TECHNICAL NOTES

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Review of poster "Biomass Production & Nutritional Value of Salt-tolerant Forages Irrigated with Saline-sodic Drainage Water: field and greenhouse studies"

Attached is an information poster titled "Biomass production & nutritional value of salt-tolerant forages irrigated with saline-sodic drainage water: field and greenhouse studies". The information in this poster was developed by staff from California State University - Fresno, University of California – Davis, and USDA-ARS – salinity laboratory.

This information poster provides a source of information and background for personnel who are providing forage alternatives to land owners who have high saline-sodic conditions. USDA-NRCS Plant Material Program cultivars 'Jose' tall wheatgrass, 'Rio' beardless wildrye and 'Solado' alkali sacaton were evaluated for forage use; moreover, the information provided documents cultivar performance quantitatively.

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Biomass Production & Nutritional Value of Salt-tolerant Forages Irrigated with Saline-sodic Drainage Water: field and greenhouse studies

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Introduction

Drainage management is a major challenge for agriculture on the Westside San Joaquin Valley (SJV). Subsurface drainage systems are often needed to control salinity and boron in the root zone, and to lower perched water tables, but their use is limited due to wildlife hazards associated with selenium in the drainage water (DW).

Re-use of saline DW for the irrigation of salt tolerant plants is a promising, on-farm, practice to reduce the volume of drainage collected and to facilitate its disposal. With increasing animal production in the valley, forage production using saline-sodic drainage water is a potential source of revenue.

Evaluation criteria for forages for DW re-use systems, such as IFDM, include:

-- salinity and boron tolerance
-- productivity and water use in saline conditions
-- nutritional value for animal feeds
-- tolerance to poorly-aerated soils with tough surface crusts
-- climatic adaptability

Several salt tolerant forages performed well under DW irrigation in a sand tank study at the USDA George E. Brown Salinity lab in Riverside (USSL). Some of these forages are also being evaluated in large field plots at Red Rock Ranch (RRR) in Five Points, CA where forage performance may be different due to the poor physical conditions of the cracking clay soil (Photo 1) and hotter, drier field conditions.

Due to the large variation in soil salinity from one forage stand to another at RRR, a greenhouse study was also begun to evaluate the more promising forages in a field soil mix under more uniform and controlled soil conditions.

Objectives

- Identify and characterize a group of salt tolerant forages suitable for long term irrigation with saline-sodic drainage water.
- Assess the nutritional value and safety of these forages for animal production.

Materials and Methods

Field at Red Rock Ranch (Five Points)

Six salt tolerant forages:

DW-irrigated	*Re-use Stage**
'Jose' tall wheatgrass (JTW) (*Agropyron elongatum*)	2 & 3
Creeping wildrye (CWR) (*Leymus triticoides* var. *'Rio'*)	2 & 3
'Alta' tall fescue (ATF) (*Festuca arundinacea*)	3
Alkali sacaton (AS) (*Sporobolus airoides* var.*'solado')*	3
Puccinellia *(Puccinellia ciliata)*	3
Freshwater-irrigated	
Salt tolerant alfalfa (ST alfalfa)	1

**In the sequential re-use system at RRR, Stage 1 = freshwater irrigated, Stage 2 = first re-use of drainage water and Stage 3 = second re-use.*

Productivity was measured using a rotational cutting system in which the entire forage plot (Photo. 2) was initially cut to 6 inches and then cuts were taken in 1 m2 sub-plots when the stand reached 12 in., 18 in., and its final height prior to heading, or flowering for alfalfa.

Organic forage was measured as metabolizable energy (ME in megajoules/kg DM) using a rumen fluid gas test; and as crude protein (CP), neutral and acid detergent fiber (NDF & ADF) and ash, using standard lab procedures.

Mineral analyses (Ca, Mg, P, S, Na, Cl, B, Se, NO3) were conducted at the UC-DANR Analytical lab, Davis, CA, using standard analytical procedures.

Greenhouse Study at CSU Fresno

Five salt-tolerant forages:

'Jose' tall wheatgrass (*A. elongatum var. 'Jose'*)
Creeping wildrye (*L. triticoides var. 'Rio'*)
Salt tolerant alfalfa (*Medicago sativum var. 'Salado'*)
Paspalum (*Paspalum vaginatum* var.*'Sealsle 1'*)
Bermudagrass (*Cynodon dactylum var. 'Giant'*).

