Evaluating Potential Forages for Suppressing Foxtail Barley and Downy Brome in Saline Pastures and Hay Fields

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Introduction

Agricultural producers across the USA and Canada consider foxtail barley (*Hordeum jubatum* L.) and downy brome (Bromus tectorum L.) major weeds detrimental to both field crop and livestock production. Foxtail barley invades disturbed pastures, hayfields, and cultivated land alike and has proven difficult to control, especially in saline soils. This perennial weed typically produces abundant quantities of wind-dispersed seed which contribute to infestations year after year. The plant's sharp, stiff, barbed awns can penetrate the tender nose and mouth parts of cattle, sheep, and horses, causing infections and lesions. Infected animals eat less, gain less weight, and produce less milk. The current chemical controls include heavy pre-emergence applications and in-crop doses in annual field crops and fall spraying in forage crops.

Foxtail barley has a shallow, fibrous root system that makes it more responsive to control by tillage than many other perennial weeds, and tends to become more of a problem whenever tillage frequency is decreased as in hayfields, pastures, and reduced-tillage grain fields. Seeds are easily carried by the wind, spreading quickly from contaminated field margins, water courses, and adjacent fields. New plants tend to invade any area that is not occupied by other plants, showing behaviour typical of a pioneer invader species. This is why the weed frequently inhabits saline environments and is known to frequent a wide range of saline soils (Dodd and Coupland 1966; Ungar 1974; Badger and Ungar 1990; Kenkel et al. 1991).

Although foxtail barley's inability to compete with other vegetation has been known for over 50 years (Cords 1960; Wilson 1967; Best et al. 1978; Badger and Ungar 1990), the use of forage plants to suppress this weed has been limited (Moyer and Boswell 2002). One reason has been the lack of a desirable forage species with superior salinity tolerance to serve as the suppressor for the control of foxtail barley. Tall wheatgrass has the tolerance but grows as a bunch grass with low palatability.

Downy brome, is an annual bunchgrass, usually germinating in the fall, overwintering as a seedling, then flowering in the spring or early summer. If fall moisture is limiting seeds can germinate in the spring and flower in the summer (Valliant et. al. 2007).

Downy brome occurs in all Canadian provinces except for Newfoundland. It is widely distributed in the U.S.A. and is especially abundant in the Great Basin and Columbia Basin areas of the western U.S.A. (Klemmedson and Smith 1964; Morrow and Stahlman 1984). An aggressive grassy weed, downy brome is a threat to winter and spring cereals, pastures, rangelands and dry hayfields. Winter wheat growers in the western U.S.A. proclaim it as their worst weed problem. Downy brome has the capability to reduce soil moisture to the permanent wilting point to a depth of 70 cm, reducing competition from other species (D'Antonio & Vitousek 1992). The long stiff awns of mature downy brome can easily puncture the skin in the mouth, throat and intestine of livestock causing discomfort and a reduction in feed intake.

Agriculture & Agri-Food Canada scientists recently released AC Saltlander green wheatgrass (*Elymus hoffmannii* Jensen & Asay), a perennial forage featuring salinity tolerance approaching and equal to that of tall wheatgrass (*Thinopyrum ponticum* (Podp.) Lui & Wang) (Steppuhn and Asay 2005; Steppuhn et al. 2006). Consequently, AC Saltlander ranks among the few perennial forage species with potential for suppressing foxtail barley and downy brome growing in saline soils. Preliminary indications reveal that it can gradually suppress foxtail barley at all salinity levels, offering potential as a low-cost, pesticide-reduced control. According to results from controlled testing, AC Saltlander can grow in saline root zones measuring well into the severe range.

The effect of root-zone salinity on forage crops follows the dictates and the confounding influences of weather. For example, forage growers appreciate that ample spring precipitation can enhance forage production in pastures and hayfields at all salinity and salinity-free levels. Snowmelt and rainfall, which infiltrate unsaturated soils in sufficient quantities to move water downward in the profile, will leach in-situ salts below root zones. This lowers salt concentrations, abates soil salinization, and moderates losses in forage production caused by salinity. If, in contrast, spring precipitation becomes limiting, salt concentrations increase, soil salinization accelerates, and forage production decreases. This report results from an industry consortium led by the Alberta Beef Producers. The objective of the study is to evaluate potential forage species for suppressing foxtail barley and downy brome in saline pasture and hay fields.

Methods

Two Alberta Canada field sites were selected in 2006 with guidance from project partners, land owners' approvals, and on-site inspections. Site 1, characterized as slightly to moderately salinized (Table 1), is located on the Hal Peterson Farm near Warner, Alberta. Site 2, characterized as moderately to severely salinized (Table 1), is located on the Gordon Chiliak Farm near Oyen, Alberta.

With the assistance of project partners, each site was evaluated for general salinity (EM38 survey), staked for plot layout, pre-seed treated with glyphosate, worked with a double-disc, roto-tilled, and harrow-packed. The same disc-drill, forage plot-seeder (with shanks spaced 30 cm apart) was used at each site. Plot size equalled 1.8 m by 12.2 m. Ten forage suppressor treatments (replicated 6 times) were compared to an unseeded control (the control was replicated 12 times) (Figure 1). The treatments included:

* Saltmaster seed mix, a commercial seed mixture (consisting of 20% each of tall fescue, tall wheatgrass, slender wheatgrass, smooth bromegrass, alfalfa) (Saltmaster mix)
* AC Rocket smooth bromegrass (SBG)
* Spredor 4 alfalfa
* AC Saltlander green wheatgrass (GWG-30)
* AC Saltlander green wheatgrass, 15 cm row spacing (GWG-15)
* Nuttall's salt-meadow grass
* Polar northern wheatgrass (NWG)
* Green and slender wheatgrass in alternating rows, 15 cm row spacing (GWG/SWG)
* Poole western wheatgrass (WWG)
* Orbit tall wheatgrass (TWG)

The Warner Site was seeded on May 16th, 2006, while Oyen was seeded on June 29th, 2006, (delayed by wet and cool weather). Plant establishment at the field study sites was determined in 2006 on July 5th at Warner and on August 3rd at Oyen. Each plot contained six sub-plots (each 0.61 m by 0.61 m in size) within which plant establishment and shoot biomass measurements were obtained. The first year establishment and survival plus new plant emergence was measured in 2007 on May 8th and 9th at Warner, and on May 30th and 31st at Oyen.

