Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE
https://doi.org. 10.58928/ku24.15412

Impact of Adding Organic Fertilizer Extract and Ascorbic Acid On The Growth And Yield Of Two Strawberry Cultivars (*Fragaria* X *Ananassa* Duch.).

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Received: 15/08/2024 **Revised: 13/09/2024** **Accepted: 15/09/2024** **Published: 01/12/2024**

ABSTRACT

A pot experiment was conducted in the plastic homes of the Faculty of Agriculture at Samarra University during the agricultural season of 2023. The purpose of the experiment was to investigate the impact of three different ratios of organic fertilizer extract (decomposed cow dung) ((0:0), (1:1), (1:2)) and three different concentrations of ascorbic acid (vitamin C) (0, 30, and 60 mg.L^{-1}) on the growth and yield of two strawberry varieties, Albion and Rubygem.. The experiment was carried out using the design of complete random sectors RCBD with three replicates and three seedlings for each experimental unit.

The findings indicated that the inclusion of ascorbic acid (vitamin C) and organic fertilizer extract (decomposed cow dung) had a substantial impact on the attributes of strawberry plants. The most notable figures recorded at the 5% probability level were 26.92 cm for plant height, 59.77 cm2 for leaf area, 33.57 g for fruit weight, 17.67 plant-1 for the number of fruits, 259.08 g. plant-1 for fruit weight, 2.69% for the percentage, 0.85% for another percentage, and 2.23% for a third percentage., dry weight of plant, number of fruits in the plant, plant yield, nitrogen level in leaves, phosphorus level in leaves and potassium level in leaves respectively as a result of the addition of organic fertilizer extract (decomposed cow dung) while the weight of the fruit reached its highest level (15.56 g) when ascorbic acid was added to a potential level of 5%. Albion excelled in all traits except for the nitrogen level in the leaves and the potassium level in the leaves. In contrast, the Rubygem only excelled in the nitrogen level in the leaves and the potassium level in the leaves.

***Keywords*:** Ascorbic acid, Cow dung extract, Organic fertilizer, *Fragaria Ananassa* Duch.

INTRODUCTION

Strawberry is a perennial herbaceous plant, one of the small-fruited fruits widely spread in the world, scientifically known as *Fragaria ananassa* Duch., is a type of berry that highly valued for its antioxidant polyphenols, which have numerous health benefits. The fruits are included in many food industries such as making pastries, jams and ice cream. Consumers worldwide widely enjoy them due to their appealing sensory properties, low calorie content, and low impact on blood sugar levels. Additionally, strawberries are abundant in bioactive compounds that have the potential to influence the body's metabolic and physiological functions., strawberries also contain large amounts of vitamins such as vitamin C, in addition to minerals they are a good source of magnesium, phosphorus, potassium, copper, zinc and manganese, which play a role in bone health and metabolism, folic acid is a vital ingredient in strawberries, which are essential for cell growth and development, especially when pregnant [1], [2], [3]. Although mineral fertilizers are an important source of major and secondary nutrients in crop production, the continuous addition of mineral fertilizers may negatively affect human and animal health and the environment, so attention has turned to the use of organic fertilizers that contain nutrients in parallel, and are sufficient for plant growth, which leads to improved growth and increased production [4]. [5] stated that organic strawberry fruits are safer because they are less sensitive than traditional and integral fruits.[6] obtained a significant increase in strawberry yield per plant(g), number of leaves, number of fruits per plant, and fruit weight (g) amounting to 343.52 g.,30.08, 20.66,30.84 g respectively, when using organic fertilizer extract.

Vitamin C (ascorbic acid) is an antioxidant that protects the body from harmful substances. The effects of free radicals have an important role in many metabolic functions, especially in forming proteins and maintaining their integrity. The total content of organic acids in strawberry plants ranges between 874.30-1216.27 mg/100 grams of fresh weight. The most common acid is citric
acid, which represents 73.5-84.7% of all organic acids [3].

The importance of the research was that in recent years the cultivation of strawberries has begun to increase and develop in our country. Still, most of them were protected agriculture, so they need a lot of chemical fertilizers and manufactured growth regulators, which have recently increased recommendations to reduce them because of their risks to health and the environment. Hence, the trend to organic agriculture and the use of an alternative to industrial growth regulators ensures access to clean fruits free of chemical fertilizer residues and harmful manufactured materials.

