

By Tom Getts UCCE

Lassen, Modoc, Plumas-Sierra County

## Intro:

So my question is, where was winter? As I write the snowpack is pretty abysmal, so we might be in for a rough summer. Currently we are sitting at 54% of average for this date, and at 45% of the April first cut off. We got a couple good shots of precipitation, but I'll be praying for a miracle march to catch us up!

So, what does this warm dry weather mean for forage producers? First is that it is time to think about weed control. Weeds germinated early last year and they have been growing like gangbusters. Getting out to make some applications to the winter annuals should be a high priority before they get much bigger. If they are too large now, then going with a systemic herbicide might be more effective than a traditional contact burndown option down the line.

Another thought is what to do in terms of water and irrigation scheduling. The first article in this issue will focus on some of the work done by the late Steve Orloff investigating strategies to maximize production in a low water year. The rest of the articles are focused on some of the work I have been doing that I wanted to share with you all. As always, I am happy to discuss any of these topics or whatever you have going on, feel free to pop by the office, or shoot me a call on my cell, which is probably the most reliable way to get ahold of me!

970-481-9174.

Cheers,

Tom

**SAVE THE DATE:**  
**Growers Meeting March 31<sup>st</sup>**  
**Late afternoon/evening.**  
**Dinner provided!**  
**Agenda to follow soon.**

- **Irrigation in a Low Water Year pg 1-3**
- **Annual Grasses in Dryland Pasture pg 4-9**
- **Resistant Kochia pg 10-15**
- **Puncturevine (Goathead) pg 16-22**

## Summarizing Steve's Strategies for Irrigation in a Low Water Year

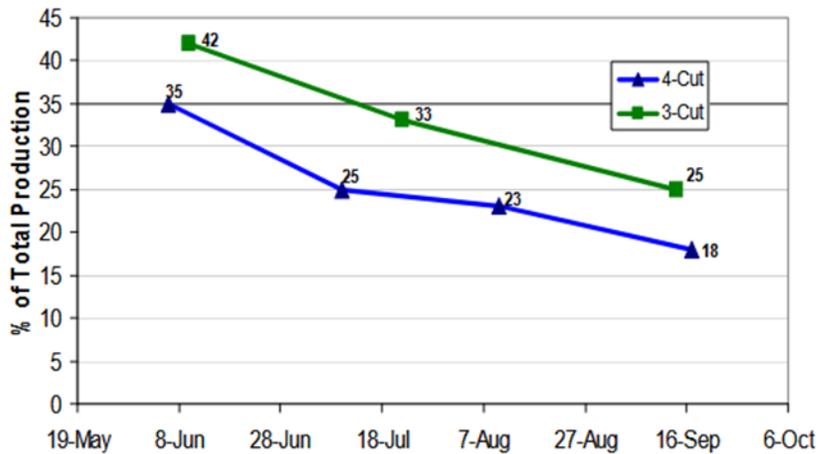
Data and ideas in this article can be attributed to the numerous alfalfa symposium proceedings authored by Steve Orloff, Dan Putnam, and Khaled Bali. For more information you can find the articles and information below. On the note of the alfalfa symposium, if you have questions about forages the symposium database is an excellent place to get science backed information relevant to the issues you might be facing.

**DEFICIT IRRIGATION OF ALFALFA AND GRASSES: WHAT ARE THE IMPACTS/OPTIONS?** Steve Orloff, Khaled Bali and Dan Putnam1 (article link) [Microsoft Word - 14CAS26\\_Orloff\\_DeficitIrrig](#)

**Deficit Irrigation of Alfalfa and Grasses:** Steve Orloff, Khaled Bali and Dan Putnam University of California Cooperative Extension (article link) [14CAS26\\_Orloff\\_DeficitIrrig.pptx](#)

**IMPLICATIONS OF DEFICIT IRRIGATION MANAGEMENT OF ALFALFA** Steve Orloff, Dan Putnam, Blaine Hanson, and Harry Carlson1 (article link) [Microsoft Word - 04 - irrigationFL-NALsymp.doc](#)

In a low water year, quite simply there might just not be enough water to go around. Different crops tolerate deficit irrigation better than others, and strategies for maximizing production might be



**Figure 2.** Percent of total seasonal production that occurs at each cutting with 3- and 4-cut schedules in the Intermountain area of California.

different from crop to crop and field to field.

Generally, alfalfa is a crop that can be good in a drought year and offer some flexibility for irrigation strategies, because of its deep root system it can access moisture from the entire soil profile, unlike irrigated grasses, which tend to have shallow roots. Additionally, alfalfa has the ability to go into drought-induced dormancy, which in most years it will pop out of when moisture returns, which many not be the case for all irrigated grass species. For vegetables or row crops, they may not be tolerant of deficit irrigation and yields can be severely impacted.

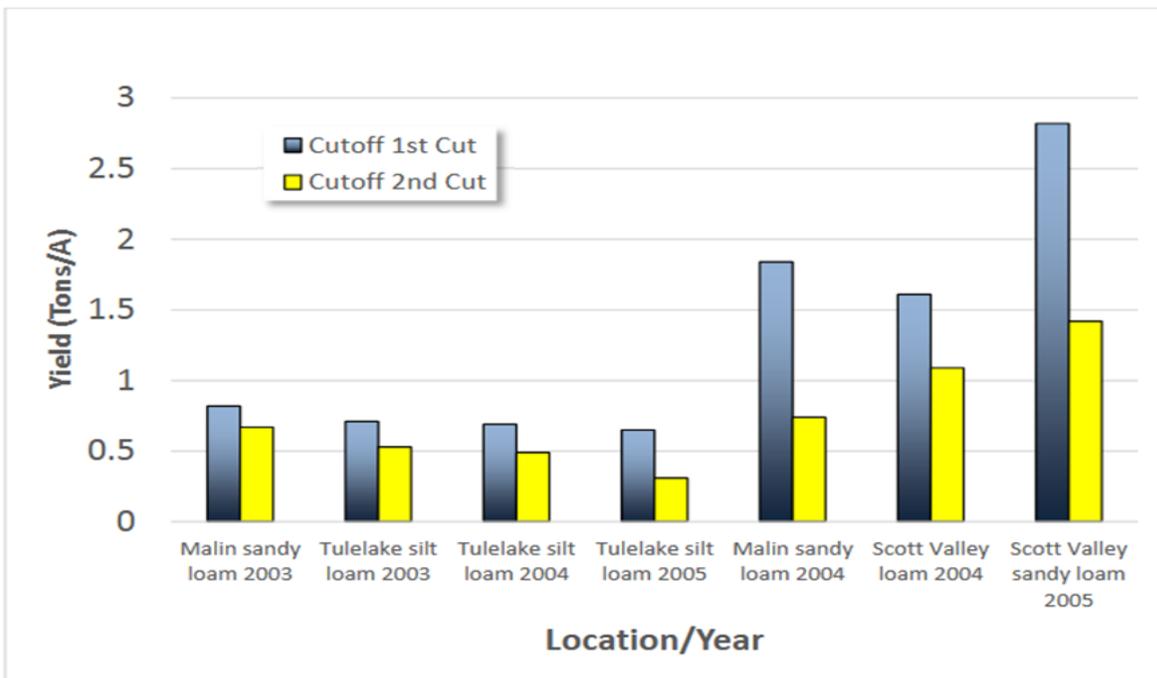
There are different strategies for alfalfa irrigation when water is limited. Fulling irrigating productive fields, and not irrigating older unproductive fields is one strategy. In certain situations, this could be warranted, especially if there are plans in the future to remove the unirrigated fields. However in certain cases there can be substantial stand loss depending on soil varieties, etc. Another strategy is to deficit irrigate all of the acreage. While this will likely not lead to any stand loss, it may also not be the most economical to garner the most profit from each unit of water applied. Spreading the water thinly below the plant's evapotranspiration requirements will result in reduced yield across all the acreage, while increasing the amount of water losses due to evaporation during application, (especially with pivots). Additionally because the entire area will need to be cut raked baled and treated for pests, there can be an increased percentage of operational cost per unit of yield (as yield

is reduced under deficit irrigation). While there is not a good option, the best option is probably noted as "cold turkey" Where acreage is irrigated fully during the first part of the year, and then the water is shut off in the middle of the summer.

