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Influence of water stress and potassium fertilizer on some characteristics of satureja hortens

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ABSTRACT: *Satureja hortens* is an annual, herbaceous plant belonging to the family Labiatae. It is known as summer savory, native to southern Europe and naturalized in parts of North America. The main constituents of the essential oil of shortness are phenols, carvacrol and thymol, as well as pcymene, caryophyllene, linalool and other terpenoids. Due to the growth of population and expansion of the agricultural, energy, and industrial sectors, the demand for water has increased extensively, and water scarcity has been occurring almost every year in many parts of the world. The field experiment was laid out split plot with randomized complete block design with three replications. Treatments included potassium fertilizer (F0= control, F1: 20 gr, F2: 40gr) and water stress (E0: control, E1: water stress in stemming, E2: water stress in flowering, E3: water stress in seedling). Analysis of variance showed that the effect of water stress and potassium on all characteristics was significant.

Key words: plant height, dry weight, fresh weight, grain yield

INTRODUCTION

Satureja hortensis L. is an annual, herbaceous plant belonging to the family Labiatae. It is known as summer savory, native to southern Europe and naturalized in parts of North America. The main constituents of the essential oil of Shortness are phenols, carvacrol and thymol, as well as p-cymene, caryophyllene, linalool and other terpenoids (Sefidkhon *et al.,* 2006). In folk medicine, *Satureja hortensis* is used as stomachic, stimulant, carminative, expectorant, the world aphrodisiac, antispasmodic and antidiarrheals (Hajhashemi, 2000; Skocibusic *et al*., 2006). In addition, savory has wide application in food, drink and perfume industries (Sefidkon *et al*., 2006; Skocibusic *et al*., 2006). The essential oil of *S. hortensis* possesses many activities such as antioxidant, antibacterial and antifungal (Gulluce *et al*., 2003; Rezaeei *et al*., 2014). The main essential oil constituents are phenolic compounds including carvacrol and thymol, as well as γ-terpinene, p-cymene, β-caryophyllene, linalool and other terpenoids (Rechinger,1982; Zawislak, 2008). Besides, adaptability to harsh environmental conditions, high yield and short growing period make *S. hortensis* as a valuable alternative crop in agriculture (Hadian *et al*., 2008). In the recent years, the interest of growing herbs such as savory as alternative crops are highly increased (Prohens *et al*., 2003). Due to the growth of population and expansion of the agricultural, energy, and industrial sectors, the demand for water has increased extensively, and water scarcity has been occurring almost every year in many parts of the world (Mishra and Singh, 2010).

Drought is known as a major abiotic factor that limits plant's growth and production. Although the general effects of drought on plant growth are fairly well known, the primary effects of water deficit at the biochemical and molecular levels are not well understood (Bhatnagar-Mathur *et al*., 2009). Drought stress is one of the most important environmental stresses affecting agricultural productivity around the world and may result in considerable yield reductions (Boyer, 1982; Ludlow and Muchow, 1990). Furthermore, the physiologic and metabolic responses of crops to dry environments have been well studied, but similar studies are lacking in medicinal and aromatic plants. Water stress decreases growth of some medicinal plants, including *Hypericum brasiliense* Choisy (Nacif de Abreu and Mazzafera, 2005) and *Bupleurum chinense* DC. (Zhu *et al*., 2009). On the other hand, many studies have shown that drought enhances the amount of secondary metabolites in a wide variety of plant species, such as *Rehmannia glutinosa* (Gaertn.) DC. (Chung *et al*., 2006). Conversely, drought caused a significant reduction in all growth parameters and essential oil yield and percentage in some medicinal plants such as peppermint (*Mentha piperita* L.) (Khorasaninejad *et al*., 2011). Water stress resulted in significant reduction of fresh and dry matter, nutrient content, and essential oil yield of Japanese mint plants (Mirsa and Strivastava, 2000). Fresh and dry weights of *Ocimum basilicum* L. were decreased as plant water deficit increased (Simon *et al*., 1992).

