Sensitivity of Two Classes of Dry Edible Beans to Plant Growth Regulator Herbicides

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New Soybean Trait Technologies

- Registrations of dicamba resistant and 2,4-D resistant soybean
- Higher use of plant growth regulator (PGR) herbicides to control herbicide-resistant weeds
- Concerns with off-target applications to sensitive crops (i.e., dry edible beans)

Dry Bean Sensitivity to PGR's*

- Early 1980's research in Scottsbluff, NE
  - Higher uses of dicamba and 2,4-D in corn
- Examined Great Northern bean sensitivity to low rates of dicamba and 2,4-D amine
  - Great Northern beans more sensitive to dicamba (11.2 g ae/ha) than 2,4-D amine (112.5 g ae/ha)
  - Yields reduced up to 67%
  - Delayed maturity
  - Reduced test weights and germination

*Lyon, D., & Wilson, R. (1986) Sensitivity of Field Beans (*Phaseolus vulgaris*) to Reduced Rates of 2,4-D and Dicamba. *Weed Science, 34*(6), 953-956.

Why now?

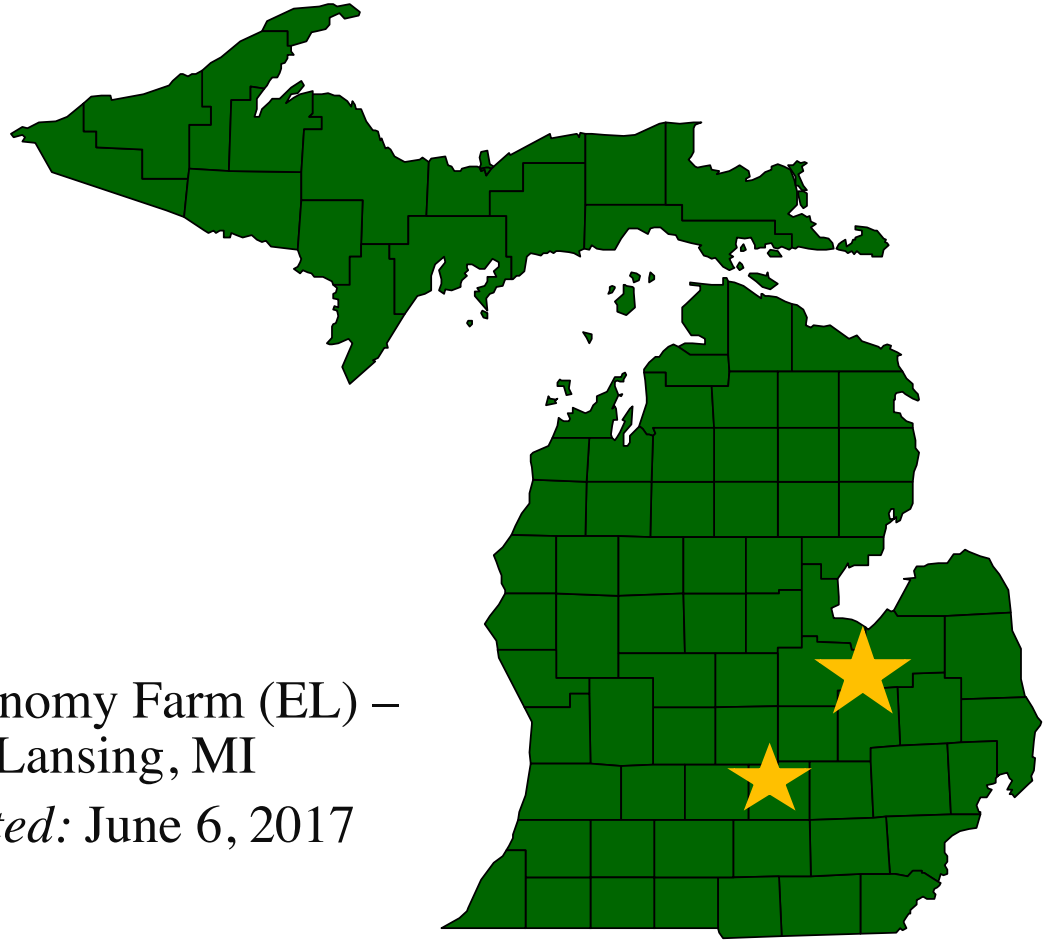
- Potential increased use of dicamba and 2,4-D in new soybean technologies
  - Higher chances for off-target deposition (tank-contamination or drift)
- Current labels allow for use later in the growing season
- Advancements in dry bean genetics
  - Improved plant architecture - upright growth (direct harvest)
  - Better disease resistance
  - Higher yielding
- Consumer concerns

