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Studying The Role of Soil Texture and Spraying with The Nutrient Unigreen and Their Effect on The Growth of Dill Plants

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Abstract: A field experiment was conducted during the 2023–2024 growing season at the College of Medicinal and Industrial Plants, University of Kirkuk, to investigate the effect of soil texture and foliar application of the nutrient Unigreen on dill (*Anethum graveolens* L.) grown in pots. The experiment consisted of nine treatment combinations arranged in a factorial design with three replications. The first factor was soil texture with three types: sandy, clay loam, and loam. The second factor was foliar spray levels of Unigreen at three concentrations: half the recommended dose (½×), the recommended dose (1×), and double the recommended dose (2×). The recommended dose was 0.15 ml L of water. The results indicated that the loam soil combined with the recommended Unigreen dose (1×) produced the highest values for all studied traits. Plant height reached 89.36 cm, number of branches was 5.32 branches plant^{-1}, number of leaves was 152.4 leaves plant^{-1}, dry weight reached 12.42 g plant^{-1}, and chlorophyll content was 16.42 µg cm^{-2}. In contrast, the lowest values were recorded in sandy soil, where plant height was 72.15 cm, number of branches was 3.28 branches plant^{-1}, number of leaves was 113.9 leaves plant^{-1}, dry weight was 5.62 g plant^{-1}, and chlorophyll content was 12.35 µg cm^{-2}. Overall, the best performance was observed in loam soil with the recommended level of Unigreen application.

Keyword: Unigreen Nutrient, Dill Plant, Sandy Soil, Clay Loam Soil, Loam Soil

Introduction

The relationship between soil, plants, and water has long been described in various terms, largely depending on the proportions and sizes of soil particles. This relationship is grounded in how soil particle size influences plant growth responses. It is well established that soil particle size directly affects the mechanical resistance to seedling emergence and the development of above-ground plant structures. The physical and chemical properties of soil have both direct and indirect impacts on plant growth and productivity through their effects on the soil's hydrological, aeration, and thermal regimes. These properties significantly influence water and air permeability, which can be inferred from soil texture, in addition to its role in shaping the soil's biological and chemical properties [1].

Soil texture classification provides essential information for understanding various characteristics associated with plant development. For instance, clayey soils typically exhibit reduced water conductivity and aeration [2]. One of the most important mechanisms through which loamy soils influence plant growth is by regulating water and nutrient availability. As soil becomes finer in texture, its capacity to retain water generally increases, thus improving plant-available water. This is because medium-fine textured soils retain more moisture compared to coarse-textured soils. Moreover, soil texture significantly affects nitrogen availability. Under favorable environmental conditions, nitrogen mineralization tends to increase as soil texture becomes finer. However, in poorly drained soils, nitrogen availability may actually decline with increased fineness. Soil texture also plays a critical role in root development and spreads, influencing the plant's ability to absorb water and nutrients [3].

Dill (*Anethum graveolens* L.) is a leafy herb of high nutritional and medicinal value. Its leaves contain between 5.20–7.7% dry matter, including 5.6–7.2% protein, 1.5–1.6% carbohydrates, and 2–5.2% fiber, in addition to being rich in vitamins [4]. Fresh and dried dill leaves are widely used to enhance flavor and aroma in food, and its fruits, when boiled, are used for their medicinal properties such as relieving colic—especially in infants—soothing nerves, improving cardiovascular and respiratory functions, regulating blood pressure, and aiding digestion through dill oil. Due to these applications, dill has significant economic importance. According to [5], the yield of fresh dill ranged from 2.15 to 5.22 tons per hectare when three cultivars—Hercules, Dukat, and Mesten—were grown. The use of nutrient-rich fertilizers is one of the key modern approaches to increasing its productivity.

Despite its economic and medicinal importance, dill has not been widely studied under Iraqi agro-ecological conditions. Therefore, this study aims to evaluate the most effective cultivation practices for dill in the Kirkuk region. Specifically, it seeks to assess the plant's response to foliar application of nutrient solutions and to identify the most suitable soil type for maximizing vegetative growth and nutritional content. Given dill's significance, it is essential to adopt modern agricultural techniques that enhance its yield and quality [7], [6].

Materials and Methods

The experiment was conducted at the College of Medicinal and Industrial Plants, University of Kirkuk, during the winter growing season of 2024–2025. The study aimed to evaluate the effects of two factors: soil type and foliar application of the Unigreen nutrient solution at three concentrations (0, 30, and 60 $mg \cdot L^{-1}$). The foliar treatments were applied twice: the first at 45 days after sowing and the second two weeks after the initial application.

Soil samples representing four soil types (loam, clay, silt, and sand) were collected, air-dried, ground, and sieved using a 2 mm mesh. Each soil sample was thoroughly homogenized, and representative subsamples were subjected to standard physical and chemical analyses, as shown in Table 1.

