Competitive Crops & Diverse Crop Rotation as Tools for IWM

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Wild World of Weeds,
Fargodome, Fargo, ND

NDSU NORTH DAKOTA STATE UNIVERSITY

Competitive Crops & Diverse Crop Rotation as Tools for IWM

- My Background
- Crop Competition & Crop Rotation Diversity
- Summary/Conclusion

Background

- Philippines

- 2008 – BSc in Agriculture (Agronomy)

- 2014 – MSc in Agronomy (Weed Science)

International Rice Research Institute

Background

- Degree in Plant Science in 2020
- Montana State University [MSU]
  - MSU – Southern Ag. Research Center, (Huntley, MT)

- screened & characterized kochia populations for multiple herbicide resistance.

e. g. to glyphosate, dicamba, ALS-inhibitors

Background

Diversity in tillage, herbicide use pattern, & crop rotation.

Barley

Corn

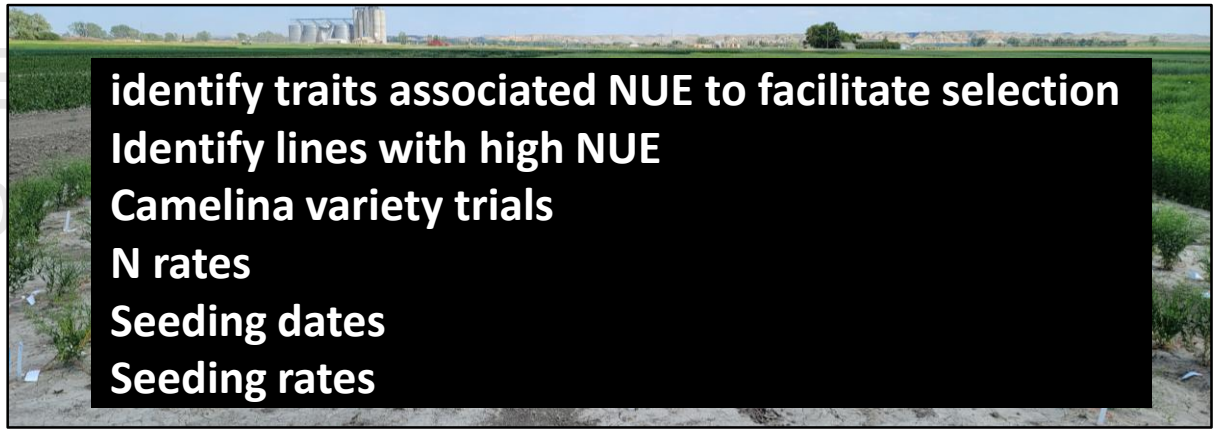
- Four-year field study on management of herbicide-resistant kochia seedbank.
- herbicide efficacy and crop safety trials for product development.

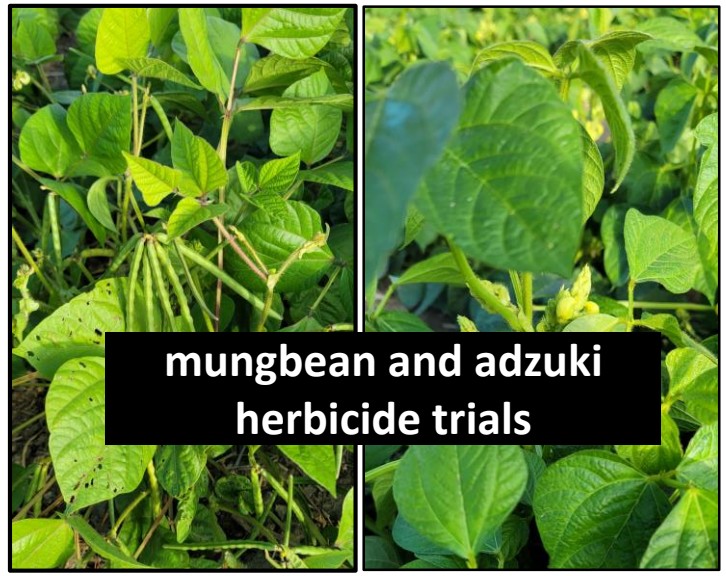
Background

MSU – EARC

Sidney, MT

[2021]





Background

NDSU – WREC

Williston, ND

[JUL, 2022]

Extension Weed Specialist

Photo by Dr. C. Keene

Role: Outreach and research efforts to tackle weed issues in ND with focus in the western ND (and eastern MT).

Competitive Crops & Diverse Crop Rotation as Tools for IWM

- ~~My Background~~
- Crop Competition & Crop Rotation Diversity
- Summary

Why crop rotation is important?

- Crops with different times of planting, harvesting, growth habit, and different production practices allow a variety of cultural techniques to be used to optimize crop competitiveness at the expense of weed growth and reproduction.
- Rotation between different crop types can help break the cycle of adapted weeds.
- Highly competitive crops prevent weeds from thriving and producing seeds.
- Herbicides used in the broadleaf crop can effectively control grass weeds that were not controlled well in the grass crop.
- Allows the introduction of herbicides having different effective MOAs to avoid successive use of a single MOA.

(Buhler 2002; Forcella et al. 1993; O'Donovan et al. 2007; Melander and Rasmussen 2001)

Why diversify crop rotation?