The study aims to achieve sustainable and healthy cultivation of strawberry plants, which increases the plant's productivity, improves the quality of the fruits, and strengthens the plant's ability to resist diseases and environmental pressures, while maintaining a clean and natural agricultural environment, by adding organic fertilizers and treating with ascorbic acid.

Materials & Methods

A potted experiment was carried out in the greenhouse of the Faculty of Agriculture / University of Samarra for the agricultural season 2023, and the seedlings of textile strawberries of the Albion variety and Rubygem were obtained from the palm paradise company for textile agriculture. The experiment included three levels of ascorbic acid: ([C1] 0, [C2] 30 and[C3] 60 $mg.l^{-1}$), and three levels of organic fertilizer extract (decomposed cow manure):

[E1]: (0:0)Distilled water only

[E2]: (1:1) 1volume of cow manure extract decomposed into 1 volume of distilled water (soaked for 24 hours before use).

[E3]: (2:1) :2 volumes of cow manure extract decomposed into 1 volume of distilled water (soaked for 24 hours before use). Treatments have been added with irrigation water. The organic fertilizer was analyzed according to Table(1):

Table (1): Chemical analysis of organic fertilizer (decomposed cow dung)

K %	P %	% N	PH	Fertilizer ratio Organic %	Type of fertilizer
٪0.5	٪0.2	٪1	7.61	21%	Cow dung

Strawberry seedlings were planted on 12/1/2023 in plastic pots (diameter 26 cm and 30 cm high) and 8 kg of dry soil were added and chemical and physical analysis of the soil was carried out (Table 2). The number of experimental units was 36 units (each pot is an experimental unit), and 3 strawberry seedlings were planted in each pot (The total number of plants included in the experiment is 108 plants) . The first batch of the two treatments (ascorbic acid extract and organic fertilizer (cow dung)) were added on 12/ 2/2023 and the rest of the batches were every ten days at once, and the total was six batches.

Table (2): Chemical and physical analysis of soil

Property	the value
Clay%	30.08
Silt%	9.52
Sand%	60.40
pH	7.65
EC conductivity	2.32 ds. m^{-1}
Organic matter	0.9
Available Nitrogen%	11.25
Available phosphorous%	14.4
Available magnesium%	15.96
Available potassium%	16.35
Available chlorine%	9.5

The following characteristics were studied (all characteristics were measured on 12/6/2023):

Plant height (cm)

Leaf area (cm^2): The leaf area was calculated according to the following equation [7]:

$LA = - 0.57 + 0.26\ L^2 + 0.19\ W^2$

Where: LA: leaf area, L: leaf length, W: leaf width, leaf length was measured in centimeters from the tip of the blade to the area where the leaf petiole connects to the stem, and leaf width was measured in centimeters from the widest area of the leaf.

Number of leaves. (leaf. $Plant^{-1}$), Dry weight of a plant (g), Fruit weight(g), Number of fruits per plant, Yield of fruits for the plant(g), It was measured by multiplying the number of fruits per plant by the weight of the fruit.

Percentage of nitrogen in leaves N%, percentage of phosphorus in leaves P% and percentage of potassium in leaves k% , estimating the nutrients in the leaves and after completing the process digestibility: the percentage of elements was calculated on the basis of dry weight [8]. The estimated elements are nitrogen (% N), which was estimated by the process of evaporation and distillation using a Micro-Kjeldahl device [9]. Phosphorus(%P): it was determined using a spectrophotometer at a wavelength of 620 nm [10].

Potassium (% K) : estimated by Flame photometer.

The experiment was implemented using a randomized complete block design (RCBD) with three replications. The results were analyzed statistically using the SPSS statistical program. Then the means of the two varieties for each treatment separately were compared using the LSD test at a 5% significance level.

Results & Discussion

1- Plant height

As can be seen from Table (3) and Figure (1) that there is a significant increase in the height of the plant as a result

of the addition of organic fertilizer extract (decomposed cow dung), the highest rate was (26.92 cm) for the treatment of E3 V1 with an increase of 26.21%, compared to the treatment of control. In comparison, the lowest rate was (15.69 cm) for the treatment E1V2. The reason for the increase in plant height may be the result of the use of organic fertilizer extract, which contains the major elements that the plant needs in large quantities due to their importance in its growth and development [11]. These findings are consistent with [6].