Dill seeds (*Anethum graveolens* L.) were sown in pots filled with the prepared soil types. The experimental units were arranged using a completely randomized design (CRD) with three replications. After seedling emergence, thinning was performed to maintain three plants per pot.

The Unigreen nutrient solution was applied at three concentrations: half the recommended dose (½), the recommended dose (1×), and double the recommended dose (2×), based on the manufacturer's guideline of 0.1–5.1 $ml \cdot L^{-1}$. The following traits were measured at maturity: plant height (cm), root length (cm), number of leaves per plant, and number of branches per plant.

Statistical analysis was conducted using analysis of variance (ANOVA), and treatment means were compared using the Least Significant Difference (LSD) test at the 5% probability level [8].

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

Attribute	Unit	Silty Clay Soil	Sandy Soil	Loam Soil
pH	-----	7.76	7.66	7.4
EC	Deci siemens m^{-1}	2.74	2.05	2.26
$CaSO_4.2H_2O$		34.65	15.87	50.5
$CaCO_3$	gm Kg^{-1}	231	232	213
O.M		13.6	4.3	10.7
CEC	cent Moul Kg $soil^{-1}$	12.66	8.67	12.52
Sand		70	830	248
Silt	gm Kg^{-1}	504	110	512
Clay		426	60	240
Textuary		**Silty clay soil**	**Sand soil**	**Loam soil**
Ready elements				
N		13.6	5.7	14.7
P	gm Kg^{-1}	5.10	2.10	8.90
K		116.53	77.3	93.16

Table 2. Contents of the spray solution prepared by Adonis Industrial S.A.L. Lebanon.

No.	Component	Concentration
1	Dry matter	7.0 – 7.9%
2	Ammonium (NH_4^+)	0.8%
3	Nitrate (NO_3^-)	1.3%
4	Urea (Total Nitrogen)	10 – 12%
5	Phosphorus (P_2O_5)	3 – 7%
6	Potassium (K_2O)	4 – 9%
7	Zinc (Zn)	75 ppm
8	Copper (Cu)	53 – 54 ppm
9	Manganese (Mn)	214 ppm
10	Iron (Fe)	154 ppm
11	Boron (B)	97 ppm
12	Molybdenum (Mo)	21 ppm
13	Additives	Vitamins and growth stimulants to enhance vegetative growth and flower induction

Results and Discussion

Plant Height (cm)

Plant height depends on both cell division and elongation, serving as an indicator of vegetative growth vigor. This trait is influenced by the quality and quantity of nutrients absorbed by the plant [2]. The data presented in Table (3) indicate that neither the nutrient solution levels nor the soil texture types had a statistically significant effect individually on plant height.

However, the interaction between nutrient levels and soil texture showed a significant effect. The highest plant height (89.36 cm) was recorded in the treatment involving the recommended concentration (0.1–5.1 $ml \cdot L^{-1}$) and loam soil, which outperformed all other treatments. In contrast, the lowest plant height (72.15 cm) was observed in the treatments with half and double the recommended concentration.

Table 3. Effect of nutrient solution levels and soil texture and their interaction on plant height (cm·plant⁻¹) of dill.

Soil Texture	1/2 Recommendation	Recommendation (1)	2× Recommendation	Means
Sandy soil	72.15	79.14	80.20	77.16
Clay loam	78.89	86.48	80.02	81.80
Loam soil	79.14	89.36	84.77	84.42
Means	76.73	84.99	81.66	—
L.S.D (5%)	2.32 (Solution Feeder)	4.02 (Interaction)		2.32 (Texture)

Number of Branches per Plant

As shown in Table (4), the best result for the number of branches (5.32 branches·plant⁻¹) was achieved with the recommended dose of the nutrient solution in loam soil. Sandy soil negatively affected this trait, likely due to its reduced capacity to retain water and nutrients [1].

There were no significant differences for this trait when nutrient levels or soil types were considered separately. However, a significant interaction between them was observed, with the lowest number of branches (3.28 branches·plant⁻¹) recorded in the combination of sandy soil and half the recommended dose.

Table 4. Effect of nutrient solution levels and soil texture and their interaction on number of branches per plant.

Soil Texture	1/2 Recommendation	Recommendation (1)	2× Recommendation	Means
Sandy soil	3.58	3.93	3.28	3.60
Clay loam	3.85	4.59	4.70	4.38
Loam soil	3.90	5.32	4.07	4.43
Means	3.77	4.61	4.01	—
L.S.D (5%)	0.48 (Solution Feeder)	0.840 (Interaction)		0.48 (Texture)

Number of Leaves per Plant

According to Table (5), there were no significant individual effects of nutrient solution levels or soil texture on the number of leaves, though apparent differences were noticed. The interaction between these two factors was significant. The highest number of leaves (152.4 leaves·plant⁻¹) was obtained in the treatment with loam soil and the recommended nutrient level, while the lowest (113.9 leaves·plant⁻¹) occurred in sandy soil with half the recommended dose. This is attributed to the efficient nutrient and water availability in loam soil, which enhances vegetative development [2].

