2021 Final Research Report

from the

East Central Research Foundation

Project Title: Establishing Salt Tolerant Forages
ADOPT# 20200423
SCA# 2020-069

Principal Investigators:

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Project Identification

1. **Project Number: Adopt#** 20200423; **SCA#** 2020-069
2. **Producer Group Sponsoring the Project:** Saskatchewan Cattleman's Association
3. **Project Location(s):** Yorkton, SK
4. **Project start and end dates (month & year):** September 2020 to February 2022
5. **Project contact person & contact details:**

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Objectives and Rationale

6. **Project objectives:**
   The objective is to compare the establishment and biomass production of various forage species when fall dormant seeded on saline soil. Salt tolerant species such as Barricade alfalfa, AC Saltlander green wheatgrass and tall wheatgrass were compared against conventional non-saline tolerant species such as smooth bromegrass and 4030 alfalfa. The goal was to demonstrate which species are best suited to provide ground cover and forage on saline soils where annual crop production is not productive and uneconomical.

7. **Project Rationale:**

   Approximately, 5.52 million acres or 11.2 percent of agricultural land in Saskatchewan are at moderate to high risk of salinization. Increasing soil salinity is a threat to producers as these areas are unproductive and often uneconomical for grain crop farming. Saline areas can continue to grow or harbor significant weed issues such as herbicide resistant kochia or foxtail barley if a crop cannot be established. It can be difficult or expensive to correct saline soils and often the best approach is to establish forage in these areas. A number of perennial forage varieties tolerant to saline soils have been developed. However, the proper forage selection will depend on the level of salinity and flooding intensity of the site among other factors.

   AC Saltlander is a variety of green wheatgrass developed by the Semiarid Prairie Agricultural Research Centre at Swift Current, which has salinity tolerance similar to tall wheatgrass[1]. Green wheatgrass has better forage quality than tall wheatgrass and is more palatable. It is well suited for pasture and hayland. Tall wheatgrass is only suited for hayland however, it is more tolerant to spring flooding than green wheatgrass which is an issue for many saline areas. Alfalfa is less tolerant of saline soils but varieties with greater salt tolerance have been developed. Three such varieties include Halo, Barricade and Bridgeview. Barricade was used in this study.

The salinity in saline soils can vary from slight to very severe within a few metres[2]. As a result seeding a mixture of species with differing salinity tolerances may increase the productivity of the stand[1]. It may also help to include deep rooted species such as alfalfa to draw down soil water levels and reduce the flow of salts to the surface[1].

The salinity tolerance of forage species tends to increase once established. However, it is difficult to establish stands as seed tends to not germinate well in dry saline soil. Seeds are more likely to germinate when soil moisture is high because the moisture dilutes the salinity, but wet soils do not support seeding equipment. Fall dormant seeding just prior to freeze up may be a better option[1], as the soil is dry enough to support equipment and the seed will not try to germinate until spring when moisture levels are higher.

[1]Revegetation of saline soils using salt tolerant grasses. Sask Forage Council. http://www.saskforage.ca/images/pdfs/Publications/Salinity%20factsheet%20final%20low%20res.pdf
[2]Top Crop Manager Salinity solutions https://www.topcropmanager.com/salinity-solutions-15902/

8. Methodology:

A trial site near Yorkton was found in late summer of 2020. Soil test results from the highly saline and moderately saline portions of the trial site can be found in Figures A and B of the appendix. Both areas had very high background levels of macronutrients as these areas have been unproductive for a long time (Appendix). The demonstration was established as an RCBD with 2 replicates and was seeded using a 10 foot Seedmaster drill on 12 inch row spacing (Figure 1). Plot width was 11 feet and length was about 70 feet to adequately traverse soil with varying salinity. Figure 2 shows the trial shortly after plots were seeded on October 23, 2020. The white powder in the picture is snow, not salt. The land on the right side of the picture is very saline and little to no plant material had been growing in this area. As plots move towards the back of the picture salinity decreases into the barley stubble.

