



Strategies for Fighting Herbicide-Resistant Weeds

Bryan Young





- Several prevalent weeds with multiple herbicide resistance
- Season-long weed germination; easily spread
- SEVERE drought for herbicide discovery!
- New crop traits are for 'old' herbicides
- Regulatory constraints on herbicide use



Best Way to Encourage Weeds #1



Best Way to Encourage Weeds #2



Herbicide-Resistant Weeds

Best Management Practices

Cultural

- Prevent introduction of new weeds
- Increase crop rotation diversity
- Reduce crop row spacing / Increase crop seeding rate
- Integrate cover crops

Mechanical

- Use tillage when appropriate
- Harvest weed seed control
- Weed electrocution
- Hand-weeding

Chemical

- Integrate diverse, effective herbicide sites of action
- Tank mixtures in foliar applications
- Reduced herbicide rates can lead to reduced effectiveness
- Soil residual herbicides

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Future Growth Opportunities



Horseweed (aka Marestalk) at Planting



January 9-

Mid-May 2018 - SEPAC



Horseweed (aka Marestalk) at Planting



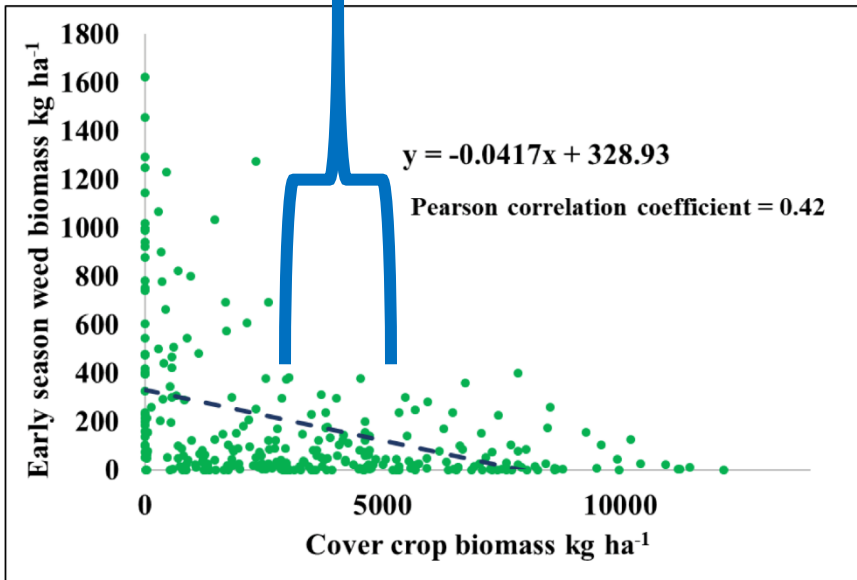
No cover crop

Cereal rye

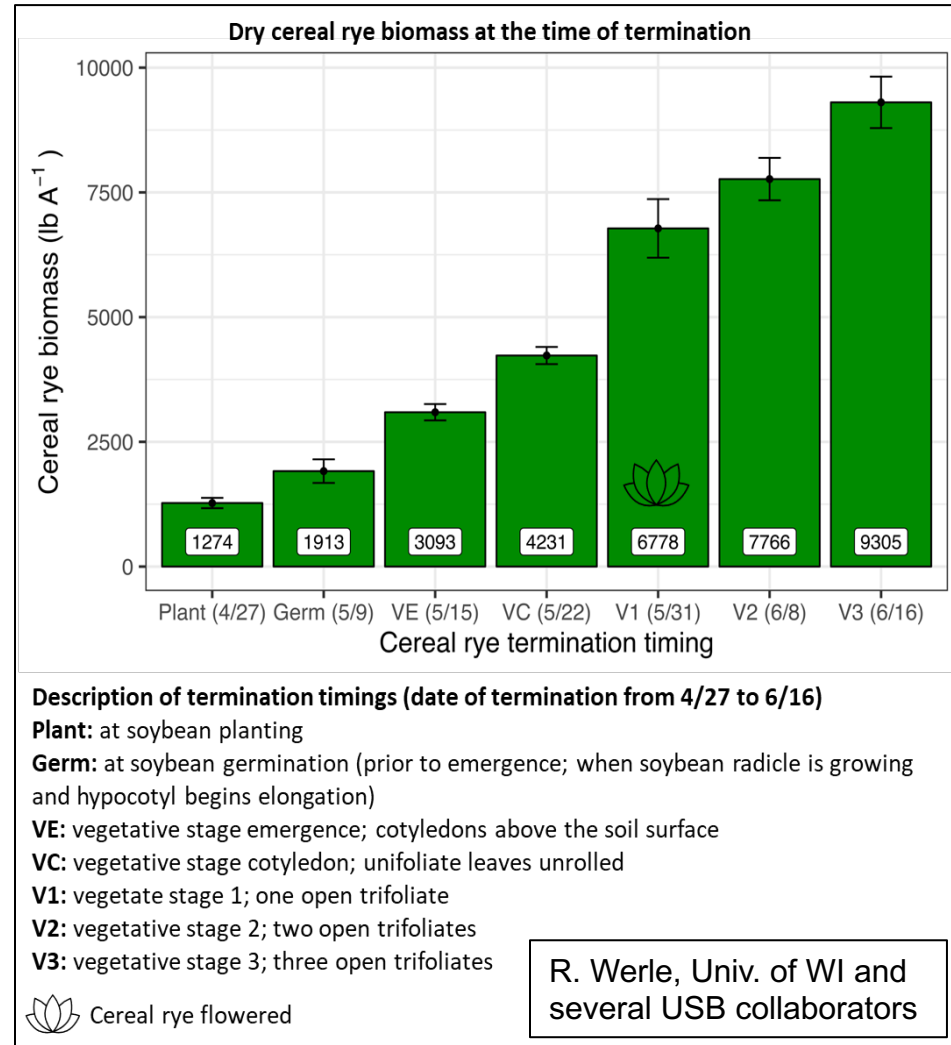
Mid-May 2018 - SEPAC

Cover Crop Biomass → Weed Suppression

4,000 – 5,000 lb/A
of dry biomass



Purdue data: 2018-2019; 6 site-years



4,500 lbs of dry cover crop biomass per acre provided effective (>70%) pigweed suppression with minimal risk of soybean yield loss.



Cover Crops - Planting Green Success

- Easier accomplished in soybeans than corn
- Corn challenges related to nutrient tie-up and insects
- Do we understand all the important factors?

