wheatgrass herbicide screening report - "TOFU"

preliminary results from K8 in 2022

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Objective

We wanted to spray wheatgrass with herbicides commonly used on the st paul campus. Some products we expected injury (acetochlor), other products we expected no injury (s-metolachlor, prowl, wolverine) but wanted to do side by side comparisons with unsprayed wheatgrass plots to get some data.

Our hope was to find a common corn/soy/small grain herbicide that could be used in wheatgrass without obvious injury and provide additional weed control options in unexpected research situations.

We wanted to use products not previously tested in northern MN

We wanted to practice doing an herbicide screening study

Wheatgrass weed control

Labels

As of 28Feb2023, 2,4-D is the only labelled herbicide in kernza and must be applied after tillering (4-8 inches tall) and before boot stage. This typically gives a 3 week window of 14May - 7June to control some broadleaf weeds in the spring.

Some herbicides labelled for "Grasses grown for seed" have been applied to kernza without obvious injury. Herbicides for perennial ryegrass, tall fescue, turf and other perennial grasses grown for seed are unlikely to cause injury. We tend to use products from the Winfield company; sometimes these generic products are not labelled for grasses grown for seed, but the original trade name product is labelled. For example, Dual Magnum herbicide is labelled for grasses grown for seed, but charger max herbicide is not labelled for grasses grown for seed even though both products contain the same active ingredient (s-metolachlor). This is true of Prowl as well.

Table 1: Herbicides labelled for grasses grown for seed production

Trade Names	Active Ingredients
Banvel	Dicamba
Bison	Bromoxynil Mcpa
Dimetric Liquid	Metribuzin
Dual	S-Metolachlor
Facet L	Quinclorac
Moxy	Bromoxynil
Prowl	Pendimethalin
Sharpen	Saflufenacil
Stingr	Clopyralid

Trade Names	Active Ingredients
Tacoma	Fenoxaprop
Zidua	Pyroxasulfone

We tested Dual, Prowl dicamba and Bison with an assumption of no injury because they were labelled for grasses grown for seed production.

Table 2: Herbicides used in this trial

Treatment Name	Active Ingredient
Acetochlor	Acetochlor
Boundary	S-Metolachlor Metribuzin
Dual	S-Metolachlor
Prowl	Pendimethalin
Axial Xl	Pinoxaden
Bison	Bromoxynil Mcpa
Dicamba	Dicamba
Facet L	Quinclorac
Wolverine	Bromoxynil Pyrasulfotole Fenoxaprop

We expected Dual, Prowl, dicamba and Bison to show no injury when applied because they were labelled for grass grown for seed.

We thought the remaining products could cause injury.

Acetochlor is a PRE and POST product for corn. We thought acetochlor may cause injury because it is labelled for POST control of volunteer wheat and barnyadgrass.

Boundary is a PRE product for soybean. We thought Boundary would likely not cause damage because it is composed of two products that are seperately labelled for grasses grown for seed, s-metolachlor and metribuzin

Axial XL is a POST product for wheat and barley. We thought Axial XL may cause injury since it is labelled for POSt control of grass weeds like barnyardgrass.

Facet L

Wolverine

We also tested an acetochlor product and Boundary Products we tested that might produce injury

PRE acetochlor boundary

POST dicamba facet L axial XL (pinoxaden) wolverine

what we already know

summarise finding of Donn v and IR4

establishing wheatgrass

Weed control in wheatgrass is most important during establishment. When we apply herbicides, we apply them to all plots so if any injury is occurring, it is happening across all plots.

For a couple years, s-metolachlor has been applied in early spring (April) for weed control with no expected or observed injury.

We have applied 2,4-D in the fall after wheatgrass is ~4" tall and not observed obvious injury.

wheatgrass sensitivity to residual herbicides

wheatgrass is a small grass seed.

There is concern that 2,4-D and s-metolachlor can impact an emerging wheatgrass seed.

