



Effects of Magnesium Levels on Vegetative Growth and Phytochemical Properties of Two Dill (*Anethum graveolens*) Cultivars

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Abstract

To study the response of two varieties of dill (*Anethum graveolens* L.) to different levels of magnesium and their effect on some vegetative and chemical traits, this experiment was conducted on a private farm in Kirkuk Governorate - Al-Hawija District - Imam Ismail Village during the winter season 2023-2024. The experiment was applied in the field according to the Randomize Complete Block Design in three replicates where the first factor included studying two varieties of dill (Lot- Lagun), while the second factor included studying three levels of magnesium: (0, 45 and 90 kg h⁻¹), where the studied traits included plant height (cm), number of main branches (branch/plant), percentage of nitrogen, percentage of phosphorus, percentage of potassium, percentage of magnesium, vitamin C, carotenoids, and showed Results: Lagum cultivar was superior to Lot cultivar in nitrogen percentage, phosphorus percentage, potassium percentage, magnesium percentage, vitamin C, carotenoids, while the level of 90 kg h⁻¹ was superior to the other levels and in most of the studied traits. While the two-way interaction between cultivars and fertilization levels was significant in plant height, and in the number of main branches, as Lagum cultivar was superior at the level of 90 kg h⁻¹.

Keywords: Dill, varieties, magnesium levels, chemical traits.

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Introduction

Dill (*Anethum graveolens* L.) is an annual medicinal plant from the Apiaceae family, originally from southwest and central Asia. It is tolerant to cold, with germination occurring at low temperatures. This plant has a short vegetative cycle, requiring about 100 to 120 days from sprouting to fruit harvesting (Ahmed, 2017).

Dill is an annual aromatic and medicinal plant and is a widely cultivated herb that is widely used for food decoration and seasoning, and for the production of essential oil. Dill leaves are one of the most common green herbs. It has a mild taste that blends with other flavors, and contains a high percentage of nutrients and is used in medical preparations, home cosmetics and perfumes (AlRediman, 2004; Al-Jubory, A. B. & Hassan, 2023).

A wide range of research has proven that dill contains unique and valuable components such as: essential oils, proteins, fibers, fatty oils, carbohydrates, macro elements (such as calcium, potassium, magnesium, phosphorus and sodium), vitamin A and niacin (Al-Zubaidi, & Khalid, 2016). Dill is also utilized to address various digestive issues, act as a cholesterol-lowering and diuretic agent, and possesses



galactagogue, antispasmodic, antiemetic, and antidiabetic properties. Herbal extracts and oils are becoming more popular due to their widespread cultivation and safety for human use.

Fertilization is a critical factor that limits plant productivity. The recent intensive use of costly mineral fertilizers has led to environmental pollution concerns. However, prolonged use of high rates of chemical fertilizers has reduced the activity of soil microflora and the stability of organic matter in the soil. Magnesium is a key component of chlorophyll in plants, and no other element can replace it magnesium in the chlorophyll molecule, although its small proportion in chlorophyll, it has a major role in the composition of this substance as it is essential in the process of photosynthesis. The promising magnesium ion is known to exchange very important signals, as it works to activate and mediate some biochemical reactions, as regulating carbon fixation in chloroplasts in the Calvin cycle may be better for that, and magnesium is an important element in the metabolic processes of ATP and is essential for many enzymes that form organic catalysts in the metabolic process of phosphorus (El-Zaeddi, et al., 2016). Due to the nutritional and medical importance of dill, it is necessary to search for modern agricultural methods to increase its vegetative and seed yield and improve its production of high-quality oil. It is necessary to study its varieties and introduce new ones to Iraq, which is one of the important methods to improve production in terms of quantity and quality (Gad, 2001). showed that the yield of fresh dill reached 15.2-22.5-ton ha⁻¹ when planting three varieties of dill: Hercules, Dukat and Mesten. In addition to using fully decomposed fertilizers and chemical fertilizers to improve soil properties and thus improve vegetative traits and thus improve and increase the percentage of oil and its good quality and thus reduce soil problems (Ghassemi-Golezani, Zehtab-Salmasi, & Dastborhan, 2011). The aim of this study is to know the levels of preferred fertilizers for this plant and the extent of their effect on the varieties to improve their quantitative and qualitative characteristics.

