1. INTRODUCTION
Jerusalem artichoke (Helianthus tuberosus, L.) is a North American crop that was consumed by Native Americans before European settlers arrived. Its tubers are a rich source of probiotic fiber and source of sugars for biofuels. The whole plant can provide inulin, protein (6-12%), and aminoacids as feed and food. Although reported as tolerant to drought and salinity, salinity effects on the production of inulin, inulin's degree of polymerization, and tuber antioxidant capacity have not been reported. Its adaptability to diverse edaphoclimatic conditions, pests and diseases, and ability to re-sprout from overwintered tubers make it a potential biofuel, food, and feed crop adaptable to areas unsuitable for conventional agricultural crops. Our objective was to evaluate crop growth, tuber yield, inulin tuber concentration and degree of polymerization, tuber antioxidant capacity, and concentration of free sugars under saline irrigation.

2. MATERIAL & METHODS
The experiment was conducted with the cultivar ‘Stampede’ at the US Salinity Lab in Riverside, CA. The average temperatures during growing season (April 29 to July 18, 2014) were 30°C (day) and 15°C (night). Days ranged from 13.5 h (April 29, planting) to 14.15 h (July 18, shoot harvest), then to 12.75 h (September 4, tuber harvest). Tubers were planted in large (3.0 m L x 1.5 m W x 2.0 m D) sand tanks (Figs. 1 & 2). This system enables complete recycling of the irrigation waters while maintaining stable root-zone salinity. Riverside tap water, pH 7.5-7.8 of average electric conductivity (ECw) = 0.7 dS m⁻¹ was mixed with high salinity water, or HSW, (ECw = 12.0 dS m⁻¹) enriched with macro and micronutrients, Na⁺, and Cl⁻ (Dias et al. 2016). EC of irrigation waters (ECw) were 1.2 (tap water plus nutrients and low NaCl), 3.9, 6.6, 9.3, and 12.5 dS/m (equivalent to 1/4 seawater).

3. RESULTS & DISCUSSION

3.1 Salt accumulation and biomass accumulation:
Statistically-significant decreases in leaf, stem, and total shoot (leaf+root) biomass occurred only between 3 (ECw=1.2 dS m⁻¹) and HSW (ECw=12 dS m⁻¹) with shoot biomass being similar at ECw ranging from 3.9 to 9.3 dS m⁻¹. Pearson’s correlation coefficient showed that salinity had a significant and negative impact on shoot biomass (Fig. 3A). While Cl⁻ increased with salinity in all organs, Na⁺ only increased in roots and tubers (Fig. 3B). Thus, Cl⁻, not Na⁺, was responsible for decreased shoot and tuber biomass (Fig. 3B). Shoot biomass decreased 67% from LSW to HSW (Fig. 3A, Table 1).

3.2 Tuber yield, total soluble solids, and sugars:
Tuber yield was reduced by salinity, similar to shoot biomass. Although reduction in tuber yield plant⁻¹ was not significant, there was a tendency for tuber yield to decrease with salinity, and in 47% from LSW to HSW.

3.3 Total antioxidant capacity:
There was no salinity effect on total antioxidant capacities of tubers, by either ORAC or TP (Fig. 6). ORAC correlated highly with TP (r²=0.69**) indicating tuber TP function as antioxidants. The increase in both Na⁺ and Cl⁻ in tubers seemed to have triggered biochemical responses that increased level of non-enzymatic antioxidants in addition to osmotic balance provided by sugars.

4. CONCLUSIONS
1. Salinity affected shoot more than tuber yield (67% vs. 47%) at ECw = 12 dS/m, but reduced tuber yield in only 11% at ECw=6.6 dS/m.
2. Plants produced 83 tons of tubers ha⁻¹ (42 tons of inulin ha⁻¹) at ECw=6.6 dS m⁻¹ (moderate salinity), and 92 tons of tubers ha⁻¹ (46 tons inulin ha⁻¹) at control salinity (ECw=1.2 dS/m). Tubers had 5-10% sucrose, 30-60% inulin. Inulin degree of polymerization (DP) of ‘Stampede’ was low and unchanged by salinity, and is suitable for biofuel production.
3. Tubers nutritional value (not presented) and antioxidant capacity was maintained at all salinity levels.
4. Chloride, not sodium, was the most toxic for the crop.
5. ‘Stampede’ can be irrigated with waters of low-moderate salinity, completing its cycle in 4 months.

Table 1. Effect of water salinity on tuber yield and soluble carbohydrate concentration. Blended waters ECw ranged from 1.2 to 12 dS/m.

<table>
<thead>
<tr>
<th>Source</th>
<th>LSW</th>
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<th>TP</th>
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<tr>
<td>Tuber</td>
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<tr>
<td>Shoot</td>
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<td>12</td>
<td>76</td>
<td>1.5</td>
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Fig. 1. Helianthus tuberosus cv. Stampede under salinity. Planting: April 29, 2014. Left: June 27 (45 DAP, left), Middle: July 8 (79 DAP, Right: September 4 (harvest, 128 DAP). Tubers shown on right are from plants irrigated with ECw = 6.6 dS/m (83 tons tuber ha⁻¹).

Fig. 2. Outdoor lysimeter system with 24 sand tanks (left). A pump system irrigates sand tanks (right) with waters from underground 3,600L reservoirs (bottom right) containing the desired treatments and maintaining a stable root-zone salinity.

Fig. 3A. Relation between leaf (A, Series 3), stem (B, Series 2) and total shoot dry matter (C, Series 3); of ‘Stampede’ and salinity level (Series 1). **Significant at p<0.01. (DP) B, free fructose (C), free glucose (D), free sucrose (E), and total sugars (F) from plants irrigated with waters of different electrical conductivities (ECw). ns = not significant **,* significant at p≤0.01, and at p≤0.05, respectively.

Fig. 4. Second order regression for the ‘Brix of tubers in response to water salinity (ECw) levels of mixed low-salinity water and high-salinity water. ** Significant at p<0.01.

Fig. 5 (Left). Tuber concentrations of fructans (A), degree of polymerization (DP) (B), free fructose (C), free glucose (D), free sucrose (E), and total sugars (F) from plants irrigated with waters of different electrical conductivities (ECw). ns = not significant **,* significant at p≤0.01, and at p≤0.05, respectively.

Fig. 6 (Right). Oxygen radical absorbance capacity (ORAC) (A), total phenolics (TP) (B). 3 plants from each tank were combined into one replicate. n=3.

Fig. 7. Shoot and tuber nutrient accumulation.

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