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Improving the Growth of Thyme Plants (*Thymus vulgaris* L.) by Nitrogen and Potassium Fertilization

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

An academic field experiment was conducted in Jibul village, located in Jableh countryside-Syria, during the agricultural season of 2022/2023. The objective of this study was to assess the role of different levels of Nitrogen fertilizer (urea 46%) at rates of 0, 75, and 150 kg.ha-1, as well as potassium sulfate fertilizer at rates of 0 and 100 kg.ha-1,in various growth characteristics of common thyme. The experiment also aimed to analyze the potential interaction effects between these factors. The experiment was conducted following a factorial design, employing a completely randomized block design with three replications. To compare the means, the least significant difference test (L.S.D.) was employed at a 5% significance level.

The results indicated that nitrogen fertilization had a significant impact on all the traits under investigation. Among the different rates tested, the application of 150 kg. ha-1 resulted in the highest plants (28.62 cm), the highest number of branches per plant (14.05 branches), as well as the greatest fresh weight (45.10 g) and dry weight of the plant (11.55 g).

Furthermore, the results also demonstrated a significant effect of potassium sulfate fertilization on most of the traits examined. Specifically, the addition of 100 kg. ha-1 led to a significant increase in plant height (23.45 cm), the number of branches per plant (11.98 branches), the fresh weight (34.55 g), and the dry weight.

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The thyme plant responded significantly to the interaction between experimental factors. Specifically, the combination of 150 kg. ha-1 of urea and 100 kg. ha-1 of potassium sulfate demonstrated the highest rates in all the traits investigated, establishing a strong interaction between the two fertilizers.

Keywords: Thyme; fertilization; nitrogen; potassium; growth.

1. INTRODUCTION

Thymus vulgaris L. is a perennial aromatic medicinal herb plant belonging to the Lamiaceae family. The Western Mediterranean and Southern Europe are the original homeland of the plant [1]. Thyme has antioxidant properties because it contains thymol, carvacrol, and many phenolic substances that reduce oxidative stress and remove free radicals [2]. The phenolic compounds found in thyme play a role in activating biochemical processes in the human body, and have a role in reducing cholesterol and preventing atherosclerosis [3].

Thyme essential oil contains two main components: thymol and carvacrol. These compounds have antibacterial, antifungal, antioxidant, antitumor, and anti-inflammatory properties [4]. Nitrogen and potassium fertilizers are important essential elements for plants [5]. The use of fertilizers containing these elements can greatly enhance the productivity and quality of fruit trees [6]. Potassium is an important and necessary element to Improving the cell growth and development by achieving ideal expansion of the cell wall, and improving the work of plant growth regulators that directly intervene in the growth and elongation of cells [7].

The results of [1] to evaluating the impact of potassium and nitrogen fertilization on the growth characteristics of common thyme, at 6 rates (0, 25, 50, 75, 100 and 125 $mg.kg^{-1}$ soil. It was observed that the maximum plant height of 38.37 cm was achieved at the 50 mg/kg soil level. Furthermore, the highest fresh weight (42.78 g/plant) and dry weight (11.92 g/plant) were obtained at the 100 mg/kg soil level.

In a study of the effect of nitrogen fertilization on common thyme, three rates of Urea (0, 200, and 400 $mg.kg^{-1}$). It was found that nitrogen fertilization had a significant impact on increasing the dry weight of thyme, as the rate of 400 $mg.kg^{-1}$ achieved the highest dry weight of 1247 kg. ha^{-1} [8].

In an experiment on the effect of nitrogen fertilizer types on the growth and productivity of thyme in Egypt, three types of nitrogenous fertilizers were used: ammonium nitrate, ammonium sulfate, and urea. The results showed a significant effect of the different nitrogenous forms on the number of side branches and plant height [9]. In an experiment on the effect of nitrogen and cytokinin on thyme growth, three rates of nitrogen were used (0, 50 and 100 kg. ha^{-1}). The impact of nitrogen on plant height, branching and leaf structure, and the plant's dry weight was noted. Maximum indicators of plant height and number of branches were obtained for a rate of 100 kg. ha^{-1} [10].

Pal [11] conducted a study to determine the influence of nitrogen, phosphorus, and potassium on the growth and development of thyme and applied three levels of nitrogen to their plants: 0, 75, and 100 kg. ha^{-1} urea, with superphosphate: 0, 125 and 150 kg. ha $^{-1}$ and potassium chloride in three doses of 0, 75, and 100 kg. ha^{-1} as well. The best growth and productivity were in the area treated with 100 kg. ha^{-1} urea, 100 kg. ha^{-1} superphosphate, and 150 kg. ha^{-1} potassium chloride. Research importance lies in the medical, pharmaceutical and economic importance of thyme, and the increased demand in local and international markets, and the scarce academic cycle of it, especially in mineral fertilization. As a result, this experiment was conducted to investigate the impact of nitrogen and potassium fertilization and their interaction on some vegetative growth characteristics of the common thyme plant.