In July of 2006, annual weeds grew and dominated the plots as is typical in forage seedings. Consequently, all plots at the Warner site were mowed at the end of the month. The Oyen site was not mowed until November 2nd, 2006. By November, 2006, a complete set of root-zone soil cores were obtained at every subplot at both sites (Table 1). As well, relative field salinity maps as measured by a non-contacting electromagnetic induction meter (EM38) in the horizontal dipole mode (0.75 m depth) were created (Figure 1).

At Warner, owing to the 2006 weed control efforts against Canada thistle, all the alfalfa plants under test were lost over the first growing season. These plots together with those seeded to Nuttall's salt-meadow grass, which failed to establish, were mowed on May 29th and 30th of 2007 and measurements were discontinued. At Oyen, ample 2007 spring and early summer precipitation resulted in above-average forage growth. In 2007, shoot biomass harvest was conducted June 26th-28th at Warner and July 4th-5th at Oyen. Suppressor forage and associated weeds within each sub-plot were cut, bagged, dried, and weighed separately. In 2008, shoot biomass harvest was conducted June 24th-26th at Warner and July 7th-9th at Oyen. The plots at both sites were mowed following shoot biomass harvests. Neither site was harvested in 2009 due to severe drought conditions. Although funding for this project ended in 2009, the plots at Oyen were harvested in 2010 and 2011 because it was observed that the suppression of foxtail barley from the forage treatments was occurring at a much slower rate, likely owing to the level of salinity at this site.

Table 1. Average saturated soil paste electrical conductivity (EC_e) from samples taken August 28th, 2006 (Warner Site) and October 20th, 2006 (Oyen Site).

	Conductivity EC_e (dS/m)				
	Warner Site				
Replicate	0-15 cm	15-30 cm	30-45 cm	45-60 cm	All depths
1	0.91	0.74	2.17	4.58	2.10
2	0.89	0.90	3.06	5.57	2.61
3	2.22	3.13	7.60	7.56	5.13
4	0.84	0.73	1.47	2.93	1.49
5	1.34	1.54	3.84	6.58	3.32
6	3.08	4.24	7.15	7.88	5.59
Average	1.55	1.89	4.22	5.85	3.37
	Oyen Site				
1	2.73	8.21	14.85	14.80	10.15
2	3.21	8.53	12.99	13.17	9.48
3	2.57	4.64	8.49	11.41	6.78
4	5.40	13.68	16.67	15.35	12.78
5	2.79	7.15	13.41	13.84	9.30
6	5.23	14.07	18.16	17.51	13.74
Average	3.66	9.38	14.10	14.35	10.37

Results and Discussion

Plant Counts

In 2006, counts of the emerging and early surviving plants by species (5-6 weeks after seeding) showed generally acceptable numbers at the Warner and Oyen sites, although somewhat reduced at the latter (Table 2). This reduction reflected the cool, wet growing conditions at the Oyen site which delayed seeding until June 29th. If one sets the acceptable count for emergence at 60 plants/m^2 for Warner and 40 plants/m^2 for Oyen, western wheatgrass, northern wheatgrass and Nuttall's salt meadow grass failed to reach minimum numbers at either site. Tall wheatgrass and smooth bromegrass emerged with the greatest frequency. The Saltmaster seed mix was next in all-around emergence. AC Saltlander ranked average to plentiful in the stands depending on the site.

