Floriculture

Genhua Niu

Section Editor

Salt Tolerance of Garden Rose Cultivars

Youping Sun[1], Genhua Niu[1], Christina Perez[2] and Pedro Osuna[3]

[1]Texas A&M AgriLife Research Center at El Paso
1380 A&M Circle, El Paso, TX 79927, USA
[2]El Paso Community College, Research Initiative for Science Enhancement Program
El Paso, TX 79925, USA
[3]Universidad Autónoma De Ciudad Juárez, Plutarco Elias Calles # 1210
Fovissste Chamizal, Ciudad Juarez, Chihuahua 32310, Mexico

gniu@ag.tamu.edu

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Significance to Industry

Lacking of high quality water is one of the main concerns in arid and semiarid regions. This forces nursery growers and landscapers to use alternative water source, such as municipal reclaimed water (1). Reclaimed water contains relatively high level of soluble salts and has high alkaline pH (2). Excess salts in irrigation water influence plant growth and development in all stages, although the degree of the negative salinity effect may be growth stage dependent. Salt tolerant ornamental plants should be identified to reduce production cost and enhance sustainable development. The pH of irrigation water also plays an important role in the plant growth and development since it changes the solubility of minerals (3). *Tagetes patula* (Marigold) is sensitive to irrigation water with electrical conductivity (EC) higher than 4 $dS \cdot m^{-1}$, and its growth reduction is significantly greater when the pH of irrigation water is 7.8 compared with 6.4 (4). Garden rose (*Rosa* spp.) is one of the most popular ornamental plants in southern regions. It has been classified as fairly salt-sensitive plant. However, rose rootstocks *R. fortuniana*, *R*. *multiflora*, *R. odorata*, and 'Dr. Huey' can tolerate moderate salinity (EC up to 4.0 $dS \cdot m^{-1}$) with acceptable growth reduction and aesthetic appearance (5, 6). More information on salt tolerance of garden roses is needed. The objective of this study was to compare the relative salt tolerance of selected garden roses. The results showed that 1) salt tolerance varied among the three tested garden rose cultivars; 2) 'Knock out' rose was more tolerant to the salt in irrigation water than 'Belinda's Dream', while 'Carefree Beauty' had the least tolerance; 3) the pH of irrigation water didn't exacerbate the negative impacts of salt on the growth and development of the three tested garden rose cultivars.

Nature of Work: On 23 March 2012, cuttings of 'Belinda's Dream', 'Carefree Beauty', and 'Knockout' (Greenheart, Arroyo Grande, CA) were transplanted into pots (8.5 × 8.5 × 8.0 cm) containing Sunshine Mix #4 (SunGro Hort., Bellevue, WA), perlite (Therm-O-Rock West, Inc., Chandler, AZ), and composted mulch (Western Organics, Inc., Tempe, AR) at a ratio of 6:1:1 in volume. The substrates were incorporated with 0.6 $kg \cdot m^{-3}$ Micromax® micronutrients (Scott, Marysville, OH) and 0.07 $kg \cdot m^{-3}$ Marathon®

1% G (OHP, Inc., Mainland, PA). On 10 April, cuttings were transplanted into 2.6-L Poly-Tainer container with a 1:1 (by volume) mix of Sunshine Mix #4 and composted mulch amended with 5 kg·m^{-3} dolomite limestone (Carl Pool Earth-Safe Organics, Gladewater, TX) and 1 kg·m^{-3} Micromax® micronutrients . All roses were grown in a shade house (25% light exclusion) during summer.

On 21 August 2012, roses were pruned to 10-12 cm high and grown in a greenhouse. AVID® 0.15 EC (2% Abamectin, Syngenta Crop Protection Inc., Greensboro, NC) was applied for controlling spider mites and aphids as needed. On 8 October, roses were pruned to ~10 cm high again. One week later, treatments were initiated with nutrient solution (control) or saline solutions at either pH of 6.6 or 7.8 by irrigating plants with at least 10% leachate. Plants were then irrigated with nutrient or saline solutions once a week. The nutrient solution at EC of 1.5 dS·m^{-1} was prepared by adding 1 g·L^{-1} 15 N-2.2 P-12.5 K (Peters 15-5-15; Scotts) to tap water. The major ions in the tap water were Na^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-} at 184, 52.0, 7.5, 223.6, and 105.6 mg·L^{-1}, respectively. Saline solution at EC of 3.9 and 7.8 dS·m^{-1} was prepared by adding calculated amount of sodium chloride (NaCl) and calcium chloride ($CaCl_2$) at 2:1 (molar ratio) to the nutrient solution. Solutions were prepared in 100-L tanks with confirmed EC of 1.64 ± 0.25, 3.88 ± 0.10, and 7.75 ± 0.25 dS·m^{-1} (mean and standard deviation) for nutrient and saline solutions, respectively. Two pH levels of 6.56 ± 0.15 and 7.78 ± 0.04 were prepared for individual solution. Whenever substrate surface started to dry, tap water was applied. On 23 October, about 9 g of Micromax® micronutrients was applied to each container.