Three water qualities:

Tap water --------- EC = 0.5 dS/m
Low saline*-------- EC = 8-10 dS/m
High saline*-------- EC = 18-20 dS/m

**Concentrated drainage water (45 dS/m) collected from the solar concentrator at RRR was diluted to make saline water*

Using a randomized complete block design, forages are grown in large pots (12 in. diam. x 14 in ht.; Photo. 3) filled with a 60:40 mix of field soil and sand. Sand is needed for adequate drainage.

Cumulative biomass and forage quality (organic and inorganic) will be measured and compared to results from the sand tank study at USSL and field plots at RRR. Forages will be cut less frequently than in the sand tank study to better represent forage management in an IFDM system.

Results

Forage Biomass Production

Creeping wildrye growing in less saline fields (ECe = 12.5 and 11.4 dS/m) produced more than 10,000 kg DM / ha over the one-year period. *'Jose'* Tall Wheatgrass had good production (> 8,000 kg DM/ha) in the better of the two fields **(Fig. 1)**. Insufficient irrigation was the likely cause of the poor production of the tall wheatgrass in the second field.

Forage Ions

Sodium, sulfur, boron, selenium, and nitrate were generally higher and calcium, magnesium, and phosphorus were generally lower in the grass forages irrigated with DW as compared to salt tolerant alfalfa irrigated with freshwater. Nitrate concentrations in DW-irrigated forages were below 200 ppm NO3-N, a safe range for animal feeding, but nitrate will continue to be monitored. Except for CWR, selenium levels were high (4 to 8.7 ppm (mg/kg DW)) in the DW-irrigated forages, presumably due to the very high Se concentration of RRR DW (0.8 to 1.2 ppm (mg/L)) **(Table 1)**.

Forage Quality

(A) with the exception of alkali sacaton (AS), the metabolizable energy (ME) of the DW-irrigated forages was between 7 and 10 MJ/ kg DM, a range considered to be "medium quality" for most cattle. Less than 7 MJ/.kg DM is not acceptable for dairy cow feeding. **(B)** ST alfalfa and Puccinellia had the highest crude protein (26.5% and 25%) and alkali sacaton (AS) had the lowest. **(C) & (D)** ST alfalfa, a legume, had lowest NDF (31%) as compared to most of the grass forages, except '*Alta*' tall fescue (ATF), which had NDF > 50% of NDF. Low NDF is desirable. Ash percentages were between 8.5 and 11.5%, and were not increased in the DW-irrigated forages as compared to ST alfalfa **(Fig 2)**.

Conclusions and Future Work

With the exception of alkali sacaton, the grass forages irrigated with saline drainage water at RRR have acceptable biomass production and organic forage quality. Calcium levels, however, are low.

'Jose' Tall Wheatgrass is a top candidate because growing in a very saline field (19 dS/m ECe), it had high forage quality (ME > 9 MJ / kg DM) and acceptable biomass production. Its low productivity in the weaker stand was probably due to insufficient irrigation.

Creeping wildrye is another good candidate for DW re-use systems based on its high biomass production (> 10,000 kg DM/ ha) and acceptable forage quality.

These two forages will be tested against bermudagrass and Paspalum in the greenhouse study.

Photo. 1. Creeping wildrye plug transplanted into saline soil in Stage 2 at RRR. ECe = about 12 dS/m ECe.

Photo. 2. Field plot of salt tolerant alfalfa at RRR. Within plots, forages are rotationally cut in 1 m^2 sub-plots until heading (grasses) or flowering (alfalfa).

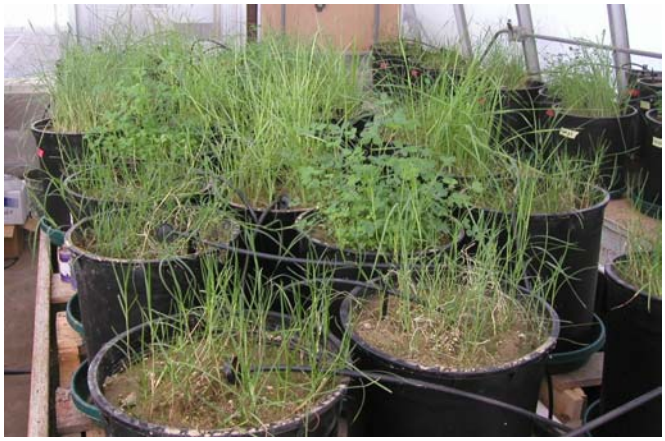


Photo. 3. Forages shortly after transplanting in greenhouse study at CSUF. Pots are irrigated by a drip system, and drainage water is re-circulated back to the source tank.

