Effect of Nano Silicon spraying on the Growth and Yield of Three Varieties of Faba Bean Grown in Saline Soil.

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Abstract:

A field experiment was carried out during winter seasons (2021-2022) in the field experiments field of the Muradiya, to know the study of the effect of silicon nanospraying on the growth and yield of three varieties of faba beans grown in saline soils. The experimental design was carried out in the arrangement of splinter panels according to the design of the complete random sectors (RCBD) in three repeats, The varieties (Turkish, Spanish and Dutch) included the main panels while the secondary panels included the paper spraying of nano-silicon Included three concentrations (0, 1 and 2 ml/L) . The process of spraying silicon nanotechnology was performed in two periods, the first spray after 88 days of germination (the stage of the beginning of flowering) and the second spray two weeks after the date of the first spray, the first season was planted on 15/10/2021. The results showed the superiority of foliar feeding with a concentration of silicon nano scale 2 ml \liter significantly in the paper area (2869.20 cm ^{2}) and the seed yield (2.75 tons / h), while the varieties outperform the Spanish variety in most of the studied characteristics plant height (108.92 cm), leaf area (3315.00 cm ^{2} and seed yield (3.01 tons / ha).

Key Word : Faba Bean – Nano-silicon – Saline soils

Introduction

Faba bean (*Vicia faba* L.) One of the plants of the leguminous family is important and widespread in the world and is one of the main sources of protein in many countries of Africa and Asia, and is grown for the purpose of obtaining green pods or soft or dry seeds, as it contributes significantly to the balance of the diet due to its content of the most important sources of vegetable protein, as it contains (25-40%) of protein rich in multiple amino acids, which compensates for animal protein, making it one of the important sources of protein, so it is considered part of It is important in the diet of peoples, especially those with limited income [1] In the statistics of the World Food Organization, the global production of green horns reached 1725395.71 tons with a cultivated area of 277445.00 AH^{-1}, while in Iraq the production of green horns reached 33354.0 tons and a cultivated area of 5421.0 cm2 [2]. The importance of the bean food crop calls for serious thinking to increase the productivity of this crop, especially cultivated under different tensile conditions, especially salt tension in the soils of central and southern Iraq, and among the most important means used for the purpose of increasing yield and overcoming some stresses, especially salt stress, is the use of foliar feeding, as foliar feeding is more efficient and economically feasible compared to other feeding methods. The large amounts

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of nutrients required by the same stage if compared to their addition through the soil. The rationale for the use of foliar spraying of silicon compounds is an assumption resulting from the fact that foliar feeding with silicon can compensate for the low absorption of roots in the case of low availability of absorbable silicon in the soil, and the relatively complex absorption process of silicon by the roots resulting in an improvement in the process of silicon absorption and beneficial effects in the plant [3], and silicon strengthens the cell walls leading to mechanical support of the aerial parts of the plant as it stimulates the plant to develop some One of the mechanisms that enable it to resist or withstand various tensile conditions, whether biotic or abiotic tension, especially under saline tension conditions [4] . [5] pointed out that spraying nano-silicon on bean plants stimulates the antioxidant system by increasing the effectiveness of antioxidant enzymes and thus improves crop growth under saline tension. In the end, nanofertilizers are the most technically advanced way to provide crops with mineral nutrients compared to conventional chemical fertilizers, and provide them with the nutrients needed to meet plant needs, reduce loss, and thus improve the efficiency of fertilizer use, as enhancing the efficiency of fertilizer use and reducing its inputs has important implications in enhancing economic and environmental benefits. [6] In a study on the pea yield, in which concentrations of nanosilicon (0, 50, 100 and 200) mmolar were sprayed that the treatment of silicon nano-100 mmol significantly affected plant height, number of leaves and leaf area, as it reached 93.3 cm, 34.6 leaf-1 and 634.3 cm2 plants-1 respectively, while the comparison treatment gave 80.6 cm, 24.2 leaf-1 and 515.8 cm2 plant-1 respectively. Note [7] that the treatment of leaves of bean plants with four concentrations of nano silicon (0, 1, 1 and 1.5 mmole), significantly affected the characteristic of the number of pods per plant, the number of seeds per pod, the weight of 100 seeds and the total seed yield, as the concentration of 1.5 mmol achieved the highest average of 12.93 (pod-1, 3.05 pod seeds-1, 71.07 g and 5.172 kg E-1) respectively, compared to the comparison treatment that gave the lowest average of (10.76 plant pods-1 and 2.86 pod seeds -1, 67.89 g and 4.313 kg E-1) respectively. Due to the importance of the above and to reduce the negative impact of soil salinity on growth indicators and bean yield through the use of the following means:

