Developing High Yielding & High-Quality Varieties & Cropping Systems for High Salinity Conditions

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RATIONALE & OBJECTIVES

- Western Alfalfa Production is challenged by reduced water supplies and increased salinity of soils and water resources. This may be exacerbated by climate change. Varieties that can sustain high yields under saline conditions are needed.
- Although some research describes alfalfa as being moderately salt sensitive from greenhouse studies, does this really hold true under field conditions?

Objectives:

To determine the effects of very high salinity irrigation water on the yield and forage quality of alfalfa varieties grown under field conditions in a long-season Mediterranean environment.

RESEARCH DESCRIPTION

- A field Trial with 33 mostly non-dormant alfalfa varieties at two salinity levels was established in early 2017 on a deep clay-loam soil under drip irrigation with a Randomized Complete Block Design with salinity as the main plot in western Fresno Co., California. High Salinity (HS) irrigation water (9.0 to 11.0 dS/m EC_w) was applied to half the trial, and Low Salinity (LS) water (0.4 to 1.5 dS/m EC_w) applied to the other half. The trial was conducted over 4 years, and yield measurements taken 7-8 times/year. Average soil salinity at the end of the trial was 12-16 dS/m in the HS treatments, and about 2.0 dS/m EC_e in the LS treatments. This saline water was a mix of salts with a high Boron level and high Sodium Absorption Level. Forage Quality was measured on selected harvests with NIRS.

RESULTS

- 3 full-year yields under high salinity averaged 76% of those with low salinity, but HS yields exceeded 10 t/acre, Table 1).
- Some varieties responded differently than others to high salinity conditions, with yield penalties between 5% and 35% of controls (STI, Table 1, Figure 1).
- Quality generally improved under saline conditions showing higher Crude Protein, NDFD and lower NDF, but quality was negatively correlated with yield (Figure 2).

Table 1. Cultivars, Fall Dormancy (FD) rating, average yield and quality under HS and LS conditions, and the Salinity Tolerance Index (STI), three full production years, 2018-20. Yield and quality parameters were significant at P<0.01.

Cultivar Number	Name	FD	HS	LS	STI
		Rating	----- t/acre -----		%
34	UC Salton	9	12.9	13.6	94.9
22	SW9573	9	12.5	13.8	90.6
2	AZ-88NDC	9	11.9	14.2	83.5
28	Integra 8810S	8	11.7	14.9	79.0
29	9R100	9	11.7	15.6	74.7
27	SW9106M	9	11.6	14.8	78.5
33	UC Impalo	9	11.6	14.4	80.0
3	CUF101	9	11.5	13.2	87.1
30	PGI 908-S	9	11.4	15.8	72.6
10	H0916ST223	9	11.4	12.3	92.4
26	SW8421RRS	8	11.2	15.7	71.8
24	SW9577	9	11.0	14.3	76.9
4	C0916ST232	9	10.8	13.4	80.5
17	R814W258S	8	10.6	14.3	74.3
21	SW8476	8	10.6	15.1	70.2
25	SW9215RRS	9	10.5	15.0	70.2
1	AZ-90NDC-ST	9	10.3	14.3	72.5
11	H0715ST209	7	10.2	12.4	82.7
18	R914W259S	9	10.1	14.1	71.5
20	SW8412	8	10.1	13.4	75.2
16	R814W257S	8	10.0	15.4	65.1
9	H0916ST218	9	9.9	13.2	74.5
19	SW8409	8	9.9	13.6	72.6
7	H0916ST216	9	9.8	12.3	80.0
6	H0716ST227	7	9.7	12.0	81.1
15	H0915ST214	9	9.6	14.3	67.1
23	SW9576	9	9.4	11.7	80.0
14	H0915ST212	9	9.4	13.1	71.8
31	AFX149092	9	9.4	14.1	66.4
13	H0815ST210	8	9.2	13.9	66.3
8	H0916ST217	9	9.1	11.7	77.5
5	H0716ST222	7	8.9	13.0	68.6
12	H0715ST211	7	8.8	12.9	68.2
Mean			*10.8*	*13.8*	*76.1*
LSD	*(P<0.05)*		*1.8*	*2.5*	

Figure 1. Three-year average yields of alfalfa varieties under high salinity and low salinity conditions, 2018-2020, Fresno Co., California. Salinity Tolerance Index (% yield of LS control) differed among varieties. To convert Mg/ha to t/acre, multiply by 0.446.