It is clear from Table (3) and Figure (1) that strawberry plants have responded significantly to the addition of ascorbic acid (vitamin C) in the description of plant height, where the highest rate was (24.24 cm) for the concentration C3 for the V1 variety, with an increase of 26.21% compared to the control treatment. In comparison, the lowest rate was (15.65 cm) for the concentration of C1 for the V2 variety. This is consistent with [4] who attributed the reason for the increase to the role of ascorbic acid in increasing the growth of various organs of plants, including roots and their activity, and then increasing their ability to Greater absorption of nutrients from the soil, including nitrogen, which leads to an increase in vegetative total and stem length.

Table (3): ANOVA of plant height, leaf area, plant dry weight, fruit weight and number of fruits of two varieties of strawberry under different treatments.

Source of variance	df	Plant Height	Leaf area	Plant dry weight	Fruit weight	Number of fruits
Varieties	1	374.66*	908.42*	1061.35*	8.29*	6.78*
Ascorbic acid	2	10.95*	62.68*	17.18*	2.55*	0.66 n.s
cow dung extract	2	44.62*	103.05*	25.97*	3.33 *	6.72*
Total	35					
LSD 0.05		1.94	2.62	2.64	2.49	3.18

* & ns indicate statistical significance at 0.05 levels, and non-significance, respectively.

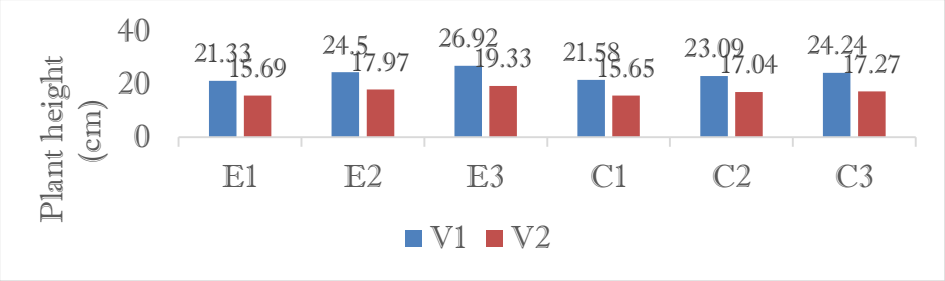

Figure (1): The effect of ascorbic acid levels and organic fertilizer on the height of two strawberry varieties . (V2, V1)Strawberry varieties,(C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels.

2- Leaf area

Table (3) and Figure (2) show that the organic fertilizer treatment has significantly increased the leaf area of the strawberry plant, the highest rate of (59.77 cm^2) for the E3 V1 treatment was an increase of 15.21% compared to the control treatment. The transaction E1V2 had the lowest rate, which was 42.8 cm2. The potential factor may be the influence of organic fertilizers on plants. Organic fertilizers consist of essential elements such as nitrogen, phosphorous, potassium, vitamins, and growth regulators. These nutrients initiate a range of enzymatic and biological activities in plants, hence promoting plant growth, cell division, and elongation. As a result, there is a rise in the height of the plants, the number of branches, leaves, and the leaf area [11]. The explanation can also be ascribed to the pivotal role nitrogen plays in plants, leading to increased nutrient uptake and enhanced features of vegetative growth.
[14]. These results are consistent with [15], [16], [17].

Table (3) and Figure (2) show that there is a significant increase in the leaf area as a result of the use of ascorbic acid, as the highest rate was (58.18 cm^2) for the C3 V1 treatment, with an increase of 12.95% compared to the control treatment, which had the lowest rate, reaching (42.63 cm^2) for the V2 variety. This may be because salicylic acid improves leaf growth and cell elongation [12]. This is consistent with [13] who attributed the reason for this increase to an increase in chlorophyll content, which leads to an increase in photosynthesis and thus reflected on the vegetative total and leaf area.