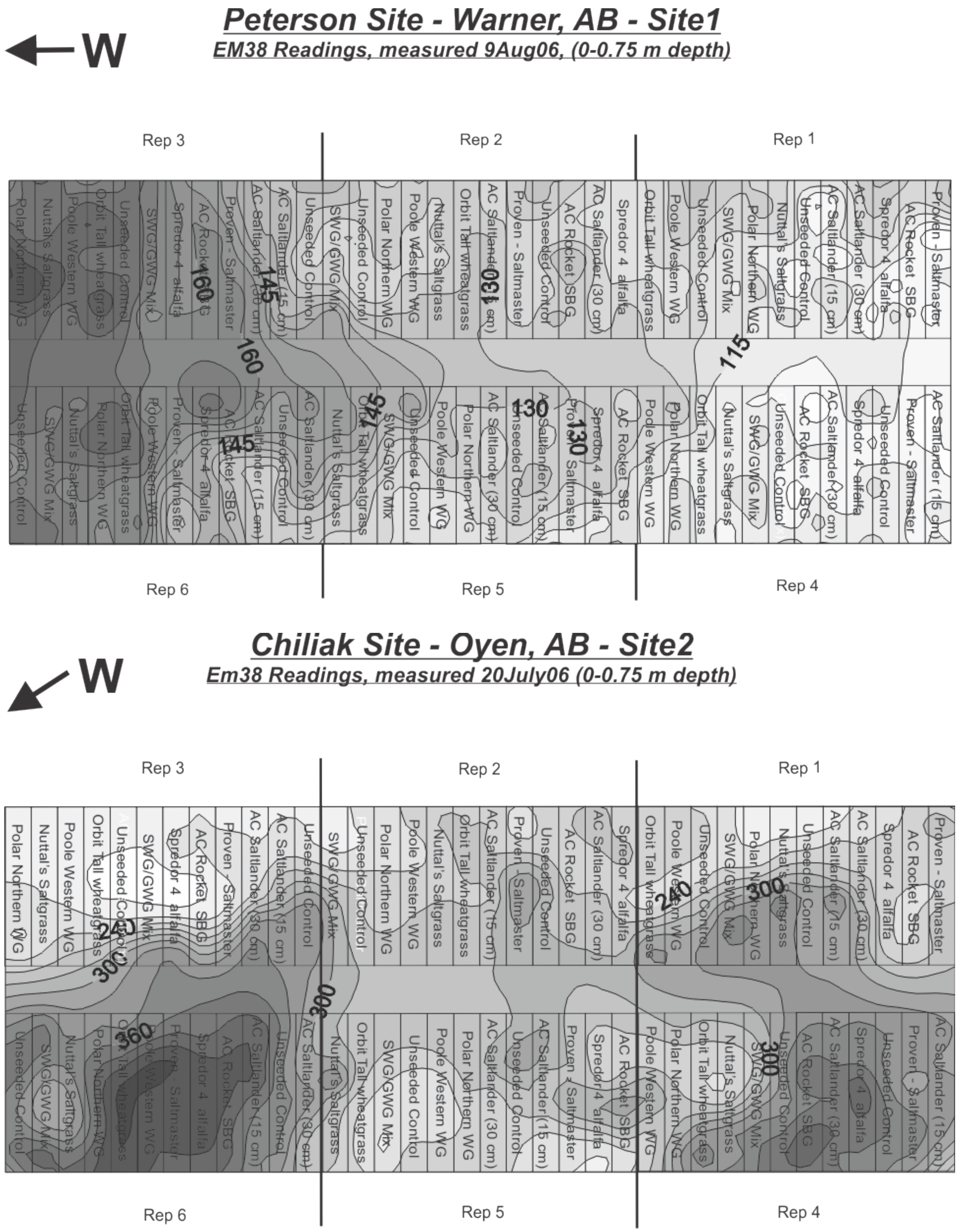

Figure 1. Plot seeding plan and relative field salinity maps (as measured by a non-contacting electromagnetic induction meter (EM38) in the horizontal dipole mode (0.75 m depth)) of the Warner and Oyen sites. Plot dimensions are 12.2 m long by 1.8 m wide. Boundary and central pathway were seeded to alternating rows of Dahurian wildrye (DWR), and green wheatgrass (GWG).

Starting in 2006, new foxtail barley plants were present in all treatment plots at each site. In general, the Oyen site counted fewer weed plants than the Warner site. At Warner, downy brome plant numbers exceeded those of foxtail barley in every treatment plot including the unseeded control. This fits the biological character of downy brome as a cool-season pioneer (or invader) species compared to the warmer temperature requirement of foxtail barley. In some treatments, the presence of downy brome appears to have reduced foxtail barley establishment.

In 2006, almost all candidate suppressor forages became established at both sites, resulting in a successful initiation of the study. Over winter, some of the established plants died, and some new seeds germinated. The 2007 plant count data provides comparisons of total establishment and survival among the candidate suppressor forages (Table 3). In 2007, the total plant counts of the test forages (the 2006 survivors and the 2007 newly emerged) one year after seeding more-or-less matched those recorded in 2006 (Tables 2 and 3). That is, the rankings among the suppressor treatments remained the same in both years at each site (Oyen and Warner).

At Warner, the presence of downy brome complicated the weed plant frequencies measured after one year. The average number of downy brome plants decreased by two to three-fold under all treatments including in the unseeded control plots. Between 2006 and 2007, the average frequency of foxtail barley plants increased by 3 to 19 plants per square metre in the Saltmaster, smooth bromegrass, green wheatgrass, alfalfa, and unseeded control plots. But, average foxtail barley counts tended to decrease by 3 to 12 plants per square metre in the alternating green/slender wheatgrass, northern wheatgrass, tall wheatgrass and western wheatgrass.

At Oyen, the average foxtail barley count in 2007 increased considerably over the 2006 count under all treatments including the unseeded control. This followed the classic pattern for foxtail barley contamination. In 2006, this plot site was treated with glyphosate, pre-worked into a forage seedbed, and seeded on the 29th of June. Coming late within the seasonal window for seeding, this preparation eliminated the existing and early germinated foxtail barley plants. In response to the early summer rains, the forage emergence was good and followed as expected for the different salinity levels of the plots. The pre-seeding preparations in 2006 minimized the foxtail barley emergence. In the fall, fresh foxtail barley seed blew in from off-plot sources. These new seeds germinated early in 2007 wherever opportunities existed in response to the excellent growing conditions. From 2006 to 2007, the average plant count of seeded forages at Oyen: (1) decreased for alfalfa, smooth bromegrass, Saltmaster, and northern wheatgrass, (2) remained the same for the green and tall wheatgrasses, and (3) increased for the green/slender wheatgrass and western wheatgrass treatments.

The Nuttall's salt-meadow grass at either Oyen or Warner averaged no greater than six plants per square metre after two years of good spring precipitation (Table 2 and 3). On the basis of plant counts at these Alberta sites, this treatment was labelled as a failure, however, measurements were continued at the Oyen site until 2010. Northern and western wheatgrasses behaved very similarly to each other. Plants of these candidate wheatgrass suppressors were found at Warner and Oyen in both years. However, average weed counts under these treatments increased at both sites from 2006 to 2007 despite the presence of established forage plants.

Above-Ground (Shoot) Biomass

The average above-ground forage biomass, cut in 2007 and 2008, from the green and tall wheatgrass, smooth bromegrass, and the Saltmaster mix treatments at Warner each exceeded the combined shoot biomass of the foxtail barley and downy brome weeds (Figures 2 and 3). The tall and green wheatgrasses tended to rank as the top two forages in average shoot biomass production; the western and northern wheatgrasses produced the least. Both of these poor producers allowed the combined foxtail barley and downy brome weed biomass to exceed the forage biomass. Of the three green wheatgrass treatments in 2007, the alternating green/slender wheatgrass treatment on average yielded the most above-ground biomass, ten times greater than that of either of the two grassy weeds. In 2008, the suppressor forages of the green and tall wheatgrass treatments completely dominated their respective plots, rendering the foxtail barley and downy brome nearly non-existent (Figure 3 and Table 4). The three green wheatgrass treatments dominated their individual stands with 97.0, 96.5 and 96.4% of their respective stands. The foxtail barley in each of these stands accounted for less than 2% of total forage yield while the downy brome tallied less than 4%. Tall wheatgrass consisted of 94.4% forage with 2.1% foxtail barley and 3,5% downy brome, and the smooth bromegrass consisted of 92.0% forage compared to 4.3% foxtail barley and 3.7% downy brome. The Saltmaster mix came in next with 77.6% of the stand consisting of forage, 6.8% foxtail barley and 15.6% downy brome. The increase in weed species in this treatment and level of salinity is likely attributed to the fact that the alfalfa was lost due to efforts in controlling Canada thistle at this site. The northern wheatgrass and western wheatgrass came in last with 41.4% and 29.4% of total yield contributed by the forage treatment respectively. The tentative success of the green wheatgrass, tall wheatgrass, and smooth bromegrass treatments and to a lesser extent the Saltmaster mix implies that root-zone salinity plays a role in the efficacy of the suppressor forages.

