A discussion on corn rootworms

Advanced Crop Advisors
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Corn rootworms – Who's managing whom?

- 1960s
  - WCR in Southern MN. (Chiang, 1965)
- 1950s-2000s
  - Cyclodiene, OP, carbamate, pyrethroid insecticide (Meinke, et al., 2021)
- 1970s
  - Insecticide degradation
- 1980s,early 2000s
  - Extended diapause NCR (Krysan et al. 1984, 1986)
- 2009 to present
  - Bt resistance and all the above(Gassman 2012, Gassman, et al. 2014, Meihls, et al. 2012,
- The Future?

Corn rootworms – Who’s managing whom?

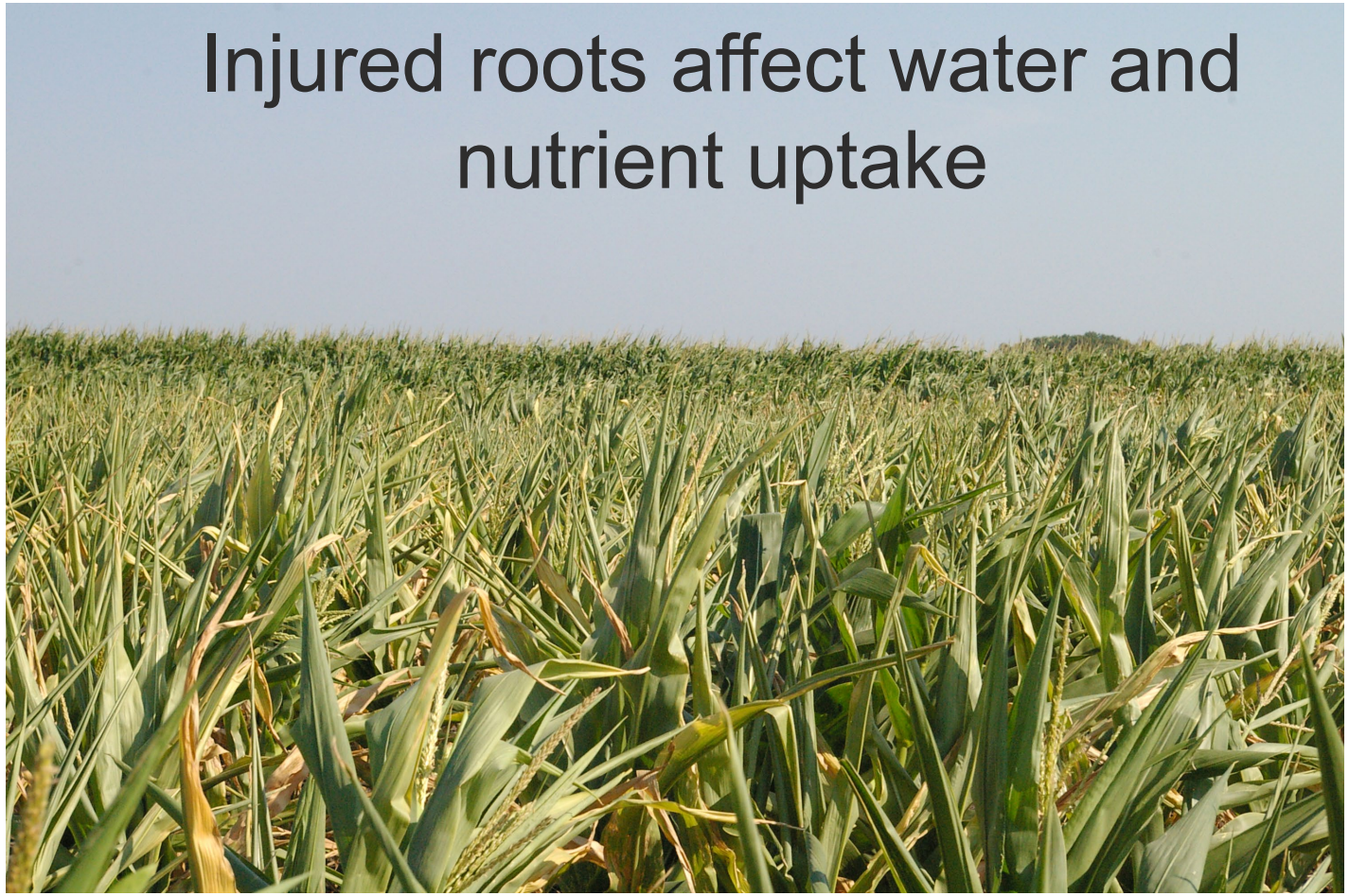
Those who don't know history are doomed to repeat it.” — Edmund Burke

“History doesn't repeat itself, but it does rhyme.” — Mark Twain

How do CRW larvae injure corn?

Bruce Potter 2022

Direct yield effects of rootworm-injured roots



How do CRW adults injure corn?

Pollination issues
Entrance for sap beetles and ear molds

Western Corn Rootworm

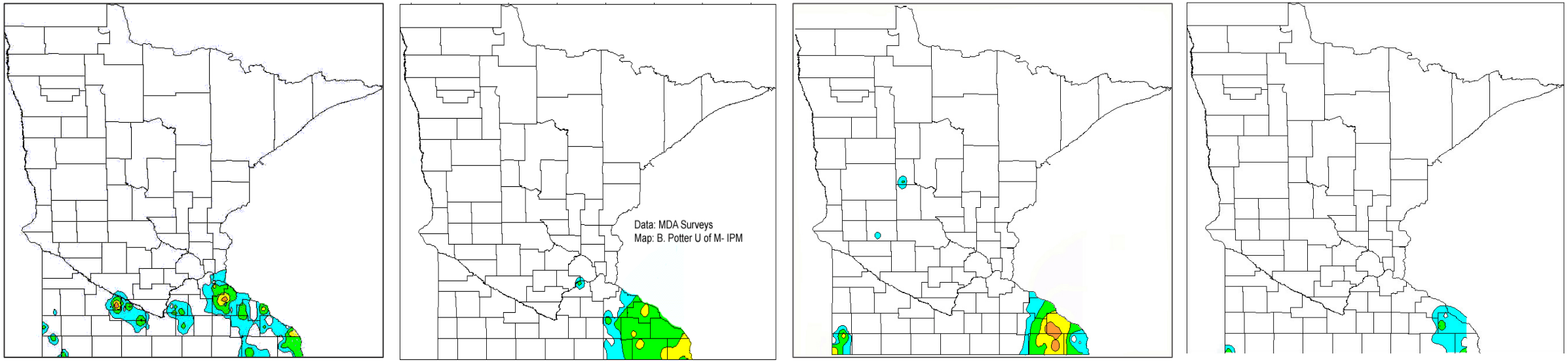
- Continuous corn
  - Variant[1] not documented in MN
  - Extended diapause not documented
- Resistance to insectic
- Resistance to Bt-traits pyramids[2]
  - Cry 3Bb1 prevalent (mCry3a, e
  - Cry34/35 Ab1

[1]Rice and Tollefson 2006
[2]Ludwig, et al. 2017
[2]Zukoff, et al . 2016
[2]Gassman 2012
[2]Frank, et al. 2013
[2]Miehls, et al. 2012

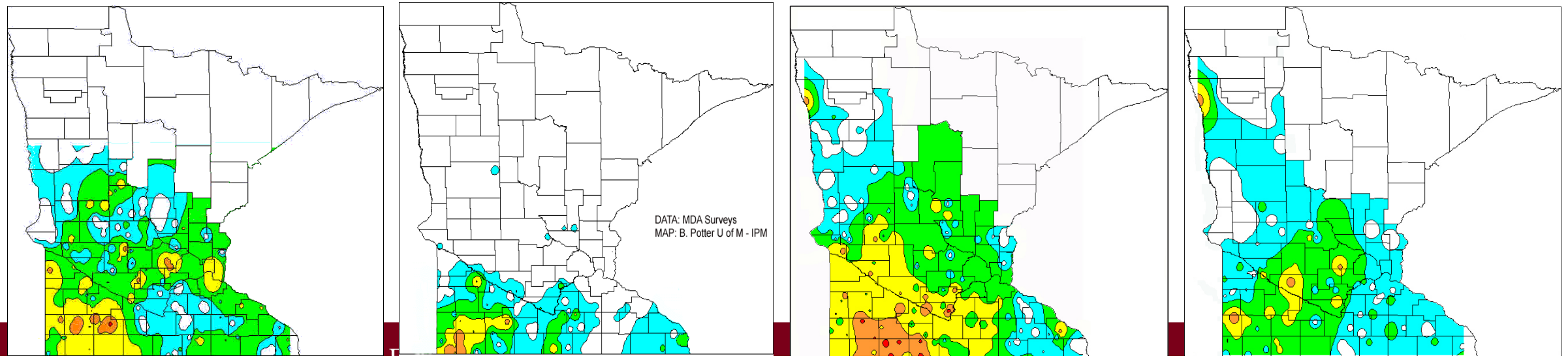
Northern Corn Rootworm

- Populations increasing?
  - NW Minnesota
- Continuous and rotated corn
  - Extended diapause
- More mobile
- Eggs cold tolerant
- Resistance to Bt (Calles-Torrez et al., 2019)