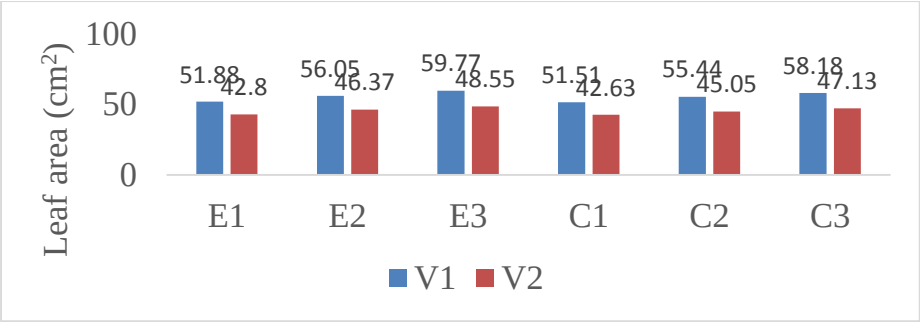

Figure (2): The effect of ascorbic acid levels and organic fertilizer on the leaf area of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels

3- Plant dry weight

It appears from Table (3) and Figure (3) that fertilization with organic fertilizer extract (decomposed cow dung) has significantly increased the dry weight of the plant and reached the highest rate (33.57 g) for the E3 V1 treatment with an increase of 14.03% compared to the control treatment while the lowest rate (19.59 g) for the control treatment for the V2 variety. Strawberry plants respond greatly to the addition of organic matter, due to their shallow and highly productive root system relative to the size of the plant, the absorption of organic matter has a role in improving the absorption of nutrients by the roots, which leads to stimulating the growth of roots and the entire plant, thus increasing the dry weight of leaves and roots [15].

It is clear from Table (3) and Figure (3) that there was a significant increase in dry weight as a result of the use of vitamin C (ascorbic acid), where the highest rate (33.37 g) for C3 V1 treatment was an increase of 14.79% compared to the control treatment. In contrast, the C1V2 treatment had the lowest rate. This may be due to the effect of ascorbic acid similar to that of growth regulators and its role in promoting growth, reducing stress caused by heat and toxins, stimulating respiration and cell division [4]. Or the reason may be that adding ascorbic acid leads to increased absorption of water and nutrients, thus improving growth, which leads to increased dry weight [4]. This is consistent with[13].

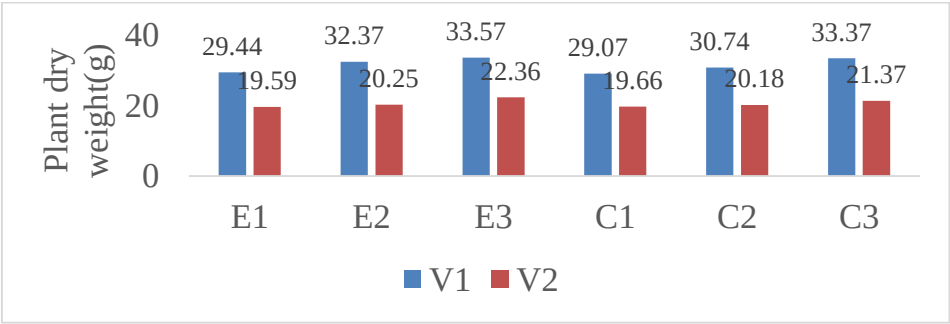

Figure (3): The effect of ascorbic acid levels and organic fertilizer on the plant dry weight of two strawberry varieties. (V2, V1) strawberry varieties, (C1, C2, C3) ascorbic acid levels, (E1, E2, E3) organic fertilizer extract levels

4- Fruit weight

It is clear from Table (3) and Figure (4) that the addition of organic fertilizer extract has a significant impact on the weight of the fruit, where the highest rate (15.45 g) for the E3 V1 treatment with an increase of 8.5% compared to the control treatment, while the lowest rate (13.37 g) for the E1 V2 treatment. The reason may be organic fertilizers that are rich in nitrogen, which stimulates protoplasm formation, increased cells, plant growth and fruit formation, development and productivity [11]. These results are consistent with [16], [17], [6], while it did not agree with [15] as organic fertilizers did not have any significant effect on fruit weight.

From Table (3) and Figure (4) it appears that the addition of ascorbic acid has a significant effect on the fruit weight of the strawberry, it reached the highest rate (15.56 g) for the treatment of C2 V1 where the percentage of increase 10.19 % compared to the treatment of control. Ascorbic acid acts as an adjunct in photosynthesis reactions. It prevents the destruction of chlorophyll and carotenoids due to its antioxidant properties, and it interferes with cell division and increases leaf surface area. It increases photosynthesis and carbohydrate production and thus improves the quality properties and content of healthy compounds in strawberry plants[13].

