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CULTURAL PRACTICES TO REDUCE SALINITY/SODIUM DAMAGE TO RABBITEYE BLUEBERRY PLANTS

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INTRODUCTION

Ericaceous plants (blueberry, azalea, rhododendron) are sensitive to excessive amounts of fertilizer, salinity, Na, and/or HCO_3 in the irrigation water and/or soil (3, 4, 5). Cultivation of blueberries under these conditions has led to marked decline in production (5). Growers frequently lack a source of good quality water for irrigation. Previous reports on other crops have indicated that modification of irrigation water chemistry (4), irrigation geometry (2), or calcium amendments (6) can be used to improve plant growth under saline conditions. This paper is a synopsis of a series of experiments we have done to determine cultural practices that can be used by growers to overcome the harmful effects of poor quality irrigation water on rabbiteye blueberry plants.

MATERIALS AND METHODS

Experiment 1. Cultivar Screening

Five cultivars of rabbiteye blueberries ('Brightwell', 'Delite', 'Tifblue', 'Premier', and 'Climax') were grown in the greenhouse using deep well water - pH = 7.2, EC = 0.4 dS/m, SAR = 17. Plant growth was evaluated after 6 months.

Experiment 2. Water Modification

'Tifblue' rabbiteye blueberry plants were grown in a greenhouse in either a 1:1 mix of peat:clay loam, peat:sandy loam or peat:loamy sand. Plants were irrigated with one of four irrigation water treatments 1) deep well water, 2) deep well water acidified to remove HCO_3, 3) well water saturated with $CaSO_4$, or 4) rainwater. The water quality for each of these treatments is listed in Table 1. Plant growth was evaluated 166 days after initiation of the study.

Experiment 3. Mulch and irrigation geometry

'Tifblue' plants were grown in the field in a fine sandy loam amended with 11 liters of peat moss in the planting hole. Whole plots were the mulch treatments with or without 3 inc of sawdust mulch. Subplots were irrigation treatments. Plants were irrigated with one 2 gallon/hour drip emitter (located at the plant base), two 1 gallon/hour emitters (located 18 in on each side of the plants), or 360° low-volume spray emitter (LVS) (located 1 m on each side of the plant). The irrigation water had a pH = 8.2, HCO_3 = 4.5 meq/l, EC = 0.35 dS/m, and a SAR = 16. Irrigation scheduling was based on maintaining soil tensiometers between -10 and -20 centibars. Plant growth and soil electric conductivity (EC) were evaluated after three years.

Experiment 4. Calcium Amendments

Field experiment: 'Tifblue' plants were grown in the field in a fine sandy loam. The planting hole was amended with 1 gallon of peat and one of five rates of gypsum ($CaSO^4$): 0, .9, 1.8, 3.5 or 7.1 oz/hole. The high rate was equivalent to 20 kg/m3. Plants were irrigated with a single emitter at the plant base (1 gallon/day) with either deep well water (same as Expt. 2.2) or pond water (pH = 6.8, HCO_3 = 0.9 meq/l, EC = 0.15 dS/m and a SAR = 0.3). Preliminary data on plant performance was collected after four months.

Greenhouse experiment: 'Tifblue' and 'Brightwell' plants were grown in sand culture and irrigated with nutrient solution. Three levels of Na (0, 25, 100 mM) and four levels of Ca (0, 1, 3, and 10 mM) were supplied in the nutrient solution in a factorial arrangement. Preliminary data on leaf chlorophyll, photosynthesis - carbon exchange ratio (CER), stomatal conductance, and transpiration were collected three weeks after treatment initiation. Gas exchange data were collected using an ADC portable gas analyzer.

RESULTS

Cultivar Screening

'Delite' had the greatest root dry weight and plant weight gain and 'Tifblue' the least following irrigation with marginal quality water (Table 2). 'Brightwell', 'Premier', and 'Climax' were intermediate in their response to marginal quality water. Top:root ratio was greatest for 'Tifblue' and 'Climax' and least for 'Climax' and 'Delite' and indicated that root growth was a very sensitive indicator to salt stress.

Water Modification

Plant weight gain increased for both deep well and rain water irrigated plants as the percentage of sand in the soil increased (Table 3). Soil type did not affect growth of plants irrigated with acidified or gypsum treated water. On the sandy loam and loamy sand soil, rain water resulted in greater growth than other treatments, while on clay loam soil deep well water resulted in less growth than other treatments. More detailed results are presented by Haby et al. (1986).

Mulch and Irrigation Geometry

Mulch increased plant volume when drip irrigated with marginal quality water but did not for plants irrigated with LVS (Table 4). Non-mulched plants were larger with the one-emitter treatment than the two-emitter treatment. Mulch reduced the soil EC in the root zone compared to no mulch, especially with the two emitter treatment. A single emitter at the plant base resulted in the lowest root zone EC, while emitters located at both sides of the plant resulted in highest EC levels. More detailed results of this experiment are presented by Patten et al. (1988).