2000 2001 2002 2003

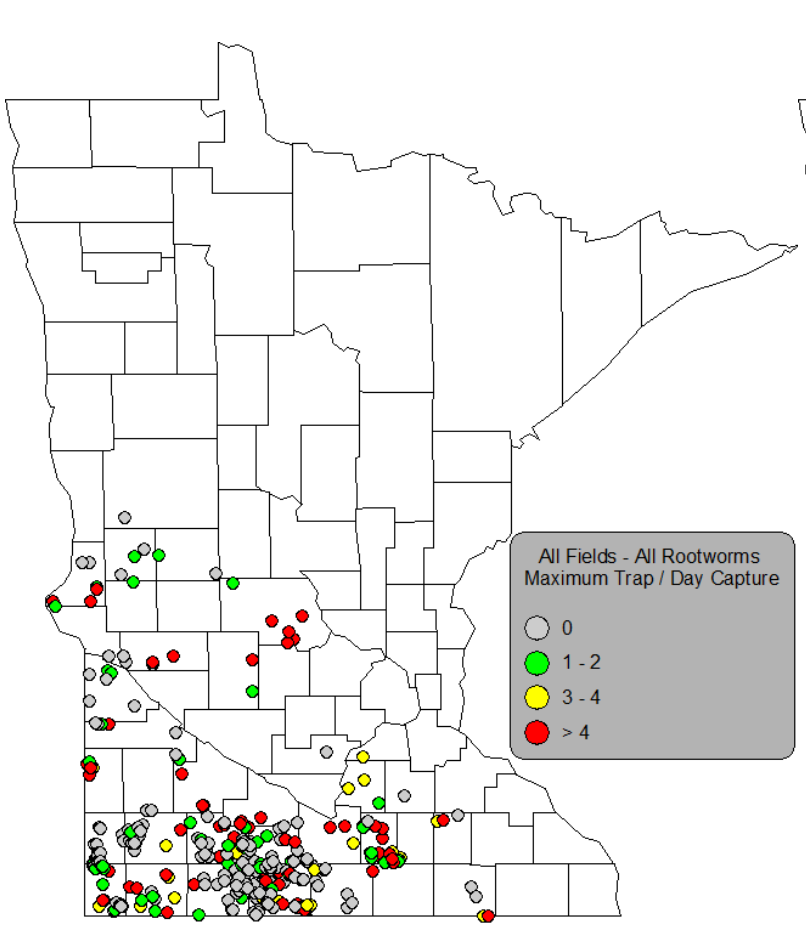


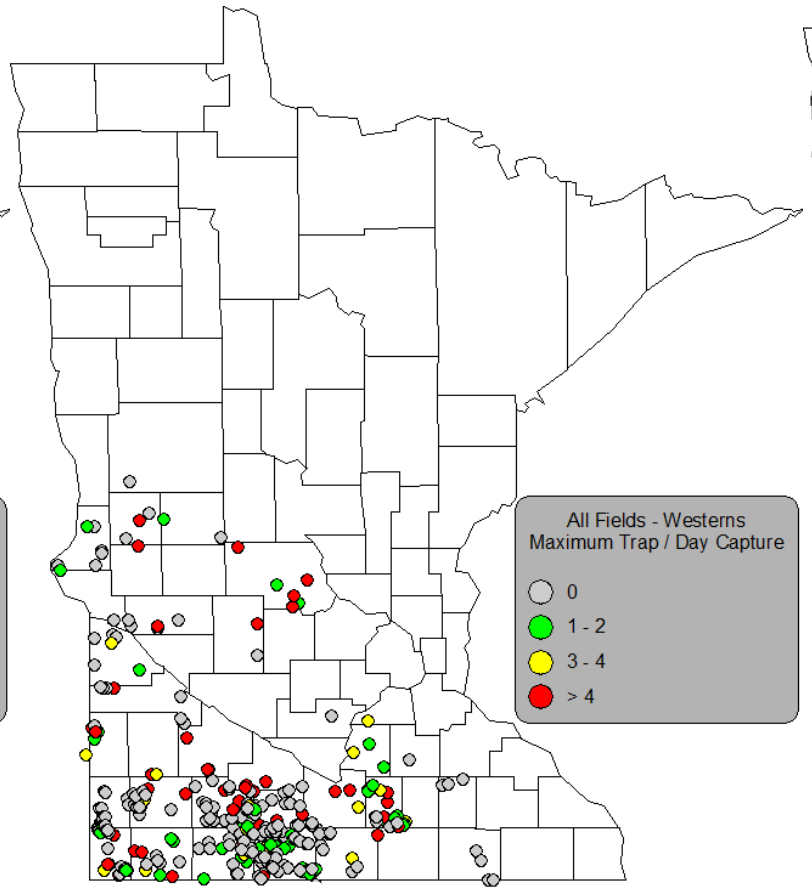
Western corn rootworm

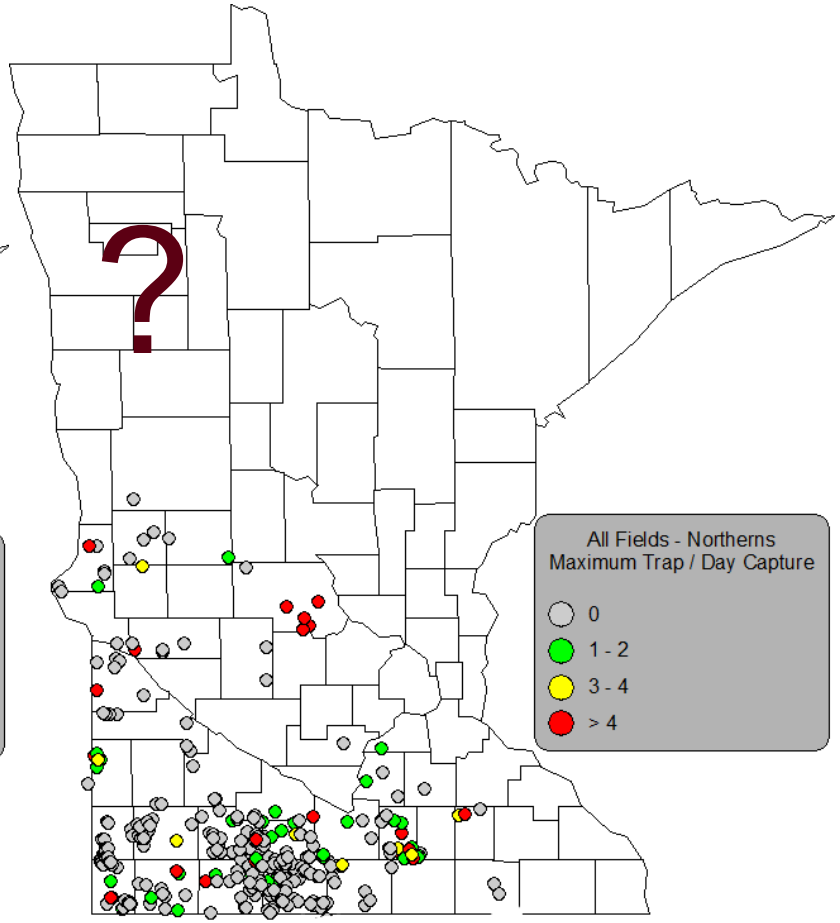


Northern corn rootworm

This work was supported, in part by the farm families of Minnesota and their corn checkoff investment







