EFFECTS OF HIGH ELECTROCONDUCTIVITY FIELD CONDITIONS ON PRODUCTION OF SIX ALFALFA VARIETIES ON THE COLORADO RIVER INDIAN TRIBES RESERVATION

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Abstract

Five alfalfa varieties were planted and grown under grower conditions on a field section that had high conductivity, while two varieties were planted and grown on a section of the same field much less affected. CUF 101, the variety grown in both areas, was the highest yielding variety in both area. Reduction in CUF 101 hay yield due to high conductivity was approximately one ton/acre in the first year of production, with a large amount of this noted in the first cutting. Yield reductions of CUF 101 due to field area and associated electroconductivity were greater the second year, with an average of 0.29 tons/acre/cutting. Total yield difference for CUF 101 was 1.72 tons/acre for the eight harvests for which data were available. Yield differences between the areas was greatest in the early spring and late fall of the first harvest year, with differences not noted in the June cutting; in year two yield differences were approximately 37% for each cutting. Salado was the second highest yielding variety in the high electroconductivity area in 1998, and equaled CUF 101 in yield from this area in 1999. Sal-T-96 and Leivas Best yielded less than 90% of CUF 101. Sal-T-96 also had the greatest number of weeds, due in part to very slow germination and fewer plants per acre compared with other varieties.

Introduction

Many of the soils on the Colorado River Indian Tribes Reservation used for alfalfa production lie in the Colorado River flood plain and have the potential to be saline (defined as electroconductivity of saturation extract greater than 10 millimhos). These salts are primarily calcium, sodium, magnesium, chloride and sulfate. An excessive amount of soil salts is reported to delay/prevent seed germination and interfere with plant growth. Just recently, a few alfalfa varieties being developed with claims of having some salt tolerance have become available for testing. This field experiment tests five alfalfa varieties for their yield and stand longevity in a high salt content field, and also compares a few alfalfa varieties in non-salt and salty fields areas to determine the extent of the yield reduction.

Methods and Materials

A field located approximately five miles south of Parker, AZ, known for its high electroconductivity on the Colorado River Indian Tribes Reservation was chosen for this experiment. Soil types in the experimental areas consisting of

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approximately 50% Gilman fine sandy loam, 35% Gilman clay loam, and 15% Agualt-Cibola sandy loam. A surface soil sample was obtained of the top three inches of soil just prior to planting from six sites in each replicate, with three samples being combined to form two composite samples (north and south halves) for each replicate.

All varieties for the salt portion and check plots of these tests were planted Nov. 25, 1997 with a Brillion planter (12 foot wide). Magna 9 plots (non-salt section of the field) were planted Nov. 20. All plots were 24 ft wide, with those in the salt area 1.233 ft long (0.679 acres) while those in the non-salt area were 1,166 ft long (0.642 acres). All varieties were replicated four times in a randomized complete block design. The field was watered on Nov. 26 to begin germination, with Eptam7E also added to the irrigation/germination water for weed control.

Plots were cut six times during 1998. After curing and baling, bales in each plot were counted and several bales weighed to obtain bale weight average for each plot. Yields per acre were then calculated. Exceptions to this protocol were the September cutting when high weed infestations and illness precluded data collection, and the November cutting when average field bale weight was used for calculations.

Plant populations were obtained on June 1-2, 1998, by placing a 2.5 ft^2 (19 x 19 inch) square in five locations in each plot, and counting number of plants (crowns) per acre. No data were obtained from the non-salt area. Soil samples were collected from each plot in both the high (salty) and low (non-salt) electroconductivity areas during June 10-17, 1998. Samples consisted of 20 soil cores/plot using a JMC soil sampler, and creating composite samples for each of the four sampling depths (0-6 inches, 6-12 inches, 12-24 inches, 24-36 inches) for each plot. Samples were later analyzed for pH, total dissolved salts (in parts/million), electroconductivity, and sodium content at the University of Arizona Maricopa Agricultural Center.

Several bales from each plot were cored using a Utah sampler. Samples from each varietal plot in the salt affected area were kept separate; however, composite samples were made for each of the two varieties in the non-salt affected area. Samples were analyzed using near-infrared (NIR) technique by Stanworth Consulting, Blythe, CA.

Weed infestations were estimated for each plot on August 27, 1998, by determining the percent of plot area infested with visible weeds (primarily sprangletop).

During 1999, data were collected from only three cuttings (March, May, June). The July cutting was moved prior to baling by high winds which moved windrows which made determinations of plot yields difficult. The August cutting was unable to be normally baled due to injury to the grower cooperator who was also harvest equipment operator; alfalfa regrowth and weeds had almost completely hidden windrows making it very difficult to obtain accurate data collection. As yields were below economic return, the field was disced in the fall of 1999, ending the experiment.

