Comparison between seaweed fertilization and chemical fertilization in their effects on some faba bean varieties

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Abstract

A field experiment was conducted during the 2023-2024 growing season in Nineveh Governorate. An experiment aimed to evaluate organic fertilizer in comparison with chemical fertilization, as well as a combination of two fertilizers, with the purpose of reducing chemical fertilization due to its environmental risks and pollution. Planting began on 3 November 2023, using a randomized complete block design (RCBD) with 36 experimental units. experiment included two factors. The first factor was three varieties of faba bean crop, including (Spanish variety LUZDEOTONO, New Zealand variety AGUADULCE, in addition to local variety). The second factor included four types of fertilizers: organic (15% seaweed extract), chemical (NPK), a mixture of organic and chemical, and a control treatment without fertilization. When fertilization was applied at the 3-5 true leaf stage, results showed superiority of Spanish variety in both pod length (23.46 cm) and seed count (6.37 seeds per pod). treatment combining organic and chemical fertilizers also outperformed Spanish variety in all studied traits. Furthermore, interaction between Spanish variety and organic-chemical fertilizer treatment resulted in a significant advantage for most of studied traits.

Keywords: faba beans, seaweed, organic fertilizer, faba bean varieties.

Introduction

Many studies have examined the effects of fertilization with seaweed extract and chemical fertilization, but only individually. This research compares these fertilizers both individually and in combination. Recent years have seen significant progress in understanding the precise molecular and physiological mechanisms that explain the positive effects of seaweed extracts (SWEs) in faba bean plants. This is particularly relevant in the context of the global trend towards sustainable and climate-smart agriculture. Recent years have seen significant progress in understanding the precise molecular and physiological mechanisms that explain the positive effects of seaweed extracts (SWEs) in faba bean plants. This is particularly relevant in the context of the global trend towards sustainable and climate-smart agriculture. A study by [1, 2] found

that foliar spraying with an extract of Ascophyllum nodosum algae (at a concentration of 3 $g.L^{-1}$) resulted in a significant increase in the leaf content of chlorophyll pigments (a, b, and total chlorophyll) and carotenoids compared to untreated plants. It also led to an improvement in the nutritional quality of faba bean seeds, as a significant increase in crude protein content was recorded (18.5% compared to 15.8% in the control). The seeds also contain iron and zinc.

This makes SWEs an effective tool not only for increasing yield but also for improving the nutritional value of the crop, thus contributing to combating malnutrition. This is attributed to the extract's content of betaine compounds and plant hormones, which stimulate the formation and activation of chlorophyll synthesis enzymes, thereby increasing vegetative growth and yield. In a field study conducted by [2] it was observed that applying seaweed extract with a 25% reduction in mineral fertilization resulted in an equivalent or greater increase in leaf nitrogen, phosphorus, and potassium content compared to plants that received full mineral fertilization without the seaweed extract. This result is explained by The extract plays a role in improving root activity and increasing the surface area for absorption, in addition to its role as a natural chelating agent that makes elements more soluble and available to the plant, This leads to an increase in plant height, the number of pods, the number of seeds per pod, seed filling, and increased weight. A study by [3] also recorded a significant increase in faba bean plant height, number of branches, and fresh and dry foliage weight in plants treated with the algae extract. The researchers attributed these results to the presence of natural growth regulators (such as auxins and gibberellins) in the extract, which promote cell division and elongation [3, 4, 5] results of the study by [4, 6] conducted under water stress conditions, showed that treating faba beans with an algal extract increased the number of pods per plant by 22.5% and the weight of 100 seeds by 18.3% compared to untreated plants subjected to water stress.