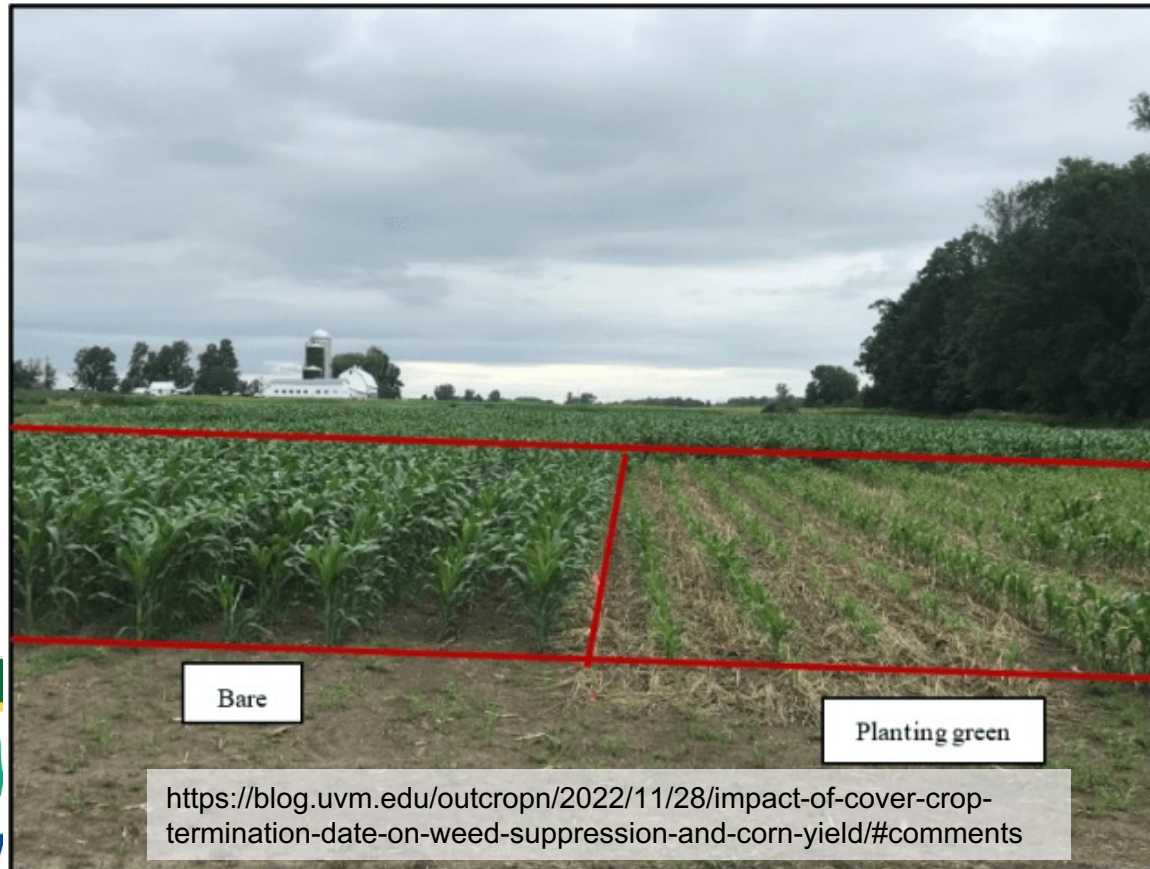
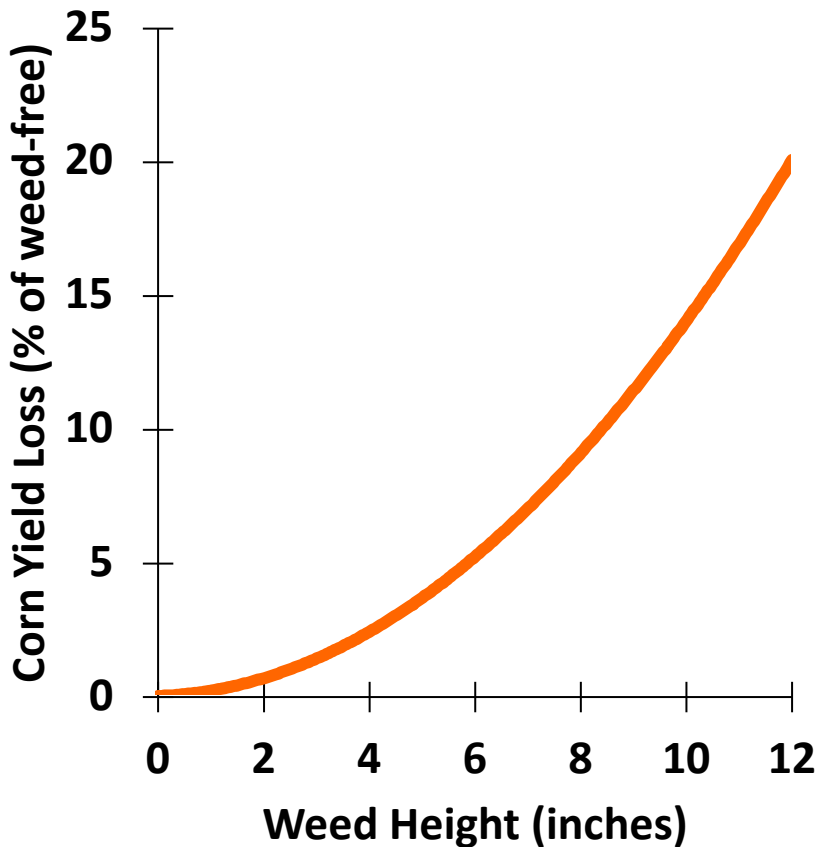


Image 2. Picture of experimental plots taken, 2-July, 2021.

FIGHT OR FLIGHT RESPONSE IN CORN:

How Weed Presence Intimidates Corn





Relationship between corn grain yield and weed size at the time of weed removal. Data from 35 field sites. *Adapted from Gower et al. 2003*