One of the main reasons a "cold turkey" irrigation strategy can be the most desirable is because the highest quality hay is produced early in the year, and most of the yield comes from the first cuttings. Looking at figure two from Steve's symposium paper, around 75% of alfalfa yield in the intermountain region comes into the hay barn by mid-July!

So how does the cold turkey approach impact yields and stand persistence the next year?

Well not fully irrigating alfalfa will lead to yield reductions however you cut it. Back in the early 2000's Steve (and others) did deficit irrigation work at seven sites in the intermountain region. Irrigating fully through 1<sup>st</sup> first cutting, and then irrigating fully through second cutting, and then stopping the irrigation. There was a wide range of yield reductions seen. When removing water after first cutting, yield was reduced anywhere from 0.6-2.8 tons (Ave 1.3) compared to a fully irrigated check. Turning the water off after second cutting resulted in a 0.31-1.4 ton yield reduction (Ave 0.75 tons/acre). Soil type played into this and heavier high OM soils had less yield reduction, as well as areas that had perched water tables. (figure four). In these studies, this cold turkey approach did not negatively impact stand persistence the following



**Figure 4.** The reduction in alfalfa yield at several sites in different years from early-season irrigation termination (irrigated up until 1<sup>st</sup> or 2<sup>nd</sup> cutting) compared with full-season irrigation in the Intermountain Region of Northern California. Note the sites on the left of the graph had a heavier soil type and/or perched water table so the yield penalty was greatly reduced.

year for alfalfa. Unlike the scenario above as only two cuttings would be taken, operational costs could be reduced by not needing to cut and bale the third or fourth cut.

Now for irrigated grasses where the story is a bit different. Generally, they have shallower roots and stand loss can be common when irrigation water is pulled off during the year. Species like wheatgrass or brome are more tolerant than species like timothy or orchard grass when they do not have water during the heat of the summer. Partial irrigations of fescue, orchard grass and timothy may be preferable to the “cold turkey” strategy that can be utilized in alfalfa, not because yield will be realized, but to help prevent stand loss in the pasture the following year. For more detailed information on managing grass pasture in drought take a look at the drought tip, by Charlie Brummer and Steve Orloff from back in 2015. (article link) [Drought Tip: Managing Irrigated Pasture during Drought](#)

In pastures where water security is not known from year to year, species like wheatgrasses could be chosen that can produce well with irrigation, but tend not to die if not irrigated.

I know I will be praying for more rain and snow to show up at some point this month!



## Annual Grasses in Dryland Pasture?

Over the years I have been working to control annual grasses, which are one of the biggest problems for not only our land managers, but also our cattle producers out on the rangelands. Species like cheatgrass, medusahead and ventenata have the ability to use up all of the moisture and nutrients as opposed to perennial grasses. Cheatgrass produces high quality forage for a couple of weeks, before it matures and cattle don't want much to do with it. Where medusahead and ventenata are silica (essentially sand) accumulators and don't ever really produce desirable high-quality forage.

These annual grasses are everywhere, and not only do they produce low forage quality, but they dry out creating the fine fuel needed to spark and carry wildfires. In the eastern side of Lassen County, annual grasses increase the fire return interval and transition perennial grasses/shrublands into annual grass dominated sites.



Picture two: Scotch thistle trial, where short white top, and hoary cress (non-desirable) invasive weeds were released where the thistle and annual grasses were controlled. Remember, whatever perennials are present will be released.

What's more annual grasses do really well under frequent fire so it is a self-feeding cycle.

Being annuals, they are easy to control with physical methods. If you have some in your yard, simple hand pulling gets the job done. In crops cultivation works well, but on our rangeland/dryland pastures there are fewer options. On improved dryland pastures using a drag in the winter can be a way to uproot them, but drags can also impact the desirable perennials. Dragging becomes more of a suppression technique than a control technique. Targeted grazing can be used to suppress them (with lots of fences and high stocking density), but the amount of annual grass control needs to be weighed against the impact of high intensity grazing to the desirable species on site.

Chemically, annual grasses have been difficult to control on rangelands wherever they grow. There are more options outside of California, but inside they are limited. Rimsulfuron typically provides one good year of control, applied in the fall as a preemergent or early post emergent treatment. Rimsulfuron is a great choice for pastures that are inundated with annual grass, but need to be planted the following year. When rimsulfuron is applied in the dormant season perennial grass tolerance can be fair, however it is not the frequent choice for these areas because of the grazing restrictions associated with it. Technically it is only labeled for rangeland restoration practices, but the price has



Picture One: Scotch thistle trial, where there was an understory of perennial grass which was released. In this case a desirable result, because it was a desirable perennial!

come down significantly from 60 dollars an acre in 2016, to 16 dollars an acre for generic products now.

The “new”, and I intentionally use quotation marks here because it is not a super new player on the

However, there are some caveats. If you don't have established perennial species, you get bare ground (photo three), and this bare ground can last for years unless it is colonized by more tolerant annual species (often are broadleaf weeds). If you have a

### Boulder County



Jim Sebastian shows where he sprayed long-acting indaziflam for cheatgrass control in Colorado.

block, chemical of choice is indaziflam. This product has been used for years in tree and vine crops, as well as along roadways in industrial vegetation management. More recently it received its grazing label in the Western US, and in California! There are no grazing restrictions associated with its use. indaziflam only has preemergent properties, but can be very effective for annual grass control where there are already established species present. And by effective, I mean lights out! Certain studies have shown effects for multiple years after treatment, most with effects lasting for annual grasses for three years. Some larger treatment studies in other states have shown the effects to last even longer.

creeping perennial weed, that is what will be released (photo two). If you have a situation that is in the goldilocks zone where you have desirable perennials to be released it can look really good and you can get a bump in forage production and quality!

We have done a lot of small plot work from 2015 to 2020. Some sites looked great at releasing perennials, where other plots created bare ground as not perennials were established. In September of 2020 we decided to put some larger (1 /3 acre) plots out in an improved dryland pasture on the outskirts of Adin. This site was a dryland pasture that had been renovated years before and with alfalfa and meadow brome. Initial production was good, but medusahead, cheatgrass and bulbous bluegrass slowly



Picture Three: Picture of Bare ground three full years after an application. No perennials were present on site, just medusahead.

invaded the site. When we made the applications in September it was before any annual grass germination had started to occur. This is really important because indaziflam will not work well once germination has begun. If you remember the winter of 2020, it was dry, and while we got good control of the annual grasses, we didn't see a big bump in production of the established perennials (picture five).

We were not super excited with the results in the spring of 2021, but no one was excited about much because of how dry the winter had been. The following year in 2022, while the winter precipitation wasn't much to speak of, we did have some nice well-timed rains in the spring that really helped the dryland pasture species grow at the right time. And not only did we get control of the cheatgrass and medusahead, but in the second year the indaziflam took out most of the bulbous bluegrass as well! I have seen this a couple of times where bulbous bluegrass tolerates indaziflam the first year, but in the second year the bulbous bluegrass dies out. Talking to folks in Wyoming, they have seen good results on the bulbous as well.

Figure one shows the annual grass and bulbous bluegrass control the second growing season after application. There was better than 90% control of all three species, with higher than 95% control of the medusahead and cheatgrass. Where figure two shows alfalfa height and meadow brome height inside and outside of the treated areas. When those perennials were not competing with the annual grasses there was a significant increase in growth with more than 7 inches of growth for the alfalfa and

14 inches of growth for the meadow brome in the treated area.