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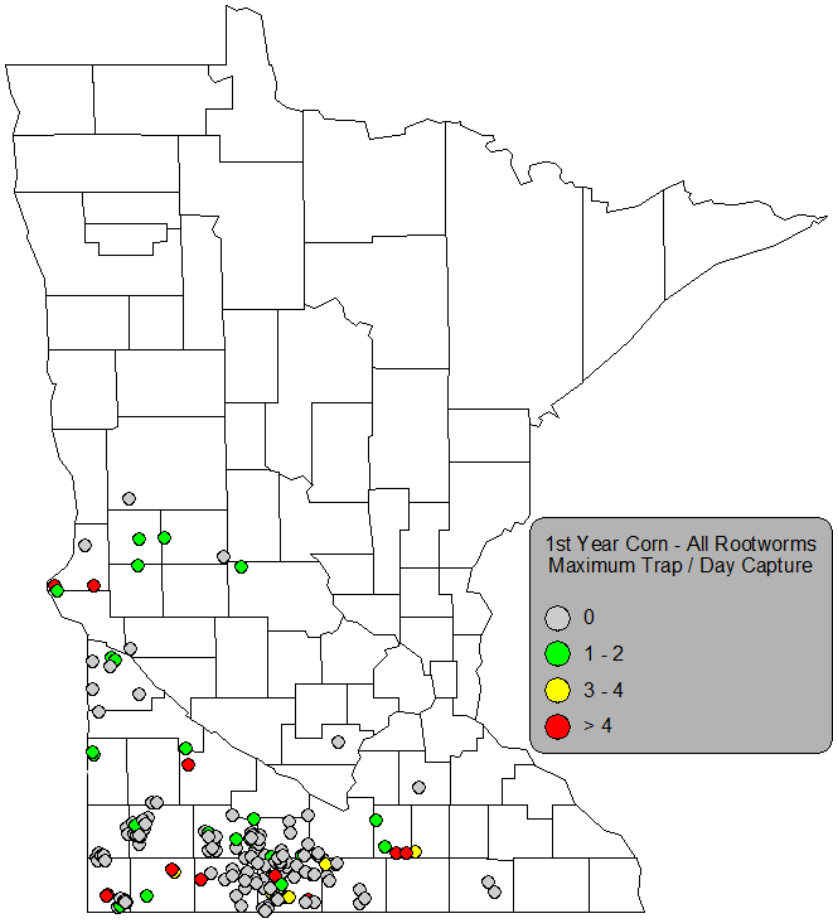

