



Article

Study of the Effect of Soil Type and Spraying with Anethum Graveolens Extract on the Growth and Yield of the Bean Plant *Vicia Faba* L

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ABSTRACT

A field experiment was conducted during the winter season of 2023–2024 in Salah Al-Din Governorate (central Iraq) to investigate the effect of soil type (loamy versus gypsiferous soils with 20% and 30% gypsum content) and foliar application of dill extract (100 ml L⁻¹) on the growth and productivity of faba bean (*Vicia faba* L.). A completely randomized design (CRD) with three replications was employed, comprising a total of 12 experimental units. The results demonstrated that foliar application of dill extract at 100 ml L⁻¹ significantly improved all studied traits compared to the control (without application). In loamy soil, the highest values were recorded for plant height (110.4 cm), root length (30.2 cm), pod length (25.2 cm), number of leaves (85 leaves plant⁻¹), number of pods (11 pods plant⁻¹), and number of seeds (7 seeds plant⁻¹). In contrast, these parameters were markedly lower in the gypsiferous soils (20% and 30% gypsum content). Furthermore, loamy soil outperformed the gypsiferous soils across all indicators, confirming the decisive role of soil type in faba bean productivity. The study highlights that applying dill extract at a concentration of 100 ml L⁻¹ in loamy soils represents a promising strategy to enhance the growth of faba bean, especially in areas with mixed or gypsiferous soils.

INTRODUCTION

Faba bean is one of the important and commonly used leguminous crops in many countries of the world, as they are an important and basic food source for some people. Their importance lies in the fact that their seeds contain a high percentage of protein (21–34%), contain most of the essential amino acids for the body, and contain quantities of substances. Sugary, starchy, and some vitamins are used as animal feed in concentrated diets [1]. Aromatic and medicinal plants are high-yielding crops that represent an important source of increasing national income. The importance of medicinal plants lies in their production of volatile oils and active ingredients that are used in many industries, the most important of which are the food, chemical, medical, perfume, and cosmetic industries. The total revenues from these industries amount to approximately 18 billion dollars annually. Due to the lack of studies in developing countries and its importance and wide spread in the Arab world and Iraq and the increasing importance of food and medicine in medicinal and industrial plants and for the purpose of expanding horizontal agriculture, including the attempt to improve gypsum soils by adding organic fertilizers, which is one of the important means of improving the soil and dispensing with organic fertilizers that affect human health, pollute groundwater and increase the level of nitrates, [2]

Dill's whose scientific name is *Anethum graveolens* L., belongs to the Apiaceae family. It is native to Egypt, Iran, and Turkey [3]. It is consumed cooked or fresh and used as a seasoning and in the manufacture of food and cosmetics. The plant is rich in vitamins and has a high nutritional value. Its fruits contain essential oils. Carbone by 30% (20.61%), Phelandrene by 60% [4], in addition to antioxidants and other compounds that are considered anti-cancer agents. The dill plant is used to treat many diseases. It is an appetite stimulant, a gas repellent, treats insomnia, and is an anti-convulsant.[5] It helps with digestion, so it is given to infants to treat colic and helps treat some diseases of the urinary system. It produces mothers' milk, and chewing its fruits eliminates bad breath, and its seeds are also given to livestock to increase milk production [6].

Soil is one of the most important natural resources, and it is the first station on which agriculture depends. Gypsum soil is widespread in Iraq, constituting more than 20% of the area of Iraq and extending from southern Sinjar to southern Iraq. these soils are characterized by having low fertility traits due to the dissolution of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) in the soil solution, which leads to a state of nutritional imbalance in these soils[7] due to the saturation of the soil solution with calcium and sulfate ions, which affects the readiness of the nutrients necessary for plant growth [8]As for loam soils are the most suitable soils for agriculture due to the availability of most nutrients. Also, adding plant extracts and some hormones led to an increase in some growth traits [9].

METHODS

Materials and working methods

The experiment was carried out during the winter season 2023-2024 in Al-Alam District in Saladin Governorate, located in central Iraq, at latitude 34.27 degrees north and longitude 43.35 degrees east. Soil samples were taken from 20% and 30% gypsum and loam soil, air dried, ground, and sieved with a sieve with holes diameter of 2 mm. loam soil it well to homogenize it, and a sample was taken from each soil, and physical and chemical analyzes were conducted for it in Table 1.

Table 1. Some chemical and physical traits of the study soils.