Forage species were dormant seeded without fertilizer. Their seeding rates and combinations are listed in Table 1. Table 2 lists the dates of operations. Stand assessments on June 18 revealed that none of the alfalfa had survived and much of the trial was starting to have weed control issues. In response, the trial was sprayed with Prestige for broadleaf weed control. While this did provide adequate control of broadleaf weeds, foxtail barley pressures were extremely high in the less saline portion of the trial. As a result, stand assessments of the dormant seeded forages were not taken from areas infested with foxtail barley. Stand assessments were focussed on the area between the foxtail barley to the north and highly saline “dead zone” to the south. Forage biomass was determined by hand clipping established perennial forage grass species within several one metre square quadrats per plot on July 21, 2021. Plant material was then dried to determine dry matter yields. The whole trial area was then sprayed out with glyphosate in fall to control the foxtail barley for the cooperating producer.

Table 1. Treatment list for dormant seeded forages on saline soil		
Trt#	**Forage Specie(s)**	**Seeding rate(s)- lb/ac**
1	AC Saltlander Green Wheatgrass	10
2	Tall Wheatgrass	12
3	Carlton Smooth bromegrass	8
4	Barricade alfalfa (salt tolerant)	6
5	4030 Alfalfa (conventional)	6
6	AC Saltlander Green Wheatgrass + Barricade Alfalfa	5 + 3
7	Carlton Smooth bromegrass + 4030 Alfalfa	4 + 3

Table 2. Dates of operations for the 2020 and 2021"Establishing Salt Tolerant Forages" trial.	
Operations in 2020	Yorkton
Pre-seed Herbicide Application	none
Seeding Date	Oct 23, 2020
Emergence Counts	June 28, 2021
In-crop Herbicide	June 18, 2021 (Prestige)
Forage Biomass Harvest	July 21, 2021


Figure 1.
SEED MASTER


Figure 2. Trial site shortly after seeding on October 23, 2020

9. Results:

Growing Season Weather

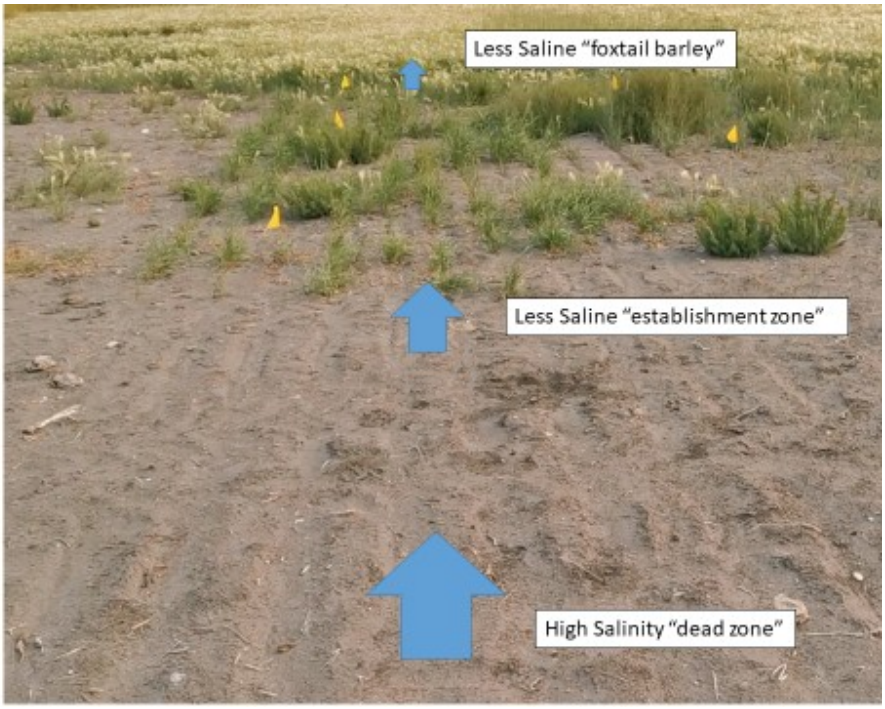
Mean monthly temperatures and precipitation amounts for Yorkton are listed in Table 3. Monthly temperatures were above the long-term average. Precipitation was well below the long-term average and soil moisture reserves were depleted.