1- Using different concentrations of foliar spraying of silicon nanoscale to improve growth indicators and yield of beans plant.

2- Cultivation of several varieties under the conditions of Babylon Governorate so that we can know the most responsive variety under the conditions of cultivation in saline soils.

MATERIALS AND METHODS

A field experiment was carried out during winter seasons (2021-2022) in the field experiments field of the Muradiya, to know the study of the effect of silicon nanospraying on the growth and yield of three varieties of faba beans grown in saline soils. The experimental design was carried out in the arrangement of splinter panels according to the design of the complete random sectors (RCBD) in three repeats, The varieties (Turkish, Spanish and Dutch) included the main panels while the secondary panels included the paper spraying of nano-silicon Included three concentrations (0, 1 and 2 ml/L) . The process of spraying silicon nanotechnology was performed in two periods, the first spray after 88 days of germination (the stage of the beginning of flowering) and the second spray two weeks after the date of the first spray, the first season was planted on 15/10/2021. The land was plowed perpendicular to the dump plow (Mold Board) deeply30 cm, and then the soil was smoothed and leveled laser and the main waterways were opened by the conqueror of the waterways, then the land was divided into three main sectors, the distance between one sector and another1 m for drivers and

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corridors for service operations, each sector contains (9) Experimental units distance between them80 cm to ensure that volatile spray does not reach the experimental units when spraying, the area of the pilot unit 6 ^{m2} with dimensions 2×3 Each experimental unit contained four Maroz, the distance between Marz and another 75 cm and between a plant and another 25 cm. The experimental plants were harvested when they reached physiological maturity, The harvesting process was carried out successively according to the ripening dates of the studied varietie.The soil and water were examined in the soil and water analysis laboratory of the Directorate of Agriculture of Babylon at the Muradia Research Station as in Table (1). The data were analyzed statistically and for all the studied traits using the method of analysis of variance according to the Genstat program , and the test of the least significant difference (LSD) at the level of probability 0.05 was used to compare the arithmetic averages. [8] .

2-1 Vegetative growth qualities of the bean plant

2.1.1 Plant height (cm)

2.1.2 Number of branches in the plant (branches plant $^{-1}$)

2.1.3 Leaf area (cm^2 plant^{-1})

2.2 Quotient characteristics and components

2.2.1 Number of pods (pod plant $^{-1}$)

2.2.2 Number of seeds in the pod (seed pod $^{-1}$)

2.2.3 Weight of 100 seeds (g)

2-2-4 Seed yield (ton h^{-1})

Table (1) Some Chemical and Physical Soil Characteristics of Field Soil and Water for the Season (2021-2022)

Sample	degree of reaction (pH)	Electrical conductivity EC (ds\ m)	Ready-made items (mg $^{kg-1}$)			Organic matter OM %	Soil separations %			
			Nitrogen	Phosphorus	Potassium		Mud	silt	sand	Soil texture
The soil	**7.8**	**7**	**31.3**	**18.2**	**125**	**0.54**	**80**	**600**	**320**	Alluvia blend
Watering water	**7.3**	**1.95**	**19.4**	**8.3**	**1.13**	**-**	**-**	**-**	**-**	

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Results and discussion

3-1 Plant height (cm)

The results of Table 2 showed significant differences between the varieties in the characteristic of plant height, as the Turkish variety achieved the highest average of 108.92 cm, while the Dutch variety achieved the lowest average of 84.24 cm, and perhaps the reason for the difference in varieties among themselves in plant height is that the Turkish variety has the genetic and physiological ability to benefit from the foliar spraying coefficients to reach the highest A number of studies have confirmed that the varieties and genetic structures of beans differ significantly in plant height [9].

