Research Findings

Thyme experimental plot in Sahili, near the city of Izmir, Turkey. Photo by IPI.

Effect of Potassium Fertilization on Essential Oils of Garden Thyme (*Thymus vulgaris* L.)

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Introduction

Thyme (*Thymus vulgaris* L.), a significant aromatic plant with around 100 species in the world, is widely used for medicinal purposes as well as in culinary dishes. There are around 40 thyme species in Turkey of which 14 are endemic (Anonymous, 2010). Most of these species grow in the wild and are harvested from the countryside, with only five percent cultivated commercially. Garden thyme has natural antibiotic properties as a consequence of the presence of thymol which constitutes around 50 percent of the total essential oils. Carvacrol is also of importance in this respect (Anonymous, 2009). It is well known that many extracts from aromatic plants possess antimicrobial properties (Yousef and Tawil, 1980). It has also been reported that carvacrol and thymol have antioxidant as well as antibacterial and antifungal effects (Aureli *et al.*, 1992).

It is widely recognised that application of mineral nutrients in fertilizers can influence the mineral and organic composition of aromatic plants, including thyme. For example at the same rate of nitrogen (N) application to thyme, ammonium nitrate treatment showed a higher percentage composition of thymol as compared with urea (Sharafzade *et al.*, 2011). In general, potassium (K) is a plant nutrient which increases yield and quality so it might therefore be considered

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to be beneficial for production of essential oils in thyme. Some evidence of this is apparent from the findings of Hornok (1983) who reported that applying 180 kg ha^{-1} K_2O fertilizer increased total essential oil content.

The objective of this project was to examine the effect of different K rates on yield, content of macronutrient elements and essential oil compounds of garden thyme (*Thymus vulgaris* L.) and their interrelationships.

Table 1. Physical properties and fertility status of the experimental soil.

Depth	Texture	pH	Soluble salts	Organic matter	$CaCO_3$	N	P	K	Ca	Mg
cm			------%------				------*mg kg^{-1}*------			
0-20	Sandy loam	7.46	0.047	0.98	20.95	0.07	1.18	118	3,240	23
20-40	Sandy loam	7.69	<0.02	0.62	26.78	0.03	1.48	59	3,360	24

Table 2. Yield and macronutrient elements content of the dried herbal material.

K rate (basal +side dressing)	Yield	Nutrient elements				
		N	P	K	Ca	Mg
kg K_2O ha^{-1}	*kg ha^{-1} fw*	------*% dm*------				
K_1 (67.5)	26,300 b	2.05	0.184	2.67	1.51	0.299
K_2 (67.5+100)	26,400 b	2.14	0.209	2.90	1.50	0.306
K_3 (67.5+200)	26,800 a	2.07	0.204	2.49	1.51	0.293
K_4 (67.5+300)	27,000 a	2.06	0.202	2.72	1.50	0.293
LSD	132.9**	ns	ns	ns	ns	ns

** Significance at P <0.01 level

Materials and methods

The soil of the experimental site was sandy loam in texture, slightly alkaline in reaction, low in organic matter, high in $CaCO_3$ and unaffected by soluble salts. The experimental soil was poor in N, P, K and Mg but rich in Ca (Table 1).

The experiment was performed in a garden thyme plantation where four different rates of K_2O (K_1, K_2, K_3 and K_4) were applied as the treatments for this study in a Randomized Block Design with four replicates per treatment. As a basal dressing, 67.5 kg ha^{-1} N, P_2O_5, and K_2O were given to all plots (each measuring 10.0 x 1.4 = 14.0 m^2) at constant amounts by incorporating 450 kg ha^{-1} 15:15:15+Zn early in spring. As a side dressing, late in the spring, an additional 67.5 kg ha^{-1} P_2O_5 was given to all of the treatment parcels in the form of phosphoric acid (H_3PO_4). To establish the K treatments, 0, 100, 200 and 300 kg ha^{-1} K_2O in the form of potassium sulphate (K_2SO_4) were also side dressed at the same time as H_3PO_4. In total, the K_2O doses were 67.5, 167.5, 267.5 and 367.5 kg ha^{-1}. Green herbal material (leaf, stalk and flower at the beginning of flowering) was collected and weighed three times during the harvesting season. Soil from the experimental site was sampled from two depths and analyzed for physical and chemical properties. Mineral nutrient elements (Ryan *et al.*, 1996) and essential oils were analyzed in the dried plant material at the second harvest. The essential oils were extracted by hydro-distillation for three hours using a Clevenger type apparatus. The composition of essential oil constituents (%) was determined using gas chromatography and mass spectrometry (GC-MS) (Toncer *et al.*, 2009).

