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Cheatgrass Biomass and Competition: Is a Greenhouse Fight a Fair Fight?

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Introduction

Rehabilitation of degraded rangelands through seeding efforts is a significant challenge for resource managers throughout the Intermountain west. In an arid environment seedling establishment has little chance of success with the presence of cheatgrass (*Bromus tectorum*). This highly competitive exotic annual grass increases the chance, rate and spread of wildfires resulting in big sagebrush/bunchgrass communities being converted to cheatgrass dominance. A fire frequency of 5-10 years (post cheatgrass invasion) compared to 60-110 years (pre cheatgrass invasion) is simply too short a period to allow succession to take place and return shrubs back to the community. The most effective method to decrease cheatgrass/fires is to establish a long-lived perennial grasses such as *Agropyron desertorum*. We find it difficult to establish native perennial grasses and suppress cheatgrass. Do native annuals have the same problem or does their "weedy" annual nature help them establish and decrease cheatgrass biomass? We hypothesized that the presence of a native annual would result in a decrease in cheatgrass biomass/fuel loads (Figure 1.)

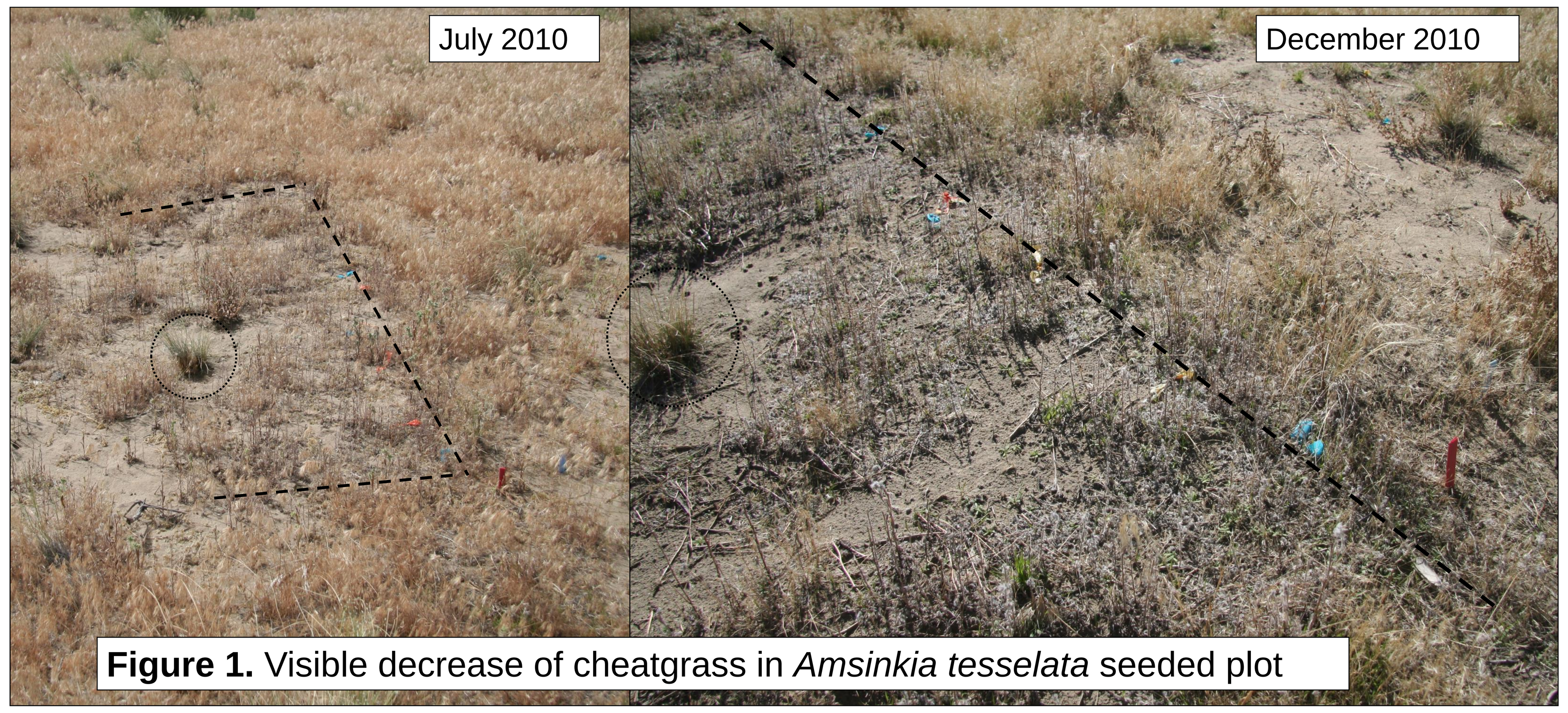


Figure 1. Visible decrease of cheatgrass in *Amsinkia tesselata* seeded plot

In order to justify a complete analysis of seeding potential for each native annual species, we first had to determine their ability to be established in cheatgrass communities using typical seeding methods. We found that very few native annual species established from traditional seeding methods (Harmon and Clements 2010). In order to ensure an observation of a native annual and cheatgrass interaction and the effects on biomass, we designed a greenhouse experiment (Figure 2) in 2009 (Methods: see Appendix A).

We then designed another field experiment (Figure 3) to be conducted in 2010 using seeding rates most probable to establish a seedling density similar to that used in the greenhouse experiment (Methods: see Appendix A).

