Effects of Foliar Application of Ascorbic Acid and Organic Fertilizer on the Vegetative Growth of Jojoba Seedlings

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Abstract

The experiment was conducted at the Agricultural Research Station belonging to the College of Agriculture, University of Kufa, on April 5, 2025, on 6-month-old jojoba seedlings, aiming to study the effect of foliar spraying with ascorbic acid and the addition of organic fertilizer, as well as their interaction, on some vegetative growth indicators of jojoba seedlings. The experiment was carried out according to the complete randomized block design (R.C.B.D) as a factorial experiment with three replications and three seedlings per experimental unit. The first factor represented ascorbic acid at three concentrations (0, 0.5, 1) g/L, while the second factor represented organic fertilizer at three concentrations (0, 10, 20) g/L. The results indicated that foliar spray treatments with ascorbic acid had a significant effect on all studied traits compared to the control treatment. The concentration of 1 g L^{-1} achieved the highest averages in seedling height, number of leaves, number of lateral branches, and the percentage of dry matter in the leaves. The treatment with organic fertilizer at a concentration of 20 g L^{-1} showed a significant superiority in all studied traits compared to the control treatment. As for the binary interaction between the two study factors in affecting the studied traits, the interaction treatment (spraying ascorbic acid at a concentration of 1 g L^{-1} + adding organic fertilizer at a concentration of 20 g L^{-1}) was significantly superior to the other treatments.

Key words: Foliar spray, organic fertilizer, jojoba seedlings, growth performance

Introduction

Jojoba (Simmondsia chinensis) is considered a desert plant that naturally grows in areas between Mexico and the southern United States. This plant belongs to a climbing family known as (Simmondsiaceae). The cultivation of jojoba has expanded in recent years due to its global commercial value for its oil, which is used in many pharmaceutical, cosmetic, and mechanical industries, making it internationally described as 'green gold' [4].

The leaves of the jojoba plant are oval and thick, covered with a dense waxy layer that reduces water loss through transpiration and resists unfavorable environmental conditions [7]. It is also classified as a dioecious plant, in which male and female flowers occur on separate plants. Pollination occurs primarily through wind, as the flowers lack scent to attract insects, while the lightweight pollen grains are capable of being dispersed over long distances [9]. Ascorbic acid, also known as vitamin C, is considered one of the vital compounds in plants, as it plays a fundamental role in many physiological processes, such as regulating photosynthesis, stimulating cell division, participating in oxidation and reduction processes, in addition to its role in enhancing the plant's resistance to various environmental stresses [10].

Organic fertilization is considered one of the most important modern agricultural

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practices aimed at improving the physical, chemical, and biological properties of the soil, as it contributes to increasing organic matter, improving soil structure, and enhancing the biological activity of beneficial microorganisms, in addition to its role in providing nutrients gradually and in a balanced manner to plants [12].

Given the economic value of Jojoba seedlings and their ability to withstand harsh environmental conditions, the study aimed to determine the best concentration of ascorbic acid and organic fertilizer in improving the vegetative growth of Jojoba seedlings.

Materials and Methods

The experiment was conducted at the Agricultural Research Station - College of Agriculture - University of Kufa, on 5/4/2025, on six-month-old jojoba seedlings that were as uniform as possible in growth and size. The seedlings were healthy, free from disease and pest infestations, and planted in containers with a capacity of 5 kg of mixed sandy soil. Subsequently, the soil of the seedlings was analyzed as shown in Table (1).

The experiment was designed according to the randomized complete block design (R.C.B.D) as a factorial experiment with two factors and three replications. The first factor represented ascorbic acid at three concentrations and the concentrations used were 0, 0.5, and 1 g/L, while the second factor represented organic fertilizer at three concentrations 0, 10, and 20 g/L, with three seedlings per experimental unit. Thus, the number of seedlings in each replication was 27 seedlings. The data were analyzed using the statistical program GenStat V12, and the means of the treatments were compared using the Least Significant Difference (L.S.D) at a 5% probability level.

Table 1: Some Chemical and Physical Properties of the Experimental Soil

Unit	Values	Properties
$ds.m^{-1}$	1.71	Electrical Conductivity (EC)
-	7.53	Soil pH
%	0.51	Available Nitrogen
%	0.46	Available Phosphorus
%	1.42	Available Potassium
Soil Fractions		
%	60	Sand
%	21	Silt
%	19	Clay
Sandy Mix		Soil Texture

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Traits Measured:

1. Seedling Height (cm)

The seedling height was measured using a measuring tape from the soil surface of the planter to the top of the seedling.

2. Number of Leaves (leaf per seedling)

It was calculated by taking the average number of leaves for all experimental units and for three replicates.

3. Number of Lateral Branches (branch per seedling)

The number of lateral branches for each seedling was counted, and then the average number of branches per treatment was calculated.