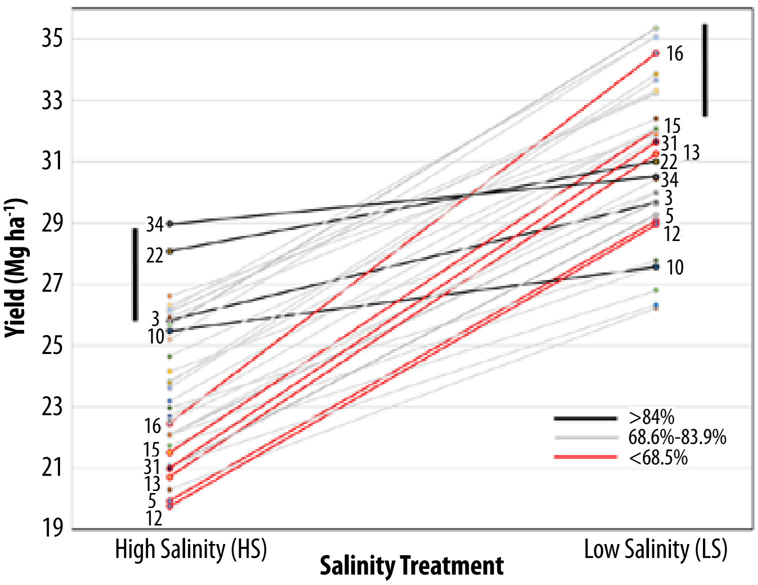
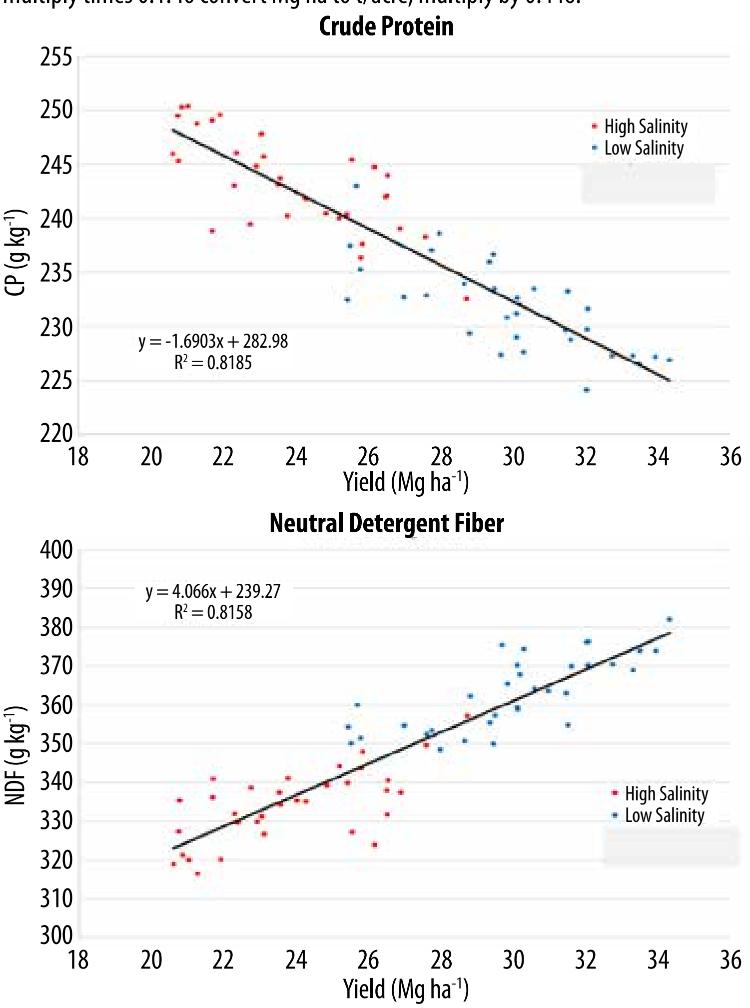


Figure 2. Crude Protein and NDF concentrations of alfalfa varieties as a function of yield, average 2-year data, 3 cuts/year, Fresno Co., California. To convert g/kg to %, multiply times 0.1. To convert Mg ha to t/acre, multiply by 0.446.



CONCLUSIONS

- This research demonstrates a remarkable level of salinity and boron tolerance in alfalfa in the field. This contradicts earlier reports that describe alfalfa as moderately salt sensitive. The average yields over 4 years under HS were considered to be economically viable for alfalfa grown in this region.
- A range of salt tolerant alfalfa varieties were identified in the field, indicating a promise for future progress in salinity tolerance. Tolerance evaluations should consider total biomass yields as well as the salinity tolerance index (STI).
- The modest improvement in forage quality of the varieties grown under HS conditions (Figure 1) is primarily an effect of lower yields, slower growth, and higher leaf-to-stem ratios under saline and water stress. We suggest that alfalfa salinity tolerance should primarily be judged based upon yield potential under saline conditions, not quality response.
- Although alfalfa is likely to be tolerant of soil salinity conditions exceeding 6.0 – 8.0 dS m-1 ECe, there is a need for appropriate soil and water management practices. These include adequate soil preparation and drainage, periodic leaching to reduce salinity, and gypsum applications for high sodic soils.

Alfalfa
U.S. Alfalfa Farmer Research Initiative

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