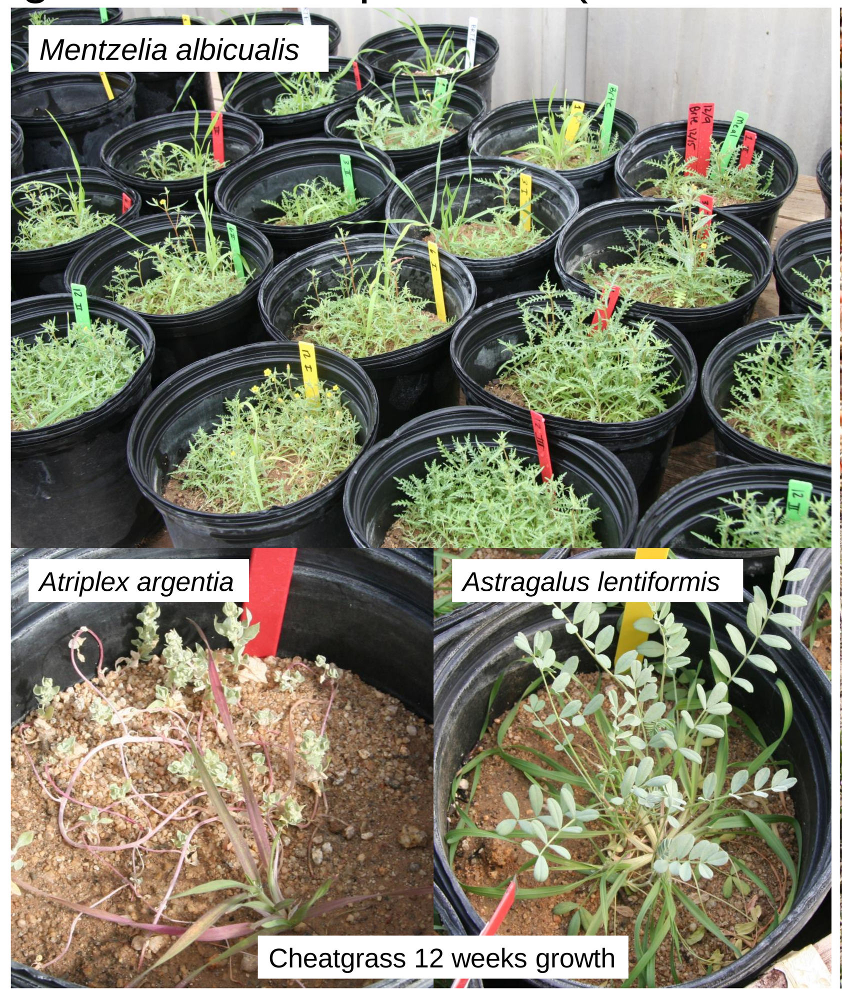


Figure 2. Greenhouse experiment 2009.
Compare equal aged cheatgrass plants with legume competitor (right) vs. annual chenopod competitor (left).

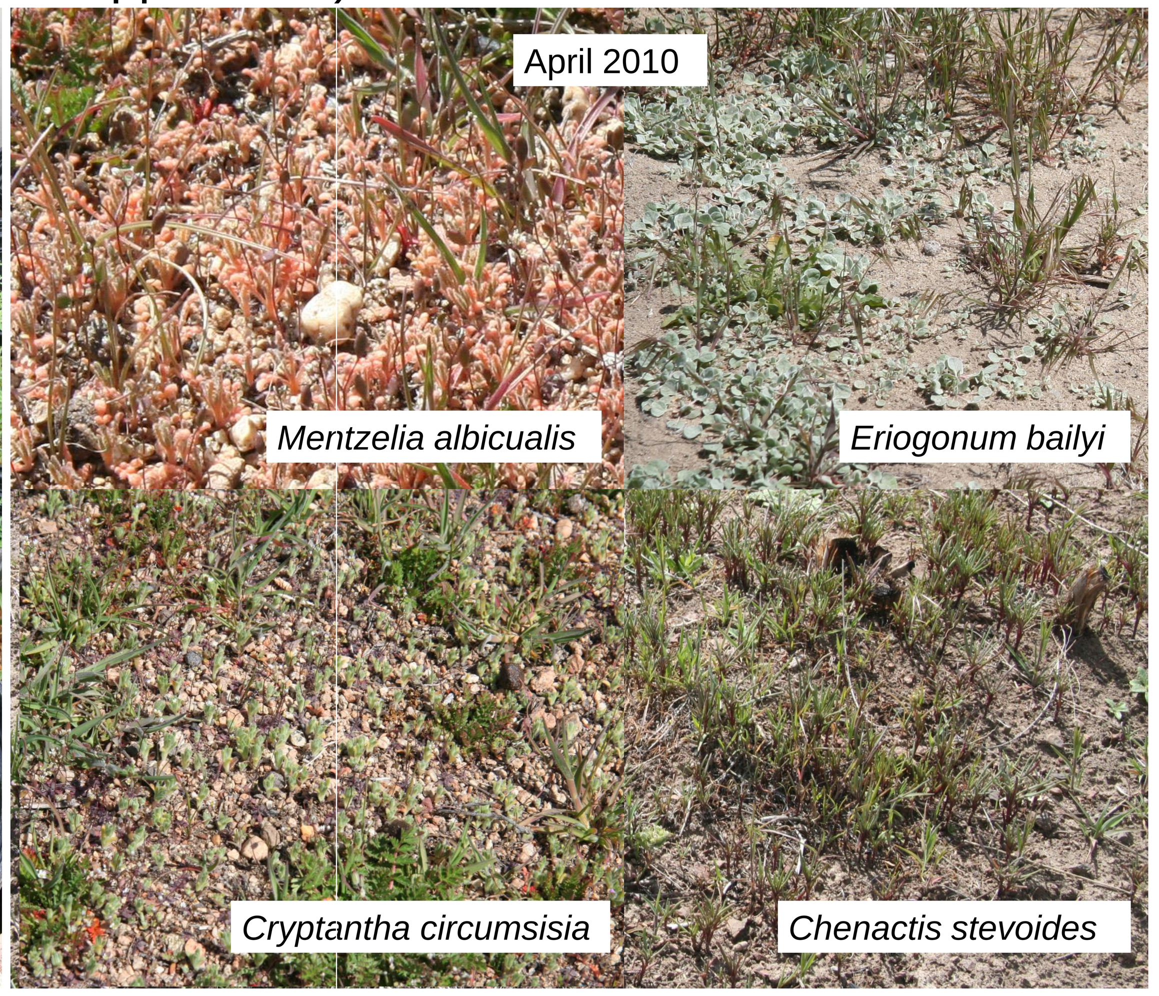


Figure 3. Field experiment (2010) seedlings. Notice the small size of *Mentzelia* plants compared to greenhouse plants (Fig 2). *Mentzelia* and *Chenactis* did not produce seed and disappeared from the site while *Cryptantha* and *Eriogonum* produced seed and established second year seedlings.

