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The effect of biological promoters on thyme plant in different harvests

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Abstract

To study the effect of biological promoters on morphology of *Thymus daenensis* Celak, this experiment was conducted in Alborz Research Station, Research Institute of Forests and Rangelands, Karaj, Iran, in 2013. Experimental design was split plot in time in the form of a randomized complete block design with three replications. The main factor was biologic promoters in seven levels (0.75 and 1.5 L/ha of Humiforte, 0.3 and 0.6 L/ha of Aminoforte, 0.5 and 1.0 L/ha of Kadostim, 0.4 L/ha of Fosnutren, and control). The sub factor was harvest. Results indicated that biological promoters significantly affected plant height, canopy diameter, the number of flowering stems and fresh and dry shoot yield at $P \leq 0.01$ and canopy circle at $P \leq 0.05$. Harvest had significant effect on canopy circle, plant height, canopy diameter, the number of flowering stems and fresh and dry shoot yield at $P \leq 0.01$. Mean comparison showed that 0.5 L/ha Kadostim had the highest plant height (15.13 cm), dry shoot yield (1128.33 kg/ha) and dry shoot yield (3757.35 kg/ha). Application of 0.5 L/ha Humiforte resulted in the highest canopy diameter (36.53 cm). Mean comparison of harvests also showed that plant height (15.9 cm), canopy diameter (32.7 cm), the number of flowering stems (195.8), fresh shoot yield (3789.2 kg/ha) and dry shoot yield (1137.92 kg/ha) were the highest in the first harvest. Regarding the obtained results, it can be concluded that yield and yield components were the highest in the first harvest, when 0.5 L/ha Kadostim was applied.

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Introduction

Thymus daenensis Celak, from Lamiaceae family, is a medicinal plant endemic to Iran. It is a herbaceous perennial plant which its shoots are being used as medicinal part (Zargari, 1990). The flowering shoots and leaves are aromatic and have a bitter and spicy flavor (Haji Akhundi and Farahani Kia, 2003). It is used as a flavoring, antitussive, antispasmodic, carminative, antimicrobial and antibacterial substance (Daman Khorshid, 1992; Riahi Dehkordi, 1982). It has antioxidant features and is used to cure cold diseases in Iran and other countries (Starch, 2005).

Biological promoters are biological substances that promote beneficial processes inside plants body. They mainly consist of amino acids and poly peptides with low molecular weight, vitamins, hormones (auxin, cytokinin and gibberelin), sugars and antioxidants. They increase plant yield as they penetrate in substrate and promote plant root development. They also increase the quality of products. In addition, they increase plants resistance to harsh environmental conditions such as drought, cold climate and heavy metals toxicity in soil. This may be attributed to changes made to enzyme activity and antioxidant synthesis (Gawronaka, 2008).

Golzadeh *et al.* (2011) studied the effect of complete fertilizer, Aminoforte (0.75 and 1.5 L/ha), Kadostim (0.75 and 1.5 L/ha), Humiforte (0.75 and 1.5 L/ha) and Fosnutren (0.75 and 1.5 L/ha) on *Matricaria recutita* L. and reported that application of the biological promoters increased yield and quality of the plant; Aminoforte 1.5 L/ha and Fosnutren 1.5 L/ha had the highest effect on Capitol yield and essential oil yield, respectively. In another research on *Trigonella foenum-graecum*, the effect of application of Aminoforte, Fosnutren, Kadostim, Humiforte, 50% of the recommended chemical fertilizer (NPK) + Humiforte, and 100% of the recommended chemical fertilizer was studied and it was reported that the highest number of grain in pod and the highest pod dry weight were related to Fosnutren (Mohammadi *et al.*, 2013).

