Managing Invasive Range Plants in Beef-Cattle Grazing Systems:
The Tale of Sericea Lespedeza in Native Tallgrass Prairie

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Tallgrass Prairie in North America

- **Covered 165 million acres prior to European settlement**
  - 6.2 million acres (4%) remains
- **The remnant is home to more than:**
  - 500 plant species
  - 700 insect species
  - 185 bird species
  - 40 mammal species
- **More ecologically diverse than rain forest ecosystems**
- **Provides an array of ecosystem services including carbon sequestration and water recycling**
- **Fire return intervals of 2 to 4 years**

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Tallgrass Prairie in North America

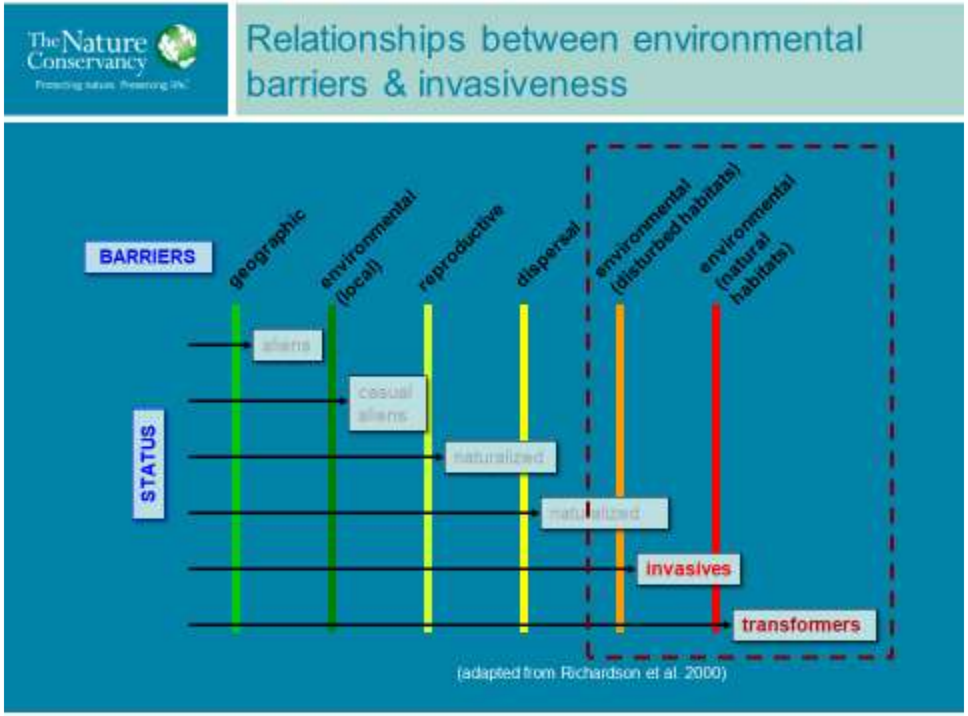
- **Dominated by C4 native grasses**
  - Leguminous native forbs fix N
  - Capable of producing ~ 4,000 kg DM per ha without agronomic inputs
  - Supports yearling cattle gains that exceed 1 kg per day during summer
- **Annually home to:**
  - ~ 1.3 million transient stocker cattle
  - ~ 500,000 beef cows
- **Provides sustainable income for many families and rural communities**
- **Susceptible to invasion by exotic plants**

Blasi et al., 2008
NASS, 2019

Sericea Lespedeza: An Ecological Transformer

"About 10% of invasive plants that change the character, condition, form, or nature of ecosystems over substantial areas may be termed *transformers*."

- **Richardson et al. (2001) Diversity & Distributions 6:93-107**



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Sericea Lespedeza: An Ecological Transformer

- **Tolerant of poor soils**
- **Deeply-rooted perennial**
- **Robust canopy**
- **Resistant to grazing**
- **High in condensed tannins**
- **Prolific seed production**
- **Extended seed dormancy**

- **Treatment with specialty herbicides is common**
  - **Herbicide treatment results in collateral damage to non-target native plants, insects, and wildlife**

Eddy et al., 2003
KDA, 2016

Where to begin? Start with basic questions.

How does [CT] fluctuate over time?

Effect of harvest date on concentration and protein-binding capacity* of CT in sericea lespedeza (DM basis)

Sampling date	Growth stage	[CT], g/kg	Protein-binding [CT], g/kg
June 1	Single-stem	103.9[a]	48.0[a]
July 1	Multiple-stem	151.1[b]	68.6[b]
August 1	Budding	191.1[d]	94.0[c]
September 1	Flowering	169.4[c]	88.6[a]
October 1	Mature	145.4[b]	69.6[b]
SEM	-	5.02	1.05

* Total phenolic compounds which precipitated proteins.

a, b, c, d Within a column, means without a common superscript differ ($P < 0.01$).

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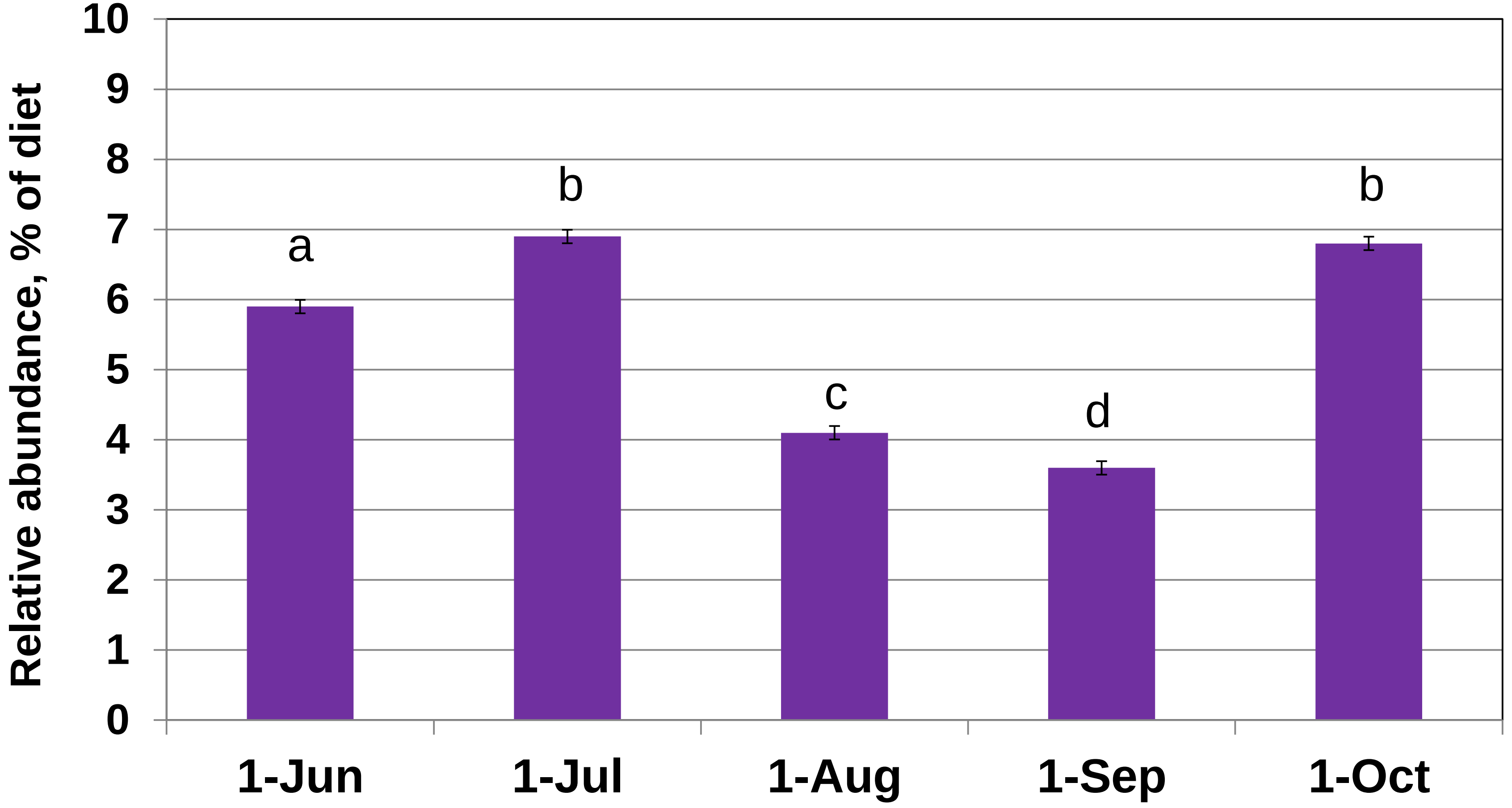
Preedy et al., 2013