Gypsum Amendments

Field experiment: Preliminary results indicated that gypsum did not ameliorate salt damage in the field (data not shown). Very high rates of calcium did not prove to be detrimental.

Greenhouse experiment: Preliminary data on CER, stomatal conductance and transpiration indicated that Ca, even at the highest rate, did not have any adverse effect. Plants treated with the high sodium level and unamended with calcium had lower CER, stomatal conductance and transpiration than plants treated with calcium (Table 5). There was a nonsignificant trend for the 1 and 3 mM rate of calcium to be more effective in ameliorating high Na damage than the 10 mM rate. 'Brightwell' was less susceptible to Na damage than 'Tifblue' (data not shown).

DISCUSSION

Treatments to modify toxicity of deep well water used for irrigation of blueberries were not successful. The fact that removal of bicarbonates with acidification or that lowering of SAR levels with gypsum was ineffective, indicates that these treatments were either harmful in themselves by increasing the EC or that they could not overcome the effect of high NA or EC levels in the soil. Growers could however, significantly improve plant growth under marginal quality irrigation water if they used mulch, irrigated with a single emitter at the plant base or LVS, and planted cultivars that were less sensitive in salts.

Increasing the water supply frequency and thereby preventing large fluctuation in the wetting and drying cycle (maintaining tensiometers > -20 centibars) would also help to prevent transient salt buildup under the plant. Overall, it appears that the threshold level for soil EC is 1.5 dS/m. Additional factors, such as Na toxicity, could be responsible for poor plant growth at soil EC levels less than 1.5 dS/m.

Experiments on amending soils with Ca to reduce salt damage suggest that Ca was not harmful to blueberries. This is contrary to other data on rabbiteye blueberries (Austin and Gains, 1986). Lab data also indicated that moderate rates of Ca partially ameliorated Na damage. Consequently, the calcifuge classification of blueberries may be more a function of soil pH than Ca levels.

CONCLUSION

The most efficacious cultural practices to reduce salinity/sodium damage of rabbiteye blueberry plants appears to be modifications of irrigation practices that reduce the accumulation of salts in the plant root zone. This would include mulching and emitter placement. 'Delite' and possibly 'Brightwell' should be the cultivars of choice to minimize potential salinity damage.

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Table 1. Water quality of irrigation treatments used in experiment two.

Water Treatment	pH	HCO_3 meq/l	EC (dS/M)	SAR
Deep Well	8.7	7.9	0.7	30
Deep Well + Acid	5.0	0.4	1.0	41
Deep Well + $CaSO_4$	8.2	3.6	2.4	2
Rain Water	6.3	0.1	0.01	0

Table 2. Performance of five rabbiteye blueberry cultivars irrigated with marginal quality irrigation water

Cultivar	Root Dry Wt. (g)	Plant Weight Gain (g)	Top:Root Dry Wt. Ratio
Tifblue	5.3	13.1	1.7
Delite	28.4	73.2	0.6
Premier	10.7	23.6	0.7
Brightwell	16.5	47.2	0.9
Climax	8.1	44.2	1.5
LSD @ 0.05	17.0	47.7	1.0

Table 3. Weight gain of container grown rabbiteye blueberry plants as affected by water treatment and soil type.

	Plant Weight Gain (g)		
	Soil Type		
Water Treatment	Clay Loam	Sandy Loam	Loamy Sand
Deep Well	19	53	64
Deep Well-Acidified	54	53	56
Deep Well+Gypsum	45	50	53
Rain Water	46	82	84

LSD @ 0.05 level = 18

Table 4. Effect of mulch and irrigation geometry on 'Tifblue' rabbiteye blueberry growth and root zone electric conductivity.

Irrigation Mulch Treatment	Canopy Volume (m^3)	Electric Conductivity (dS/M)
+ One Emitter	0.32	0.5
+ Two Emitters	0.33	0.8
+ Low Volume Spray	0.42	0.9
- One Emitter	0.23	1.2
- Two Emitters	0.15	3.7
- Low Volume Spray	0.44	1.5
LSD @ 0.05	0.07	0.7

Table 5. Effect of calcium and sodium rate on leaf carbon exchange rate (CER), stomatal conductance, transpiration and chlorophyll levels on 'Tifblue' rabbiteye blueberries grown in sand culture.

Calcium level (mM)	Sodium level (mM)	CER umol $m^{-2}s^{-1}$	Stomatal conductance $mMm^{-2}s^{-1}$	Transpiration rate $mMm^{-2}s^{-1}$
0	0	10.1	0.32	6.7
1	0	8.5	0.29	6.5
3	0	9.1	0.27	5.8
10	0	9.1	0.26	6.1
0	25	7.7	0.23	5.2
1	25	9.5	0.25	6.1
3	25	8.4	0.30	6.7
10	25	9.6	0.27	6.1
0	100	3.2	0.15	2.5
1	100	3.9	0.15	4.2
3	100	7.0	0.13	4.3
10	100	5.8	0.13	3.8
LSD @ 0.05		2.9	0.11	1.5