Journal of Horticultural Research 2015, vol. 23(1): 17-20
DOI: 10.2478/johr-2015-0003

DE GRUYTER
OPEN

THE EFFECT OF SODIUM CHLORIDE ON GROWTH AND QUALITY OF *PLECTRANTHUS FORSTERI* Benth. 'NICO'

Short communication

Agnieszka KRZYMIŃSKA*, Maria ULCZYCKA-WALORSKA
Poznań University of Life Sciences
Dąbrowskiego 159, 60-594 Poznań, Poland

Received: May 2015, Accepted: June 2015

Edited by: B. Matysiak

ABSTRACT

Experiments were conducted on the response of *Plectranthus forsteri* 'Nico' to NaCl. Plants were grown in pots of 1.5 dm^3 and 0.15 dm^3 water solution of NaCl at concentrations 0, 5, 10, 15, 20 g dm^{-3} in 2011 and 0, 10, 20, 30, 40 g dm^{-3} in 2012 were applied one time in the beginning of experiment. Sodium chloride applied at 10-40 g NaCl·dm^{-3} water, reduced plant growth and values of SPAD readings. It may be stated that *Plectranthus forsteri* 'Nico' plants are tolerant to medium concentrations of sodium chloride (5-20 g NaCl·dm^{-3} water) and therefore can be planted in flowerbeds in urbanized areas.

Key words: salinity, *Plectranthus*, growth in urbanized area

INTRODUCTION

An increasingly serious problem currently observed in urban areas is connected with the use of sodium chloride routinely applied in winter road maintenance (Howard & Maier 2007). Excessive amount of sodium chloride can cause negative morphological and phenological changes in plants (Zhu 2007), although Sudhir & Murthy (2004) and Parida & Das (2005) reported that growth and development in certain species is sometimes stimulated by elevated salinity. Therefore, it can be assumed that the response of plants to NaCl is genotype-specific.

Flowerbeds, often with decorative leaves are an indispensable element in urban green areas (Todorova et al. 2004). One of example is *Plectranthus forsteri* Benth. that is used increasingly often. Available literature provides no information on the response of *Plectranthus forsteri* 'Nico' to sodium chloride. For this reason we decided to evaluate tolerance of this plant to NaCl.

MATERIALS AND METHODS

Two experiments were conducted in a greenhouse of the Department of Ornamental Plants, the Poznań University of Life Sciences in 2011 and 2012.

Cuttings of *Plectranthus forsteri* 'Nico' were rooted in a greenhouse in multitrays and then transplanted to pots of 0.3 dm^3. After 3 weeks, shoots were pinched over the 3rd leaf. The plants that reached the marketable phase (27th of July 2011 and the 18th of June 2012) were transplanted into pots of 1.5 dm^3 filled with peat substrate of pH 6.7. Based on the chemical analysis, the substrate was fertilized with N 120, P 60 and K 160 mg·dm^{-3}. Each pot was filled with 1 dm^3 substrate to which 0.15 dm^3 of NaCl-water solution was given. In 2011 - 5, 10, 15 or 20 g NaCl per dm^3 water and in 2012 - 10, 20, 30 or 40 g NaCl per dm^3 water was applied. The control treatment received 0.15 dm^3 water. Table 1 presents the electrical conductivity (EC) values recorded in the substrate depending on the applied NaCl dose.

*Corresponding author:
e-mail: akrzym@up.poznan.pl

To provide a constant NaCl concentration in the substrate throughout the experimental period, plants grown in pots placed in saucers were watered with tap water to obtain an identical weight of the substrate with plants. The experiments lasted until the end of growing season in 2011 (Nov. 14th) and July 19th in 2012 when most stressed plants showed yellowing and strong leaf desiccation. Each treatment comprised 12 plants: 4 pots in 3 replications.

Plant height and diameter as well as total length of primary lateral shoots were measured at the beginning and end of the experiment. The increments were calculated in relation to the initial value. The SPAD readings (leaf greenness) were taken with N-tester of YARA on the third developed leaf from the apex on the longest lateral shoot at the beginning and end of the experiment. The changes were calculated, such the other features.

At the end of the experiment fresh weight was recorded and the chemical analysis of leaves was performed. Levels of ions were determined in leaves, used atomic absorption spectrometry for Na^+, Ca^{2+} and K^+ and nefelometrical method for Cl^-. To obtain a dry mass plants was dried in an oven at 105 °C.