2. MATERIALS AND METHODS

2.1 Research Site

This experiment was conducted on a farm during the agricultural season 2022-2023 in Jaiboul village - Lattakia Governorate- Syria, which has a moderate climate suitable for growing thyme (Fig. 1).

Fig. 1. Research site

2.2 Preparation of Soil

Two perpendicular plowings were carried out, the first at a depth of 30 cm, and the second at a depth of 10 cm, then the land was divided according to the design of the experiment. It is clear from the results of the soil analysis that the soil is suitable for growing thyme (Table 1). Thyme seedlings, 10 cm long, were obtained from a private nursery in katilibiyah area, and were planted in rows within the plots in lines separated at 50 cm from one to another, and 20 cm between one line and another. The experimental plots were irrigated throughout the trial period at a rate of (1 liter per plant) every week, and all service operations were carried out on time according to the plants' needs. A certain amount of organic fertilizer was added to the experimental field about 1 ton. ha^{-1} and 150 kg ha-1 of Phosphate fertilizer as (P2O4 45%) with the first plowing, and half the amount of nitrogen and potassium was added while preparing the land for planting. The second batch was added a month after planting.

2.3 Experiment Design

A factorial experiment is carried out in a randomized block design with three replicates, and contained 2 factors:

(1) Nitrogen fertilization rate: it includes 3 treatments (0 – 75 – 150 kg. ha^{-1}) of urea $(NH_2)_2CO$ (N46%).

(2) Potassium fertilizer: It includes two rates (0-100 kg. ha^{-1}) of potassium sulphate K_2SO_4 (K_2O%50). The area of the experimental plot was 6 m^2. studied indicators were measured in the pre-flowering stage:

1. Plant height (cm): It was measured using a meter.

2. Number of branches: Averages of ten plants were ten plants were taken from each experimental plot.

3. Plant fresh weight (g): Plants were harvested in the pre-flowering stage, at a height of 10 cm above the soil surface and weighed directly using a sensitive balance.

4. Plant dry weight (g): Plants were harvested in the pre-flowering stage, at a height of 10 cm above the soil surface, and dried at room temperature until the weight was stable.

2.4 Statistical Analysis

Analysis of variance was performed using CoStat - Software version 6.4, and the $L.S.D_{5\%}$ value was calculated to compare the means.

Table 1. Site soil analysis results

mechanical analysis			EC decimens/m	PH	$Caco_3$%	potassium Mg. kg^{-1}	phosphor mg. kg^{-1}	Nitrogen Mg. kg^{-1}
Clay %	Silt%	Sand%						
38	**30**	**31**	**1.9**	**7.10**	**1**7.00	183.00	25.00	32.00

3. RESULTS AND DISCUSSION

3.1 Response of plant Height to the Studied Factors and the Interaction between Them

Thyme plant with plant height index responded significantly ($p < 0.05$) to nitrogen fertilization, and the maximum plant height was when fertilized at a rate of 150 kg. ha^{-1} (28.62 cm), and the lowest plant height in the control treatment (17.42 cm) (Table 2). This can be explained by the role of nitrogen in supporting plant growth, and the results are consistent with those of [9].

Plant height was also significantly affected by potassium fertilization, as the highest plant height (23.45 cm) was when fertilizing at a rate of 100 kg. ha^{-1}, while the lowest plant height was in the control treatment (21.80 cm) (Table 2).

The height of the thyme plant responded significantly to the interaction between the two experimental factors, and was highest (30.20 cm) when fertilized with a rate of 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulfate, while the lowest height (17.00 cm) was in non-fertilized plants. This is due to the importance of potassium in facilitating the absorption of other elements from the soil, the most important of which is nitrogen. This is consistent with what was found [1].

3.2 Response of Number of Branches to the Studied Factors and the Interaction between Them

Thyme plant with number of branches index responded significantly ($p < 0.05$) to nitrogen fertilization, and the maximum number of branches was when fertilized at a rate of 150 kg. ha^{-1} (14.05 branches), and the lowest number of branches (9.47 branches) in the control treatment (Table 2). This is attributed to the role of nitrogen in the branching of plants, and our results are consistent with the findings of [9], and with what was reported by [10] on common thyme (Table 2).

The number of branches was also significantly affected by potassium fertilization, as the highest number of branches (11.98 branches) was when fertilizing at a rate of 100 kg. ha^{-1}, while the lowest number of branches was in the control treatment (10.76 branches) (Table 2).