Characteristic	Unit	Gypsum soil 20%	Gypsum soil 30%	Loam soil
pH		7.50	7.75	7.2
EC	DC Siemens M^{-1}	2.32	2.35	2.13
$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$		191	289	30.5
CaCO_3	gm. kg^{-1}	225	272	198
O.M		10	8.3	11.2
CEC	Centmol mmol .K gm^{-1}	12.66	10.32	14.32
Sand		632	460	258
Silt		107	298	499
Clay		261	242	243
Textury	gm. kg^{-1}	S.C.L		L
Ready elements				
N		14.1	13.2	17.6
P	mg . kg^{-1}	5.40	4.78	7.1
K		126.61	98.34	85.6
dissolved ions				
Na		1.32	1.53	1.01
Ca		6.12	8.44	4.34
Mg		6.11	5.21	7.34
Cl		3.12	2.51	1.30
CO_3		Nil	Nil	Nil
HCO_3	mmol.L $^{-1}$	1.27	2.15	1.67
SO_4		9.32	6.33	4.32

Then the solution was extracted from the dill plant, and some tests were conducted to determine the components of the solution, and it was prepared in concentrations of 0, 25, 50, and 100 ml. L⁻¹ of 5 kg of soil in each pot was planted with bean seeds, and the treatments were randomly distributed according to a completely randomized design (C.R.D) with three replications. The seedlings were thinned to three plants per pot. The weed control process was carried out manually. Field measurements were taken when the crop matured, and the following traits were studied: plant height (cm), root length, pod length, number of leaves, number of pods, and number of seeds. Statistical analysis was conducted using the least difference test. Significant (L.S.D) below 5% probability level [10].

Table 2. Shows the chemical components of dill plant

Material type	Quantity %	Material type	Quantity %
Unsaturated fats	5.0	Fibers	45.3
Water	14	Carbohydrate	7.0
Minerals	3.3	Calcium, phosphorus, iron,	15.4
Vitamin C and essential oils	4.6	Sodium, potassium	5.4

RESULTS AND DISCUSSION

Plant height

Table 3 shows the values of plant height. The treatment with 100 ml of dill extract gave the highest plant height compared to the rest of the treatments, and the lowest height was for the 0 ml treatment. This increase came as a result of the treatment with dill extract, which stimulated the plant to increase the height, and thus the character of the plant's height is It may have differed as a result of its influence on agricultural transactions [5] While the loam soil outperformed the other soils because it contained a small amount of gypsum, which in turn restricts nutrients and is not easy for the plant [2]. As for the best addition to soil, the loam soil with the addition of 100 ml of dill extract outperformed and gave the highest plant height of 110 cm, less the height achieved by 30% gypsum soil with 0 ml treatment reached 70 cm.

Table 3. Arithmetic averages of spray treatments, soil types, and their interaction together for the bean crop according to plant height (cm).

Type soil/ Transactions Spraying	Loam soil	Gypsum 20%	Gypsum 30%	Spray coefficient averages
0	74.0	72.4	70.2	72.5
25	89.6	84.2	83.6	85.8
50	98.2	92.7	89.0	93.3
100	110.4	96.3	94.4	100.36
Average soil	93.05	86.4	84.3	87.95
LSD 5%	LSD(A)=2.89	LSD(B)=3.34	LSD(AxB)=5.79	=86.69

Root length

It is clear from Table 4 that the significant effect of the dill extract. If the treatment with 100 ml of dill extract gave an increase in root length, amounting to 30 cm, compared to the 0 ml treatment, which gave the lowest root length, amounting to 17 cm. Adding the dill extract encouraged vegetative growth, which led to An increase in the green covering, which increased the process of photosynthesis, which led to an increase in nutrients that encouraged increased root growth [4], while the loam soil outperformed the other soils, as for the best addition to soil, the loam soil with the addition of 100 ml of dill extract outperformed and gave the highest root length of 30 cm, while the lowest root length was achieved by the gypsum soil with a depth of 50 cm with the 0 ml treatment, which reached 15 cm.

Table 4. Arithmetic averages of spray treatments, soil types, and their interaction together for the legume crop in root length (cm).