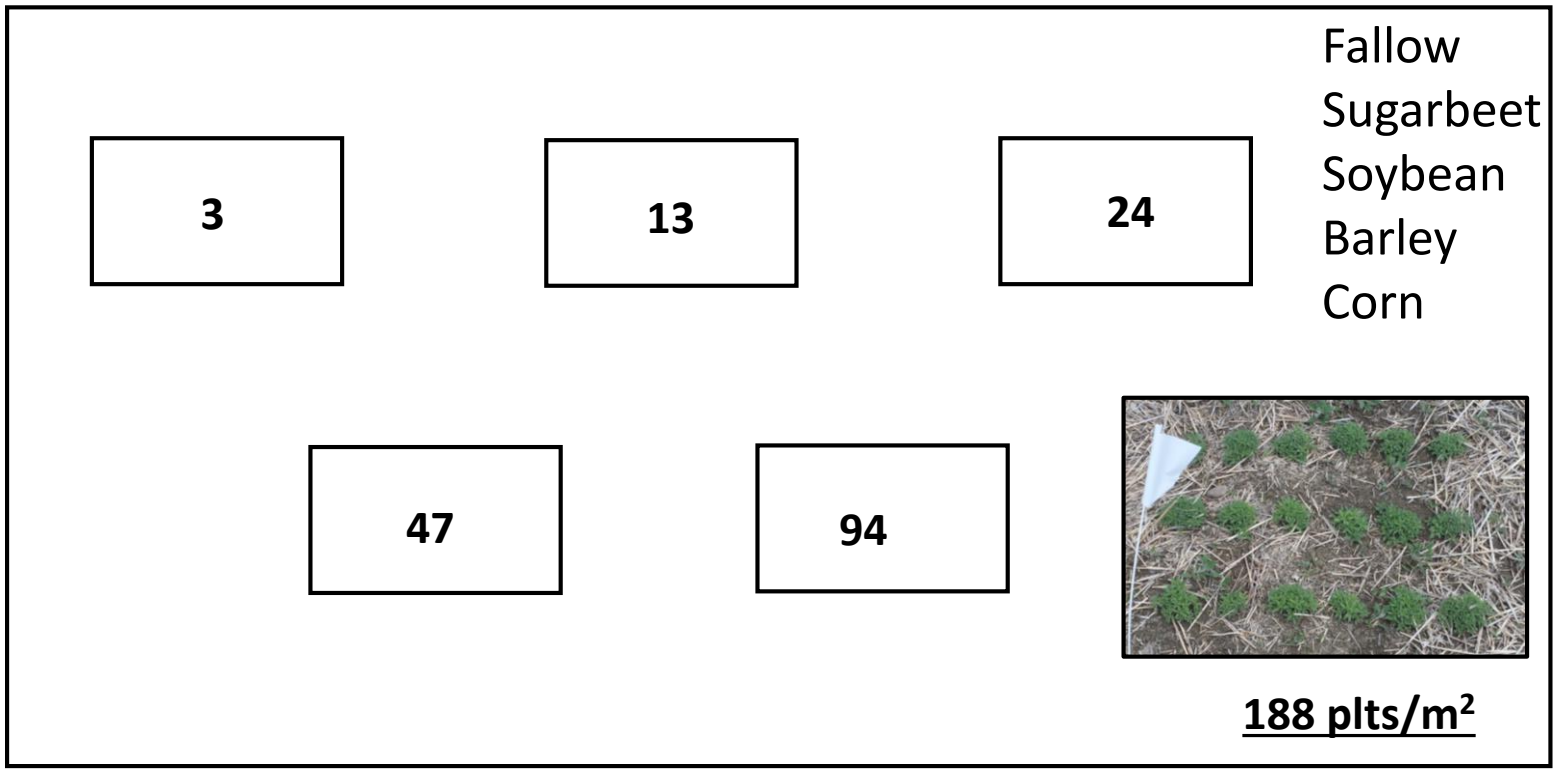
- Crops with different times of planting, harvesting, growth habit, and different production practices allow a variety of cultural techniques to be used to optimize crop competitiveness at the expense of weed growth and reproduction.

”provide an unstable and frequently inhospitable environment that prevents the proliferation of a particular weed species/biotypes.”

(Liebman & Dyck 1993)

- Herbicides used in the broadleaf crop can effectively control grass weeds that were not controlled well in the grass crop.
- Allows the introduction of herbicides having different effective MOAs to avoid successive use of a single MOA.

