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The Effect Of NaCl and Na_2SO_4 On Proline And Soluble Sugars In Borage Under Hydroponics Condition

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Content of proline and soluble sugars was regularly studied under saline condition. Based on the results, the contents of proline increased and soluble sugars decreased under salinity. It was concluded that Borage was able to resist against stress due to changing contents of these compounds during salinity.

Key words: NaCl, Na_2SO_4, *Borage (Borago officinalis L.), soluble sugars, proline*

INTRODUCTION

Salinity is one of the most important problems in the farmlands of the world. Annually, million tons of salt penetrate into the farmlands through irrigation (Kingsbury et al., 2012). On the other hand, by population increasing, the demand for more food obligates the human to use the saline water and soil for agricultural and food production purposes in near future (Babaiyan and Ziatabar, 2002). Approximately, over 800 million hectares of land are salt-affected throughout the word (Munns, 2002). Salinity induces a wide range of perturbations at the cell and whole plant levels. Salt stress results from a number of detrimental processes involving the toxic action of Na^+ and Cl^- ions, the impairment of mineral nutrition, the modification in the water status of the plant tissues and secondary stresses such as oxidative stress linked to the production of toxic reactive oxygen intermediates (Bajji et al., 2009). Salt tolerant plants have the ability to minimize the detrimental and physiological adaptations (Hameed and Ashraf, 2008).

Primarily, salinity damages plants by the osmotic effect, the effect of specific ion toxicity and subsequently by nutritional stress (Song et al., 2009). In order to fight with the stress effects, plants synthesize and accumulate substances which can be adjusted with osmotic pressure and these materials include amino acids, sugars and hormones. Proline is a one of the amino acids which plays a vital role in osmotic adjustment of plant cells. Also, by attraction of the ions, the plants can save their water potential in a lower level, which causes the increase of water content in plants (Zhao and Harris, 2001). All these processes require energy and result to a decrease in the productivity and performability of the plant (Hanson et al., 2005). The reduction in plant growth under salinity is a consequence of several physiological responses including modification of water status, photosynthetic efficiency, carbon allocation and utilization (Abdul Jaleel et al., 2007). In general, various mechanisms contribute to salt tolerance in plants, among these mechanisms, the most common proposed mechanisms consist of compartment of ions in vacuoles, accumulation of compatible solutes in the cytoplasm, as well as genetic salt resistance (Girija et al., 2002)

Borage, an annual herbaceous plant native in Europe, North Africa, and Asia Minor (Beaubaire and Simon, 2005), is a medicinally important plant, which has more than 20% gamma linolenic acid in its seed oil (El Hafid et al., 2002). The leaves of borage are reportedly used as diuretic, demulcent, emollient, expectorant tools (Leung and Foster, 2001) In traditional Iranian medicine, the aerial parts of borage are reportedly used for treatment of a variety of ailments (Naghdi et al., 2008). However, borage is an important medicinal plant, must be cultivated commercially in order to meet the ever-increasing demand for pharmaceutical industry. Although borage is cultivated in many countries for medicinal uses, no studies were performed concerning the effect of salinity on the phytochemical and production potential of borage during the growth cycle, therefore, it is of great importance to investigate borage for its salt-tolerance capacity in order to exploit the saline lands for its cultivation. The present research investigates the effect of saline water on physiological specifications of Borage.

