

Response of some faba bean varieties to Foliar Application of Arginine and Its Role in Mitigating Salinity Stress on Growth and Yield

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Abstract:

A field experiment was carried out during the winter season 2024-2025. with the aim of responding to three varieties of faba bean to Foliar application with Arginine and its reflection in reducing the Salinity stress in the growth and Productivity, the experiment was carried out in the order of the split plot plates according to the design of RCBD with three replicates, the experiment included three factors, the first important factor is the cultivation of three varieties of beans (the Dutch variety, the Italian variety, and the Spanish variety. V1, 2V, and 3V respectively which were placed in the Main plots, while the Sub-plots included three concentrations of Arginine, namely a Control treatment (Ar 0), a spray treatment of 50 mg/L (Ar 1), and a spray treatment of 100 mg/L (Ar 2). Productivities showed that the Spanish variety was significantly superior in the studied traits of plant height 85.74 cm, leaf area 2773 cm², number of pods/plant 5.80 pods/plant and seed yield 4.71 ton h⁻¹. On the sequel. As for spraying with Arginine, at a concentration of 100 mg L⁻¹, the studied traits of plant height 96.79 cm, leaf area 3035 cm², number of pods 6.23 pods/plant and seed yield 5.38 ton h⁻¹ respectively.

Keywords: Varieties of beans – Arginine – Saline soil

Introduction:

Faba bean *Vicia faba* L. is a major leguminous crop worldwide and a vital source of plant-based protein (25-40%)[1] especially in developing countries. However, its productivity in central and southern Iraq is severely limited by soil salinity. Salinity induces physiological imbalances, including reduced nutrient uptake, inhibition of root growth, and oxidative stress caused by the accumulation of Reactive Oxygen Species (ROS [8]. Bean varieties are highly diverse in terms of morphological, physiological and productive traits, due to genetic variations, breeding and selection conditions, as well as adaptation to different agricultural environments. These differences include seed

size, shape and color, plant length, number of branches, flowering and maturity date, in addition to the varieties varying in their ability to withstand environmental stresses such as salinity, drought, and high or low temperatures, as well as their resistance to diseases and pests [7], in a global FAO statistic, the global production of green pods reached 1725395.71 tons and a cultivated area of 277445.00 h⁻¹ In Iraq, the production of green pods reached 33354.0 tons with a cultivated area of 5421.0 h⁻¹ [4]. The importance of the food bean crop calls for serious thinking to increase the productivity of this crop, especially cultivated under different stress conditions, especially salt stress in the soils of central and southern Iraq, salinity leads to many physiological

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imbalances in bean plants, the most important of which is the decrease in the absorption of nutrients, inhibition of root growth, poor root node formation and the activity of Rhizobium bacteria, as well as a decrease in photosynthesis efficiency due to low chlorophyll content and intracellular ionic balance disturbance. Salinity also contributes to the increased accumulation of reactive oxygen species (ROS), which causes oxidative stress that reflects negatively on the integrity of cell membranes and leads to weakening of Pod setting and dropping, decreased number of pods and Seed filling, and consequently a decrease in the total yield of the crop [10]. In light of these challenges, biostimulant Foliar application techniques, particularly amino acids, have emerged as one of the most promising new strategies to mitigate the negative effects of salt stress. Arginine is an amino acid of high physiological importance in plants, as it is characterized by being a rich store of organic nitrogen, and is involved in multiple biopathways including the synthesis of polyamines and nitric oxide, which are essential compounds in regulating cell division, improving Pod setting, enhancing photosynthetic efficiency, and regulating plant response to environmental stresses, especially salinity [8]. Based on the above, it is important to study the role of Foliar application with Arginine in mitigating the negative effects of salt stress on the growth and productivity of different varieties of bean crop, with the aim of determining the best concentrations and spraying timings that contribute to improving physiological performance under salinity conditions.

Materials and Working Methods:

A field experiment was carried out during the winter season 2024-2025 in the field of one of the farmers in the of Babil Governorate, with the aim of responding to three varieties of beans to Foliar application with Arginine and its reflection in reducing