Table 3. Mean monthly temperatures and precipitation amounts for 2021 along with long-term normals (1981-2010) for Yorkton in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		----------*Mean Temperature (°C)* ----------				
Yorkton	2021	8.9	19.1	21.0	17.3	16.5
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***
		---------- *Precipitation (mm)* ----------				
Yorkton	2021	24.6	18.1	35.2	69.7	147.6
	Long-term	***51***	***80***	***78***	***62***	***272***

As stated in the materials and methods, the alfalfa did not survive the dormant seeding. Thus the whole trial was sprayed with prestige to control broadleaf weeds. Unfortunately, there was no way to control the foxtail barley, which was growing very heavily in the less saline portion of the trial. Stand assessments were not taken within the foxtail barley because of the heavy competition and difficulty to separate grass species. However, stand assessments were done in the "establishment zone" between the foxtail barley area and the very saline "dead zone" where no dormant seeded forages survived (Figure 3).

Figure 3. AC Saltlander seeded at 10 lb/ac



Since the alfalfa did not establish, this provided an opportunity to compare seeding rates for some of the perennial grass forages. While there are some substantial differences between treatments, statistics have not been shown for either the emergence or yield data as 2 replicates does not provide much power to detect differences. The emergence and forage yield for Carlton smooth bromegrass and AC Saltlander were highest at their higher seeding rates (Figures 4 and 5). Tall wheatgrass (Figure 6) provided the most dry matter, followed by AC Saltlander (Figure 7) and then Carlton smooth bromegrass (Figure 8). The bromegrass was expected to be lower yielding as it does not have as high a resistance to salinity. While data was not taken from the foxtail barley area, the Tall wheatgrass was competing with the foxtail barley and grew above it (Figure 9). AC saltlander was also present but did not grow above the foxtail barley canopy.

Figure 4. Emergence (plants/m^2) of dormant seeded perennial grasses grown on saline soil (establishment year)

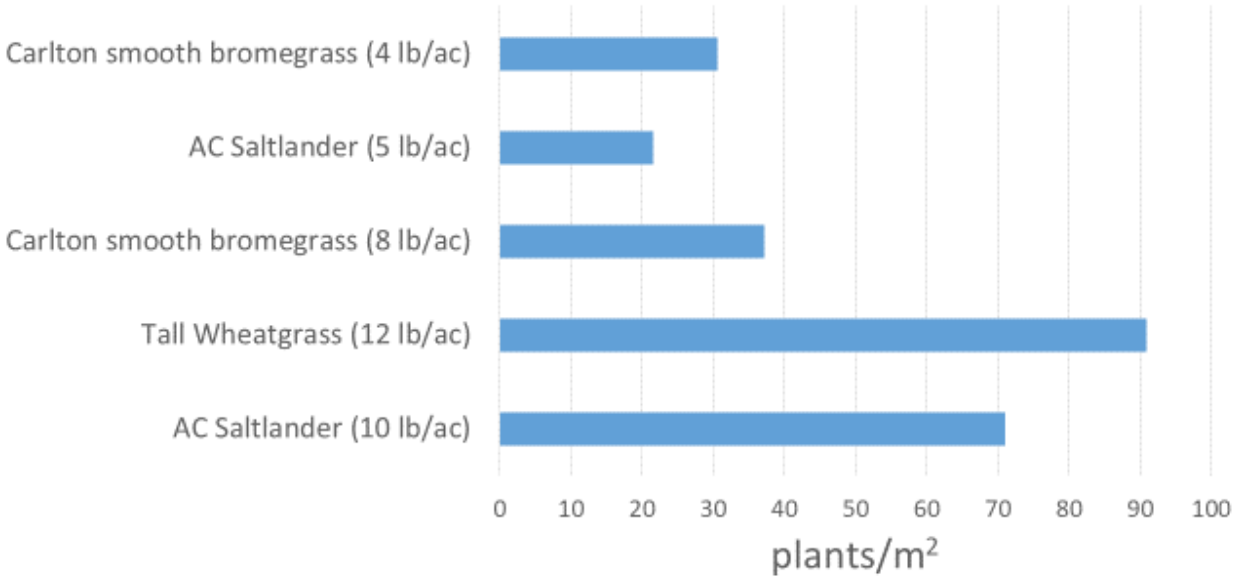


Figure 5. Dry Weight yields (kg/ha) of dormant seeded perennial grasses grown on saline soil (establishment year-July 21)