At Oyen, the average 2007 and 2008 above-ground biomass for the alfalfa, smooth bromegrass, tall wheatgrass, green wheatgrass, Saltmaster mix, and the green/slender wheatgrass treatments, each exceeded the average foxtail barley shoot biomass (Figures 4 and 5). Conversely, the average shoot biomass of the weed exceeded those of the northern and western wheatgrasses and the Nuttall's salt-meadow grass. As at Warner, the green wheatgrass treatments appeared near if not at the top in weed suppression and forage production. And, among the three green wheatgrass treatments, the green/slender wheatgrass treatment tended to rank as the best. The better than average growing season precipitation during 2007 at Oyen likely reduced the negative effects of root-zone salinity at that site. Between 2007 and 2008, the shoot

Table 2. Average 2006 plant emergence and early survival at the two field test sites as frequency (number of plants per square metre) n number of weeks after seeding. [GWG = green wheatgrass; SWG = slender wheatgrass]

Suppressor treatment Site (n)	Emergence and early survival (number per square metre)		
	Forages	Foxtail barley	Downy brome
Warner, AB (5 weeks)			
Spredor 4 alfalfa	131.7	5.0	91.5
GWG-15	100.9	3.4	80.4
GWG-30	84.9	2.4	90.7
Smooth bromegrass	105.6	3.2	72.7
Saltmaster mix	95.8	4.6	68.0
GWG/SWG	79.2	15.0	51.4
Tall wheatgrass	121.2	12.5	43.9
Nuttall's salt-meadow grass	1.1	24.8	72.8
Northern wheatgrass	47.4	28.7	63.6
Western wheatgrass	32.5	22.3	60.4
Unseeded control	0	12.5	91.2
Oyen, AB (5 weeks)			
Spredor 4 alfalfa	72.3	15.8	
GWG-15	46.9	16.8	
GWG-30	46.4	9.6	
Smooth bromegrass	60.6	13.4	
Saltmaster mix	51.8	11.6	
GWG/SWG	40.8	8.7	
Tall wheatgrass	62.4	10.8	
Nuttall's salt-meadow grass	0.8	14.1	
Northern wheatgrass	20.8	15.2	
Western wheatgrass	5.9	10.8	
Unseeded control	0	12.1	

Table 3. Average 2007 plant count (established and survived plus newly emerged) at Warner and Oyen field test sites recorded as frequency (number of plants per square metre) one year after seeding. [GWG = green wheatgrass; SWG = slender wheatgrass]

Suppressor treatment	Emerged and survived		
	Forages	Foxtail barley	Downy brome
Warner, AB			
Spredor 4 alfalfa	11.9	24.2	28.4
GWG-15	42.7	10.2	32.1
GWG-30	31.7	10.0	31.7
Smooth bromegrass	35.4	10.8	27.1
Saltmaster mix	24.0	11.7	28.9
GWG/SWG	46.6	12.5	19.6
Tall wheatgrass	49.3	7.4	19.2
Nuttall's salt-meadow grass	0.5	21.2	34.4
Northern wheatgrass	13.6	16.4	35.7
Western wheatgrass	7.4	17.3	32.6
Unseeded control	0	17.5	41.2
Oyen, AB			
Spredor 4 alfalfa	42.1	130.9	
GWG-15	45.4	78.3	
GWG-30	44.1	93.3	
Smooth bromegrass	52.8	88.1	
Saltmaster mix	41.7	65.3	
GWG/SWG	69.8	35.1	
Tall wheatgrass	56.4	44.1	
Nuttall's salt-meadow grass	5.7	62.5	
Northern wheatgrass	14.0	73.4	
Western wheatgrass	18.8	59.5	
Unseeded control	0	89.6	

biomass of the foxtail barley increased in the control, Nuttall's salt-meadow grass, northern wheatgrass, western wheatgrass, alfalfa, smooth brome, Saltmaster mix, and tall wheatgrass plots. The foxtail barley biomass did not increase in any of the green wheatgrass plots.