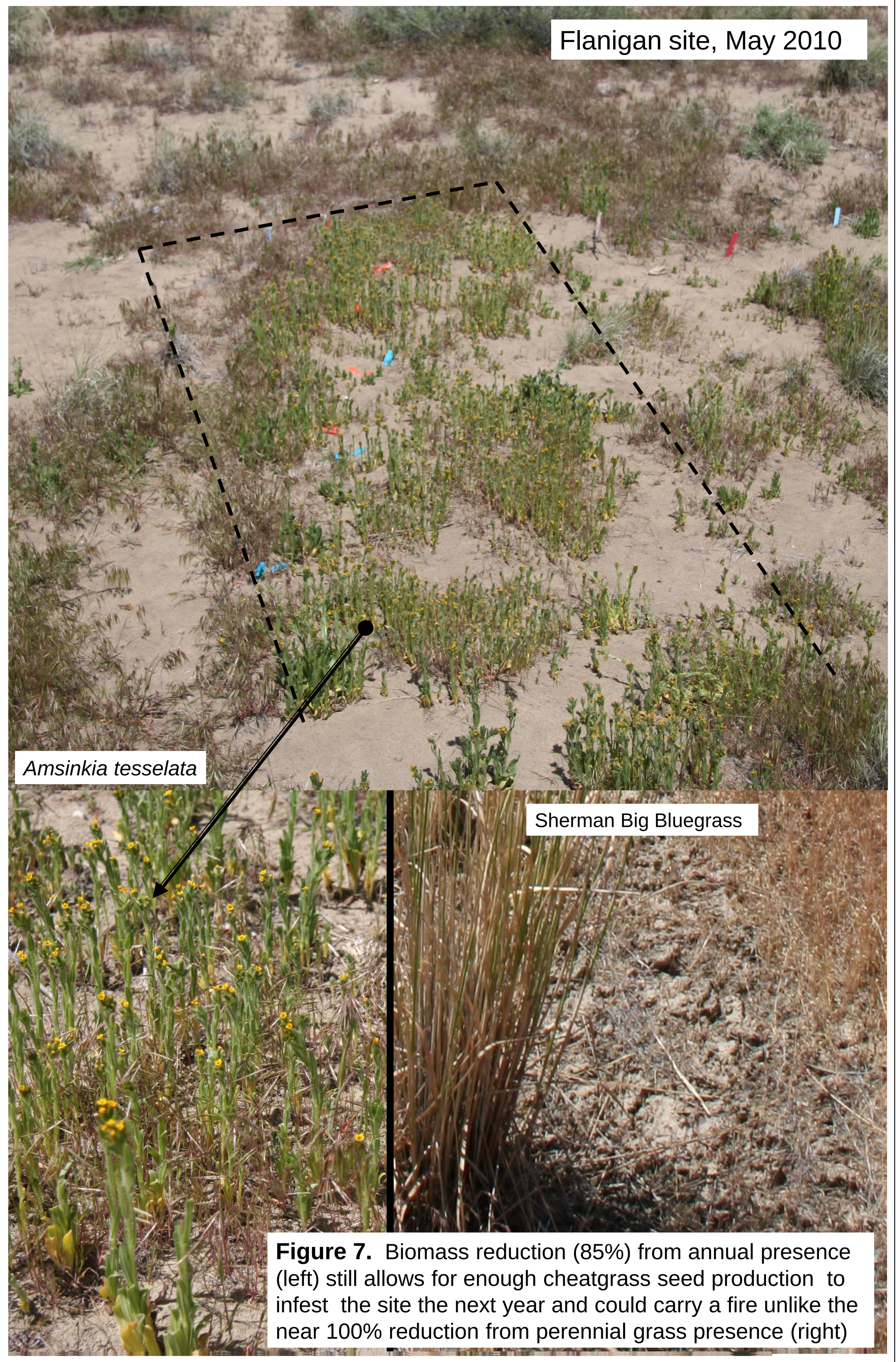


Figure 7. Biomass reduction (85%) from annual presence (left) still allows for enough cheatgrass seed production to infest the site the next year and could carry a fire unlike the near 100% reduction from perennial grass presence (right)

Table 2. Mean Cheatgrass biomass(g) for **primary treatment (A)** [presence of competitor species], and **secondary treatments (B)** [delayed emergence of cheatgrass], **(C)** [Delayed emergence and Fertilized at 6 weeks growth], **(D)** [fertilized], and **(E)** [lower competitor density]. Shaded values are significantly (p≤0.05) different from control values, underlined values are significantly different than treatment (A), bold values are significant differences from fertilizer application

	A Annual present	B Delayed BRTE	C Delayed Fertilized	D No Delay Fertilize	E Low density
CONTROL 16 weeks*	1.24				
CONTROL 24 weeks	5.04				
Agropyron desertorum	1.38				**4.83**
Amsinkia tesselata	1.4			2.29	
Atriplex argentia	0.96	.52	**2.87**		
Atriplex truncata*	0.12				0.18
Camosonia bothii*	0.24			**5.22**	0.27
Camosonia strigulosa	3.34			**9.99**	
Chenactis stevoides	1.74	0.91	**7.36**		
Eriogonum bailyi	2.4			**4.93**	
Eriogonum nidularium*	0.77			2.05	0.44
Lappula redowski	2.34	3.37	**5.06**		
Layia glandulosa	2.32				
Mentzelia albicualis	1.63	0.29	**8.56**		
Pectocarya setosa	1.93	**6.33**	**13.85**		3.91