Leachate was collected periodically, and the EC of the leachate was measured using an EC meter (Model B-173, Horiba, Ltd., Japan). To reduce the salt accumulation, plants in control treatment were flushed with tap water to lower the salinity in the root zone. The temperatures in the greenhouse were maintained at 29.8 ± 7.1 °C (mean ± standard deviation) during the day and 21.2 ± 1.9 °C at night. The daily light integral (photosynthetically active radiation) was 13.3 ± 3.7 mol·m^{-2}·d^{-1}.

Upon termination of the experiment (i.e. 13 December), number of flowers were counted. Foliar salt damage was rated by giving a score to every plant from 0 to 5, where 0 = dead, 1 = over 90% foliar damage (salt damage: burning, necrosis, and discoloration); 2 = moderate (50-90%) foliar damage; 3 = slight (<50%) foliar damage; 4 = good quality with minimal foliar damage; and 5 = excellent without any foliar damage. New shoots were severed, and the length of all shoots was measured. All shoots were dried at 65 °C to constant weight, and the dry weight was noted.

The study was designed for each cultivar as a factorial experiment with three EC levels and two pH levels of irrigation water and six replications per treatment. All data were analyzed by a two-way analysis of variance (ANOVA) using PROC GLM. Means separation among treatments was conducted using Tukey's HSD multiple comparison. All statistical analyses were performed using SAS software (Version 9.1.3, SAS Institute Inc., Cary, NC).

Results and Discussion: The leachate ECs of garden roses that received irrigation of nutrient solution (control) and saline solution at EC of 3.9 and 7.8 $dS{\cdot}m^{-1}$ were measured weekly (Fig. 1). The pH of irrigation water didn't affect the leachate ECs of garden roses for all dates except 20 November. The leachate ECs of garden roses were similar between pH 6.6 and pH 7.8 for all dates except 7 November for nutrient solution (control) treatment and 20 and 27 November for saline solution at EC of 3.9 $dS{\cdot}m^{-1}$. In addition, the leachate ECs for plants watered with saline solution at EC of 7.8 $dS{\cdot}m^{-1}$ were insignificant between pH 6.6 and pH 7.8 for all dates.

No interactions were observed in all plant growth attributes of 'Belinda's Dream' except visual score. EC of irrigation water significantly affected shoot dry weight, visual score, and number of flowers, but pH of irrigation water only impacted number of flowers (Table 1). Averaged across pH levels, there was an overall 20.5% and 37.0% reduction in shoot dry weight, 27.7% and 34.0% in the number of flowers of plants irrigated with saline solution at EC of 3.9 and 7.8 $dS{\cdot}m^{-1}$, respectively. Plant quality as quantified by visual score was negatively impacted by increased EC of irrigation water.

All plant growth attributes of 'Carefree Beauty' were unaffected significantly by the EC × pH interactions (Table 2). There was a significant reduction by increased EC of irrigation water in shoot dry weight, total length of new shoots, and visual score. Averaged across pH levels, there was an overall 24.3% and 43.9% reduction in shoot dry weight, 19.5% and 28.0% in total length of new shoots of plants irrigated with saline solution at EC of 3.9 and 7.8 $dS{\cdot}m^{-1}$, respectively. Plant quality became worse as EC and pH of irrigation water increased.

There were no interactions in all plant growth attributes of 'Knockout' except total length of new shoots. EC of irrigation water significantly affected all plant growth attributes (Table 3). Averaged across pH levels, there was an overall 6.6% and 33.7% reduction in shoot dry weight, 0.7% and 24.4% in total length of new shoots, 5.4% and 25.8% in number of flowers of plants irrigated with saline solution at EC of 3.9 and 7.8 $dS{\cdot}m^{-1}$, respectively. The increase in both EC and pH of irrigation water was associated with decrease in plant quality.

In summary, salt tolerance varied among three tested garden rose cultivars. 'Knock out' rose was more tolerant to the salt in irrigation water than 'Belinda's Dream', while 'Carefree Beauty' had the least tolerance. The pH of irrigation water didn't exacerbate the negative impacts of salt on the growth and development of garden rose.