There was still a bit of interspaces between the plants, and there did appear to be some annual forbs coming into the picture, but the annual grasses and the competition they faced were eliminated. I am super excited about the results and the potential for this material to be used to release successful dryland plantings, or areas of desirable natives that have been invaded with invasive annual grasses. With two BIG caveats: you can create bare ground for a long time.... And you will release whatever perennial is present on the site desirable, or undesirable. Picture Four is from the Clear Lake National wildlife refuge, where annual grasses have been successful controlled releasing desirable perennials in sage grouse habitat.

If you have a pasture that is invaded with annual grasses that you would like to control, indaziflam



Picture Four: Picture taken in a firebreak at the Clear Lake National Wildlife refuge. Two years after treatment. Old medusahead thatch can still be seen in the interspaces of the perennials.

could be a tool worth checking out. I would suggest starting small, and doing some test strips to see what it would look like if you take out the annuals. There have been instances where I didn't even realize there were desirable perennials before an application was made! Treating strips is a great way to see what perennials already exist and minimize the risk of creating bare ground.

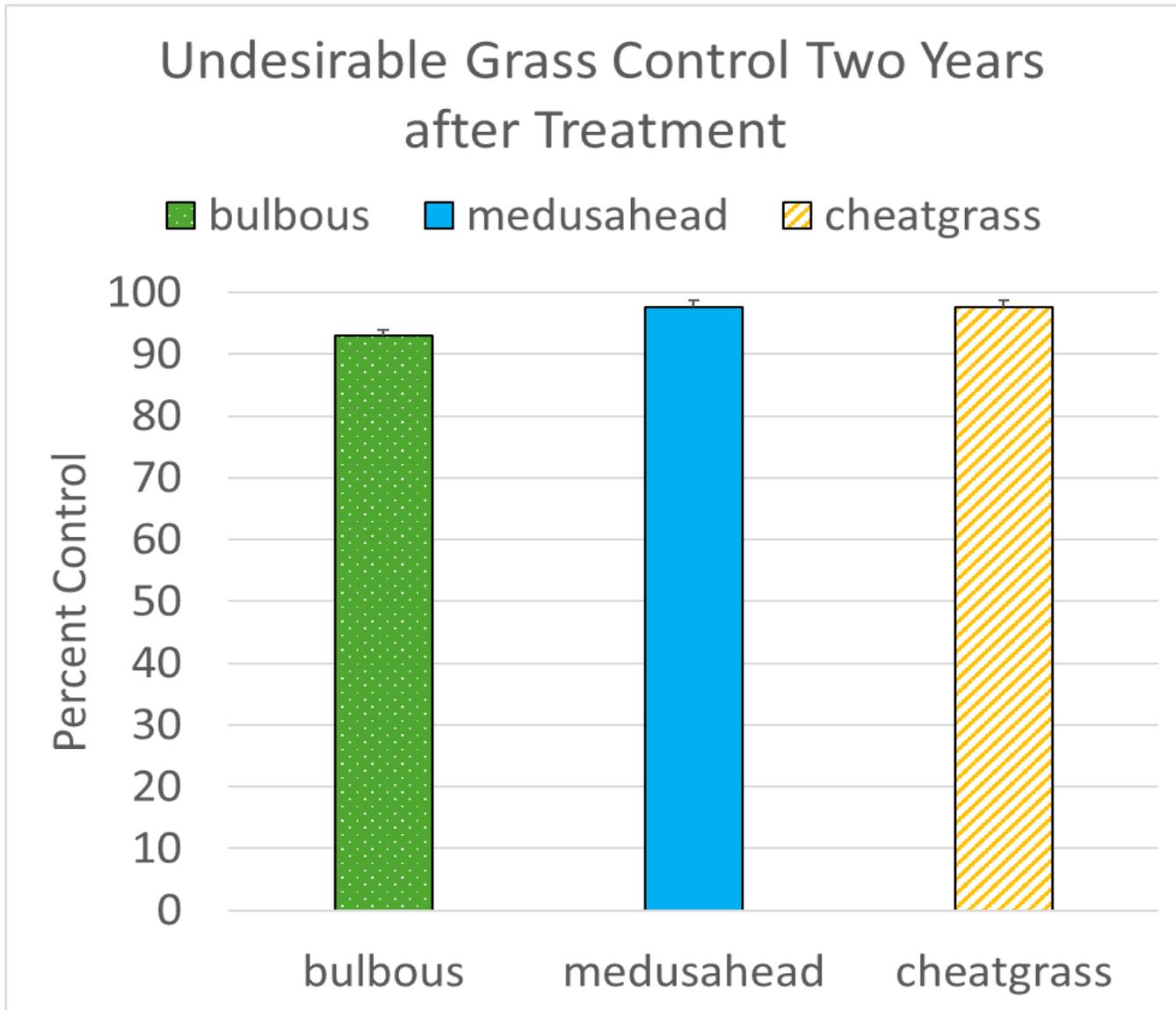


Figure one: Percent control two years after application of bulbous bluegrass, medusahead and cheatgrass. All were very successfully controlled even in the second growing season following application.

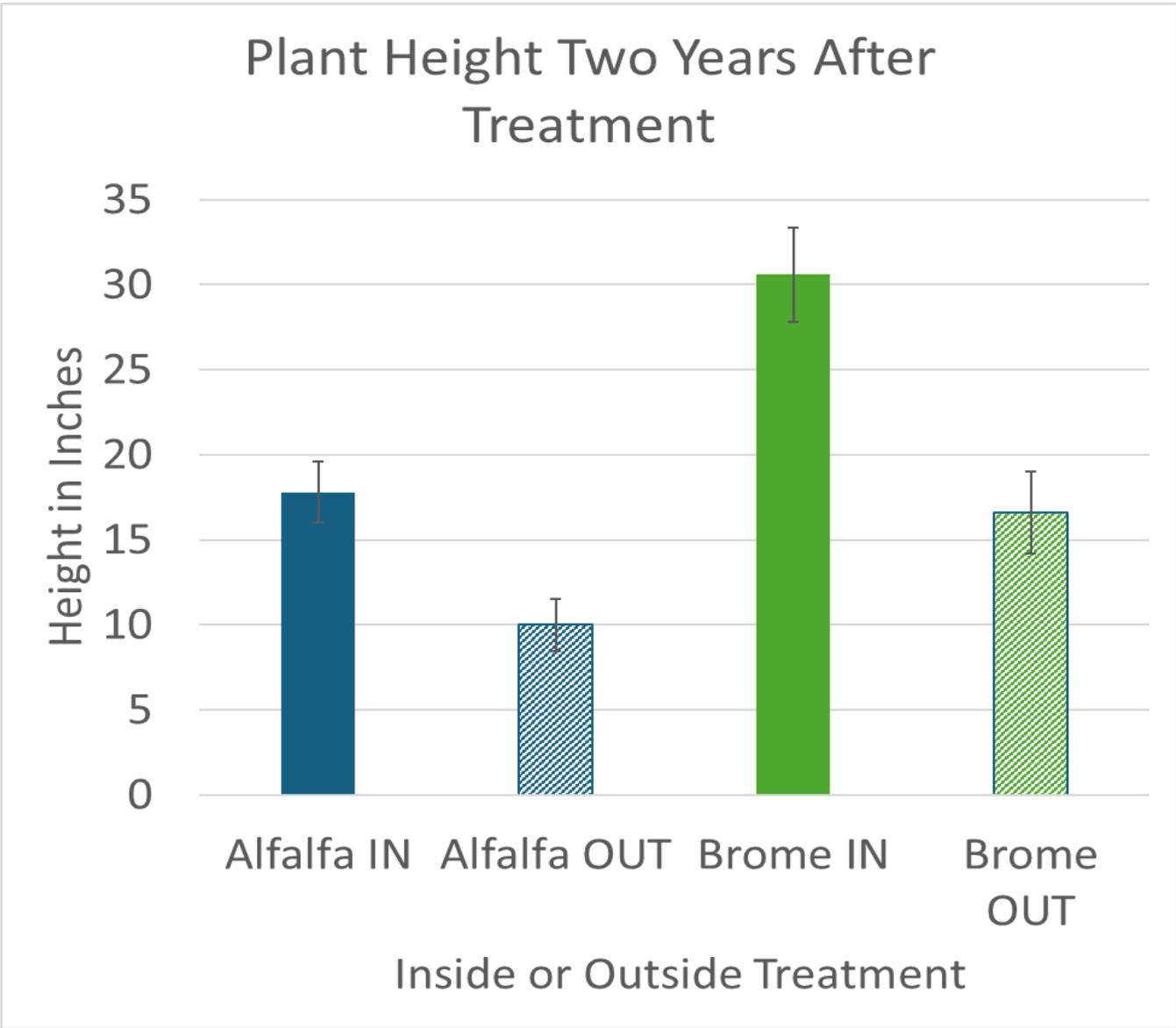


Figure Two: Dryland pasture crop height inside of the treated area and outside of the treated area. Both dryland alfalfa and meadow brome had significantly more height where competition was eliminated from annual grasses.