How much will experienced cattle eat?

Relative abundance of sericea lespedeza in diets of beef cows grazing native range in the Kansas Flint Hills



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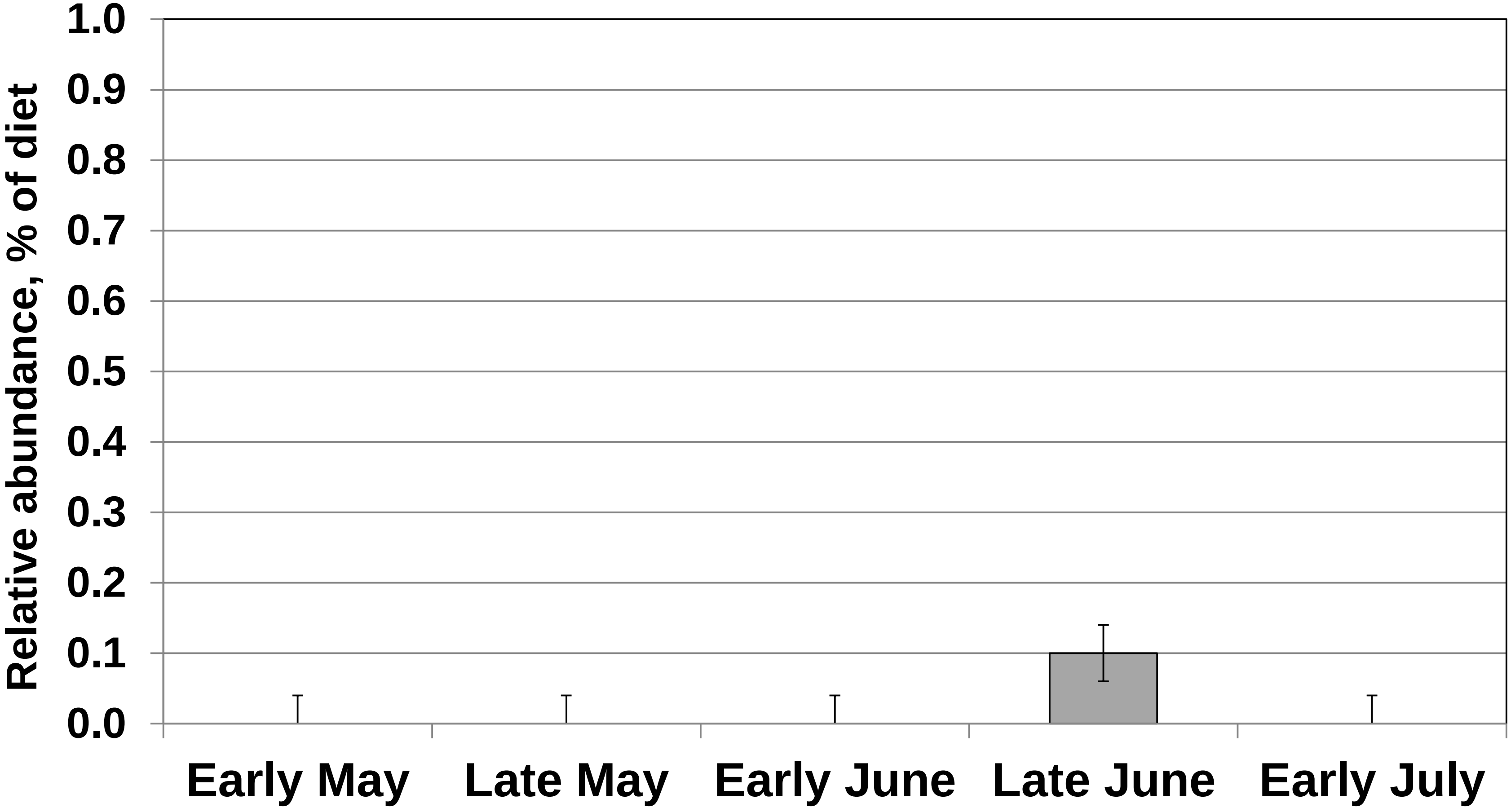
Preedy et al., 2013

[a, b, c, d] Means without a common superscript differ ($P < 0.01$).

How much will naive cattle eat?