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Table 1. Effects of electrical conductivity (EC) and pH (6.6 or 7.8) of irrigation water on plant growth of rose ‘Belinda’s Dream’ at the experiment termination.

EC	Shoot dry weight (g)		Total length of new shoots (cm)		Visual score[z]		Number of flowers	
	6.6	7.8	6.6	7.8	6.6	7.8	6.6	7.8
Control	19.1a[y]	20.4a	147.2a	155.0a	5.0a	4.7a	5.3a	5.2a
3.9	15.7ab	15.7ab	140.9a	124.0a	3.8b	4.5a	4.8a	2.8b
7.8	13.2b	11.6b	121.2a	126.3a	2.8c	1.8b	4.2a	2.8b
ANOVA								
EC	***[x]		NS		***		*	
pH	NS		NS		NS		*	
EC × pH	NS		NS		*		NS	

[z] Visual score was rated with a score from 0 to 5, where 0 = dead, 1 = over 90% foliar damage (salt damage: burning, necrosis, and discoloration); 2 = moderate (50-90%) foliar damage; 3 = slight (<50%) foliar damage; 4 = good quality with minimal foliar damage; and 5 = excellent without any foliar damage.
[y] Means with same letters within column are not different tested by Tukey’s HSD multiple comparisons at $P < 0.05$.
[x] NS, *, **, ***: nonsignificant, significant at $P < 0.05$, 0.01, and 0.001, respectively.

Table 2. Effects of electrical conductivity (EC) and pH (6.6 or 7.8) of irrigation water on plant growth of rose 'Carefree Beauty' at the experiment termination.

EC	Shoot dry weight (g)		Total length of new shoots (cm)		Visual score[z]		Number of flowers	
	6.6	7.8	6.6	7.8	6.6	7.8	6.6	7.8
Control	15.5a[y]	13.6a	193.4a	139.5a	5.0a	4.8a	8.3a	6.3a
3.9	11.1b	11.0ab	127.9b	139.8a	4.7a	3.3b	7.0a	6.8a
7.8	7.8b	8.6b	114.0b	125.6a	3.7b	3.0b	5.8a	6.0a
ANOVA								
EC	***[x]		*		***		NS	
pH	NS		NS		**		NS	
EC × pH	NS		NS		NS		NS	

[z] Visual score was rated with a score from 0 to 5, where 0 = dead, 1 = over 90% foliar damage (salt damage: burning, necrosis, and discoloration); 2 = moderate (50-90%) foliar damage; 3 = slight (<50%) foliar damage; 4 = good quality with minimal foliar damage; and 5 = excellent without any foliar damage.

[y] Means with same letters within column are not different tested by Tukey's HSD multiple comparisons at $P < 0.05$.

[x] NS, *, **, ***: nonsignificant, significant at $P < 0.05$, 0.01, and 0.001, respectively.

Table 3. Effects of electrical conductivity (EC) and pH (6.6 or 7.8) of irrigation water on plant growth of rose 'Knock Out' at the experiment termination.

EC	Shoot dry weight (g)		Total length of new shoots (cm)		Visual score[z]		Number of flowers	
	6.6	7.8	6.6	7.8	6.6	7.8	6.6	7.8
Control	28.5a[y]	27.9a	229.8ab	262.8a	5.0a	4.8a	15.8ab	15.2a
3.9	28.5a	24.2ab	290.0a	199.0ab	4.8a	4.5a	16.5a	12.8a
7.8	21.0b	16.4b	197.3b	175.3b	3.5b	2.7b	12.5b	10.5a
ANOVA								
EC	***[x]		*		***		*	
pH	NS		NS		*		NS	
EC × pH	NS		*		NS		NS	

[z] Visual score was rated with a score from 0 to 5, where 0 = dead, 1 = over 90% foliar damage (salt damage: burning, necrosis, and discoloration); 2 = moderate (50-90%) foliar damage; 3 = slight (<50%) foliar damage; 4 = good quality with minimal foliar damage; and 5 = excellent without any foliar damage.

[y] Means with same letters within column are not different tested by Tukey's HSD multiple comparisons at $P < 0.05$.

[x] NS, *, **, ***: nonsignificant, significant at $P < 0.05$, 0.01, and 0.001, respectively.