This suggests the extract's role in improving fruit set and seed filling, even under suboptimal conditions. In a two-season trial, [5] found that foliar spraying with seaweed extract (concentration 4 ml. L^{-1}) resulted in the highest seed yield of 4.12 tons. ha^{-1} compared to 3.28 $tons.ha^{-1}$ in the control treatment, representing a 25.6% increase. This was interpreted as a simultaneous improvement in all the aforementioned yield components. The benefits are not limited to increased quantity but extend to improved quality. A study by [6] confirmed that seeds from plants treated with algae extract contained a higher percentage of crude protein and total carbohydrates compared to seeds from untreated plants. The study by [1] confirmed that application of seaweed extracts not only increased yield but also improved nutritional quality of faba bean seeds. A significant increase in crude protein content was recorded (18.5% compared to 15.8% in the control group). This study aims to compare organic and chemical fertilizers by examining their effects on the growth and yield traits of certain faba bean varieties, and to explore potential for reducing environmental pollution caused by chemical fertilization by using organic fertilizers instead.

Materials and Methods

experiment was carried out in Nineveh Governorate, during 2023-2024 season. In this study, three varieties of faba bean crop were used with three types of fertilizers, namely (organic fertilizer, seaweed extract 15% - chemical fertilizer NPK type Extra Top with a concentration of 45% phosphorus and 55% potassium - mixing between organic and chemical fertilizer - in addition to a control treatment), To compare different varieties, fertilization methods, and their interactions, land was plowed and divided into equal experimental units of 1.5 m² each. Irrigation was based on rainfall, with supplemental irrigation as needed. Planting was done in rows with 25 cm between rows and 25 cm between plants. experiment included two factors. first factor: Varieties, which included three varieties of faba bean crop (Spanish variety LUZDEOTONO, New Zealand variety AGUADULCE, in addition to local variety). second factor: Fertilizer, which includes four levels: (organic fertilizer, including 15% seaweed extract; chemical fertilizer NPK type Extra Top with a concentration of 45% phosphorus and 55% potassium; a mixture of organic and chemical fertilizer; and a control treatment with no fertilizer). Fertilizers were applied as a foliar spray when faba bean crop had 3-5 leaves. experiment was carried out using a completely randomized block design (RCBD). With three replicates, the experiment included 36 experimental units. area of experimental unit was $1.5m^2$, in which fertilizers were distributed randomly according to each variety. data obtained for studied traits were analyzed using SAS computer programs. Comparisons between means were made using Duncan multi-range method. Traits studied: Plant height. Number of branches. $Plant^{-1}$. Number of pods. $Plant^{-1}$. Pod length (cm). and Number of seeds. $Pod^{-1.}$

Results and Discussion

Plant Height (cm)

The results in Table (1) indicate that there is no significant effect of the difference in varieties on the plant height trait, while there was a significant effect of the types of fertilization used on this trait, as the highest significant values for the plant height trait were obtained with the treatment of mixing organic and chemical fertilization, which amounted to 69.94 cm compared to the control treatment and other treatments. This may be due to the availability of all the nutrients necessary for plant growth through the combination of organic and chemical fertilization, which has led the plant to elongate and grow better. This is consistent with [7, 8]. As can be seen from the results obtained, there is a significant bilateral interaction between the experimental factors, as the highest height of the faba bean plant was obtained, significantly, when the Spanish variety was treated with a mixture of organic and chemical fertilizer, reaching 73.50 cm. The lowest significant values were obtained in the control treatment.

Table (1): Effect of fertilization type on plant height (cm) of faba bean varieties

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	55.50cde	67.17b	65.83b	73.50a	b65.50
AGUADLCE	50.50e	59.83c	58.17c	69.50ab	b 59.50
local	51.83de	57.67cd	58.50c	66.83b	b58.71
effect of fertilization	52.61c	60.83b	61.56b	69.94a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