RESULTS

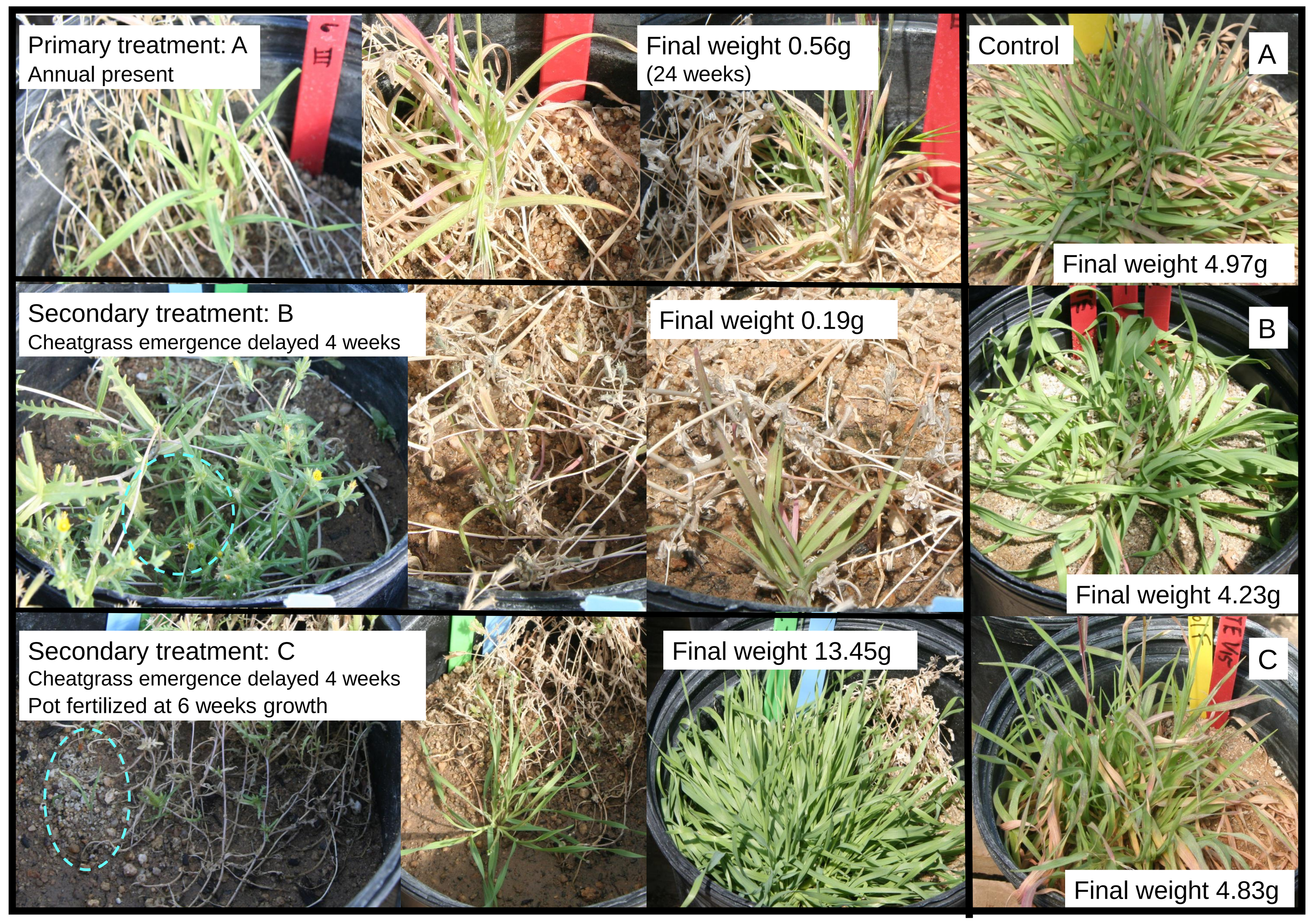
Our results found, in the greenhouse, the presence of most competitor species significantly decreased the biomass of cheatgrass (see Results: Figure 4), most pronounced reductions were with cheatgrass delayed emergence (Table 2). Interestingly the only significant increase of cheatgrass biomass involved a legume competitor (*Astragalus lentiformis*). In the field our results found that only 43% of seeded species established in the presence of cheatgrass for all sites combined (Table 3), with only three species significantly decreasing cheatgrass biomass (Results: Figure 5). The confounding results emphasize a need for "on the ground" proofing of greenhouse research.

DISCUSSION

Moisture was not limited in the greenhouse experiment and soils were low in nitrogen. Either could result in cheatgrass having less competitive advantage and adjacent plants having large negative effects on biomass. The effect was less pronounced in field tests. Our results find that our hypothesis was accepted (the presence of an annual did decrease cheatgrass biomass), but proceed with caution. Theses results are not intended to dismiss the effectiveness of long-lived perennial grasses at decreasing cheatgrass biomass/fuel loads (Figure 6).

Figure 6. Crested wheatgrass (*Agropyron desertorum*) and Sherman big bluegrass (*Poa secunda*) (right) suppressing cheatgrass.

The reality of using native annual species to decrease cheatgrass biomass in the field is far from applicable for various reasons. It is unlikely the reduction of cheatgrass biomass from annual presence is great enough to stop fires as is seen with perennial grasses (Figure 7). Persistent cheatgrass suppression is required and native annuals come and go from year to year. These studies are in no way suggesting decreasing the use of perennial grasses in favor of native annuals for rehabilitation of rangelands. We are attempting to understand the role of native annuals in a now exotic annual dominated landscape.



6 weeks | 10 weeks | 14 weeks | 6 weeks
Competitor species: *Mentzelia albicaulis* | Control