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml $^{liter-1}$ achieved the highest average of 97.70 cm, compared to the comparison treatment (distilled water only), which achieved the lowest average of 88.72 the reason for the increase is attributed to the role of silicon in increasing plant growth by improving the mechanical strength of stems and leaves and thus providing the best condition for radiation interception. Photosynthesis, light absorption and increasing the plant's ability to photosynthesize, which in turn leads to an increase in vegetative growth of the plant, these results are consistent with the findings [10] and the bilateral interference between the varieties and silicon nanospraying did not have any significant effect.

Table (2) Effect of Varieties and Nano silicon on Plant Height (cm) Characteristic of Faba Bean.

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	dutchman	Manes nano silicon
0	102.74	82.84	80.60	88.72
1	109.80	87.15	84.07	93.67
2	114.03	90.84	88.03	97.70
Manes Varieties	108.92	86.94	84.24	
LSD $_{0.05}$	V= 2.999 SI= 1.223 SI*V =NS			

3.2 Number of branches (branches plant $^{-1}$)

The results of Table 3 showed that there are significant differences between the varieties for the two seasons in the number of branches, the Spanish variety achieved the highest average of 9.12 plant $^{branches-1}$, while the Dutch variety achieved the lowest average of 8.35 branches / plant, due to the genetic variability between the varieties as well as the difference in their ability to exploit growth factors and respond to environmental factors prevailing in the region.

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml $^{liter-1}$ achieved the highest average of 9.45 branches / plant, compared to the comparison treatment (distilled water only) which gave the lowest average of 8.17 and 8.80 Branch / plant, the

reason is due to the role of silicon in strengthening the cell walls, which leads to mechanical support of the aerial parts of the plant and thus increases the height and the number of branches as well as silicon has an important role in increasing the absorption of water and nutrients such as potassium and increasing the rate of biosynthesis of chlorophyll and the efficiency of photosynthesis [11].

Table (3) Effect of Varieties and Nano silicon on the Number of Branches (Branch / Plant) of Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	dutchman	Manes nano silicon
0	7.98	8.57	7.93	8.17
1	8.92	8.99	8.17	8.70
2	9.63	9.79	8.92	9.45
Manes Varieties	8.85	9.12	8.35	
$LSD_{0.05}$	V= 0.328 SI = 0.206 SI*V =0.586			

3-3 Leaf area (cm^2)

The results of Table 4 showed significant differences between the varieties for the two seasons in the characteristic of the leaf area cm 2, the Spanish variety achieved the highest average of 3315.00 cm 2 , while the Turkish variety achieved the lowest average of 2347.60 cm^2 , the reason for the difference between the varieties in the leaf area may be due to the difference in their genetic origins, which control in specific proportions the phenotypic and anatomical characteristics of the plant as well and Most of the genetic structures of beans give a leafy area determined by the number of leaflets and the width and length of the leaflet, so this trait is controlled by the genetic and environmental factor mainly in determining the leaf area of the plant[12]

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 $^{ml-1}$ achieved the highest average of 2869.20 cm 2 / plant, compared to the comparison treatment (distilled water only), which achieved the lowest average of 2492.90 cm^2 / plant, this increase can be attributed to the fact that spraying silicon on the vegetative system increases the efficiency of enzymatic activity and affects the epidermal cells at the angle of inclination of the leaf in a way that makes it standing, which increases The efficiency of photosynthesis also increases the proportion and thus enhances photosynthesis [4]. The bilateral overlap between the study factors had no significant effect on this characteristic.