We only use glyphosate as a burndown prior to planting wheatgrass so there is not plant-back interval if we need to replant.

When terminating a wheatgrass stand, glyphosate alone is effective, but it's very important the plant is actively growing. One time we harvested kernza in August and then the plant went dormant after harvest for a month due to the drought. We could not kill the stand until it actively started regrowing.

Introduction

IWG was planted in fall of 2021. In spring of 2022, PRE herbicides were applied and then IWG injury was scored ~10 days after application. In summer of 2022, POST herbicide treatments were applied and IWG injury was scored again ~10 days after application.

IWG injury was scored on a scale of 0-10, where 10 was severe damage. Scoring was done blind by Jesse in spring, and by Jesse Cole and Lara in summer.

The weed abundance was also visually scored. The site for this preliminary study was chosen because high weed pressure was expected, however there was very low weed pressure throughout the entire field during the study. The weed scores were meant to indicate relative differences in weeds among plots and if any sort of weed injury was visible. Due to low weed pressure, the weed-free plot treatment was not maintained and was managed identically to the weedy plots. There still were very few weeds (<1 plant per square meter) Due to the low weed pressure, the primary utility of the tofu data set is the IWG injury data.

Herbicides were applied at maximum rates and the summer applications were about 1-2 weeks later than ideal and IWG plants were already quite large and some seedheads were starting to emerge. The POST treatments were a worst case scenario and if no injury was observed in this study, it's very unlikely any injury will be observed.

Plot plan

		10'										
		70'									N	
	6'	101	102	103	104	105	106	107		W		E
PeWhe		acetochlor	acetochlor	acetochlor	acetochlor	acetochlor	acetochlor	acetochlor			S	
		weed-free control	weedy control	dicamba	bison	wolverine	facet L	axial XL				
		201	202	203	204	205	206	207				
		prowl	prowl	prowl	prowl	prowl	prowl	prowl				
		axial XL	weed-free control	wolverine	weedy control	facet L	bison	dicamba				
		301	302	303	304	305	306	307	30'			
		dual	dual	dual	dual	dual	dual	dual				
		wolverine	facet L	bison	weedy control	dicamba	weed-free control	axial XL				
		401	402	403	404	405	406	407				
		weedy control	weedy control	weedy control	weedy control	weedy control	weedy control	weedy control				
		dicamba	weedy control	bison	facet L	axial XL	weed-free control	wolverine				
		501	502	503	504	505	506	507				
		boundary	boundary	boundary	boundary	boundary	boundary	boundary				
		bison	axial XL	weedy control	dicamba	weed-free control	wolverine	facet L				
LegacyNet		PREs applied last week of April										
		POST applied first week of June										
		All applications at full labelled rates										
		weed-free treatments will be weeded by hand / hoe										
		visually score crop injury and weed injury and ground cover for wholeplot and subplot										
		possible: quantify dry biomass (crop and/or weed) % change from weedy+weed-free controls										
		possible: quantify yield change as % change from weedy+weed-free controls										
		possible: quantify % cover using canopeo										
		possible: fly drone over to detect changes in greenness + cool photo										
		only 1 rep, pilot study										