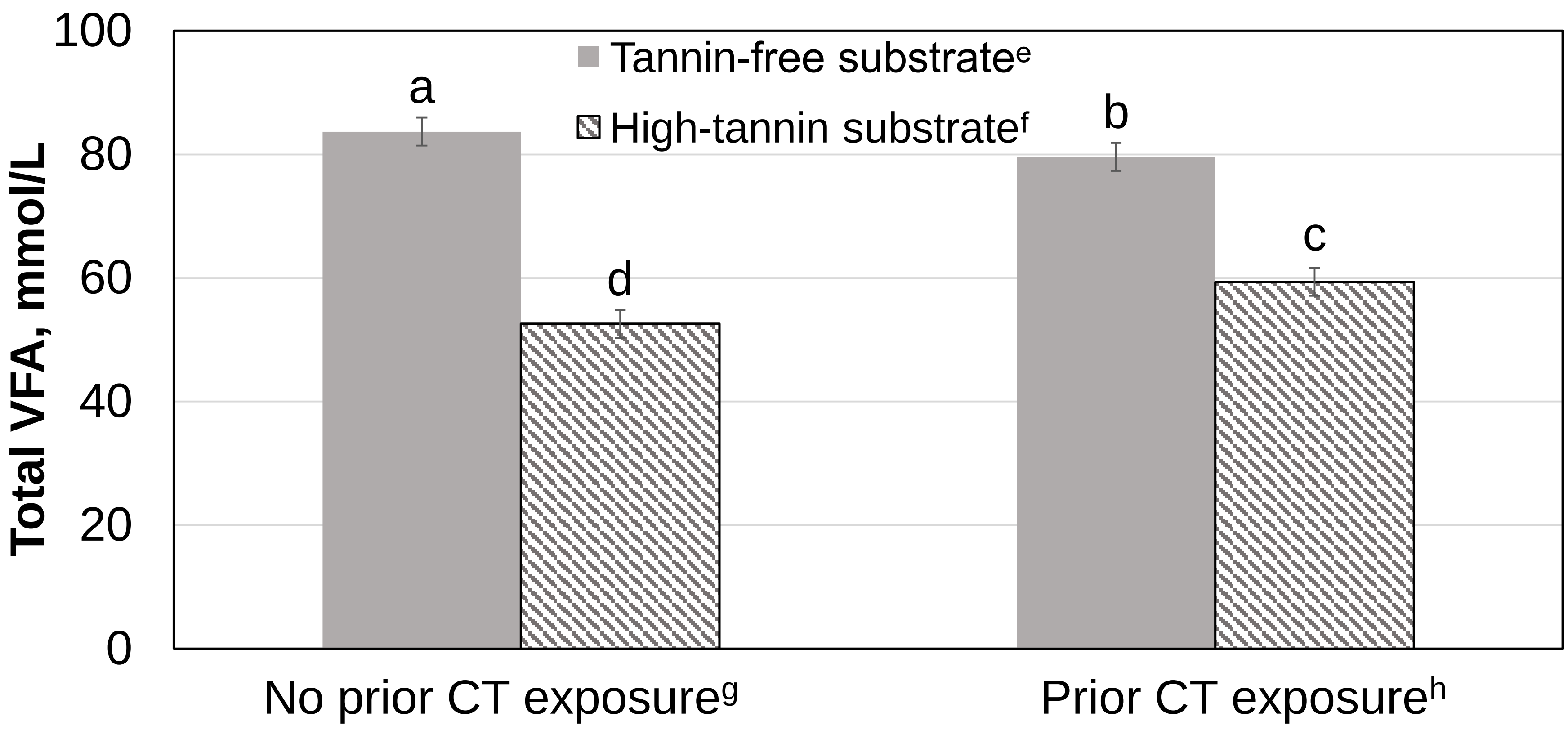
Relative abundance of sericea lespedeza in diets of yearling beef steers grazing native range in the Kansas Flint Hills



Sowers et al., 2019

Can ruminal microbes adapt to a high CT diet?

Effects of Culture Substrate and Prior Tannin Exposure on Total VFA Concentration



Hoehn et al., 2018

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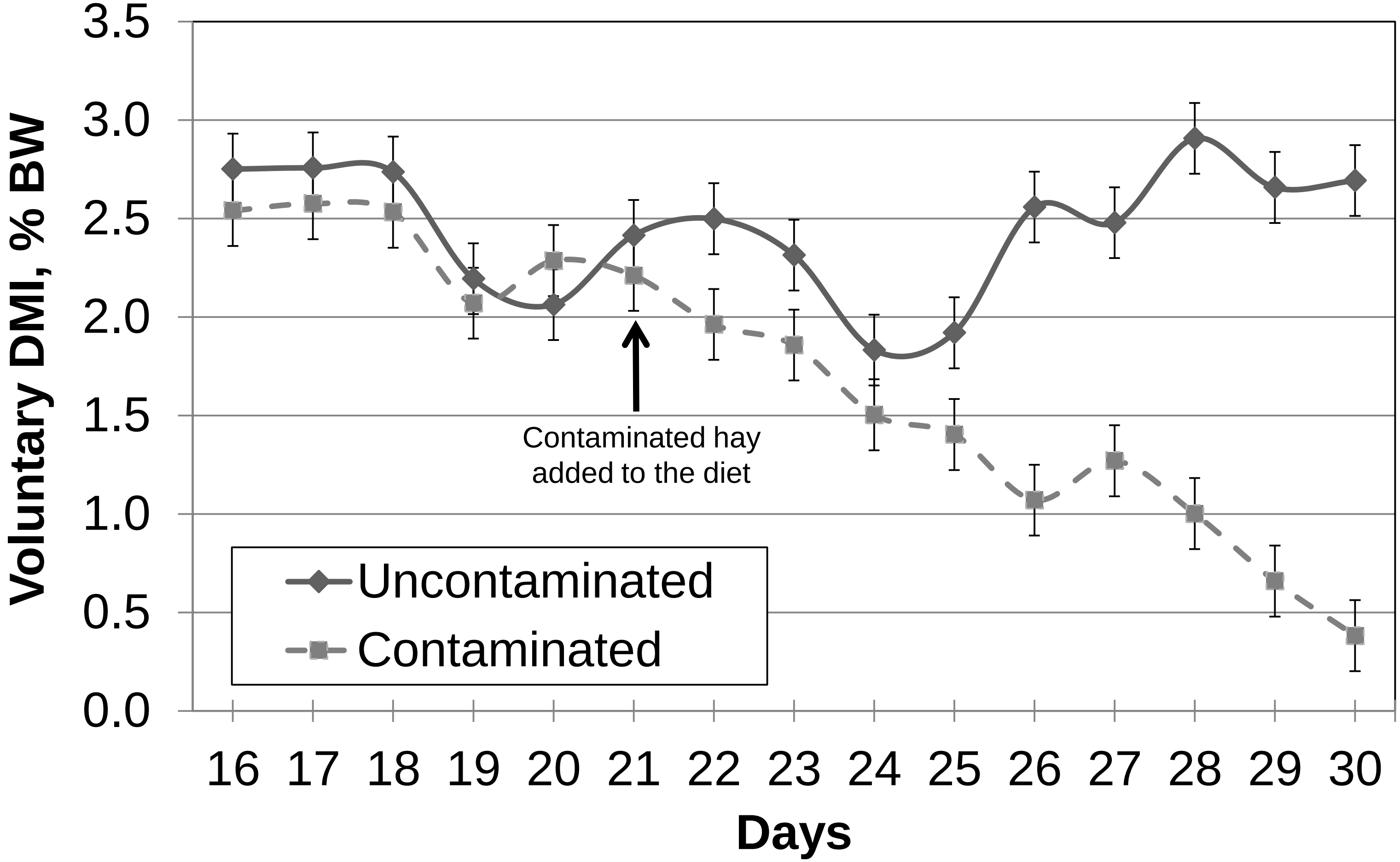
[a, b, c, d] Means with unlike superscripts differ (P < 0.001).
[e., f] High CT or tannin-free substrate.
[g, h] Adapted to high CT or tannin-free substrate for 21 d.

Can we study intake in confinement?

