Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm
2014 Vol. 4 (4) October-December, pp.87-92/Ghaedi and Aboutalebi
Research Article

EFFECT OF SODIUM CHLORIDE AND CALCIUM CHLORIDE ON VEGETATIVE CHARACTERISTICS AND AMOUNT OF GREEN SWEET BASIL (*OCIMUM BASILICUM*) ESSENTIAL OIL

Ghaedi S. and *Aboutalebi A.
Department of Horticulture, Jahrom Branch, Islamic Azad University, Jahrom, Iran
**Author for Correspondence*

ABSTRACT
Basil essence (*Ocimum basilicum* L.) widely has utilization in food industries, perfumery, oral and dental processing and traditional medicine. In this study, was evaluated on the effect of NaCl and $CaCl_2$ on plant growth and amount of essence of sweet basil (green) in the greenhouse. The applied treatments were including sodium chloride and calcium chloride both in concentrations of 0 (Control treatment), 2, 4, 6 and 8 gL^{-1}. This experiment was performed in completely randomized design with 9 treatments and 4 replications. Then seeds were sown in each 5-kg pot in depth of 2 cm. The obtained results indicated that the highest plant height was related to control and NaCl 6 gL^{-1} treatments, lateral shoot number in control and $CaCl_2$ treatments, dry weight in NaCl and control treatments, essence content in control and $CaCl_2$ treatments, sodium content in NaCl treatment and chloride content in $CaCl_2$ treatment.

Keywords: *Essential Oil (Essence), Green Sweet Basil, Sodium Chloride, Calcium Chloride*

INTRODUCTION
Sweet basil (*Ocimum basilicum* L.) is a herbaceous and annual plant belonging to Mint family (Labiateae). *Ocimum* genus has 30 species that *O. basilicum* is the most important economic species of them and nowadays was economically cultivated in the all warm-temperate regions. Basil also is used in food, makeup, health and perfume industries (Omidbeigi, 2000). Basil has been defined in the most pharmacopeias as the medicinal plant. Effective materials of vegetative tissues of basil are appetizer and are used to cure flatulence and help to food digestion. From this plant can be used to cure some heart diseases as well as for healing of splenalgia (Omidbeigi, 2000). Basil is a rich source of annular components and essences like other plants of Labiateae family, which are insects repulsive and have antibacterial, antifungal and antivirus function (Juliani and Simin, 2002). Essences usually accumulate in the gland hairs in the leaf surface, stem and flower that in basil widely produce and store within shield-like glands and is containing main components such as phenyldepropanoids and terpenoids.
According to definition, salinity consisting excessive existence of soluble salts and mineral elements in the water and soil solution, which causing to accumulation of salt in the root zone and confuse sufficient water absorption from soil solution by plant. Salinity is the important abiotic stress that has injurious effects on plant yield and crop quality. Amounts of sodium chloride and sodium sulphate are from specialties of a saline soil, which are increasing in the unsuitable irrigation and drainage and salt accumulation in desert and semi-desert regions. Salinity is the limited factor for growth that leads to create of nutritive restrictions via reduction of phosphorous, potassium, nitrate, calcium uptake and increasing intercellular ionic concentration and osmotic (Rahimi, 2006; Aboutalebi and Hassanzadeh, 2014). High percentage of the used drugs in the advanced countries has plant origin. Regards to the increasing trend of saline lands and shortage of lands for agriculture, identification of salt tolerant medicinal plants has very importance. Soil and water salinity are the main restrictive factors for plant growth in the most regions of Iran especially dried and semi-dried regions (Hosseini and Rezvani-moghaddam, 2006). Seed priming by NaCl was used to increase salinity tolerance in various stages of growth in the plants such as Tomato (Cano *et al*., 1991), Asparagus (Bittencort *et al*., 2004), Melon (Sivritepe *et al*., 2005) and Cucumber (Esmaielpour *et al*., 2006), which in these cases priming caused to increase tolerance to salinity in the above plans. Tomato and Asparagus seed priming by PEG and KNO3 increased salinity tolerance and KNO3 had higher efficiency than PEG (Pill *et al*., 1991).

