Journal of Elementology ISSN 1644-2296

Kabay T. 2022.
Effects of different potassium doses on growth rates and micronutrients of drought-sensitive beans.
J. Elem., 27(2): 239-247. DOI: 10.5601/jelem.2021.26.4.2181

RECEIVED: 20 October 2021
ACCEPTED: 21 April 2022

ORIGINAL PAPER

EFFECTS OF DIFFERENT POTASSIUM DOSES ON GROWTH RATES AND MICRONUTRIENTS OF DROUGHT-SENSITIVE BEANS

Turgay Kabay

Ercis Vocational School
Van YuzuncuYil University,Van, Turkey

Abstract

When plants are exposed to abiotic stress, such as drought, their growth slows down and, in extreme condition, the plants might even begin to dry out, which causes great economic losses for the producers. One of the most important ways to save plants with less damage in stress environments, such as drought, is to fertilize them with potassium fertilizers because the plants with sufficient potassium amounts increase their tolerance to drought stress. This study aimed to determine the effects of potassium doses in order to decrease yield and quality losses due to drought stress during bean production. The cv. Zulbiye, a drought susceptible cultivar, and the bean genotype V71, a drought susceptible bean genotype, were chosen from previous studies. The bean seeds of these varieties were sown into 2 liter pots filled with perlite. Four doses of potassium (K) were applied as 0 K mg kg^{-1} (control), 500 mg kg^{-1} K, 1000 mg kg^{-1} K, and 2000 mg kg^{-1} K, in a completely randomized factorial experimental design with four replications, each having 4 pots. The seedlings were supplied with Hoagland solution and kept in a growth chamber with day temp. of 22-25°C and night temperatures of 17-19°C. Irrigation was completely stopped in the 20-day-old seedlings in drought stress treatment for 12 days, while the control seedlings were irrigated regularly. On the 20th day of the drought stress, the study was terminated, and the growth rate and some microelement contents (Cu, Mn, Zn and Fe) were determined. While there was a decrease in the growth rate and the amount of micronutrients in the plants in the group exposed to drought, it was observed that the negative effect of drought decreased and the growth rate and the amount of micronutrients started to increase in the plants to which potassium doses had been applied. It was also noticed that drought stress symptoms were decreased especially after the application of the doses of 1000 and 2000 mg kg^{-1} K.

Keywords: drought, growth rate, micronutrients, *Phaseolus vulgaris*.

Turgay Kabay, Ercis Vocational School, Van Yuzuncu Yil University, Van, Turkey, (ORCID ID: 0000-0002-3239-0037); e-mail: turgaykabay@gmail.com

INTRODUCTION

Proper irrigation and plant nutrition are required to improve yield and quality in beans. Balanced nutrient treatments, especially at initial seeding or into the seedling growth medium, may improve yield and quality as well as plant resistance to abiotic and biotic stressors. Recent droughts negatively influenced yield and quality in several plants including beans. In bean genotypes exposed to drought stress, plant growth and development, leaf relative water content, relative growth ratio, membrane damage index and kernel K and Ca values were lower in drought-sensitive genotypes while drought--tolerant genotypes had quite close values to the control plants (Kabay, Şensoy 2016, Kabay, Şensoy 2017). An experiment was in which in pumpkin was grown with no fertilization (control), humic substances (HS) fertilizer, complex fertilizers, compost and mixture of complex fertilizers, and humic substances fertilizers; and the biggest average content of the macro- and micro--elements was found in pumpkins fertilized with the complex fertilizers, but all the applied fertilizers increased the content of calcium, iron, manganese, sodium and zinc in the pumpkin fruit (Paulauskiene et al. 2018). It was reported in a previous study that greater K and Ca ion concentrations in green herbage and roots of melons improved plant resistance to stress conditions, and oxidative and antioxidative enzyme activities increased under drought stress (Kuşvuran 2010). Potassium supply to plants rebalanced the already disturbed inner-cell electrolyte balance, increased K content and also balanced intracellular activities (Kacar et al. 2006, Yıldız, Terzi 2007, Wang et al. 2013). In a study carried out with different salt concentrations on 20 different bean genotypes, green herbage and root fresh and dry weights varied in a broad range and these values of sensitive genotypes were negatively influenced by salt concentrations (Kıpçak, Erdinc 2016). In another study, two sugar cane cultivars were grown under saline conditions and decreasing K ratios and plant growth were reported with increasing salinity levels while an additional K supply improved plant growth and development (Ashraf et al. 2015). It was reported in a previous study carried out to determine the effects of potassium sulphate (50% K_2O; 0, 4, 8, 12 kg K_2O^{da-1}) and magnesium sulphate (16% MgO; 0, 2, 4, 6 kg MgO^{da-1}) on sunflowers that single K treatments increased leaf macro- (N, P, K, C, Mg, S) and micro--nutrients (Fe, Zn, Mn, Cu, B) (Ertiflik, Zengin 2015). It was reported in another study carried out to determine the effects of organic and chemical fertilizers on plant nutrition and growth of peppers grown under-cover that plant nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe) and manganese (Mn) concentrations significantly increased with different fertilizer treatments (Özkan et. al. 2013). In a study carried out with tomato cultivars, decreasing plant growth and development, as well as plant K and Ca levels were reported under dry and saline conditions (Ali, Rab 2017). In another study carried out with different K_2O doses