Materials and Methods

This experiment was conducted on a private farm in Kirkuk Governorate - Al-Hawija District - Imam Ismail Village during the winter season 2023-2024 to study the effect of magnesium levels on some vegetative and chemical traits in two varieties of dill (*Anethum graveolens* L.). The first factor included studying three levels of magnesium: (0,45 and 90 kg h⁻¹), while the second factor included studying two varieties of dill (Lot- Lagun). The experiment was applied in the field according to the Randomize Complete Block Design in three replicates. After determining the experimental land, all soil service operations were carried out, as the land was plowed twice perpendicularly using a hoe. Then the experimental land was divided into experimental units, the area of the experimental unit (2 x 2 m) = 4 m², containing four area lines Between one line and another 0.75 m, then the seeds were planted in the panels in lines at a rate of four lines in each experimental unit on 11/15/2023. As for the planting depth, it is shallow because the seeds are small in size. Magnesium was added after 45 days of germination and according to the mentioned levels, was used and the differences between the averages of the characteristics were tested at a probability level of 5% using Duncan's test for the variable range, according to Gokul, Poonkodi, & Angayarkanni (2021).

Triats Studied:

1. **Plant height (cm).**
2. **Number of main branches (branch/plant).**
3. **Percentage of nitrogen:** Estimate nitrogen in the plant sample extracts using the micro-Keldahl device according to the method described by Hussein, (1995).
4. **Percentage of phosphorus:** Estimate phosphorus in the plant sample extracts using the Spectro photo meter according to what was stated in IPNI, (2007).



5. **Percentage of potassium:** Estimated in plant sample extracts using flame photometer according to IPNI, (2007).
6. **Percentage of magnesium:** Estimated the concentration of magnesium using Atomic Absorption Spectrophotometer Model AA6200 in the laboratories of the Department of Chemical Engineering - College of Engineering - Tikrit University.
7. **Vitamin C (mg\100g):** Estimated vitamin C using the formula 2,6-dichlorophenolindophenol according to the method of Khalid, (2012).
8. **Carotenoids(mg\100g)** Carotenoids were estimated as mentioned in Mahler, (2004). by taking 100 g of plant leaves and mixing them well in a Mixture blender, then taking 2 g of the mixture and pouring it onto filter paper, then the sample was slowly washed with pure acetone (about 40 ml) until the orange/yellow colors were completely extracted in a 500 ml plastic container. After that, 50 ml of hexane was added and shaken well, and about 400 ml of water was added to separate the carotenoid phase in the hexane layer from the acetone-water mixture layer, and the absorbance of the hexane layer was measured at a wavelength of 485 nm to estimate the total carotenoid content.

Results and Discussion

Plant Height

The results of Table 1 indicate the effect of study factors on plant height trait that there were no significant differences between Lot and Lagum cultivars in plant height trait, as their averages reached 80.11 and 86.00 cm, respectively. As for the effect of magnesium levels, the level of 90 kg h⁻¹ was significantly superior to the rest of the levels, as it reached 91.67, while the interaction between cultivars and fertilization levels was significant at the level of 90 kg h⁻¹ for both cultivars, as it reached 101.00 and 82.33 cm, respectively, and it was superior to the other levels. The effective role of magnesium in the course of chemical reactions and physiological processes comes from the fact that it represents the center of the chlorophyllin molecule, in addition to activating a significant number of enzymes that control the production of proteins and the formation of chromosomes (Mahler, 2004). These results are consistent with was reached by Page, Miller, & Keeney, (1982).

Table 1. Effect of Adding Different Levels of Magnesium and Their Interaction on Plant Height (cm) for Two Dill Cultivars

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	77.67 c	80.33 ab	82.33 a	80.11 b
Lagum	94.00 b	63.00 c	101.00 a	86.00 a
Mean	85.83 c	71.67 b	91.67 a	

Note: Similar letters do not differ in terms of statistical significance

Number of Main Branches

The results of Table 2 indicate the effect of the study factors on the number of main branches trait that there were also no significant differences between the Lot and Lagum varieties in the number of main branches trait, as their averages reached 7.444 and 8.555 branches/plant, respectively. As for the effect of magnesium levels, the level of 90 kg h⁻¹ was superior, as it reached 9.500 branches/plant, while the level of 0 kg h⁻¹ gave the lowest rate, as it reached 6.500 branches/plant. As for the binary interaction between varieties and fertilization levels, the Lagum variety was superior at the level of 90 kg h⁻¹, as it reached 10,000 branches/plant, while the Lot variety had the lowest averages at the level of 0 kg h⁻¹, as it reached 6.000 branches/plant. Most cytoplasmic particles such as mitochondria, dictyosomes,



endoplasmic reticulum, etc. need magnesium, and therefore its availability in appropriate quantities for the plant is considered essential for the functioning of these organelles, in addition to its role in building ATP molecules and nucleic acids (Ranganna, 1977). The previous results agree, to some extent, with the results (AlRediman, 2004) on parsley, Rashed, (2002) on dill.