4. Percentage of Dry Matter in Leaves (%)

Three leaves were taken from each experimental unit. They were washed with tap water, then with distilled water to remove soil, and then air-dried. Afterward, they were placed in perforated paper bags and in an electric oven at 65°C until a constant weight was achieved, and then the samples were weighed using a sensitive electronic balance. The percentage of dry matter was calculated according to the following equation:

$$\text{Percentage of Dry Matter in Leaves} = \frac{\text{Dry Weight}}{\text{Fresh Weight}} \times 100\%$$

3- Results and Discussion:

3 - 1 Seedling Height (cm)

The results of Table (2) indicate a significant effect of treatment with ascorbic acid on the average height of Jojoba seedlings, as the treatment (1 g L^{-1}) gave the highest average for this characteristic, reaching 59.88 cm compared to the control treatment (0 g L^{-1}), which gave 55.00 cm. Moreover, the addition of organic fertilizer caused a positive effect on the average seedling height, as the treatment (20 g L^{-1}) significantly exceeded with the highest value of 63.09 cm compared to the control treatment (0 g L^{-1}), which gave 52.15 cm.

The interaction between ascorbic acid and organic fertilizer had a significant effect on the average seedling height, as the treatment (spraying ascorbic acid at 1 g L^{-1} + adding organic fertilizer at 20 g L^{-1}) recorded the highest average of 65.87 cm compared to the control interaction treatment, which gave the lowest value of 50.52 cm.

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Table 2: Effect of foliar spraying with ascorbic acid and the addition of organic fertilizer on the growth of jojoba seedlings and the interaction between them in the average seedling height (cm)

Organic fertilizer Concentrations g L^-1	Ascorbic acid Concentrations g L^-1			Average organic fertilizer
	0	0.5	1	
0	50.52	52.31	53.63	52.15
10	54.21	57.31	60.13	57.22
20	60.27	63.13	65.87	63.09
Average ascorbic acid	55.00	57.58	59.88	
L.S.D 0.05	organic fertilizer		Ascorbic acid	Interaction
	1.04		1.04	2.06

3-2 Number of leaves (leaf per seedling)

The results shown in Table (3) indicate the presence of significant differences in the number of leaves among the treatments as a result of spraying with ascorbic acid, where treatment (1 g L-1) excelled by giving the highest average number of leaves, reaching 168.33 leaves per seedling, while the control treatment (0 g L-1) recorded the lowest average number of leaves, reaching 147.00 leaves per seedling. It is also noted from the same table that the addition of organic fertilizer significantly affected the average number of leaves, as treatment (20 g L-1) excelled by recording the highest average number of leaves, reaching 175.33 leaves per seedling, compared to the control treatment (0 g L-1), which achieved the lowest average of 138.33 leaves per seedling.

Table (3) also indicates the presence of a significant effect of the interaction between the study factors. The treatment (spraying with ascorbic acid 1 g L^-1 + addition of organic fertilizer 20 g L^-1) gave the highest average total number of leaves, reaching 190 leaves per seedling, whereas the comparative treatment showed the lowest average number of leaves, amounting to 130 leaves per seedling.

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Table 3: Effect of foliar spraying with ascorbic acid and the addition of organic fertilizer on the growth of jojoba seedlings and their interaction on the average number of leaves per seedling (leaves per seedling)

Organic fertilizer Concentrations g L^-1	Ascorbic acid Concentrations g L^-1			Average organic fertilizer
	0	0.5	1	
0	130	138	147	138.33
10	150	159	168	159.00
20	161	175	190	175.33
Average ascorbic acid	147.00	157.33	168.33	
L.S.D 0.05	organic fertilizer		Ascorbic acid	Interaction
	4.11		4.11	8.20

3-3 Number of lateral branches (branch per seedling)

The results presented in Table (4) indicated that spraying with ascorbic acid had a positive effect on increasing the number of lateral branches, particularly with the treatment (1 g L^{-1}), which recorded the highest significant increase in the average number of lateral branches, reaching 9.53 branches per seedling compared to the other treatments. The control treatment (0 g L^{-1}) recorded the lowest average number of lateral branches, amounting to 6.96 branches per seedling.

Regarding soil fertilization with organic fertilizer, the level of significance was reached at the treatment of (20 g L^{-1}), which achieved the highest average in the number of lateral branches, amounting to 9.33 branches per seedling, while the control treatment (0 g L^{-1}) recorded the lowest average number of lateral branches, amounting to 7.15 branches per seedling.

As for the binary interaction between ascorbic acid spray treatments and organic fertilizer treatments, it had a significant effect on the average number of lateral branches of jojoba seedlings. The interaction treatment (ascorbic acid spray 1 g L^-1 + addition of organic fertilizer 20 g L^-1) achieved the highest significant increase, reaching 11.00 branches per seedling, whereas the control interaction treatment recorded the lowest average number of lateral branches, reaching 6.00 branches per seedling.