Effect of Crop Competition



Sugarbeet	Soybean	Barley	Corn	Fallow
glyphosate	glyphosate	Pyrasulfotole + bromoxynil	glyphosate	glyphosate

kochia growth and fecundity

crop situation x weed density

followed usual planting date and practices for each crop situation

trial repeated

kochia emerged before crops did

Effect of Crop Competition

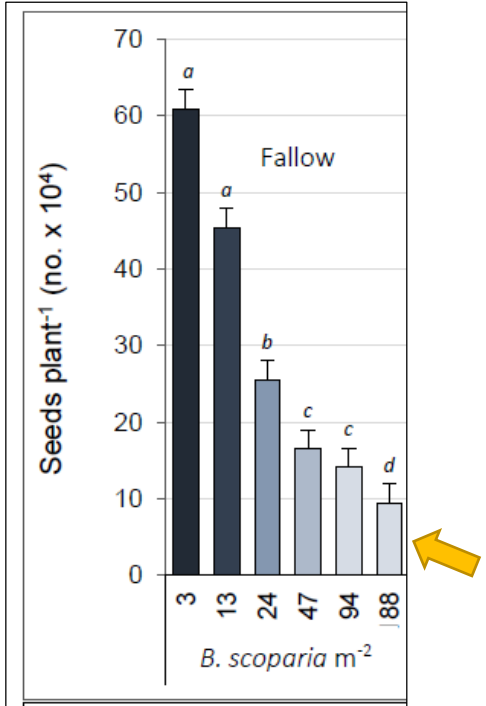

Fallow

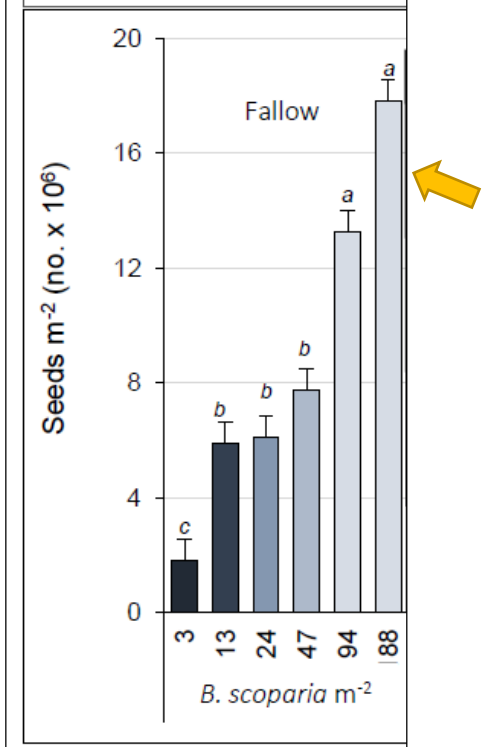

Sugarbeet


Soybean

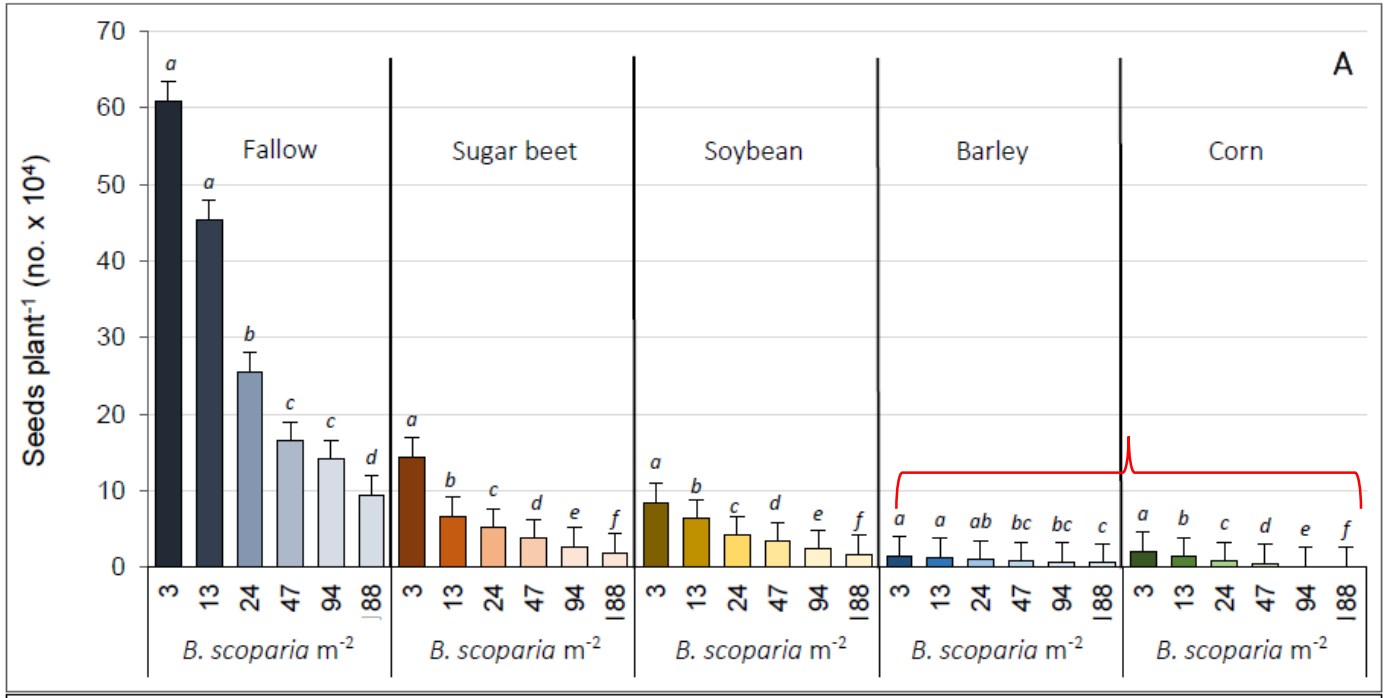

Barley


Corn


Seeds plant-1 (no. x 10⁴)
70
60
50
40
30
20
10
0
Fallow
a
a
b
c
c
d
3
13
24
47
94
88
B. scoparia m-2


Seeds m-2 (no. x 10⁶)
20
16
12
8
4
0
Fallow
c
b
b
b
a
a
3
13
24
47
94
88
B. scoparia m-2

barley, tall wheat varieties, corn, cereal rye, winter triticale,



Field had kochia resistant to ALS-inhibitors

Table 4. *Bassia scoparia* density and seed production (estimated marginal means) as affected by ALS-inhibiting herbicide treatment and crop at four locations near Huntley, MT, Powell and Lingle, WY, and Scottsbluff, NE, in 2014.