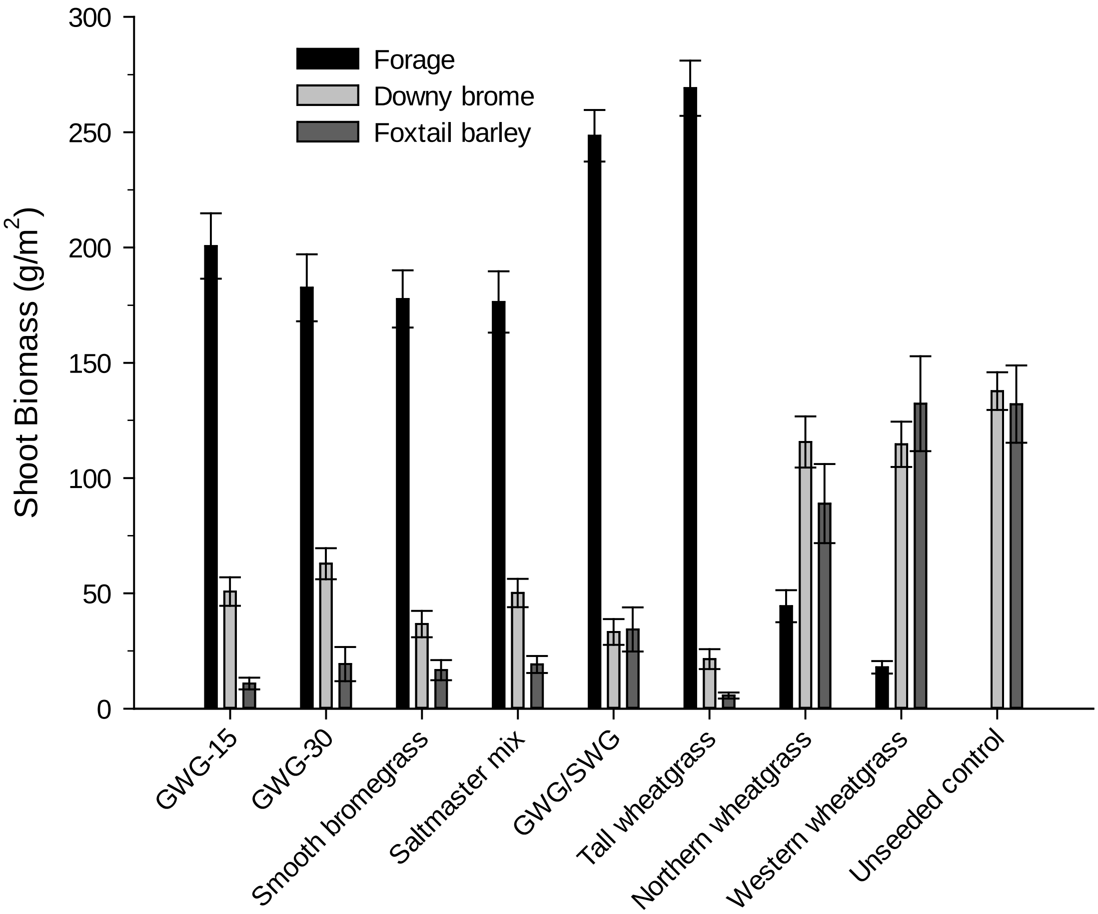

Figure 2. Mean above-ground biomass for suppressor forages and weeds by treatments at the Warner Site, harvested June 26-28, 2007; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean

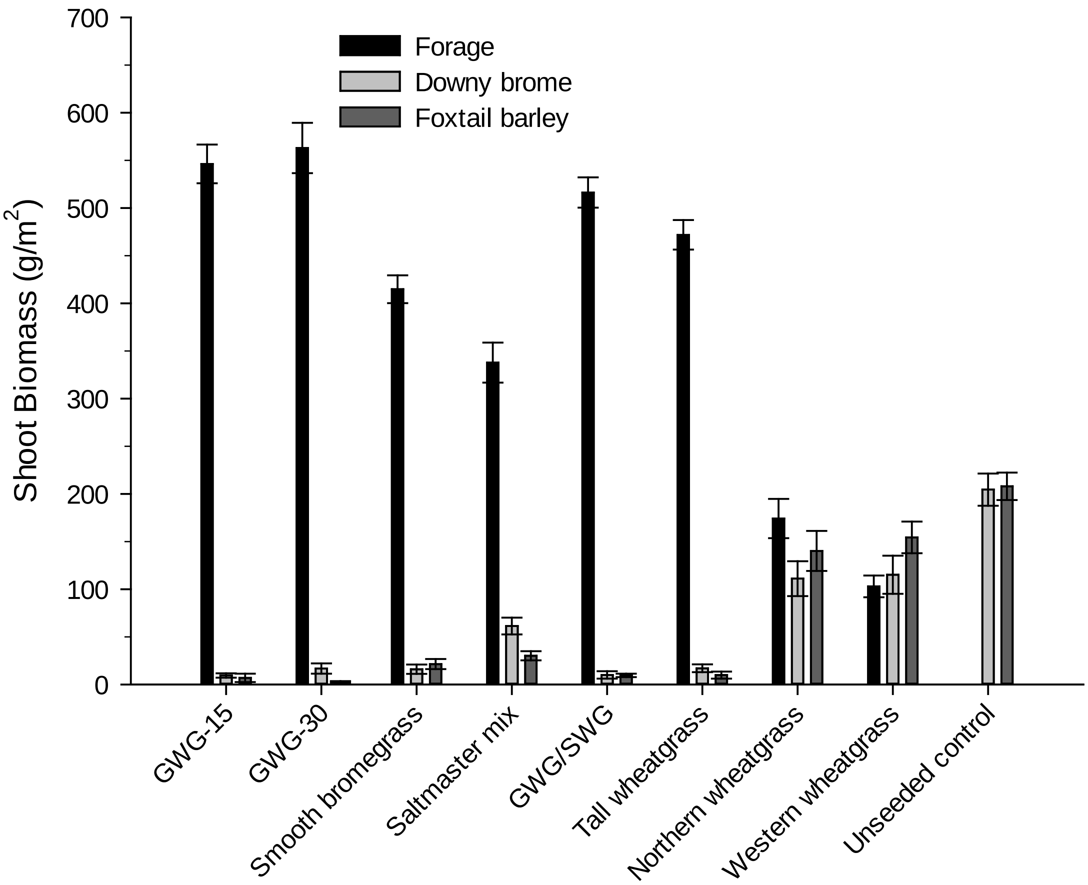

Figure 3. Mean above-ground biomass for suppressor forages and weeds by treatments at the Warner Site, harvested June 24-26, 2008; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean.