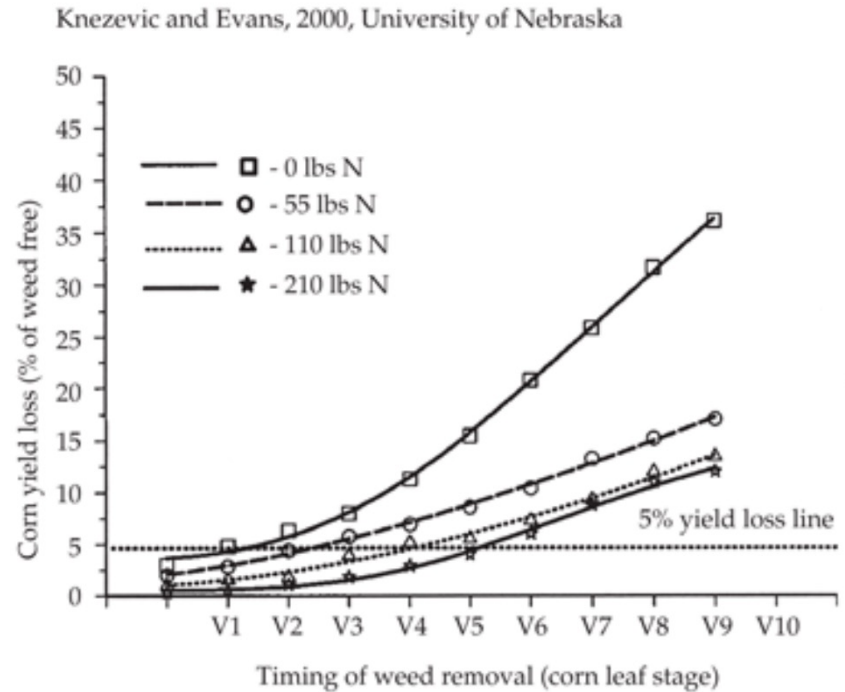


Figure 1. Corn yield loss and beginning of the critical period of weed control as influenced by the timing of weed removal and nitrogen rate.

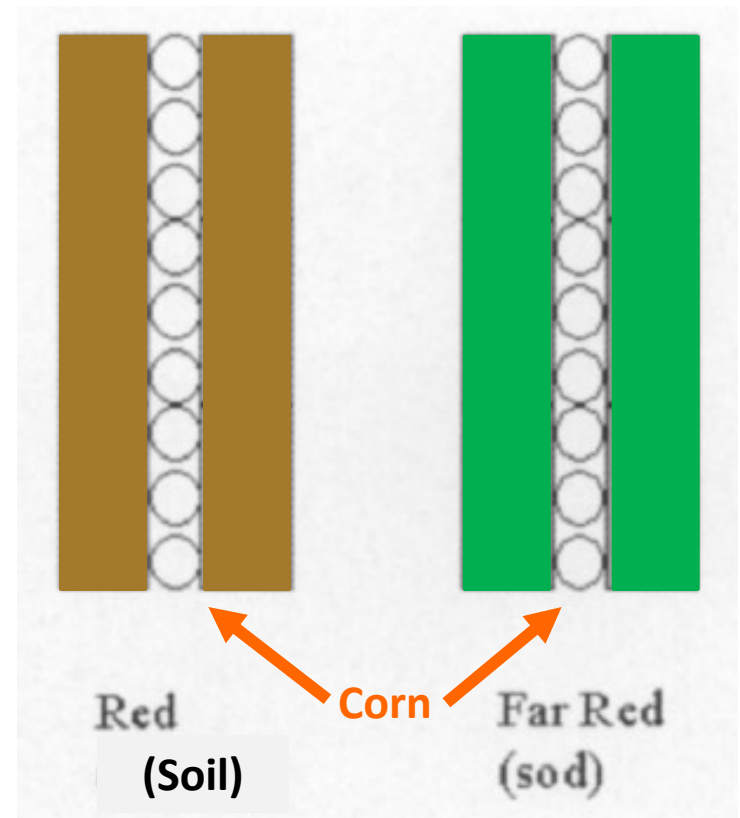
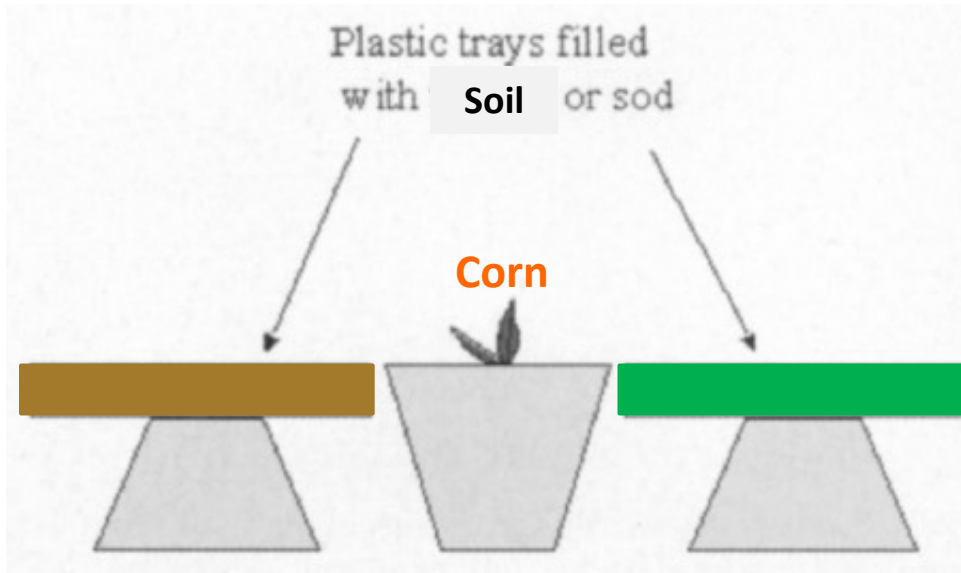
Where does the yield loss come from?