Table 5. Effect of nutrient solution levels and soil texture and their interaction on the number of leaves per plant.

Soil Texture	1/2 Recommendation	Recommendation (1)	2× Recommendation	Means
Sandy soil	113.9	134.1	116.2	121.4
Clay loam	122.3	147.7	134.3	134.8
Loam soil	124.3	152.4	144.7	140.5
Means	120.2	144.7	131.7	—
L.S.D (5%)	6.21 (Solution Feeder)	10.75 (Interaction)		6.21 (Texture)

Dry Weight (g plant⁻¹)

Dry weight is a key indicator of overall plant growth. It reflects the plant's metabolic capacity and is significantly influenced by soil texture, which affects nutrient availability and root development. Better soil conditions promote photosynthesis, leading to higher biomass accumulation [1].

As shown in Table (6), nutrient solution levels had a significant effect on dry weight. The recommended level (0.1–5.1 ml·L⁻¹) resulted in the highest dry weight (12.42 g·plant⁻¹), while half the recommended dose yielded the lowest (5.62 g·plant⁻¹). The positive results in loam soil are likely due to its superior nutrient-holding capacity, improved aeration, and water retention [9], [11].

Table 6. Effect of nutrient solution levels and soil texture and their interaction on dry plant weight (g·plant⁻¹).

Soil Texture	1/2 Recommendation	Recommendation (1)	2× Recommendation	Means
Sandy soil	5.62	8.17	7.11	6.96
Clay loam	7.46	10.68	9.65	9.26
Loam soil	6.71	12.42	10.45	9.89
Means	6.60	10.42	9.07	—
L.S.D (5%)	0.91 (Solution Feeder)	1.58 (Interaction)		0.91 (Texture)

Total Chlorophyll Content (μg·cm⁻²)

Table (7) indicates no significant main effects of nutrient levels on total chlorophyll content, though visual differences were present. However, a significant effect of the interaction was observed. The highest chlorophyll content (16.42 μg·cm⁻²) was recorded in plants treated with the recommended nutrient level. The lowest content (12.25 μg·cm⁻²) was noted under half the recommendation in sandy soil. This is attributed to the ability of clay loam soil to improve chemical and biological processes that enhance chlorophyll synthesis [5].

Table 7. Effect of nutrient solution levels and soil texture and their interaction on total chlorophyll content (μg·cm⁻²).

Soil Texture	1/2 Recommendation	Recommendation (1)	2× Recommendation	Means
Sandy soil	12.25	15.21	14.77	14.77
Clay loam	14.86	16.42	15.36	15.36
Loam soil	13.86	14.93	14.23	14.23
Means	14.32	15.52	14.77	—
L.S.D (5%)	1.32 (Solution Feeder)	2.30 (Interaction)		1.32 (Texture)

Summary of Growth Traits

Table (8) summarizes the significant effects of soil type, nutrient concentration, and their interaction on all studied traits: plant height, branch number, leaf number, dry weight, and chlorophyll content [10]. Loam soil showed superior performance across traits due to its nutrient availability [12], and the recommended nutrient dose (1) yielded the best results in all growth parameters [13].

Table 8. Mean squares of soil types and nutrient spray concentrations on dill yield and growth traits.

S. o. V.	d.f.	M.S.				
		Plant Height (cm)	**Number of Branches (Branch Plant^{-1})**	**Number of Leaves (Leaf Plant^{-1})**	**Dry Weight (g)**	**Chlorophyll (Microgram cm^{-2})**
R	2	23.79	0.88	27.19	0.43	2.97
(A)	2	136.73**	1.97**	863.12**	21.00**	3.99
(B)	2	175.05**	1.38*	1358.37**	33.88**	8.81*
A*B	4	17.68*	0.43	62.85	2.19	1.73
Error	16	5.4	2.23	38.57	0.82	1.76

N.S., *, ** Not Significant, Significant at 5%, 1% respectively; A = Soil texture; B = Spray concentration

Conclusion

The application of the nutrient solution significantly enhanced vegetative growth traits such as plant height, number of branches, number of leaves, and chlorophyll content. Moreover, soil texture played a crucial role in plant development, as coarse-textured soils negatively affected growth and yield due to their limited ability to retain water and nutrients. Notably, higher chlorophyll content was observed in clay loam soils compared to loam, reflecting the superior water and nutrient retention capacity of finer-textured soils. Therefore, cultivating dill in loam soils is recommended for optimal growth and productivity. Additionally, future studies are encouraged to explore different types and concentrations of nutrient solutions to identify the most effective fertilization strategies. The integration of micronutrients and growth stimulants is also advised to enhance leaf and seed yield and improve the overall performance of dill cultivation.

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