Effects of sericea lespedeza contamination* on intake of tallgrass prairie hay by beef cows



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Eckerle et al., 2011a

* Contaminated prairie hay = 5.5% CP, 41% ADF

* Uncontaminated hay = 5.4% CP, 40% ADF

Can the effects of CT on ruminal N availability be managed?

Binding affinity of condensed tannins for bovine serum albumin (BSA) in the presence of polyethylene glycol (PEG) or corn steep liquor (CSL)*

Sample	Mitigator	Mitigator Dose[a]	True Protein Availability[b] (%)	CT-Bound Protein[c] (%)
Tannin + BSA	None	0	42.7	57.3
Tannin + BSA	PEG	16	59.0	41.0
Tannin + BSA	CSL	16	155.7	-

[a] Mitigator dose is expressed as mg/mg BSA in the original sample.
[b] True protein availability was expressed as % BSA protein in the original sample.
[c] CT-bound protein was expressed as the inverse of true protein availability.
* CSL = 45.1% DM, 34.4% CP (DM basis).

Can the effects of CT on ruminal N availability be managed?

Effects of increasing dose of corn steep liquor (CSL) on intake and digestion of tallgrass prairie hay contaminated by sericea lespedeza

	Corn steep liquor intake, (kg DM /d)				
Item	**0**	**0.6**	**1.2**	**1.8**	**SEM**
Forage DMI, g/kg $BW^{0.75}$	69.9[a]	80.7[b]	80.9[b]	84.6[b]	3.09
Total-tract DM Digestibility, %	52.6[a]	55.6[a]	65.6[b]	66.3[b]	2.02
Total-tract N digestibility, %	-1.5[a]	18.6[b]	51.7[c]	52.3[c]	1.94
Total digestible DMI, g/kg $BW^{0.75}$	40.9[a]	55.0[ab]	75.2[bc]	87.6[c]	2.14

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Eckerle et al., 2011b

[a, b, c] Means within a row lacking common superscripts differ ($P > 0.05$).

Can CT mitigation influence diet selection?

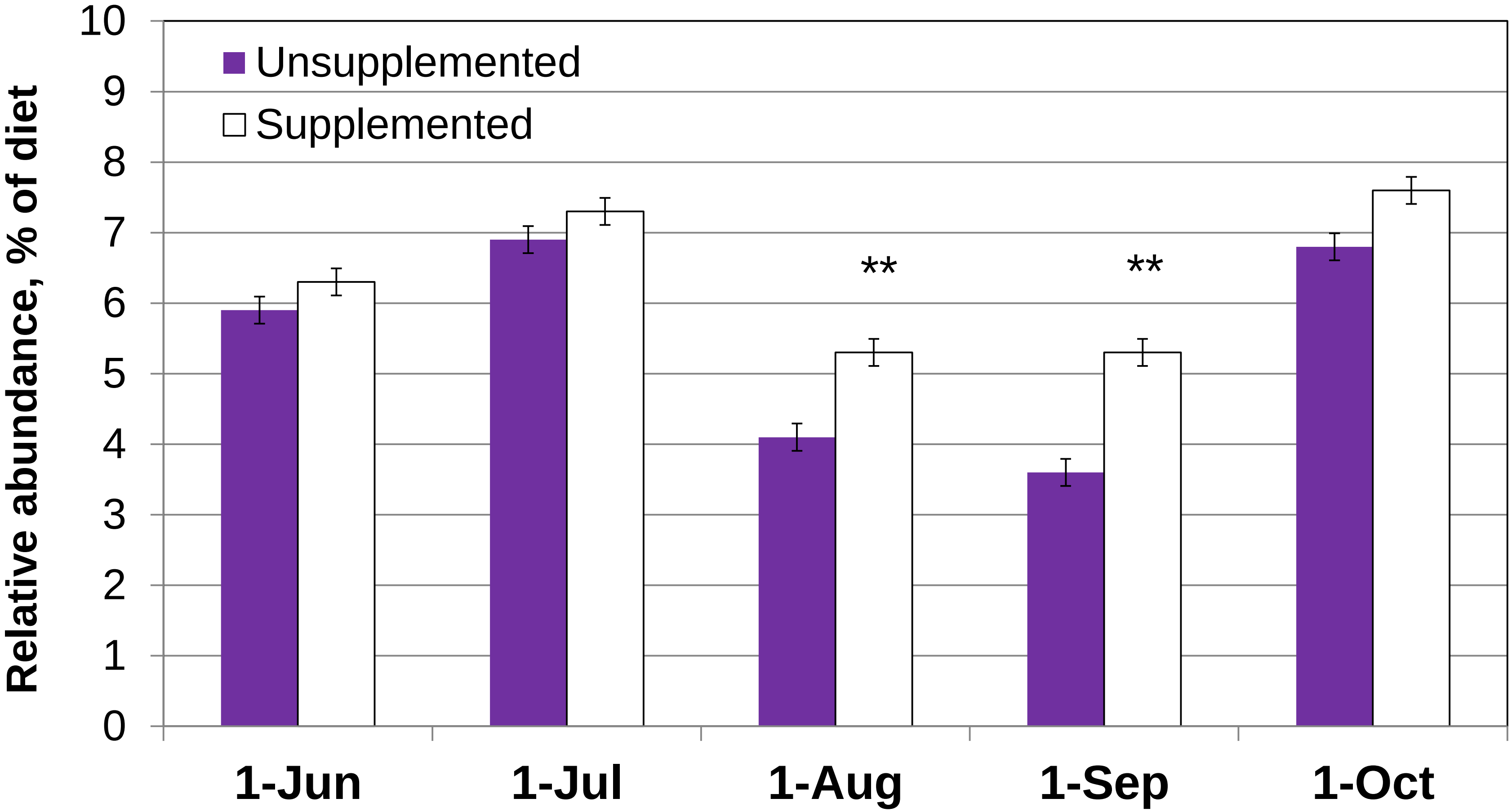
Effects of low-level CSL supplementation on forage intake and total tract digestion

	CSL intake, (kg DM /d)			
Item	**0**	**0.6**	**SEM**	***P* - Value**
Uncontaminated forage DMI, g/kg $BW^{0.75}$	43.6	41.6	3.10	0.65
Contaminated forage DMI, g/kg $BW^{0.75}$	50.3	63.0	2.48	< 0.01
Total forage DMI, g/kg $BW^{0.75}$	93.9	104.7	3.90	0.05
Total-tract DM digestibility, %	50.5	53.9	1.66	0.17
Total digestible DMI, g/kg $BW^{0.75}$	48.7	63.7	3.49	< 0.01

Eckerle et al., 2011c

Can CT mitigation work under field conditions?