Type soil/ Transactions Spraying	Loam soil	Gypsum20%	Gypsum30%	Spray coefficient averages
0	17.5	16.5	15.1	16.36
25	21.4	19.2	17.3	19.30
50	25.1	23.3	22.2	23.53
100	30.2	26.2	24.4	26.93
Average soil	23.65	21.3	19.75	21.54
LSD 5%	LSD(A) = 1.28	LSD(B) = 1.48	LSD(AxB) = 2.57	$\bar{X} = 21.44$

Pod length (cm):

Table 5 shows the effect of spraying with dill extract. The 100 ml treatment was superior to the dill extract and gave an increase in pod length compared to the 0 ml treatment, which gave the lowest pod length. Increasing the concentration of spraying with the extract led to an increase in the availability of nutrients and growth factors, and this encouraged growth. Vegetative and photosynthesis process, which leads to increased accumulation of material nutrients in the plant, which led to an increase in the length of the pod, while the loam soil outperformed the other soils. As for the best addition to soil, the loam soil with the addition of 100 ml of dill extract outperformed and gave the highest pod length of 25 cm, while the lowest pod length was achieved by the deeply gypsum soil. 50 cm with the 0 ml treatment reached 12 cm. The reason for the resulting increase may be attributed to the efficiency of the loam soil because it contains a good bed for root growth and an increase in the availability of nutrients.

Table 5. Arithmetic averages of spray treatments, soil types, and their interaction together for the bean crop according to pod length (cm).

Type soil/ Transactions Spraying	Loam soil	Gypsum20%	Gypsum30%	Spray coefficient averages
0	15.3	14.0	12.1	13.8
25	18.1	17.6	15.3	17.0
50	22.3	20.8	18.5	20.53
100	25.2	23.3	22.4	23.63
Average soil	20.22	18.54	16.78	18.64
LSD 5%	LSD(A)=0.85	LSD(B)=0.98	LSD(AxB)=1.70	=17.91

The description of the number of leaves in a plant

As shown in Table 6, the effect of spraying with dill extract, as the treatment with 100 ml of dill extract excelled and gave an increase in the number of leaves compared to the 0 ml treatment, which gave the lowest number of leaves. Spraying the dill extract improved the growth of the plant and increased its height as well. The number of leaves in the plant increased, while the loam soil excelled and produced the highest number of leaves compared to the rest of the soil. As for the best addition to soil, the loam soil excelled with the addition of 100 ml of dill extract and gave the highest number of leaves, reaching 85 leaves. Plant⁻¹. As for the lowest number of leaves, it was achieved by the gypsum soil at a depth of 50 cm with the 0 ml treatment, which amounted to 58 leaves. The reason for the superiority of the loam soil treatment over the gypsum soil treatment may be attributed to increased readiness nutrients in the loam soil due to the decrease in the presence of calcium and sulfate ions, which combine with the element ions and lead to the precipitation of the elements and turn into more stable compounds [11]. The reason for the superiority of the 100 ml.L⁻¹ treatment in the loam soil over the rest of the treatments could be due to the positive effect of the intervention. Among the two factors was the loam soil factor and the spray factor with dill extract, which was reflected in the growth characteristics, including the height of the plant and the number of leaves.

Table 6. Arithmetic averages of spray treatments, soil types, and their interaction together for the legume crop in terms of the number of leaves (leaf).

Type soil/ Transactions Spraying	Loam soil	Gypsum20%	Gypsum30%	Spray coefficient averages
0	64	62	58	61.33
25	69	62	60	63.66
50	74	72	70	72.0
100	85	78	74	79.0
Average soil	73	86.5	65.5	71.57
LSD 5%	LSD(A)= 2.09	LSD(B)=2.41	LSD(AxB)=4.18	=69.11

The number of pods per plant

As shown in Table 7, the treatment with 100 ml of dill extract was superior and gave an increase in the number of pods compared to the 0 ml treatment, which gave the lowest number of pods. Spraying the dill extract improved the growth of the plant, increased the height of the plant as well, and increased the number of leaves in the plant, consequently. The material stored in estuaries increased, while the loam soil excelled and produced the highest number of pods compared it the rest of the soil, as for the best addition to soil, the loam soil excelled with the addition of 100 ml of dill extract and gave the highest number of pods, reaching 14 pods. Plant⁻¹. As for the lowest number of pods, it was achieved by the gypsum soil at a depth of 50 cm with the 0 ml treatment, which amounted to 5 pods. Plant⁻¹. It is clear from the table that spraying and the type of loam soil led to a significant increase in the number of pods. The reason for the superiority of the spray treatment 100 ml on the rest of the parameters can be attributed to the positive effect of the interaction between the two factors, which are both the loam soil factor and the factor of spraying with the extract. It appears that there is a clear response to spraying under the conditions of this soil, which was reflected in the growth characteristics, including the number of pods [12].