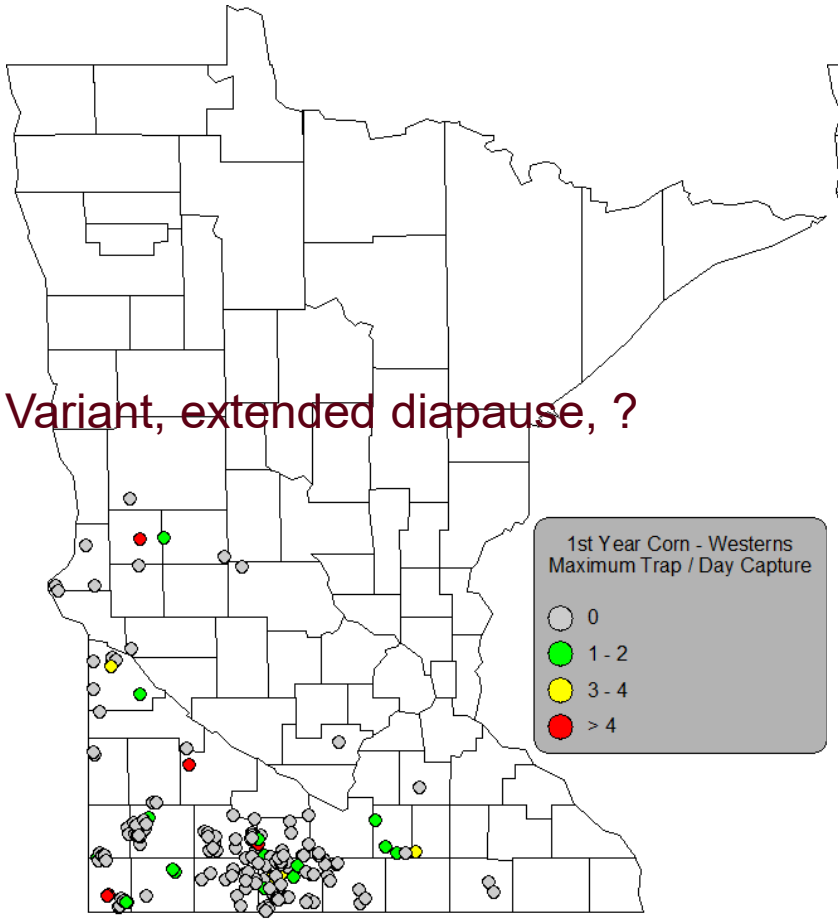

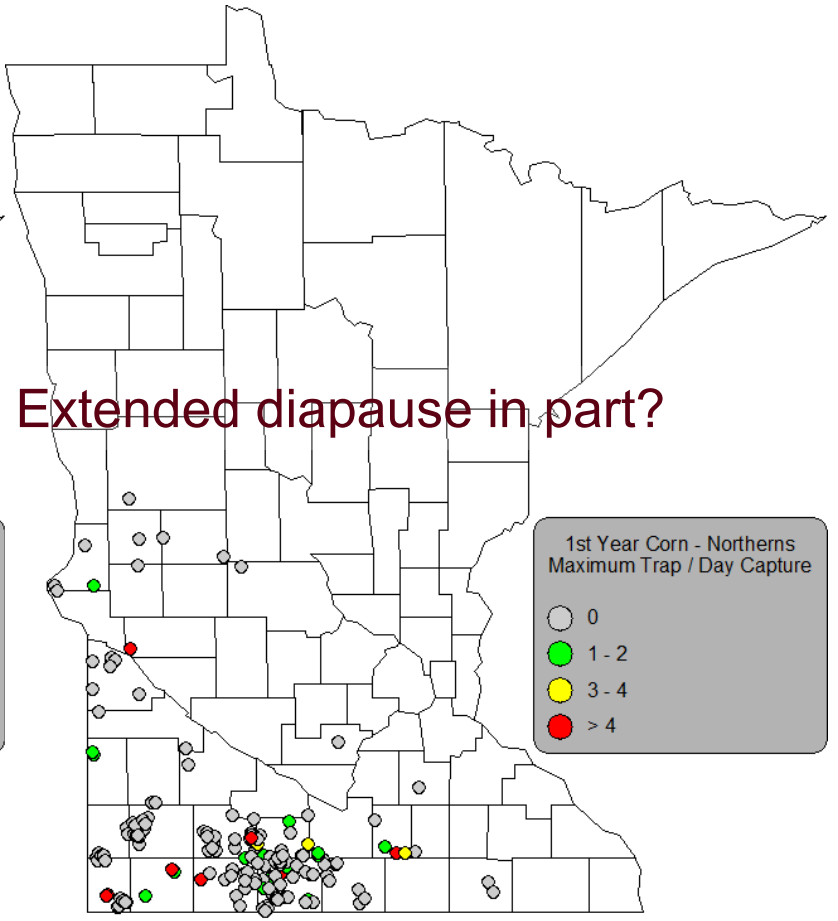

Rotated Corn 2022 CRW Trapping project

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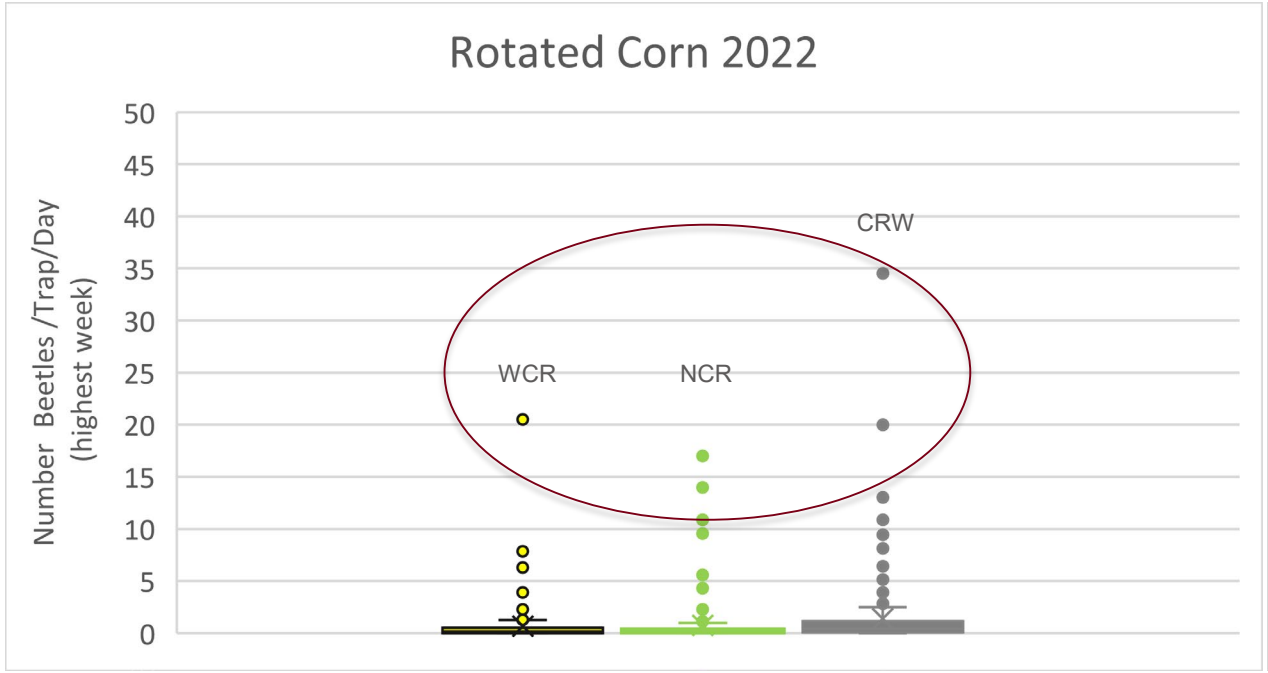
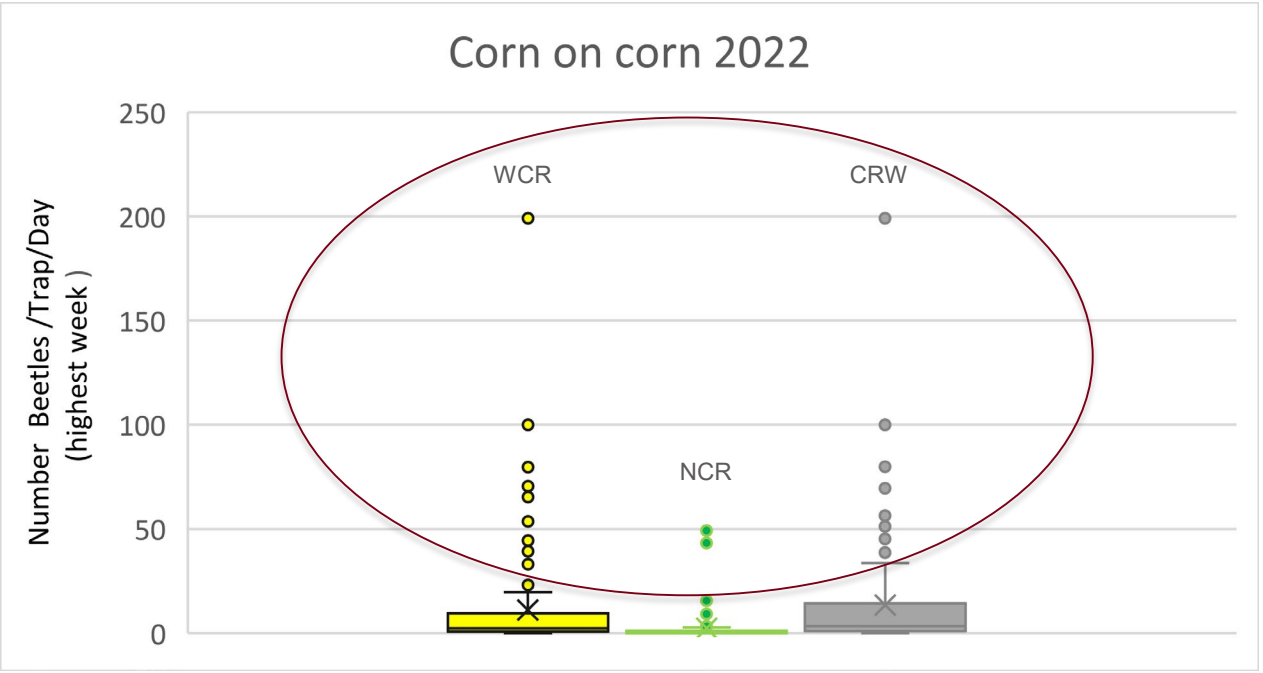
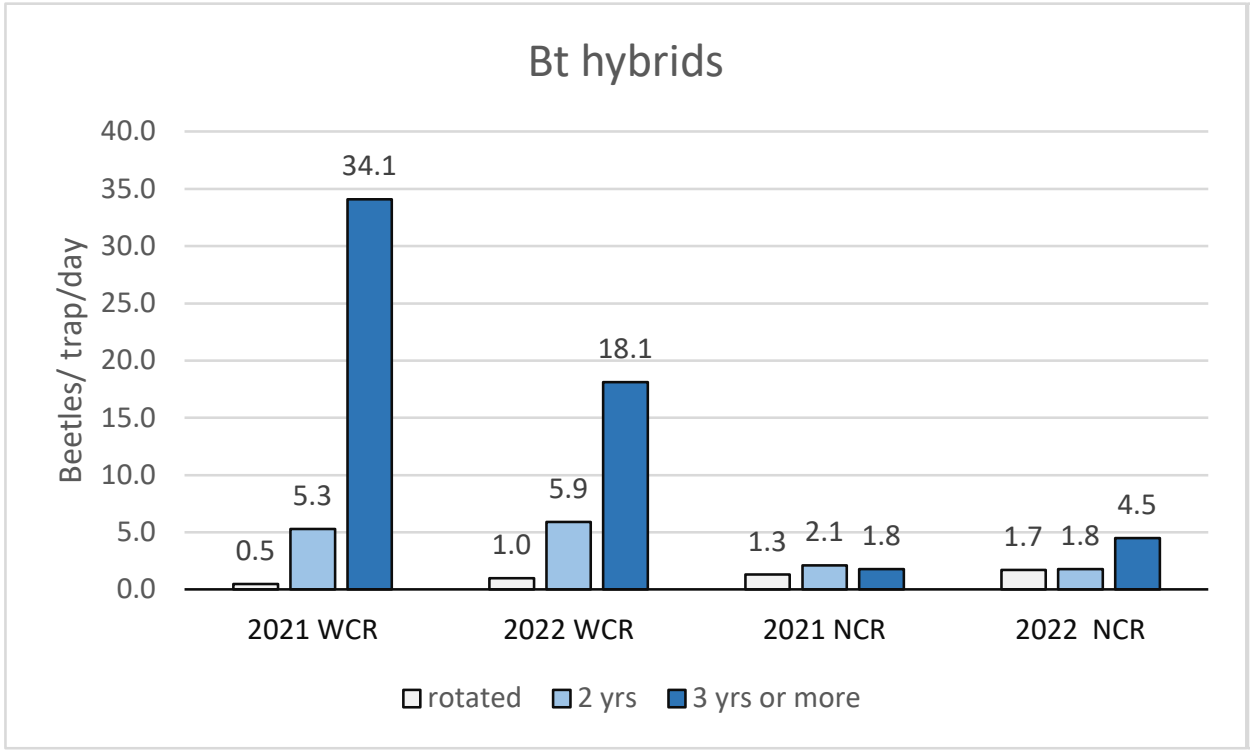
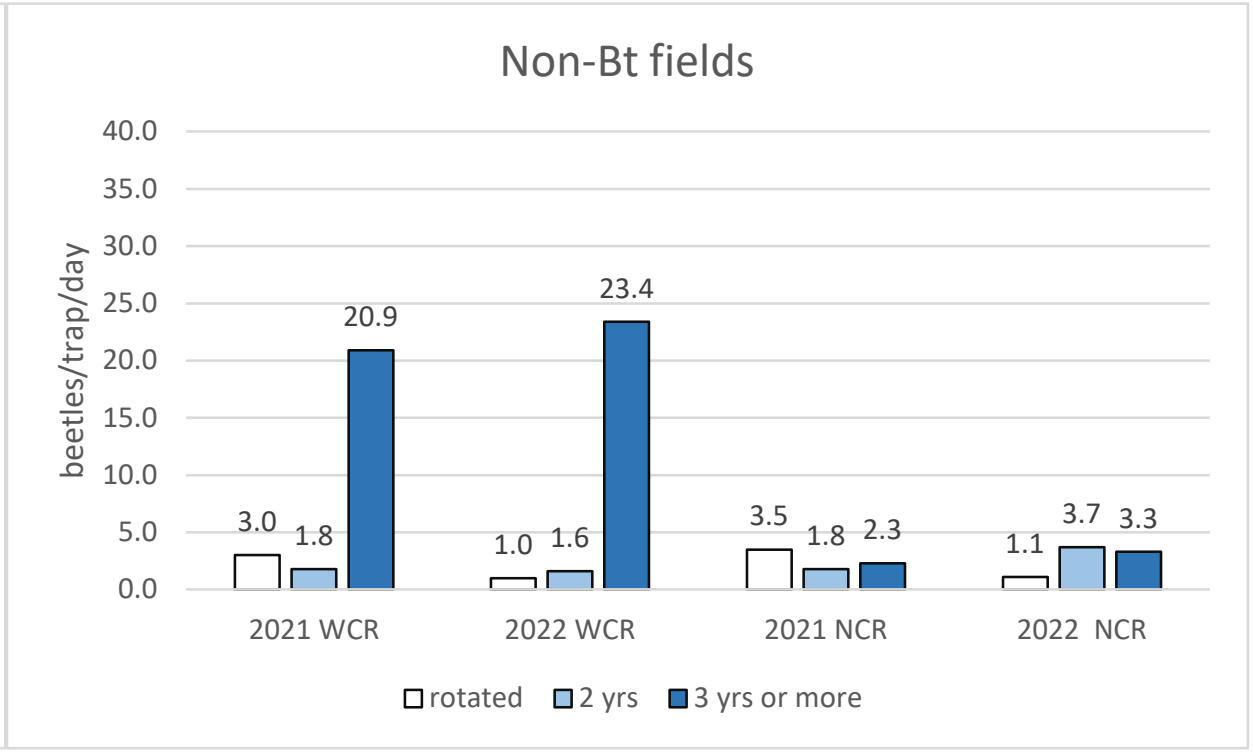