Number of branches. Plant^{-1}

Table (2) shows that there is a significant effect of the difference in varieties on the trait of number of branches per plant, as the most branches per plant were obtained in the Spanish and AGUADLCE varieties, which amounted to 5.37 and 5.37 respectively, while the lowest significant value for this trait was in the local variety, which amounted to 4.5 branches per plant, This superiority may be due to the genetic factor of each variety and its interaction with the environmental factor in terms of suitability, which led the plants to increase size of vegetative growth, including an increase in the number of branches. This is consistent with [9, 10]. There is also a significant effect of the types of fertilization used in the experiment on the trait of the number of branches per plant, as the treatment of mixing organic and chemical fertilizers was superior in forming the most number of branches per plant, which amounted to 6.67 branches compared to the other treatments, while the lowest significant value for this trait was obtained with the comparison treatment, which amounted to 3.89 branches, The reason may be due to meeting the necessary needs of the plant's nutrients, which prompted it to form new branches. This is considered a positive phenomenon because each branch will produce a number of pods, thus increasing the yield. This is in agreement with [11, 12, 31, 28]. Table (2) shows that there is a significant bilateral interaction between the experimental factors, as the highest significant values for the number of branches in the plant were obtained when the Spanish variety was treated by mixing organic fertilizer with chemical fertilizer, with the number of branches reaching 6.83. One branch per plant, while the lowest significant values for this trait were observed in the control treatment and for all varieties.

Table (2): Effect of fertilization type on number of branches in faba bean varieties. Plant^{-1}.

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	4.33def	5.33cd	5.00cde	6.83a	a5.37
AGUADLCE	4.00ef	5.33cd	5.50c	6.67ab	a 5.37
local	3.33 f	4.33def	4.67cde	5.67bc	b 4.50
effect of fertilization	3.89c	5.00b	5.06b	6.39a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

Pod length (cm)

Table (3) shows a significant effect of variety on pod length. The highest significant value for pod length, 23.46 cm, was obtained with the Spanish variety, while the lowest significant value, 20.03 cm, was obtained with the local variety. This difference may be due to this superiority is attributed to the specific genetic factor of each variety and its responsiveness to environmental factors, which aligns with the findings of [13, 14, 25]. As can be seen from the same table, there is a significant effect of the type of fertilizer on the pod length characteristic. The longest pods, reaching 23.76 cm, were obtained significantly in the treatment combining organic and chemical fertilizers compared to the other treatments. This may be attributed to the provision of the plant's nutritional requirements increases photosynthetic efficiency, leading to increased elongation of the pod-forming cells. This finding is consistent with [12,15, 16]. Table (3) indicates a significant two-way interaction between the experimental factors, with the highest significant value obtained when treating the Spanish variety. Mixing organic fertilizer with chemical fertilizer resulted in a pod length of 25.50 cm, while the lowest significant values were observed in the control treatment, particularly for the local variety, which reached 18 cm

Table (3): Effect of Fertilization Type on Pod Length (cm) of Faba Bean Varieties.

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	20.66cde	23.83ab	23.83ab	25.50a	23.46a
AGUADLCE	19.17ef	21.43cd	21.17cd	23.67b	21.36b
local	18.00f	19.83de	20.16de	22.13bc	20.03c
effect of fertilization	19.28c	21.70b	21.72b	23.76 a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

Number of pods per plant

Table (4) indicates a significant effect of variety differences on the number of pods per plant. The highest significant values were obtained when cultivating the Spanish and AGUADLCE varieties, reaching 6.50 and 6.12 pods per plant, respectively, compared to the local variety. This may be due to the genetic factor and the extent of its interaction and response to prevailing environmental conditions. This is consistent with [10, 17, 18, 24] The results also showed a significant effect of different fertilizer types on the number of pods per plant, with the highest significant values for this trait being obtained in the treatment of mixing organic fertilizer with chemical fertilizer, which reached 6.61 pods per plant compared to the other treatments. This may be due to supplying the plant with all the nutrients it needs, which leads to strong vegetative growth and then strong fruit growth by stimulating an increase in flower set and thus an increase in the number of pods formed. This is considered positive because it leads to an increase in the final yield. These results are consistent with [8, 18, 19]. The results also indicate a significant bilateral interaction of the experimental factors, as the highest significant values were obtained when the Spanish variety was treated by mixing organic fertilizer with chemical fertilizer, which amounted to 7 pods per plant, while the lowest significant values were obtained when the control treatment, especially the local variety, where the number of pods per plant amounted to 4.33 pods.