the Salinity stress in the growth and Productivity, s The experiment was conducted according to an RCBD design with a split-plot arrangement with three replications, the experiment included three factors, the first important factor is the cultivation of three varieties of beans the Dutch variety, the Italian variety, and the Spanish variety. V1, 2V, and 3V respectively which were placed in the Main plots, while the Sub-plots included three concentrations of Arginine, namely Control treatment (Ar 0), spray treatment at a concentration of 50 mg/L (Ar 1) and a spray treatment with a concentration of 100 mg/L (Ar 2). The spraying of Arginine was carried out in two periods, the first period of spraying after 88 days of germination (the stage of the beginning of flowering) and the second period of spraying two weeks after the date of the first spraying. The soil was analyzed and the soil was said to be cultivated and the soil had a clay texture with a pH of 7.78 and EC = 7.11, then the land was tilled perpendicular by a mold board with a depth of 30 cm, and then the soil was smoothed and leveled with a laser leveling and the main waterways were opened by the opener of the waterways, then the land was divided into three main sectors, the distance between one sector and the last, the distance between the two sectors is 1 m for the waterways and corridors for service operations, each sector contains [13] experimental units, the distance between them is 80 cm to ensure that the flying spray does not reach the The experimental units at spraying, the area of the experimental unit is 6 m² with dimensions of 2×3 m, and each experimental unit contained four Furrows, the distance between one and another is 75 cm, and between one plant and another is 25 cm. The experimental plants were harvested when they reached full physiological maturity, and the harvesting process was carried out successively according to the maturity dates of the studied varieties. Data

analysis was performed statistically and for all studied traits using the method of analysis of variance according to Genstat software, and the least significant difference (LSD) test was used at a probability level of 0.05 to compare the arithmetic Means [2].

A- Vegetative growth characteristics of the bean plant

1- Plant Height (cm)

Results and Discussion

Plant Height (cm)

Productivities of Table (1) indicated that there were significant differences between the varieties in the plant height trait, as the Spanish variety excelled with the highest Mean of (85.74 cm), while the Dutch variety recorded the lowest Mean (77.94 cm). This superiority is attributed to the genetic differences between the varieties in the efficiency of vegetative growth and their ability to benefit from environmental resources, especially nutrients, which is reflected in the increase in division and cellular elongation [9].

Productivities of the table also showed that spraying Arginine at a concentration of 100 mgL^{-1} achieved the highest Mean plant height (96.79 cm), while the non-spraying treatment recorded the lowest Mean of (66.99 cm). This is explained by the role of arginine as a precursor to the synthesis of polyamines and nitric oxide, which contribute to stimulating cell division and improving photosynthesis efficiency, leading to increased vegetative growth [5].

2- Number of branches per plant (Branch⁻¹)

3- Leaf Area (cm² Plant⁻¹)

B- Characteristics and components of the product

1- Number of pods (plant pod⁻¹)

2- Number of seeds per pod (pod seed⁻¹)

3- Weight 100 seeds (g)

4- Seed Yield (ton\h)

The interaction between faba bean varieties and arginine concentrations had a non-significant effect on plant height (Table 1), indicating that the response pattern of plant height to foliar-applied arginine was generally consistent across the studied varieties. Nevertheless, numerically, the Spanish variety sprayed with 100 mg L^{-1} arginine recorded the highest plant height, whereas the Dutch variety under the control treatment showed the lowest values.

The absence of a significant interaction suggests that arginine-induced enhancement of cell division and elongation occurred independently of varietal differences. This indicates that arginine acts through fundamental physiological mechanisms such as nitrogen metabolism, nitric oxide signaling, and polyamine biosynthesis, which are similarly expressed across the genotypes. Similar trends were reported under abiotic stress conditions where amino acid application promoted vegetative growth regardless of genotype.

Table (1) Effect of varieties and Arginine on plant height (cm) of bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Dutch	Mean Arginine
0	62.6	67.1	71.27	66.99
50	79.13	83.4	85.87	82.8
100	92.1	98.17	100.1	96.79
Mean Varieties	77.94	82.89	85.74	
LSD _{0.05}	V=3.064 A= 1.415 V*A= NS			

Number of Branches (Branch⁻¹)

Productivities of Table 2 showed that the Spanish variety was significantly superior in the number of branches, recording the highest Mean of (9.867 branches.plant⁻¹), while the Dutch variety recorded the lowest Mean of (7.507 branches.plant⁻¹). This is due to the genetic difference between the varieties in branching ability, resulting from the difference in hormonal control and vegetative growth [6].

As for the spray treatments, the treatment of spraying arginine at a concentration of 100 mg.L⁻¹ achieved the highest mean (9.64 branch.plant⁻¹), while the non-spray treatment gave the lowest mean of (7.259 branches.plant⁻¹). This superiority is due to the role of arginine in increasing the formation of cytokinins, which reduces apical dominance and encourages the formation of lateral branches [11].

Table (2) The effect of varieties and Arginine on the number of branches (branch/plant) of the bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	6.553	7.18	8.043	7.259
50	7.61	8.573	10.59	8.924
100	8.357	9.597	10.967	9.64
Mean Varieties	7.507	8.45	9.867	
LSD _{0.05}	V=0.2874 A= 0.2252 V*A= 0.3808			

The interaction between varieties and arginine concentrations was significant for number of branches per plant (Table 2). The Spanish variety treated with 100 mg L⁻¹ arginine produced the highest number of branches, whereas the Dutch variety under the control treatment recorded the lowest value.