(0, 40, 80, 120 and 160 kg ha^{-1}) on tomatoes, the best effects were achieved with 120 kg K_2O ha^{-1} treatments (Çolpan et al. 2013). Significant differences were reported in quality attributes of tomato cultivars under good irrigation and drought stress conditions (Hirye et al. 2020). Five different PEG-6000 concentrations were applied to tomatoes to reflect artificial drought stress, and decreasing shoot lengths, leaf lengths, number of leaves and leaf areas were reported with increasing PEG-6000 concentrations (Ayaz et al. 2015).

Gonzalez and Pastenes (2012) carried out a study to assess the effects of water and heat stress on physiological parameters of beans, and reported that water stress-sensitive bean genotypes were negatively influenced by heat stress while heat tolerant genotypes yielded close values to control plants. In a study carried out with foliar sprays of 50 mg kg^{-1} selenium (in the form of Na_2SeO_4) and 300 ppm silicon (in the form of K_2SiO_3) on cucumber (*Cucumis sativus* L.) plants, positive impacts of treatments on the number of leaves, plant height, number of fruits, fruit weight, fruit diameter, fruit length, fruit firmness, fruit total soluble solids content (TSSC), fruit pH, EC and leaf N, P, K, Mg, Ca, Fe, Se and Si contents were reported (Gonzalez, Pastenes 2012, Çetinsoy, Daşgan 2016).

This study was conducted to determine the effects of different potassium (K) doses on relative growth rates and plant Cu, Fe, Zn and Mn contents of the drought-sensitive Zulbiye cultivar and V71 bean genotypes.

MATERIAL AND METHOD

Effects of different potassium doses (0, 500, 1000 and 2000 ppm K) on growth rates and Cu, Fe, Zn and Mn contents of the drought-sensitive V71 bean genotypes and Zulbiye bean cultivar were investigated in this study. Bean seeds were planted into 2-liter pots containing perlite + potassium doses (0, 500, 1000, 2000 ppm). Following the germination of the seeds, thinning was performed leaving two plants in each pot. Experiments were conducted in randomized blocks according to a factorial experimental design with 4 replications, with 4 pots in each replicate. Experiments were conducted in a climate chamber with day temp. of 22 - 25°C and night temp. of 17 - 19°C. Experimental pots were irrigated with Hoagland nutrient solution throughout the experiments. When the bean plants reached day 20 of growth, irrigations were continued on control plants, but terminated on drought-stressed plants. Following the 12-day drought period, analyses were performed on plants, such as:

Determination of the relative growth rate – RGR (g fresh weight day^{-1})

Before and after drought stress applications, the plants were weighed and the difference between the two measurements was divided by the number of days (Kusvuran 2010).

Mineral element analysis

At the end of the drought experiment, the shoot and root samples from stressed and control plants were dried in an oven at 65°C until constant weight. Then the dry samples (200 mg) were grounded, pre-digested with ethyl alcohol, and then incinerated to ash at 550°C. The ash samples were dissolved with a 3.3% HCl solution, filtered with blue-band filter paper, and then Na, K, and Ca was determined by atomic absorption (Bağcı 2010, Kusvuran, 2010, Kabay, Şensoy 2017).

The statistical analysis

Analysis of variance based on general linear models was carried out in the SAS 9.4.1 statistical program. The Duncan multiple comparison tests were used to measure statistical differences between the genotypes (Yeşilova, Denizhan 2016).