Older two-pass harvest method for prostrate bean varieties

Objectives

- Simulate low-dose exposure of dicamba and 2,4-D on dry edible beans
- Determine if two classes of dry bean (black and navy) respond similarly to PGR exposure
- Determine if the stage of bean at PGR exposure influences dry edible bean response

Research Locations



Saginaw Valley Research and Extension Center (SVREC) – Richville, MI

Planted: June 8, 2017

Agronomy Farm (EL) – East Lansing, MI

Planted: June 6, 2017

Experimental Design –

3 factors, 4 replications

Dry bean class*
‘Zenith’ black bean
‘Merlin’ navy bean

*Seeding rate: 269,000 seeds ha^{-1}

Experimental Design –

3 factors, 4 replications

Dry bean class*	Application timing
‘Zenith’ black bean	Two trifoliate (V2)
‘Merlin’ navy bean	Pre-flower (V8)

*Seeding rate: 269,000 seeds ha^{-1}

Experimental Design –

3 factors, 4 replications

Dry bean class*	Application timing	Herbicide treatments		
			Rate (%)	g ae/ha
‘Zenith’ black bean	Two trifoliate (V2)	Dicamba	0.1%	0.56
‘Merlin’ navy bean	Pre-flower (V8)		1.0%	5.6
			10%	56
		2,4-D choline	0.1%	1.12
			1.0%	11.2
			10%	112
		Control	0%	

*Seeding rate: 269,000 seeds ha^{-1}

Evaluations and Analysis

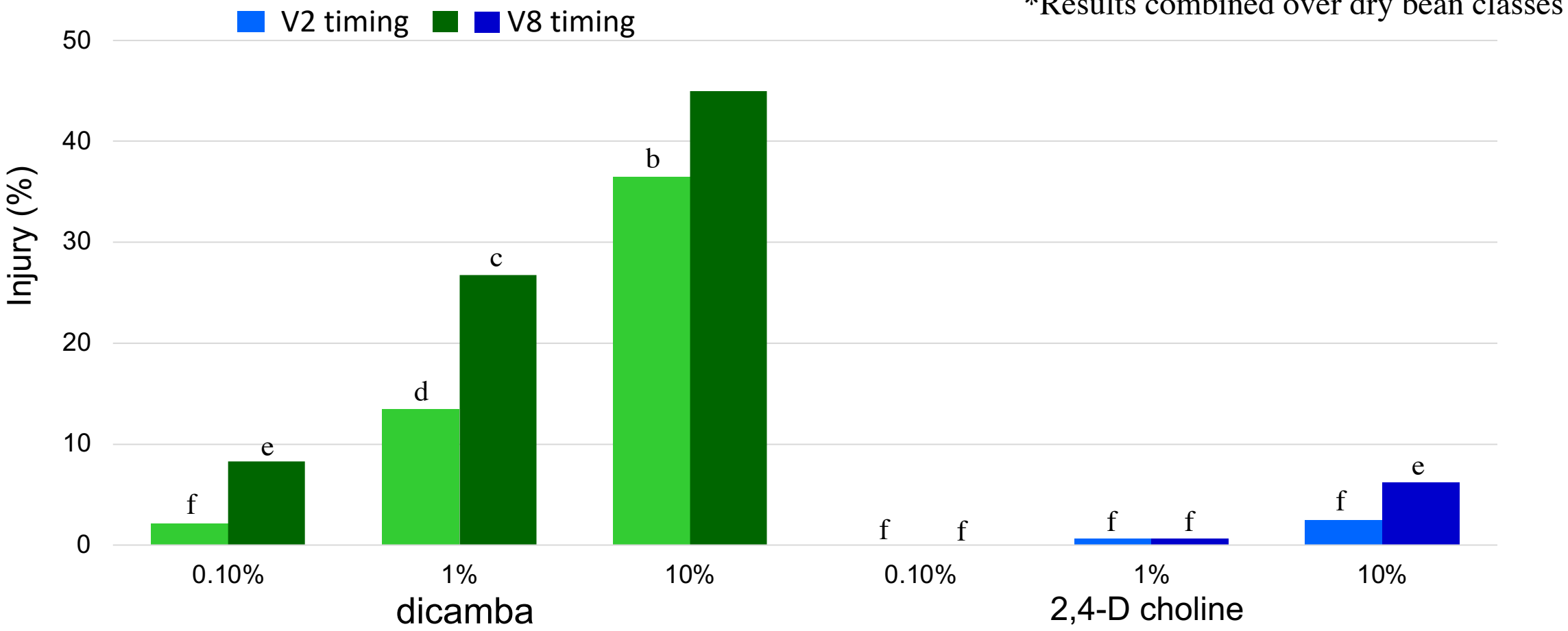
- Dry bean injury 7, 14, 21 and 28 DAT
- Canopy closure
- Visual estimates of maturity
- Yield - adjusted to 18% moisture
- Data analyzed using PROC Mixed in SAS
  - Interactions and main effects tested
- Mean separation with Fisher's Protected $LSD_{(0.05)}$
- Maturity data analyzed with the drc package in R