This significant interaction reflects the differential genetic capacity of varieties to respond to arginine-induced hormonal modulation. Arginine is known to enhance cytokinin biosynthesis and reduce apical dominance, thereby stimulating lateral bud outgrowth. The superior branching response of the Spanish variety suggests a higher sensitivity to these hormonal signals or a greater ability to convert arginine into growth-promoting metabolites under saline stress conditions.

Leaf Area (cm² Plant⁻¹)

Productivities of Table 3 showed that the Spanish variety excelled in leaf area, recording the highest Mean of (2773 $\text{cm}^2.\text{plant}^{-1}$), while the Dutch variety recorded the lowest Mean of (2504 $\text{cm}^2.\text{plant}^{-1}$). This is due to the increase in the number and size of leaves as a result of the genetic efficiency of the Spanish variety in vegetative growth [11].

Productivities of the same table also showed significant differences between the concentrations of arginine spraying, with the highest Mean leaf area concentration of 100 mg/L^{-1} (3035 $\text{cm}^2.\text{plant}^{-1}$), while the

comparison treatment recorded the lowest mean (2230 $\text{cm}^2.\text{plant}^{-1}$). This explains the role of arginine in increasing chlorophyll content and improving photosynthesis efficiency, leading to an increase in effective leaf area [3]. Results

Table (3) Effect of varieties and Arginine on the leaf area of the plant cm^2 / plant for bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	2212	2233	2245	2230
50	2287	2532	3015	2611
100	3014	3030	3060	3035
Mean Varieties	2504	2598	2773	
LSD _{0.05}	V= 176.3 A= 139.3 V*A= 234.8			

Number of pods (pod/plant)

Productivities of Table 4 showed significant differences between the cultivars superior to the Spanish variety in the number of pods, recording the highest Mean of (5.89 $\text{pods}.\text{plant}^{-1}$), while the Dutch variety recorded the lowest Mean of (5.23 $\text{pods}.\text{plant}^{-1}$). This superiority is attributed to the efficiency of the Spanish variety in Pod setting and the reduction of flower drop [5].

in Table (3) revealed a significant interaction between faba bean varieties and arginine concentrations for leaf area. The highest leaf area was observed in the Spanish variety sprayed with 100 mg L^{-1} arginine, while the lowest values were associated with all varieties under the control treatment.

This interaction indicates that varietal differences in leaf expansion capacity become more pronounced under arginine application. The enhanced leaf area may be attributed to improved chlorophyll synthesis, increased photosynthetic efficiency, and enhanced osmotic adjustment mediated by arginine and its derivatives. The Spanish variety likely possesses superior genetic traits that enable better exploitation of the physiological benefits of arginine under salinity stress.

Productivities of Table 4 also showed that there were significant differences between the spraying of Arginine at a concentration of 100 mg.L^{-1} gave the highest Mean number of pods (6.23 $\text{pods}.\text{plant}^{-1}$), while the treatment of no spraying recorded the lowest mean of (4.897 $\text{pods}.\text{plant}^{-1}$). This is due to the improvement of the nutritional status of the plant during the flowering

phase and the increase in flower stability [9].

The interaction effect between varieties and arginine concentrations was significant for number of pods per plant (Table 4). The highest pod number was recorded when the Spanish variety was treated with 100 mg L⁻¹ arginine, while the lowest was observed in the Dutch and Italian varieties under the untreated control.

This interaction highlights the combined role of genetic potential and foliar nutrition in reproductive success. Arginine application during flowering likely enhanced pollen viability, reduced flower abortion, and improved assimilate supply to developing reproductive organs. Varieties with higher sink strength, such as the Spanish variety, benefited more from arginine supplementation, resulting in increased pod retention.

Table (4) The effect of varieties and Arginine and their interaction on the number of pods of a pod/plant of the bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	4.23	4.23	6.23	4.89
50	5.23	5.897	5.23	5.45
100	6.23	6.23	6.23	6.23
Mean Varieties	5.23	5.452	5.897	
LSD _{0.05}	V=0.2519 A= 0.1977 V*A= 0.3341			

Number of seeds per pod (seed/pod)

Productivities of Table 5 showed the superiority of the Spanish cultivar as it achieved the highest Mean number of seeds per pod (5.45 seeds.pod⁻¹), while the Dutch variety recorded the lowest Mean of (5.28 seeds.pod⁻¹). This is due to genetic differences in fertilization efficiency and seed formation [6].

For the spray treatments, the treatment of spraying arginine at a concentration of 100 mg.L⁻¹ was superior to the highest Mean (5.90 seeds.pod⁻¹), while the non-spray treatment recorded the lowest Mean of (4.85 seeds.pod⁻¹). This is explained by the increased transport of photosynthesis products and nitrogen to the developing pods [3].