RESULTS AND DISCUSSION

Recently intensifying droughts negatively influence yield and quality in plant production. Identification of the effects of different potassium doses on bean plants exposed to drought stress will make contribution to production practice. Therefore, in this study, effects of different potassium doses on relative growth rates and micro-nutrients in drought-sensitive beans were investigated. In the Zulbiye bean cultivar, while the relative growth rate of untreated control plants was 0.220 g fresh weight day^{-1}, the value of untreated drought plants was 0.088 g fresh weight day^{-1}; there was a 60% reduction in the relative growth rate of plants under drought stress. The relative growth rate of 2000 mg kg^{-1} K-treated control plants was 0.265 g fresh weight day^{-1}, the value of 2000 mg kg^{-1} K-treated drought plants was 0.113 g fresh weight day^{-1}; there was a 57.36% reduction in the relative growth rate of plants under drought stress. In the V71 genotype, the relative growth rate of untreated control plants was 0.180 g fresh weight day^{-1}, the value of untreated drought plants was 0.080 g fresh weight day^{-1}; there was a 55.56% reduction in the relative growth rate of plants under drought stress. The relative growth rate of 2000 mg kg^{-1} K-treated control plants was 0.243 g fresh weight day^{-1}, the value of 2000 mg kg^{-1} K-treated drought plants was 0.112 g fresh weight day^{-1}; there was a 53.91% reduction in the relative growth rate of plants under drought stress (Table 1). In the bean genotypes exposed to drought stress, plant growth and development, leaf relative water content, relative growth ratio, and membrane damage index were lower in drought-sensitive genotypes while drought-tolerant genotypes had values quite close to the ones in control plants (Kabay, Şensoy

Table 1

Effects of potassium doses on relative growth rates RGR (g fresh weight day^{-1}) of bean plants under drought stress, change (%)

Beans	Treatment	Growth rates of control plants (g fresh weight day^{-1})	Growth rates of drought plants (g fresh weight day^{-1})	Change (%)
Zulbiye	0 mg kg^{-1} K	0.220*cd**	0.088*cd**	-60.0
	500 mg kg^{-1} K	0.243*b*	0.097*bc*	-60.08
	1000 mg kg^{-1} K	0.257*a*	0.103*ab*	-59.92
	2000 mg kg^{-1} K	0.265*a*	0.113*a*	-57.36
V71	0 mg kg^{-1} K	0.180*e*	0.080*d*	-55.56
	500 mg kg^{-1} K	0.207*d*	0.090*bd*	-56.52
	1000 mg kg^{-1} K	0.225*c*	0.102*ab*	-54.67
	2000 mg kg^{-1} K	0.243*b*	0.112*a*	-53.91

* There is a significant difference ($p<0.05$) between values followed by the different letters in each column.

2016, Kabay, Şensoy 2017). It was reported in a previous study that greater K and Ca ion concentrations in green herbage and roots of melons improved plant resistance to stress conditions (Kuşvuran 2010). Significant differences were reported in quality attributes of tomato cultivars under good irrigation and drought stress conditions (Hirye et al. 2020). Five different PEG-6000 concentrations were applied to tomatoes to reflect artificial drought stress, and decreasing shoot lengths, leaf lengths, number of leaves and leaf areas were reported with increasing PEG-6000 concentrations (Ayaz et al. 2015).

In the Zulbiye bean cultivar, the Cu concentration of untreated control plants was 8.142 mg kg^{-1} and the value of untreated drought plants was 8.090 mg kg^{-1}; there was a 0.635% reduction in the Cu content of plants under drought stress. The Cu concentration of 2000 mg kg^{-1} K-treated control plants was 8.182 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 8.115 mg kg^{-1}; there was a 0.819% reduction in the Cu content of plants under drought stress. In V71 genotype, the Cu concentration of untreated control plants was 8.225 mg kg^{-1} and the value of untreated drought plants was 8.215 mg kg^{-1}; there was a 0.122% reduction in the Cu content of plants under drought stress. The Cu concentration of 2000 ppm K-treated control plants was 8.255 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 8.235 mg kg^{-1}; there was a 0.242% reduction in the Cu content of plants under drought stress (Table 2). In the Zulbiye bean cultivar, the Fe concentration of untreated control plants was 73.627 mg kg^{-1} and the value of untreated drought plants was 73.613 mg kg^{-1}; there was a 0.019% reduction in the Fe content of plants under drought stress. The Fe concentration of 2000 mg kg^{-1} K-treated control plants was 73.678 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was