Herbicide	Crop	*B. scoparia*		
		plants ha^{-1}	seeds $plant^{-1}$	seeds m^{-2}
ALS inhibitors	Corn	1,870 d[a]	1,480 n	297 y
	Dry bean	329 c	2,660 n	173 y
	Spring wheat	180 abc	952 mn	53.4 xy
	Sugar beet	1,740 d	23,800 o	3,980 z
Non–ALS inhibitors	Corn	61.8 ab	225 m	10.8 x
	Dry bean	204 bc	5,330 n	310 y
	Spring wheat	10.9 abc	0	0
	Sugar beet	22.8 a	3,260 no	171 xy

(Mosqueda et al. 2020)

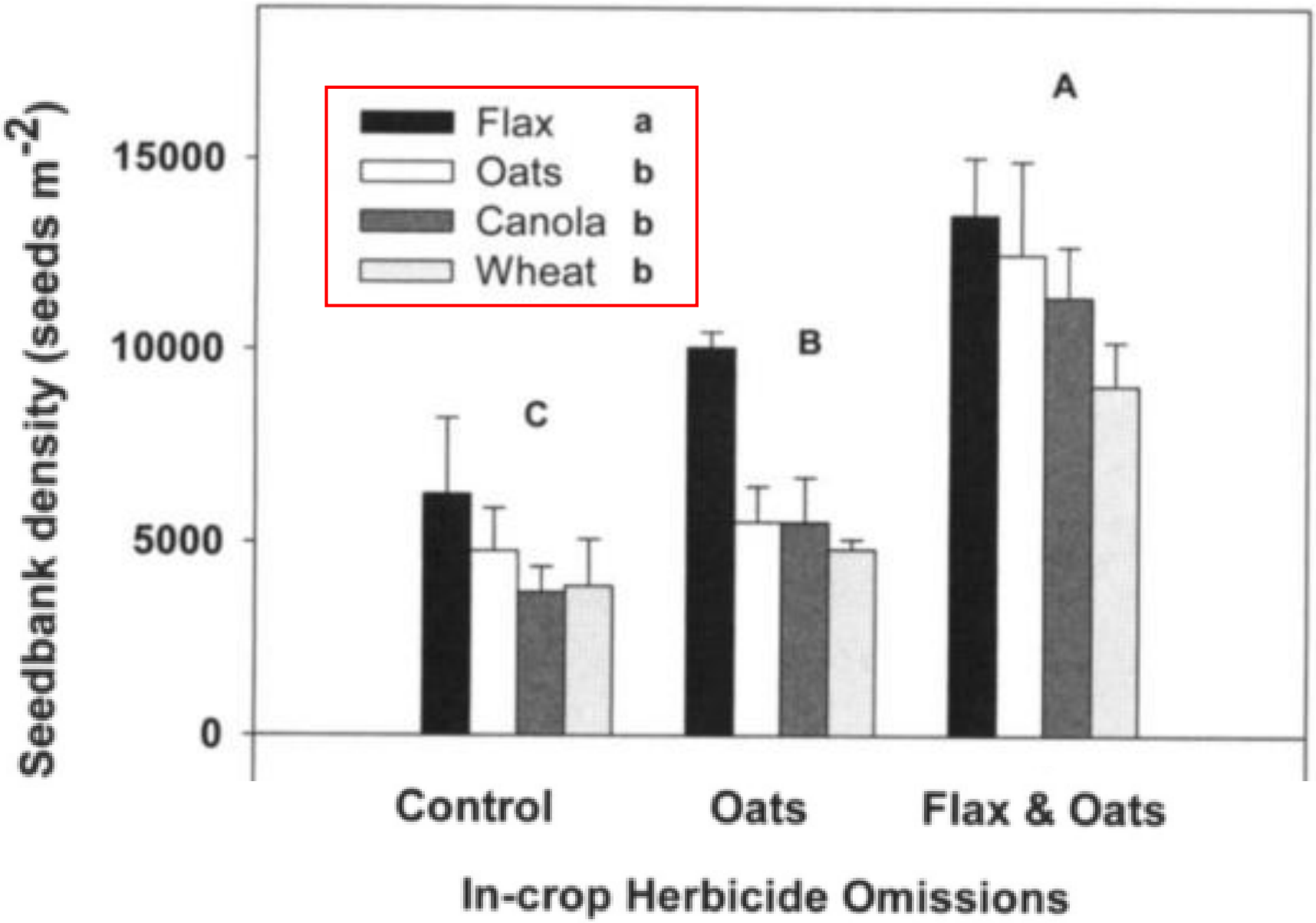
Diversity in Crop Rotation, Tillage, and Herbicide Use Pattern

Table 2. Average kochia plants/m^2 within each tillage practice, crop rotation, and herbicide use pattern in the 3rd year of the study.