Data were primarily analyzed by analysis of variance and means separation; correlation testing was also completed for numerous variables.

RESULTS

Average ECe for the top three inches of top soil field was 16.9 in the salty area of the field, which would be expected to greatly affect yield if the entire root zone was at this level. The winter of 1997-1998 was an El Niño year, however, resulting in much higher than normal rainfall. An area weather station recorded 0.83, 0.16 and 2.84 inches of rainfall for December 1997, January 1998 and February 1998 respectively (total of 3.84 inches), equivalent to an entire year of average rainfall for the area. This rainfall probably helped to leach salts down from the soil surface and allowed improved stands and yields compared with an average year when the only significant amounts of water would be applied through surface irrigation waters from the Colorado River (ECe of approximately 1.8). Temperatures were also below normal from April-June.

Differences in variety emergence was noted on Dec. 29, 1997. Plots of CUF 101 looked green and this variety was considered the best established on this date, followed closely by Leivas Best (a local selection out of CUF 101 by the grower cooperator, Roy Leivas). The next tier of varieties were WL 525 HQ, Salado and Salado + Rhizocote XL. Sal-T-96 did not have much, if any, germination and plots appeared as bare ground. In the non-salt area, CUF 101 was also the quickest established variety, with Magna 9 plots not appearing quite as green.

1998 Results

Greatest reduction in yield between salt and non-salt areas during the first year of production was in the first cutting, when yield differences averaged 0.55 tons/acre. Mean yields from the two field areas were almost identical for the June 30 cutting. No significant differences existed for quality factors (Table 2), although higher relative feed values were generally noted for those replicates having higher salt levels, but these also had reduced yields.

June yields in the salt affected area during the first production year were most highly correlated ($r=-0.68$, $p<2.4\times10^{-4}$) with the ECe of the soil at 12-24 inches in depth when sampled in mid-June, July yields were most highly correlated with ECe at the 24-36 inch depth ($r=-0.66$, $p<3.9\times10^{-4}$) from this sampling date. Soil profile ECe was much lower in June than the preplant top soil measurements, with average ECe being 2.43, 4.87, 6.24 and 7.23 for the 0-6, 6-12, 12-24 and 24-36 inch depths respectively in the salty area, and were also lower at the same depths of the non-salt affected area (0.99, 3.22, 4.32, 4.64).

Wheel traffic also damaged certain varieties, primarily Salado. This led to increased weed presence, especially in wheel tracks. Weeds were also very prevalent in plots of Sal-T-96.

1999 Results

Yields from all plots was much lower than in 1998. This may have been due to salt accumulations and lack of rainfall to dilute such, unlike the previous winter when rainfall greatly exceeded normal. Yields from the salty area averaged were more than 60% less than the same time period of 1998; however, those from the less affected area were also reduced by almost 50% compared with 1998.

CUF 101 yielded averaged about 37% less in the salty area compared to CUF 101 yields in the less affected area in 1999. Unlike the previous year, the differences remained fairly constant on a percentage basis (34.7-41.5%) for the three cuttings for which data were obtained.

CUF 101, the highest yielding variety in the salt affected area of the field in 1998, tied with Salado for 1999. Sal-T-96 was the next highest yielding variety, and also had much better yields comparatively in 1999 (96.1% of CUF 101) than in 1998 (84.3%). It may be that Sal-T-96 has more fall dormancy than the other varieties in this experiment, which may help explain the slow germination and growth noted for this variety. Fall dormancy ratings for Sal-T-96 were not available at planting, however when more dormant alfalfa varieties (fall dormancy classes 7 adn 8) are planted later in the year (late November) than optimal (mid-October) for this area, differences in emergence and growth due to differences in fall dormancy are more pronounced. Yields of Leivas Best were the lowest each year.

In the section of the field that was less salt affected, yields of Magna 9 which were very similar to those of CUF 101 in 1998 (99.2%), were only 88.9% of this variety in 1999 and 96.5% over the experimental period. Magna 9 averaged slighlty over 1.09 tons of hay per cutting, while CUF 101 averaged slightly over 1.13 tons/cutting.

Table 1. First year (1998) mean alfalfa variety hay yields and comparisons by field area.