Picture Five: Treated area one year after treatment. Notice all of the bare-ground between established perennial plants. While we got good control of the annual grasses there wasn't much moisture that year and growth was minimal.



Picture Six: This is the improved pasture site outside of Adin two years after treatment. While it was a dry winter, we had well timed spring range to produce a lot of forage. See the competition from cheatgrass and bulbous bluegrass in the foreground of the picture, where the green tall vegetation is meadow brome and alfalfa that was released from competition following the indaziflam treatments.



Picture seven: This is the same treatment, but this time standing in the treatment area. There was significantly more desirable perennial growth in the treated squares. Another one can be seen in the distance on the hill slope behind the white truck.

## Resistant Kochia!

Kochia, the bane of many western states, and one that I see more and more throughout north eastern California. When I moved here from Colorado Kochia was public enemy number one back on the plains. It was everywhere, crop fields, on rangelands, in natural areas, and there was rampant resistance. When I moved to Susanville, I didn't see a lot of it. and I asked about it, and folks indicated it was a minor problem, which was surprising to me, just because of



Kochia Out behind Safeway in Susanville. It is thriving in this disturbed area growing nearly 6 ft tall!

what it was like back home. Fast forward 10 years, and Kochia seems to be on many of the roadsides in Lassen County and I am seeing it in more fields. Maybe it was my lack of observation, but it seems like it is spreading!

Why is Kochia a problem, well it is a summer annual weed and has a long germination window. It doesn't need much moisture and also grows well in certain irrigated situations. It is a prolific seed producer to the tune of 30,000-100,000 seeds per plant! While

there are herbicides that can be used for Kochia, one of the biggest issues is its ability to develop resistance to common chemistries. in Kansas, Colorado and Wyoming it is resistant to ALS inhibitors (Raptor, Thunder, Telar), glyphosate (RoundUp), dicamba, 2,4-D, and others.

When I moved here, I asked about resistance, and it was not something that was high on producers or land manager's minds. Agricultural/spraying practices are just less intense up here than they are in the wheat belt or the great plains.

With that being said the Modoc Ag department approached Rob Wilson and I about problems controlling Kochia on the roadways a couple years ago. So, we offered to put out some test pots to see if we couldn't figure out what would give good control along the roadways, primarily looking at pre-emergent control.

When you are using an herbicide with soil activity that will prevent seeds from germinating, it is very important that it gets incorporated down into the soil profile, so you actually get the seed germination inhibition. In certain parts of the country where they get lots of dependable summer rain, this can occur throughout the year. In California., without a Mediterranean climate, we are limited to the wet season to reliably get moisture on top of herbicide applications and push the material down into the soil where they can do their work.

In the Klamath basin we had one set of demonstration plots go out in the beginning of May, and we got significant precipitation to push the herbicides into the soil. It wasn't the case with my application in Surprise Valley that got put out in late May, so they were not incorporated... Because they were not incorporated, we didn't get the residual control of the herbicides. I also put out some additional demonstration plots in the fall and spring which is ideal, because applications need to go out before moisture. The rest of the article is going to focus on results from those trials and some greenhouse work.

Putting herbicides out in the fall and spring in the intermountain area is not without hassle. Typically, we have large fluctuations in day to nighttime temperatures, with frost being a common occurrence through May. Which means, that you need

to un-winterize and re-winterize sprayers before and after the application occurs. While burdensome, it will pay off in terms of weed control seen compared to making application of pre-emergent

sistance. Seedlings were grown in the greenhouse and sprayed with increasing rates for two ALS inhibiting herbicides and Glyphosate to evaluate the potential for resistance.



Photo One- Picture showing that Oust alone was not controlling the Kochia, and the addition of Chateau added significant preemergent control. This signified resistance to Oust!

herbicides without forecasted rainfall.

The plots were put out with a UTV sprayer applying 30 gallons/acre with boomless nozzles at two sites, south of Cedarville along the roadway and then at the Cedarville airport. Plots were demonstration size, 12 ft \* 120 long, and all treatments were replicated four times for statistical purposes. Glyphosate and a non-ionic surfactant were included in all treatments to burn down emerged vegetation that was present at the sites. Plots were evaluated at both field sites, and treatment results were combined across sites because site was not significantly different. Results are presented 9 months and 13 months after treatment for the fall applications, and 2 and 6 months for the spring treatments. Based on the results in the field trials, seeds were collected from Kochia populations throughout the intermountain region and sent down to UC Davis to Dr. Al-Khatib's lab where his Post Doc Deniz Inci supervised greenhouse screening trials of Kochia to evaluate it for re-

For the fall treatments, applications that included fumioxazin, or indaziflam performed well (table one) where indaziflam treatments provided longer control through the summer than Flumioxazin did. Oust (sulfometuron) at the high rate of 6 oz per acre did not offer any Kochia control at either evaluation timing. When looking at the amount of soil cover by species, 9 months after treatment in the untreated check there was 13 percent cover of cheatgrass, and no cheatgrass present in the Oust plot. Because Oust also has good activity on cheatgrass, this suggested that the Kochia in Surprise Valley was resistant to the ALS inhibiting herbicide Oust (table three) because the Kochia was controlled but the cheatgrass was not. Results from the spring treatments also reflected the lack of Kochia control with Oust suggesting resistance, where adding Flumioxazin to the tank provided excellent cheatgrass and Kochia control.



Picture two- Picture showing that Oust alone was not controlling the Kochia, and the addition of Chateau added significant preemergent control. This signified resistance to Oust!

Greenhouse results were mixed. Chlorsulfuron (Telar) was the first herbicide screened, it has a very similar binding site to sulfometuron, which showed resistance in the field. Chlorsulfuron is also commonly used in pastures for noxious weed control such as whitetop or thistles. Both populations of Kochia screened from the Surprise Valley area appeared to be resistant (Table 3). Likewise, both populations in Surprise Valley appeared to be resistant to imazamox, which is commonly used to control broadleaf weeds in seedling alfalfa. There also appeared to be low levels of glyphosate resistance in the Alturas and Tulelake populations.

While we may not be seeing big issues with Kochia control outside of roadway applications, there is potential for lack of control in our cropping systems. And it is important that if you spray a weed and it doesn't die (and you think it should, right timing growth stage, etc.) then that is the weed you want to control through other means and keep it from producing seeds! While we don't have widespread herbicide resistance in the region, the more time that passes, and the more herbicide applications that are made, the more potential for resistance to continue to develop and spread. Generally, if using herbicides, using multiple

modes of action in the same tank can be a helpful way to prevent and delay resistance. If you have suspected resistant weeds, please let me know! Just like invasive weeds the best way to handle a resistant population is while it is small before it spreads to your neighbor's property and beyond! And these trials show that we do have kochia resistance in the region!