Table 2

Effects of potassium doses on Cu and Fe concentrations of bean plants under drought stress (ppm), change (%)

Beans	Treatment	Control Cu	Drought Cu	Change (%)	Control Fe	Drought Fe	Change (%)
Zulbiye	0 mg kg^{-1} K	8.142*f**	8.090*f**	-0.635	73.627*b**	73.613*a**	-0.019
	500 mg kg^{-1} K	8.155*ef*	8.098*e*	-0.698	73.662*a*	73.615*a*	-0.064
	1000 mg kg^{-1} K	8.168*e*	8.113*d*	-0.673	73.663*a*	73.625*a*	-0.051
	2000 mg kg^{-1} K	8.182*d*	8.115*d*	-0.819	73.678*a*	73.625*a*	-0.072
V71	0 mg kg^{-1} K	8.225*c*	8.215*c*	-0.122	73.420*d*	73.370*c*	-0.068
	500 mg kg^{-1} K	8.234*bc*	8.223*bc*	-0.134	73.433*d*	73.375*c*	-0.079
	1000 mg kg^{-1} K	8.245*ab*	8.233*ab*	-0.146	73.455*c*	73.383*bc*	-0.098
	2000 mg kg^{-1} K	8.255*a*	8.235*a*	-0.242	73.463*c*	73.390*b*	-0.099

* There is a significant difference ($p<0.05$) between values with the different letters in each column.

73.625 mg kg^{-1}; there was a 0.072% reduction in the Fe content of plants under drought stress. In the V71 genotype, the Fe concentration of untreated control plants was 73.420 mg kg^{-1} and the value of untreated drought plants was 73.370 mg kg^{-1}; there was a 0.068% reduction in the Fe content of plants under drought stress. The Fe concentration of 2000 mg kg^{-1} K-treated control plants was 73.463 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 73.390 mg kg^{-1}; there was a 0.099% reduction in the Fe content of plants under drought stress. (Table 2). In the Zulbiye bean cultivar, the Zn concentration of untreated control plants was 29.530 mg kg^{-1} and the value of untreated drought plants was 29.468 mg kg^{-1}; there was a 0.209% reduction in the Zn content of plants under drought stress. The Zn concentration of 2000 mg kg^{-1} K-treated control plants was 29.570 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 29.520 mg kg^{-1}; there was a 0.169% reduction in the Zn content of plants under drought stress. In the V71 genotype, the Zn concentration of untreated control plants was 29.515 mg kg^{-1} and the value of untreated drought plants was 29.460 mg kg^{-1}; there was a 0.186% reduction in the Zn content of plants under drought stress. The Zn concentration of 2000 mg kg^{-1} K-treated control plants was 29.545 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 29.505 mg kg^{-1}; there was a 0.135% reduction in the Zn content of plants under drought stress (Table 3). In the Zulbiye bean cultivar, the Mn concentration of untreated control plants was 47.763 ppm and the value of untreated drought plants was 47.360 mg kg^{-1}; there was a 0.843% reduction in the Mn content of plants under drought stress. The Mn concentration of 2000 mg kg^{-1} K-treated control plants was 47.795 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 47.380 mg kg^{-1}; there was a 0.868% reduction in the Mn content of plants under drought stress.

Table 3

Effects of potassium doses on Zn and Mn concentrations of bean plants under drought stress (ppm), change (%)

Beans	Treatment	Control Zn	Drought Zn	Change (%)	Control Mn	drought Mn	Change (%)
Zulbiye	0 mg kg^{-1} K	29.530*d*	29.468*cd*	-0.209	47.763*b*	47.360*c*	-0.843
	500 mg kg^{-1} K	29.535*cd*	29.475*cd*	-0.203	47.785*a*	47.368*c*	-0.872
	1000 mg kg^{-1} K	29.552b	29.478*cd*	-0.250	47.788*a*	47.373*c*	-0.868
	2000 mg kg^{-1} K	29.570*a*	29.520*a*	-0.169	47.795*a*	47.380*c*	-0.868
V71	0 mg kg^{-1} K	29.515*e*	29.460*d*	-0.186	47.733*d*	47.465*b*	-0.561
	500 mg kg^{-1} K	29.527*d*	29.467*cd*	-0.203	47.740*cd*	47.475*ab*	-0.555
	1000 mg kg^{-1} K	29.535*cd*	29.490*bc*	-0.152	47.753*bc*	47.495*a*	-0.540
	2000 mg kg^{-1} K	29.545*bc*	29.505*ab*	-0.135	47.760*b*	47.480*ab*	-0.586

* There is a significant difference ($p<0.05$) between values with the different letters in each column.