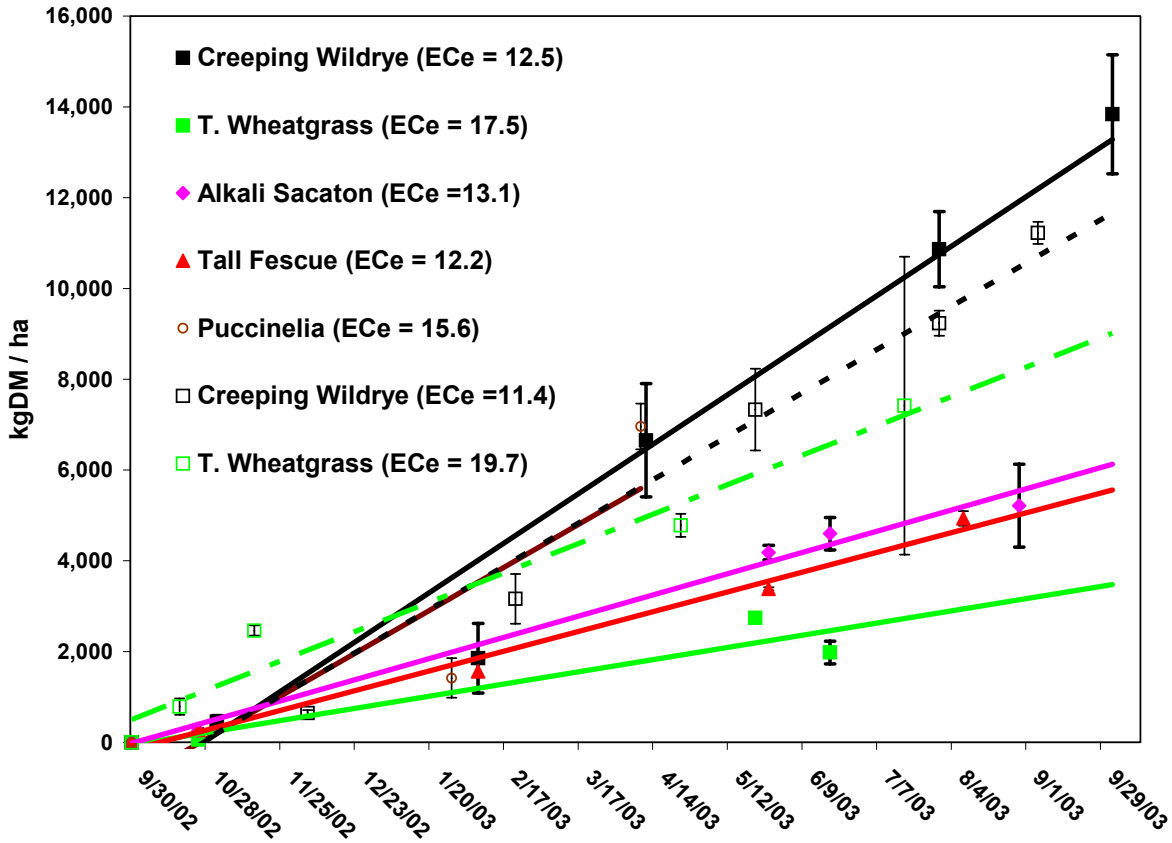
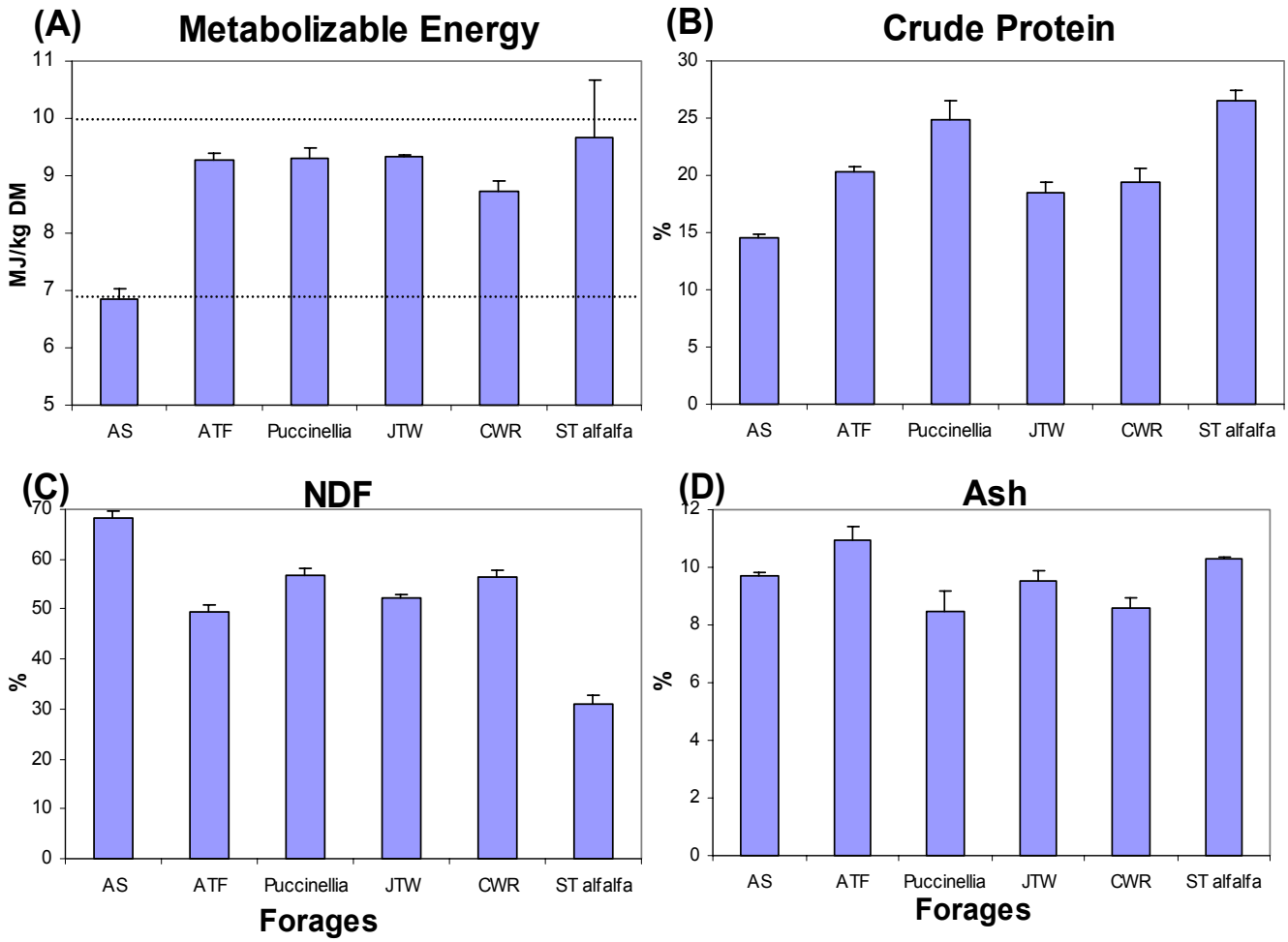