	Number Fields	RW-Bt	Beetles/Trap/Day (highest week capture) WCR	NCR	Total RW	% WCR
Rotated Corn	173	ALL	0.7	0.8	1.5 (1.5)	52.5
Corn on Corn	139	ALL	10.68	2.46	13.2 (12.3)	75.6
Grand Mean	**312 (338)**	**ALL**	**5.2**	**1.5**	**6.7 (6.4)**	**63.7**

Crop Rotation and Bt effect on CRW (statewide sticky trap)





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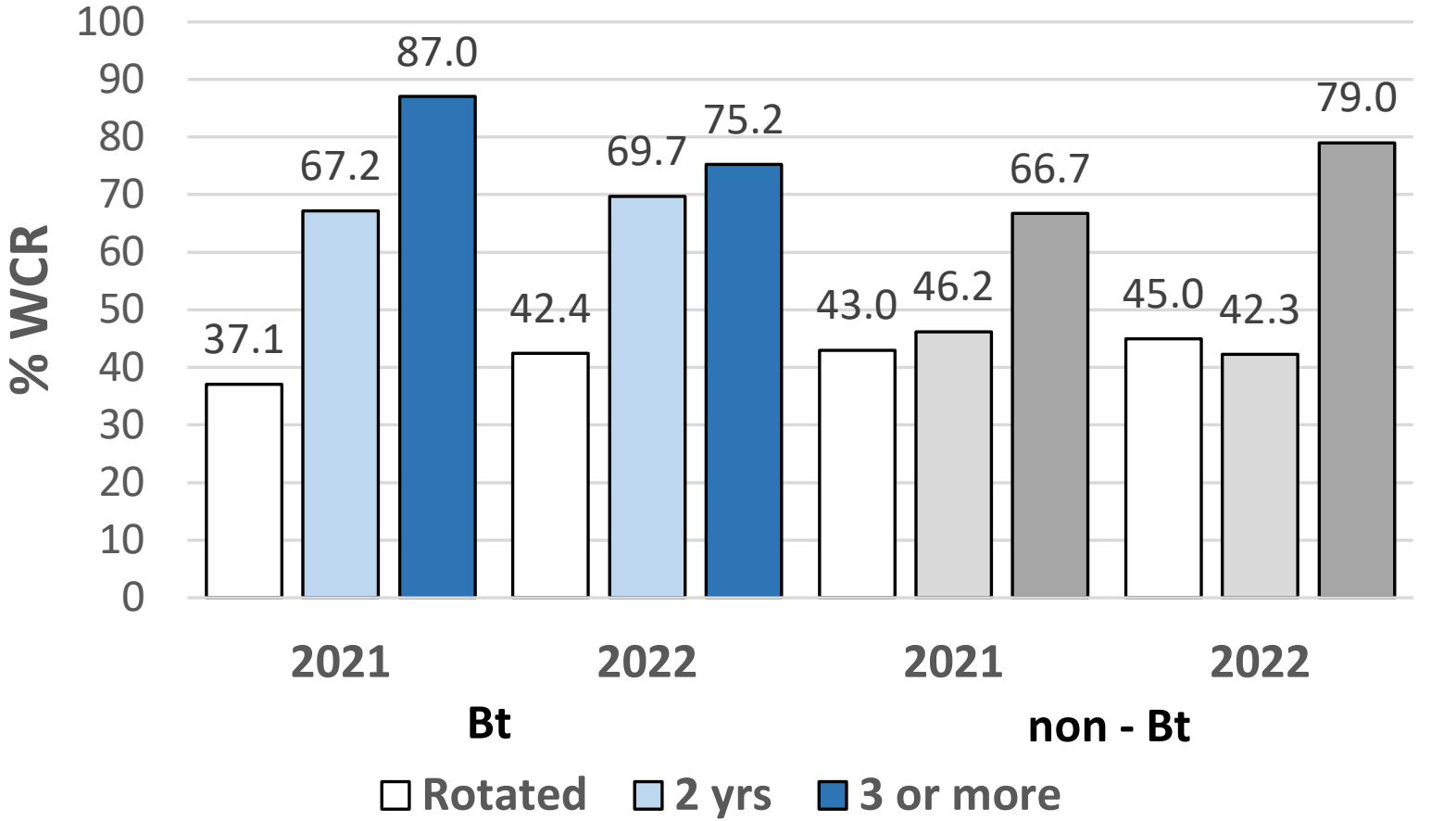