Crop Rotation	Herbicide Treatment					
	ALS only	ALS rotation	ALS/NonALs mixture	ALS only	ALS rotation	ALS/NonALs mixture
	Minimum Tillage			Intensive Tillage		
Continuous corn	**67**	**2**	**3**	**37**	**2**	**1**
Corn – Sugarbeet – Corn – Sugar beet	**481**	**56**	**4**	**296**	**43**	**11**
Corn – Dry bean – Corn -Sugarbeet	**64**	**65**	**4**	**31**	**7**	**3**
Corn – Dry bean – Wheat -Sugarbeet	**28**	**2**	**3**	**8**	**1**	**1**

With a known ALS-resistant kochia seedbank in all sites (5%).
Multisite-years: Huntley MT, Powell and Lingle WY, Scottsbluff, NE)

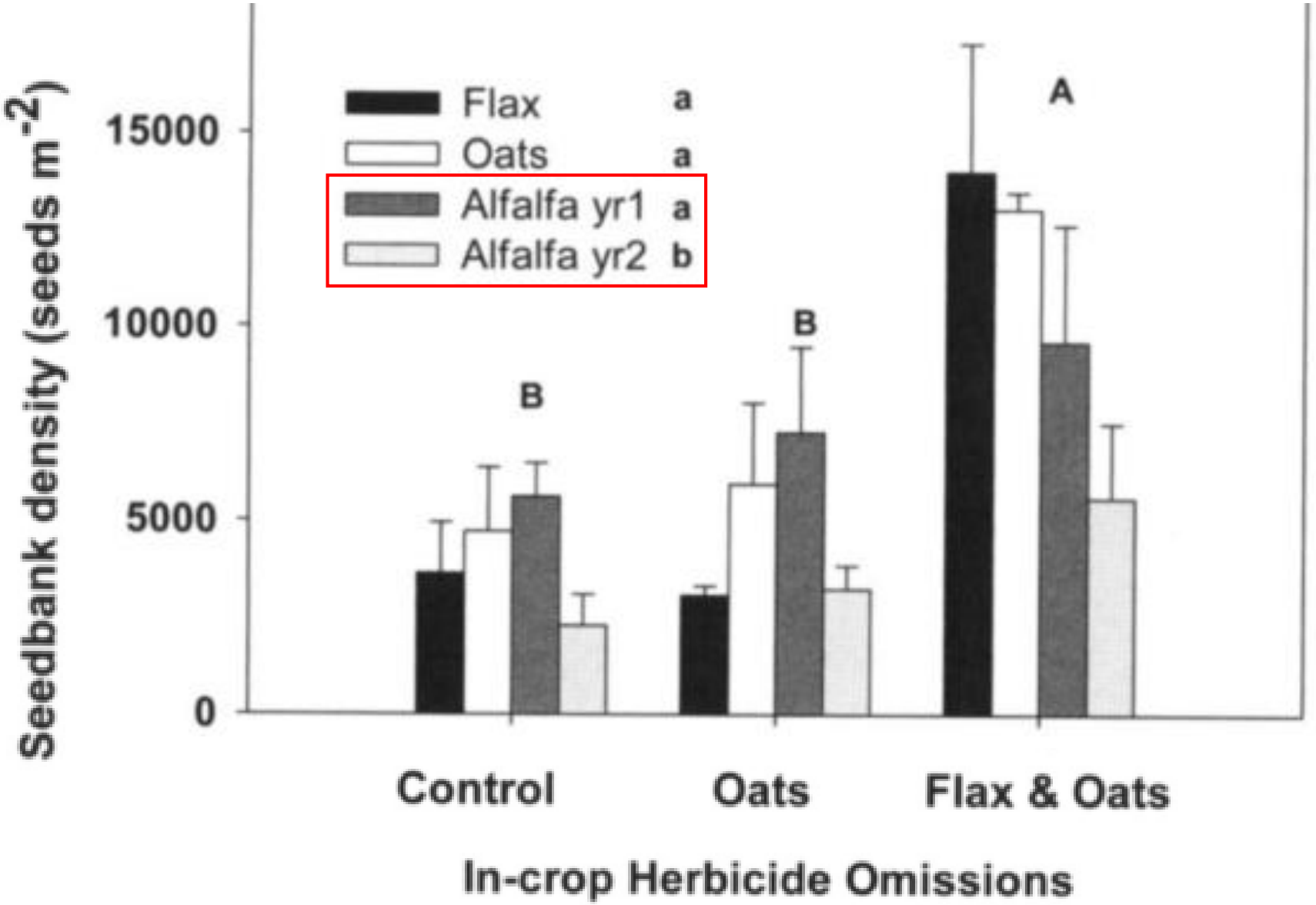
(Mosqueda et al. 2018)



10-yr study (2000-09)

- effect of in-crop herbicide omissions
- weed seedbank density
- 16 cores soil samples/plot (2009)
- exhaustive germination
- crops present each year

(Gulden et al. 2011)



- Same study
- But 2yrs of alfalfa in the rotation
- instead of canola and wheat

(Gulden et al. 2011)