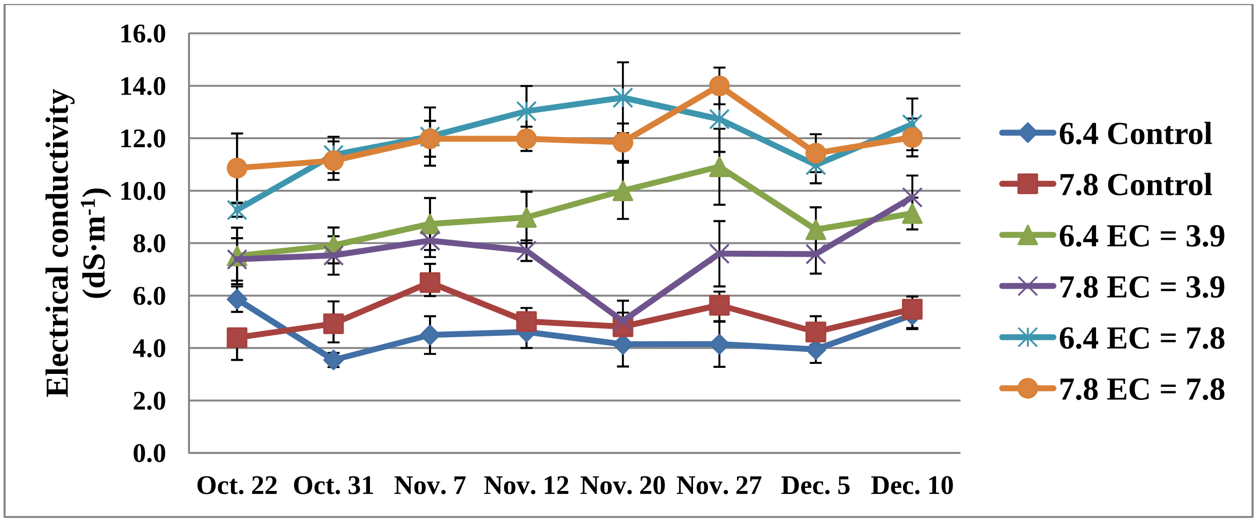

Fig. 1. Leachate electrical conductivity (EC) and pH of garden roses were measured weekly as affected by the EC and pH of irrigation water. Vertical bars represent standard error of six replications.

Ornamental Pepper Evaluation

Susan. S. Worthey, R. Crofton Sloan, Cameron Tate, and Thomas E. Horgan

North Mississippi Research and Extension Center
Mississippi State University, Verona, MS 38879

srh12@msstate.edu

Index words: variety trial, *Capsicum annum,* landscape value

Nature of Work: Peppers (*Capsicum annuum* L.) have market popularity among gardeners and landscapers due to ornamental characteristics such as colorful foliage, unique growth habit, fruit shape, and fruit color (1). New pepper cultivars possess improved ornamental characteristics of heirloom varieties combined with those of Indian and African pepper germplasm. Cultivars evaluated in this trial were new or vegetable garden types that are not commonly grown as ornamentals. The popular trend in using vegetables in ornamental plantings has been occurring for years. Vegetables that have been bred with ornamental characteristics have been the foundation of this trend (2). Stommel has been involved in breeding peppers for several years. His research has a two-fold advantage: increase the varieties of ornamental peppers for the consumer and lay the foundation for anthocyanin research to develop colorful plants for use in the plant industry (3).

Seeds of 26 pepper cultivars were sown on February 15, 2012. Plants were transplanted to the raised landscape beds on April 16, 2012. The beds were constructed with crosstie sides and filled with sandy topsoil and ammoniated pine bark at a 2:1 ratio. Pepper plants were irrigated with staked spray nozzles as needed. The beds were fertilized monthly with 8-8-8 at the rate of 1 lb/100 ft2. Plants were evaluated on May 30, June 13, July 10, and July 25 by using a visual quality rating for plant vigor, foliage appearance, overall landscape rating, plant uniformity, uniqueness, and fruit display on a scale of 1 - 5, where 1 = poor; 3 = moderate, and 5 = superior. Disease and insect rating were rated on a scale of 1-5, where 1= slight insect / disease presence, 3= moderate, 5= dead. Plant height and width were measured at the end of the study. The experimental design was a randomized completed block with 4 replications. Means were separated by Fisher's Protected Least Significant Difference (SAS Version 9.3, Cary, NC)

Results and Discussion: The ratings of cultivars varied with the evaluation dates and are reported by date. 'Joe's Round' was the tallest pepper in this trial and was followed by 'Ethem' and 'Caribbean Hot' (Table 1). 'Cherry Stuffer' had greatest width than all other cultivars except 'Joe's Round' and 'Thai Hot'. 'Fire on the Mountain' had one of the highest ratings in fruit and landscape ratings among the four dates reported (Table 2). 'Ethem' had the lowest rating for landscape rating and fruit for all dates except for May 30. 'Ethem' had the lowest overall landscape rating. The top rated pepper varieties showed great ornamental potential with high landscape rating and good fruit qualities. Most of the peppers with the exception of some of the lower rated varieties would make a good addition to the growing program for the consumer interested the ornamental characteristics of garden variety peppers.