MATERIALS AND METHODS

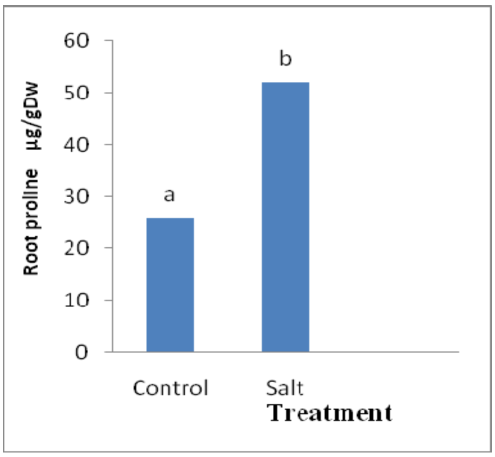
This study was done in the laboratory and greenhouse of Plant Science Department of Payam noor University of Isfahan, Iran, from the interval of March 2011 to January 2012. Seeds of Borage were obtained from Neka Research Center (North of Iran). After applying *Benomyl* fungicide on them, the seeds were rinsed with distilled water and irrigated, following planted in vermiculite. After germination and appearance of two leaves, the plants were nourished by 0.5 Longshtein solution. In 4-leaves stage, the plants were divided to two groups: control and salinity. To evaluate the effect of salinity on some physiological characteristics of the medicinal plant of Borage an experiment was carried out sodium chloride and sulfate sodium with volume ratio 2:1 and 100 mM on borage were applied in 4 leaves stage. During salinity treatment the content of proline and soluble sugars were measured regularly. Extraction and estimation of proline were conduced according to the procedures described by Bets et al. (1973). Plant material, 0.1 g per sample, was homogenized in 10 ml of 3% (w/v) aqueous sulphosalicylic acid; the homogenate was filtered through Whatman No.2 filter paper. Two milliliters of filtrate was then mixed in a test tube with 2 ml acid ninhydrin solution and 2 ml glacial acetic acid, and then was incubated at 100˚C water bath for 1 h. The reaction was terminated by placing the mixture in an ice bath. It was then extracted with 4 ml toluene and the chromophore phase aspirated from the aqueous phase. The absorbance rate was read at 520 nm using a spectrophotometer. Concentrations of proline in the leaves are expressed on a DW basis. The total soluble sugars were measured using the phenol-sulfuric acid. To measure total soluble sugars of the leaves, the solution of 5% $ZnSO_4$, 0.3 % $NB(OH)_2$, 5% (v/v) phenol solution and sulfuric acid was used based on Stewart method. Finally, absorption rate was read at 485 nm by spectrophotometry (Stewart, 1989). Concentrations of total soluble sugars in the leaf and root are expressed on a DW basis. Statistical calculations were done by SPSS 16 software. Mean values and significance were determined by Duncans multiple range tests at 5% probability level.

RESULTS

During salinity treatment, contents of proline and soluble Sugars were measured regularly. Based on the results, the contents of proline in the aerial parts and root increased and soluble sugars decreased after salinity treatment significantly, and the lowest amount of proline was related to the control treatment (Table 1).

Table 1. Measured proline and soluble sugars of aerial parts and root

Number of plants	Proline of aerial parts at control treatment µm/gdw	Proline of aerial parts at salinity treatment µm/gdw	Proline of root at control treatment µm/gdw	Proline of root at salinity treatment µm/gdw	Soluble Sugars of aerial parts at control treatment µm/gdw	Soluble sugars of aerial parts at salinity treatment µm/gdw	Soluble sugars of root at control treatment µm/gdw	Soluble sugars of root at salinity treatment µm/gdw
1	64±3.2	75±3.75	25±1.25	67±3.35	78±3.9	79±3.95	73	51±2.55
2	78±3.9	73±36.5	29±1.45	65±3.25	75±3.75	76±3.5	84±4.2	68±3.4
3	68±3.4	82±4.1	17±.85	64±3.2	92±4.6	84±4.2	73	65±3.25
4	58±2.9	75±3.75	21±1.05	38±1.9	99±4.95	78±3.9	63±3.15	63±3.15
5	35±1.78	71±3.55	28±1.4	56±2.8	71±3.55	80±4	71±3.55	76±3.8
6	43±1.7	72±3.6	36±1.8	38±1.9	76±3.55	77±3.88	71±3.55	48±2.4
7	40±2	69±3.45	25±1.25	39±1.95	99±4.95	85±3.75	70±3.35	41±2.05
Average	55±2.75	74±3.7	26±1.3	52±2.95	84±4.2	80±4	72±3.6	59±2.95



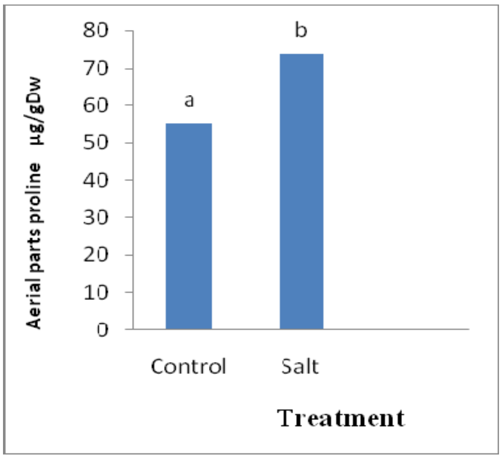


Figure 1. The effect of a salt on proline in borage.