Results were subjected to the one-way analysis of variance using the Statistica programme. Means were grouped applying the Duncan test at the significance level $\alpha = 0.05$. Percentage values in the statistical analysis were compared using the transformation of data according to Bliss. Data were compared within each year separately.

RESULTS AND DISCUSSION

Treatment of *Plectranthus forsteri* 'Nico' with sodium chloride influenced plant growth and development. Plants treated with NaCl had a more compact habit than the control plants. In 2012, after using 30 and 40 g NaCl·dm^{-3} water leaves yellowed and desiccated.

Plants treated with 10 and more grams of NaCl·dm^{-3} showed the significantly lower percentage increment in height, length of lateral shoots and plant diameter than control plants in both years of study (Table 1). The application of 15 g NaCl per dm^3 water and more in 2011 and 10 g NaCl per dm^3 water and more in 2012 caused a creeping habit while control plants and those growing in the substrate with lower NaCl doses had an erect habit. The reduction of plant height was also observed at the application of NaCl on *Tagetes* L. and *Ageratum* L. (Zapryanova & Atanassova 2009).

Table 1. Influence of NaCl dosage on some features of *Plectranthus forsteri* 'Nico'

NaCl in g·dm^{-3} water and recorded EC in mS·cm^{-1} (in brackets)	Increase in plants height (%)	Increase in total length of lateral shoots (%)	Increase in plants diameter (%)	Fresh weight of plants (g)	SPAD changes (%)
2011					
0 (0.57)	69.1 d	85.7 d	53.0 c	116.5 a	33.4 e
5 (1.10)	60.7 d	70.6 c	49.1 c	147.2 bc	16.1 d
10 (1.52)	50.4 c	63.1 bc	40.0 b	156.2 c	7.6 c
15 (1.81)	31.8 b	56.3 b	34.5 b	137.8 b	-10.4 b
20 (2.83)	16.8 a	14.1 a	22.1 a	142.2 bc	-22.4 a
2012					
0 (0.51)	43.9 c	276.1 c	103.2 e	50.2 d	49.7 e
10 (1.95)	27.3 b	196.1 b	91.9 d	49.5 d	23.9 d
20 (3.22)	11.3 a	165.7 b	57.7 c	36.9 c	11.2 c
30 (4.55)	7.3 a	56.8 a	23.3 b	28.3 b	-15.5 b
40 (6.04)	5.5 a	45.4 a	11.9 a	20.3 a	-33.3 a

In both experiments the dose of 20 g NaCl per dm^3 water resulted in a reduction of plants diameter by 50% in relation to the control. In 2012, plant diameter was almost 10-fold smaller at the application of 40 g NaCl per dm^3 water.

In 2011 the lowest fresh weight was in control plants and this trait was not affected with increasing NaCl doses up to 20 g dm^{-3} in 2011 while in 2012 fresh weight decreased with the NaCl concentration beginning with 20 g dm^{-3} (Table 1). The reduction of the increase in fresh weight under the influence of sodium chloride at EC 12.5 $dS \cdot m^{-1}$ was reported in studies on *Petunia* × *atkinsiana* D. Don, *Calendula officinalis* L. and *Calceolaria hybrida* Hort. (Fornes et al. 2007). In the case of *Ceriops roxburghiana* Arn. (Rajesh et al. 1998) opposite dependencies were observed.

In both experiments the SPAD index decreased with an increase in NaCl doses (Table 1). Similar results were presented for *Calceolaria hybrida* and *Calendula officinalis* (Fornes et al. 2007). Fornes et al. (2007) and Rajesh et al. (1998) observed the opposite effect of NaCl (increase in chlorophyll content) in experiments conducted on *Petunia* × *atkinsiana* and *Ceriops roxburghiana*, respectively.

The chemical analysis of leaves showed an increase in the concentration of both Na^+ and Cl^- ions with an increased concentration of NaCl in both years of study (Table 2). Ca^{2+} concentration was fairly constant irrespective of the applied NaCl dose and the concentration of K^+ increased at 15 and 20 g $NaCl \cdot dm^{-3}$. In 2012 Ca^{2+} concentration grew steadily in plants treated by 20 $g \cdot dm^{-3}$ and more. The concentration of K^+ was not dependent on the NaCl treatment in 2012. In 2012 contents of K^+ and Ca^{2+} were higher than in 2011 at the same NaCl concentrations. This finding confirmed studies on *Petunia* × *atkinsiana* and *Calendula officinalis* (Fornes et al. 2007). One of the mechanisms limiting the negative effect of Na^+ cations is an ability of plant to maintain accumulation of K^+ and Ca^{2+} at a constant or increased level. According to Fornes et al. (2007) the concentration of K^+ cations decreased in *Calceolaria hybrida*. The concentration of Ca^{2+} did not change in *Iris lactea* var. *chinensis* until treatment with 280 mmol $NaCl \cdot dm^{-3}$ (Bai et al. 2008) and increased in *Calceolaria hybrida* (Fornes et al. 2007). In our experiment of 2012 on *Plectranthus forsteri* 'Nico' the concentration of Ca^{2+} increased at 30 and 40 g per dm^3 and in 2011 a slight increase of K^+ was recorded at 15 and 20 g per dm^3.

