Production of *Celosia argentea* irrigated with saline wastewaters

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1 INTRODUCTION

The use of water resources has become one of the most important environmental issues in recent years, especially in southern California. Agriculture has historically been one of the primary users of water resources for the purposes of irrigation. In many regions, however, competition between agriculture and urban users is increasing due to population growth (Parsons, 2000). Likewise, flower growers and nurseries have also used the highest quality water to irrigate sensitive crops. But many cut flowers can tolerate moderate to high amounts of salinity and could be irrigated with wastewaters or greenhouse effluents containing higher amounts of salts. This would enable growers to reduce precious fresh water use and reduce nutrient containing greenhouse effluents. Subsequent discharges into the environment would then reduce eutrophication potential and also reduce the total volume of wastewaters produced by increasing water-use-efficiency.

Celosia sp. is in the Amaranthaceae, a family closely associated with the Chenopodiaceae that contains numerous species which are known for their salt tolerance. Given this association and its ability to withstand rather warm temperatures, *Celosia* was selected for its potential as a salt tolerant floral crop and was included in the floriculture salt screening program at the Salinity Laboratory. Therefore, the purposes of this investigation were to: 1) determine whether marketable cut flowers of two varieties of *Celosia argentea* could be produced under increasing salinity based on stem length; 2) assess phenotypic characters for each cultivar under increasing salinity; and 3) evaluate ion interactions and uptake for each cultivar under increasing salinity.

2 METHODS

Two cultivars of *Celosia argentea* var. *cristata* were used in this investigation ("Chief Rose" and "Chief Gold"). Experiments were conducted under greenhouse conditions at the George E. Brown, Jr., Salinity Laboratory in Riverside, California, USA. A 2 × 6 factorial design was used to assess the effects of ionic water composition (representing sea water (SWD) and drainage water from the Imperial and Coachella Valleys (ICV)) and salinity (2.5, 4.0, 6.0, 8.0, 10.0, and 12.0 dS m^{-1}) on productivity and ion composition of *C. argentea*. Treatments were replicated three times.

Seeds of "Chief Rose" and "Chief Gold" were sown in each of 36 greenhouse sand tanks resulting in 30 plants per cultivar per tank. Soils were irrigated with a base nutrient solution of 2.5 dS m^{-1} until the appearance of first leaves when treatments were applied. Shoots were harvested after 1 month to provide for 1 g dried plant material. Ion analyses were performed for total S, total P, Ca^{2+}, Mg^{2+}, Na^{+}, and K^{+} with inductively coupled plasma optical emission spectrometry (ICPOES) using a nitric-perchloric acid digest and Cl^{-} was analyzed by coulometric-amperometric titration from unfiltered nitric-acetic acid extracts. Ten plants were measured for stem length (soil line to base of inflorescence), stem weight, stem

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diameter (7 cm from soil line), inflorescence length, inflorescence weight, and number of leaves when harvested after flowering for each variety in each tank.

Two-way fixed effects general linear model (GLM) analyses of variance (ANOVA) were performed to determine effects of ionic water composition (ICV or SWD) and salinity on individual ion composition, stem length, stem weight, stem diameter, inflorescence length, inflorescence weight, and number of leaves for each cultivar based on tank means of three replicate tanks of ten plants for each variable. Significant differences between individual means were determined by Bonferroni multiple comparison procedure when differences were found by ANOVA. Statistical analyses were performed with Number Cruncher Statistical Systems (NCSS) 2001 (Hintze, 2001).

3 RESULTS AND DISCUSSION

Significant two-way interactions were found between water ionic composition and salinity for all ion concentrations for “Chief Rose” and “Chief Gold” including total S, total P, Ca^{2+}, Mg^{2+}, Na^{+}, and K^{+} and Cl^{-}. Both varieties responded similarly to mineral uptake. Concentrations for Ca^{2+}, K^{+}, and total-P decreased whereas Mg^{2+}, Na^{+}, and Cl^{-} concentrations increased in plant tissues as substrate salinity increased. Decreases in Ca^{2+} and K^{+} in plant tissues can be attributed to an increase in Na^{+} in treatment solutions as Na^{+} outcompetes the other ions for binding sites on roots. Decreases in total-P can be tied to an increase in Ca^{2+} in the irrigation solutions. As Ca^{2+} increases, calcium phosphate forms making P unavailable for plant uptake (Sharpley et al., 1992; Grattan and Grieve, 1999). Increases in Mg^{2+}, Na^{+}, and Cl^{-} can also be attributed to increases of these ions in substrate solutions.

Overall, stem length, stem weight, stem diameter, number of leaves, inflorescence length, and inflorescence weight tended to decrease as salinity increased for both cultivars. Barr (1992) suggests that the minimal stem length needed for marketability is 41 cm. These results indicate that “Chief Rose” and “Chief Gold” are marketable when produced under saline conditions. “Chief Gold” may be produced in saline waters with soil water electrical conductivities of 12 dS m^{-1} for both water compositions. “Chief Rose” may be produced in salinity concentrations up to 10 dS m^{-1} where water compositions would mimic those of the Imperial and Coachella Valleys that contain higher sulphate levels and up to 8 dS m^{-1} for water compositions similar to sea water where sodium and chloride predominate.

4 CONCLUSIONS

Saline wastewaters may be used to produce marketable cut flowers of *Celosia argentea* based on a minimum stem length of 41 cm. “Chief Gold” can be produced under saline conditions where electrical conductivities reach 12 dS m^{-1} for water ionic compositions mimicking sea water or wastewaters of the Imperial and Coachella Valleys of southern California. “Chief Rose” is best produced in ionic water compositions similar to the Imperial and Coachella valleys up to 10 dS m^{-1}, but can also be produced in sea water compositions up to 8 dS m^{-1}. All phenotypic measurements tended to decrease as salinity increased in both water ionic compositions for both cultivars. Both varieties responded similarly to uptake of minerals when exposed to different water ionic compositions. Ca^{2+}, K^{+}, and total-P concentrations decreased whereas Mg^{2+}, Na^{+}, and Cl^{-} concentrations increased in plant tissues as substrate salinity increased. Uptake can be related to ion concentrations in substrate solutions.

5 REFERENCES

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