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Table (4) Effect of varieties and nano silicon on the characteristic of the leaf area of the plant cm ^{2} / plant for the Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	Dutch	Manes nano silicon
0	2144.1	3131.5	2203.1	2492.90
1	2354.7	3335.8	2441.0	2710.50
2	2543.9	3477.8	2586.0	2869.20
Manes Varieties	2347.60	3315.00	2410.00	
LSD $_{0.05}$	V= 27.29	SI = 27.29	SI*V =NS	

***3-4 Number of pods (pod/plant*)**

The results of Table 5 showed significant differences between the varieties for the two seasons in the number of pods, the Spanish variety achieved the highest average of 20.36 pods / plant, compared to the Dutch variety, which achieved the lowest average of 17.30 pods / plant, and perhaps the reason for the variation in the characteristic of the number of pods to the superiority of the same variety in the number of branches in the plant (Table 3) reflected positively in the processing of new emerging sites in the plant such as flowers with their requirements of manufactured food to increase the percentage of fertility in flowering Hence increasing the number of pods in the plant. In this area, he pointed out [13] that the plant can increase the percentage of fertility and nodes in flowers and pods, which can be equipped with photosynthetic products only,

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml / liter achieved the highest average of 19.85 cornets / plant, compared to the comparison treatment (distilled water only), which achieved the lowest average of 17.80 plant cornets, perhaps due to the fact that silicon improves the activity of the photosynthesis process and the efficiency of its representation in the plant and then increase the dry matter and these factors are associated with the efficiency of transportation and the result is obtaining the largest number of filled seeds And the weight increase of 100 seeds Table (6), which leads to a high yield [14].

The interference between the varieties and nanosilicon had a significant effect on the number of pods, as the interference between the Spanish variety and the 2 ml / liter silicon nanospray spray achieved a high average of 21.32 pods / plant, while the interference between the Dutch variety and the comparison treatment achieved the lowest average of 16.07 pods / plant.

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Table (5) Effect of Varieties and Nano silicon on the Number of Pods Pod / Plant for Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	Dutch	Manes nano silicon
0	18.08	19.22	16.07	17.80
1	18.88	20.52	17.46	18.96
2	19.84	21.32	18.37	19.85
Manes Varieties	18.94	20.36	17.30	
$LSD_{0.05}$	V= 0.202 SI= 0.172 SI*V = 0.287			

3.5 Number of seeds per pod (seed/pod)

The results of Table 6 showed significant differences between the varieties in the number of seeds in the pod, the Spanish variety achieved the highest average of 5.18 seeds / pod, while the Dutch variety achieved the lowest average of 4.56 seeds / pod, and the reason for this is due to the difference in the genetic nature of the variety from other varieties in the characteristic of the number of seeds in the pod, as well as the ability of the variety to transfer photosynthetic products as well as the transfer of nutrients, especially related to increasing the percentage of fertility in pods from the source. Downstream, this finding agreed with the findings of [15] who pointed out that the varieties differ among themselves in the number of seeds in the pod.

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml / liter achieved the highest average of 5.18 seeds / pod, compared to the comparison treatment (distilled water only) which achieved the lowest average of 4.68 seeds / pod. Bilateral overlap between varieties and silicon spraying had no significant effect on this characteristic.

Table (6) Effect of Varieties and Nano silicon on the Characteristic of the Number of Seeds in the Pod Pod $^{Seed\ -1}$ of the Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	Dutch	Manes nano silicon
0	4.78	4.93	4.32	4.68
1	4.84	5.04	4.62	4.84
2	5.24	5.54	4.73	5.18
Manes Varieties	4.96	5.18	4.56	
$LSD_{0.05}$	V=0.100 SI= 0.150 SI*V =NS			

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3-5 weight 100 seeds (g)

The results of Table 7 showed significant differences between the varieties for the two seasons in the characteristic of weighing 100 seeds, the Spanish variety achieved the highest average of 216.92 g, while the Dutch variety achieved the lowest average of 183.95 g, and the reason for the variation in the weight of 100 seeds may be the nature of the genetic structure and its ability to absorb the products of the photosynthesis process produced from the source and the small number of seeds in the pod reflected positively with the weight of 100 seeds, and [13] The seed weight of any plant is a function of the rate of photosynthesis and the transport of its products. This finding is consistent with other researchers who have confirmed significant differences for bean varieties in the average weight of 100 seeds [16].