$$y = \frac{d}{1+\exp[b(\log(x)-\log(e))]}$$

Dicamba injured dry beans more than 2,4-D*

- SVREC (21 DAT)

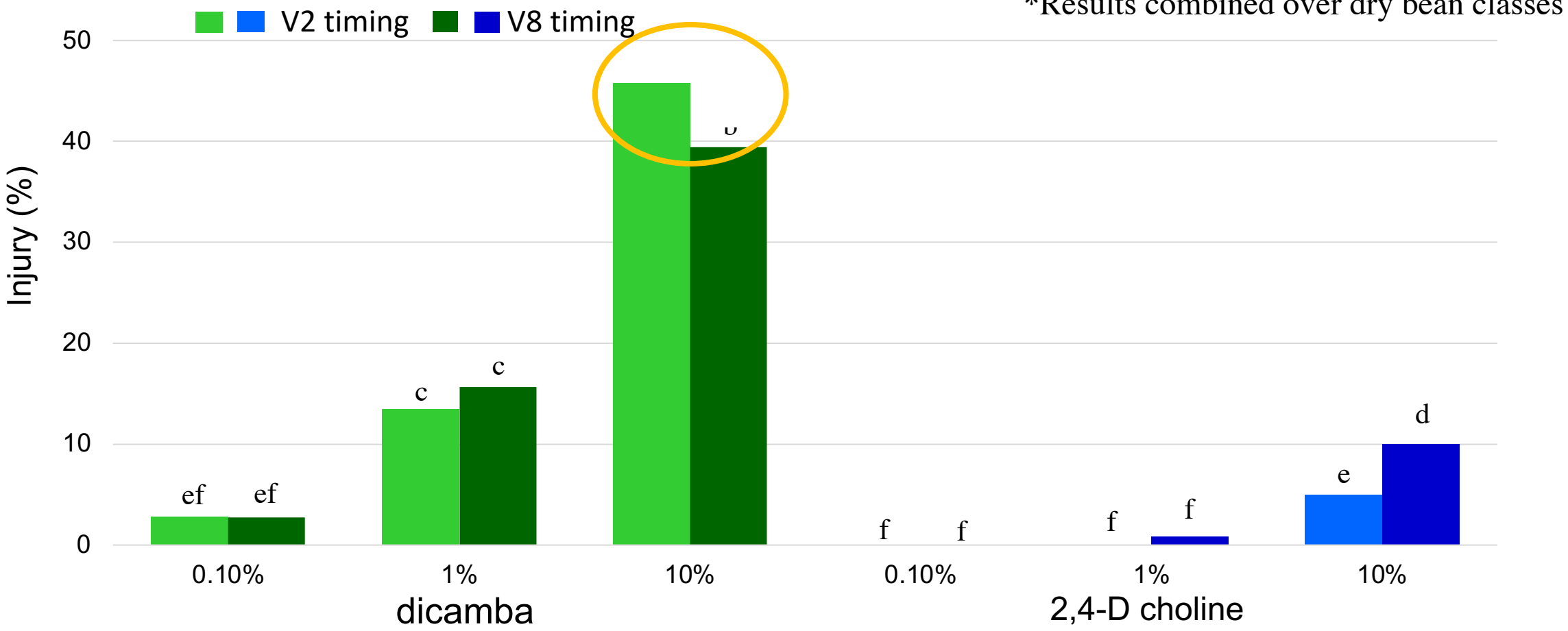
*Results combined over dry bean classes

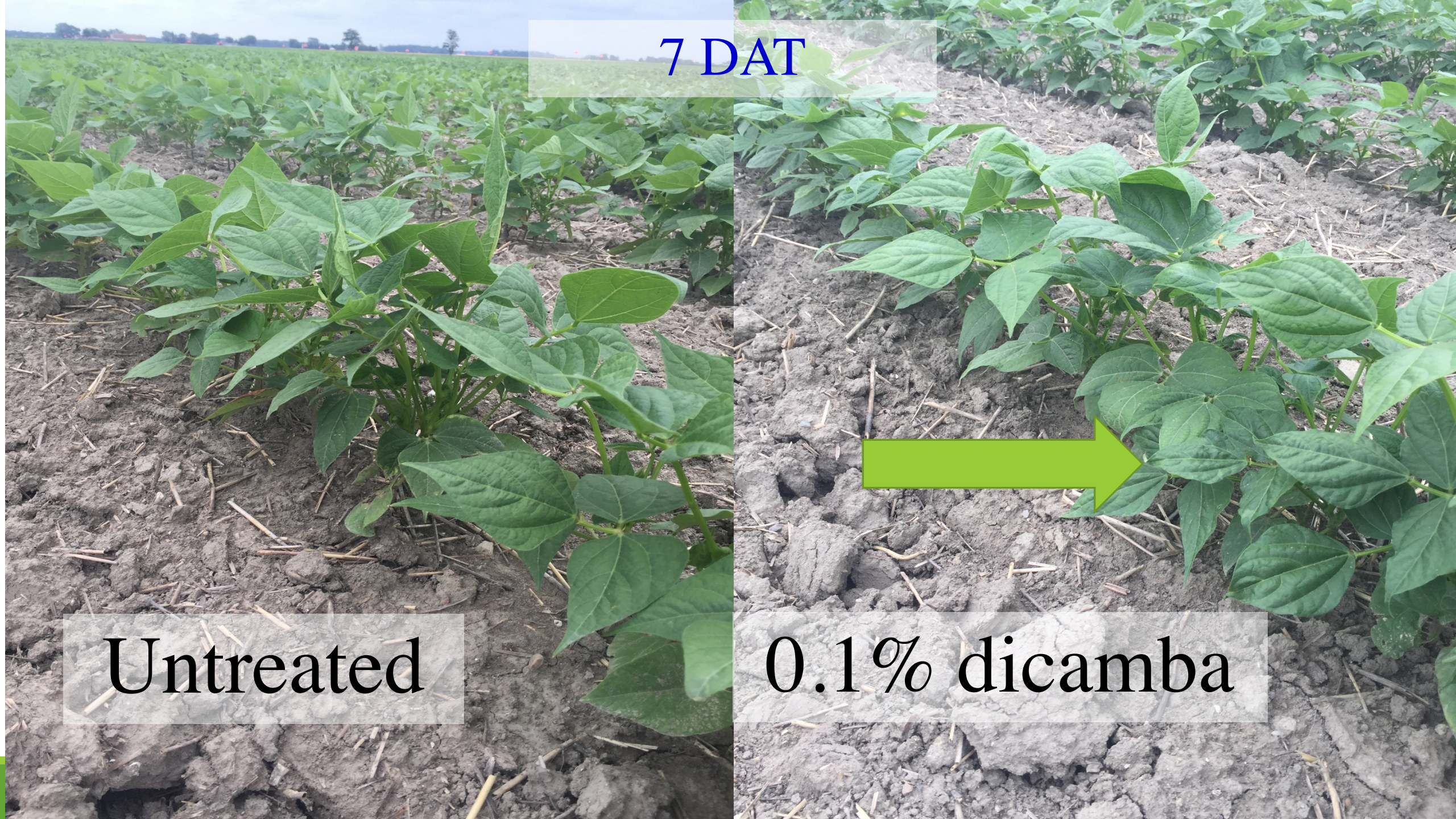