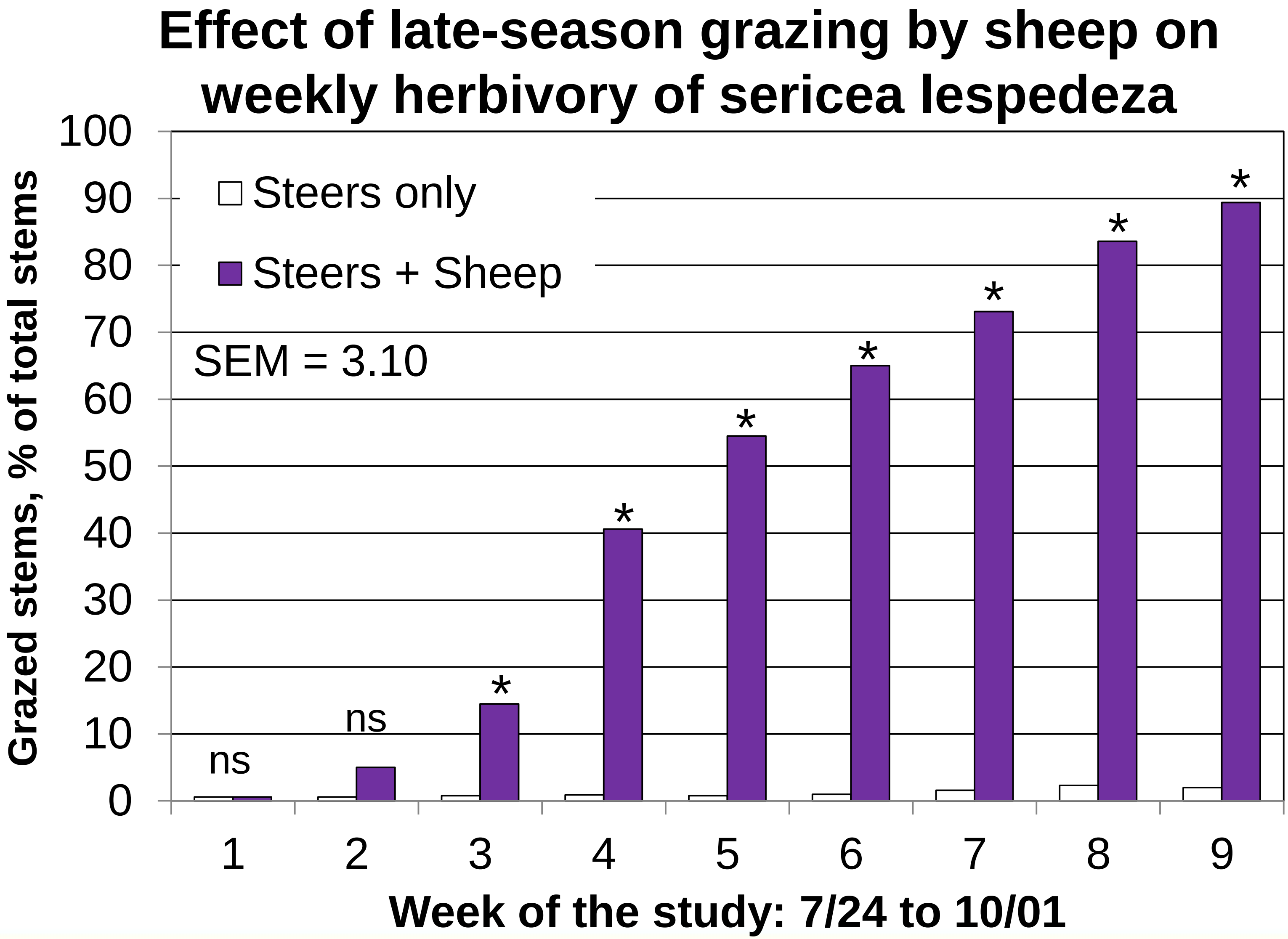
Effects of corn steep liquor supplementation on the abundance of sericea lespedeza in diets of grazing beef cows



Preedy et al., 2013

** Treatments differ within month (*P* < 0.01)

Can targeted grazing by small ruminants be used to control sericea lespedeza?



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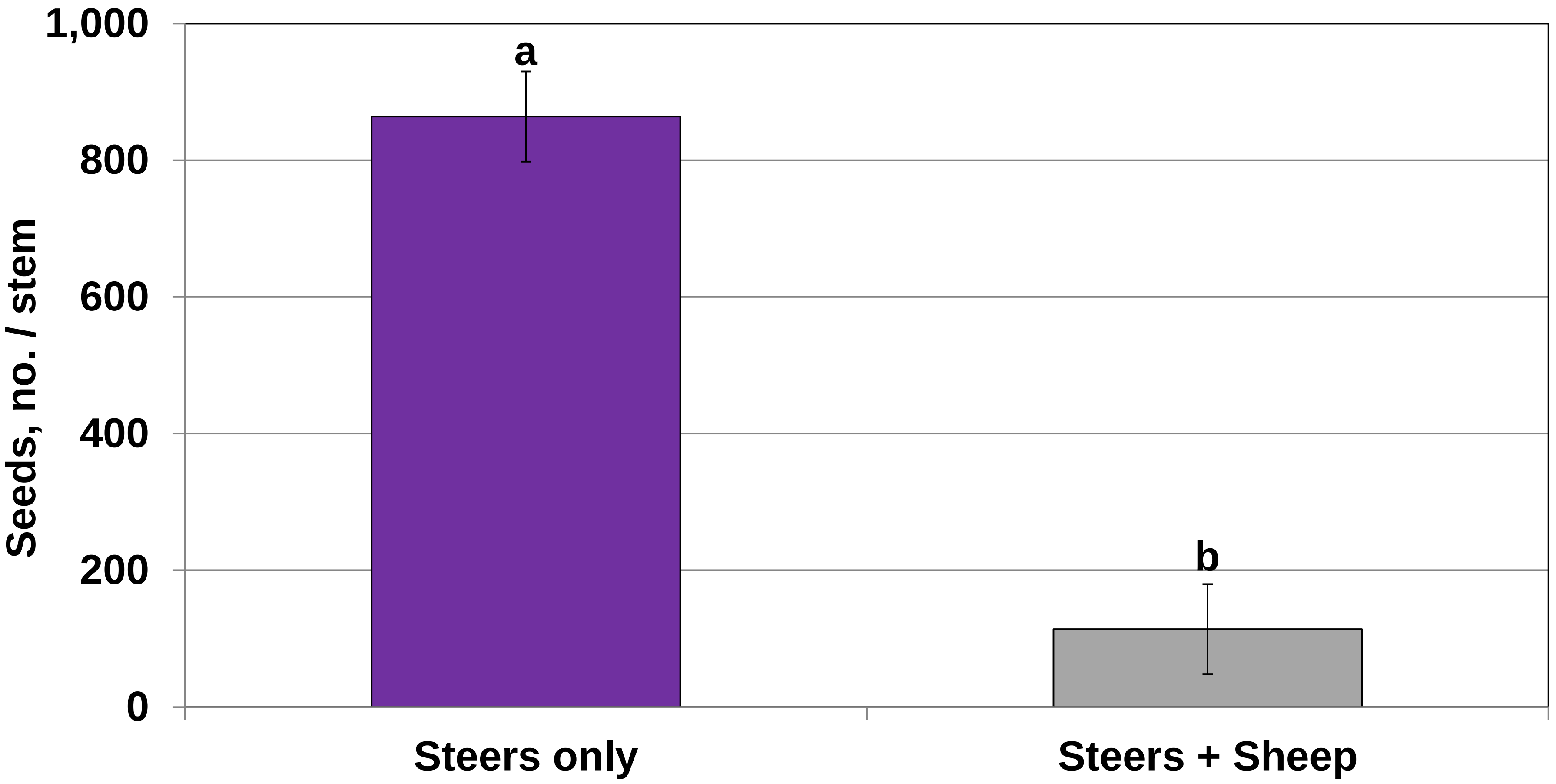
Lemmon et al., 2017