Table 2. The Effect of Adding Different Levels of Magnesium and Their Interaction on Number of Main Branches (Branch/Plant) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	6.00 c	7.33 abc	9.00 ab	7.44 a
Lagum	7.00 bc	8.66 abc	10.00 a	8.55 a
Mean	6.50 b	8.00 ab	9.50 a	

Note: Similar letters do not differ in terms of statistical significance

Percentage of Nitrogen

The results of Table 3 indicate the effect of the study factors on the nitrogen percentage trait (%), as the Lagum variety outperformed the Lot variety in the nitrogen percentage trait (%) with a significant difference, as its average reached 4.22222%. As for the effect of magnesium levels, there were no significant differences between the levels. As for the two-way interaction between the varieties and fertilization levels, the Lagum variety outperformed the Lot variety at all levels with a significant difference, as it reached 4.1766, 4.2133, and 4.130%. The use of fertilizers led to an increase in the mineral content compared to unfertilized plants, which may be related to their relatively high content of nutrients, a higher degree of water retention, decomposition of organic fertilizers, and slow release of nutrients in available forms, which were sufficient to meet the requirements of growing plants. The results obtained were in good agreement with the results of Shaimaa, (2018). on sweet fennel, coriander and anise plants and Wszelaczyńska, et al., (2024) on dill. The results also agree with Yoo, Bang, & Pike, (2020).

Table 3. The Effect of Adding Different Levels of Magnesium and Their Interaction on Nitrogen Content (%) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	3.88 b	3.95 b	3.98 b	3.94 b
Lagum	4.18 a	4.21 a	4.28 a	4.22 a
Mean	4.03 a	4.08 a	4.13 a	

Note: Similar letters do not differ in terms of statistical significance

Percentage of Phosphorus

The results of Table 4 indicate the effect of the study factors on the percentage of phosphorus (%) trait, as the Lagum variety outperformed the Lot variety in the percentage of phosphorus (%) trait, with a significant increase, as its average reached 0.119%. As for the effect of magnesium levels, the level 45 kg h⁻¹ outperformed the rest of the levels, as it reached 0.105% compared to the levels 0 kg h⁻¹ and 90 kg h⁻¹, as they reached 0.102 and 0.103%. As for the effect of magnesium levels, there were no significant differences between the levels. As for the bilateral interaction between the varieties and fertilization levels, the Lagum variety outperformed and at All levels on the Lot variety reached 0.1163, 0.1186 and 0.1236%.



The results are consistent with those of Wszelaczyńska, et al., (2024). The results obtained were in good agreement with the results of Rashed, (2002) on sweet fennel, coriander and anise plants and Shaimaa, (2018) on dill.

Table 4. The Effect of Adding Different Levels of Magnesium and Their Interaction on Phosphorus Content (%) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	0.089 b	0.09 b	0.10 b	0.09 b
Lagum	0.116 a	0.12 a	0.12 a	0.12 a
Mean	0.10 ab	0.11 a	0.10 ab	

Note: Similar letters do not differ in terms of statistical significance

Percentage of Potassium

The results of Table 5 indicate the effect of the study factors on the potassium percentage trait (%), as the Lagum variety outperformed the Lot variety in the potassium percentage trait (%) significantly, as its average reached 12.340%, while the Lot variety averaged 11.730%. As for the effect of magnesium levels, there were no significant differences between the levels. As for the two-way interaction between the varieties and fertilization levels, the Lagum variety outperformed the Lot variety at all levels, as its highest average reached 12.3533% at the level of 90 kg h⁻¹. The results agree with Wszelaczyńska, et al., (2024).

Table 5. The Effect of Adding Different Levels of Magnesium and Their Interaction on Potassium Content (%) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	11.722 b	11.730 b	11.739 b	11.730 b
Lagum	12.331 ab	12.336 ab	12.353 a	12.340 a
Mean	12.026 a	12.033 a	12.046 a	

Note: Similar letters do not differ in terms of statistical significance

Percentage of Magnesium

The results of Table 6 indicate the effect of the study factors on the percentage of magnesium (%) trait, as the Lagum variety outperformed the Lot variety in the percentage of magnesium (%) trait, with a significant superiority, as its average reached 1.468%, while the Lot variety reached an average of 1.154%. As for the effect of magnesium levels, the level 90 kg h⁻¹ outperformed the rest of the levels, as its average reached 1.4050% compared to the other two levels. As for the two-way interaction between the varieties and fertilization levels, the Lagum variety outperformed the Lot variety at all levels, as its highest average reached 1.6067% and at the level 90 kg h⁻¹. The results are consistent with Wszelaczyńska, et al., (2024).