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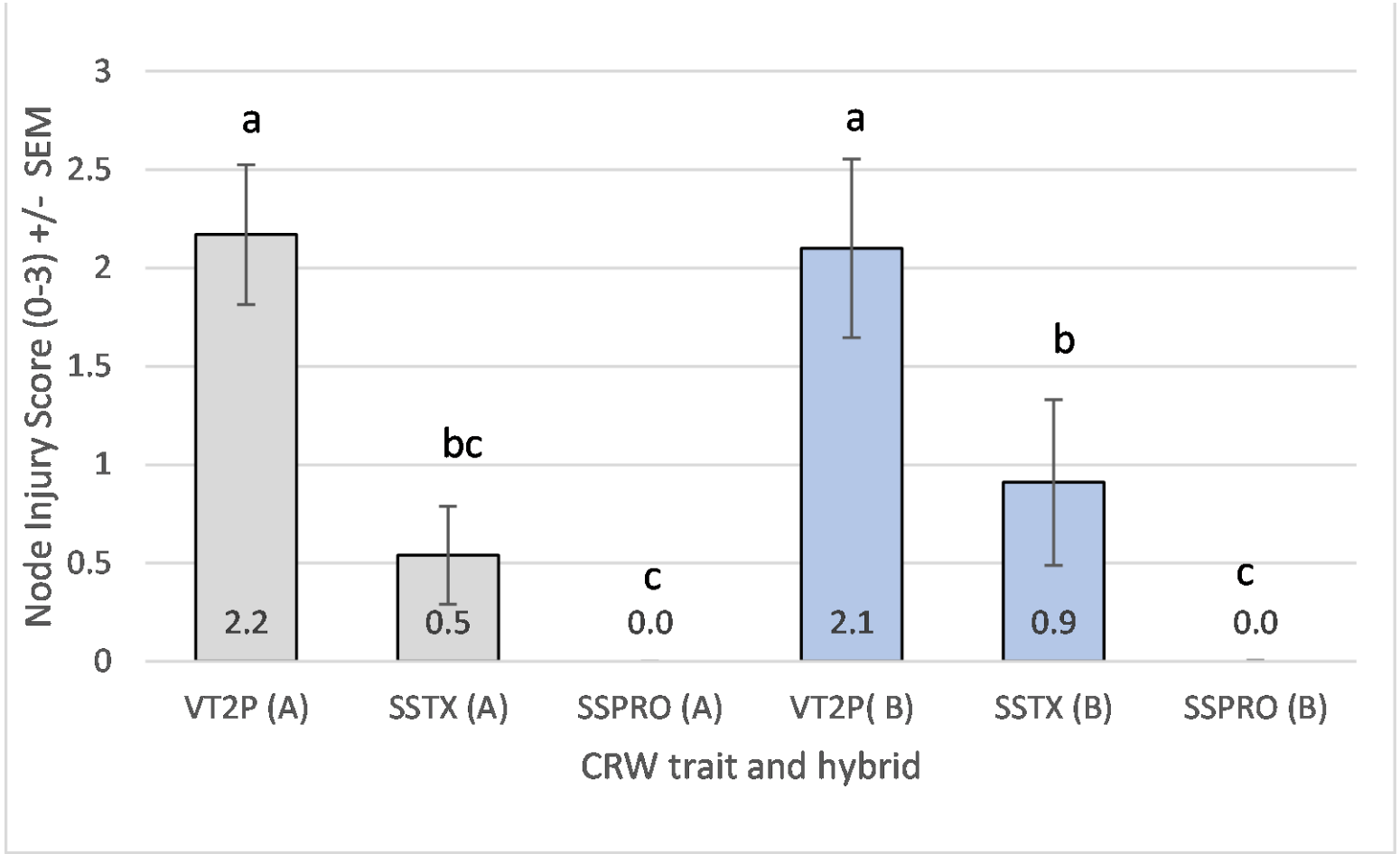
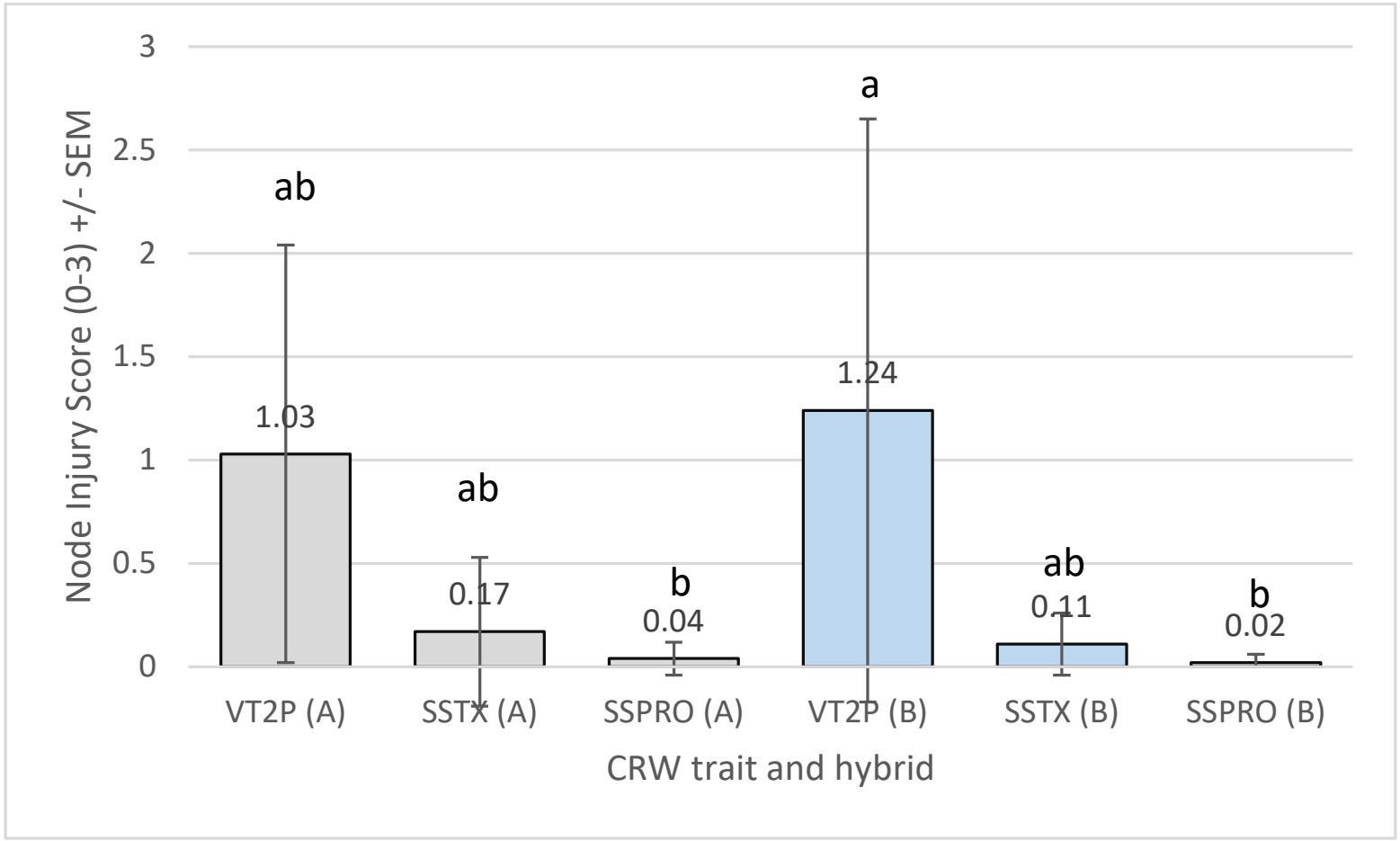
What about traits?

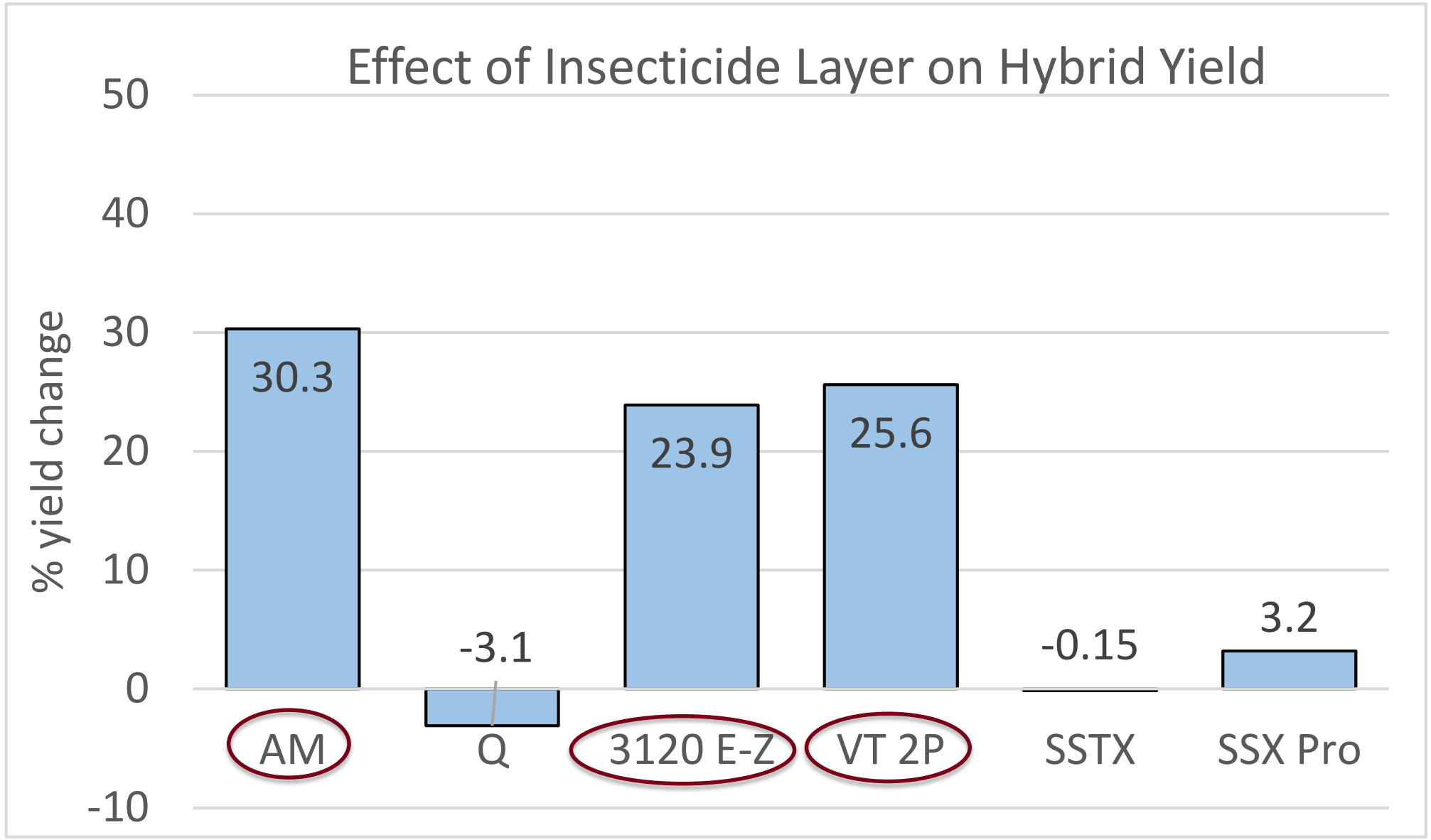


Lamberton, Mn 2021

What about traits?



