast suspension with licorice extract and the addition of Azotobacter chroococcum treatments exhibited substantial differences in terms of the number of leaves. The M1T2 treatment achieved the highest value, which was 36.12 cm, while the M0T0 treatment recorded the lowest number of leaves, 27.45 cm.

The reason for the superiority of plants in terms of leaf count may be attributed to the presence of auxin-like substances in the plant extract. These substances increase the concentration of growth regulators within the plant, which in turn leads to increased cell division and an increase in the number of leaves. This result is consistent with the findings of Hussein (2002) on cucumbers and Al-Rawi (2004) on squash plants.

Table (3) Effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* on Number of leaves (Leaf Plant^{-1}) .

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	27.45	181.15	32.25	29.8
M1	31.00	207.9	36.12	33.29
Mean of extracts	29.22	194.52	34.18	
L.S.D.0.05	T=2.987	M= 8.371	TM=3.021	

Leaf area :

The results from Table 4 indicated that the study variables exhibited substantial differences in the plant's leaf area characteristic. The highest rate of leaf area (38.13 dcm2) was achieved by the T2 treatment, which was considerably superior to the rest treatments T0 and T1, which amounted to (34.13 and 35.87 dcm2), respectively, with an increase rate of 11,71 and 6.3%. Additionally, it was observed that there were substantial variations in the addition of Azotobacter treatments. The M1 treatment (37.92 dcm2) substantially outperformed the control treatment. Significant differences in terms of lef area were observed in the binary interactions between the yeast suspension with licorice extract and the addition of Azotobacter chroococcum treatments, as per Table 4. The highest rate of leaf area was recorded in the T2M1 treatment, amounting to (40.72 dcm^2), while the lowest rate leaf area recorded (32.62 dcm^2) in the T0M0 treatment.

The reason may be attributed to the effect of plant extracts and the amino acids they contain and some important nutrients in the important activities of the plant (such as magnesium and iron), which are considered the determining factor for the expansion of the surface area of plant leaves due to their effect on cell division and expansion, the manufacture of chlorophyll, and important metabolic processes. This result is consistent with Hussein (2002).

Table (4): The effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* treatments on leaf area (dcm^2 plant^{-1}).

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	32.62	181.15	35.55	34.17
M1	35.65	207.9	40.72	37.92
Mean of extracts	34.13	194.52	38.13	
L.S.D.0.05	T=1.512	M= 8.371	TM= 3.231	

Dry weight of vegetative growth (g):

The dry weight of vegetative growth between the study variables was significantly different, as evidenced by the results of Table 5. The M1 treatment demonstrated the highest rate of Azotobacter chroococcum addition (93.80 g), which was substantially higher than the control treatments M0 (68.40 g) and resulted in a 37.13 % increase. Additionally, it demonstrated that there were substantial variations between the interventions including yeast suspension and licorice extract. The T2 treatment (102.11 g) demonstrated a substantial advantage over the other regimens. The dry weight of vegetative growth in the binary interactions between yeast suspension with licorice extract and adding Azotobacter chroococcum treatment was significantly different in the T2M1 treatment (117.49 g) than in the T0M0 treatment (55.43 g), as shown in the table below.

The reason may be attributed to the effect of the extracts containing some nutritional elements, which increased the leaf area (Table 4), which is important in the plant's vital activities, and thus increasing the efficiency of the photosynthesis process and increasing the carbohydrates produced, which is reflected in the accumulation of dry matter in the vegetative system, and this is consistent with the Najim (2005).

The A. chroococcum bacterium's capacity to readily fix atmospheric nitrogen may be responsible for the increase in the dry weight of the shoot. This satisfies a portion of the plant's requirement for this critical nutrient, which is essential for the synthesis of amino acids and proteins, as well as the construction of the chlorophyll molecule and the nucleic acids RNA and DNA. The shoot's growth is positively correlated with the plant's dry matter weight increase (see Table 5). Furthermore, the A. chroococcum bacteria enhance the growth of the root system and increase its density by producing growth regulators, such as auxins, which enhance the plant's capacity to assimilate water and nutrients from the soil solution surrounding the roots (Megawer and Mahfouz, 2010).

Table (5): The effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* on dry weight of vegetative growth (g).

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	55.43	181.15	86.73	68.40
M1	79.89	207.9	117.49	93.80
Mean of Extracts	67.66	194.52	102.11	
L.S.D.0.05	T= 9.311	M= 8.371	TM=16.652	

Number of fruits (fruit plant^{-1})

Significant differences in the number of fruits characteristic of the plant were observed between the study variables, as indicated by the results of Table 6. The T2 treatment produced the highest number of fruits (32.89 fruit plant-1), which was significantly higher than the remainder of the treatments (T0 and T1). The respective increase rates were (15.56 & 5.1%) and (28.46 & 31.28 fruit plant-1). Additionally, it was observed that there were substantial variations in the addition of Azotobacter treatments. The M1 treatment (32.74 fruit plant^{-1}) was significantly superior to control treatment . From the Table 6 below, there were significant differences in terms of lef area in the binary interactions between yeast suspension with licorice extract and adding *Azotobacter chroococcum* treatments. The highest rate of leaf area was recorded in the T2M1 treatment, amounting to (34.26 fruit plant^{-1}), while the lowest rate leaf area recorded (26.99 fruit plant^{-1}) in the T0M0 treatment.