The linalool and methyl chavicol contents of sweet basil, as percentage of total essential oil, increased as water stress increased (Simon *et al*., 1992). Nutrition plays a key role in the growth and development of all crop plants. In the case of medicinal plants that synthesize essential oils, nutrients can effectively increase oil yield and quality (Aziz *et al*. 2010, Jabbari *et al*. 2011). A second important nutrient for plants is potassium, which usually occurs in the plant at quite a high concentration, in particular in the meristematic tissues and in the phloem. Disturbances in nitrogen metabolism, resulting from potassium deficiency, manifest themselves in changes in the proportions between nitrogen fractions as well as in the accumulation of harmful amino substances (agmatine, N-carbamoyl putrescine, putrescine) and ammonium ions (Nowacki 1980) in the plant.

MATERIAL AND METHODS

The experiment was conducted at the zabol which is situated between 31° North latitude and 61° East longitude. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics. The field experiment was laid out split plot with randomized complete block design with three replications. Treatments included potassium fertilizer (F0= control, F1: 20 gr, F2: 40gr) and water stress (E0: control, E1: water stress in stemming, E2: water stress in flowering, E3: water stress in seedling). Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

A. Plant height

Analysis of variance showed that the effect of water stress on Plant height was significant (Table 1). The maximum of Plant height of treatments control was obtained (Table 2). The minimum of Plant height of treatments water stress in stemming was obtained (Table 2). Analysis of variance showed that the effect of Potassium on Plant height was significant (Table 1). The maximum of Plant height of treatments 40 gr was obtained (Table 2). The minimum of Plant height of treatments control was obtained (Table 2).

Table 1: Anova analysis of the *Satureja hortensis* affected by water stress and potassium.

S.O.V	df	Plant height	Dry weight	Fresh weight	Grain yield
R	2	6.361	0.331	1.253	14.151
Irrigation	3	319.519**	6.263**	134.676**	74.430**
Error a	6	9.880	0.301	3.846	4.670
Potassium	2	170.528**	3.342**	67.617**	58.098**
Irrigation * Potassium	6	4.157^{ns}	0.081^{ns}	5.922^{ns}	0.545^{ns}
Error b	16	4.417	0.228	2.290	0.960
total	35	-	-	-	-
CV (%)	-	7.18	11.65	7.61	6.17
*, **, ns: significant at $p<0.05$ and $p<0.01$ and non-significant, respectively.					

B. Dry weight

Analysis of variance showed that the effect of water stress on dry weight was significant (Table 1). The maximum of dry weight of treatments control was obtained (Table 2). The minimum of dry weight of treatments water stress in stemming was obtained (Table 2). Analysis of variance showed that the effect of Potassium on dry weight was significant (Table 1). The maximum of dry weight of treatments 40 gr was obtained (Table 2). The minimum of dry weight of treatments control was obtained (Table 2).

Table 2: Comparison of different traits affected by water stress and potassium.

Treatment	Plant height	Dry weight	Fresh weight	Grain yield
Water stress				
control	38a	5.2a	25a	20a
stemming	24c	3b	15b	17ab
flowering	27bc	3.3b	17b	15b
seedling	27b	4b	19b	14b
potassium				
control	28c	3.8b	18b	14c
20 gr	31b	4.2b	19b	16b
40gr	33a	5a	22a	18a
Any two means not sharing a common letter differ significantly from each other at 5% probability				

C. Fresh weight

Analysis of variance showed that the effect of water stress on fresh weight was significant (Table 1). The maximum of fresh weight of treatments control was obtained (Table 2). The minimum of fresh weight of treatments water stress in stemming was obtained (Table 2). Analysis of variance showed that the effect of Potassium on fresh weight was significant (Table 1). The maximum of fresh weight of treatments 40 gr was obtained (Table 2). The minimum of fresh weight of treatments control was obtained (Table 2).

D. Grain yield

Analysis of variance showed that the effect of water stress on grain yield was significant (Table 1). The maximum of grain yield of treatments control was obtained (Table 2). The minimum of grain yield of treatments water stress in seedling was obtained (Table 2). Analysis of variance showed that the effect of Potassium on grain yield was significant (Table 1). The maximum of grain yield of treatments 40 gr was obtained (Table 2). The minimum of grain yield of treatments control was obtained (Table 2).

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