Sivritepe *et al.,* (2005) found that seed priming of Melon increased its resistance to salinity in the germination and plantlet growth stages. Enhancement of salinity resistance after priming is due to increasing Na+ and Cl- ions in the root and organic acids and sugars in the leaf. Seed priming lead to increase compatibility to salt and sugar and proline amount increase in the treated plants and reduce toxicity of elements. However, it can be concluded that seed priming lead to reduce inhibitory effects of salts in plantlet growth stage. Esmaielpour *et al.,* (2006) reported that seed priming of two Iranian cucumbers by NaCl solution increased germination percent and velocity, leaf area and dry weight of plantlets. Influence of priming in deduction of harmful salinity effects in high salinity level was more than low salinity levels. In addition, seed priming increased potassium, calcium and proline in the cucumber plantlets. These results indicated that seed priming has been increased salinity resistance of cucumber plantlets via acceleration of potassium and calcium absorption and induction of proline accumulation and osmotic regulation. Investigations of other researchers on other plants also indicated that seed priming decreased negative effects of unfavorable environmental conditions and improving plantlet growth (Bradford, 1985; Arin and Kayak, 2003; Anwar *et al*., 1981). Asadi *et al.,* (2011) in order to evaluate effect of salinity stress on germination of Basil in completely randomized design with seven treatments (NaCl 0, 50, 100 150, 200, 250 and 300 Mmol) in four replication found that by increasing salinity levels, length and dry weight of radicle and plumule decreased. Thus, response of basil plant to salinity levels has not been desirable in germination stage. Dadkhah *et al*., (2007) in evaluation the effect of salinity on germination and growth of medicinal plants concluded that germination percent and growth of plantlet significantly increased by rising of salinity. In addition, type of salt significantly affected germination and plantlet growth. Khamri (2007) in study on the effect of salinity on seed germination and plantlet growth of six medicinal plants found that four plant of *Hibiscus sabdariffa*, *Cassia angustifolia*, *Ocimum basilicum* and *Hyssopus officinalis* had no germination in 200 Mmol NaCl. Seed germination was observed in two plants of *Cyamopsis tetragonoloba* and *Cynara scolymus* in 200 Mmol NaCl. More tolerance against salinity in recent species is possible to cultivate and revenue from these plants or other tolerant species in the saline regions. Delavari-parizi *et al.,* (2011) in the study evaluated the effect of salicylic acid on peroxidation of lipids, sugars and elements of Na and K in the leaf and root of green basil under salinity stress. Peroxidation of membrane lipids in the leaf and root significantly decreased in salicylic acid treatment and salinity of 100 Mmol. Amount of malondialdehyde significantly increased in salinity of 200 Mmol and by increasing salinity stress amount of sugar in the leaf significantly increased. Amount of sugar significantly decreased in the synchronized treatment of salinity and salicylic acid in the salinity of 100 Mmol and significantly increased in salinity of 200 Mmol. Amount of sodium in the leaf increased by salinity and decreased in salicylic acid treatment compared control treatment. Amount of sodium significantly decreased in the synchronized treatments of 100 and 200 Mmol salinity and salicylic acid. Amount of potassium in the leaf significantly decreased in salinity stress. Amount of potassium in the leaf and root significantly decreased in the synchronized treatments of salinity and salicylic acid, which indicate improving salinity effect in the presence of salicylic acid. Banchio *et al.,* (2009) by adding *Bacillus subtilis* (GBO3) to the soil in the planting basil in order to increasing essence content found that two main part of essence components of basil including Alpha-Terpineol and Eugenolas well as root and stem dry and fresh weight increased.

MATERIALS AND METHODS

In order to evaluate the effects of sodium chloride and calcium chloride on vegetative characteristics and essence content of green basil was performed a pot experiment in the spring of 2013 in the greenhouse located in Yasouj (altitude 1870 m). The used treatments were consisting control, 2, 4, 6 and 8 gL^{-1} NaCl or $CaCl_2$. Ten seeds were sown in the 5-liters pots in depth of 2 cm. In stage of 4-leaves the plants were thining and were kept one plant in each pot. Until 8-leaves stage all pots were irrigated by ambient water (control treatment). Six weeks after planting (8-leaves stage) the pots were treated by solutions containing NaCl and $CaCl_2$ treatments.