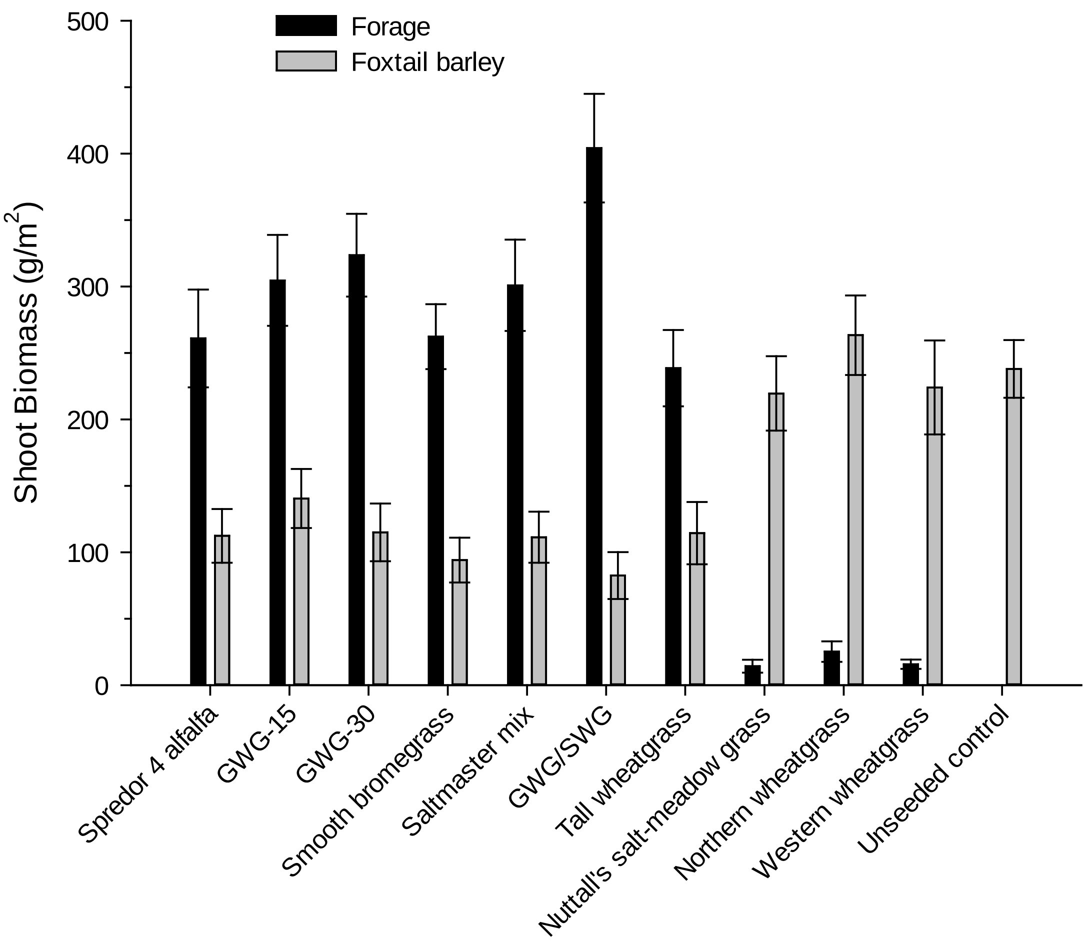

Figure 4. Mean above-ground biomass for suppressor forages and weeds by treatments at the Oyen Site, harvested July 4-5, 2007; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean.

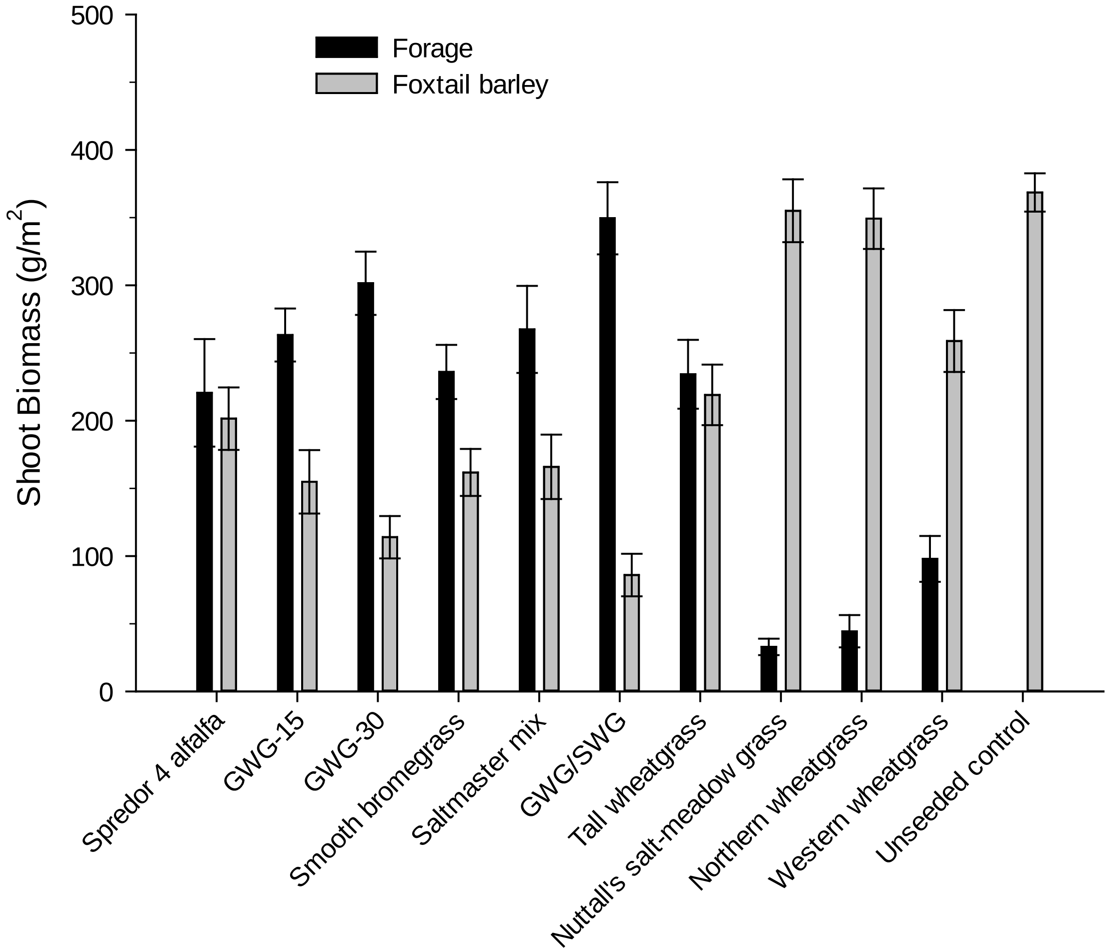

Figure 5. Mean above-ground biomass for suppressor forages and weeds by treatments at the Oyen Site, harvested July 7-9, 2008; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean.

Both sites experienced severe drought conditions during the 2009 growing season. Consequently the sites were not harvested in 2009 due to poor plant growth. Both sites received some precipitation in the fall of 2009. This caused the sites to “green” up slightly and allow some visual observations.

Visually, the Warner plots appeared to have fared better in 2009 than the Oyen plots, perhaps in part due to lower levels of salinity. The green wheatgrass plots and the tall wheatgrass plots showed the tallest, if not the densest, forage populations; these forage crops have almost eliminated the foxtail barley and downy brome plants in their stands. Slender wheatgrass was still evident in the plots where it was seeded together with green wheatgrass. The smooth bromegrass and the Saltmaster forage mix appeared to rank next in terms of competitiveness. The least competitive treatments were Nuttall's salt-meadow grass, northern wheatgrass, and western wheatgrass.