Datasets

```
## Rows: 35
## Columns: 7
## $ experimental_unit <dbl> 101, 102, 103, 104, 105, 106, 107, 201, 202, 203, 20~
## $ PRE               <chr> "acetochlor", "acetochlor", "acetochlor", "acetochlo~
## $ POST              <chr> "weed-free control", "weedy control", "dicamba", "bi~
## $ date              <dttm> 2022-05-19, 2022-05-19, 2022-05-19, 2022-05-19, 202~
## $ weed_vis_score    <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ iwg_injury        <dbl> 4, 4, 4, 4, 4, 4, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ person            <chr> "jesse", "jesse", "jesse", "jesse", "jesse", "jesse"~
```

```
## Rows: 105
## Columns: 7
## $ experimental_unit <dbl> 101, 102, 103, 104, 105, 106, 107, 201, 202, 203, 20~
## $ PRE               <chr> "acetochlor", "acetochlor", "acetochlor", "acetochlo~
## $ POST              <chr> "weed-free control", "weedy control", "dicamba", "bi~
## $ date              <dttm> 2022-06-13, 2022-06-13, 2022-06-13, 2022-06-13, 202~
## $ weed_vis_score    <dbl> 2, 1, 3, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0~
## $ iwg_injury        <dbl> 0, 0, 0, 3, 2, 7, 1, 1, 0, 1, 0, 0, 5, 3, 3, 2, 3, 0~
## $ person            <chr> "jesse", "jesse", "jesse", "jesse", "jesse", "jesse"~
```

```
## Rows: 35
## Columns: 4
## $ experimental_unit <dbl> 101, 102, 103, 104, 105, 106, 107, 201, 202, 203, 20~
## $ PRE               <chr> "acetochlor", "acetochlor", "acetochlor", "acetochlo~
## $ POST              <chr> "weed-free control", "weedy control", "dicamba", "bi~
## $ yield_kgha        <dbl> 680.8173, 672.7444, 497.8309, 600.0880, 853.0399, 57~
```