Table 1: Evaluation the vegetative parameters and element amounts by influenced different treatments

Parameters / Treatments	Plant height (cm)	lateral shoot No.	Chlorophyll content (mg)	Dry weight (g)	Moisture %	Essence content (%)	Na (ppm)	K (ppm)	Ca (ppm)	Cl (ppm)
Control	†84.5^{a}	15.0^{a}	8.08^{a}	1.17^{a}	76.6^{c}	0.326^{b}	3.84^{c}	358^{a}	139^{d}	0.55^{d}
NaCl 2 gL^{-1}	81.0^{ab}	11.0^{c}	5.70^{a}	1.11^{ab}	77.8^{bc}	0.137^{g}	11.0^{c}	410^{a}	275^{cd}	1.01^{c}
NaCl 4 gL^{-1}	70.0^{b}	10.5^{cd}	7.91^{a}	0.90^{bc}	81.9^{ab}	0.212^{d}	24.7^{c}	525^{a}	540^{bcd}	1.13^{bc}
NaCl 6 gL^{-1}	85.0^{a}	10.5^{cd}	8.64^{a}	0.88^{bc}	82.4^{ab}	0.201^{e}	54.1^{b}	475^{a}	635^{bc}	1.49^{ab}
NaCl 8 gL^{-1}	70.5^{b}	8.0^{d}	6.17^{a}	0.84^{c}	83.2^{a}	0.070^{i}	80.4^{a}	470^{a}	775^{b}	1.73^{a}
$CaCl_2$ 2 gL^{-1}	78.2^{ab}	14.5^{a}	8.75^{a}	0.88^{bc}	82.4^{ab}	0.338^{a}	4.7^{c}	395^{a}	500^{bcd}	1.01^{c}
$CaCl_2$ 4 gL^{-1}	79.0^{ab}	14.0^{ab}	7.20^{a}	0.76^{c}	84.9^{a}	0.256^{c}	4.6^{c}	342^{a}	722^{b}	1.27^{bc}
$CaCl_2$ 6 gL^{-1}	76.8^{ab}	12.5^{abc}	5.82^{a}	0.70^{c}	86.0^{a}	0.170^{f}	8.1^{c}	390^{a}	1235^{a}	1.70^{a}
$CaCl_2$ 8 gL^{-1}	69.5^{b}	11.5^{bc}	5.29^{a}	0.90^{bc}	82.1^{ab}	0.123^{h}	8.4^{c}	375^{a}	1370^{a}	1.77^{a}

†*Means in each column, having similar letters are not significantly different (p<0.01) according to DMRT.*

To prevent sudden shock arising from salinity stress, salinity treatments were begun from the lowest level (2 gL^{-1}) and higher concentrations gradually were added to the pots during several days (each 24-hour: 2 gL^{-1}). During experiment period, the greenhouse temperature was between 17 to 28 °C and the required light was supplied by natural sun light. The windows of the greenhouse were closed at 12:00 O'clock of night and opened in the morning at 10.00 O'clock. In the full flowering stage (about six weeks after onset of salinity treatments) the parameters such as plant height, lateral shoot number, chlorophyll content, dry weight, essence amount and elements concentration of sodium, potassium, calcium and chloride were measured. Amount of essence was measured by Clevenger device. Plant length was measured by using metallic meter. Chlorophyll Index was randomly measured in three leaves by chlorophyll meter (Hansatech Instruments model CL-01). Amount of sodium, potassium and calcium were measured by flam photometer device (model bwbxb). Chloride amount was recorded by chloride meter device (Jenway model pclm-3). The obtained data was analyzed by MSTAT-C software and the means were compared by Duncan's multiple range test at $p<0.01$.

RESULTS AND DISCUSSION

Results

Comparison the Effect of Different Treatments on the Evaluated Parameters

The highest plant height was in the control and NaCl treatments. The lowest plant height was observed in the highest concentrations of NaCl and $CaCl_2$. The greatest lateral shoot number obtained in the control and $CaCl_2$ treatments. The least lateral shoot number was observed in the highest concentration of NaCl. Treatment type had no significant influence on leaf chlorophyll. The highest dry weight was related to NaCl and control treatments. The lowest dry weight was observed in $CaCl_2$ treatment. The highest and lowest moisture percent were in NaCl and $CaCl_2$ treatments respectively. The greatest essence content obtained in the control and $CaCl_2$ treatments, while the lowest essence content was observed in NaCl treatment. The lowest and highest sodium amount was observed in control and NaCl treatment respectively (Table 1).