Visually, it appeared that the foxtail barley populations at the Oyen site increased from 2008 to 2009, while most of the forages may have decreased in many of the plots. The green wheatgrass tended to show the least foxtail barley and seemed to be the most effective in competing with the foxtail barley under the drought conditions of 2009. Most of the slender wheatgrass in the green/slender wheatgrass plots had disappeared from these stands. As expected, the green wheatgrass has spread, at least partially filling the area vacated by the slender wheatgrass. The Nuttall's salt-meadow grass, alfalfa, northern wheatgrass and western wheatgrass appear to be losing the competition against the foxtail barley. Although the tall wheatgrass seems to be growing fairly well, the foxtail barley has invaded the inter-row space. The Saltmaster forage mix appears to be losing ground as well. The tall fescue, slender wheatgrass and most of the alfalfa has all but died out, leaving only the tall wheatgrass and some smooth bromegrass. The remaining stand appears too thin to effectively compete with the foxtail barley.

Although the funding for this project ended in 2009, the Oyen site was harvested in 2010 and 2011. It was observed that suppression was slowed considerably at this site, likely owing to the increased salinity. In 2010, the plots containing green wheatgrass had forage yields of more than double the yields of foxtail barley (Figure 6). The only other treatment to out-yield the foxtail barley was the Saltmaster forage mix. All other treatments had higher yields of foxtail barley compared to forage yields. The treatments faring the poorest were Nuttall's salt-meadow grass, northern wheatgrass and western wheatgrass.

The 2011 yields were somewhat lower due to slightly drier conditions compared to 2010. By this season the green wheatgrass treatments had reduced the foxtail barley to 7.7, 7.8 and 19.4% of total yield (Figure 7 and Table 5) and consisted of 92.3%, 92.2% and 80.6% of total yield. The increase in foxtail barley in the green/slender wheatgrass treatment could likely be attributed to a lower seeding rate due to being part of a mixture (slender wheatgrass) which has since died out, leaving only the green wheatgrass. Tall wheatgrass consisted of 54.7% forage and 45.3% foxtail barley, western wheatgrass 54.1% and 45.9%, smooth bromegrass 50.1% and 49.9%, Saltmaster mix 46.6% and 53.4%, alfalfa 39.3% and 60.7% and northern wheatgrass 22.0% forage and 78.0% foxtail barley. The Nuttall's salt-meadow grass was not harvested because the stand had almost completely died out.

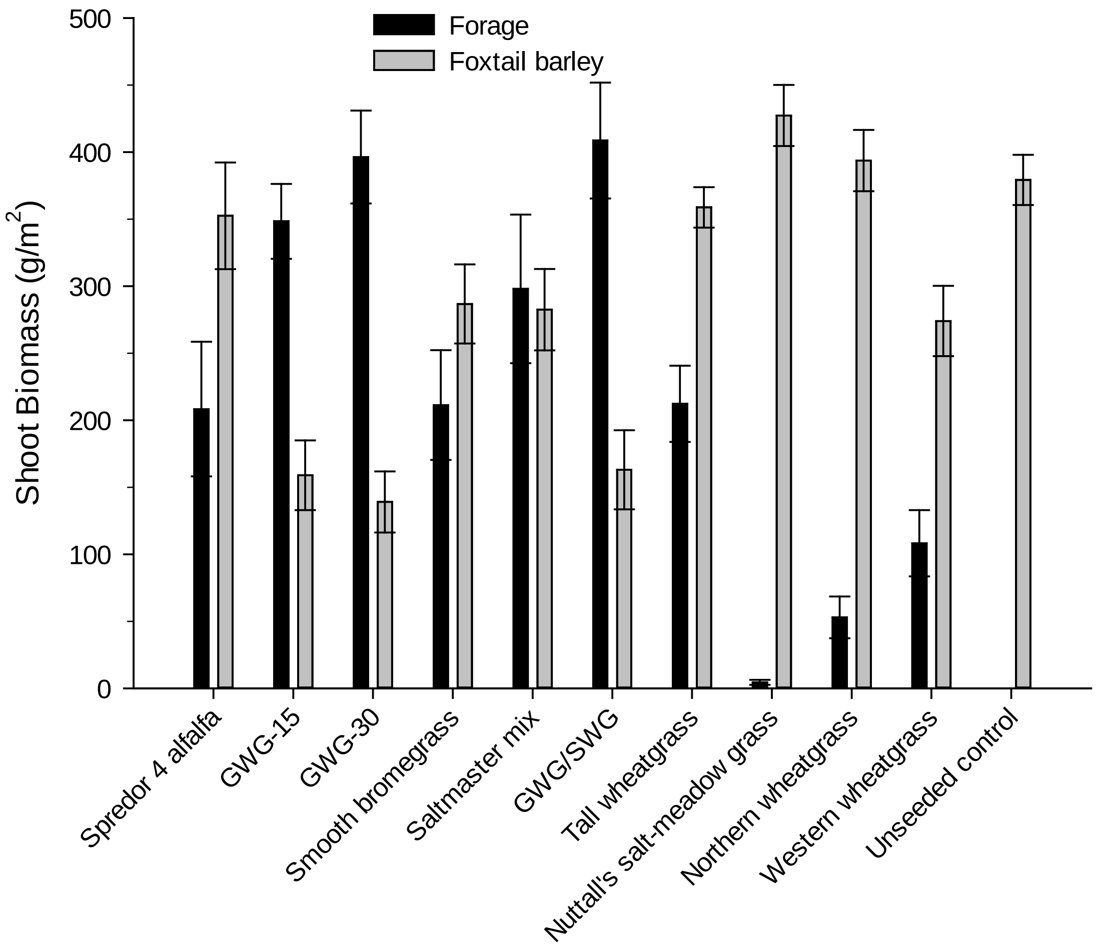

Figure 6. Mean above-ground biomass for suppressor forages and weeds by treatments at the Oyen Site, harvested August 4-5, 2010; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean.