The results of the table also indicated that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml liters achieved the highest average of 201.36 g, compared to the comparison treatment (distilled water only), which gave the lowest average of 194.52 g, this increase may be due to the role of silicon affecting the increase in the rate of photosynthesis, changing the behavior of stomata and reducing the rate of transpiration in the leaves, and this means that the efficiency of photosynthesis increased significantly in the different stages of growth down to the seeds and that Using silicon in appropriate quantities can be useful in increasing photosynthesis efficiency that would affect the increase of yield indicators.

The results of the table also showed a significant effect of interference between varieties and nanosilicon in the characteristic of weighing 100 seeds, the interference between the Spanish variety and nanosilicon spraying at a concentration of 2 ml / liter achieved the highest average of 218.47 g, while the interference between the Dutch variety and the comparison treatment achieved the lowest average of 180.39 g.

Table (7) Effect of Varieties and Nano Silicon on the Weight of 100 Seeds of Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	Dutch	Manes nano silicon
0	189.62	213.53	180.39	194.52
1	194.84	218.76	183.44	199.01
2	198.67	218.47	186.92	201.36
Manes Varieties	194.38	216.92	183.59	
$LSD_{0.05}$	V=0.690 SI= 0.422 SI*V=0.807			

3.6 Seed yield (ton/h)

The results of Table 8 showed significant differences between the varieties for the two seasons in the characteristic of the total seed yield, the Spanish variety achieved the highest average of 3.01 tons / ha, compared to the Dutch variety, which achieved the lowest average of 2.11 tons / h, and the reason for the variation in the recipe of seed yield is that the varieties differ among themselves in this trait

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as a result of their difference in growth indicators and the yield of the number of pods and the number of seeds weighing 100 seeds according to their genetic differences and is Seed yield in most crops is the main target and is a complex quantitative trait controlled by a large number of genetic factors as well as environmental influences, growing conditions and their interactions, and is a function of all its main and secondary components and other growth characteristics [17].

The results of the table also showed that there are significant differences between the concentrations of silicon nano, as the concentration of 2 ml / liter achieved the highest average of 2.75 tons / ha, compared to the comparison treatment (distilled water only), which achieved the lowest average of 2.17 tons / ha, this increase is due to the role of silicon in increasing the yield indicators

The interference between the varieties and nanosilicon had a significant effect on the total seed yield, the interference between the Spanish variety and nanosilicon spraying at a concentration of 2 ml / liter achieved a maximum average of 3.39 tons / ha, while the interference between the Dutch variety and the comparison treatment achieved the lowest average of 1.88 tons / ha.

Table (8) Effect of Varieties and Nano silicon on the Characteristic of Total Seed Yield Ton h ^{1} for Faba Bean

Nano Silicon L\ ml	Varieties			
	Turkish	Spanish	Dutch	Manes nano silicon
0	1.98	2.62	1.88	2.17
1	2.27	3.01	2.09	2.46
2	2.50	3.39	2.34	2.75
Manes Varieties	2.25	3.01	2.11	
LSD $_{0.05}$	V=0.074 SI= 0.087 SI*V = 0.133			

Conclusions:

From the results obtained from the study, we conclude the following:

1- Silicon nanotechnology had a positive effect on the plant, especially the concentration of 2 ml / l, which exceeded in most of the characteristics of growth and yield, we recommend conducting more research on paper spraying silicon nanometers at higher concentrations and observing the extent of the plant's response to it.

2- Cultivation of the Spanish variety under the conditions of the experiment in order to excel in most of the characteristics of vegetative growth and indicators of yield and components and its introduction in future experiments related to agricultural operations to achieve the highest possible productivity and compare it with other varieties of Faba Bean

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