* Treatments differ within week (*P* < 0.01)

Effect of late-season grazing by sheep on seed production by sericea lespedeza



Lemmon et al., 2017

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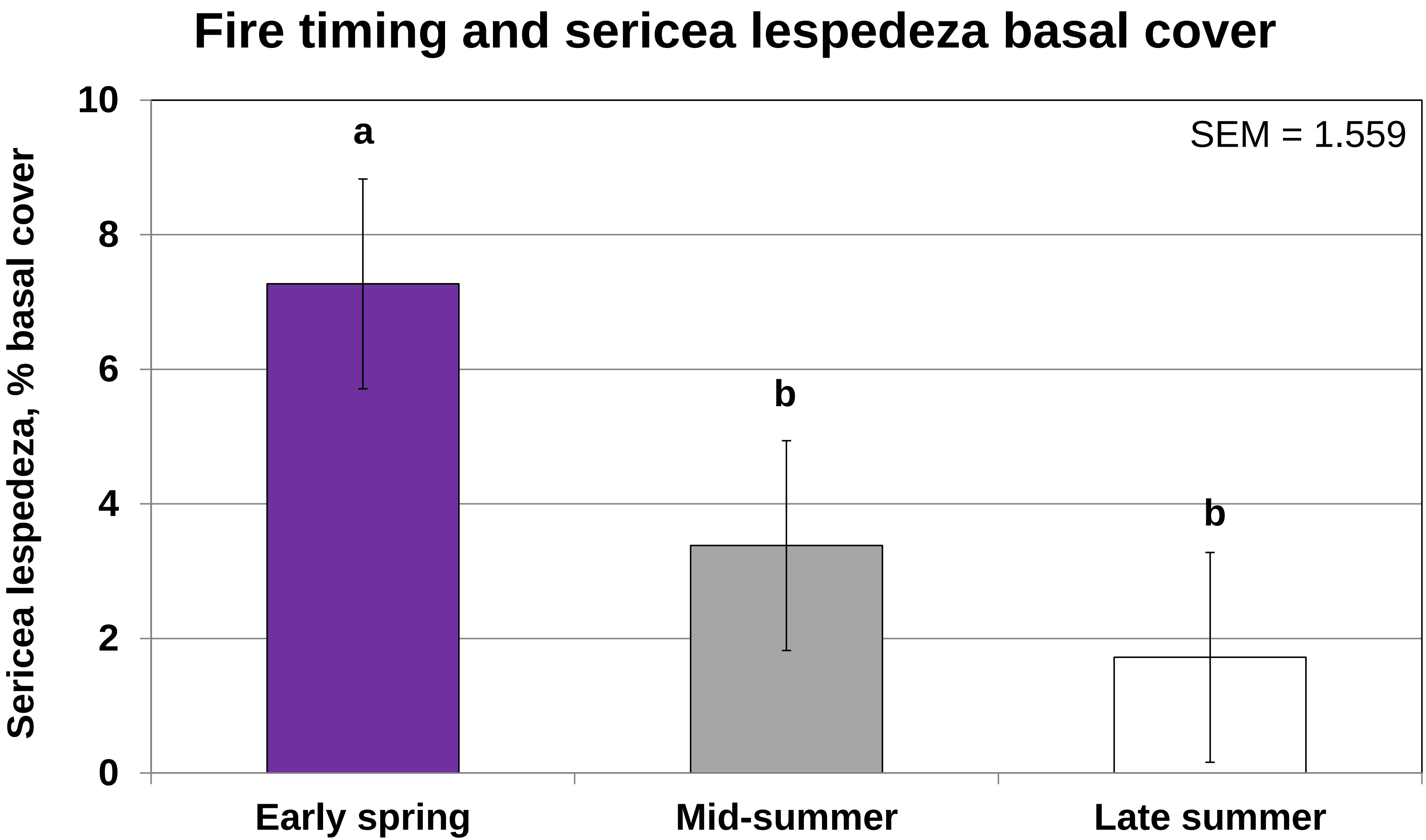

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Alexander et al., 2019

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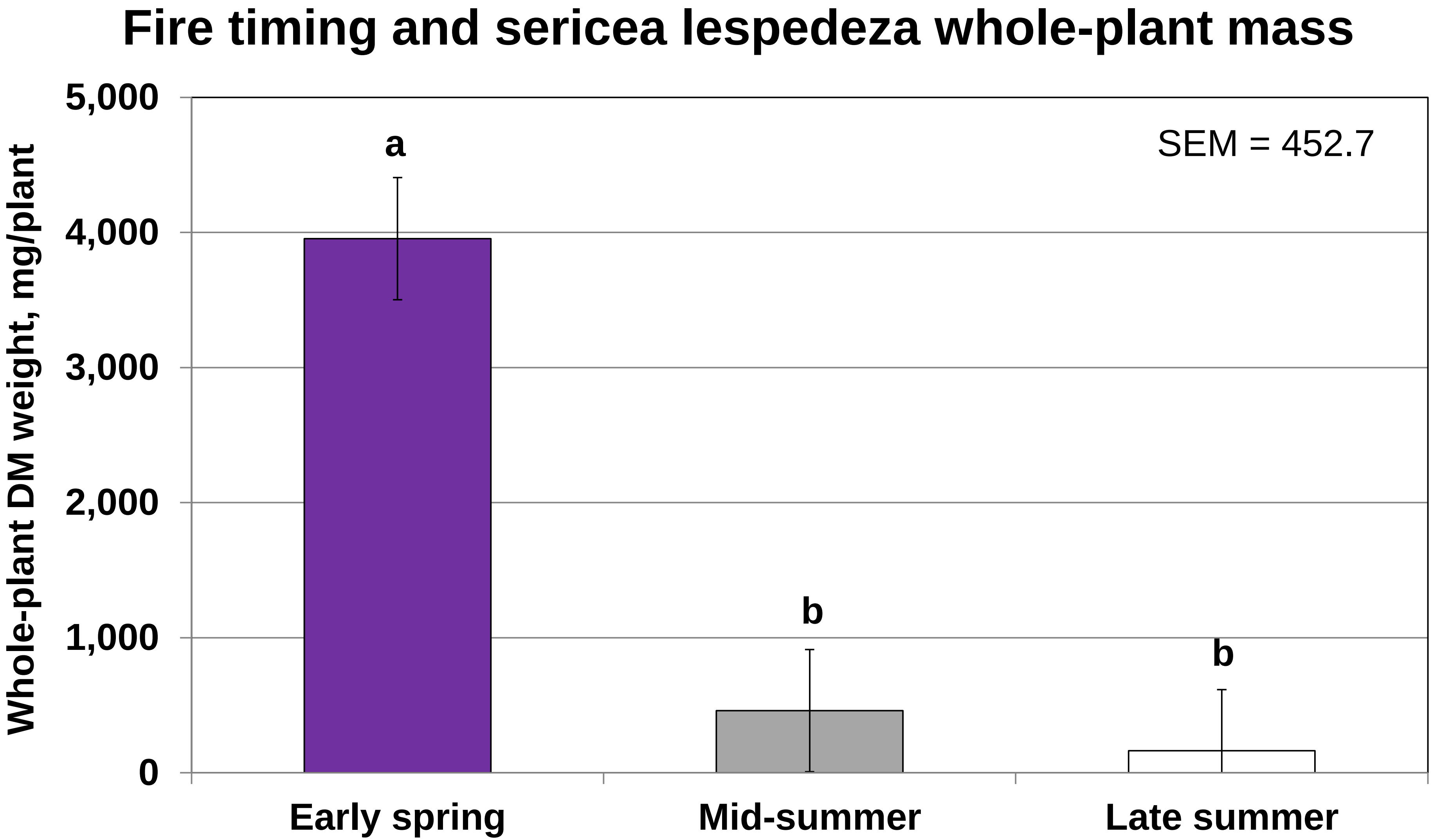