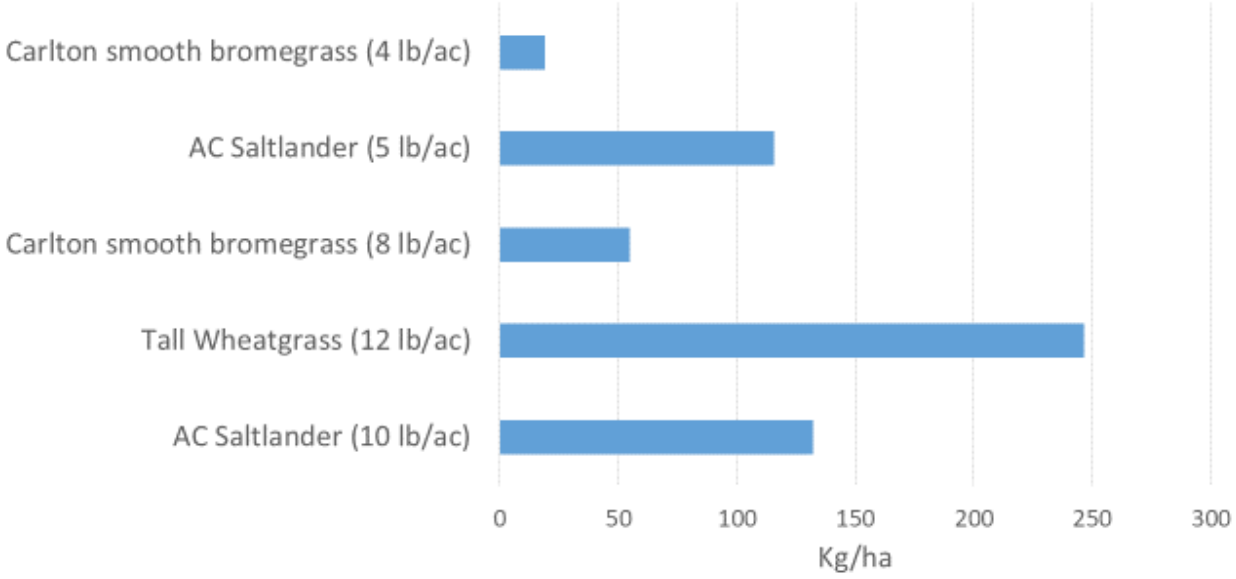


Figure 6. Tall Wheatgrass (12 lb/ac) – in "establishment zone"

Figure 7. AC Saltlander (10 lb/ac)- in the "establishment zone"