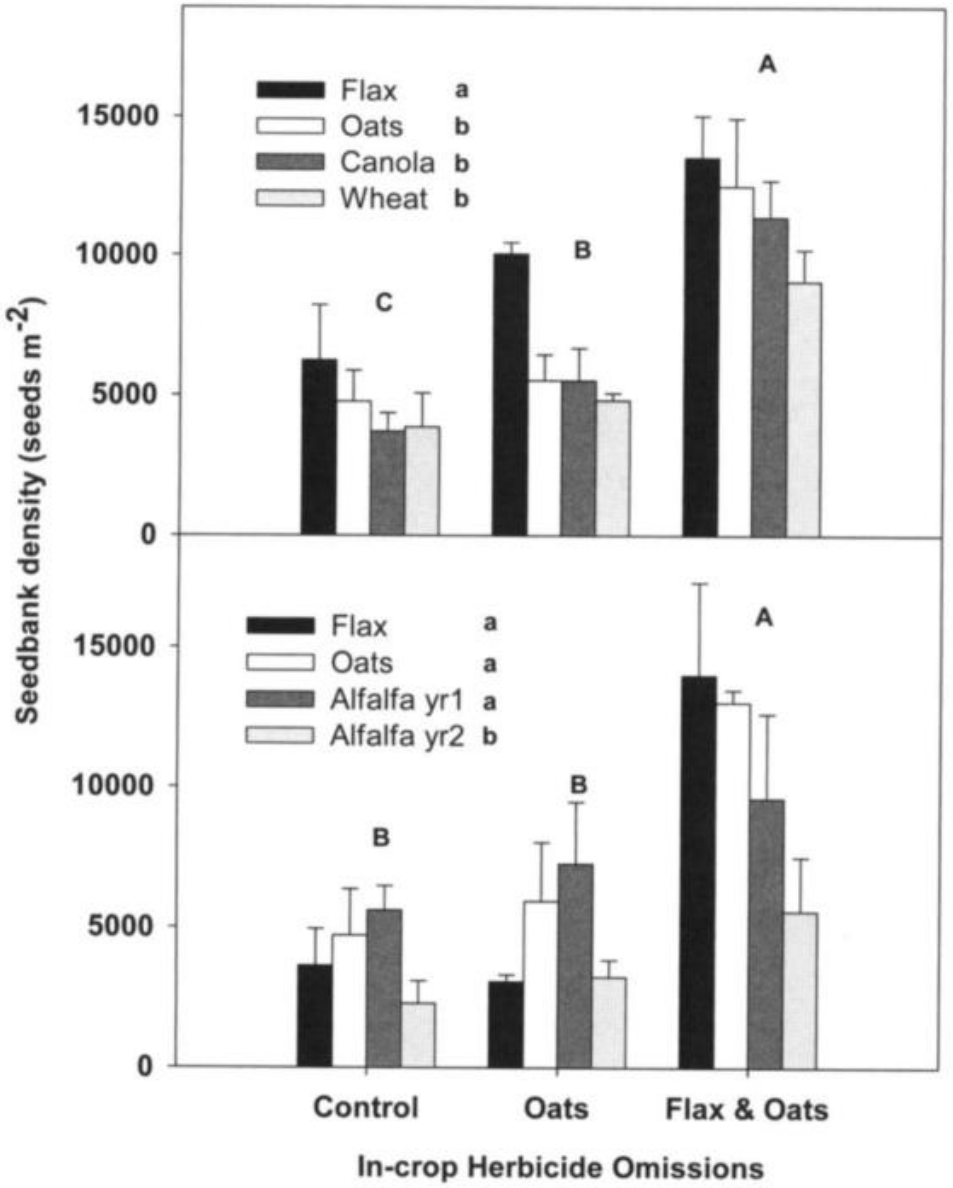


Figure 1. Total germinable weed seedbank density in an annual-crop only (top) and alfalfa-crop (bottom) rotation after 10 yr of in-crop herbicide omissions during oats and flax and oats. Crop and herbicide-omission treatments followed by different letters are statistically significantly different based on Fisher's Protected LSD means comparison conducted within each main effect. Bars indicate standard errors of the means.