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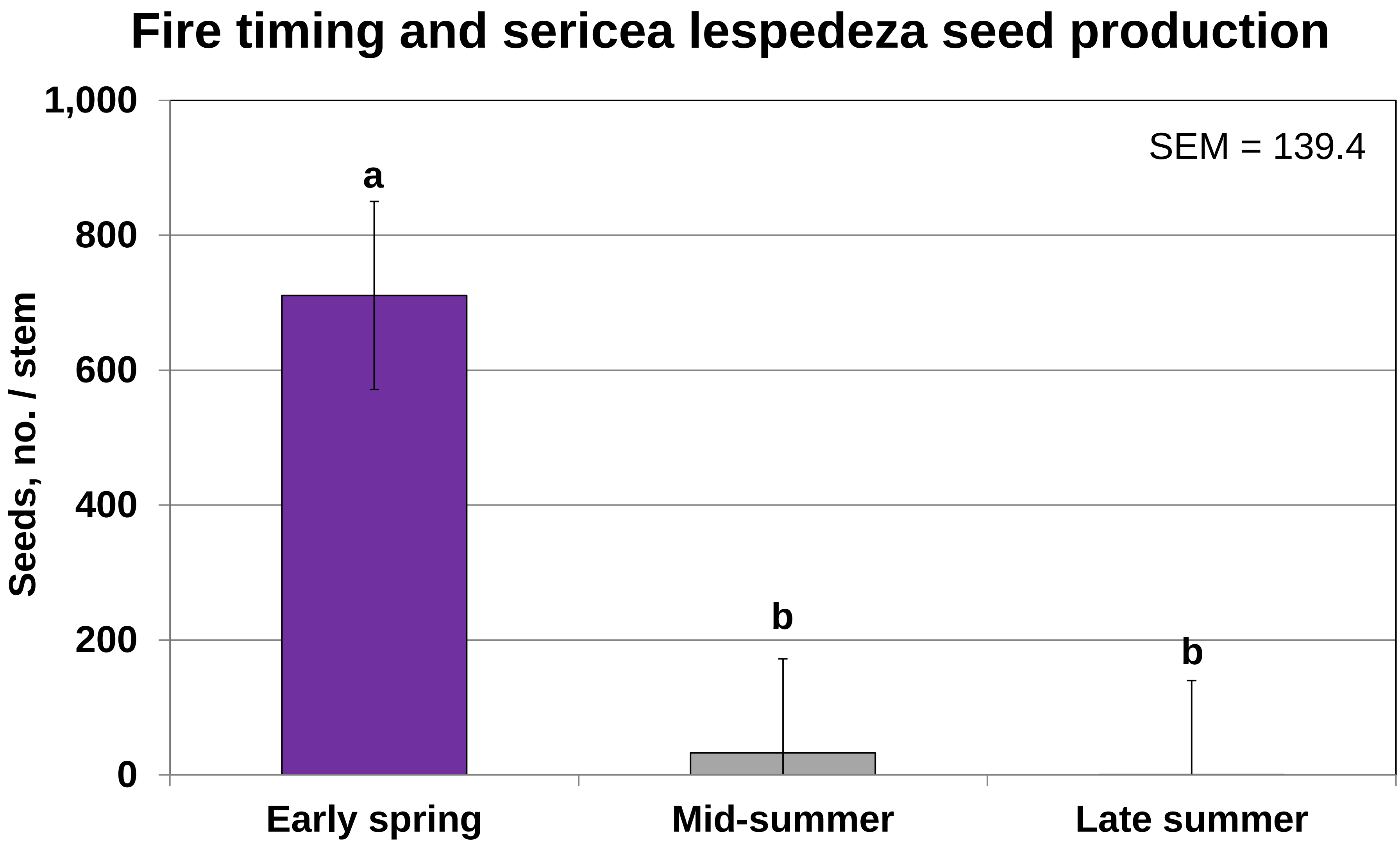