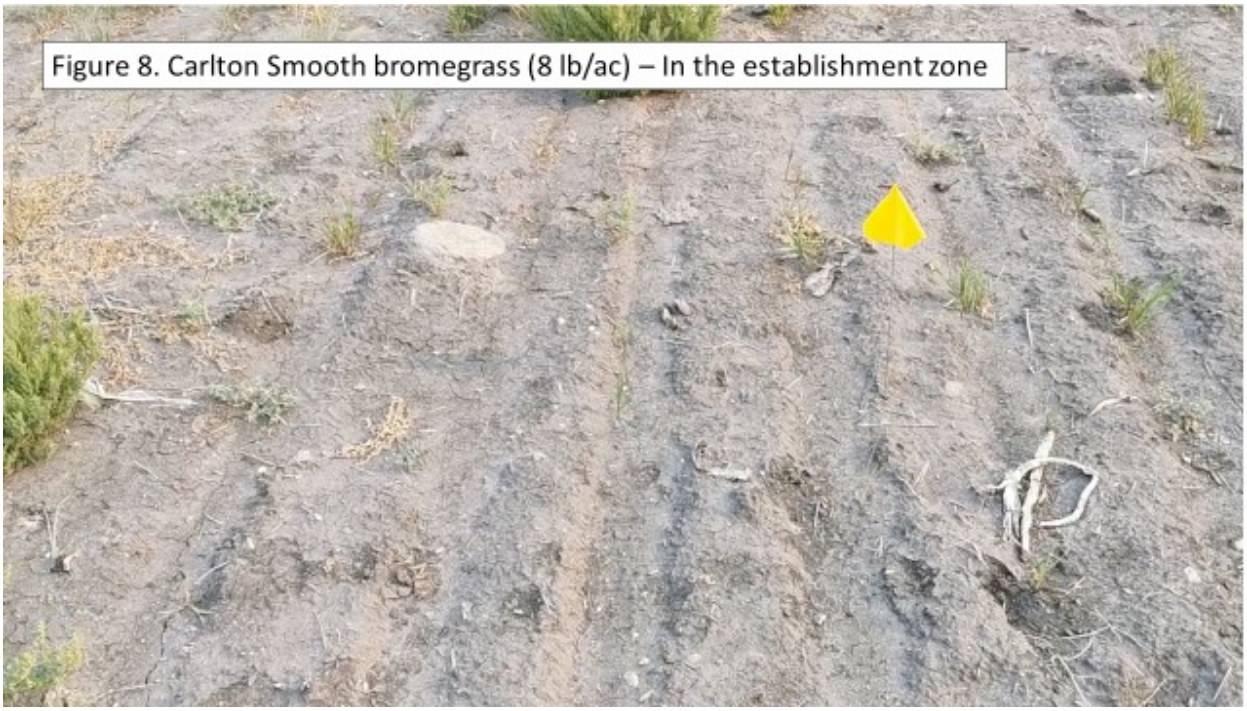


Figure 8. Carlton Smooth bromegrass (8 lb/ac) – In the establishment zone

Figure 9. Tall Wheatgrass (12 lb/ac) – in foxtail barley

10. Conclusions and Recommendations

Dormant seeding of perennial grasses into saline soil was somewhat successful but dormant seeding alfalfa was not. Even "Barricade", the salt tolerant alfalfa variety, could not be established in any portion of the saline area. None of the grass species were successfully established within the most saline area of the field. Within the less saline areas, AC Saltlander and Tall wheatgrass were successfully established. Carlton Smooth Bromegrass was also present in this area but had much less growth relative to the saline tolerant grasses. Within the even lesser saline foxtail barley area, AC Saltlander and particularly Tall wheatgrass had a presence but were under severe competition. It would have been interesting to continue the experiment to determine if either AC Saltlander or Tall wheatgrass species could eventually out compete the foxtail barley given enough time. As foxtail barley is a short-lived perennial that reproduces by seed, perhaps mowing might eventually favour AC Saltlander or Tall wheatgrass by preventing the foxtail barley from setting seed. This study shows the challenge of establishing perennial forage in saline areas. Weed control needs to be part of the plan. Mature foxtail barley must be either cultivated or sprayed out with glyphosate prior to seeding. Despite this, salt tolerant grasses will still need to compete against foxtail barley seedlings. However, past research from Swift Current has shown that AC Saltlander can reduce stands of foxtail barley by 80% given enough time.

