THE EFFECT OF SALT (NaCl) CONCENTRATIONS ON LEAF AND BULB DEVELOPMENT OF HYACINTH (*Hyacinthus orientalis* "Fondant") GROWING IN WATER-CULTURE

SU KÜLTÜRÜNDE YETİŞTİRİLEN SÜMBÜL (*Hyacinthus orientalis* "Fondant") BİTKİSİNİN YAPRAK VE SOĞAN GELİŞİMİNE TUZ (NaCl) KONSANTRASYONLARININ ETKİSİ

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ABSTRACT

In this study, the effects of salt concentrations applied to hyacinth (*Hyacinthus orientalis* "Fondant") on leaves and bulbs were determined in water culture. In water culture, a solution of ½ percent diluted Hoagland nutrient solution was used. Four different concentrations (500 (S1), 1000 (S2), 2000 (S3) and 4000 ppm (S4)) salt (NaCl) were applied together with the control group (T0) which was not salted into the water culture. Hyacinth bulbs were planted in pots with peat:perlite mixture in 1:1 ratio. They were kept in the laboratory until leaves emerged. The hyacinths taken into the water culture were applied with salt in the flowering stage. At the end of the study, according to the applications the lowest and highest average values were in the number of leaf, leaf length, leaf width, bulb weight, bulb length and bulb width as 6.000-7.026 pieces (S4-S3), 107.401-254.343 mm (S4-S1), 20.723-29,769 mm (S3-S1), 20.35-24.900 g (S4-S3), 32.364-36.724 mm (S4-S3) and 35.215-36.618 mm (S4-S3), respectively. The difference between the average values of the applications was statistically insignificant in bulb width; the difference between leaf number, leaf length and leaf width averages at $p < 0.001$; bulb weight at $p < 0.05$ and bulb length at $p < 0.01$ level was found to be significant. At the end of the study, it was determined that 4000 ppm salt application (S4) had a negative effect on leaf and bulb growth.

Keywords: Bulb, Hyacinth, *Hyacinthus orientalis*, Leaf, Salt, Water Culture

ÖZET

Bu çalışmada bir süs bitkisi olan sümbüle (*Hyacinthus orientalis* "Fondant") su kültüründe uygulanan tuz konsantrasyonlarının yaprak ve soğanlara yaptığı etkiler belirlenmiştir. Su kültüründe ½ oranında seyreltilmiş Hoagland besin çözeltisi kullanılmıştır. Su kültürü içine tuz uygulanmayan kontrol grubuyla (T0) beraber dört farklı konsantrasyon (500 (T1), 1000 (T2), 2000 (T3) ve 4000 ppm (T4)) tuz (NaCl) uygulaması yapılmıştır. Sümbül soğanları, içlerinde 1:1 oranlarında torf:perlit karışımı bulunan saksılara dikilerek; yapraklar çıkana kadar laboratuvarda tutulmuştur. Su kültürüne alınan sümbüllere çiçeklenme aşamasında tuz uygulanmıştır. Çalışmanın sonunda uygulamalara göre en düşük ve en yüksek ortalama değerler yaprak sayısı, yaprak uzunluğu, yaprak genişliği, soğan ağırlığı, soğan uzunluğu ve soğan genişliğinde sırasıyla 6.000-7.026 adet (T4-T3), 107.401-254.343 mm (T4-T1), 20.723-29.769 mm (T3-T1), 20.35-24.900 g (T4-T3), 32.364-36.724 mm (T4-T3) ve 35.215-36.618 mm (T4-T3) olarak tespit edilmiştir. Uygulamalara ait ortalama değerler arasındaki fark soğan genişliğinde istatistik olarak önemsiz bulunurken; yaprak sayısı, yaprak uzunluğu ve yaprak genişliği ortalamaları arasındaki fark p<0.001 düzeyinde; soğan ağırlığında p<0.05 ve soğan uzunluğunda p<0.01 düzeyinde önemli bulunmuştur. Çalışmanın sonunda 4000 ppm'lik tuz uygulamasının (T4) yaprak ve soğan gelişimine olumsuz etki yaptığı belirlenmiştir.

Anahtar Kelimeler: Hyacinthus orientalis, Soğan, Su Kültürü, Sümbül, Tuz, Yaprak.