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Table 1. Pepper Cultivar Characteristics

Cultivar	Height (cm)	Width[y] (cm)	Scoville Heat Units (shu)	Overall Landscape Rating[w]
Apache	38.4 ij[z]	30.2 p	70,000-80,000	3.8 a-c
Basket of Fire	35.7 j	41.8 no	80,000	4.0 ab
Cajun Belle	60.5 e	59.4 f-h	100-1,000	3.3 d-h
Caribbean Red	77.1 b	63.6 de	200,000-400,000	2.9 h-j
Chenzo Black	58.6 e	63.5 de	Sweet	3.3 d-i
Cherry Stuffer	70.8 d	72.3 a	Sweet	3.3 d-h
Cheyenne	32.4 k	33.2 p	30,000	3.8 b-e
Chinese Five Color	74.2 bc	71.2 ab	5,000-30,000	3.6 b-g
Czechoslavakian Black	53.0 f	62.7 d-f	3000	3.3 d-h
Ethem	76.9 b	56.6 hi	Sweet	2.6 j
Fire on the Mountain	49.3 g	49.7 kl		4.5 a
Jimmy Nardello	60.4 e	65.9 cd	Sweet	3.3 d-i
Joe's Round	84.2 a	70.9 ab	30,000-50,00	3.3 d-i
Loco Red	51.7 fg	56.3 hi	24,000	4.0 ab
McMahon's Bird	40.3 hi	54.0 ij	30,000-60,000	2.8 ij
Patio Blush Pink	41.4 hi	46.1 lm	Sweet	3.3 c-i
Peppa Blanca Rostra	40.1 hi	41.7 no	100-1000	3.9 a-c
Pinot Noir	61.0 e	67.9 bc	Sweet	3.4 b-h
Royal Black	51.6 fg	48.7 kl	5000-30,000	3.1 f-i
Sweet Cherry	60.1 e	61.0 e-g		3.0 g-j
Sweet Red Heat	29.3 k	33.5 p		3.5 b-h
Tangerine Dream	39.6 hi	49.1 kl	Sweet	3.8 a-d
Tasty Hot Cherry	51.4 fg	57.2 g-i	5,000-30,000	3.2 e-h
Tasty Patio Hot Wings	30.2 k	38.5 o	30,000	3.6 b-f
Tequila Sunrise	39.5 hi	52.3 jk	Sweet	3.4 c-h
Thai Hot	71.3 cd	71.5 ab	5000-60,000	3.3 c-i

[z] Means within the same column followed by the same letter are not different according to Fisher's Protected Least Significant Difference ($p<0.05$).

[y] Width = (width + width2)/2

[w] Landscape Rating: 1 – 5: 1 = poor; 3 = moderate, and 5 = superior.