Treatment type had no significant influence on potassium content. Anyhow, the highest and lowest potassium amounts were in NaCl and control treatments respectively.

The highest calcium content was observed in $CaCl_2$ treatment, which had direct relation to increasing concentration of $CaCl_2$ treatments. The lowest calcium content was in control treatment. The highest and lowest chloride amounts were in $CaCl_2$ and control treatments respectively (Table 1).

Comparison the Main Components of Basil Essence

According to the quantitative and qualitative analysis of basil essence, distinguished that in the all treatments Methyl chavicol allocated the highest amount between all components. α-pinene was among 10 main components only in the control treatment. Trans- α-Bergamotene was among 10 main components in the all treatments except control treatment. In $CaCl_2$ 8 gL^{-1} α-cadind and in NaCl 8 gL^{-1} α-zingiberene were among 10 main components of basil essence.

Discussion

Salinity increase the required energy to maintain natural conditions of cell, subsequently remain less energy for growth requirements. Thus, the plants usually are the weaker in the salt conditions and have the smaller leaves than normal plants. In the salt stress, by increasing osmotic pressure, vegetative growth decrease. In the first, plant growth stop without any external symptoms. Therefore, recognition the salt effect is difficult in this stage but gradually appear changes in the leaves structure (Yarnia *et al*., 2001). In the present study, plant height decreased by enhancing concentration of NaCl and $CaCl_2$ that is according to the finding of Sadeghi-lotfabadi *et al.,* (2009) in the common pea plant. Plant height non-significantly increased in $CaCl_2$ 2 gL^{-1} to 4 gL^{-1} but by increasing concentration decreased. Reduction of plant height influence by salinity stress in this study is according to the report of Hassani and Omod-beigi (2003) on basil.

Based on the obtained results in the present investigation, the highest lateral shoot number was observed in control treatment and the lowest in NaCl treatments, which is conform to the findings of Khorsandi *et*

al., (2010) based upon reduction of number and length of lateral shoot by enhancing salinity level. Treatment type had no significant influence on leaf chlorophyll content that in not according to the findings of Najafi and Sarhangzadeh (2012) on forage maize and Kaya *et al.,* (2002) on strawberry. They reported that salinity and flooding led to decrease leaf chlorophyll.

We observed dry weight decreased by increasing salinity level, which is according to the report of Hassani and Omid-beigi (2003) on basil. The results of most investigations indicate that essence amount decrease influenced by salinity. Prasad (1996) also reported that salinity variably affected essence content in the various species of Labiateae family, which is according to the results of the present study.

Conclusion

Germination is the most sensitive stage of plant growth. Statistical analysis showed that salinity stress had significant influence on growth parameters, vegetative yield and essence content and relative growth of plant decreased by enhancing salinity levels. In addition, salinity significantly decreased plant height, dry weight and essence amount.

REFERENCES

Aboutalebi AH and Hassanzadeh Khankahdani H (2014). Salinity and Citrus rootstock and interstock. *International Journal of Plant, Animal and Environmental Sciences* **4**(2) 654-672.

Anwar A, Khan and Peck H (1981). Osmo-conditioning of carrot seeds to improve seedling establishment and yield in cold soils. *Journal of Agrobiology* **75** 845-846.

Arin LT and Kayak Y (2003). The effect of pre-sowing treatment on emergence and seeding growth of tomato seed (*Lycopersicon esculentummil)* under several stress conditions. *Pakistan Journal of Biological Sciences* **6** 994-990.

Asadi K, Habibi-Lahiji S, Asadi-Dashbolagh-Lachin-Garousi ZH and Moradi P (2011). Effect of salinity stress on germination of basil seed. National conference of Modern Discussions in Agriculture, Islamic Azad University of Saveh (In Persian)

Banchio E, Xie X, Zhang H and Pare PW (2009). Soil bacteria elevate essential oil accumulation and emission in sweet basil. *Journal of Agricultural Food Chemistry* **57**(2) 653-659.

Bittencort ML, Dias C and Araujo RE (2004). Effects of priming on asparagus seed germination and vigor water and temperature stress. *Seed Science and Technology* **32**(2) 616-607.