In the V71 genotype, the Mn concentration of untreated control plants was 47.733 mg kg^{-1} and the value of untreated drought plants was 47.465 mg kg^{-1}; there was a 0.561% reduction in the Mn content of plants under drought stress. The Mn concentration of 2000 mg kg^{-1} K-treated control plants was 47.760 mg kg^{-1} and the value of 2000 mg kg^{-1} K-treated drought plants was 47.480 mg kg^{-1}; there was a 0.586% reduction in the Mn content of plants under drought stress (Table 3). It was reported in another study carried out to determine the effects of organic and chemical fertilizers on plant nutrition and growth of peppers grown under-cover that plant nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe) and manganese (Mn) concentrations significantly increased with different fertilizer treatments (Özkan et al. 2013). In a study carried out with tomato cultivars, decreasing plant growth and development, as well as plant K and Ca levels were reported under dry and saline conditions (Çolpan et al. 2013, Ali, Rab 2017, Hirye et al. 2020). It was reported that pumpkins fertilized with complex fertilizers increased the content of calcium, iron, manganese, sodium and zinc in the pumpkin fruit (Paulauskiene et al. 2018). In a study carried out with foliar sprays of 50 mg kg^{-1} selenium (in the form of Na_2SeO_4) and 300 mg kg^{-1} silicon (in the form of K_2SiO_3) on cucumber (*Cucumis sativus* L.) plants, positive impacts of the treatments on the number of leaves, plant height, number of fruits, fruit weight, fruit diameter, fruit length, fruit firmness, fruit total soluble solids content (TSSC), fruit pH, EC and leaf N, P, K, Mg, Ca, Fe, Se and Si contents were reported (Çetinsoy, Daşgan 2016). It was reported in a previous study carried out to determine the effects of potassium sulphate (50% K_2O; 0, 4, 8, 12 kg K_2O^{da-1}) and magnesium sulphate (16% MgO; 0, 2, 4, 6 kg MgO^{da-1}) on sunflowers that single K treatments increased leaf macro- (N, P, K, C, Mg, S) and micro-nutrients

(Fe, Zn, Mn, Cu, B) (Ertiflik, Zengin 2015). It has been reported in another study that organic and chemical fertilizers improve the growth and development and increase the nutrient content of vegetable plants under abiotic stress (Kabay et al. 2018a, Kabay et al. 2018b, Kabay 2018, Kabay 2019).

CONCLUSION

Many solutions have been tried by researchers since drought restricts plant production. In many abiotic stress conditions, such as drought, one of the best solutions is to increase the amount of potassium in the plant growing medium. The effect of increasing doses of potassium on the Zulbiye and V71 bean genotypes, which were found to be drought sensitive in previous studies, was investigated. In the present study, it was seen that the plants exposed to drought were more damaged by the negative effects of drought if grown without potassium doses, that is the control group in this experiment, but the extent of this damage decreased with an increase of the potassium dose.

Based on the present findings, it was concluded that increasing K doses had positive effects the Zulbiye and V71 bean genotypes exposed to drought. There were decreases in the relative growth rates and plant Fe, Zn, Cu and Mn concentrations under drought stress conditions, but the values increased with increasing K doses and more positive effects were observed, especially from 1000 and 2000 mg kg^{-1} K applications.

REFERENCES

Ali S.G., Rab A. 2017. *The influence of salinıty and drought stress on sodium. potassium and proline content of Solanum lycopersicum* L. cv. Rio Grande. Pak. J. Bot., 49(1): 1-9.

Ashraf M., Shahzad S.M., Arif M.S., Riaz M., Ali S., Abid M. 2015. *Effects of potassium sulfate on adaptability of sugarcane cultivars to salt stress under hydroponic conditiıons*. J. Plant Nutr., 38: 2126-2138 ISSN: 0190-4167

Ayaz M., Ahmad R., Shahzad M., Khan N., Shah M.M., Khan S.A. 2015. *Drought stress stunt tomato plant growth and up-regulate expression of SlAREB, SlNCED3, and SlERF024 genes*. Sci. Hort., 195: 48-55.