Table 2. Pepper cultivar characteristics for four dates in 2012

	May 30		June 13		July 10		July 25	
Cultivar	Fruit Rating[y]	Landscape Rating	Fruit Rating	Landscape Rating	Fruit Rating	Landscape Rating	Fruit Rating	Landscape Rating
Apache	3.3 a	3.0 bc [z]	3.3 b-e	3.8 ab	4.0 a-e	4.3 a-d	4.75 a	4.5 a
Basket of Fire	2.8 a	3.0 bc	3.0 c-f	3.8 ab	3.8 b-f	4.5 ab	5.0 a	4.8 a
Cajun Belle	3.0 a	3.0 c	3.0 c-f	3.3 a-d	3.0 fg	3.7 b-f	4.25 a-c	3.3 cd
Caribbean Red	3.0 a	2.8 c	2.5 e-g	2.8 c-e	3.3 d-g	3.3 c-f	3.8 b-d	3.0 de
Carmen	3.0 a	3.0						
Chenzo Black	3.0 a	3.0 bc	2.5 e-g	3.3 a-d		4.0 a-e	3.3 d-f	2.8 de
Cherry Stuffer	3.0 a	3.0 bc	3.0 c-f	3.3 a-d	3.5 c-f	3.5 b-f	3.8 b-d	3.3 cd
Cheyenne	3.3 a	3.3 a-c	3.3 b-e	3.8 ab	3.5 c-f	3.5 b-f	4.25 a-c	4.5 a
Chinese Five Color	3.3 a	3.5 ab	3.3 b-e	2.8 c-e	4.3 a-d	3.6 b-e	4.5 ab	4.3 ab
Czechoslavakian Black	3.0 a	3.0 bc	3.8 a-c	3.8 ab	3.3 e-g	3.0 ef	3.0 d-f	3.3 cd
Ethem	2.0 c	3.3 a-c	3.0 c-f	2.0 e	3.0 fg	2.7 f	3.7 b-d	2.3 e
Fire on the Mountain	3.5 a	3.8 a	4.3 a	4.0 a	4.3 a-c	5.0 a	4.5 ab	4.8 a
Jimmy Nardello	3.5 a	2.8 c	3.8 a-c	3.3 a-d	4.0 a-e	3.5 b-f	4.25 a-c	3.5 b-d
Joe's Round	2.5 a	2.8 c	3.0 c-f	3.8 ab	3.5 c-f	3.8 b-e	2.8 ef	2.8 de
Loco Red	3.0 a	3.25 a-c	3.8 a-c	3.8 ab	4.7 ab	4.3 a-c	4.5 ab	4.8 a
McMahon's Bird	2.8 a	3.0 bc	2.3 fg	2.0 e	2.5 g	3.0 ef	2.5 f	3.0 de
Patio Blush Pink	2.5 a	3.5 ab	2.5 e-g	3.0 b-d	3.3 e-g	3.3 d-f	3.3 d-f	3.5 b-d
Peppa Blanca Rostra	3.3 a	3.8 a	4.0 ab	3.5 a-c	4.8 a	4.3 a-d	4.25 a-c	4.0 a-c
Pinot Noir	2.8 a	3.5 ab	3.5 a-d	3.3 a-d	4.3 a-d	3.8 b-e	3.3 d-f	3.3 cd
Royal Black	2.5 a	3.0 bc	3.0 c-f	3.3 a-d	3.3 e-g	3.3 d-f	3.0 d-f	3.0 de
Sweet Cherry	2.5 a	3.0 bc	2.0 g	2.5 de	3.3 d-g	3.3 c-f		
Sweet Red Heat	2.5 a	2.8 c	3.5 a-d	3.3 a-d	3.3 e-g	4.0 a-e	3.5 c-e	4.0 a-c
Tangerine Dream	2.5 a	3.5 ab	2.8 d-g	3.3 a-d	3.5 c-f	4.3 a-d	4.25 a-c	4.3 ab
Tasty Hot Cherry	3.3 a	2.3 c	2.3 fg	3.0 b-d	3.3 e-g	3.5 b-f	3.0 d-f	4.3 ab
Tasty Patio Hot Wings	2.5 a	2.8 c	3.0 c-f	3.5 a-c	3.8 b-f	4.0 a-f	4.5 ab	3.5 b-d
Tequila Sunrise	2.8 a	3.5 ab	2.8 d-g	2.5 de	3.5 c-f	3.5 b-f	3.8 b-d	4.0 a-c
Thai Hot	2.8 a	3.8 a	2.0 g	3.0 b-d	3.5 c-f	3.3 d-f	3.5c-e	3.3 cd

[z] Means within the same column followed by the same letter are not different according to Fisher's Protected Least Significant Difference ($p<0.05$).

[y] Rating: 1 – 5: 1 = poor; 3 = moderate, and 5 = superior.

Salt Tolerance of *Artemesia schmidtiana*, *Buddleia davidii*, and *Lantana* sp.

Youping Sun[1], Genhua Niu[1], Christina Perez[2], and Pedro Osuna[3]

[1]Texas A&M AgriLife Research Center at El Paso
1380 A&M Circle, El Paso, TX 79927, USA
[2]El Paso Community College, Research Initiative for Science Enhancement Program
El Paso, TX 79925, USA
[3]Universidad Autónoma De Ciudad Juárez, Plutarco Elias Calles # 1210
Fovissste Chamizal, Ciudad Juarez, Chihuahua 32310, Mexico

gniu@ag.tamu.edu

Index Words: dry weight, growth, osmotic potential, salinity

Significance to Industry: Nursery production and landscape industry are facing ever-increasing pressure in using limited high quality water for irrigating plants. Municipal reclaimed water is an alternative water source for irrigating landscape plants in areas with limited supply of high quality water (1). Reclaimed water contains relatively high level of soluble salts compared to potable water (2). Salt tolerant ornamental plants are needed for landscapes where alternative waters may be used for irrigation. *Artemesia schmidtiana* ‘Silver Mound’, *Buddleia davidii* ‘Nanho Blue’, and *Lantana* X 'Luscious Citrus' are popular ornamental plants. However, information on their responses to irrigation water with elevated salts is limited. A greenhouse study was conducted to determine their responses to elevated salinity in order to provide more information for growers and gardeners. Our results indicated that although their growth is reduced at elevated salinity, no foliar salt damage was observed. Among the tested species, *Artemesia schmidtiana* 'Silver Mound' was more tolerant to salt than *Lantana* X 'Luscious Citrus', followed by *Buddleia davidii* ‘Nanho Blue’.