Ghaseminejad *et al.* (2011) tested the effects of Aminoforte, Kadostim, Fosnutren, Humiforte (0.75, 1.0 and 1.5 L/ha concentrations) and chemical fertilizers ($N_{70}P_{70}K_{70}$ kg/ha) on *Lallemantia iberica* and reported that application of biological promoters significantly affected seed yield; Fosnutren and Kadostim were the most effective treatments. In another experiment which was conducted to study the effect of biological promoters (0.75 and 1.5 L/ha Kadostim, Fosnutren, Aminoforte and Humiforte) and chemical fertilizers (70 kg/ha NPK) on morphological parameters of *Carum copticum*, it was found that plant height, the number of lateral branches, the number of leaves, shoot dry yield and chlorophyll content were the highest in 1.5 L/ha Kadostim, stem diameter was the highest in 0.75 L/ha Fosnutren, and the number of spikes in plant and grains in plant were the highest in the chemical fertilizer treatment (Mirshekari *et al.*, 2012).

Regarding the limitations in production rate and uncontrolled application of chemical fertilizers, high costs of chemical fertilizers and also their damages to the environment, it is required to take advantages of non-chemical sources. So, the objective of this experiment was to study the effect of biological promoters on the morphological parameters of *Thymus daenensis* Celak.

Materials and methods

Site and treatments

In order to study the effect of biological promoters on the morphology of *Thymus daenensis* Celak, this experiment was conducted in Alborz Research Station, Research Institute of Forests and Rangelands, Karaj, Iran, in 2013. Experimental design was split plot in time in the form of a randomized complete block design with three replications. The main factor was biologic promoters in seven levels (0.75 and 1.5 L/ha of Humiforte, 0.3 and 0.6 L/ha of Aminoforte, 0.5 and 1.0 L/ha of Kadostim, 0.4 L/ha of Fosnutren, and control). The sub factor was harvest in two levels (the first and the second cuts). The measured traits included canopy circle, plant height, canopy diameter, the number of flowering stems, stem diameter and fresh and dry shoot yield.

Soil properties

The soil at the test site contained 35.71% clay, 38.78% silt and 25.51% sand. The pH was 7.48 and EC was 1.02 ds/m. Other soil properties are listed in Table 1.

Plot size was 2 × 3 m, 1.5 m was left between plots and 2.5 m was left between blocks. The interval of planting rows and the interval of plants on the rows was 40 cm.

Data collection and statistical analysis

Irrigation was conducted quickly after transplanting. During the growth period, weeds were controlled manually. At the full flowering stage, harvest was conducted and morphological parameters were measured. To do this, three middle rows of each plot were harvested and the traits were measured using digital scale, meter, ruler and caliper. Data were analysis using SAS software and means were compared according to the Duncan's multiple range test.

Results and discussion

Canopy circle

Analysis of variance indicated that biological promoters had significant effect on canopy circle at P≤0.05. The effect of harvest was also significant at P≤0.01; however, the effect of the interaction of two factors not significant (Table 2). Mean comparison of the effect of biological promoters on canopy circle (Table 3) indicated that this trait was the highest (103.18 cm) in 0.5 L/ha Kadostim and the lowest (85.08 cm) in the control. Application of 0.5 L/ha Kadostim increased canopy circle by 21.27% compared with the control. Biological promoters affect plants growth and yield through the stimulation of phytohormones production and stimulation of plant physiological processes. They also improve soil conditions (Gawronaka, 2008). Tomas-Barberan *et al.* (2009) reported that application of some biological promoters increased soil physico-chemical properties and fertility in tea plants cultivation which resulted in the improvement of poly phenols and amino acids content in plant tissues.

Table 1. The properties of the test site soil.

N (%)	P (ppm)	K (ppm)	Ca (Meq/l)	Mg (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)	Fe (ppm)
0.09	8.16	360	9.78	68	0.37	0.42	12.88	3.18

Mean comparison of the effect of harvest on canopy circle (Table 4) showed that this trait was the highest (102.8 cm) in the first harvest and the lowest (83.7 cm) in the second harvest. Koochaki *et al.* (2009) conducted a two year experiment to test the effect of biofertilizers on *Hyssopus officinalis* and found that treatments increased plant height, stem diameter, dry and fresh yield and essential oil yield. They reported that morphological traits and shoot yield were in the second year, compared with the first year. In the second year, application of biofertilizers increased fresh and dry shoot yield and essential oil yield; these traits were higher in the first cut compared with the second cut.