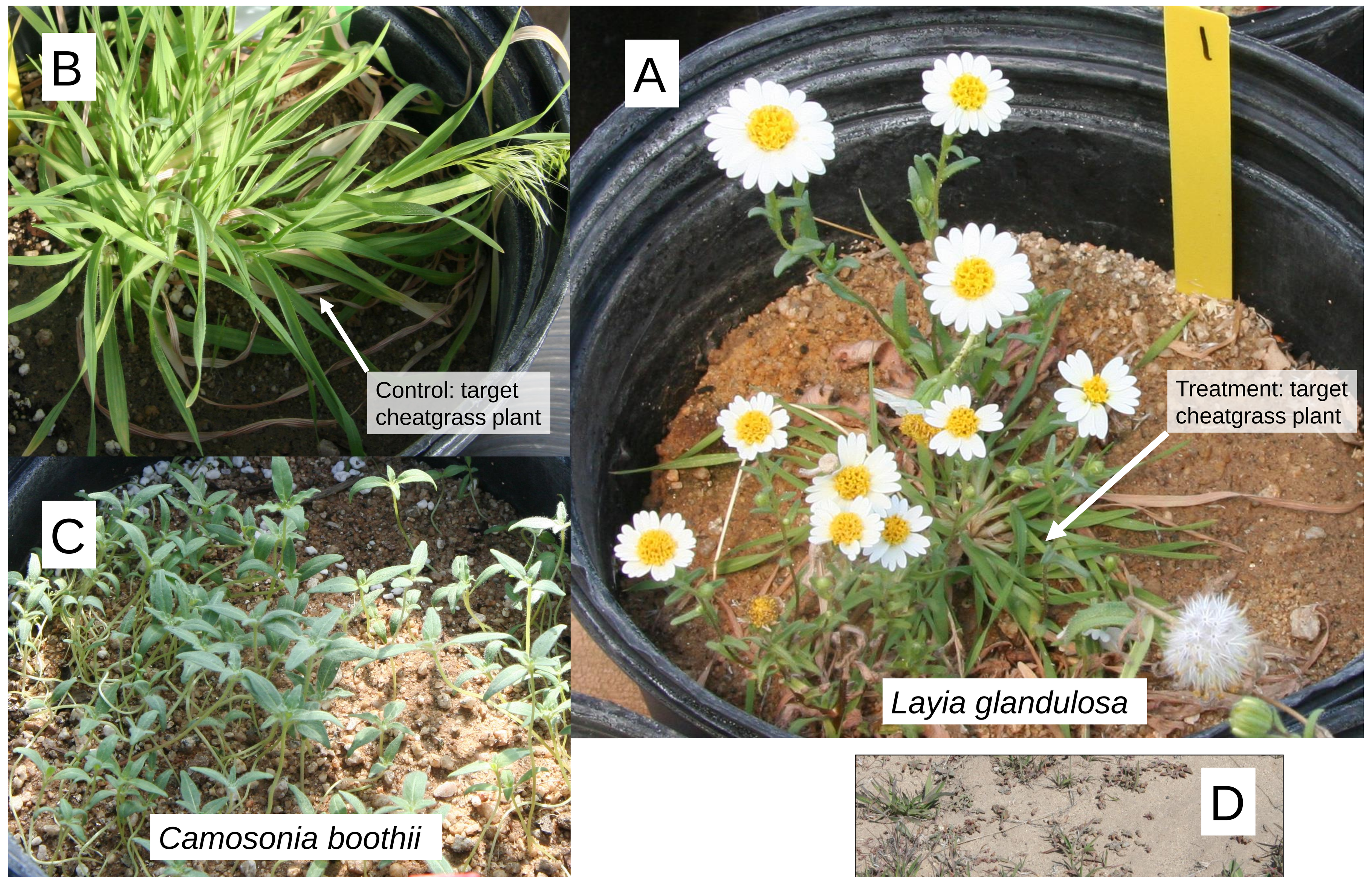
Table 3. Mean cheatgrass biomass (g) per 100cm^2 sample for each competitor species and test site. Shaded values are significantly (p≤0.05) different from raked control. Underlined values represent increased biomass and (X) are seeded species that did not establish

	Flanigan	Doyle	Empire	Sand hills
Control	7.16	2.47	2.69	3.04
Raked Control	4.23	*2.86*	1.17	3.0
Amsinkia tesselata	0.62	*2.91*	0.52	*4.28*
Atriplex argentia			*1.94*	
Camosonia bothii*	3.8			
Chenactis douglasii			X	X
Chenactis stevoides	X		1.03	1.96
Cryptantha circumsia		1.60	0.36	X
Eriastrum sparsiflorum		2.53	X	X
Erigeron concinnus		X	X	X
Eriogonum bailyi	1.65	1.57	*1.23*	X
Eriogonum deflexum		X	X	
Gilia inconspicua	X	2.22	X	X
Lappula redowski			X	
Layia glandulosa			X	X
Mentzelia albicualis		*3.44*	*1.55*	2.68
Pectocarya setosa			X	X
Phacelia bicolor	X			
Phacelia inconspicua		X	X	
Tiquilia plicata	X			
Vulupia festuca		2.25	X	X