Results

Yield and macronutrient element contents of the herbal material are presented in Table 2. The fresh yield values were between 26,300-27,000 kg ha^{-1}. The mineral nutrient contents in the dried material were as follows: N (2.05-2.14%), P (0.184-0.209%), K (2.49-2.90%), Ca (1.50-1.51%), and Mg (0.293- 0.306%).

Yield showed an increasing trend with the increasing rates of K. According to the findings, the K_3 application (267.5 kg ha^{-1} K_2O) seems to be the most appropriate rate for an economic yield (data of economic analysis not shown).

Excluding Ca content of the dried plant material which was not influenced by K treatments, other macronutrient elements (N, P, K, Mg) were almost all higher at the higher rates of K compared to the K_1 treatment where only 67.5 kg ha^{-1} K_2O was applied as a basal dressing. Macronutrient elements reached the highest values in the K_2 treatment.

The four major oil constituents found were thymol, para cymen, carvacrol and G terpinen, as also reported by Sharafzade *et al.*, 2011. According to analysis of statistical variance, the effect of K applications on the essential oils content was not significant. However, a positive correlation was observed between the rate of K application and the plant levels of thymol and carvacrol expressed in terms of percentage distribution of the essential oil constituents (0.9184 and 0.9431 respectively) (Fig. 1). Data in Fig. 1 also shows a negative correlation between K application rate and percentage of para cymen (-0.6391) but no correlation between K application and the

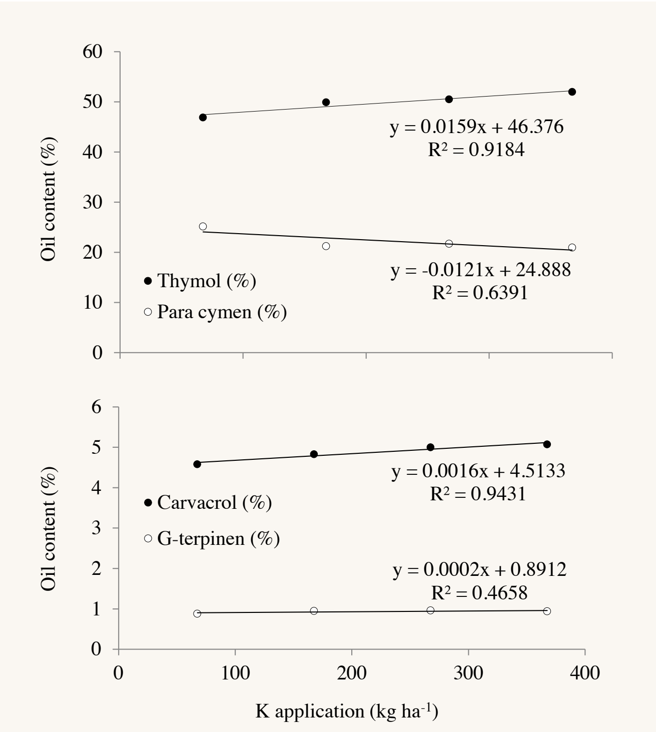

Fig. 1. Correlation between rate of K application and the levels of the four main essential oils in garden thyme (*Thymus vulgaris* L.) as percentage of the total.

Thyme was used by the ancient people of the Mediterranean, and now a "must" in many cuisines. Photo by IPI.

percentage of G-terpinen. From these data it may be suggested that either the increasing amounts of thymol and carvacrol or increasing rates of K_2O applications decreased the para cymen contents of garden thyme.

To conclude, increasing rates of K increased N, P, K and Mg contents up to K_2 rate and green herb yield up to the K_3 application. However, the results relating to the nutrient elements were not statistically significant. Since the effects of K up to the K_4 rate on the relative distribution of the four essential oil constituents differed between individual oils this might imply that further K doses should be tested to reach a stable trend.

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