Table (4): Effect of fertilization type on the number of pods of faba bean varieties. Plant^{-1}.

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	6.00bcd	6.67 a	6.33abc	7.00a	a 6.50
AGUADLCE	5.50cd	6.33abc	6.00bcd	6.67ab	a 6.12
local	4.33e	5.33d	5.33d	6.17abcd	b 5.29
effect of fertilization	5.28c	6.11b	5.89b	6.61 a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

Number of seeds. Pod^{-1}

The results in Table (5) show a significant effect of the difference in faba bean varieties on the trait of the number of seeds per pod, as the highest significant values for this trait were recorded in the Spanish variety, which amounted to 6.37 seeds per pod. This may be due to the genetic traits of this variety and its interaction with the prevailing environmental conditions, and this is consistent with [9, 10,17, 23]. The results show a significant effect of the fertilizer type on the number of seeds per pod. organic fertilizer treatment and the mixed organic and chemical fertilizer treatment outperformed the other treatments in terms of the highest values for this trait, achieving 6.28 and 6.67 seeds per pod, respectively. The pods are produced consecutively, which

may be due to the plant's strong growth resulting from the abundance of nutrients supplied to it. This means increased photosynthesis efficiency and increased dry matter, which encouraged the production of a larger number of pods and a greater number of seeds within each pod. This is consistent with [12, 18, 20, 28] Abbas and Aziz, 2019, and Al-Ubaidi, 2021., Essa and Ahmed (2025). The results also indicate a significant bilateral interaction of experimental factors in the number of seeds per pod, as the highest significant value was obtained when the Spanish variety was treated by mixing organic and chemical fertilizer, which amounted to 7 seeds per pod, noting that it did not differ significantly with the other varieties within the same treatment.

Table (5): Effect of fertilization type on number of seeds trait of faba bean varieties. Pod^{-1}

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	5.50 d	6.50ab	6.50ab	7.00a	a 6.37
AGUADLCE	5.33de	6.33abc	5.67cd	6.33abc	b 5.91
local	4.67e	6.00bcd	5.33de	6.66 ab	b 5.66
effect of fertilization	5.17c	6.28a	5.83b	6.67 a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

Yield kg. dunum^{-1}

Table 6 indicates a significant effect of experimental factors, as the Spanish variety significantly outperformed others in recording the highest yield value, reaching 1692.31 kg per dunam. This may be attributed to the genetic makeup of each variety and its susceptibility to environmental conditions, as well as the correlation of this trait with other traits. This aligns with [12, 22, 28] . fertilization method also had a significant effect on yield quantity, as treatment combining organic fertilization with seaweed extract and chemical fertilizer resulted in the highest significant yield, reaching 1707.57 kg. dunum^{-1}. This may be due to This treatment also leads to superiority of most of previously mentioned traits. Furthermore, the algae extract may contain betaine compounds and plant hormones that stimulate the formation and activation of chlorophyll synthesis enzymes, thus increasing vegetative growth and yield. This is consistent with. [1, 21, 23, 28]. The bilateral interaction between the study factors was also significant, as the highest significant value for the quantity of yield was obtained when the Spanish variety was treated with the mixture treatment between seaweed extract and chemical fertilizer, which amounted to 1781.50 kg/dunum compared to the other treatments.

Table (6): Effect of fertilization type on Yield kg. dunum^{-1} of faba bean varieties

varieties	Types of fertilization				effect of varieties
	control	seaweed fertilizer	NPK	Fertilizer mixing	
Spanish	1563.80d	1701.73b	1722.20b	1781.50a	1692.31a
AGUADLCE	1489.07e	1520.17de	1505.70e	1700.97b	1553.98b
local	1376.73f	1487.73e	1498.40e	1640.23c	1500.78c
effect of fertilization	1476.53c	1569.88b	1575.43b	1707.57a	

Values followed by identical letters do not differ significantly from each other at a probability level of 5%.

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