Methods

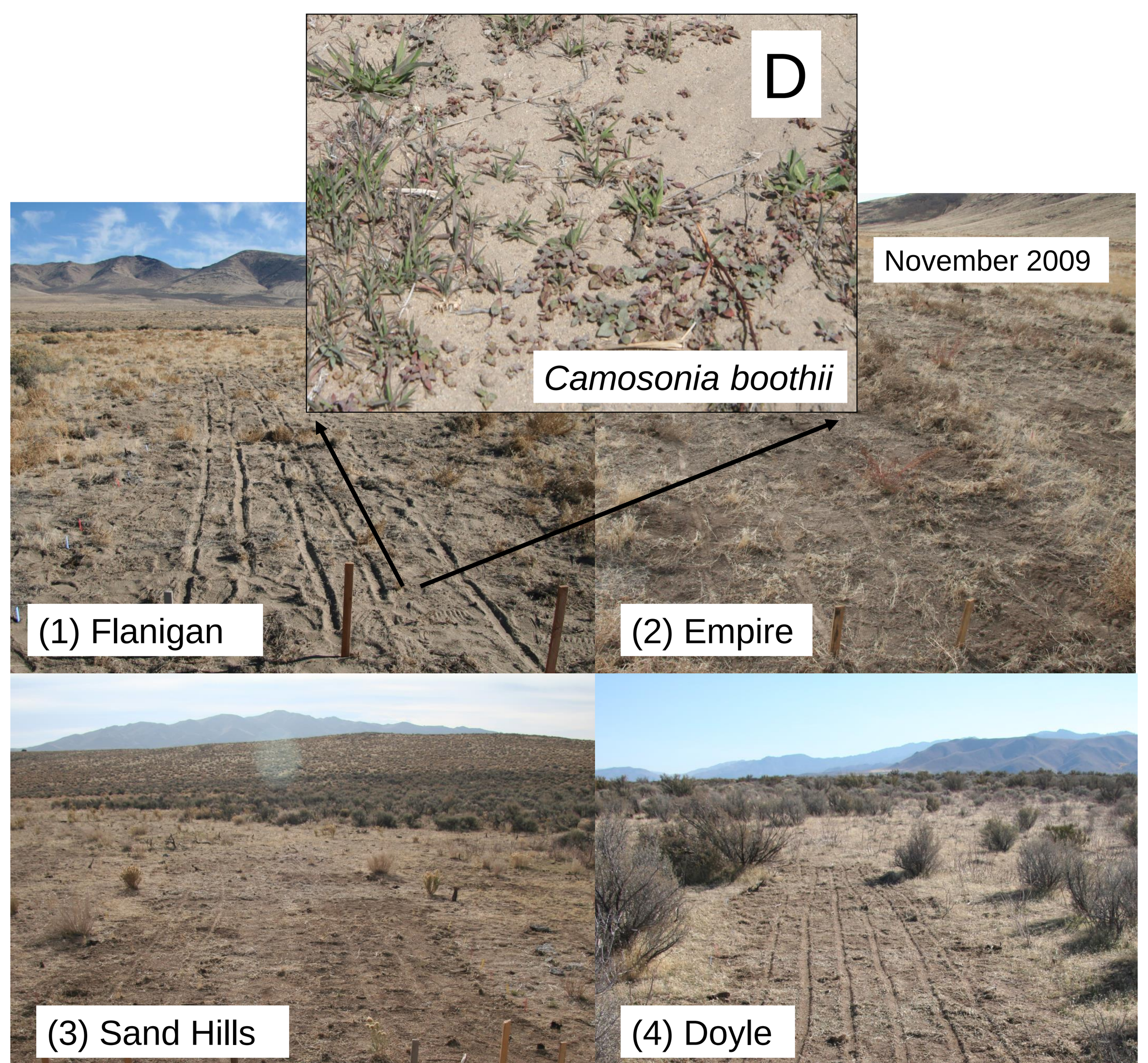
Greenhouse Study

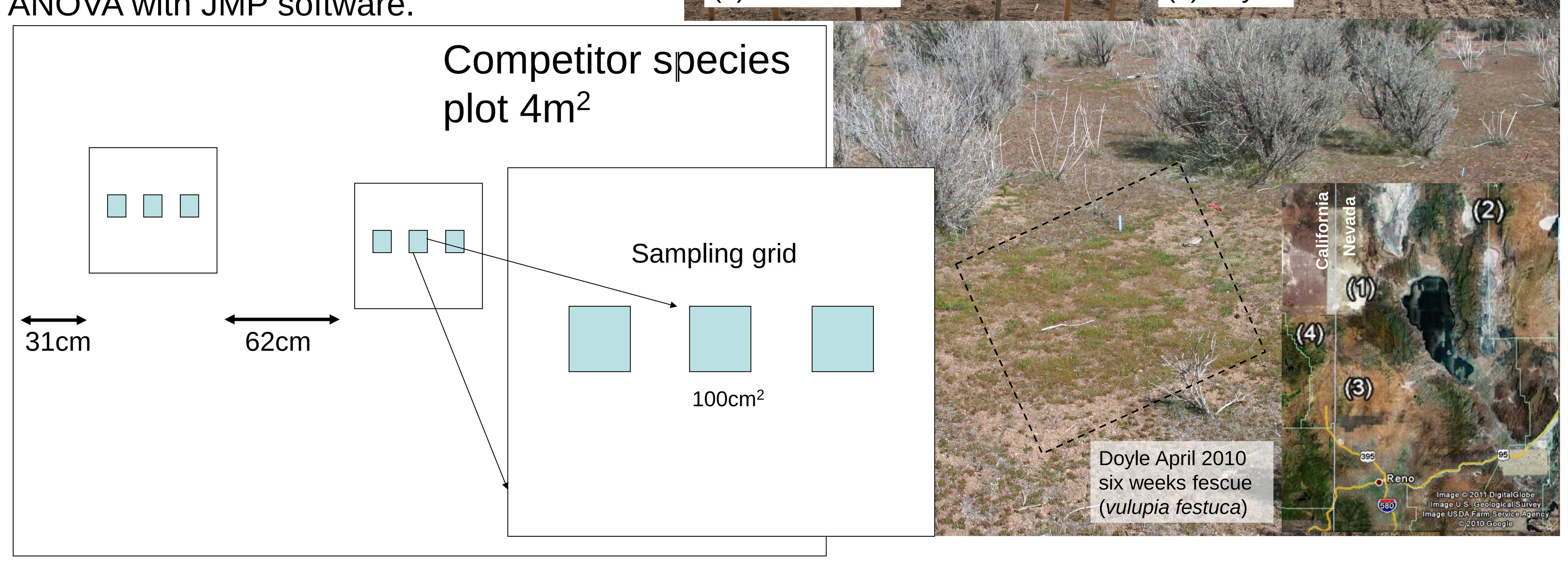
Experiments were conducted at the ARS greenhouse facilities in Reno Nevada. Two and a half gallon (8.83 dm³) pots with low nitrogen soil (see Results: Table 1) were used. Pots were regularly watered as to maintain adequate moisture. Sylvania lumalux LU400 lights were used to maintain a 16/8hr light/dark cycle. The response variable was the above ground biomass including seed production of one target cheatgrass plant (A & B) after 16 or 24 weeks of growth. We used one primary treatment: presence (A) or no presence (B) of a competitor in the pot with the single target cheatgrass plant. We used a natural (heavy) seed rain in the pots for competitor native annual species and used the randomly occurring seedling density (C) as would occur naturally in the field (D). We also used two secondary treatments: (1) delaying cheatgrass germination 4 weeks post competitor germination and (2) adding fertilizer (Miracle grow® all purpose fertilizer) one time application after six weeks cheatgrass growth to the "delayed" treatment pots. twelve competitor species were each tested separately. Soil pH, EC and nutrient levels were measured post experiment (Table 3). Cheatgrass biomass comparisons were made using a one way ANOVA with JMP software.