Percent Bare Ground-Fall Treatments				
Trt	9 MAT	Tukey	13 MAT	Tukey
untreated	16	B	20	C
Glyphosate 32 oz + Oust 6oz	28	B	24	C
low-rate Glyphosate 19.5oz + Oust 6oz + Chateau 10 oz	94	A	84	AB
Glyphosate + Prominade xtl 10oz/ (Château+ Matrix)	82	A	74	B
Glyphosate 32 fl oz/A + Imazapyr + Method 8oz	26	B	24	C
Glyphosate 32 fl oz/A + Milestone 5 oz/ Telar 0.5 oz/A + Esplanade (5oz)	96	A	97	A
Glyphosate 32 + Method 8 oz/A + Esplanade 7 oz/A	95	A	98	A

Table One: Percent bare ground 9 months and 13 months following the fall application on the roadways. Because there were not site differences values were average across site for this table. Oust alone was not different than the untreated check. Letter values indicate statistical differences utilizing Tukey Pair wise comparisons  $p < .05$  at each time point. Colorization is just to help visualize differences in the data.

Cover Kochia and Cheat								
Trt	Kochia 9 MAT	Tukey	Kochia 13MAT	Tukey	Cheat 9MAT	Tukey	Cheat 13MAT	Tukey
Untreated	63	A	72	A	14	A	3.75	A
Glyphosate 32 oz + oust 6oz	70	A	71	A	0	B	0	A
low-rate Glyphosate 19.5oz + Oust 6oz + Chateau 10 oz	4	B	13	BC	0	B	0	A
Glyphosate + Prominade xtl 10oz/Z (Château + Matrix)	14	B	22	B	1	B	0	A
Glyphosate 32 fl oz/A + Imazapyr + Method 8oz	64	A	70	A	3	B	0	A
Glyphosate 32 fl oz/A + Milestone 5 oz/ Telar 0.5 oz/ A + Esplanade(5oz)	2	B	2	C	0	B	0	A
Glyphosate 32 + Method 8 oz/A + Esplanade 7 oz/A	2	B	1	C	0	B	0	A

Table Two: Percent cover by Kochia and Cheatgrass 9 months and 13 months following the fall application on the roadways. Because there were not site differences values were average across site for this table. Oust alone offer control of cheatgrass, but not Kochia indicating that the Kochia may be resistant. Letter values indicate statistical differences utilizing Tukey Pair wise comparisons  $p < .05$  at each time point. Colorization is just to help visualize differences in the data.

Percent Bare ground- Spring Treatments				
Trt	2 MAT	Tukey	6 MAT	Tukey
untreated	23	B	23	C
Glyphosate 32 oz + Oust 6oz	29	B	27	C
Low rate Glyphosate 19.5oz + Oust 6oz + Chateau 10 oz	89	A	75	AB
Glyphosate + Prominade xtl 10oz (Château + Matrix)	91	A	81	AB
Glyphosate 32 fl oz/A + 1.5pt. Imazapyr + Diuron 8lbs	91	A	85	AB
Glyphosate 32 fl oz/A + Milestone 5 oz/ Telar 0.5 oz/A + Esplande(5oz)	86	A	63	B
Glyphosate 32 + Method 8 oz/A + Esplanade 7 oz/A	95	A	94	A

Table Three: Percent bare ground 2 months and 6 months following the spring application on the roadways. Because there were not site differences values were average across site for this table. Oust alone was not different than the untreated check. Letter values indicate statistical differences utilizing Tukey Pair wise comparisons  $p < .05$  at each time point. Colorization is just to help visualize differences in the data.

Chlorsulfuron Percent Control in Greenhouse Trial										
Trt	1-IREC		2-Alturas		3-Honey Lake		4-Suprise XL		5-Suprise Airport	
	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err
0X	0	0	0	0	0	0	0	0	0	0
1/2X	91	9	73	10	86	14	34	13	47	16
1X	89	7	100	0	88	9	21	7	31	8
2X	100	0	87	10	95	5	59	16	71	16
4X	100	0	75	16	91	7	75	8	63	20



Table Four: Percent Kochia control in greenhouse trial down in Davis. Rates of chlorsulfuron were tested from a 1/2x field rate, all the way up to a 4x field rate. Populations in Surprise Valley were not adequately controlled confirming resistance. Even plants at the 4X rate did not die!

Imazamox Percent Control in Greenhouse Trial										
Trt	1-IREC		2-Alturas		3-Honey Lake		4-Suprise XL		5-Suprise Airport	
	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err
0X	0	0	0	0	0	0	0	0	0	0
1/2X	75	13	78	12	100	0	28	13	78	10
1X	84	5	94	4	91	6	20	8	71	13
2X	69	16	91	7	69	12	69	16	53	17
4X	94	4	79	11	95	5	36	13	47	17

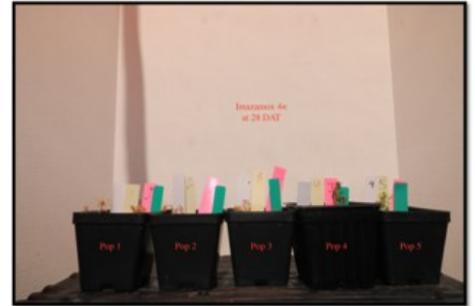


Table Five: Percent Kochia control in greenhouse trial down in Davis. Rates of Imazamox were tested from a 1/2x field rate, all the way up to a 4x felid rate. Surprise Valley were not adequately controlled confirming resistance, where low levels of resistance may be occurring at the other sites.

Glyphosate Percent Control in Greenhouse Trial										
Trt	1-IREC		2-Alturas		3-Honey Lake		4-Suprise XL		5-Suprise Airport	
	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err
0X	0	0	0	0	0	0	0	0	0	0
1/2X	50	19	57	20	100	0	43	17	50	19
1X	50	19	56	17	90	10	93	7	94	4
2X	69	13	91	7	94	6	94	6	88	13
4X	95	5	100	0	100	0	100	0	63	18



Table Six: Percent Kochia control in greenhouse trial down in Davis. Rates of Glyphosate were tested from a 1/2x field rate, all the way up to a 4x felid rate. Populations in Alturas and Tulalake were not adequately controlled at the field rate indicating low levels of resistance.

## Puncturevine

Goatheads, caltrop, Devils weed, or whatever you want to call it is a nuisance that plagues the people of Lassen County (and beyond!). It is the bane of cyclists, and is transported by tires, people and animals and is a widespread issue wherever the seeds end up. You only have to step on one of the spikey seed heads barefoot in the middle of the night to remember why this plant gets its name, and curse whoever tracked the seed in the house without taking their shoes off!

So, what can you do about puncturevine? Well, it is a summer annual that only grows from seed. What makes it difficult to control is its ability to have multiple flushes (germination events) throughout the summer. Typically starting in early May as soils heats up and puncturevine starts germinating all the way through September. Last year I found a plant next to a trail in late October that was only a few inches in diameter that had just germinated weeks before but was already putting on seed. This extended germination cycle is why puncturevine is so difficult to control. While small it is relatively easy to kill, either by uprooting the seedlings with a hoe or chemical means (typically glyphosate or 2,4-D). Unfortunately, and especially on years when we get a couple shots of summer rain, a few weeks after initial efforts to eradicate the first seedlings, a new flush of seedlings will take their place.

So how do you get rid of it? Well one way is to smother it. Puncturevine does not like competition and needs light to germinate (which will be demonstrated in a minute). Seed removal is another strategy, with people dragging old carpets on dirt lots to help pickup seeds, and this can be “semi” effective. Then there are biocontrol weevils which have been released, and while the seed head weevil is established in Lassen County, the stem weevil does not seem to like our colder higher elevation compared to the



Picture Two: Courtesy of Lynn Sosnowski- UC. Notice the leaves of prostrate knotweed are simple and the papery white casings on the stems.

rest of California, both types of weevils typically need to be present to gain suppression. Again, physical removal is very effective, if you can visit a site every couple of weeks throughout the growing season to control the seedlings hand pulling or hoeing works. . To that point, what typically happens is puncturevine starts to form the large characteristic mats before it catches someone’s eye. Once large mats form the plants need to be pulled and bagged to prevent seeds from maturing. Pulling plants with mature seeds can just spread the problem, as seeds will fall off during the process. I would say there are a couple “look alike” plants, particularly prostrate knot weed which folks tend to confuse with puncturevine (picture one and two). Yellow flowers and dissected leaves are key characteristics of the puncturevine, and both form mats on the soil surface (Picture Three and Four).

