

Salinity Tolerance and Forage Quality Comparison for Four Varieties of Alfalfa (*Medicago sativa*)

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Introduction

- Alfalfa (*Medicago sativa*) is an important forage and the most valued hay crop for California's dairy industry, which leads the nation in milk production. Statewide, alfalfa was grown on 515,000 acres in 2020 (USDA-NASS, 2020), down from over a million acres in 2006.
- California alfalfa yields average 7.1 tons/acre, nearly twice the U.S average, due to a long growing season that allows for more cuts per year and breeding efforts to address changing conditions in climate, water availability and soil quality (Geisseler and Horwath, 2016).
- With increasing drought and irrigation water scarcity, lower quality irrigation waters that are often saline are increasingly used for forage irrigation, as are marginal soils, higher in salinity.
- Alfalfa seed companies have foreseen this trend and invested considerable resources into breeding more salt tolerant varieties (Alforex, <https://www.alforexseeds.com/alforex-alfalfa-seed-technology/hi-salt-salinity-tolerant-alfalfa-seed/>).

Methods

- In this experiment, four alfalfa cultivars are being evaluated at five irrigation water salinity levels (0.5, 5, 10, 15, 20 ds/m ECw) using a split plot design in an outdoor pot experiment with four repetitions.
- The cultivars include two newly licensed varieties from Barkley Seed, Inc. (B6604-0588F, B6269 SR), a salt tolerant control (AZ90NDCST) and a public control (CUF101).
- The seedlings were established under non-saline conditions and grown in large pots (#15) filled with a 4:1 ratio of fritted clay to peat moss.
- Nutrient solution (1/4 strength Hoagland's) was applied every two weeks. Once salinization began, the plants were cut to the crown and then harvested at 30, 59, and 88 days, just prior to flowering in the controls.
- Dry matter production was determined after each cutting, and sodium and potassium accumulation in shoot tissue was measured using nitric acid digestion and the MPAES for detection.
- A companion seed germination test is also being conducted.

Photos

- Development of seedlings and nodulation period (Photo A).
- Plant comparison after cut 1 (30 DAT) and 2 (59 DAT) (Photo B, C)
- Seed germination trial using germination paper (D, E)
- Seed germination using a soil medium moistened with saline solutions (F, G)



A



B



C



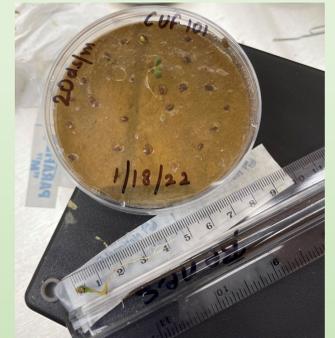
D



E



F



G

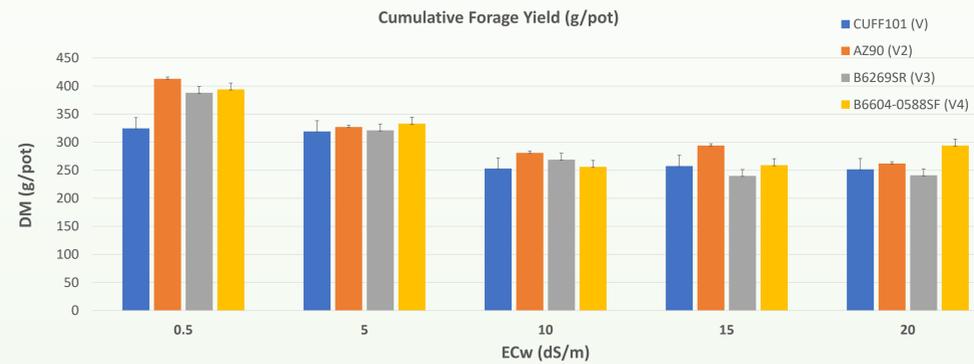


Fig. 1. Cumulative forage dry matter yield (DMY) for three cuts in response to increasing salinity in the irrigation water (ECw).

Salinity Level	Variety	% Germination
0.5	1	16.7
	2	96.7
	3	80.0
	4	96.7
10	1	36.7
	2	70.0
	3	96.7
	4	100.0
20	1	6.7
	2	10.0
	3	16.7
	4	76.7

Table 1 (left). Seed Germination Percentage at 23 days for seeds germinated in saline solutions (0.5, 10 and 20 dS/m ECw)

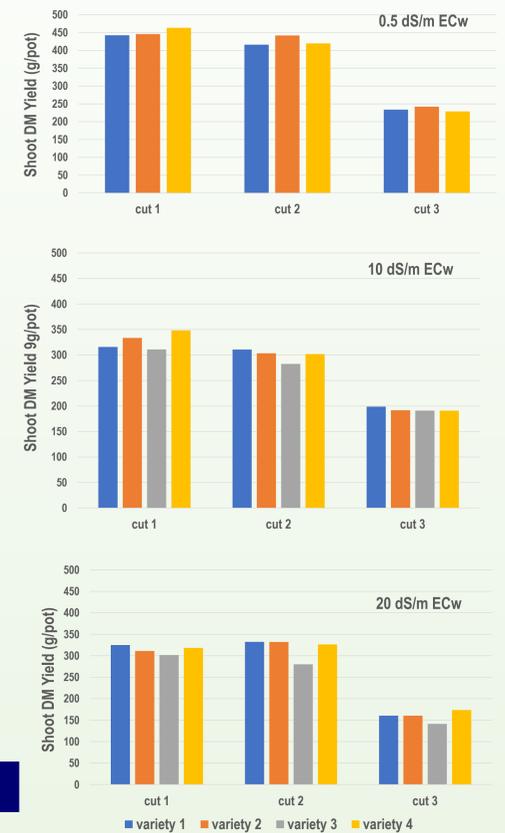


Fig. 2 Forage Dry Matter Yield (DMY) for cuts. Varieties: CUF 101 (1), AZ 90 (2), B6269 SR (3), B6604-0588F (4) are displayed in the graphs above.

Results

- As compared to the non-saline control (0.5 dS/m), cumulative forage dry matter yield was reduced by 31% at both of the highest salinity levels (15 and 20 dS/m ECw), respectively (Fig. 1).
- There were no significant differences in cumulative shoot DM yield between varieties (Fig. 1), nor in DM yield at each cut (Fig. 2).
- Exposure to a 10 dS/m solution did not have a large effect on seed germination whereas at 20 dS/m ECw, germination was reduced substantially, particularly for varieties 1, 2 and 3.
- Variety 4 (B6604-0588F) had the highest germination percentage at 10 and 20 dS/m ECw (Table 1).

Conclusions and Future Work

- The fritted clay medium used in this experiment provided good drainage, but it did not lend itself well to the preparation of saturated soil pastes for the measurement of soil salinity and it was difficult to establish high salinity in the growing medium which may explain the absence of differences in DM yield amongst the alfalfa varieties exposed to 10, 15 and 20 dS/m EC in the irrigation water. A longer-term experiment with more cuts may also be needed to differentiate variety salt tolerance.
- The pot experiment is being repeated using a 60:40 field soil to sand growing medium which will facilitate the development of higher levels of soil salinity, while maintaining good drainage due to the sand fraction. The experiment will be run from April to September 2022 to allow for 6 cuts of the forage.
- Preliminary results for seed germination indicate that Variety 4 (B6604-0588F) may have superior seed germination at high salinity (10 and 20 dS/m saline solution). A second germination trial is underway.

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