Field study

Multiple native annual species (table 2) were broadcast separately at four sites near northwestern Nevada in November 2009. All sites were infested with cheatgrass. Each native species was broadcast and raked over a 1m x 4m plot at a natural seeding rate (high seeding rate >50seeds/3dm). Cheatgrass biomass was sampled in June 2010. All biomass was collected in a fixed 100cm² square (n=9) for each individual competitor species and control plots. Biomass was only collected from plots were the competitor species established. Cheatgrass biomass comparisons were made using a one way ANOVA with JMP software.





RESULTS

	pH	EC ds⁻ᵐ	NH_4^+ ppm	NO_3^- ppm
Control	7.52	1.12	3.83	22.16
Cheatgrass Control	7.78	0.34	0.38	1.94
Primary Treatment (*Chenactis stevoides*)	7.72	0.32	1.14	1.57
Secondary Treatment (*Chenactis stevoides*) Delay + Fertilized	7.68	1.27	0.30	1.25
Flanigan*	7.6	0.21	0.61	1.51
Empire*	7.15	0.29	1.29	5.43
Comparison Soil	7.4	19.5	3.31	290.1

Table 1. Soil values following greenhouse experiment. **Control** soil = watered with no plants, **Cheatgrass Control** = 1 cheatgrass plant, **Primary and Secondary Treatments** = 1 cheatgrass plant and multiple competitor plants, and **Comparison Soil** = Cheatgrass competition study conducted by University Nevada Reno during the same year in the same greenhouse.
*Field soils were sampled from 10cm depth in April.