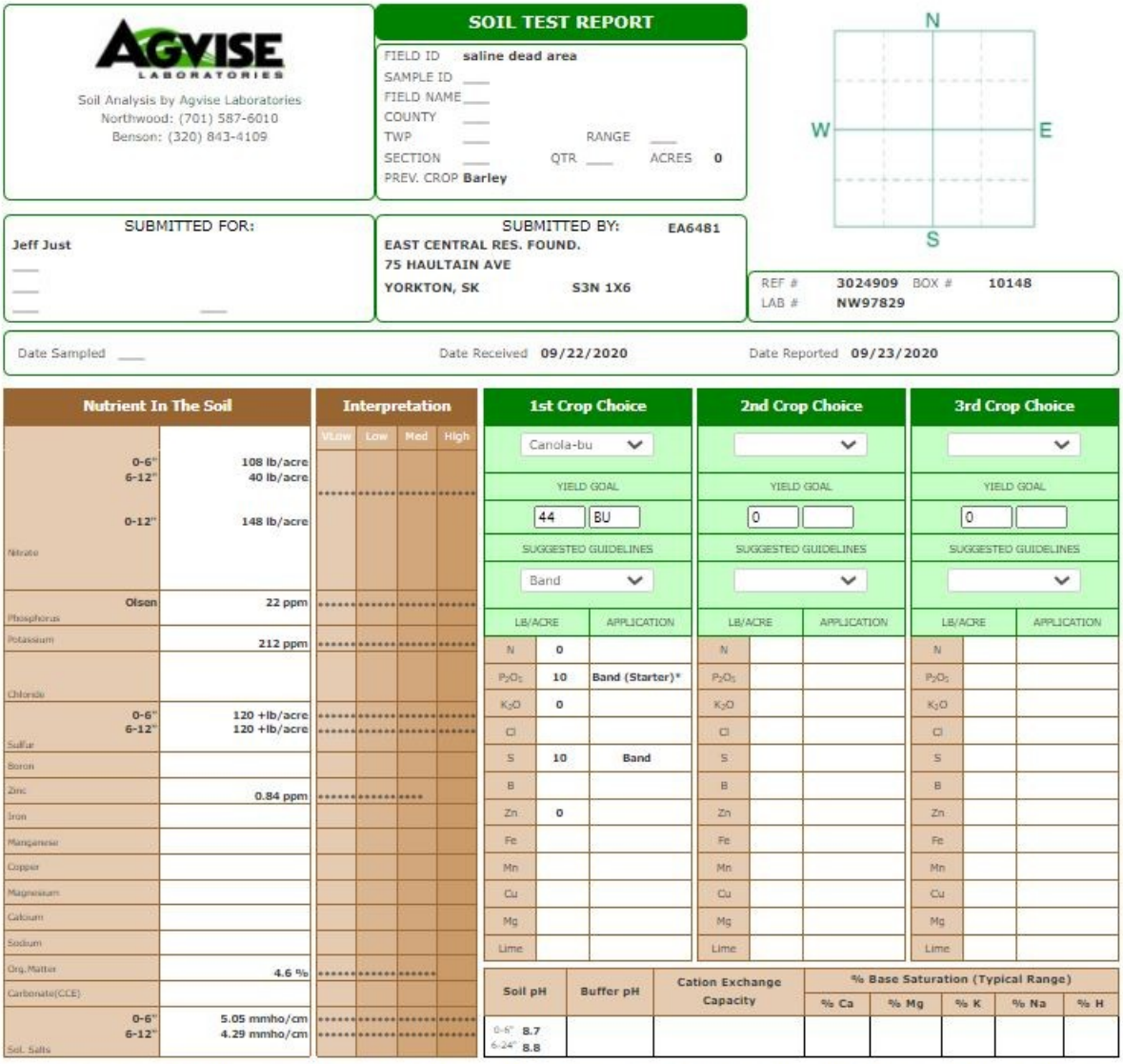
Supporting Information

11. Acknowledgements:

This project was funded through the Agriculture Demonstration of Practices and Technologies ADOPT and Saskatchewan Cattleman's Association.

12. Appendices

Figure A. Soil test results from the fall of 2020 in a highly saline area of the trial.



AGVISE LABORATORIES

Soil Analysis by Agvise Laboratories
Northwood: (701) 587-6010
Benson: (320) 843-4109

SOIL TEST REPORT

FIELD ID saline dead area
SAMPLE ID ___
FIELD NAME ___
COUNTY ___
TWP ___ RANGE ___
SECTION ___ QTR ___ ACRES 0
PREV. CROP Barley