Bradford KJ (1985). Seed priming improves germination and emergence of cantaloupe at low temperature. *Horticultural Science* **20**(3) 596.

Cano EA, Bolarin MG, Perez F and Caro M (1991). Effect of NaCl priming on increased salt tolerance in tomato. *Journal of Horticultural Sciences* 628-621.

Dadkhah A, Rassam-Resid GH and Moghtader H (2007). Evaluation the effect of salinity on germination and planlet growth of medicinal plants. 5th Iranian Horticultural Sciences Congress (In Persian).

Delavari-Parizi M, Baghizadeh A, Enteshari SH and Manouchehri-Kalantari KH (2011). Study the effect of salicylic acid on resistant and induction oxidative stress in green basil plant under salinity stress. *Journal of Plant Biology* **4**(12) 25-36 (In Persian).

Esmaielpour B, Ghassemi-Golezani K, Rahimzadeh-Khoui F, Gregoorian V and Toorchi M (2006). The effect of NaCl priming on cucumber seedling growth under salinity stress. *Seed Science and Technology* **4**(2) 347-349.

Hassani A and Omid-beigi R (2003). Effect of salinity of NaCl on essence amount and accumulation of compatibility metabolites in basil plant. 3rd Iranian Horticultural Sciences Congress, Karaj (In Persian).

Hosseini H and Rezvani-Moghaddam P (2006). Effect of drought and salinity stress on germination of Plantago ovata. *Iranian Agronomy Researches Journal* **1**(4) (In Persian).

Juliani HR and Simin JE (2002). Antioxidant activity of basil. *Trends in New Crops and New Uses* 575-579.

Kaya C, Higgs D, Saltali K and Gezerel O (2002). Response of strawberry grown at high salinity and alkalinity to supplementary potassium. *Journal of Plant Nutrition* **25**(7) 1415-1427.

Khamri A (2007). Evaluation salinity tolerance of six medicinal plants (*Cyamopsis tetragonoloba*, *Cynara scolymus*, *Hibiscus sabdariffa*, *Cassia angustifolia*, *Ocimum basilicum* and *Hyssopus officinalis* in germination stage. *Seasonal Scientific and Research of Iranian Medicinal and fragrant Plants* **3** 331-339 (In Persian).

Khorsandi A, Hosseini, Sefidkon F and Shirzad H (2010). Effect of salinity stress arising from NaCl on growth, yield and amount and compositions of *Agastache foeniculum* essence. *Seasonal Scientific and Research of Iranian Medicinal and fragrant Plants* **3**(26) 38-45 (In Persian).

Najafi N and Sarhangzadeh A (2012). Effect of NaCl and soil flooding on vegetative properties of herbage maize in greenhouse conditions. *Journal of Sciences and Technical of Greenhouse Cultivation* **3**(10) (In Persian).

Omid-beigi R (2000). *Production and Products of Medicinal Plants* (Astane Ghodse Razavi Press) Mashhad **3** (In Persian).

Pill WG, Frett JJ and Morneau DC (1991). Germination and seedling emergence of primed tomato and asparagus seeds under adverse conditions. *Horticultural Science* **26** 1160-1162.

Prasad MNV (1996). *Plant Eco-physiology* (John Wiley and Sons, Inc.) New York **542** 173-206.

Rahimi A (2006). Effect of osmotic salt and water stress on germination and seedling growth of two Plantago species. *Pakistan Journal of Biological Sciences* **9**(15) 2812.

Sadeghi-Lotfabadi S, Arazmjoo A, frouzandeh M and Saadatian B (2009). Effect of different salinity levels on some vegetative parameters of two common pea varieties. 1st National Conference of Environmental Stresses in Agricultural Sciences (In Persian).

Sivritepe NO, Sivritepe A, Eris A and Turha A (2005). The effects of NaCl pre-treatments on salt tolerance of melons grown under long- term salinity. *Horticultural Science* **106**(4) 568-581.

Yarnia M, Heidari-Sharifabadi H and Rahimzadeh-Khoui F (2001). Effects of compatible metabolites on water relationship of Alfalfa varieties in various salinity levels. *Iranian Agronomy Sciences Journal* **4**(3) 40-48 (In Persian).