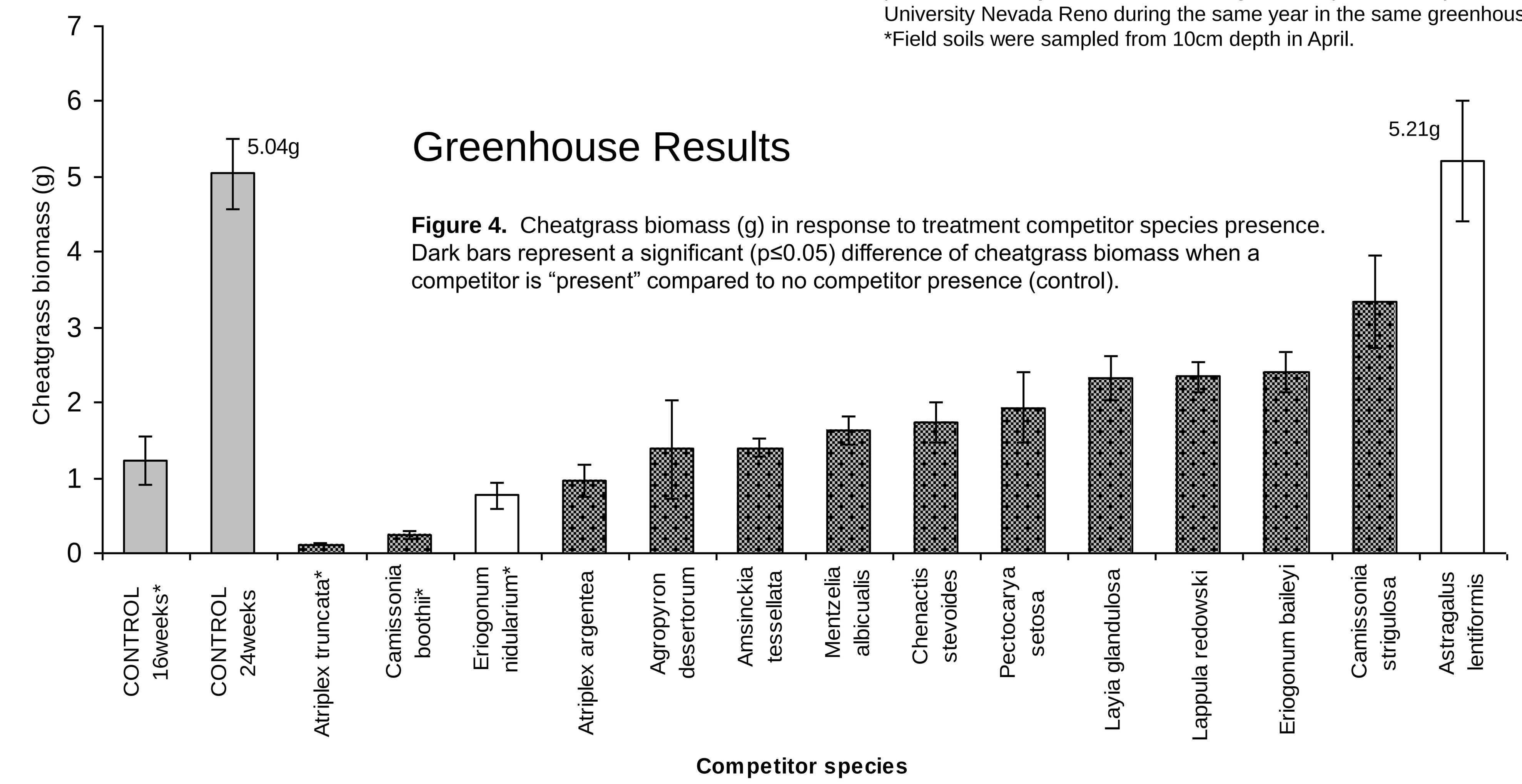
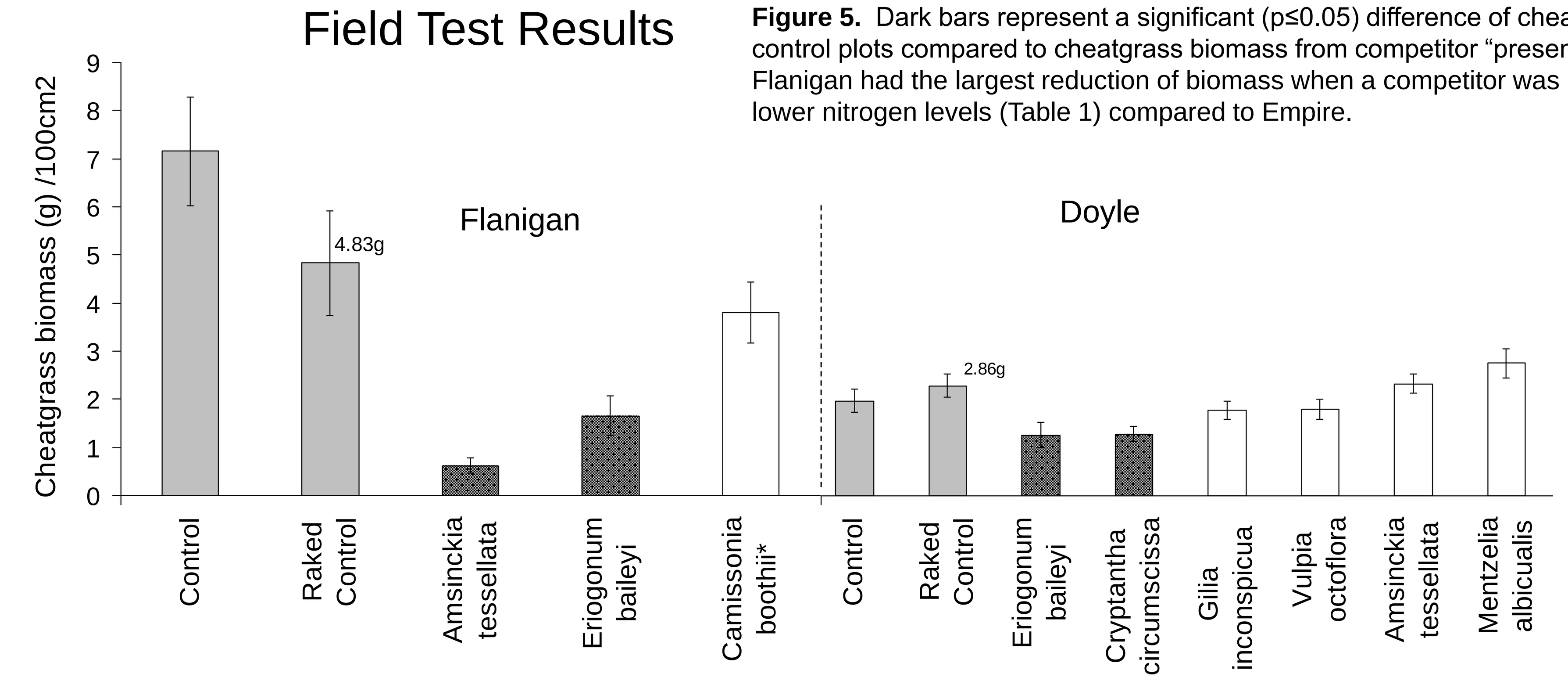
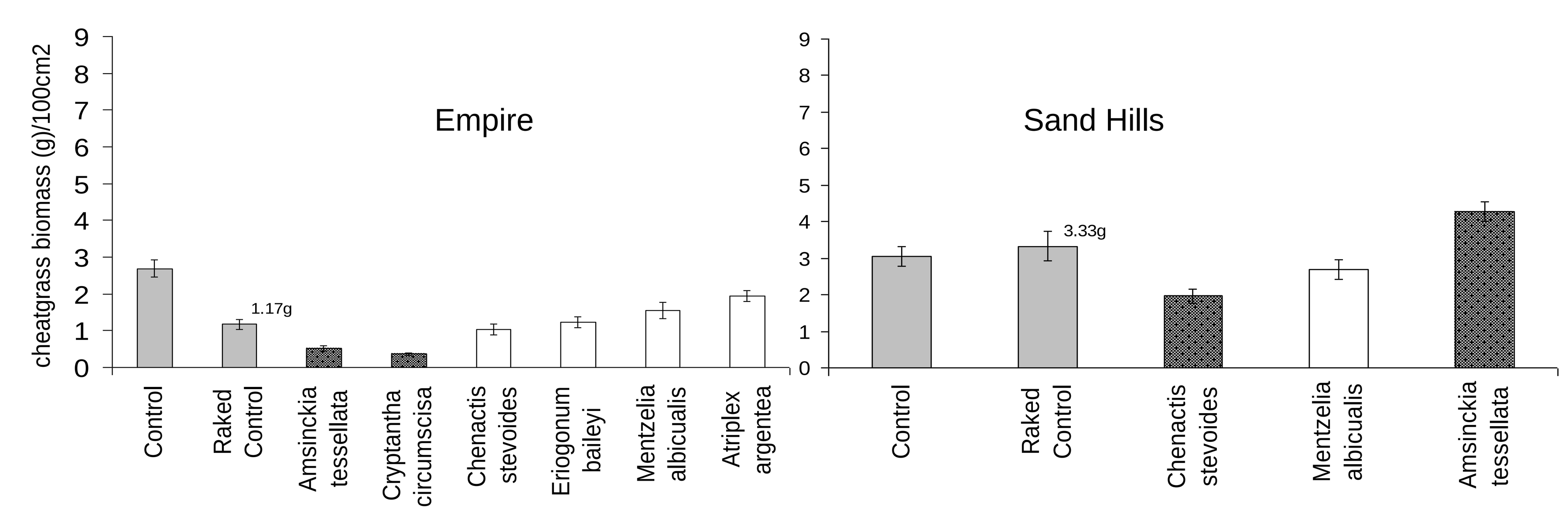


Figure 4. Cheatgrass biomass (g) in response to treatment competitor species presence. Dark bars represent a significant (p≤0.05) difference of cheatgrass biomass when a competitor is "present" compared to no competitor presence (control).

Field Test Results

Figure 5. Dark bars represent a significant (p≤0.05) difference of cheatgrass biomass control plots compared to cheatgrass biomass from competitor "present" plots. Flanigan had the largest reduction of biomass when a competitor was present and lower nitrogen levels (Table 1) compared to Empire.





Fall germination of cheatgrass is often earlier than native plants. Timing is thought to be one major advantage it has. Native annual germination timing can vary greatly from year to year. At our field sites minimal Fall cheatgrass germination occurred (Nov-Dec 2009). Most native annuals emerged at the same time as cheatgrass at our field test sites in 2010.

Literature cited

Harmon, D.N., Clements, C.D. 2010. Revegetation Potential of Great Basin Native Annuals and Perennial Grasses: Does Facilitation Occur? [abstract]. Society for Range Management. 63:64.