Table 6. The Effect of Adding Different Levels of Magnesium and Their Interaction on Magnesium Content (%) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	1.11 c	1.15 c	1.20 c	1.15 b
Lagum	1.30 bc	1.5 ab	1.61 a	1.47 a
Mean	1.21 b	1.32 ab	1.41 a	

Note: Similar letters do not differ in terms of statistical significance

Vitamin C

The results of Table 7 indicate the effect of the study factors on the vitamin C trait (mg\100g), as the Lagum variety outperformed the Lot variety significantly in the vitamin C trait (mg\100g), as its average reached 113.750 mg\100g, while the Lot variety reached 105.690 mg\100g. As for the effect of magnesium levels, the level kg h⁻¹ 90 outperformed the rest of the levels, as its average reached 113.070 mg\100g compared to the first and second levels, as they reached 106.150 and 106.650 mg\100g, respectively. As for the binary interaction between the varieties and fertilization levels, the Lagum variety outperformed the Lot variety at all levels, as it reached 115.350 mg\100g higher. Overlap at the level of 90 kg h⁻¹ compared to the lowest overlap between varieties and fertilization levels, which reached 100.533 mg\100g. This increase is due to the fact that magnesium is essential in many vital processes in plants, including its role as a basic element in the chlorophyll molecule and as an activator of many enzymes. Improving the magnesium content in plants enhances the efficiency of the photosynthesis process, which increases the production of sugars and antioxidant compounds, such as vitamin C (Zende Bad, et al., 2018). The study is consistent with the findings of Page, Miller, & Keeney, (1982).

Table 7. The Effect of Adding Different Levels of Magnesium and Their Interaction on Vitamin C (mg\100g f.w) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	100.53 e	105.46 c	111.07 bc	105.69 b
Lagum	112.76 b	113.13 ab	115.35 a	113.75 a
Mean	106.15 b	106.65 b	113.07 a	

Note: Similar letters do not differ in terms of statistical significance

Carotenoids

The results of Table 8 indicate the effect of the study factors on the carotenoids trait, as the Lagum variety significantly outperformed the Lot variety in the carotenoids trait, as its average reached 172.697 mg\100g, while the Lot variety average reached 164.349 mg\100g. As for the effect of magnesium levels, the 90 kg h⁻¹ level outperformed the rest of the levels, as its average reached 171.143 mg\100g compared to the first and second levels, as they reached 166.370 and 168.056 mg\100g, respectively. As for the binary interaction between the varieties and fertilization levels, the Lagum variety outperformed the Lot variety at all levels, as it reached 175.450 mg\100g, the highest interaction, and at the 90 kg h⁻¹ level, compared to the lowest interaction between the varieties and fertilization levels, as it reached 162.447 mg\100g. This improvement, which can be explained by increased photosynthetic efficiency with improved magnesium availability, may be due to increased formation of carotenoids as essential compounds that play a vital role in photosynthesis by protecting chlorophyll from photodamage and enhancing energy transfer to protect chlorophyll and contribute to the efficiency of light energy transfer.



The positive effect on growth characteristics, total chlorophyll and total carotenoids in response to biofertilizers may be attributed to increased hydration in plant tissues (Zende Bad, et al., 2018).

Table 8. The Effect of Adding Different Levels of Magnesium and Their Interaction on Carotenoids (mg\100g fw) for Two Varieties of Dill Plant

Treat.	Magnesium			Mean
	0 kg h ⁻¹	kg h ⁻¹ 45	90 kg h ⁻¹	
Lot	162.44 ed	163.76 e	166.83 d	164.34 b
Lagum	170.29 c	172.35 b	175.45 a	172.69 a
Mean	166.37 bc	168.05 b	171.14 a	

Note: Similar letters do not differ in terms of statistical significance

Conclusion

The use of different varieties of dill (*Anethum graveolens* L.) was affected by magnesium, which played a vital role in plant growth, as it showed a significant effect on plant height and the number of main branches when used at a level of 90 kg ha⁻¹, indicating the importance of this element in improving the vegetative growth of plants as well as its effect on the nutrients in the plant. It will also result in a noticeable effect of magnesium on the percentage of nutrients such as nitrogen, phosphorus, and potassium in plants, such that the Lagum variety outperformed the Lot variety in the content of these elements, reflecting the difference in response between varieties to different magnesium levels. This element played a role in the amount of vitamin C and carotenoids, as they played an important role in enhancing the nutritional content of plants from vitamins, which are two basic compounds of antioxidants, in addition to the role of magnesium as a main component in chlorophyll and as an activator for many enzymes that contribute to photosynthesis and energy formation in the form of ATP. Thus, the availability of magnesium in sufficient quantities helps improve the physiological efficiency of plants. These results are largely consistent with previous studies on other plants such as parsley, dill, fennel, coriander, and anise, which enhances the credibility of the results and supports the importance of magnesium as a major nutrient in improving the quality and productivity of plants in general. Magnesium played an effective role as a fertilizing substance in enhancing many plant and chemical traits, and its effect depends largely on the level of fertilization and the variety. The importance of magnesium in improving growth and quality traits in plants, but it also illustrates the complexity of its effect, which depends on a set of factors including the plant variety, the level of fertilization, and environmental conditions.

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