Variety	1st Cut[1] April 20	2nd cut May 26	3rd cut June 30	4th cut July 30	5th cut Sept. 17	6th cut Nov. 5	Total yield	% of Cuf 101
(Salty area of field)								
CUF 101	0.81 bc	1.72ab	1.64a	0.94abc	*DATA*	0.68 bc	5.79	100.0
WL525HQ	0.80 bc	1.57ab	1.49a	0.90abc	*NOT*	0.62 c	5.38	92.9
SALADO	0.91 b	1.69ab	1.56a	0.79 bc	*OBTAINED*	0.58 c	5.53	95.5
LEIVAS BEST	0.51 c	1.48ab	1.33a	0.99abc	*DUE TO*	0.61 bc	4.92	85.0
SAL-T-96	0.64 c	1.44 b	1.48a	0.83 bc	*WEEDS*	0.49 c	4.88	84.3
SALADO + RHIZOCOTE XL	0.93 b	1.64ab	1.47a	0.73 c	*AND*	0.46 c	5.23	90.3
(non-salty area)								
MAGNA 9	1.37a	1.84a	1.52a	1.03ab	*ILLNESS*	0.85ab	6.61	99.2
CUF 101	1.27a	1.85a	1.54a	1.10a		0.90a	6.66	100.0
COMPARISON OF CUF 101 FROM SALTY AREA TO NON-SALTY AREA								
YIELD (Tons/acre)	- 0.46	- 0.13	+ 0.10	-0.16		-0.22	-0.87	
% DIFFERENCE	- 36.2	- 7.0	+ 6.5	-14.5		-24.4	-13.1	
VALUE ($/acre)	- 50.14	- 13.91	+ 8.50	-10.40		-18.92	-84.87	

[1] Means in columns followed by the same letter are not significantly different at the P≤0.05 level.

Table 2. Second year (1999) yield data (tons/acre) and 1998-1999 totals

Variety	1st Cut[1] March 20	2nd cut May 13	3rd cut June 30	Sum	% of CUF 101	1998 Yield	Total yield	% of Cuf 101
(Salty area of field)								
CUF 101	0.31a	0.62a	0.60ab	1.54a	100.0	5.79	7.33	100.0
WL 525 HQ	0.21a	0.52ab	0.59ab	1.33ab	86.3	5.38	6.73	91.8
SALADO	0.27a	0.65a	0.61ab	1.53a	99.9	5.53	7.06	96.4
LEIVAS BEST	0.21a	0.48 b	0.51 b	1.20 b	78.3	4.92	5.82	79.4
SAL-T-96	0.26a	0.60a	0.62ab	1.48a	96.1	4.88	6.35	86.7
SALADO + RHIZOCOTE XL	0.22a	0.56ab	0.64a	1.42ab	92.1	5.23	6.64	90.6
(non-salty area)								
MAGNA 9	0.45a	0.81 b	0.89 b	2.16 b	88.7	6.61	8.77	96.5
CUF 101	0.53a	0.95a	0.95a	2.43a	100.0	6.66	9.09	100.0
YIELD REDUCTION OF CUF 101 IN SALTY AREA COMPARED WITH NON-SALTY AREA								
YIELD DIFFERENCE	0.22	0.33	0.35	0.87		0.85	1.72	
% Difference	-41.5	-34.7	-36.8	-36.6		-13.1	-19.4	

[1]Significant differences existed between field areas. Means in sub-columns (same field area) followed by the same letter are not significantly different at the P≤0.05 level.

Table 3. Mean quality measurements, plant stands (June 1998), weed infestation, and lbs/acre of seed planted (Nov. 1997).

Variety	Lbs. planted per acre	Plants/acre[1] June 1, 1998	Hay quality - June 30, 1998 cutting[1] % Protein[2]	A.D.F[2]	TDN[3]	RFV	Aug. 27, Mean % Weed Infestation[1]
(Salty area of field)							
CUF 101	22.1	942,235a	18.8 a	30.8 a	53.3 a	152.6a	2.25a
WL 525 HQ	22.75	805,664ab	19.85a	28.65a	54.75a	163.8a	3.25a
SALADO	15.1	761,441 b	18.85a	31.15a	53.1 a	150.55a	17.5 a
LEIVAS BEST	22.1	938,534a	19.65a	29.15a	54.4 a	165.0a	1.5 a
SAL-T-96	20.6	519,420 c	20.05a	30.85a	53.3 a	151.9a	41.75 b
SALADO + RHIZOCOTE XL	19.9	719,630 b	18.8 a	30.85a	53.25a	151.9a	11.25a
(non-salty area)							
MAGNA 9	21.6	no data	18.7	29.7	54.1	162.4	0.0 a
CUF 101	22.1	no data	18.1	30.1	53.8	156.4	0.0a

[1] Means in columns followed by the same letter are not significantly different at the $P \leq 0.01$ level.
[2] 100% dry matter basis
[3] 90% dry matter basis