Table 2. Analysis of variance of the effect of treatments on the measured traits.

SOV	df	Mean Squares (MS)						
		Canopy circle	Plant height	Canopy diameter	Number of flowering stems	Stem diameter	Dry shoot yield	Fresh shoot yield
Replication	2	ns	ns	ns	ns	ns	**	**
Biologicalpromoters (A)	7	*	**	**	**	ns	**	**
Error (A)	14	874.62	19.8	213.01	14479.16	0.12	86907.51	963708.78
Harvest (B)	1	**	**	**	**	ns	**	**
A × B	7	ns	ns	ns	ns	ns	ns	ns
Error	16	0.46	0.62	0.55	0.23	0.01	510.58	8.16
CV (%)	-	8.72	5.66	7.67	9.26	10.06	8.16	5661.82

ns, nonsignificant; **, significant at P≤0.01; *, significant at P≤0.05.

Results of mean comparison of the effect of interaction of biological promoters × harvest is given in Table 5.

Plant height

Analysis of variance indicated the significant effect of biological promoters and harvest on plant height at P≤0.01; however, the effect of interaction of the two factors was not significant (Table 2). Mean comparison of the effect of biological promoters indicated that plant height was the highest (15.13 cm) in 0.5 L/ha Kadostim and the lowest (12.58 cm) in the control. Application of 0.5 L/ha Kadostim increased plant height by 20.27% compared with the control (Table 3). Shehata *et al.* (2011) observed that foliar application of amino acids increase plant height in celeriac. Golzadeh *et al.* (2011) also reported the enhancement of plant height in Matricaria chamomilla as the result of biological promoters application. These finding were also observed in the experiments of Rafiee *et al.* (2012) on *Calendula officinalis* L. and Sani (2010) on *Descurainia sophia*; who reported that Kadostim is effective on plant height.

Table 3. The effect of biological promoters on the measured traits.

Treatments	Canopy circle (cm)	Fresh shoot yield (kg/ha)	Dry shoot yield (kg/ha)	Plant height (cm)	Canopy diameter (cm)	Number of flowering stems	Stem diameter
Kadostim 1	92.76c	3474.3b	1043.33b	15.05a	26.98cd	120.9h	1.1abc
Humiforte 0.75	87.0e	3280.05c	991.67c	12.65b	23.45f	150.7g	1.13abc
Humiforte 1.5	100.61b	3729.6a	1120.0a	14.29a	36.53a	186.46c	1.25a
Fosnutren 0.4	86.76e	3269.06c	981.7c	14.43a	30.48b	240.18b	1.09bc
Aminoforte 0.3	100.85b	3740.7a	1123.33a	14.86a	25.55e	164.43f	1.14abc
Aminoforte 0.6	89.5d	3302.25c	991.67c	12.81b	26.48de	271.68a	1.05c
Kadostim 0.5	103.18a	3757.35a	1128.33a	15.13a	27.48c	176.88e	1.24ab
Control	85.08f	3224.55c	968.33c	12.58b	26.3de	177.73d	1.19abc

Means in a column followed by the same letter are not significantly different at P≤0.01.

Mean comparison of the effect of harvest on plant height (Table 4) indicated that plant height was the highest (15.9 cm) in the first harvest and the lowest (11.9 cm) in the second harvest; it was 33.69% higher in the first harvest compared with the second harvest. Generally, the beginning of the flowering stage is the most suitable time for harvest (Taherian, 2011).

Canopy diameter

Results indicated that biological promoters and harvest had significant effect on canopy diameter (P≤0.01); however, the effect of their interaction was not significant (Table 2). Mean comparison of biological promoters showed that this trait was the highest (36.5 cm) in 1.5 L/ha Humiforte and the lowest (23.4 cm) in 0.75 L/ha Humiforte (Table 3). Application of 1.5 L/ha Humiforte increased canopy diameter by 55.77% compared with 0.75 L/ha Humiforte. Yuckmilasarojnee *et al.* (2009) found that application of biological promoters such as amino acids increased pepper growth and yield; this is a sustainable method of yield improvement.