Red:Far-Red Ratio of Reflected Light:

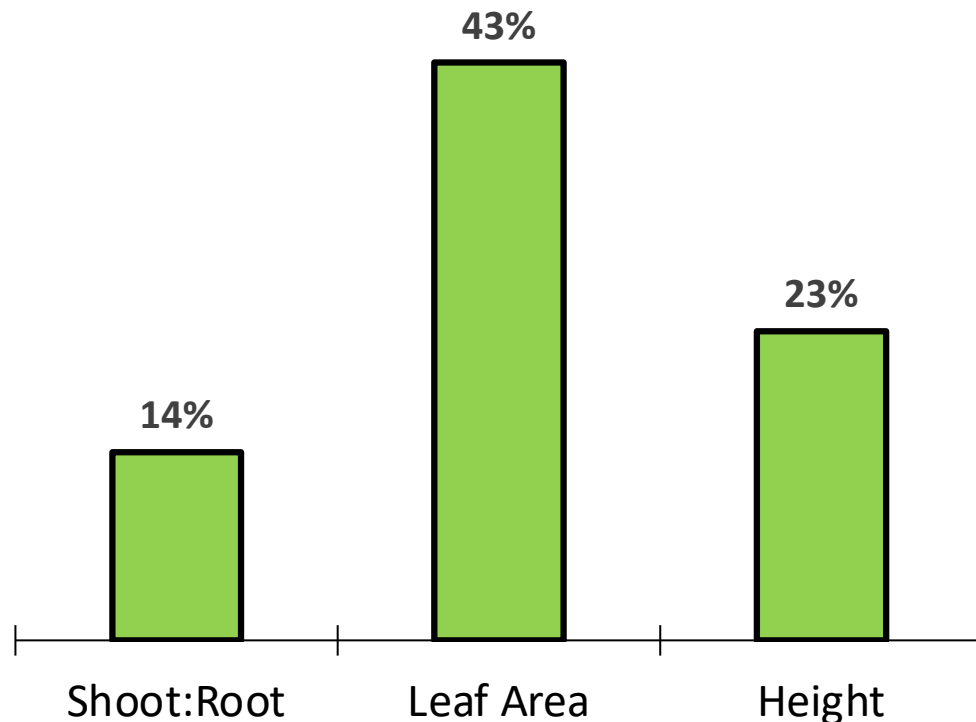
A Hypothesis of Why Early-Season Weed Control Is Important in Corn



Red:Far-Red Ratio of Reflected Light:

A Hypothesis of Why Early-Season Weed Control Is Important in Corn

Change Relative to Bare Soil (%)



Corn Growth with Sod

28% reduction in corn leaves perpendicular to corn row when adjacent to sod.



Implications on Corn Production

- ❑ Weed interference includes light in addition to soil resource competition.
 - ▣ Lower relative root growth would limit resource acquisition from the soil
 - ▣ Delayed leaf orientation to perpendicular to crop row would reduce season-long light capture

- ❑ Under what environmental conditions would this result in yield loss?

- ❑ How much does this apply to corn growth when planting into green covers?