A significant interaction was observed between varieties and arginine concentrations for number of seeds per pod (Table 5). The maximum number of seeds per pod was obtained from the Spanish variety sprayed with 100 mg L⁻¹ arginine, whereas the minimum was recorded in the Dutch variety under the control treatment.

This response suggests that arginine plays a crucial role in enhancing fertilization efficiency and early embryo development. The improved nitrogen availability and enhanced translocation of photoassimilates under arginine application may have supported better seed set, particularly in genetically superior varieties capable of efficient assimilate partitioning.

Table (5) Effect of varieties and Arginine and their interaction on the number of seeds per pod of pod seed ^{pod-1} for bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	4.78	4.96	4.81	4.85
50	5.39	5.42	5.48	5.43
100	5.69	5.95	6.06	5.9
Mean Varieties	5.28	5.44	5.45	
LSD _{0.05}	V=0.03597 A=0.02600 V*A=0.04539			

Weight 100 Seeds (g)

Productivities of Table 6 showed the superiority of the Spanish variety in the weight of 100 seeds, recording the highest Mean (153.45 g), while the Italian variety recorded the lowest Mean (151.00 g). This superiority is attributed to the difference in the efficiency of nutrient packaging [9]. Productivities of the same table also showed that the concentration of 100 mg/L⁻¹ achieved the highest Mean weight of 100 seeds (160.93 g), while the comparison treatment recorded the lowest Mean of (146.45 g). This is due to the role of arginine in stimulating protein synthesis

and improving Seed filling [5]. The interaction between varieties and arginine concentrations showed a non-significant effect on 100-seed weight (Table 6). However, numerically, the highest seed weight was recorded in the Spanish variety treated with 100 mg L⁻¹ arginine.

The lack of a significant interaction indicates that seed filling processes responded similarly to arginine application across varieties. Arginine likely enhanced protein synthesis and assimilate accumulation during seed development in all genotypes, leading to uniform improvement in seed weight irrespective of varietal differences.

Table (6) The effect of varieties and Arginine and their interaction on the weight of 100 grams of bean seeds

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	145.18	145.88	148.303	146.45
50	150.69	147.18	148.663	148.84
100	159.49	159.94	163.37	160.932
Mean Varieties	151.79	151	153.45	
LSD _{0.05}	V=0.5887 A= 0.4607 V*A= 0.7795			

Seed yield (ton h⁻¹)

Productivities of Table 7 showed the significant superiority of the Spanish variety as it achieved the highest Mean seed yield (4.71 ton h⁻¹), while the Italian variety recorded the lowest Mean of (4.31

ton h⁻¹). This is due to the difference between varieties in the efficiency of converting vegetative growth into an economic yield [12] As for the spraying treatments, spraying arginine at a concentration of 100 mg/L⁻¹

achieved the highest Mean seed yield (5.38 ton h^{-1}), while the non-spraying treatment recorded the lowest Mean of (3.81 ton h^{-1}). This superiority is attributed to the cumulative effect of improving vegetative growth traits and yield components as a result of spraying arginine. Seed yield was

significantly affected by the interaction between varieties and arginine concentrations (Table 7). The highest seed yield was obtained from the Spanish variety sprayed with 100 mg L^{-1} arginine, while the lowest yield was recorded under

Table (7) Effect of varieties and Arginine and their interaction in the trait of total seed yield ton h^{-1} of bean plant

Concentrations Arginine mg/L	Varieties			
	Dutch	Italian	Spanish	Mean Arginine
0	3.32	3.36	4.75	3.81
50	4.81	4.17	4.24	4.41
100	5.59	5.41	5.15	5.38
Mean Varieties	4.57	4.31	4.71	
LSD _{0.05}	V=0.2294 A= 0.1614 V*A= 0.2850			

Conclusions

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

The highest results achieved in this study show that the Spanish variety is significantly superior in most of the vegetative growth traits and the yield and seed yield of the bean plant compared to the rest of the varieties studied, reflecting its high genetic efficiency in the exploitation of environmental resources. Productivities

the control treatment, particularly in the Italian variety.

This significant interaction confirms that maximum yield improvement requires both a high genetic yield potential and optimal physiological stimulation through foliar arginine application. Yield enhancement resulted from the cumulative positive effects on vegetative growth, pod number, seed number, and seed weight. The Spanish variety demonstrated superior ability to translate improved growth and reproductive traits into higher economic yield under saline conditio

also showed that the spraying of Arginine, especially at a concentration of 100 mg L^{-1} , significantly contributed to improved growth and productivity by enhancing the physiological processes associated with cell division, photosynthesis efficiency, and the transmission of photosynthetic products to the reproductive organs. Therefore, the Spanish variety can be approved with a spray of 100 mg.L^{-1} as an effective treatment to increase the yield of the bean plant under experimental conditions.

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