Table 4. The effect of harvest on the measured traits.

Treatments	Canopy circle (cm)	Dry shoot yield (kg/ha)	Fresh shoot yield (kg/ha)	Plant height (cm)	Canopy diameter (cm)	Number of flowering stems	Stem diameter
First harvest	102.79a	1137.92a	3789.29a	15.99a	32.65a	195.82a	1.17a
Second harvest	83.65b	947.5b	3155.18b	11.96b	23.16b	176.41b	1.12a

Means in a column followed by the same letter are not significantly different at P≤0.01.

Mean comparison of the effect of harvest on canopy diameter indicated that it was the highest (32.7 cm) in the first harvest and the lowest (23.2 cm) in the second one (Table 4). Nik Khah (2008) reported that the beginning of the flowering stage is the most suitable time for harvest.

The number of flowering stems

Analysis of variance showed that biological promoters and harvest had significant effect on the number of flowering stems (at P≤0.01); however, the effect of their interaction was not significant (Table 2). Mean comparison of biological promoters represented that the number of flowering stems was the highest (271.68) in 0.6 L/ha Aminoforte and the lowest (120.9) in 1.0 L/ha Kadostim (Table 3). In another experiment on *Picea abies* L. Karst, application of Kadostim Fosnutren, Aminoforte and Humiforte increased plant growth and root development (Slawik, 2005).

Table 5. The effect of interaction of biological promoters × harvest on the measured traits.

Treatments	Canopy circle (cm)	Dry shoot yield (kg/ha)	Fresh shoot yield (kg/ha)	Plant height (cm)	Canopy diameter (cm)	Number of flowering stems	Stem diameter
A_1B_1	102.16c	1140.0b	3796.2b	17.46a	31.96c	130.7n	1.06bc
A_2B_1	97.1e	1083.33cd	3607.5cd	14.53b	27.86f	159.93k	1.09bc
A_3B_1	110.33b	1216.67a	4051.5a	16.16a	41.24a	196.03e	1.28ab
A_4B_1	96.66e	1080.07cd	3562.62cd	16.52a	35.56b	250.03c	1.1abc
A_5B_1	110.5b	1220.0a	4062.6a	16.93a	30.43e	174.26i	1.12abc
A_6B_1	98.96d	1103.33bc	3674.1bc	14.63b	31.33cde	281.6a	1.05c
A_7B_1	112.26a	1200.0a	3996.0a	17.23a	32.3c	186.6g	1.23abc
A_8B_1	94.33f	1060.0de	3529.8de	14.46b	30.5de	187.46f	1.06bc
A_1B_2	83.36h	946.67f	3152.4f	12.63c	22.0hi	111.10	1.13abc
A_2B_2	76.9j	886.67g	2952.6g	10.76e	19.03j	141.46m	1.17abc
A_3B_2	90.9g	1023.33e	3407.7e	12.43cd	31.83cd	176.9h	1.23abc
A_4B_2	76.86j	883.33g	2941.5g	12.33cd	25.4g	230.33d	1.07bc
A_5B_2	91.2g	1026.67e	3418.8e	12.8c	20.66i	154.6L	1.15abc
A_6B_2	80.03i	880.0g	2930.4g	11.0de	21.63hi	261.76b	1.06bc
A_7B_2	64.1f	1056.67de	3518.7de	13.03c	22.66h	167.16j	1.24abc
A_8B_2	75.83j	876.67g	2919.3g	10.7e	22.1h	168.0j	1.33a

Means in a column followed by the same letter are not significantly different at P≤0.01.