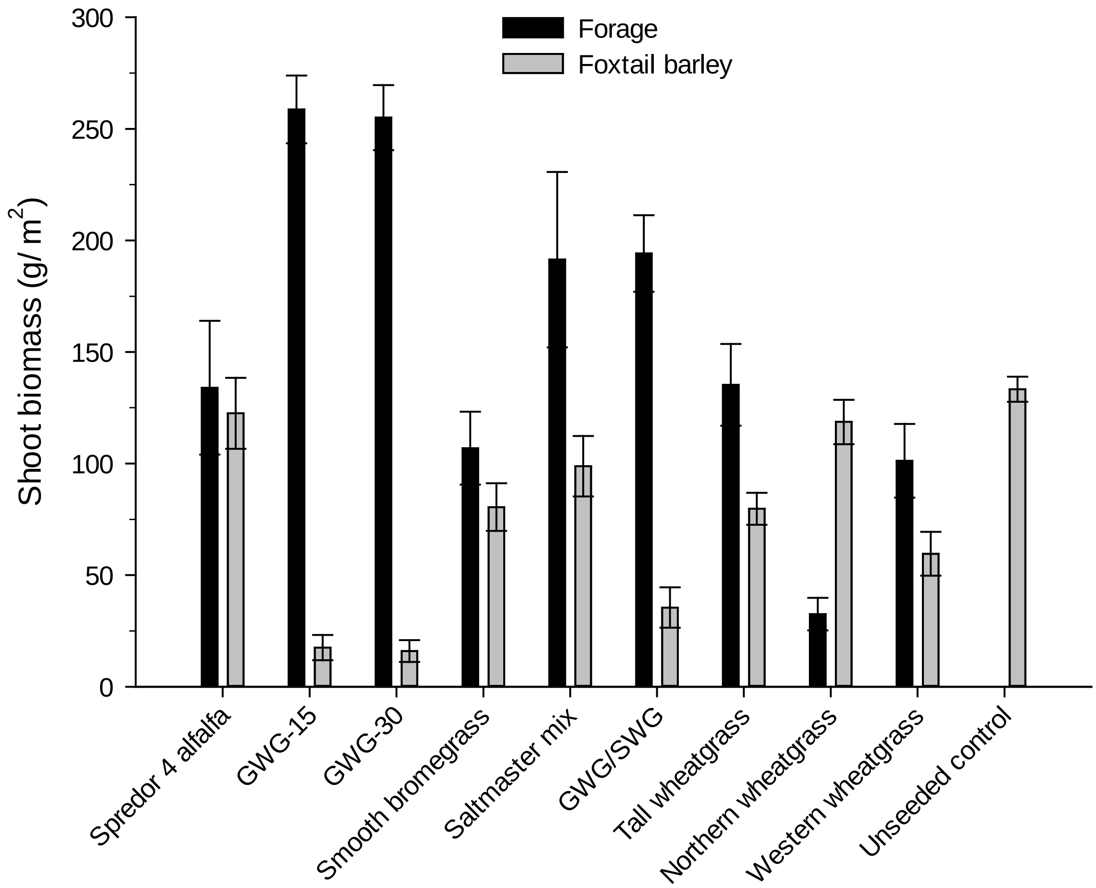

Figure 7. Mean above-ground biomass for suppressor forages and weeds by treatments at the Oyen Site, harvested August 15-16, 2011; GWG = green wheatgrass, 15 & 30 cm row spacings; SWG = slender wheatgrass. Error bars = standard error of the mean.

Table 4. Mean percent of total yield for suppressor forages, foxtail barley, and downy brome by treatments at the Warner Site, harvested June 24-28, 2008; GWG = green wheatgrass, SWG = slender wheatgrass.

Forage Treatment	% of Total Yield		
	Forage	Foxtail Barley	Downy brome
GWG-15	97.0[a]	1.2[d]	1.8[d]
GWG/SWG	96.5[a]	1.7[d]	1.8[d]
GWG-30	96.4[a]	0.5[d]	3.2[d]
Tall wheatgrass	94.4[a]	2.1[d]	3.5[d]
Smooth bromegrass	92.0[a]	4.3[d]	3.7[d]
Saltmaster mix	77.6[b]	6.8[d]	15.6[c]
Northern wheatgrass	41.4[c]	32.5[c]	26.0[b]
Western wheatgrass	29.4[d]	42.7[b]	27.9[b]
Control		52.4[a]	47.6[a]
RMSE	13.7	18.0	18.1

* Significance at the 0.05 α error level. Values within each column followed by the same lower case letter do not differ significantly at P α ≤ 0.05 according to the paired means Student's t-tests.

Table 5. Mean percent of total yield for suppressor forages and foxtail barley by treatments at the Oyen Site, harvested August 15-16, 2011; GWG = green wheatgrass, SWG = slender wheatgrass.

Forage Treatment	% of Total Yield	
	Forage	Foxtail Barley
GWG-15	92.3[a]	7.7[e]
GWG-30	92.2[a]	7.8[e]
GWG/SWG	80.6[a]	19.4[e]
Tall wheatgrass	54.7[b]	45.3[d]
Western wheatgrass	54.1[b]	45.9[d]
Smooth bromegrass	50.1[bc]	49.9[cd]
Saltmaster mix	46.6[bc]	53.4[cd]
Alfalfa	39.3[c]	60.7[c]
Northern wheatgrass	22.0[d]	78.0[b]
Control		100.0[a]
RMSE	33.4	30.2

* Significance at the 0.05 α error level. Values within each column followed by the same lower case letter do not differ significantly at P α ≤ 0.05 according to the paired means Student's t-tests.

Conclusions

From this project, results indicate that it is possible to suppress foxtail barley and downy brome using the forage crops currently available. However, the more severe the salinity, the greater the challenge for the forage to suppress the weeds, the narrower the choice of forage species that will succeed and more favourable environmental conditions are needed. In the site where the salinity ranged from slight to moderate, the forage treatments which successfully suppressed foxtail barley were green wheatgrass, green/slender wheatgrass mix, tall wheatgrass and smooth bromegrass. Forages which are slow to establish appear unable to compete effectively with foxtail barley and/or downy brome. Do not skimp on seeding rates, especially as the salinity increases. As well, be careful when selecting saline mixes, as the less saline tolerant species tend to die out of the sward leaving opportunity for undesirable species to invade. In the site with salinity ranging from moderate to severe, the choice of forages from this project appears limited to treatments containing green wheatgrass. Even so, for this forage to successfully establish within this range of salinity, favorable environmental conditions and considerable time is needed.

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