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Alexander et al., 2019

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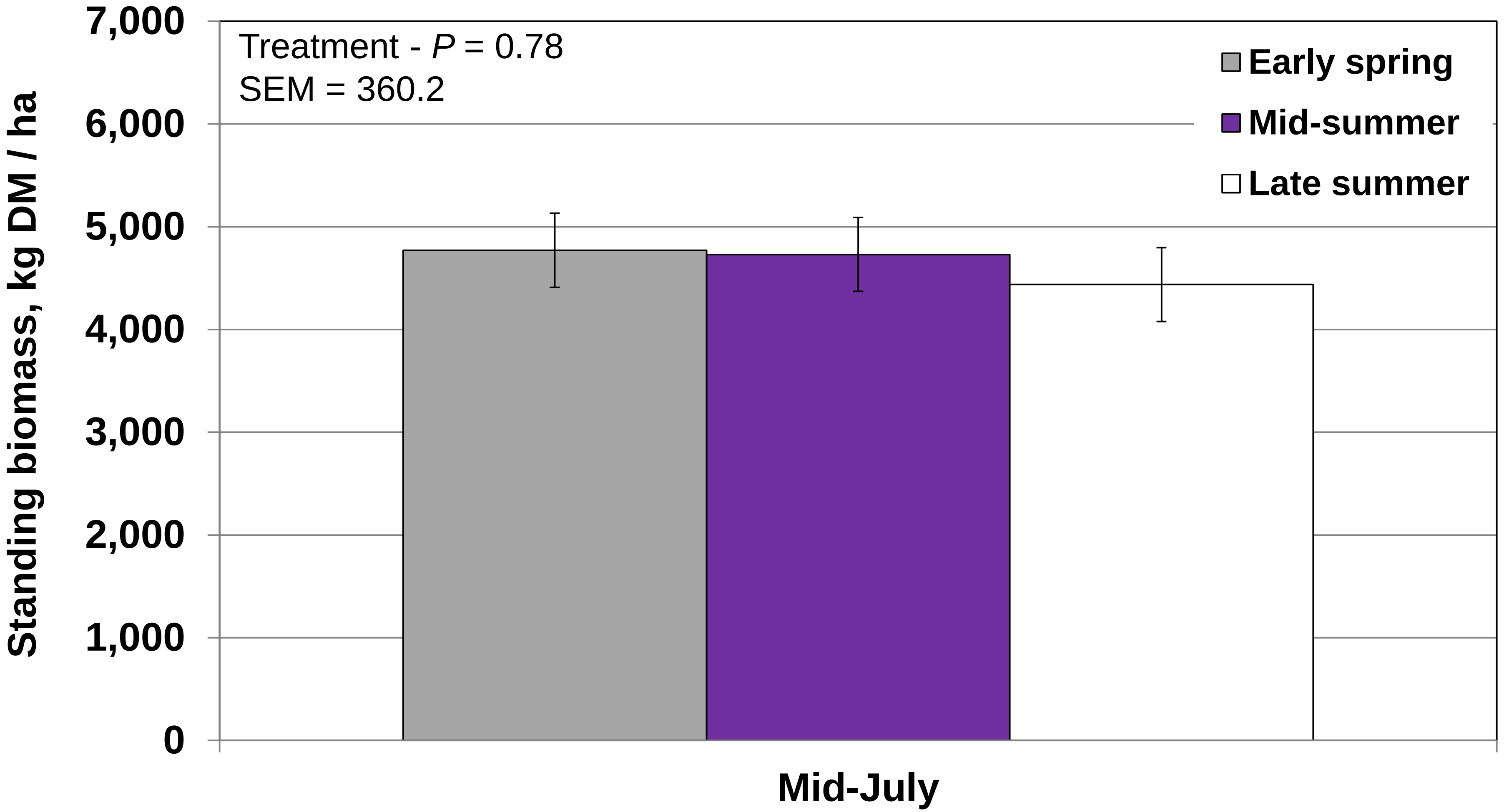
Spring Burn 2014
Mid-Summer Burn 2014
Late-Summer Burn 2014
Pasture 5
27167.0 mg
Pasture 1
968.3 mg
Pasture 2
0 mg
Pasture 6
54662.0 mg
Pasture 4
3502.0 mg
Pasture 3
0 mg
Pasture 9
30355.0 mg
Pasture 7
225.0 mg
Pasture 8
8.10 mg


Spring Burn
2017
Mid-Summer Burn
2017
Late Summer Burn
2017
Pasture 5
27524.10 mg
Pasture 1
691.50 mg
Pasture 2
0 mg
Pasture 6
35719.20 mg
Pasture 4
12.10 mg
Pasture 3
0 mg
Pasture 9
25832.90 mg
Pasture 7
698.40 mg
Pasture 8
0 mg


So… what happened to everything else?

Fire timing and peak forage biomass



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Pasture # 8
Burned 08.01.14
Pictured on 09.26.14

Fire timing and graminoid cover, % of total basal cover

Item	Early spring	Mid-summer	Late summer	SEM*	P-value†
Total grass cover, %	82.8	85.9	86.5	2.17	0.20
C4 grasses, %	67.7	65.9	64.8	3.40	0.70
C3 grasses and sedges, %	15.1	19.7	21.7	3.11	0.11
Annual grasses, %	0.07	0.33	0	0.227	0.31

* Mixed-model SEM associated with comparison of treatment main effect means.

† Treatment main effect.

Fire timing and forb cover, % of total basal cover

Item	Early spring	Mid-summer	Late summer	SEM*	P-value†
Total forb cover, %	15.4	12.1	11.2	2.28	0.16
Perennial forbs, %	15.3[a]	10.9[b]	9.7[b]	2.05	0.02
Sericea lespedeza, %	7.3[a]	3.4[b]	1.7[b]	1.56	< 0.01
Baldwin's ironweed, %	0.7[a]	0.2[b]	0.4[b]	0.16	0.01
Western ragweed, %	3.3[a]	0.9[b]	0.7[b]	0.53	< 0.01
Major wildflowers, %	0.6[a]	0.9[ab]	1.4[b]	0.28	0.03
Annual forbs, %	0.1[a]	1.2[b]	1.5[b]	0.52	0.02

* Mixed-model SEM associated with comparison of treatment main effect means.

† Treatment main effect.

a, b Within row, means with unlike superscripts differ ($P \leq 0.05$).

Fire timing and forb cover, % of total basal cover

Item	Early spring	Mid-summer	Late summer	SEM*	P-value†
Total forb cover, %	15.4	12.1	11.2	2.28	0.16
Perennial forbs, %	15.3[a]	10.9[b]	9.7[b]	2.05	0.02
Sericea lespedeza, %	7.3[a]	3.4[b]	1.7[b]	1.56	< 0.01
Baldwin's ironweed, %	0.7[a]	0.2[b]	0.4[b]	0.16	0.01
Western ragweed, %	3.3[a]	0.9[b]	0.7[b]	0.53	< 0.01
Major wildflowers‡, %	0.6[a]	0.9[ab]	1.4[b]	0.28	0.03
Annual forbs, %	0.1[a]	1.2[b]	1.5[b]	0.52	0.02

* Mixed-model SEM associated with comparison of treatment main effect means.

† Treatment main effect.

‡ Combined basal cover of catclaw sensitive briar, dotted gayfeather, heath aster, prairie coneflower, purple poppy-mallow, purple prairie-clover, round-headed prairie clover, and white prairie-clover.

a, b Within row, means with unlike superscripts differ ($P \leq 0.05$).

Fire timing and plant-species diversity

Item	Early spring	Mid-summer	Late summer	SEM[*]	P-value[†]
Overall species richness	22[a]	27[b]	27[b]	1.6	< 0.01
Native species richness	21[a]	25[b]	26[b]	1.6	< 0.01
Graminoid richness	10	11	11	0.6	0.46
Forb richness	10[a]	15[b]	15[b]	1.2	< 0.01
Forb evenness	0.70[a]	0.76[b]	0.81[b]	0.039	0.02
Forb diversity	0.57[a]	0.73[b]	0.83[b]	0.066	< 0.01

[a, b] Within row, means with unlike superscripts differ ($P \leq 0.05$).

Lessons Learned

- Most of the value of rangeland to society can't be quantified by animal production or animal-based revenue
- Understanding the basic biology of invasive organisms is essential to find their Achilles' Heel(s)
- For most invasive organisms, multi-faceted control mechanisms will likely be necessary to cover an inclusive range of land managers
- You won't know all you need to know to find answers – learn it from colleagues and students
- Every location has enigmatic agricultural problems, related to invasive species or otherwise.
  - Some are shared with other regions. You own the rest. Don't expect enthusiastic buy-in from "outside" funding sources.
  - Find ways to engage the stakeholder base.
  - Keep knocking on doors; eventually, somebody with a checkbook will respond.