N / W / E / S

SUBMITTED FOR:
Jeff Just

SUBMITTED BY: EA6481
EAST CENTRAL RES. FOUND.
75 HAULTAIN AVE
YORKTON, SK S3N 1X6

REF # 3024909 BOX # 10148
LAB # NW97829

Date Sampled ___ Date Received 09/22/2020 Date Reported 09/23/2020

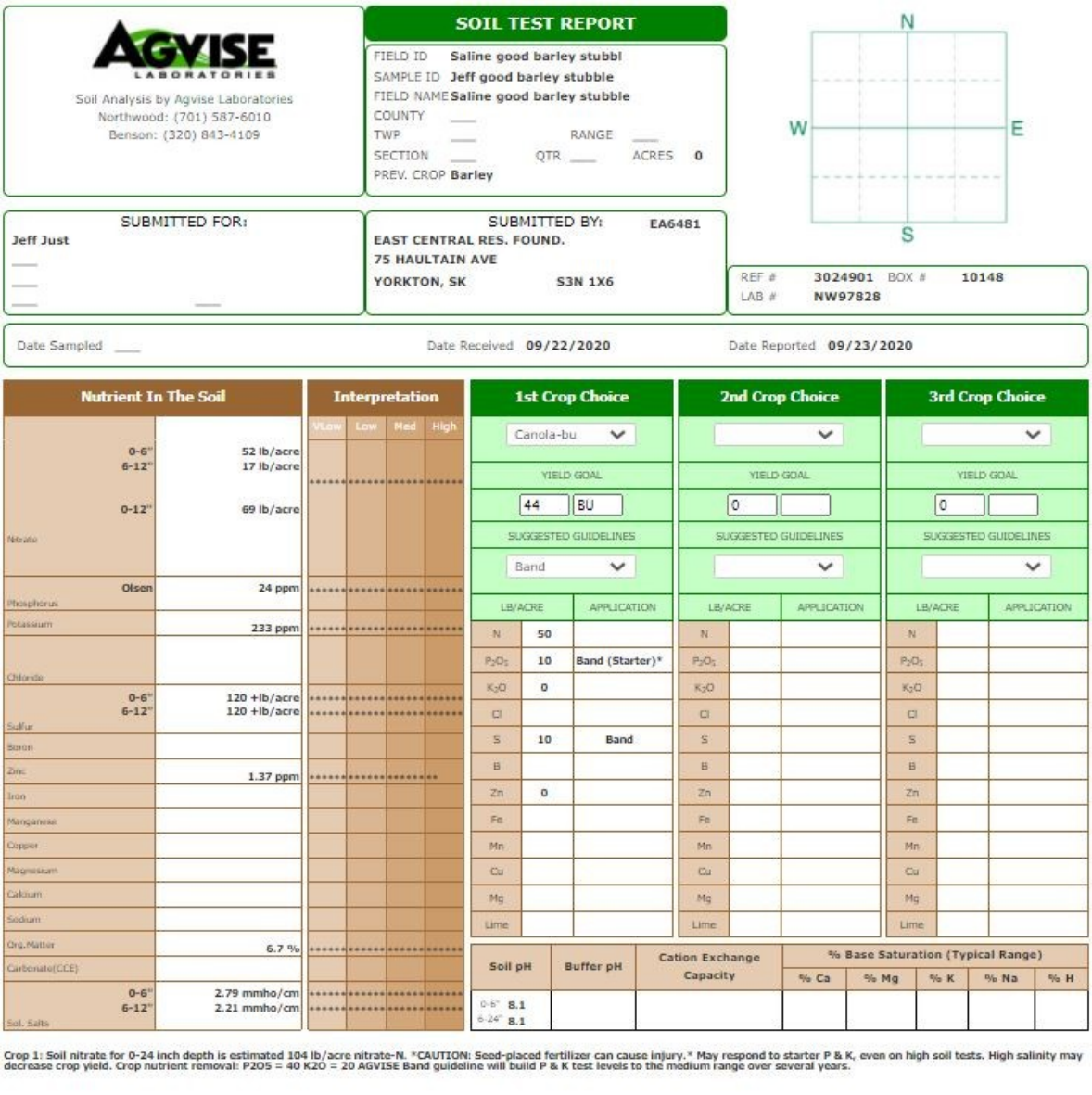
Nutrient In The Soil		Interpretation (VLow / Low / Med / High)
0-6"	108 lb/acre	
6-12"	40 lb/acre	
0-12" Nitrate	148 lb/acre	
Olsen Phosphorus	22 ppm	
Potassium	212 ppm	
Chloride		
0-6"	120 +lb/acre	
6-12" Sulfur	120 +lb/acre	
Boron		
Zinc	0.84 ppm	
Iron		
Manganese		
Copper		
Magnesium		
Calcium		
Sodium		
Org. Matter	4.6 %	
Carbonate(CCE)		
0-6"	5.05 mmho/cm	
6-12" Sol. Salts	4.29 mmho/cm	

1st Crop Choice		2nd Crop Choice		3rd Crop Choice	
Canola-bu					
YIELD GOAL		YIELD GOAL		YIELD GOAL	
44	BU	0		0	
SUGGESTED GUIDELINES		SUGGESTED GUIDELINES		SUGGESTED GUIDELINES	
Band					
LB/ACRE	APPLICATION	LB/ACRE	APPLICATION	LB/ACRE	APPLICATION
N 0		N		N	
P_2O_5 10	Band (Starter)*	P_2O_5		P_2O_5	
K_2O 0		K_2O		K_2O	
Cl		Cl		Cl	
S 10	Band	S		S	
B		B		B	
Zn 0		Zn		Zn	
Fe		Fe		Fe	
Mn		Mn		Mn	
Cu		Cu		Cu	
Mg		Mg		Mg	
Lime		Lime		Lime	

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.7 6-24" 8.8							

Crop 1: Soil nitrate for 0-24 inch depth is estimated 222 lb/acre nitrate-N. *CAUTION: Seed-placed fertilizer can cause injury.* May respond to starter P & K, even on high soil tests. High salinity may decrease crop yield. Crop nutrient removal: P2O5 = 40 K2O = 20 AGVISE Band guideline will build P & K test levels to the medium range over several years.