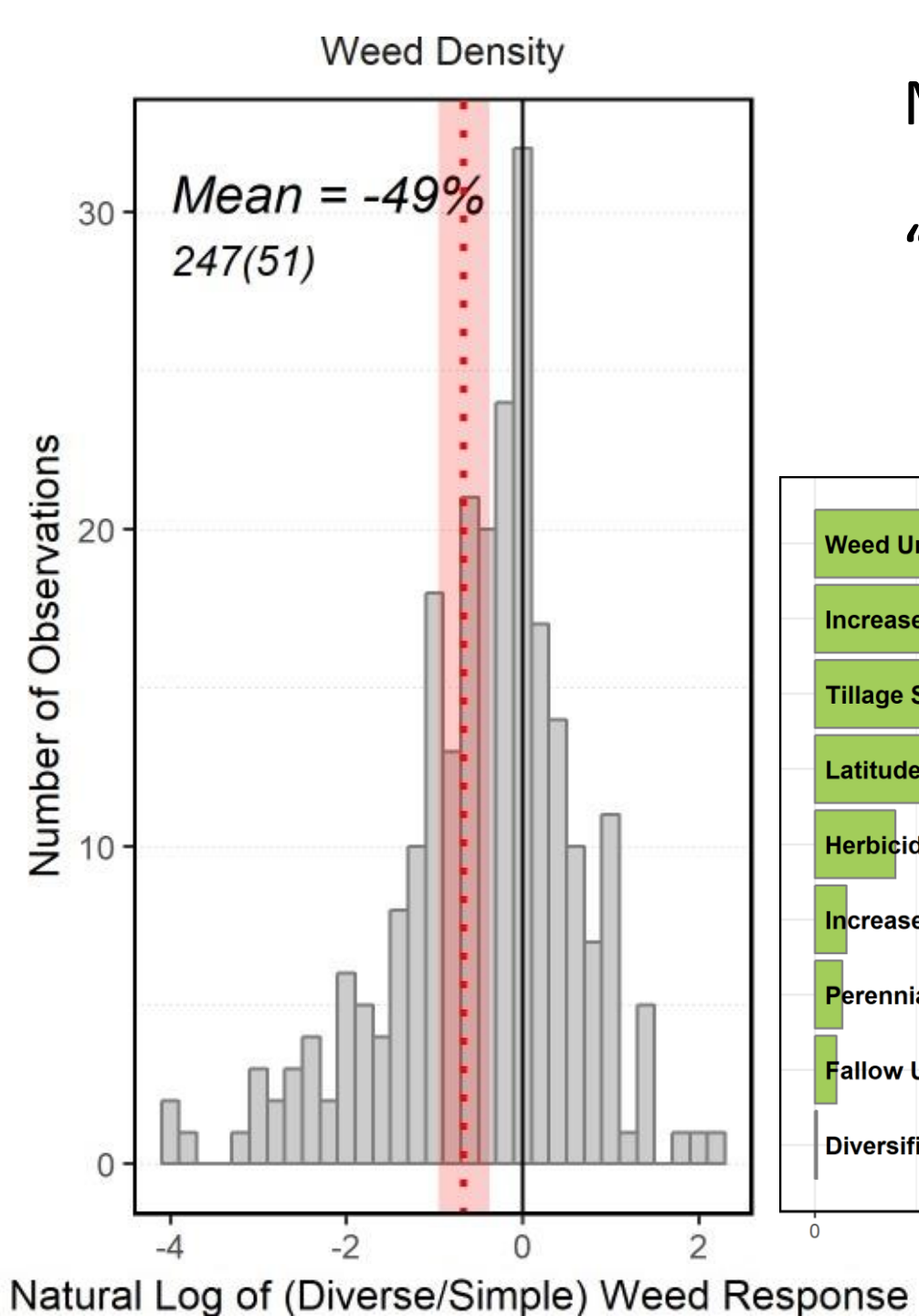
So, even with a diverse crop rotation and with competitive crops (oats, alfalfa), effective herbicides are still needed in the rotation to keep weed seedbanks low.

I can see similar scenario with resistant weeds.

e.g. failed to control G. foxtail in wheat with Discover NG then applying Assure II in the succeeding pulse crop.

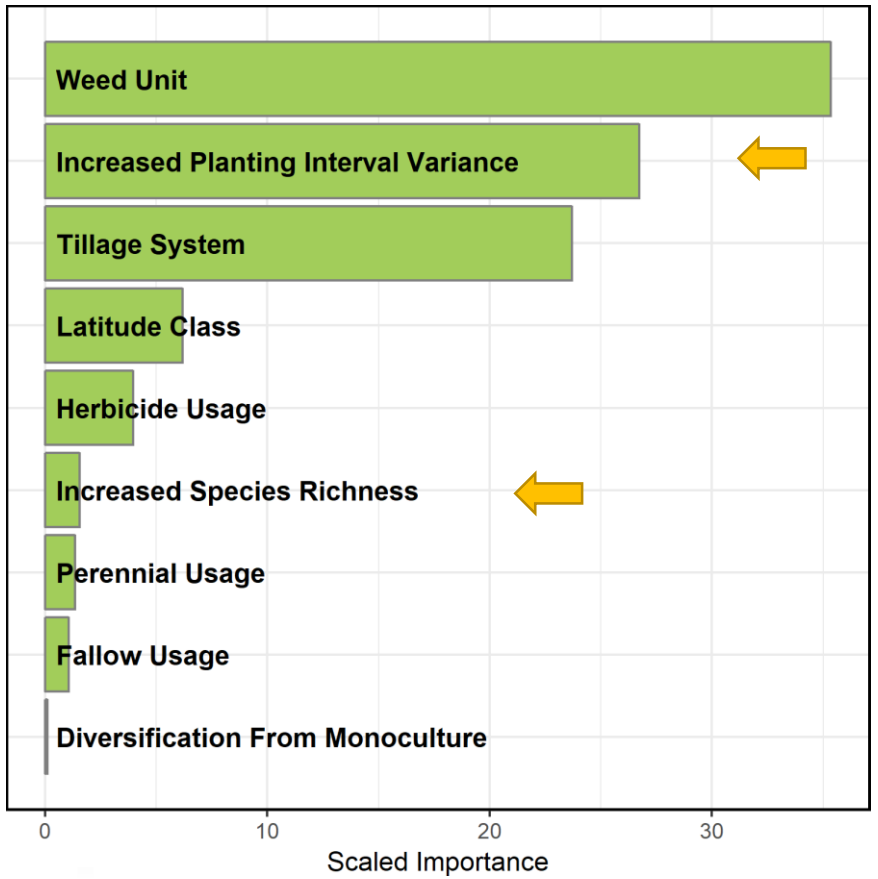
A diverse crop rotation must be paired with effective MOA in the rotation.