1. INTRODUCTION

Salinity is a worldwide problem affecting yield and quality of crops. It has natural origins such as soil and water and causes problems for plant growth, (Grattan and Grieve, 1999). Salt in soil, from irrigation water and irrational chemical fertilizers use without considering soil analysis results could negatively affect horticulture crops such as vegetables and fruits and field crops such as cereals and pulses. Besides, salt could also affect ornamental species used for aesthetic and visual purposes as well as for landscape purposes. Effects of salt on cultivated plants other than ornaments are through lowering their yield and quality. Various impaired metabolic events, especially lower photosynthetic activity, in crops exposed to salinity could lower survival of plants (Çulha and Çakırlar, 2011). Navarro et al. (2008) and McCammon (2009) noted that due to the scarcity of enough fresh water for agriculture in the world ornamental plants are watered using alternative water sources with high salt contents (Koksal et al., 2015). Recently, selection of salt tolerant plant species and salt tolerant genotypes within species has been the focus of many investigators, and intense studies have been carried out for this purpose.

The aim of the present study carried out in water culture, considered a form of soilless agriculture, was to determine the effects of different salt concentration on leaf and bulb development of hyacinth plant.

2. MATERIAL AND METHOD

The field trials were conducted in "completely randomized design" with three replications. Each replication consisted of four bulbs. Bulbs of *Hyacinthus orientalis* cv. "Fondant" were obtained from Asya Lale Ornamental Seed Company and were planted in pots containing 1:1 perlite:peat mixture for root development (Figure 1a). After rooting and leaf development, bulbs were transferred to Hoagland nutrient solution (Hoagland and Arnon, 1938) in water-culture. Duration of time between planting of bulbs in pots and transferring them to water-culture was 50 days (Figure 1b). Applied salt (NaCl) concentrations were 0, 500, 1000, 2000 and 4000 ppm. The first salt application was started 13 days after commencing water-culture, i.e. when flower stalks developed and florets formed (Figure 1c). Effects of salt doses on leaf and bulb development in hyacinth were determined (Figure 1d). Figure 1 shows the stages from planting of the bulbs to transferring to water-culture.

The analysis of the data was done in the SAS 9.1 statistical package program according to randomized plot trial design. LSD multiple comparison test was used for comparing the averages. Tests were performed at $\alpha = 0.05$ importance level (Düzgüneş et al., 1987). Descriptive statistics in terms of the traits emphasized; given as average and standard error.

3. RESULTSS AND DISCUSSION

Differences among the salt doses used (0, 500, 1000, 2000 and 4000 ppm) were significant at $p<0.001$ level for the number of leaves, leaf length and width, at $p<0.01$ for bulb length and at $p<0.05$ for bulb weight. On the other hand, no difference was found among salt doses for bulb width (Table 1).

Figure 1. Planting, Culturing, Leafing and Flowering of Hyacinth Bulbs. a-bulbs in pots, b-bulbs in water-culture, c-floret blooming and salt application, d-flowers in salt applications.

Table 1. Effect of Salt Doses on Hyacinth Leaf and Bulb Properties

Treatments	Leaf number***	Leaf length (mm)***	Leaf width (mm)***	Bulb weight (g)*	Bulb length (mm)**	Bulb width (mm)
S0	6.386 BC	180.456 C	25.489 B	21.260 AB	32.956 BC	36.226
S1	6.750 AB	254.343 A	29.769 A	21.986 AB	32.590 C	36.380
S2	6.750 AB	227.372 B	22.164 BC	21.912 AB	36.269 AB	35.251
S3	7.026 A	121.265 D	20.723 C	24.900 A	36.724 A	36.618
S4	6.000 C	107.401 D	25.745 AB	20.355 B	32.364 C	35.215
Significant degree	P<0.001	P<0.001	P<0.001	P<0.05	P<0.01	NS

S0: control, S1: 500 ppm NaCl, S2: 1000 ppm NaCl, S3: 2000 ppm NaCl, S4: 4000 ppm NaCl

*: In the same letter, there is no statistically significant 5% difference between the averages; **: In the same letter, there is no statistically significant 1% difference between the averages; ***: In the same letter, there is no statistically significant 0.1% difference between the averages; NS: Not significant

S0: control, S1: 500 ppm NaCl, S2: 1000 ppm NaCl, S3: 2000 ppm NaCl, S4: 4000 ppm NaCl

Figure 2. Effect of applications on leaf and bulb properties; a-leaf number, b-leaf length (mm), c-leaf width, d-bulb weight, e-bulb length, f-bulb width

NUMBER OF LEAVES

The highest number of leaves were obtained from T3 treatment (7.026 leaves) while T4 (6000 leaves) treatment produced the least number of leaves (Figure 2a). The highest salt dose of 4000 ppm lowered the number of leaves prominently (Table 1).