Spring data

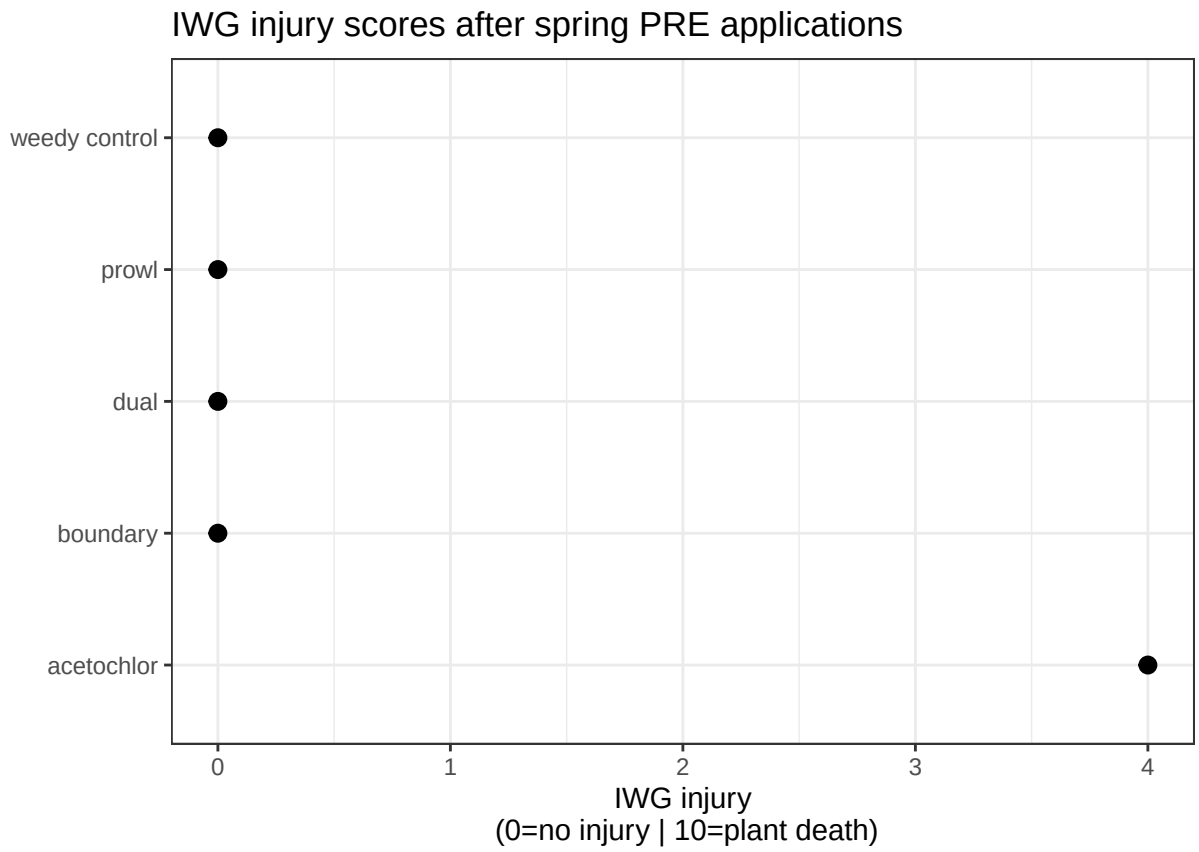

Table 3: IWG injury scores collected by Jesse on 19May2022

PRE	injury	weed	n
acetochlor	4	0	7
boundary	0	0	7
dual	0	0	7
prowl	0	0	7
weedy control	0	0	7