Lamberton, Mn 2022



Benefits of RW control in SW MN High pressure (1.4 - 2.0 NIS) WCR populations Cry3 resistant populations w/ evidence of Cry 34/35 resistance	
Management	**Benefit of treatment**
Bt traits*	0.5 to 2.0 nodes (24 -100%)
Granules	up to 1.7 nodes (34 -99%)
Liquids	up to 1.3 nodes (0 - 98%)
Seed applied (RW rate)	up to 0.6 nodes (24 -33%)
*Traits may be even less effective on some populations	

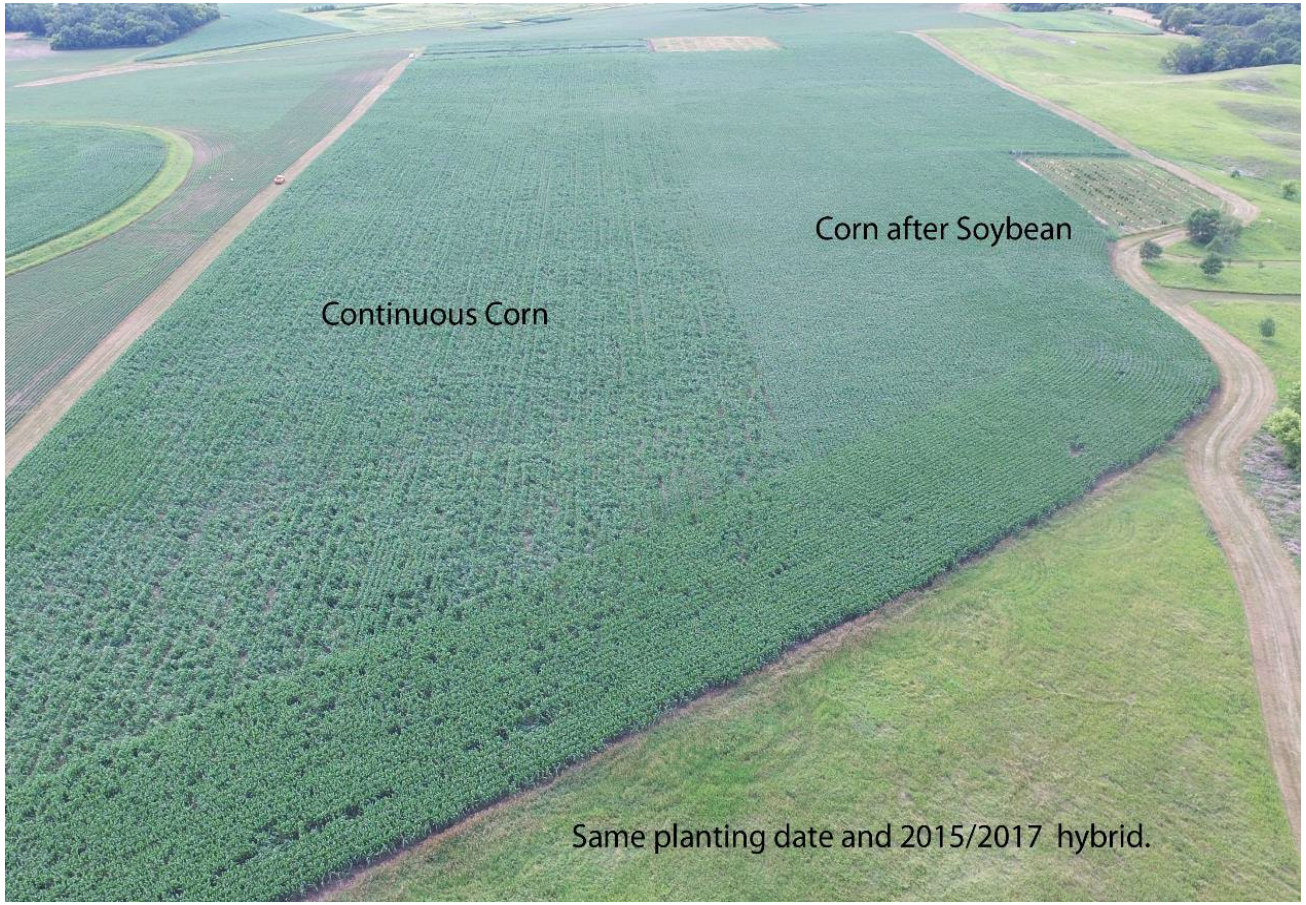
Management practices are not necessarily additive.

What about new traits?

- RNAi needs a functional Bt to perform well
- Temptation to place in worst CRW situations
- Possibility of unexpected injury
- Selection for resistance of all traits

Risk factors for CRW

- High beetle populations
- Long-term continuous corn
- Concentration of continuous corn fields
- Long-term use of the same management practice
- Early/late silking *including volunteer corn*

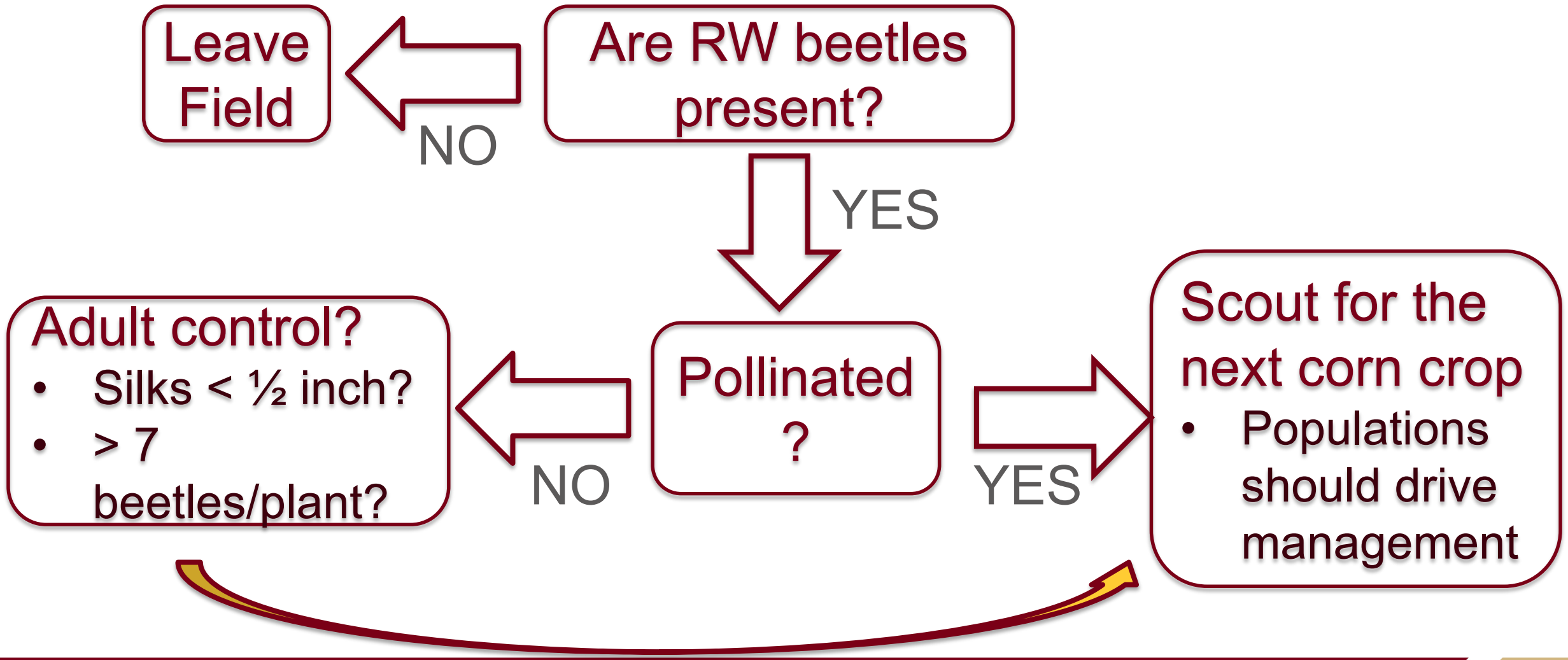


Bruce Potter 2022

Corn rootworm management

Bruce Potter 2022

Managing CRW: Scouting corn at silk



Managing CRW: Scouting beetles

Whole plant counts

- Scout weekly (~2 wks after emergence – dried silk)
- 12 stops in a U pattern (50 paces between stops)
- Examine 2 plants at each stop
- 0.75 to 1 beetle/ plant (continuous corn)
- 4.5 beetles/plant (rotated)