LEAF LENGTH (MM)

T1 treatment produced the longest leaves (254.343 mm), whereas T4 produced the shortest ones (107.401 mm) (Table 1). The highest salt dose used (4000 ppm) negatively affected leaf lengths (Figure 2b). However, 500 and 1000 ppm doses seemed to positively affect leaf lengths compared to control treatment.

LEAF WIDTH (MM)

T1 treatment produced the widest leaves (29.769 mm) while T3 produced the narrowest ones (20.723 mm) (Figure 2c). As in leaf length, T1 appeared to positively affect leaf width compared to other salt doses (Table 1). As can be understood from the measurements, T4 treatment resulted in increases in leaf width. This feature was prominent during the measurements of leaf lengths and widths. Leaves were short and wide in the highest salt dose. The leaves which did not grow remained short and blunt at the bottom.

BULB WEIGHT (G)

The heaviest bulbs were produced by 2000 ppm salt application as 24.900 g and the lightest ones by 4000 ppm as 20.355 g (Figure 2d). Compared to T4 dose, T3 and lower doses, as well as control treatment, resulted in heavier average bulbs (Table 1).

BULB LENGTH (MM)

In terms of bulb lengths, bulb length of T3 treatment (36.724 mm) was highest and T4 was lowest (32.364 mm) (Figure 2e). Similar to bulb weight, bulb length was also positively affected by 2000 ppm salt dose.

BULB WIDTH (MM)

The highest average bulb width was observed in T3 treatment (36.618 mm) and the lowest was in T4 (35.215 mm) (Figure 2f). Similar to bulb weight and length, bulb width was positively affected by 2000 ppm salt application. It could be stated that 4000 ppm salt dose negatively affected bulb width compared to other salt doses and control treatment (Table 1).

Previous studies showed that excess Na^+ and Cl^- contents result in impaired growth and flowering, color deterioration in leaves, turning the leaf edges to brown color and eventual drying, thereby lowering the quality of ornamental plants (Bernstein et al., 1972).

In a study aiming to determine the effect of salt application on growth of *Kalanchoe blossfeldiana* plant in media with or without mycorrhiza, salt (NaCl) especially at a high dose was found to hamper plant growth. Salt led to decreases in root length, weight and functions (Shannon and Grieve, 1999) and in leaf area (Munns and Tester, 2008). Another study into the salt tolerance levels of *Cestrum aurantiacum, Cotoneaster lacteus, Eugenia myrtifolia, Pyracantha 'Harlequin'* and *Teucrium fruticans* species showed that major responses of plants to salt included decreases in leaf area, leaf number and leaf dry weight (Cassaniti et al., 2009). Borde et al. (2010) applied 0, 100, 200 and 300 mM salt doses to garlic plant (*Allium sativum* L.) and found that modedose doses resulted in highest values for leaf area, and fresh and dry plant weight (Borde et al., 2010). Türkoğlu et al. (2011) found that 50, 100 and 200 mM salt applications resulted in rotting of hyacinth bulbs (*Hyacinthus orientalis*) while 400 mM dose produced necrosis on leaves. The same study revealed that increasing salt concentration resulted in smaller stoma sizes. In another study to determine the effects of 34 and 68 mmol NaCl salt doses in daffodil (*Narcissus tazetta* L.) grown in media with or without mycorrhiza, it was observed that 68 mmol salt dose decreased average leaf length and width (Çığ et al., 2014). The same study found that fresh and dry weights of leaves, and length, number, fresh or dry weights of leaves were negatively affected by increasing salt doses. Another study found that fresh weights of leaves, flowers and bulbs decreased in *Ornithogalum saundersiae* plants exposed to salinity stress and that compared to control salt stressed plants had late start of flowering (Salachna et al., 2016).

Our findings are in accordance with the findings from the previous studies. Deterioration in leaf and bulb quality varied with salt doses applied and the highest salt dose led to rotting of bulbs. It was found that inside of bulb was empty at high salt doses, which resulted in their rotting. Leaves, on the other hand, remained blunt and compact, and caused them to rot. Positive effects of some salt doses on leaf and bulb development could be explained by the fact that although Na^+ and Cl^- ions constitute stress factors, they are also taken in by plants at low amounts and used as nutrient.

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