Summer data

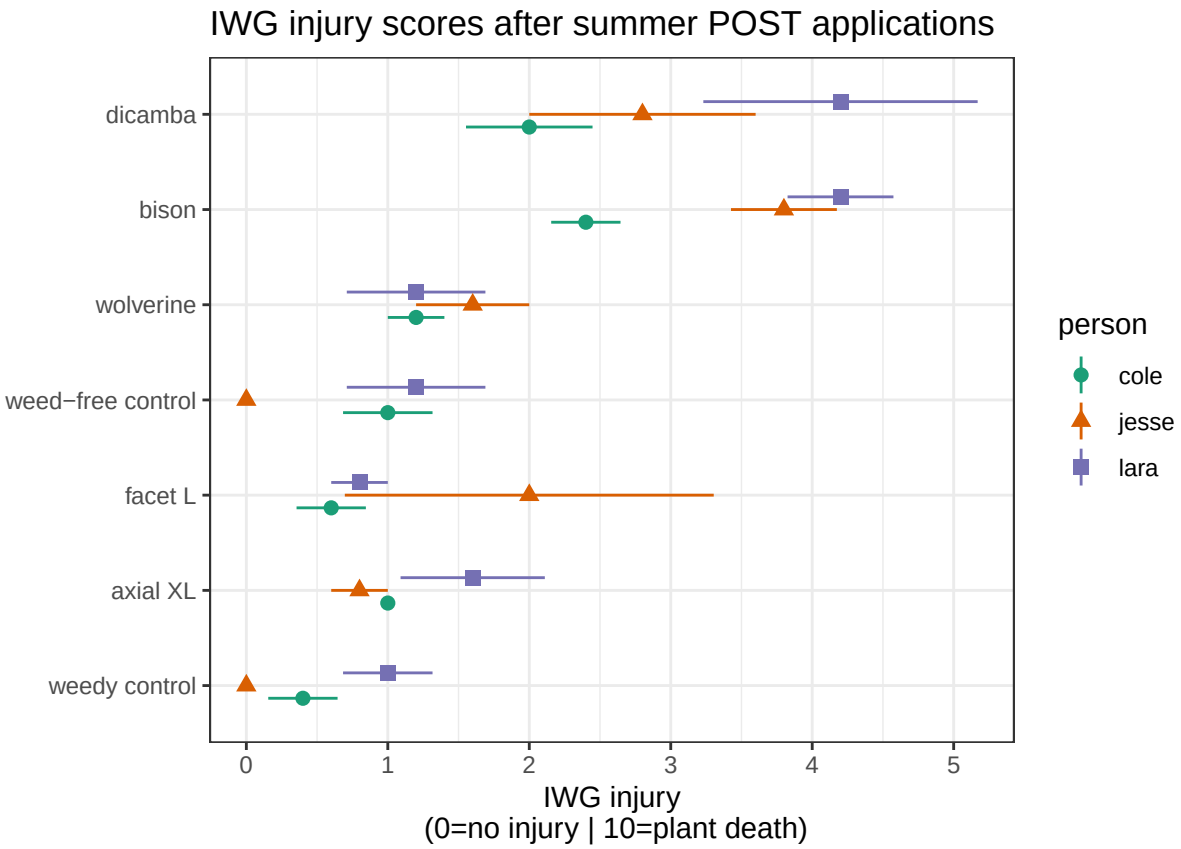

Table 4: IWG injury scores collected by Jesse on 13Jun2022

POST	injury	weed	n
axial XL	1.1	0.2	15
bison	3.5	0.6	15
dicamba	3.0	0.6	15
facet L	1.1	0.4	15
weed-free control	0.7	1.0	15
weedy control	0.5	0.6	15
wolverine	1.3	0.2	15

Yield data

Table 5: IWG yields did not differ among different PRE applications

PRE	Yield (kg ha)	n
boundary	782 a	7
acetochlor	603 a	7
weedy control	595 a	7
dual	549 a	7
prowl	522 a	7

Table 6: IWG yields that share the same letter do not differ among POST applications

POST	Yield (kg ha)	n
wolverine	775 a	5
weedy control	704 a	5
facet L	680 ab	5
weed-free control	657 ab	5
axial XL	607 ab	5
bison	512 ab	5
dicamba	336 b	5

Findings

IWG was resilient to maximum rates of unlabelled herbicides applied at times when the risk of crop injury was high. All plants produced grain and there were no obvious differences in grain yield in the field, though differences in grain yield were detected after threshing.

With the exception of acetochlor, the PRE herbicides did not cause any observable damage to the IWG plant and yields did not differ among control and plots that received different PREs. Months after application, IWG plants that received an aceotochlor application were stunted.

ALL POST herbicides caused observable damage to the IWG plant. Of these herbicides, Axial XL caused the least visible damage and yields did not differ between axial and plots that recieved no herbicides. Axial XL (Pinoxaden) is a grass herbicide, which is exciting as we currently do not have any grass herbicides available.

Wolverine is an herbicide commonly used by the wheat breeding lab on wheatgrass. Here we observed visible crop injury though this may be due to the high rate and the late timing, but no yield impact. The higher rates of injury observed in plots where dicamba and bison and facet were applied may be simply due to timing, as these growth regulators were applied to IWG after seedheads had begun to emerge. IWG sprayed with dicamba yielded the lowest (336 kg ha vs. 655.8333333 kg ha average of other plots)

The low injury observed in the PREs (prowl, dual and boundary) and the low injury in Axial XL even at a high rate and late timing is useful information if grass weeds pose a problem in future experiments. Pinoxaden controls foxtails and oat, but not brome.

The lack of yield penalty observed in wolverine and facet and all PREs is exciting.

Recommendations

Currently, the only option for the control of grass weeds is through PREs. Further trials looking at other grass herbicides and that look at different timings of the herbicides in this study would provide more information.

IWG is a very competitive plant that often doesn't warrant an herbicide application. The most injurious weeds to yield are likely winter annuals, which can be controlled with 2,4-D applied in the fall or early spring. Weed control, especially in patchy or underfertilized IWG stands can be helpful for ease of harvest, as large lambsquarter weeds can clog combine headers and add unwanted moisture to the grain tank. Again, 2,4-D is a good tool for the control of these summer annual escape weeds.

The primary reason to do further research into IWG tolerance to grass herbicides is for the scenario we observed in the NALI experiment where downy brome choked out the IWG and alfalfa. In this scenario, we did not know there was a history of Downy Brome at this site and our primary control method would have been a PRE we would've had to have applied after IWG emergence. If we had a POST grass herbicide for Downy Brome that was safe on IWG, it would've been able to save the study. Future research should look at other grass herbicides that could control downy brome and measure the effects of PRE and grass POST herbicides on *establishing* wheatgrass stands.