Managing CRW: Scouting beetles

Yellow sticky traps

- Begin ~2 wks after beetle emergence
- 6-8 traps (50-100 paces between traps)
- Change traps weekly
- 4-6 beetles/trap/day (continuous corn)
- Moderate weather effects
- Don’t quit early on late-silking fields

Managing CRW: Reducing egg-laying

HOW

- Egg laying begins ~ 2 weeks after beetles emerge
- Scout twice a week
- ✓ 1 beetle/plant
- ✓ 10% of females have eggs
- Re-spray as needed

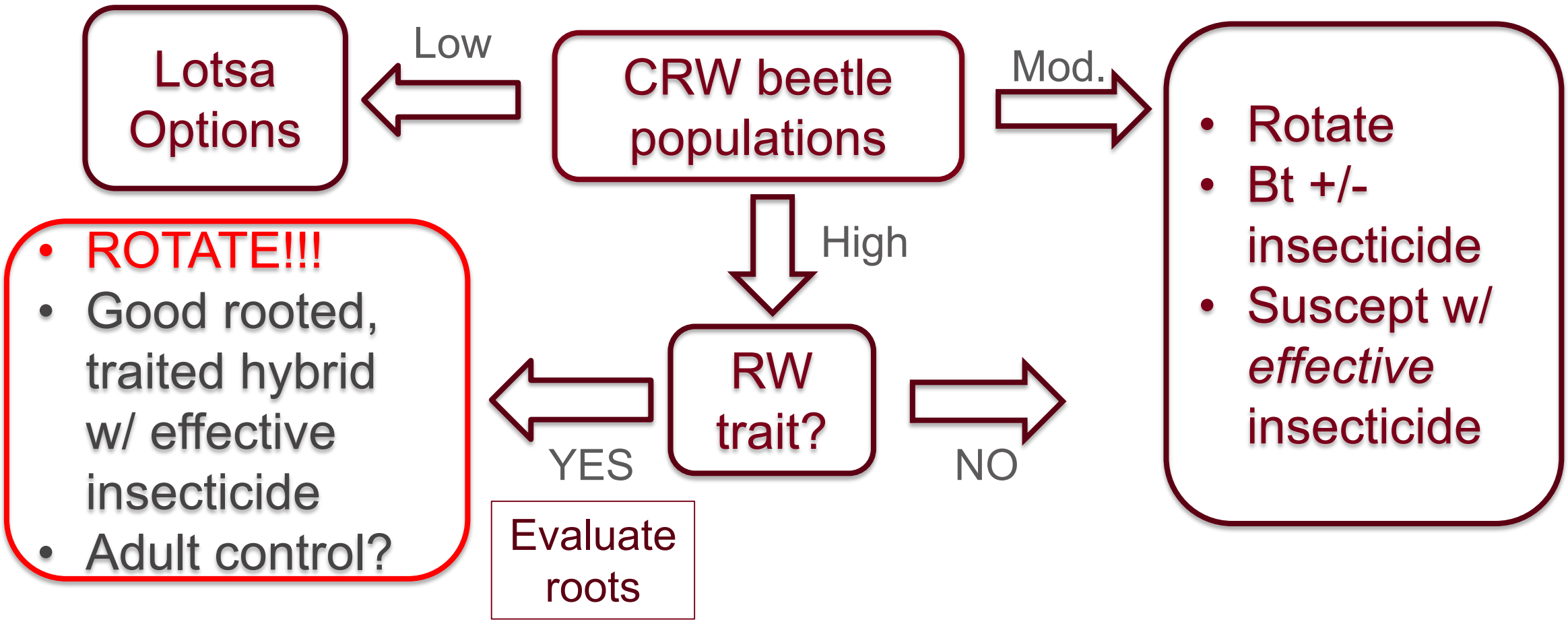
Ostlie and Leaf rev. 2022

CONCERNS

- Labor intensive
- Later than VT fungicide
- Single application is often inadequate
- Unlikely to change Bt resistance frequency
- Selects for insecticide resistance

Meinke, et al. 2021
Souza, et al. 2020, 2019

Managing CRW: Decisions…Decisions



Thank you for your attention!

Any questions?

"We are doomed to repeat the mistakes of the past, and no amount of education gleaned from our propensity for self-destruction and misguided thinking ever teaches us anything. Not anything that we remember for more than a generation or two.

I think maybe we learn a few things each time that we don't forget. A few things that stick with us. It's just hard to pass those things on to those who come after us because if they didn't live through it, they don't view it the same way we do. If you don't experience something firsthand, it's a lot harder to accept."— Terry Brooks

Seed applied insecticide products labeled for control of corn rootworm larvae*					
Compound	Trade name	Insectic. Group [1]	RUP	Comm. Trt. Only	Signal Word
abamectin + thiomethoxar	Avicta complete corn	A + N	X		Caution
clothianidin	Poncho,Nipsit INSIDE	N		X	Caution
Clothianidin + B. Firmus	Poncho Votivo	N + B		X	Caution
imadicloprid	Gaucho 600, Senator 600, Attendant 600 Dyna-Shield Imadicloprid 5	N			Caution
thiomethoxam	Cruiser 5S	N			Caution

[1] P - Pyrethroid (3A) OP- Organophoshate (1B) N - Neonicitinoid (4A) A - Avermectin (6) B - Biological

[2] At -plant B = Band, TB - T-band, I-F= In-furrow

[3] P-P = Post-Plant, Directed application w/cultivation

[4] Organophosphate insecticides can interact w/ some corn herbicides

* Field corn only, does not include pop, sweet, seed corn.

Use high rates for RW control.

Seed applied insecticides may not provide adequate control under high RW pressure.

Liquid insecticides labeled for control of corn rootworm larvae*										
Compound (s)	Trade name		Insectic. Group [1]	Labeled Timing [2] At-plant B	At-plant TB	At-plant I-F	P-P [3]	H INT [4]	Closed System	RUP	Signal Word
bifenthrin	Capture, Sniper	LFR	P		X	X				X	Caution
	Capture	3RIVE 3D	P			X			X	X	
bifenthrin + *B. amyloliquefaciens*	Ethos	XB	P + B		X	X				X	Caution
	Ethos	3D	P + B			X			X	X	
broflanilide	Nurisma		G			X					Caution
chlorethoxyfos + bifenthrin	Index		OP +P			X		X		X	Danger
gamma cyhalothrin	Declare [a]		P		X	X					Caution
lambda cyhalothrin	Warrior II		P	X	X	X				X	Warning
	Silencer VXN			X	X	X				X	Caution
	Silencer, several others			X	X	X				X	Warning
tefluthrin	Force	EVO	P		X	X				X	Danger

[1] P - Pyrethroid (3A) OP- Organophoshate (1B) G-Meta-diamide B - Biological

[2] At -plant B = Band, TB - T-band, I-F= In-furrow

[3] P-P = Post-Plant, Directed application w/cultivation

[4] Organophosphate insecticides can interact w/ some corn herbicides

[a] light-moderate infestations only

* Field corn only, does not include pop, sweet, seed corn.

Liquids may provide less control than granules.

Liquid RW insecticides tend to be less consistent, especially when dry or late egg hatch.

Granule Insecticide products labeled for control of corn rootworm larvae*

Compound	Trade name		Insecticide Group [1]	Labeled Timing [2] At-plant B	At-plant TB	At-plant I-F	P-P [3]	H INT [4]	Closed System	RUP	Signal Word
cyfluthrin + tebupirimipho	Aztec	2.1 G	P + OP	X	X	X				X	Warning
	Aztec	4.7 G	P + OP						X	X	Warning
chlorethoxyfos + bifenthri	Smartchoice	HC	OP + P			X		X	X	X	Danger
phorate	Thimet	20G	OP	X			X	X		X	Danger
tefluthrin	Force	3G, 6.5 G	P	X	X	X		X		X	Caution
	Force	10G HL	P	X	X	X			X	X	Caution
tefluthrin	Precept		P	X	X					X	Caution
terbufos	Counter	15G, 20G	OP	X		X	X	X	X	X	Danger

[1] P - Pyrethroid (3A) OP- Organophoshate (1B)

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Granules tend to perform most consistently across environments and RW pressures.