Bağcı E. 2010. *Identification of drought-induced oxidative stress in chickpea with physiological and biochemical parameters (unpublished Ph.D. Thesis)*. Ankara U. Fac. of Sci., 403 p.

Çetinsoy M.F., Daşgan H.Y. 2016. *Effects of foliar selenium and silicon fertilizers on cucumbers*. Nevşehir Jl of Sci and Tec. TARGID Spec. Iss., 243-252.

Çolpan E., Zengin M., Özbahçe A. 2013. *The effects of potassium on the yield and fruit quality components of stick tomato*. Hort. Env. Biotechnol., 54(1): 20-28.

Ertiflik H., Zengin M. 2015. *Effects of ıncreasing rates of potassium and magnesium fertilizers on the nutrient contents of sunflower leaf*. Selcuk J. Agr. Food Sci., 29(2): 51-61.

Gonzalez C.J., Pastenes C. 2012. *Water-stress-induced thermotolerance of photosynthesis in bean (Phaseolus vulgaris* L.*) plants: The possible involvement of lipid composition and xanthophyll cycle pigments*. Env. Exp. Bot., 77: 127-140.

Hirve M., Jain M., Rastogi A., Kataria S. 2020. *Heavy metals, water deficit, and their interaction in plants: an overview*. In Plant Life Under Changing Env. (pp. 175-206).

Kabay T., Şensoy S. 2016. *Drought stress-induced changes in enzymes, chlorophyll and ions of some bean genotypes*. Y. Y. U. J. Agric. Sci., 26(3): 380-395.

Kabay T., Şensoy S. 2017. *Enzyme, chlorophyll and ion changes in some common bean genotypes by high temperature stress*. Ege U. J. Agric. Sci., 54(4): 429-437.

Kabay T., Ekincialp A. Erdinç Ç., Şensoy S. 2018*b*. *The impact of low temperatures on plant growth in some common bean genotypes*. Fresen. Env. Bull., 27(12*a*): 8715-8722

Kabay T., Alp Y., Şensoy S. 2018*a*. *Effect of vermicompost application on some plant characteristics in lettuce (Lactuca sativa* L.*)* Fresen. Env. Bull., 27(12b): 9942-9948.

Kabay T. 2018. *Effects of different potassium doses on ion, chlorophyll and enzyme contents of drought sensitive bean plants*. Fresen. Env. Bull., 27(11): 7733-7738

Kabay T. 2019. *Effects of different potassium doses on development of high temperature sensitive bean plants*. Fresen. Env. Bull., 28(1): 320-325.

Kacar B., Katkat B., Öztürk Ş. 2006. *Plant physiology*. Nobel Press, 2: 493-533

Kıpçak S., Erdinç Ç. 2016. *Identification of salt tolerance levels of some bean (Phaseolus vulgaris l.) genotypes grown in van lake basin*. Y.Y.U. J. Agric. Sci., 421-429.

Kuşvuran Ş. 2010. *Relationships between physiological mechanisms for drought and salinity tolerance of melons*. Ç. U. Ins. of Nat. and Appl. Sci. 356 p. Adana. (in Turkish)

Özkan C.F. Asri F.Ö. Demirtaş E.I., Arı N. 2013. *Effects of organic and chemical fertilizers on nutritional status and plant growth of peppers grown under-cover*. J. Soil Water, 2(1-2): 96-101.

Paulauskiene A., Danilcenko H., Pranckietiene I., Taraseviciene Z. 2018. *Effect of dıfferent fertılızers on the mıneral content of pumpkın fruıt*. J Elem, 23(3): 1033-1042.

Wang M., Zheng Q., Shen Q., Guo S. 2013. *The critical role of potassium in plant stress response*. Int. J. Mol. Sci., 14: 7370-7390. DOI: 10.3390/ijms14047370

Yeşilova A., Denizhan E. 2016. *Modelling mite counts using Poisson and negative binomial*. Fresen Env. Bull., 25: 5062-5066.

Yıldız M., Terzi H. 2007. *Identification of plant heat stress tolerance with cell vigor and photosynthetic pigmentation tests*. Erciyes U. J. Sci., 23(1-2): 47-60. (in Turkish)