The obtained results may confirm the thesis that *Plectranthus forsteri* 'Nico' is tolerant to medium concentrations of sodium chloride in the substrate.

Table 2. Content of some ions in leaves of *Plectranthus forsteri* 'Nico' (% dry matter)

NaCl ($g \cdot dm^{-3}$)	Levels of ions			
	Na^+	Cl^-	Ca^{2+}	K^+
	2011			
0	0.49	0.61	2.92	2.22
5	0.80	1.27	2.76	2.22
10	1.24	1.87	2.58	2.06
15	1.71	2.86	2.92	2.59
20	1.94	3.38	2.76	2.79
	2012			
0	0.66	1.58	3.34	5.24
10	2.44	4.27	3.20	4.80
20	3.29	6.49	3.46	5.08
30	4.60	9.14	4.00	5.28
40	5.80	10.86	4.80	5.52

CONCLUSIONS

1. Increasing doses of sodium chloride from 5 to 40 $g \cdot dm^{-3}$ of water result in reduced growth and from 20 $g \cdot dm^{-3}$ also fresh weight of *Plectranthus forsteri* 'Nico'.
2. With an increase in the concentration of sodium chloride from 5 to 40 $g \cdot dm^{-3}$ water the SPAD index decreased in *Plectranthus forsteri* 'Nico'.
3. It can be assumed that *Plectranthus forsteri* 'Nico' plants are tolerant to medium concentrations of sodium chloride (5-20 g $NaCl \cdot dm^{-3}$ water) which enables their planting in urbanized areas.

REFERENCES

Bai W.B., Li P.F. Li B.G., Fujiyama H., Fan F.Ch. 2008. Some physiological responses of Chinese iris to salt stress. Pedosphere 18(4): 454-463. DOI: 10.1016/S1002-0160(08)60036-3.

Fornes F., Belda R. M., Carrión C., Noguera V., García-Augustín P., Abad M. 2007. Pre-conditioning ornamental plants to drought by means of saline water irrigation as related to salinity tolerance. Scientia Horticulturae 113: 52-59. DOI: 10.1016/j.scienta.2007.01.008.

Howard K.W.F., Maier H. 2007. Road de-icing salt as a potential constraint on urban growth in the Greater Toronto Area, Canada. Journal of Contaminant Hydrology 91: 146-170. DOI: 10.1016/j.jconhyd.2006.10.005.

Parida A.K., Das A.B. 2005. Salt tolerance and salinity effects on plants: a review. Ecotoxicology and Environmental Safety 60: 324-349. DOI: 10.1016/j.ecoenv.2004.06.010.

Rajesh A., Arumugam R., Venkatesalu V. 1998. Growth and photosynthetic characteristics of *Ceriops roxburghiana* under NaCl stress. Photosynthetica 35(2): 285-287. DOI: 10.1023/A:1006983411991.

Sudhir P., Murthy S.D.S. 2004. Effects of salt stress on basic processes of photosynthesis. Photosynthetica 42(4): 481-486. DOI: 10.1007/S11099-005-0001-6.

Todorova A., Asakawa S., Aikoh T. 2004. Preferences for and attitudes towards street flowers and Teres in Sapporo, Japan. Landscape and Urban Planning 69: 403-416. DOI: 10.1016/j.landurbplan.2003.11.001.

Zapryanova N., Atanassova B. 2009. Effects of salt stress on growth and flowering of ornamental annual species. Biotechnology & Biotechnology Equipment 23: 177-179. DOI: 10.1080/13102818.2009.10818394.

Zhu J.-K. 2007. Plant salt stress. Encyclopedia of Life Sciences. www.els.net (17.02.2012). DOI: 10.1002/9780470015902.a0001300.pub2.