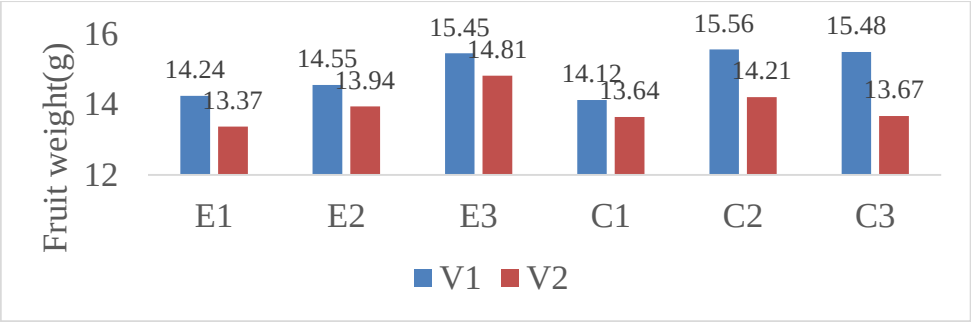

Figure (4): The effect of ascorbic acid levels and organic fertilizer on the fruit weight of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels

5- Number of fruits

From Table (3) and Figure (5), we note that there is a significant increase in the number of fruits as a result of the addition of organic fertilizer extract (decomposed cow dung), as the highest rate was (17.67 fruits. plant^{-1}) for the E3 V1 treatment with an increase of 8.67%, while the lowest rate was (15.01 fruits. plant^{-1}) for the control treatment of the V2 variety. The notable impact of organic fertilizer can be attributed to the augmentation of nitrogen (N) and potassium (K) elements in the plant. These elements play a crucial role in various essential processes that result in enhanced vegetative growth, increased production of photosynthesis products, accumulation of carbohydrates and proteins, and improved fruit quality in terms of quantity and weight [10]. These results are in line with and this aligns with [18], [16].

It is clear from Table (3) and Figure (5) that there are no significant differences between the coefficients of adding ascorbic acid in the characteristic of the number of fruits. The reason may be the effect of environmental conditions in reducing the effectiveness of ascorbic acid

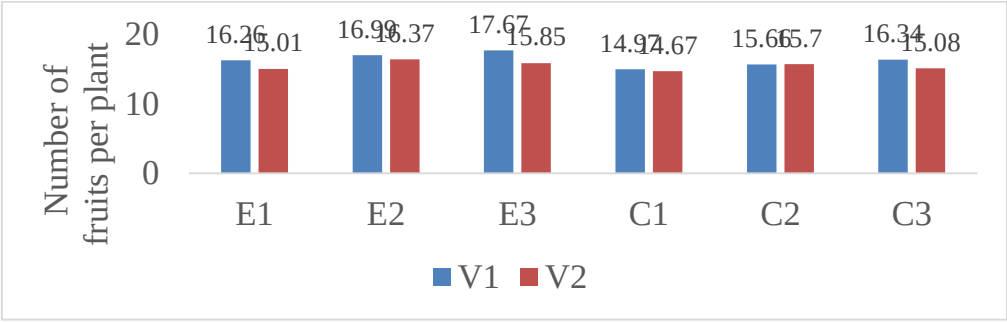

Figure (5): The effect of ascorbic acid levels and organic fertilizer on the number of fruits of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels.

6- Plant yield

From Table (4) and Figure (6), it appears that the addition of organic fertilizer extract has significantly increased the yield of fruits, as the highest rate was (259.08 g. plant^{-1}) for the E3 V1 treatment with an increase of 15.38%, while the lowest rate was (212.11 g. plant^{-1}) for the E1V2 treatment. The reason may be that the addition of chemical fertilizer leads to an increase in the number of leaves and leaf area, thus increasing the percentage of nutrients in the leaves, then increasing the dry weight of the plant, which is reflected positively on the increase in yield by increasing the average number of fruits, length, diameter and weight of the fruit and the total yield [16]. Perhaps the increase in yield may be a positive correlation between the number of fruits and the yield [19]. These results are consistent with [15], [6].