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Can also
impact
weed SEEDS

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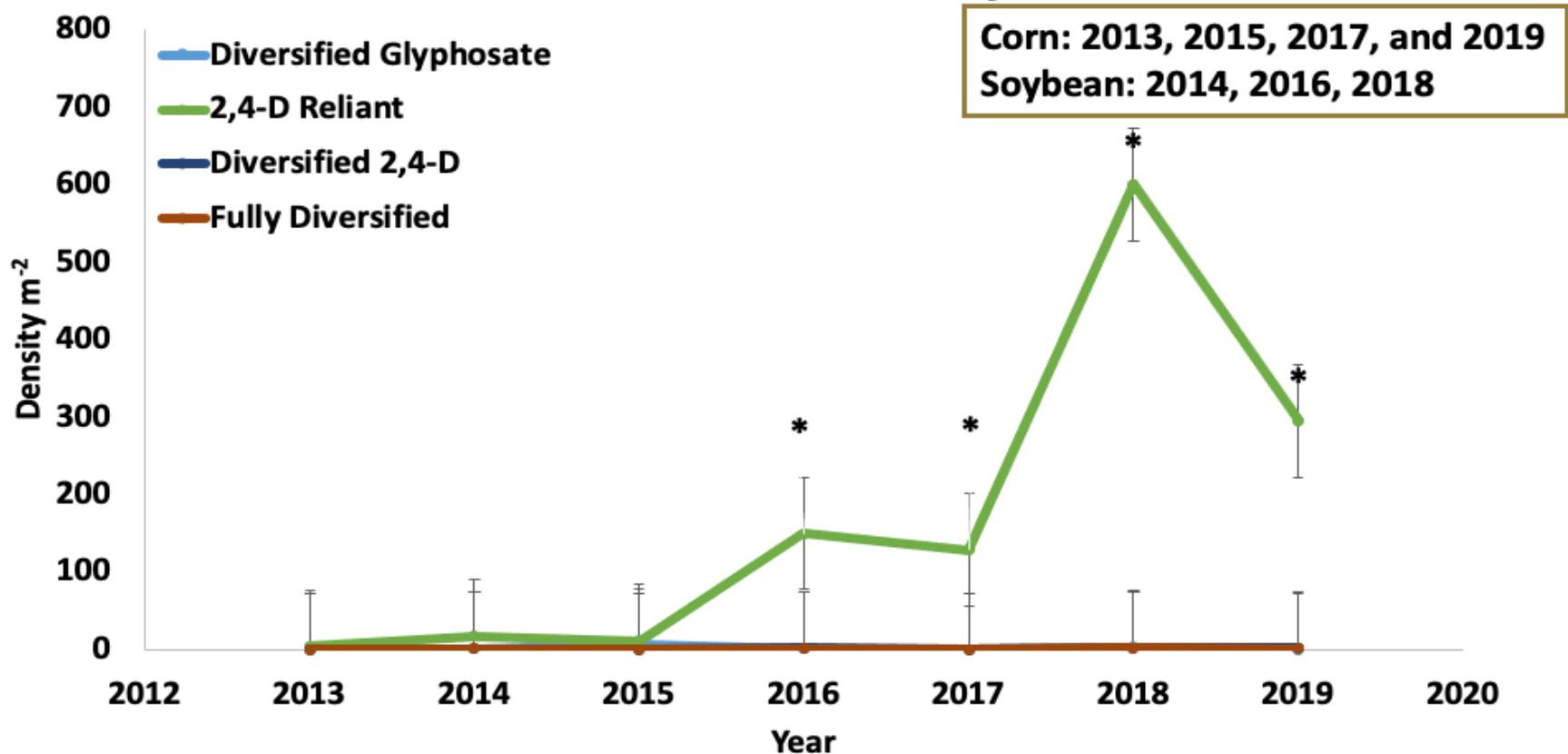
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Considerations for Selecting a Herbicide Program

- Cover crop species
- Cover crop growth stage
- Weeds present
- Crop to be planted
- Weather
- Type of herbicide used



2,4-D (Enlist) Cropping Systems Trial - Total Weed Density



Avoiding weed shifts and herbicide-resistant weeds

Diversity in herbicides and practices

- Additional herbicide sites of action PRE and POST
- Tillage, cover crops, crop rotation (3rd crop – wheat, hay, specialty crops), something that doesn't use the same herbicides

- ❖ Small weeds / timely applications
- ❖ Avoid negative herbicide interactions
- ❖ Gain new, effective herbicides/uses
 - ❖ Manage herbicide costs
 - ❖ Herbicide stewardship

How do we get there?

Increased or Continued Technology Focus

- Herbicide safeners
 - ▣ Ex. Isoxaflutole POST in corn
- Herbicide encapsulations
 - ▣ Extended residual?
 - ▣ Prevent foliar injury POST, yet provide soil residual
 - Ex. Surtain (pending EPA approval)
- Foliar applications of RNAi to defeat herbicide resistance mechanisms
- Herbicide-Resistant crops

UAV Pesticide Applications

- Initial use imaging for field diagnosis....and recreation
- Early applications for fungicides

Pros

- Small, confined, obstructed field areas
- Challenging topography
- Late-season
- Low, relative purchase price

Cons

- Rapidly evolving technology with variable configurations
- Limited payload
- Labor intensive per acre
- License and labeling




Are herbicides applied in this system really optimized as a BMP?

WEED-IT

Green



 **AUGMENTA** EN (US) ▾



WeedSeeker2

Solinftec

Green

Blue River/
John Deere



ode
ONE SMART SPRAY



Lighting Units



Connectivity Unit



Camera



Control Unit

Machine Learning and Targeted Spray Application

Potential Benefits

- Reduce foliar herbicide costs
- Reduce environmental loading and impact
 - Will EPA capture this value?
- Potential to reduce crop injury for some herbicides
- Improve management of herbicide-resistant weeds
 - ???? – Tell me more
- Increase herbicide actives available/commercialized
 - Herbicide actives considered too injurious may result in minor injury when selectively applied
 - Will this pertain to developmental herbicides largely considered non-selective or marginally selective?
 - “Expensive” herbicides for mass production may now be cost effective if not applied broadcast
- Field maps of weed infestations by species?