When it comes to herbicides, when puncturevine is small it is easily controlled with many foliar herbicides, but again the problem is the flushes of seedlings throughout the summer requiring multiple treatments. Typical complaints are that a landowner will spray once or twice with glyphosate during the summer, but the puncturevine keeps coming! The next logical question for one familiar with herbicides is: Can you apply something to prevent the seeds from germinating? And the answer is Yes! Time of year really matters with pre-



Picture One: Courtesy of Robert Norris UC Davis- Prostrate knotweed spreading out on the soil surface, often confused for goat heads.

emergent herbicides in a climate that is dry in the summer, because by the time puncturevine starts to germinate in our corner of the world, we may or may not get enough rain to push (incorporate) those herbicides into the soil where they can prevent seed germination. It is a waste to have the herbicides sit on the soil surface.... Typically, you need at least ¼ of an inch of rain for incorporation, where ½ inch or more is ideal.

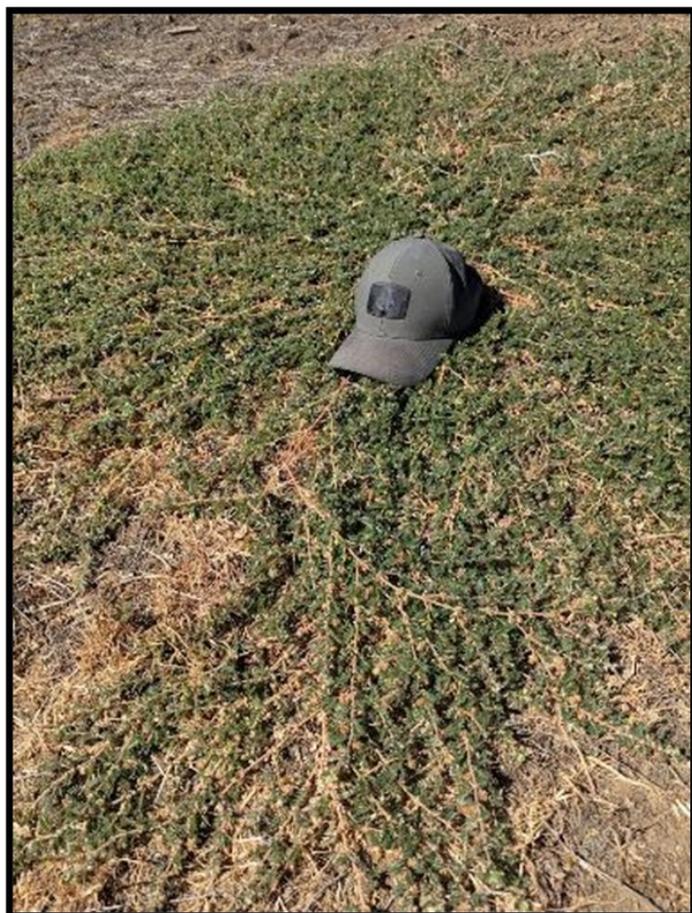
In 2023 we had a banner puncturevine year, summer rains produced a bumper crop and dormant seeds rose and proliferated. I was able to secure two empty lots in Susanville both of which were completely loaded with puncturevine to test of some materials, (picture four and five) as well as the “Goathead Roller”. I have never salivated (gotten excited) at a study site like this one before, because these plots were uniform and completely inundated with puncturevine! Weed scientists love a nice uniform stand of weeds, because it makes comparison of treatments easy. One thing I said above and will say again is that goat heads don't really like too much competition. Local fire mitigation which requires mowing or trimming vegetation in mid-June may also be impacting the success of the puncturevine. While mowing is absolutely necessary to reduce standing fuels and fire risk, eliminating that vegetation may also contribute to the goat head



Picture Four: Courtesy of UC Regents. Leaves are compound, or stick straight out from the stem with little leaflets. Flowers are yellow but hopefully you can identify it and kill it before it flowers because the seeds form quick!



Picture Five: Courtesy of Phil Westra. This is a puncturevine seedling, and the growth stage you want to be able to identify it and kill it! Hand pulling or a hoe works great at this stage!



Picture Three: Puncturevine typically has reddish stems and grows in the mats as you can see here .

problems “releasing” them from competition.

Primarily I was interested in test pre-emergent herbicides in the fall and spring prior to any germination when I knew we would likely get incorporating rain to push them into the ground. I had two sites, one with trees and grapevines nearby (Russell Street), and one without desirable tree roots extending into the application area. I mention this because some pre-emergent herbicides are relatively safely applied over roots and are commonly used in vineyards and orchards (indaziflam, rimsulfuron, flumioxazin, pendimethalin), where others, MAY have the ability to be taken up by desirable tree roots causing harm because of this (imazapyr, chlorsulfuron, and imazapic) were not used at Russell Street. During testing both homeowner products and professional products were used. There were two timings of application, one in October, and then one in April both before rain fell. All treatments had glyphosate included at 32 oz to kill emerged vegetation along with a nonionic surfactant at 0.25%v/v.



Picture Six: The Russel Street site was completely inundated in the fall goat head vines and thousands of seeds.

I also wanted to test the “Goathead Roller” or a seed picker upper. And boy did I bite off a little more than I wanted to chew with that contraption (picture 6). It certainly worked to pick up seeds, but this took time! It was a lovely March afternoon, and I planned on rolling the four plots at each site knowing that a storm was rolling through the next day. At the Russel Street site, I rolled and rolled and rolled and it took me all afternoon... On average I rolled each 10\*20 ft plot for 40 minutes a piece, and while the rate of seed pick-up slowed down, the contraption was still picking up seeds after the forty minutes. I didn’t have the patience to roll each 200 square ft. plot longer than forty minutes. And it did pick up the seeds, nearly 30 lbs. of seeds over the four plots or



Picture Seven: The Modoc Street site in the spring. See the vines and seeds from the year before and the copious number of seeds on the street. Just this little amount of grass growth was enough to prevent most seeds from being picked up.



inhibited the rollers ability to pick up the seeds.... (But I knew they were there) (Picture seven-look at the sidewalk with all the seeds). So, if you use something like a “Goathead Roller” make sure there isn’t any vegetation growing to impact the neoprene to soil surface contact. Just one quick quote on economics, using the hand roller on an acre would scale up to 154 hours/acre to remove those seeds at the first site. So, if you could pay someone \$15 an hour that would come out to \$2,314/acre so not necessarily an affordable option on scale, but could be an option for a small area.

In terms of the overall study there were some results that surprised me. The first being that the untreated check had minimal goatheads. By minimal I don’t think there were any goat heads By minimal I don’t think there were any goat heads growing in the four replications at each site. What there was an abundance of other annual vegetation that shaded the goatheads out, at one site broadleaf vegetation and at the other site cheatgrass (Picture 9/10). We know the seeds were there because the “roller” had picked up nearly 90,000 per plot (and you’ll just have to trust me but it

Picture Eight: Seeds picked up from one plot at the Russell Street site. Approximately 80,000 seeds per 10\*20 ft. plot.



Picture Nine: Untreated control Russell Street. Note the prickly lettuce suppressing the goat heads from germinating.

didn't get them all). We didn't mow so there was plenty of annual vegetation to shade the soil surface as well as limit goat head germination. In terms of herbicides all did a good job at suppressing vegetation in the first year, and some did better than others on the goatheads. At the Russell Street site, most treatments initially gave good control, where by August of 2024, Rejuvra (indaziflam) applied in the fall and Matrix (rimsulfuron) of other treatments. Russian thistle was dominate in the Revujra and Roundup 365 (imazapic) treatments made in the fall, but was almost absent in the Flumiguard treatment at the same timing. In the spring Russian thistle was the most dominate annual vegetation on the site, but with little growing in either treatment made the spring of 2024 with Flumigaurd or Prowl (pendimethalin). Red Stem filaree was a minor component of cover in many of the treatments, but was eliminated where Roundup 365, Ortho Ground Clear (imazapyr) or Telar (chlorsulfuron) were applied. While the goal was to eliminate goatheads, what vegetation that takes place following an herbicide application, is always of interest and should be taken into consideration based on the site and management objectives.