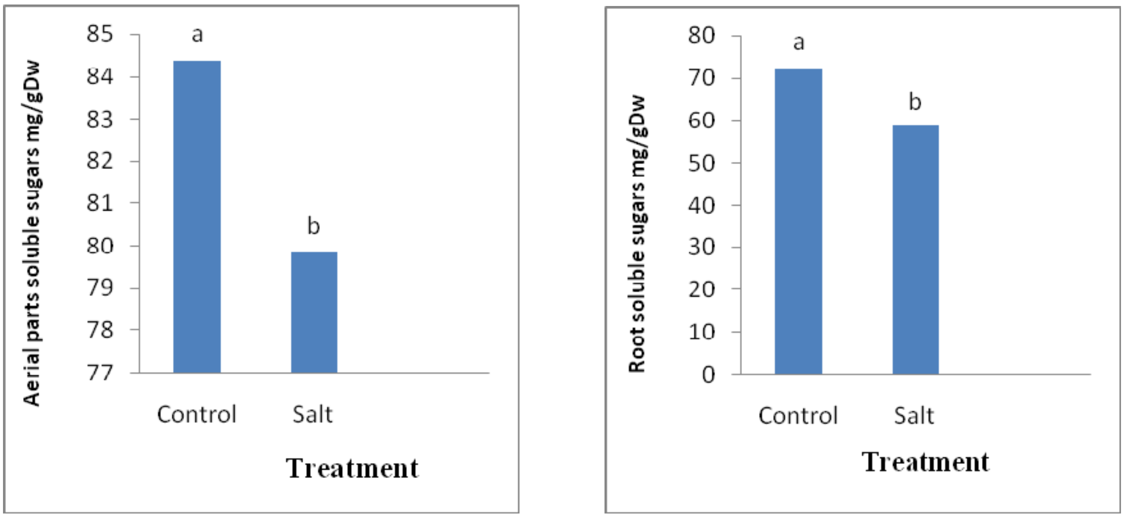


Figure 2. The effect of a salt on soluble sugars in borage

DISCUSSION

In this study proline concentration in the leaf and root of Borage was increased with salinity treatment, representing the positive role of proline in the salt tolerance of this crop. proline, as a signaling/regulatory molecule, can activate multiple responses, which are component to the process of adaptation to abiotic stresses including salt stresses (Ashraf and Orooj, 2006). Increasing of proline under salinity has also been reported in some medicinal plants (Hajar et al., 2011; Munns., 2002; Ashraf and Orooj, 2006; Abdul Jaleel et al., 2007). Soluble sugars of aerial parts and root were decreased in response to the salinity. While, accumulation of soluble sugars in response to environmental stress has been widely reported despite specific reduction in net CO_2 assimilation levels (Chaves et al., 2003; Meloni et al., 2008). Sugars, in addition to the role of regulating osmotic balance, also act as the metabolic signals in the stress conditions (Chaves et al., 2003). It was observed that the osmotic adaptation in plants exposed to salinity can take place by accumulation of high concentration of inorganic ions or solutions with low molecular weight, highly soluble compounds that usually are nontoxic at high cellular concentrations. Generally, they protect plants from stress in different ways, including contribution to cellular osmotic adjustment, detoxification of reactive oxygen species, protection of membrane integrity and stabilization of enzymes/proteins (Ahmad et al., 2008).

CONCLUTION

The results emerged that the accumulation of proline and reduction soluble sugars is a good indicator for salinity tolerance of Borage. So the plant resists against salt by means of osmotic adjustment and compartment within the cells. This process is essential for plant survival in saline conditions.

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Hidroponik Şəraitində Duz Stresinin Dərman Göyzabanı Bitkisinin Prolin Amin Turşusu Və Həllolan Şəkərlərin Miqdarina Təsiri

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Tədqiqat işində şoranlığın dərman göyzabanı bitkisində prolin və şəkərlərin biosintezinə təsiri hidroponik şəraitdə aparılmışdır. Alınmış nəticələrə əsasən, şoranlığın təsirindən prolin amin turşusunun miqdarı artmış, həll olan şəkərlərin miqdarı isə azalmışdır. Beləliklə, dərman göyzabanı bitkisi tərkibində bu maddələrin miqdarını dəyişməklə şoranlıq stresinə qarşı müqaviməti təmin etməyə qadirdir.

Влияние Солевого Стресса На Содержание Аминокислоты Пролин И Растворимых Сахаров У Бурачника Лекарственного В Гидропонических Условиях

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Исследования проводились в гидропонических условиях действия засоления на биосинтез пролина и сахаров у растения бурачника лекарственного. Согласно полученным результатам, содержание аминокислоты пролин увеличивалось, а содержание растворимых сахаров уменьшилось. Таким образом, изменяя в своем составе содержание вышеуказанных веществ, растение бурачник лекарственный способно повышать устойчивость к солевому стрессу.