Table 2. The effect of nitrogen and potassium fertilization and the interaction on plant height and Number of branches

Potassium (kg. ha^{-1})	Nitrogen (kg. ha^{-1})	plant height (cm)		No of branches (branch. plant-1)
0	0	17.00 e		9.10 e
	75	17.75 e		9.85 d
	150	19.4 d		10.15 d
	0	22.40 c		
100				11.05 c
	75	27.05 b		13.05 b
	150	30.20 a		15.05 a
L.S. $D_{5\%}$		0.99		0.53
Mean K		0	21.80 b	10.76 b
		100	23.45 a	11.98 a
L.S. $D_{5\%}$			0.34	0.18
Mean N		0	17.42 c	9.47 c
		75	20.90 b	10.60 b
		28.62 a		14.05 a
L.S. $D_{5\%}$		0.42		0.22

The number of branches responded significantly to the interaction between the two experimental factors, and was highest (15.05 branches) when fertilized with a rate of 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulfate, while the lowest number of branches (9.10 branches) was in non-fertilized plants (Table 2). This is due to the importance of nitrogen in activating the activity of plant growth regulators, which play the main role in cell growth and development [7], and our results are in line with what has been reported [1].

3.3 Response of Plant Fresh Weight to the Studied Factors and the Interaction between Them

Thyme plant with Plant fresh weight index responded significantly ($p < 0.05$) to nitrogen fertilization, and the maximum Plant fresh weight was when fertilized at a rate of 150 kg. ha^{-1} (45.10 g), and the lowest Plant fresh weight was (25.27 g) in the control treatment (Table 3).

The Plant fresh weight was also significantly affected by potassium fertilization, as the highest fresh weight (34.55 g) was when fertilizing at a rate of 100 kg. ha^{-1}, while the lowest Plant fresh weight was in the control treatment (30.45 g) (Table 3).

The Plant fresh weight responded significantly to the interaction between the two experimental factors, and was highest Plant fresh weight (50.05 g) when fertilized with a rate of 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulfate, while the lowest Plant fresh weight (25.05 g) was in non-fertilized plants (Table 3). This is attributed to the vital role of potassium in providing the ionic environment for metabolic processes in the cytosol, and as such it acts as a regulator of various processes, including growth regulation [12]. This is consistent with the findings of [1].

3.4 Response of Plant Dry Weight to the Studied Factors and the Interaction between Them

Thyme plant with Plant dry weight index responded significantly ($p < 0.05$) to nitrogen fertilization, and the maximum Plant dry weight was when fertilized at a rate of 150 kg. ha^{-1} (11.55 g), and the lowest Plant dry weight was (7.37 g) in the control treatment (Table 3). This is due to the role of essential nitrogen in the composition of dry matter in the plant, and our results are in line with what has been reported [8].

The Plant dry weight was also significantly affected by potassium fertilization, as the highest dry weight (9.93 g) was when fertilizing at a rate of 100 kg. ha^{-1}, while the lowest Plant dry weight was in the control treatment (8.83 g) (Table 3).

Table 3. The effect of nitrogen and potassium fertilization and the interaction on fresh weight and dry weight

potassium (kg. ha^{-1})	Nitrogen (kg. ha^{-1})	fresh weight (g)		dry weight (g)
0	0	25.05 e		7.10 f
	75	25.50 de		7.65 c
	150	26.15 d	8.35 d	
	0	28.10 c		10.10 c
100				
	75	40.15 b		11.05 b
	150	50.05 a		12.05 a
L.S. D$_{5\%}$		1.04		0.24
Mean K		0	30.45 b	8.83 b
		100	34.55 a	
				9.93 a
L.S. D$_{5\%}$			0.36	0.08
Mean N		0	25.27 c	7.37 c
		75	27.12 b	9.22 b
		150	45.10 a	11.55 a
L.S. D$_{5\%}$			0.44	0.10

The Plant dry weight responded significantly to the interaction between the two experimental factors, and was highest Plant dry weight (12.05 g) when fertilized with a rate of 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulfate, while the lowest Plant dry weight (7.10 g) was in non-fertilized plants (Table 3). This can be justified by the effect of nitrogen and potassium on the formation of proteins, activating the work of many plant enzymes, activating the process of photosynthesis and transporting its products, and this is consistent with what was indicated [1].

4. CONCLUSIONS

common thyme plant responded significantly to nitrogen and potassium fertilization. A urea amount of 150 kg. ha^{-1} resulted in higher plant height (cm), higher number of branches (branches) per plant, and higher fresh weight (g) and dry weight (g) of the plant.

The rate of 100 kg. ha^{-1} Potassium sulfate achieved the highest plant height (cm), the highest number of branches, and the highest wet weight (g). The highest dry weight of the plant (g). The interaction between factors had a significant effect on all Studied characteristics, and the interaction treatment of 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulfate achieved the highest rates in plant height (cm), number of branches on the plant (branch), and fresh (g) and dry (g) weight. The study recommends further research on the production and fertilization of common thyme**.** Potassium fertilizer had a significant effect on all variables studied. The interaction between these two factors had a significant effect on all the indicators studied, and the treatment using 150 kg. ha^{-1} urea and 100 kg. ha^{-1} potassium sulphate led to the highest level in all studied traits. The study recommends further research on the production and fertilization of common thyme.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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