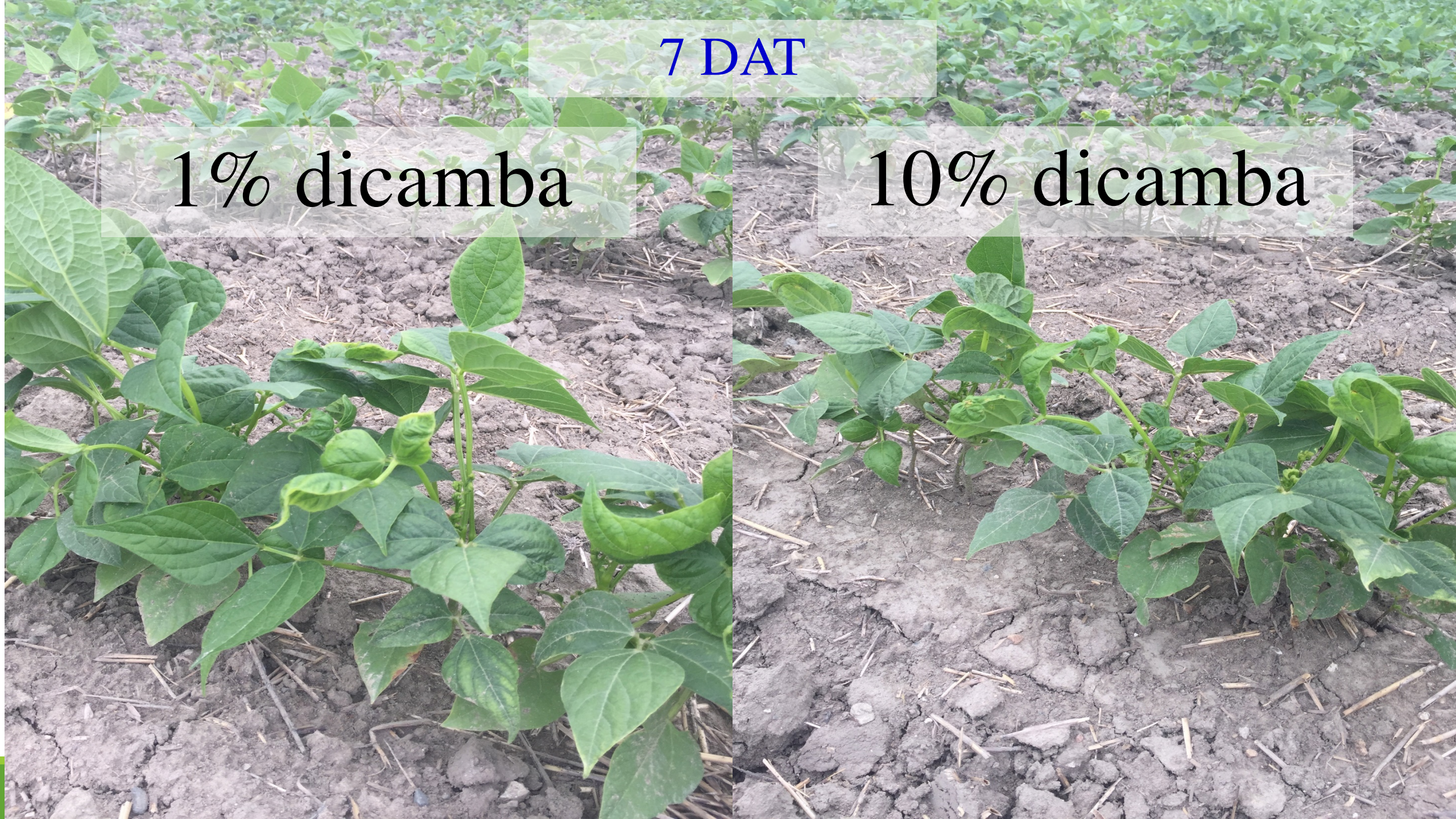
Dicamba injured dry beans more than 2,4-D*