Reduction in Crop Injury



Glyphosate (Control)



**Cobra (12.5 fl oz/A)
BROADCAST**



**Cobra (12.5 fl oz/A)
SEE & SPRAY**

Machine Learning and Targeted Spray Application

Potential Challenges

- Initial equipment costs
- Potential cost for annual subscriptions for additional features
- Complexity
 - Crop and weed model updates
 - Sensitivity settings to spray weed targets
 - How much spray do I mix for 40 acres?
- “Long” shadows can create large problems
- Gaining more favorable EPA regulations for selective applications
- Crop row spacing and spray travel direction
- Weeds under the crop row or less than 1”
- Compatibility with PWM, direct injection, and high travel speeds

Target Buffering



Two Tank / Two Boom System

Potential Benefits

- ❑ Resolve negative herbicide interactions
- ❑ Alleviate EPA concerns for off-target impact of herbicide combinations
- ❑ Allow for greater herbicide optimization
 - ▣ Adjuvants
 - ▣ Carrier volume
 - ▣ Droplet size

Control of Volunteer RR Corn



Clethodim
Broadcast



Clethodim
+ Dicamba
+ Glyphosate
Broadcast



Clethodim
Broadcast

Dicamba
+ Glyphosate
Selective

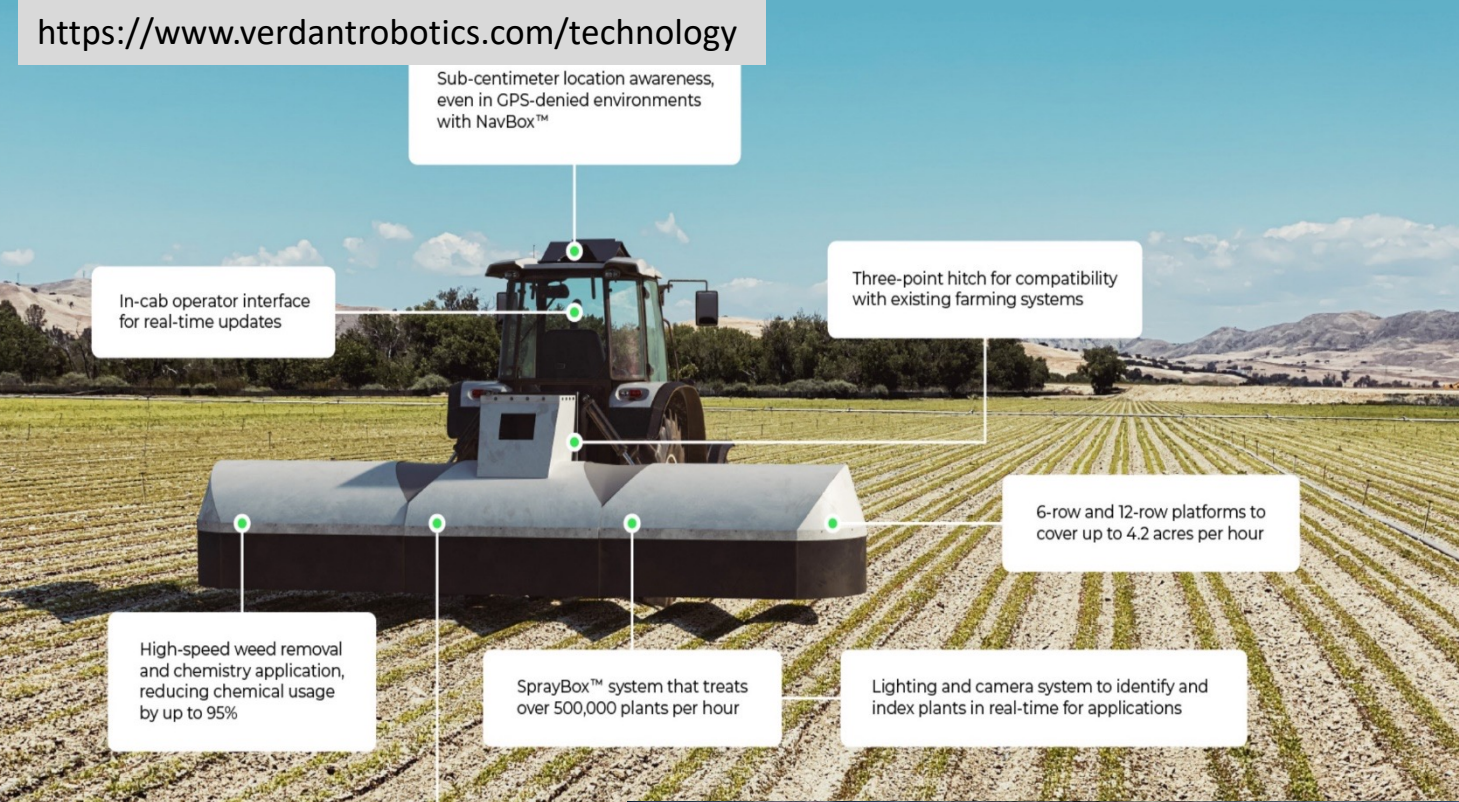
Two Tank / Two Boom System

Potential Challenges

- Initial cost
- Reduced tank size for broadcast applications
 - Fewer acres sprayed per tank relative to conventional sprayer
 - How much carrier do I need for soil residual herbicides?
- Complexity of building the best herbicide strategy
- Mixing and loading time increases

Will Regulation from EPA Change with Selective Applications?

- Variable rate herbicide applications
 - By weed size
 - By soil type
- Will an application to 5% of the field always be considered a broadcast application?
- Can herbicide application rates be increased if herbicide residue levels in crop are reduced from selective applications?
- If herbicide dose is reduced in field margins, or at least only applied to 5% of the area in the perimeter spray pass, will this impact labeling for endangered species?



Sub-centimeter location awareness, even in GPS-denied environments with NavBox™

In-cab operator interface for real-time updates