While the results of the study were unexpected, there are some key take aways: At these two sites, having vegetation growing or thick litter at the time of goathead germination

was enough to suppress their populations. All herbicides besides Flumigarud at both sites applied in either fall or spring gave good control through the first part of the summer, and at one site most gave good control through the entire growing season. What you chose to spray might be dependent on your situation. As a homeowner product that contained imazapic, imazapyr and pendimethalin all performed well when applied in the spring. However, only pendimethalin can be use "safely" over desirable tree roots. For those treating larger homesteads, professional products like amino-pyralid, indaziflam, and chlorsulfuron could be additional options (with Rejuvra being safe over tree roots). Regardless it is always important to apply prior to moisture if you want to get the best bang for you to break out of the pre-emergent properties associated with any of these materials!



Picture Ten: The Untreated check at the Modoc street site, nearly 100 percent cheatgrass cover crowding out and preventing any goat head germination.

Puncturevine Control Russell Street				
Trt	June	Tukey	August	Tukey
Fall Flumigaurd 12 oz	89.5	ab	61.25	A
Fall Rejuvra 7oz	98	ab	99	A
Goathead roller	55	a	62.25	A
Spring Flumi 12oz + Matrix 4oz	48.75	a	32.25	A
Spring Flumigaurd 12 oz	99	ab	77	A
Spring Matirx 4 oz	99	b	99	A
Spring Prowl 4 quarts	88.25	a	67.25	A
Spring Rejuvra 7oz	91.75	ab	67	A
Untreated	92.25	ab	99	A

Figure One: Percent Goathead control at the Russell Street site in 2024, ratings were taken in June and August. (Prowl/Pendimethalin can be purchased for homeowners in products like Preen).

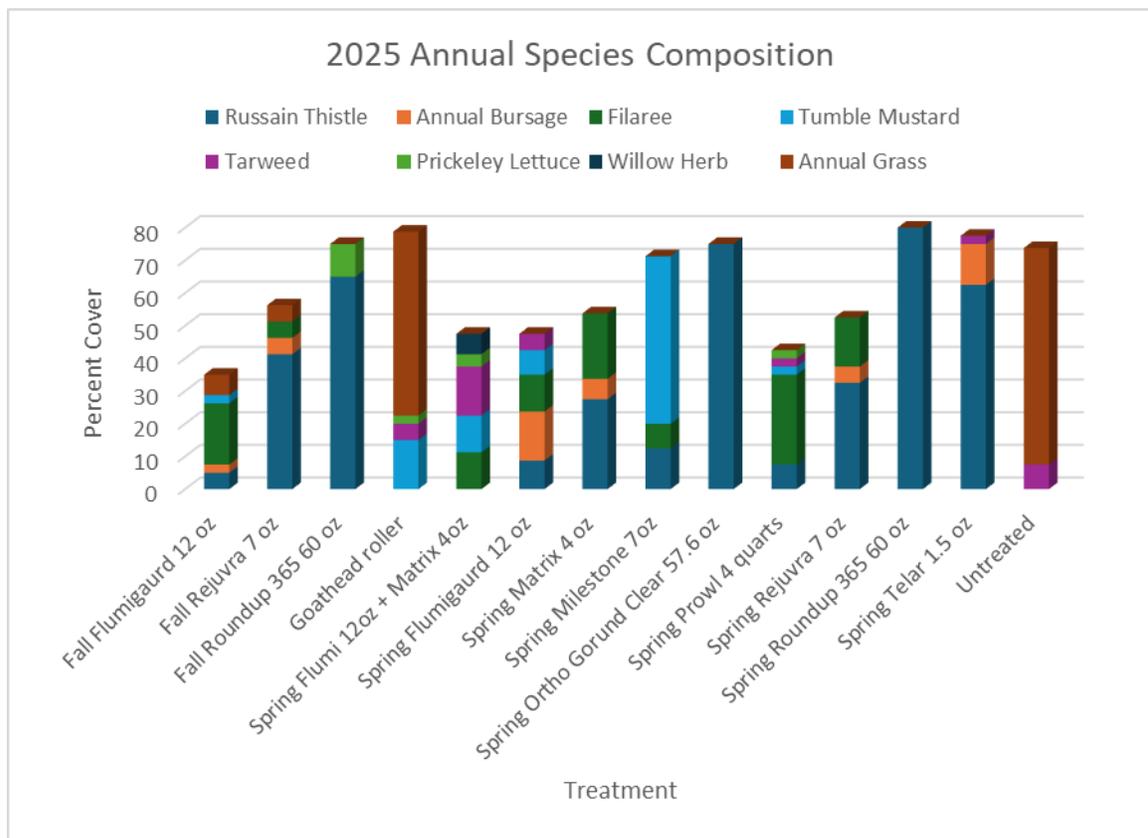


Figure Two: Percent Vegetation Cover Russel Street Site 2024 by species class.

Puncturevine Control Modoc St.						
trt	June		August		Aug-24	
Fall Flumigaurd 12 oz	95.5	a	68.5	ab	99	a
Fall Rejuvra 7 oz	98	a	99	a	99	a
Fall Roundup 365 60 oz	99.25	a	99	a	99	a
Goathead roller	92.5	a	99	a	99	a
Spring Flumi 12oz + Matrix 4oz	50	b	28.75	c	99	a
Spring Flumigaurd 12 oz	66	b	38.75	bc	99	a
Spring Matrix 4 oz	98.25	a	99	a	99	a
Spring Milestone 7oz	98	a	99	a	99	a
Spring Ortho Gorund Clear 57.6 oz	99.25	a	98.25	a	99	a
Spring Prowl 4 quarts	99	a	96.75	a	99	a
Spring Rejuvra 7 oz	91.75	a	88	a	99	a
Spring Roundup 365 60 oz	99.25	a	99	a	99	a
Spring Telar 1.5 oz	99.5	a	99	a	99	a
Untreated	90	a	99	a	99	a

Figure Three: Percent Puncturevine control at the Modoc street site, in June and August of 2024, and August of 2025.