The reason may be due to the increase in compounds and metabolic products from its main plant, which is the leaves, and by increasing their number and area (Table 3 and 4), the activity and growth of the roots in length and area will increase, thus increasing the absorption of water and the necessary elements dissolved in it, and as a result of improved vegetative growth and an increase in nutrients manufactured in the leaves and their transfer to the fruits, which leads to increase the number of fruits, this is consistent with what Al-Abdullah (2008) and Ayotamuno *et a.,*/ (2007) found when they studied cucumber plants.

Table (6): The effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* treatments number of fruits (fruit plant^{-1}).

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	26.99	181.15	31.52	29.01
M1	29.94	207.9	34.26	32.74
Mean of Extracts	28.46	194.52	32.89	
L.S.D.0.05	T=1.467	M= 8.371	TM= 2.453	

Early yield (kg plant^{-1})

It was evident from Table (7) that the study variables exhibited substantial differences in the plant's early yield characteristic. The T2 treatment demonstrated the highest rate of yield (4.03g plant-1), which was substantially higher than the other treatments. It was also observed that the M1 treatment (3.8 g plant-1) was considerably superior to the control treatments, and there were significant differences between the different treatments that included Azotobacter chroococcum. It was evident from the table below that the binary interactions between yeast suspension with licorice extract and the addition of Azotobacter chroococcum treatments exhibited substantial differences in terms of early yield. In the M1T2 treatment, the highest value was recorded at 4.44 g plant-1, while the M0T0 treatment recorded the lowest yield at 2.96 g plant-1.

The extract's elements may have contributed to this by increasing the efficiency of the photosynthesis process, which in turn increased the quantity of manufactured carbohydrates and their transfer from their manufacturing sites to their storage sites in the fruits. This resulted in an increase in the vegetative growth parameters mentioned earlier, which was reflected in an increase in the plant's yield. These results are consistent with the research conducted by Hussein (2002) and Imran (2004) on cucumber plants.

Table (7) Effect of yeast suspension with licorice extract and adding *Azotobacter chroococcum* on early yeild (kg plant^{-1}) .

Extracts / Azotobacter	T0	T1	T2	Mean of Azotobacter
M0	2.96	181.15	3.62	3.22
M1	3.06	207.9	4.44	3.80
Mean of Extracts	3.01	194.52	4.03	
L.S.D.0.05	T=0.302	M= 8.371	TM=0. 523	

We conclude from this experiment that it is possible to improve the efficiency of bio fertilizer(5 g of *Azotobacter chroococcum*) with 10g of yeast suspension and licorice extract, which produced best results for increasing the vegetative growth characteristics and yield of cucumber .

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تأثير البكتريا *Azotobacter chroococcum* والرش بالمستخلصات النباتية في نمو وحاصل نباتات الخيار في البيت البلاستيكي

الخلاصة

اجريت هذه التجربة خلال الموسم الشتوي 2023-2024 داخل حالة البيت البلاستيكي الواقع في محطة البحوث الزراعية / كلية الزراعة / جامعة المثنى / منطقة البندر لتقييم استجابة الخيار الصحراوي *Cucumis sativus* L. للأسمدة الحيوية والرش بالمستخلصات النباتية . تضمنت الدراسة عاملين هما معلق الخميرة ومستخلص عرق السوس: T0: معاملة السيطرة (بدون إضافة)، T1: 5 غم لتر$^{-1}$ وT2 10غم لتر$^{-1}$. العامل الثاني هو المعاملة ببكتريا *Azotobacter chroococcum* وكانت كالتالي : M0 بدون إضافة (معاملة المقارنة) و M1 هي 5 غم من Azotobacter chroococcum للنبات . نفذت تجربة عاملية باستخدام تصميم القطاعات العشوائية الكاملة (R.C.B.D.) بثلاثة مكررات، وقورنت المتوسطات باستخدام اختبار L.S.D عند مستوى احتمال 0.05.

وبشكل عام أظهرت النتائج تأثيراً معنوياً لجميع عوامل التجربة مفردة أو متداخلة في جميع الصفات المدروسة وكانت أعلاها في معاملة التداخل (T2M1) في صفات : عدد الأوراق والمساحة الورقية والوزن الجاف للنمو الخضري وعدد الثمار والحاصل المبكر بلغ (221.93 سم، 36.12 ورقة، 40.72 دسم^{2}، 117.49 غم، 34.26 ثمرة و 4.44 كغم نبات$^{-1}$) على التوالي.