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Table 4: Effect of foliar spraying with ascorbic acid and the addition of organic fertilizer on the growth of jojoba seedlings and their interaction on the number of lateral branches (branch per seedling)

Organic fertilizer Concentrations g L^-1	Ascorbic acid Concentrations g L^-1			Average organic fertilizer
	0	0.5	1	
0	6.00	7.51	7.93	7.15
10	7.21	8.17	9.67	8.35
20	7.67	9.33	11.00	9.33
Average ascorbic acid	6.96	8.34	9.53	
L.S.D 0.05	organic fertilizer		Ascorbic acid	Interaction
	0.33		0.33	0.61

3-4 Percentage of dry matter in the leaves (%)

The results in Table (5) show the effect of spraying treatment with ascorbic acid. The treatment (1 g L-1) had the highest percentage of dry matter in the leaves, reaching 28.33%, compared to the control treatment (0 g L-1), which gave the lowest average dry matter in the leaves at 26.69%.

As observed from the results of Table (5), there are significant differences in the percentage of dry matter in the leaves as a result of the organic fertilizer treatments, which reached their peak at the treatment (20 g L^-1), yielding the highest percentage of 28.39% compared to the other treatments, whereas the control treatment (0 g L^-1) produced the lowest dry matter percentage in the leaves, reaching 26.98%.

The interactions of the binary treatment between ascorbic acid and the application of organic fertilizer significantly influenced the dry matter content of jojoba seedling leaves. The combined treatment of 1 g L^{-1} ascorbic acid foliar spray and 20 g L^{-1} organic fertilizer produced the highest value (29.37%), significantly outperforming the other treatments. In contrast, the untreated control recorded the lowest dry matter percentage (26.20%).

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Table 5: Effect of foliar spraying with ascorbic acid and the addition of organic fertilizer on the growth of jojoba seedlings and their interaction in the percentage of dry matter in the leaves (%)

Organic fertilizer Concentrations g L^-1	Ascorbic acid Concentrations g L^-1			Average organic fertilizer
	0	0.5	1	
0	26.20	27.13	27.60	26.98
10	26.86	28.41	28.01	27.76
20	27.01	28.80	29.37	28.39
Average ascorbic acid	26.69	28.11	28.33	
L.S.D 0.05	organic fertilizer		Ascorbic acid	Interaction
	0.17		0.17	0.32

The role of ascorbic acid in increasing vegetative growth indicators in jojoba seedlings, represented by the average seedling height (Table 2), the average number of leaves (Table 3), the average number of lateral branches (Table 4), and the percentage of leaf dry matter (Table 5), may be attributed to the vital role that ascorbic acid plays in many physiological processes within the plant. These include cell growth and differentiation, in addition to its role as a cofactor for numerous enzymes and hormones within the plant, such as auxins, gibberellins, and cytokinins [11]. These factors encourage cell division, the growth of lateral shoots, and leaf expansion as a result of stimulating cell division, enlargement, and cell wall extension [6].

Ascorbic acid also plays a role in increasing the number of leaves of the plant due to the increase in the number of branches, as it works to increase the chlorophyll content in the leaves, thereby enhancing vegetative and root growth in the plant [8]. Moreover, appropriate concentrations of ascorbic acid, particularly the concentration of 1 g/L, have led to a suitable effect that contributed to stimulating growth-promoting substances such as auxins, gibberellins, and endogenous cytokinins, thereby increasing cell division and elongation, followed by the translocation of manufactured nutrients toward the branches to boost their growth and development. This is expected to increase manufactured nutrients, mainly carbohydrates, and their use in various construction and growth processes in the plant, which has led to an increase in plant height, the number of leaves, and lateral branches [2].

Regarding the increase in the dry matter content in the leaves, the reason may be that spraying with ascorbic acid encouraged the plant to enhance

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the synthesis and accumulation of metabolites in the leaves, alongside improving the photosynthesis process and the availability of nutrients. This led to an increase in the amount of carbohydrates and the protein content in the leaves, thereby resulting in a higher proportion of this trait in the leaves [1].

The improvement and increase in the vegetative growth indicators of jojoba seedlings may be attributed to the significant role that organic fertilizers play in raising nitrogen levels in the plant, which helps maintain the stability of chlorophyll pigments and prevents their enzymatic degradation under varying environmental conditions. This, in turn, encourages growth, increases cell size, and consequently enhances the overall vegetative mass and leaf area of the seedlings, in addition to improving the physical and chemical properties of the soil, increasing the efficiency of biological processes, enhancing soil fertility, and supplying it with macro and micronutrients [5].

The results indicate that the combined interaction between ascorbic acid and organic fertilizer improved the vegetative growth characteristics in jojoba seedlings, as ascorbic acid is one of the antioxidants that work to protect cellular components from various environmental conditions. In addition, the interaction between these factors achieved the highest values in the vegetative growth traits during this study, which indicates the importance of combining foliar spraying with ascorbic acid and soil addition of organic matter. Organic fertilizer provides a nutrient-rich environment for the plant, containing essential elements important for its growth, thereby increasing the plant's capacity for vegetative growth [3].

Conclusion

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