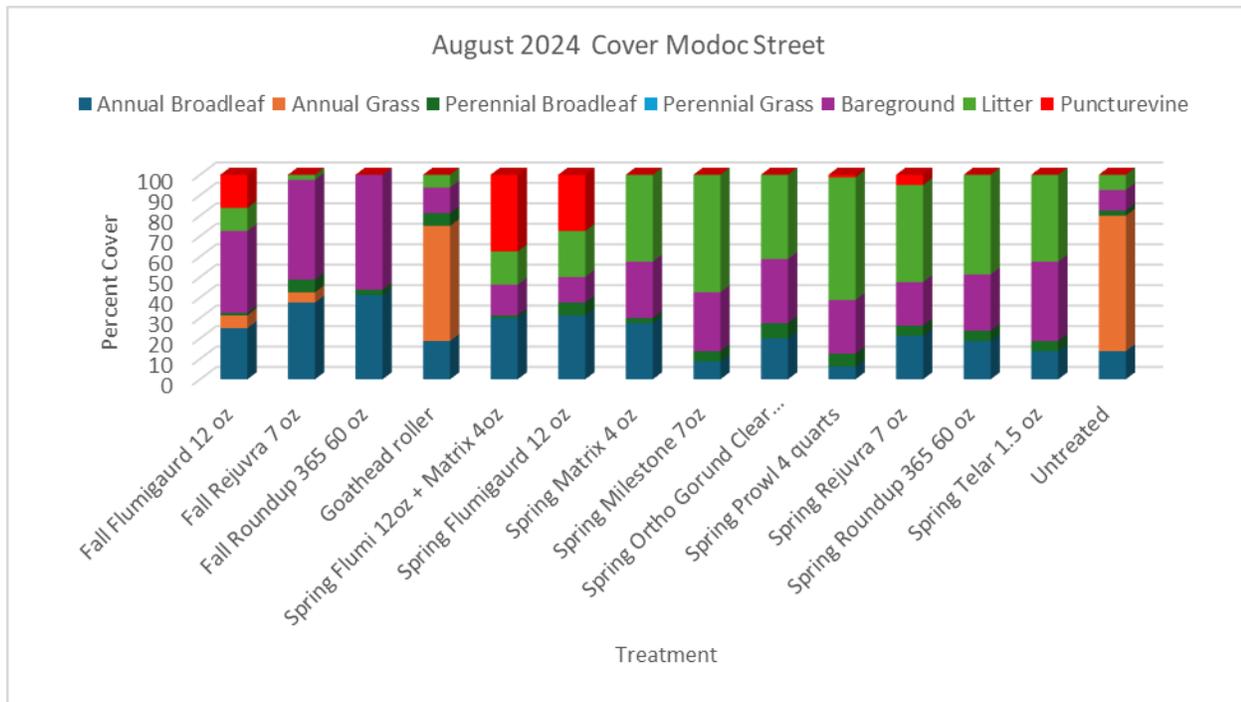


Figure Four: Percent Vegetation Cover Modoc Street Site 2024 by species class.

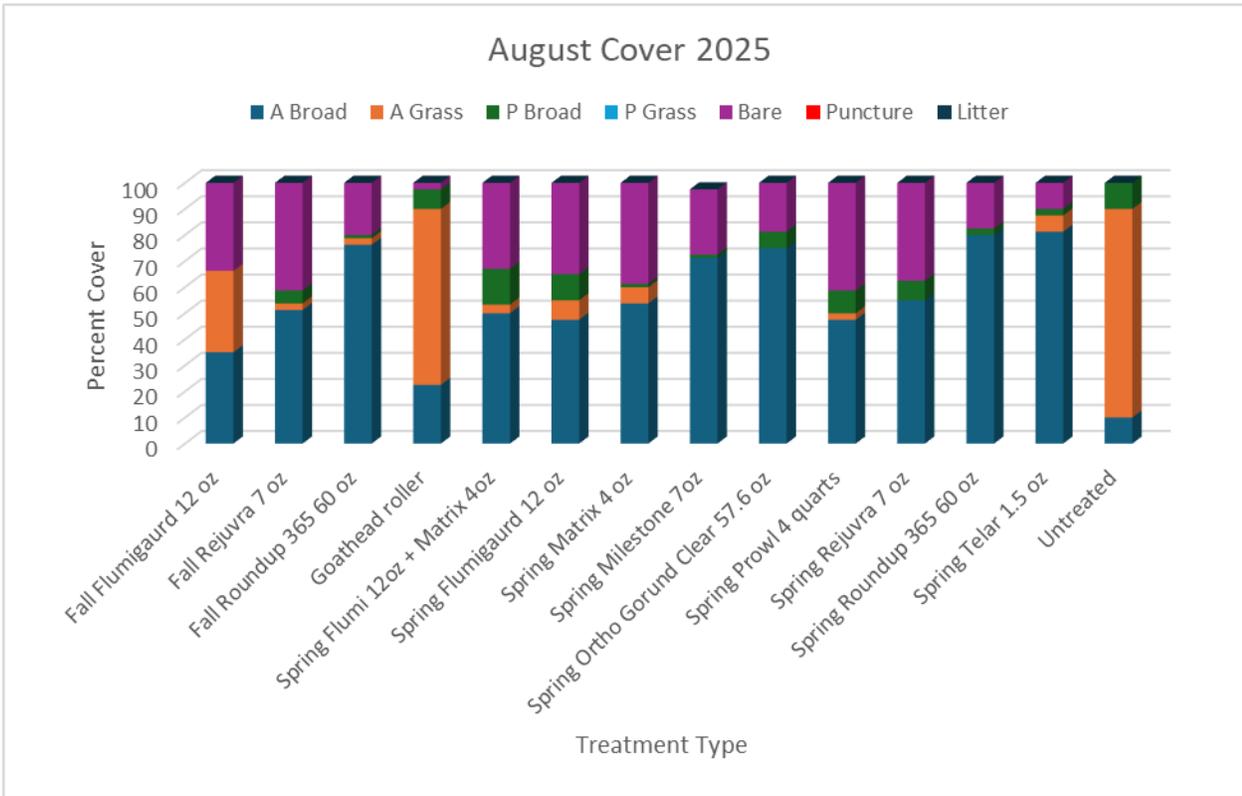


Figure Five: Percent Vegetation Cover Modoc Street Site 2025 by species class.

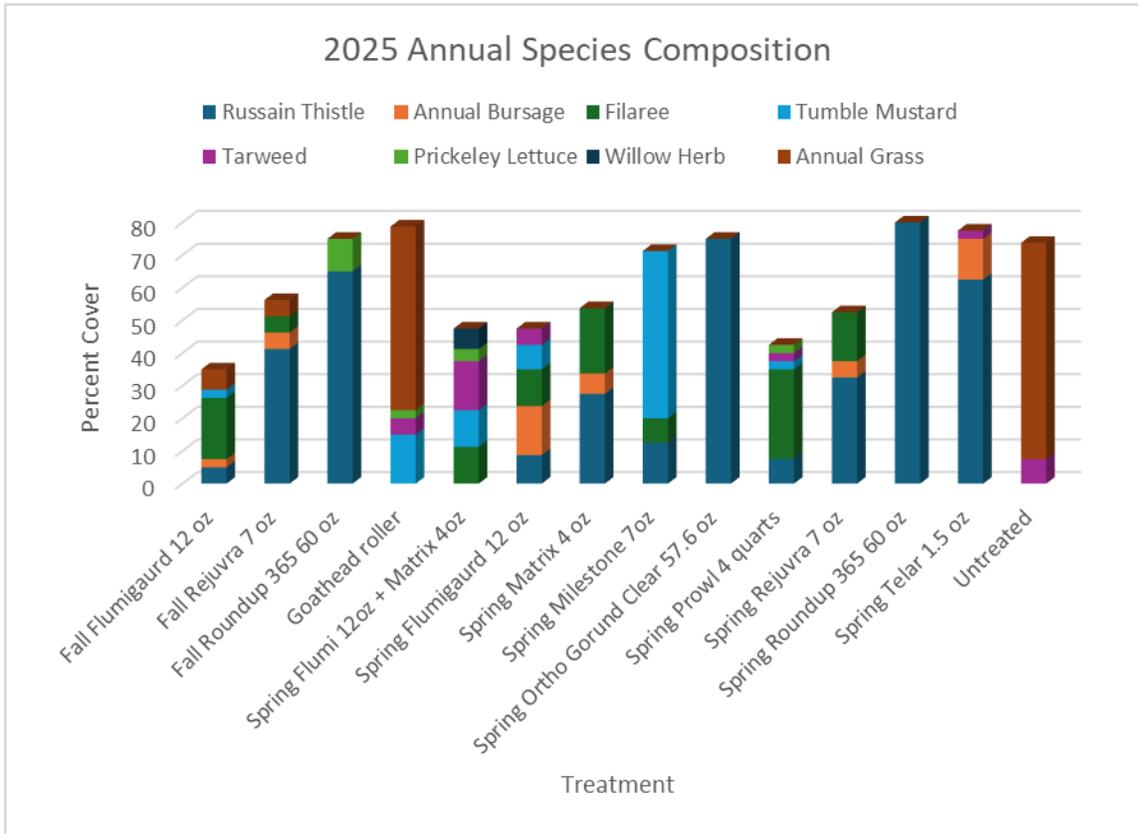


Figure six: Modoc Street site annual species percent cover by treatment. Large differences occurred by treatment in 2025, with Certain treatments favoring Russian thistle, or Tumble mustard, where no herbicide was applied annual grasses dominated.

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