Nature of Work: Rooted cuttings of *Artemesia schmidtiana* ‘Silver Mound’, *Buddleia davidii* ‘Nanho Blue’, and *Lantana* X 'Luscious Citrus' were received from Southwest Perennials Inc. (Dallas, TX) on 3 May, 2012. The cuttings were transplanted into 9 cm × 9 cm × 8.5 cm Dillen® inserts with Sunshine Mix #4 (SunGro Hort., Bellevue, WA) and grown in a greenhouse. They were watered with 0.72 $g \cdot L^{-1}$ 15 N- 2.2 P- 12.5 K (Peters 15-5-15; Scotts, Marysville, OH) nutrient solution until treatment initiated. On 22 May, all plants were transplanted into 2.6-L Poly-Tainer containers (No.1S, 16.5 x 16.5 cm) with fresh Sunshine substrates.

Treatment solutions were initiated on 4 June and terminated on July 23. Saline solutions at electrical conductivity (EC) of 4.0 and 8.0 $dS \cdot m^{-1}$ (EC4 and EC8) were created by adding calculated amount NaCl and CaCl2 at 2:1 molar ratio to nutrient solution. The nutrient solution at EC of 1.5 $dS \cdot m^{-1}$ was prepared by adding 1.25 $g \cdot L^{-1}$ 15 N- 2.2 P- 12.5 K to tap water. The major ions in the tap water were Na^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-} at 184.0, 52.0, 7.5, 223.6, and 105.6 $mg \cdot L^{-1}$, respectively. The treatment solution was applied weekly with ~10% leaching fraction. Leachate EC and pH were recorded using EC meter (Model B-173, Horiba, Ltd., Japan). Nutrient solution was applied between treatments whenever the surface of the media became dry.

All plant height (cm), plant width (cm) at perpendicular directions, and length (cm) of all shoots were measured. Upon termination of the experiment, ten plants per species per treatment were severed at the substrate surface, and shoot dry weight (DW) were determined after oven-dried at 70 °C to constant weight. Leaf osmotic potential was determined as described in Niu et al. (3). Specifically, leaves of ten plants were sampled from the middle section of the shoots in the early morning at the end of the experiment, sealed in a plastic bag, and immediately stored in a freezer at –20 °C until analysis. Frozen leaves were thawed in the plastic bag at room temperature before sap was pressed out with a Markhart leaf press (LP-27, Wescor, Logan, UT) and analyzed using a vapor pressure Osmometer (Vapro Model 5520, Wescor, Logan, UT).
The experiment was a split-plot design with species as the main plot and salinity of irrigation water as subplot with 20 replications. All data were analyzed using SAS software (Version 9.1.3, SAS Institute Inc., Cary, NC). To determine the differences among salinity levels on plant growth, Tukey's HSD multiple comparisons were performed.

Results and Discussion: Although growth index of *Artemesia schmidtiana* 'Silver Mound' was reduced by salt treatment, its dry weight was not affected (Table 1). Plants irrigated with saline solution at EC4 and EC8 were 5.0% and 15.7% smaller than those with nutrient solution (control).

Salt treatment considerably decreased the length of shoots and dry weight of *Buddleia davidii* 'Nanho Blue' (Table 1). Compared to control, plants watered with saline solution at EC4 and EC8 were 10.3% and 18.8% shorter in shoot length, while 26.7% and 49.9% lighter in dry weight, respectively.

Salt treatment reduced the growth index, length of shoots, and dry weight of *Lantana* X 'Luscious Citrus' plants (Table 1). In term of the growth index, *Lantana* X 'Luscious Citrus' plants irrigated with saline solution at EC4 and EC8 were 13.2% and 32.2% smaller, respectively, compared to control. Plants watered with saline solution at EC4 and EC8 were 20.4% and 26.6% shorter in length of shoots than those with nutrient solution (control). In addition, plants irrigated with saline solution at EC4 and EC8 had 9.2% and 44.2% less dry weight than those with nutrient solution (control).