Table 7. Arithmetic averages for spray treatments, soil types, and their interaction together for the bean crop according to the number of pods (pod)

Type soil/ Transactions Spraying	Loam soil	Gypsum20%	Gypsum30%	Spray coefficient averages
0	7	6	5	6
25	9	8	8	8.33
50	11	10	9	10
100	14	13	11	12.66
Average soil	10.25	9.25	8.25	9.24
LSD 5%	LSD(A)= 0.88	LSD(B)=1.02	LSD(AxB)=1.77	=9.08

The number of seeds per pod

It is noted from Table 8 that the 100 ml treatment of dill extract was superior and gave an increase in the number of seeds per pod compared to the 0 ml treatment, which gave the lowest number of seeds. Spraying the dill extract improved the growth of the plant and increased its height. The number of pods in the plant also increased. Consequently, the number of seeds increased [12], while the loam soil excelled and produced more seeds compared to the rest of the soils, as for the best addition with soil, the loam soil excelled with the addition of 100 ml of dill extract and produced the highest number of seeds, reaching 7 seeds. pod⁻¹, while the lowest number of seeds was achieved by the 0 ml treatment, which reached 4 seeds. pod⁻¹, spraying with the extract, and the type of loam soil had a significant effect on the number of seeds.

The reason may be that the extract contains some hormones and regulators of growth that work to stimulate and increase plant growth, thus increasing the number of seeds. As for the reason for the

superiority of gypsum soil treatments and spraying, there is a clear response to spraying under the conditions of this soil, in addition to increasing the efficiency of the roots in absorbing nutrients and transporting them to the upper parts, and then its positive effect is reflected in the number of seeds. Seeds [6] The reason for the superiority of the binary interference treatment may also be attributed to the fact that all interaction factors indicate the beneficial effect of both factors, which are the loam soil factor and the extract spray factor.

Table 8. Arithmetic averages of spray treatments, soil types, and their interaction together for the legume crop in the number of seeds per pod (seedpod⁻¹).

Type soil/ Transactions Spraying	Loam soil	Gypsum20%	Gypsum30%	Spray coefficient averages
0	4	4	4	4
25	5	4	4	4.33
50	6	5	5	5.33
100	7	5	5	5.66
Average soil	5.5	4.5	4.5	4.82
LSD 5%	LSD(A)=0.59	LSD(B)=0.68	LSD(AxB)=1.19	=4.94

Analysis of variance of coefficients

Table 9 shows the analysis of variance represented by the means of the squares of the spray treatments with dill and the three soil types and their interactions. The mean squares of the spray factor levels were significant at the 1% probability level in the characteristics of plant height, root length, pod length, number of leaves, number of pods, and number of seeds in the plant. This is attributed to the discrepancy between spraying levels, indicating the important role of the dill solution in the biological and physiological processes that occur in the plant, and provides the plant with elements, the most important of which are calcium, phosphorus, iron, sodium, and potassium. The mean squares of the three soil types used in the experiment were highly significant, and for the studied traits, they were all at the probability level of 0.01. The reason is attributed to the response of the crop to spraying and the deepening of the roots into the soil. The mean squares of the binary interactions between the two factors of the study were highly significant in the plant height trait, and the binary interactions or interactions were non-significant with all the other traits studied. The reason for the significant interaction between the two factors in the plant height trait is the response of the two environments together and their direct effect. In this capacity [13; 14].

Table 9. Mean squares of soil types and spray concentrations on the bean crop and for the studied traits.

S.O.V	d.f	M.S					
		Plant height (cm)	Root height (cm)	Pod length (cm)	Number of leaves (leaf Plant-1)	Number of pods (Pod Plant-1)	Number of seeds (Seed Plant-1)
(A)	3	264.19**	38.52**	38.58**	130.36**	4.00**	5.44**
(B)	2	1197.43**	197.55**	138.10**	648.59**	42.39**	7.88**
AxB	6	72.26**	3.52 N.S	1.43 N.S	9.84 N.S	1.14 N.S	0.22 N.S
Error	24	11.80	2.33	1.02	6.16	1.11	0.50

** = Significant at the 1% probability level * Significant at the 5% probability level = ^{N.S}. Not significant. soil type = A. Spray levels = B

CONCLUSION

The loam soil was superior to the other soil types in all the studied traits, while the application of dill plant extract at 100 ml L⁻¹ outperformed all other treatments. Moreover, the interaction of loam soil with the addition of 100 ml L⁻¹ of dill extract showed superiority across all evaluated traits. It is therefore suggested to explore other plant extracts as well as to test different soil types with various additives in future studies.

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