It appears from Table (4) and Figure (6) that there is a significant increase in the yield of strawberries as a result of the addition of ascorbic acid, where the highest rate was (243.84 g. plant^{-1}) for the C3 V1 treatment, with an increase of 14.24% compared to the control treatment, while the lowest value was (198.86 g. plant^{-1}) for the control treatment for the V2 variety. The reason may be that vitamin C leads to an increase in vital activity, which increased the plant's ability to absorb nutrients easily, which have a major role in improving vegetative growth and thus improving the sexual ratio of flowers and increasing productivity [4].

Table (4): ANOVA of plant height, leaf area, plant dry weight, fruit weight and number of fruits of two varieties of strawberry under different treatments.

Source of variance	df	Yield per plant	Nitrogen content of leaves	Phosphorus content of leaves	Potassium content of leaves
Varieties	1	6523.88*	0.05*	0.06*	0.11*

Ascorbic acid	2	1335.66*	1.30*	0.12*	2.26*
cow dung extract	2	4236.92*	1.40 *	0.45*	2.61*
Total	35				
LSD 0.05		60.24	0.36	0.28	0.49

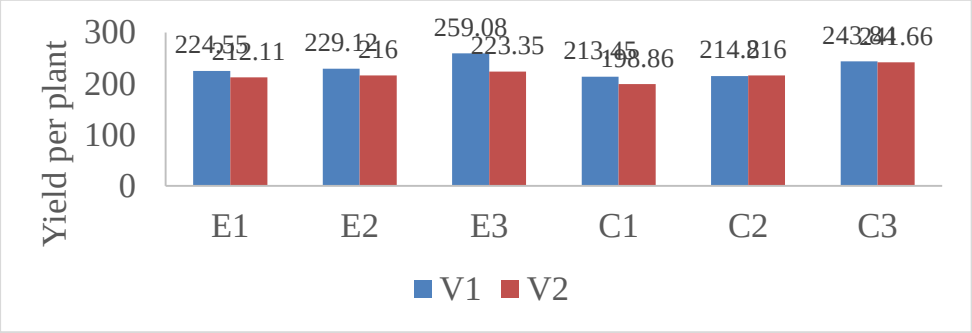

Figure (6): The effect of ascorbic acid levels and organic fertilizer on the plant yield of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels.

7- Percentage of nitrogen in leaves

Table 4 and Figure 7 demonstrate that applying organic fertilizer extract has greatly enhanced the percentage of nitrogen in leaves. The E3 V2 treatment showed the highest rate of 2.69%, which is a 45.41% increase compared to the control treatment. On the other hand, the control treatment for the V2 variety had the lowest rate of 1.85%.

The increase in nitrogen in the leaves when using compost extract (decomposed cow dung) may be caused by the slow decomposition of cow dung in water and the slow release of nitrogen, which contributes to increasing the availability of this element in the plant. These results are consistent with [17].

It is clear from Table (4) and Figure (7) that strawberry plants have responded significantly to the addition of ascorbic acid (vitamin C), which led to an increase in the percentage of nitrogen in the leaves, where the highest value was (2.67%) for the C3V1 treatment, where the increase rate was 38.34% compared to the control treatment. In comparison, it was less (1.86%) value for the C1V2 treatment. The reason may be that ascorbic acid reduces oxidation in plant cells, which enhances the efficient use of nutrients, including nitrogen.

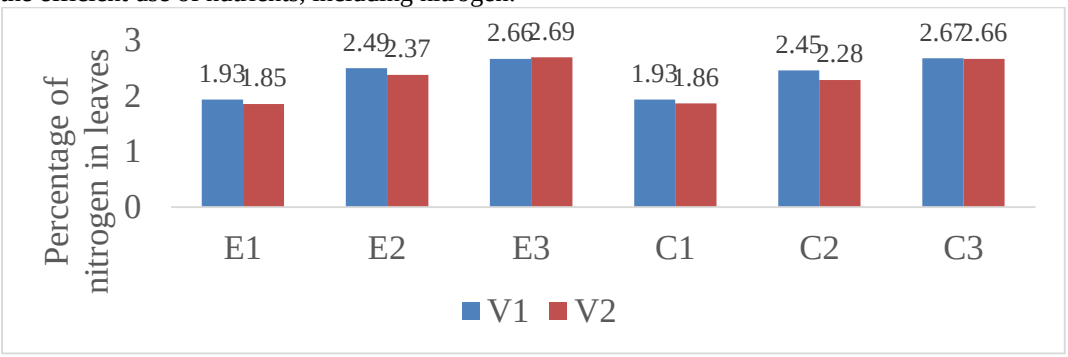

Figure (7): The effect of ascorbic acid levels and organic fertilizer on the percentage of nitrogen in leaves of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels

8- Percentage of phosphorus in leaves

Table (4) and Figure (8) show that the addition of organic fertilizer extract has significantly increased the Percentage of phosphorus in leaves, reaching the highest rate (0.85%) for the E3 V1 treatment with an increase of 112.5% compared to the control treatment. The reason may be that organic fertilizer promotes microbial activity in the soil, which is important in converting phosphorus from its unavailable forms to forms that plants can easily absorb. These results are consistent with [15].

The data presented in Table (4) and Figure (8) clearly demonstrate a substantial impact of adding ascorbic acid on the percentage of phosphorus in leaves. The C3V1 treatment exhibited the highest phosphorus rate of 0.76%, representing an 80.95% increase compared to the control treatment, which had the lowest rate. The reason may be that ascorbic acid may be a catalyst or helper in the process of absorbing elements, which increases the plant's ability to absorb phosphorus available in the soil and thus increases its percentage in the plant.

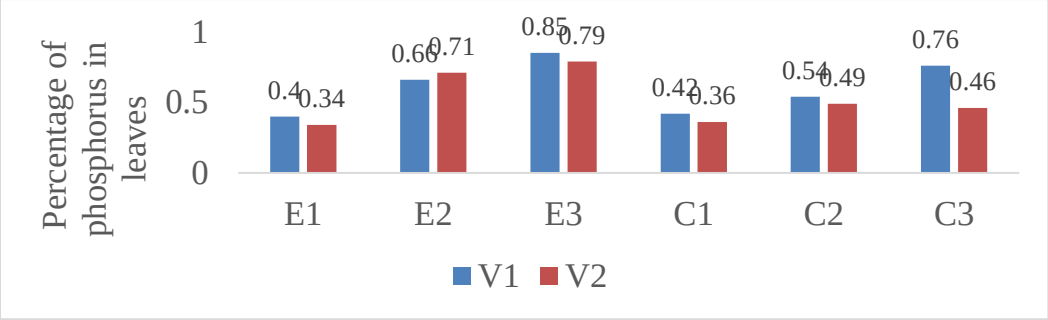

Figure (8): The effect of ascorbic acid levels and organic fertilizer on the percentage of phosphorus in leaves of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels

9- Percentage of potassium in leaves

Table (4) and Figure (9) show that there is a significant increase in the percentage of potassium in the leaves as a result of the use of organic fertilizer extract, where the highest rate was (2.23%) for the treatment of V2 E3 with an increase of 142.39% compared to the control treatment. These results are consistent with [15].

From Table (4) and Figure (9), it is clear that the addition of ascorbic acid led to a high percentage of potassium in the leaves, where the highest rate was (2.04%) for the C2 V2 treatment, with an increase of 119.35% compared to the control treatment, which had the lowest rate. The reason may be that ascorbic acid is an antioxidant agent in plant cells, which enhances the efficient use of nutrients, including nitrogen. It may be a catalyst or helper in the process of absorbing elements, which increases the plant's ability to absorb phosphorus available in the soil and thus increases its percentage in the plant.

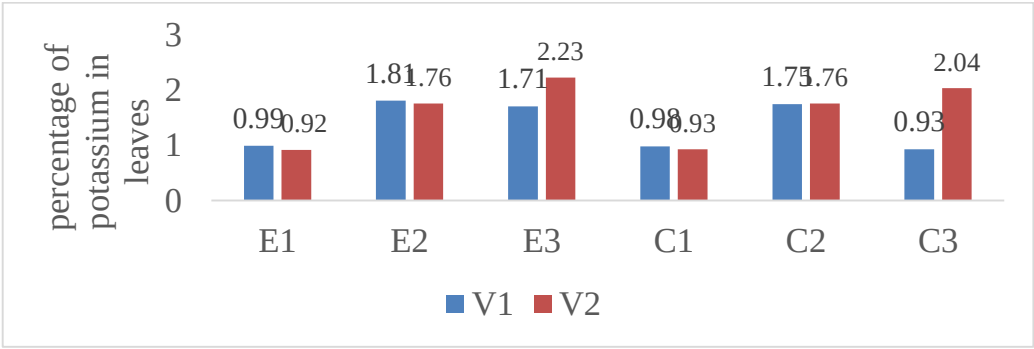

Figure (9): The effect of ascorbic acid levels and organic fertilizer on the percentage of potassium in leaves of two strawberry varieties . (V2, V1)Strawberry varieties, (C1,C2,C3) levels of ascorbic acid ,(E1,E2,E3) organic fertilizer extract levels.