Figure B. Soil test results from the fall of 2020 in a moderately saline area of the trial.



AGVISE LABORATORIES

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Northwood: (701) 587-6010
Benson: (320) 843-4109

SOIL TEST REPORT

FIELD ID **Saline good barley stubbl**
SAMPLE ID **Jeff good barley stubble**
FIELD NAME **Saline good barley stubble**
COUNTY ___
TWP ___ RANGE ___
SECTION ___ QTR ___ ACRES **0**
PREV. CROP **Barley**

N / W / E / S

SUBMITTED FOR:
Jeff Just
___
___
___ ___

SUBMITTED BY: **EA6481**
EAST CENTRAL RES. FOUND.
75 HAULTAIN AVE
YORKTON, SK **S3N 1X6**

REF # **3024901** BOX # **10148**
LAB # **NW97828**

Date Sampled ___ Date Received **09/22/2020** Date Reported **09/23/2020**

Nutrient In The Soil		Interpretation (VLow / Low / Med / High)
0-6"	52 lb/acre	
6-12"	17 lb/acre	
0-12" Nitrate	69 lb/acre	
Olsen Phosphorus	24 ppm	
Potassium	233 ppm	
Chloride		
0-6"	120 +lb/acre	
6-12" Sulfur	120 +lb/acre	
Boron		
Zinc	1.37 ppm	
Iron		
Manganese		
Copper		
Magnesium		
Calcium		
Sodium		
Org.Matter	6.7 %	
Carbonate(CCE)		
0-6"	2.79 mmho/cm	
6-12" Sol. Salts	2.21 mmho/cm	

1st Crop Choice			2nd Crop Choice			3rd Crop Choice		
Canola-bu								
YIELD GOAL			YIELD GOAL			YIELD GOAL		
44	BU		0			0		
SUGGESTED GUIDELINES			SUGGESTED GUIDELINES			SUGGESTED GUIDELINES		
Band								
LB/ACRE		APPLICATION	LB/ACRE		APPLICATION	LB/ACRE		APPLICATION
N	50		N			N		
P_2O_5	10	Band (Starter)*	P_2O_5			P_2O_5		
K_2O	0		K_2O			K_2O		
Cl			Cl			Cl		
S	10	Band	S			S		
B			B			B		
Zn	0		Zn			Zn		
Fe			Fe			Fe		
Mn			Mn			Mn		
Cu			Cu			Cu		
Mg			Mg			Mg		
Lime			Lime			Lime		

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.1 6-24" 8.1							

Crop 1: Soil nitrate for 0-24 inch depth is estimated 104 lb/acre nitrate-N. *CAUTION: Seed-placed fertilizer can cause injury.* May respond to starter P & K, even on high soil tests. High salinity may decrease crop yield. Crop nutrient removal: P2O5 = 40 K2O = 20 AGVISE Band guideline will build P & K test levels to the medium range over several years.

Abstract

13. Abstract/Summary:

In late fall of 2020, a trial was established near Yorkton to determine if dormant seeding was a viable means of establishing a perennial forage into saline soil. Treatments included salt tolerant species such as Barricade alfalfa, AC Saltlander green wheatgrass and tall wheatgrass. These species were compared against non-saline tolerant species such as Carlton smooth bromegrass and 4030 alfalfa. The goal of the project was to demonstrate which species are best suited to provide ground cover and forage on saline soils where annual crop production is not productive and uneconomical. Plots were long, traversing soils of varying salinity. Regardless of landscape position, neither the saline tolerant "Barricade" alfalfa or the conventional "4030" alfalfa were successfully established by dormant seeding in late fall. While none of the grasses could be established in the highly saline "dead zone", the perennial grasses could be established in the less saline transition zone between the "dead zone" and the heavily infested area of foxtail barley. However, the saline tolerant AC Saltlander green wheatgrass and Tall wheatgrass were much more productive than the saline sensitive Carlton smooth bromegrass. Both saline tolerant species established within the heavily populated foxtail barley area as well but only the tall wheatgrass grew above the canopy. This trial shows the difficulty of establishing a perennial forage in saline soil. Effective weed control must also be part of the plan.