A_1, 1 L/ha Kadostim; A_2, 0.75 L/ha Humiforte; A_3, 1.5 L/ha Humiforte; A_4, 0.4 L/ha Fosnutren; A_5, 0.3 L/ha Aminoforte; A_6, 0.6 L/ha Aminoforte; A_7, 0.5 L/ha Kadostim; A_8, Control.

B_1, the first harvest; B_2, the second harvest.

Mean comparison of the effect of harvest on the number of flowering stems indicated that this trait was the highest (195.82) in the first harvest and the lowest (176.41) in the second harvest. The number of flowering stems was 11% higher in the first harvest compared with the second harvest (Table 4).

Dry flowering shoot yield

Analysis of variance indicated the significant effect of biological promoters and harvest on dry shoot yield (at P≤0.01); however, the effect of their interaction was not significant (Table 2). Mean comparison of biological promoters indicated that dry shoot yield was the highest (1128.33 kg/ha) in 0.3 L/ha Kadostim and the lowest (968.33 kg/ha) in the control (Table 3). Application of 0.3 L/ha Kadostim in creased dry shoot yield by 16.5%. Yuckmilasarojnee *et al.* (2009) reported that application of amino acids containing biological promoters increased yield of pepper. In another experiments on *Philodendron erubescens* conducted by AbouDahab and El-Aziz (2006), application of amino acids increased the number of leaves, fresh and dry shoot yield and also other growth parameters. Moradi *et al.* (2010) also reported that application of nitrogen resulted in the enhancement of economic yield and biologic yield of *Plantago ovata*. So, the enhancement of growth and yield as the result of Kadostim may be attributed to the synergistic effect and correlation of amino acids, nitrogen and potassium in the formulation of Kadostim.

Mean comparison of the effect of harvest on dry shoot yield indicated that this trait was the highest (1137.92 kg/ha) in the first harvest and the lowest (947.5 kg/ha) in the second harvest (Table 4). Yazdi *et al.*

(2007) studied the effect of planting density and harvest on thyme and reported that the highest dry yield was achieved in the first harvest of the first year.

Fresh flowering shoot yield

Analysis of variance indicated the significant effect (at P≤0.01) of biological promoters and harvest on fresh shoot yield; however, their interaction had no significant effect (Table 2). Men comparison of biological promoters indicated that fresh shoot yield was the highest in 0.5 L/ha Kadostim, 0.3 L/ha Aminoforte and 1.5 L/ha Humiforte (3757.35, 3740.7 and 3729.6 kg/ha respectively). This trait was the lowest (3224.55 kg/ha) in the control (Table 3). Application of 0.5 L/ha Kadostim, 0.3 L/ha Aminoforte and 1.5 L/ha Humiforte increased this trait by 16.52, 16.0 and 15.66%, respectively, compared with the control. In another experiment on celeriac plant, it was found that application of amino acids increased leaf yield (Shehata *et al.*, 2011). These findings are also in agreement with those of Sani (2010) who reported that Kadostim was the best treatment for yield improvement in *Descurainia sophia*. So, Kadostim is effective on chlorophyll content because it contains amino acids and amino acids have correlation with the content of nitrogen containing compounds. Amino acids increase plant growth and yield due to their effects on plant's chlorophyll content (Jeyhouni, 2012).

Application of biological promoters improved *Plantago ovata* growth and yield because they sustainably provide amino acids and some mineral nutrients. This effect is more significant than the effects of chemical fertilizers (Cassman *et al.*, 1994). In that experiment, Kadostim was the most effective treatment. It must be noticed that different amino acids and various types of nitrogen containing compounds presents in the formulation of Kadostim (Ammonium forms, nitrate forms and organic forms). *Plantago ovata* grows well in soils which are rich in potassium; so, presence of potassium in the structure of Kadostim may have great effect on the growth and yield of this plant.

Mean comparison of the effect of harvest on fresh shoot yield indicated that this trait was the highest (3789.29 kg/ha) in the first harvest and the lowest (3155.18 kg/ha) in the second harvest (Table 4). Fresh shoot yield was 20.1% higher in the first harvest than in the second harvest.

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