Salt treatment decreased leaf osmotic potential for three tested plant species (Table 2) and the degree of decreasing in leaf osmotic potential varied among species. Compared to control, the osmotic potential of *Artemesia schmidtiana* 'Silver Mound' plants was 21.3% and 20.3% lower when they were irrigated with saline solution at EC4 and EC8, while that of *Lantana* X 'Luscious Citrus' were 54.3% and 57.0%. For *Buddleia davidii* 'Nanho Blue' plants, the reduction of osmotic potential reached 92.8% and 105.2% when they were received saline solution at EC4 and EC8, respectively.

In summary, the growth of *Artemesia schmidtiana* ‘Silver Mound’, *Buddleia davidii* ‘Nanho Blue’, and *Lantana* X 'Luscious Citrus' is reduced at elevated salinity. Based on their dry weight, *Artemesia schmidtiana* ‘Silver Mound’ was more tolerant to salt than *Lantana* X 'Luscious Citrus', followed by *Buddleia davidii* ‘Nanho Blue’.

Literature Cited

1. Wu, L.Sh., W.P. Chen, C. Grench, and A. Chang. 2009. Safe application of reclaimed water reuse in the southwestern United States. University of California Division of Agriculture and Natural Resources Bul. 8357.
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3. Niu, G., D.S. Rodriguez, and T. Starman. 2010. Response of bedding plants to saline water irrigation. HortScience 45:628-636.

Table 1. Growth index, length of shoots, and dry weight of *Artemesia schmidtiana* ‘Silver Mound’, *Buddleia davidii* ‘Nanho Blue’, and *Lantana* X 'Luscious Citrus' irrigated with nutrient solution at electrical conductivity (EC) of 1.5 (Control), or saline solution at EC of 4.0 (EC4), or 8.0 (EC8) $dS \cdot m^{-1}$ for 7 weeks.

Species	Treatment	Growth index (cm)^{z}	Length of shoots (cm)^{y}	Dry weight (g)^{y}
Artemesia schmidtiana ‘Silver Mound’	Control	19.8 ± 0.5 a^{x}	-	40.8 ± 1.0 a
	EC4	18.8 ± 0.3 a	-	41.1 ± 1.2 a
	EC8	16.7 ± 0.3 b	-	37.7 ± 0.9 a
Buddleia davidii ‘Nanho Blue’	Control	-	23.6 ± 1.2 a	35.2 ± 1.5 a
	EC4	-	21.2 ± 1.1 ab	25.8 ± 1.6 b
	EC8	-	19.2 ± 1.1 b	17.6 ± 0.7 c
Lantana X 'Luscious Citrus'	Control	57.0 ± 2.3 a	44.3 ± 2.5 a	35.8 ± 1.8 a
	EC4	49.5 ± 2.7 a	39.1 ± 1.6 ab	32.5 ± 1.7 a
	EC8	38.6 ± 1.7 b	36.0 ± 1.8 a	20.0 ± 1.2 b

^{z} Growth index = [(height + width1 + width2)/3], mean ± standard error of twenty plants.
^{y} Mean ± standard error of ten plants.
^{x} For each plant species, means with same lowercase letters within column are not significantly different among treatments by Tukey’s HSD multiple comparison at $P < 0.05$.

Table 2. Leaf osmotic potential of *Artemesia schmidtiana* ‘Silver Mound’, *Buddleia davidii* ‘Nanho Blue’, and *Lantana* X 'Luscious Citrus' irrigated with nutrient solution at electrical conductivity (EC) of 1.5 (Control), or saline solution at EC of 4.0 (EC4), or 8.0 (EC8) $dS \cdot m^{-1}$ for 7 weeks.

Species	Treatment	Osmotic potential (MPa)[z]
Artemesia schmidtiana ‘Silver Mound’	Control	-1.14 ± 0.04 a[y]
	EC4	-1.38 ± 0.06 b
	EC8	-1.37 ± 0.06 b
Buddleia davidii ‘Nanho Blue’	Control	-0.66 ± 0.10 a
	EC4	-1.27 ± 0.09 b
	EC8	-1.35 ± 0.05 b
Lantana X 'Luscious Citrus'	Control	-0.61 ± 0.06 a
	EC4	-0.94 ± 0.04 b
	EC8	-0.96 ± 0.04 b

[z] Mean ± standard error of ten plants.
[y] For each plant species, means with same lowercase letters within column are not significantly different among treatments by Tukey’s HSD multiple comparison at $P < 0.05$.