Three-point hitch for compatibility with existing farming systems

6-row and 12-row platforms to cover up to 4.2 acres per hour

High-speed weed removal and chemistry application, reducing chemical usage by up to 95%

SprayBox™ system that treats over 500,000 plants per hour

Lighting and camera system to identify and index plants in real-time for applications

Laser weeding system nearing deployment for non-chemical weeding





**TECHNOLOGICAL ADVANCES IN WEED CONTROL:
Will These be the Major Frameshift Change
We've Been Waiting For?**

It Depends



WEED OUT RESISTANCE

- Know Your Weeds
- Know Weed Growth
- Know Weed Seed Characteristics
- Know Herbicide Resistance

IN THE FIELD

- Rotate Crops
- Use Multiple Herbicide Sites of Action
- Incorporate Tillage Practices

SPRAY ATTENTION

- Know Herbicide Site of Action and Properties
- Manage Drift
- Know Environmental Conditions
- Know Your Neighbors

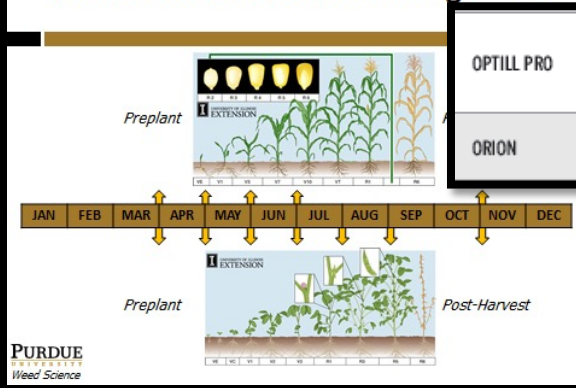
THE BOTTOM LINE

- Manage Risk
- Know Cost-Benefits of Practices
- Know the Cost of Poor Weed Control

Weed Seed Management



Critical Times for Weed Management



OPTILL PRO	saflufenacil	Sharpen	14
	imazethapyr	Pursuit	2
	dimethenamid-P	Outlook	15
ORION	florasulam	-----	2
	MCPA	MCPA	4



Supported by



Thank You!



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Questions?

I WILL
TAKE ACTION AGAINST
HERBICIDE-RESISTANT WEEDS.

I will know my weeds. When they grow. When they pollinate. And I will stop them before they go to seed.

I will take action in the field and do whatever it takes to give my crops the upper hand against weeds.

I will take action with careful herbicide management and use multiple herbicide sites of action, because every action counts.

I will take action because it's my bottom line. It's not about this year or the next. It's about the long term.

I will take action. This time. For all time.

Now is the time to take action against herbicide-resistant weeds. Visit www.TakeActionOnWeeds.com to learn how you can prevent herbicide-resistant weeds from spreading.

Take ACTION
HERBICIDE-RESISTANCE
MANAGEMENT

Brought to you by the soy checkoff