Conclusions

The excessive use of chemical fertilizers in the world leads to negative repercussions on the environment and human health, Organic fertilizer is essential for enhancing the productivity of agricultural land and minimizing environmental pollution caused by excessive use of chemical fertilizers. Recycling organic waste is a crucial factor in ensuring an adequate supply of organic fertilizers to meet the demands of agricultural land. The use of vitamin C (ascorbic acid) in agriculture can help improve the growth and development process in plants and enhance their immunity against diseases and environmental stresses. Accordingly, this research was conducted using three levels of organic fertilizer extract (decomposed cow manure) ((0:0), (1:1), (1:2)) and three levels of ascorbic acid: (0, 30 and 60 $mg.l^{-1}$) and by observing its effect on the growth and productivity of two varieties of strawberries Albion and Rubygem. The concentration of the coefficients C3 and E3 was higher in most of the parameters. The Albion variety excelled in all traits except for the percentage of potassium in leaves, and the Percentage of nitrogen in leaves in the treatment of organic fertilizer extract only.

Acknowledgment

The researcher expressed his gratitude to the Faculty of Agriculture/Samarra University for their assistance in completing this research.

Conflict of Interest

The author declares that there is no conflicts of interest regarding the publication and/or funding of this manuscript.

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تأثير إضافة مستخلص الأسمدة العضوية وحمض الأسكوربيك على نمو وانتاج اثنين من أصناف الفراولة

(*Fragaria X ananassa* Duch.)

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الخلاصة

نفذت تجربة اصص في البيت البلاستيكي التابع لكلية الزراعة / جامعة سامراء للموسم الزراعي 2023 لدراسة تأثير اضافة ثلاثة مستويات من حامض الاسكوربيك (فيتامين***C***) هي (0 و 30 و 60 ملغم.لتر−1) وثلاثة مستويات من مستخلص الأسمدة العضوية (روث الابقار المتحلل) ((0 :0)، (

1:1)، (1:2)) في نمو وحاصل صنفين من الفراولة ***Albion*** و ***Ruby Gem*** . نفذت التجربة باستخدام تصميم القطاعات العشوائية الكاملة ***RCBD*** بثلاثة مكررات وبواقع ثلاث شتلات لكل وحدة تجريبية . وحللت النتائج إحصائيا باستخدام برنامج ***SPSS var 24*** . وقد أظهرت النتائج ان لإضافة حامض الاسكوربيك ومستخلص الأسمدة العضوية (روث البقر المتحلل) تأثير معنوي في صفات نبات الفراولة، حيث تم تسجيل اعلى معدل لها (26.92 سم) ، (59.77سم2)، (33.57 غم)،(17.67 ثمرة. نبات−1)،(259.08 غم. نبات−1)،(2.69%)،(0.85%)،(2.23%) لصفات ارتفاع النبات، المساحة الورقية، عدد الثمار، وزن الثمار، الوزن الجاف للنبات، عدد الثمار في النبات، حاصل النبات، مستوى النتروجين في الأوراق، مستوى الفسفور في الأوراق، مستوى البوتاسيوم في الأوراق على التوالي نتيجة إضافة مستخلص السماد العضوي(روث البقر المتحلل) بينما بلغ أعلى معدل لوزن الثمرة (15.56 غم) عندما تمت إضافة حامض الأسكوربيك. وقد تفوق الصنف ***Albion*** في جميع الصفات ما عدا صفة مستوى النتروجين في الأوراق ومستوى البوتاسيوم في الأوراق، بينما لم يتفوق الصنف ***Ruby Gem*** سوى في صفتي مستوى النتروجين في الأوراق ومستوى البوتاسيوم في الأوراق.

الكلمات المفتاحية: حامض الاسكوربيك، مستخلص روث الابقار، تسميد عضوي، نبات الفراولة، فيتامين