Fig. 1. Forage Dry Matter Production from Sept. 2002 to 2003.

Forage	Soil Salinity (ECe)	Na (%)	Cl %	S %	B ppm	Se ppm	NO_3-N ppm	Ca %	Mg %	P %
JTW	19.7	1.35	1.26	0.47	718	6.27	67.5	0.30	0.17	0.12
JTW	17.5	1.03	1.05	0.51	680	8.67	125	0.34	0.20	0.22
Puccinellia	15.6	0.68	1.36	0.40	60	4.98	175	0.34	0.14	0.24
ATF	12.2	1.25	1.19	0.57	790	6.05	128	0.41	0.20	0.18
CWR	11.4	0.10	1.26	0.25	50	0.78	180	0.41	0.12	0.22
CWR	12.5	0.42	0.80	0.49	333	8.65	72.5	0.43	0.16	0.14
AS	13.1	0.32	1.09	0.54	315	4.28	75.0	0.72	0.25	0.12
ST alfalfa	3.7	0.52	1.00	0.40	115	0.84	27.5	1.66	0.24	0.25
" "	5.1	0.59	1.01	0.38	125	0.97	22.5	1.61	0.23	0.28

Table 1. Ion composition of forages sampled in the fall/winter (2002-2003) period.



<u>Fig. 2</u>. Forage Quality in field plots at RRR, Oct. 2002 to Feb. 2003. All were DW-irrigated with the exception of the ST alfalfa which was freshwater-irrigated.