(Gulden et al. 2011)



Meta-analysis

"Does diversifying crop rotations suppress weeds?"

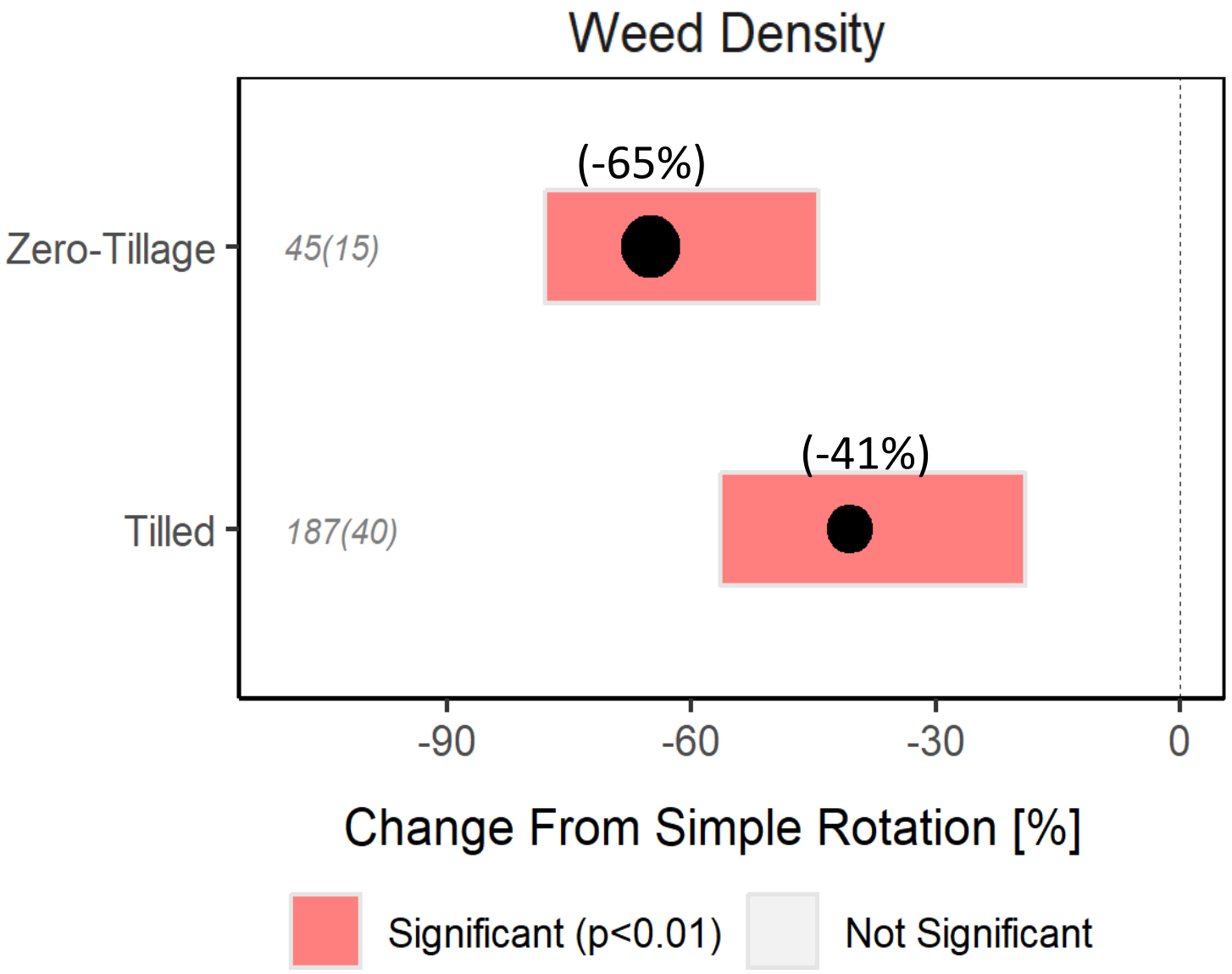


Simple rotation:

- 1 crop species
- 1 crop and fallow
- 2 crops species in 2yrs

"crop planting dates was more effective in suppressing weeds than increasing crop species richness alone."

(Weisberger et al. 2019)



"Increasing rotational diversity reduced weed density more under zero-tillage conditions (65%) than tilled conditions (41%)."

(Weisberger et al. 2019)

Summary/Conclusion

- Competitive crops and crop rotational diversity should be viewed as viable tools for weed control and weed seedbank management.
- Herbicides remain the backbone for weed control, but should not be viewed as a separate tool.
- Integration of cultural and ecological weed management approaches with our effective herbicide programs remains our best hope to stay ahead of weeds.

Thank you!

NDSU | EXTENSION

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Photo by Dr. C. Keene

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