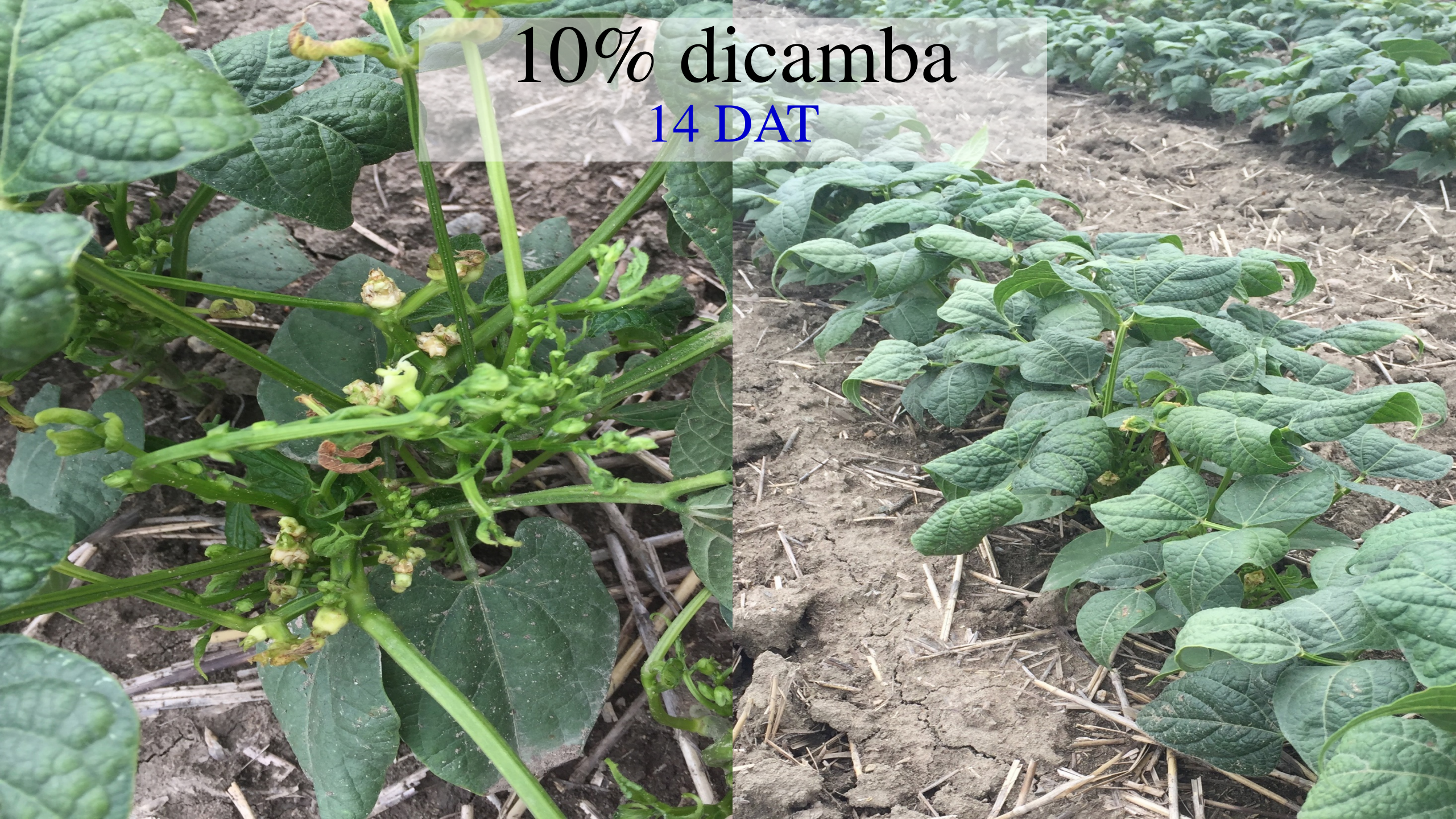
- East Lansing (21 DAT)

*Results combined over dry bean classes



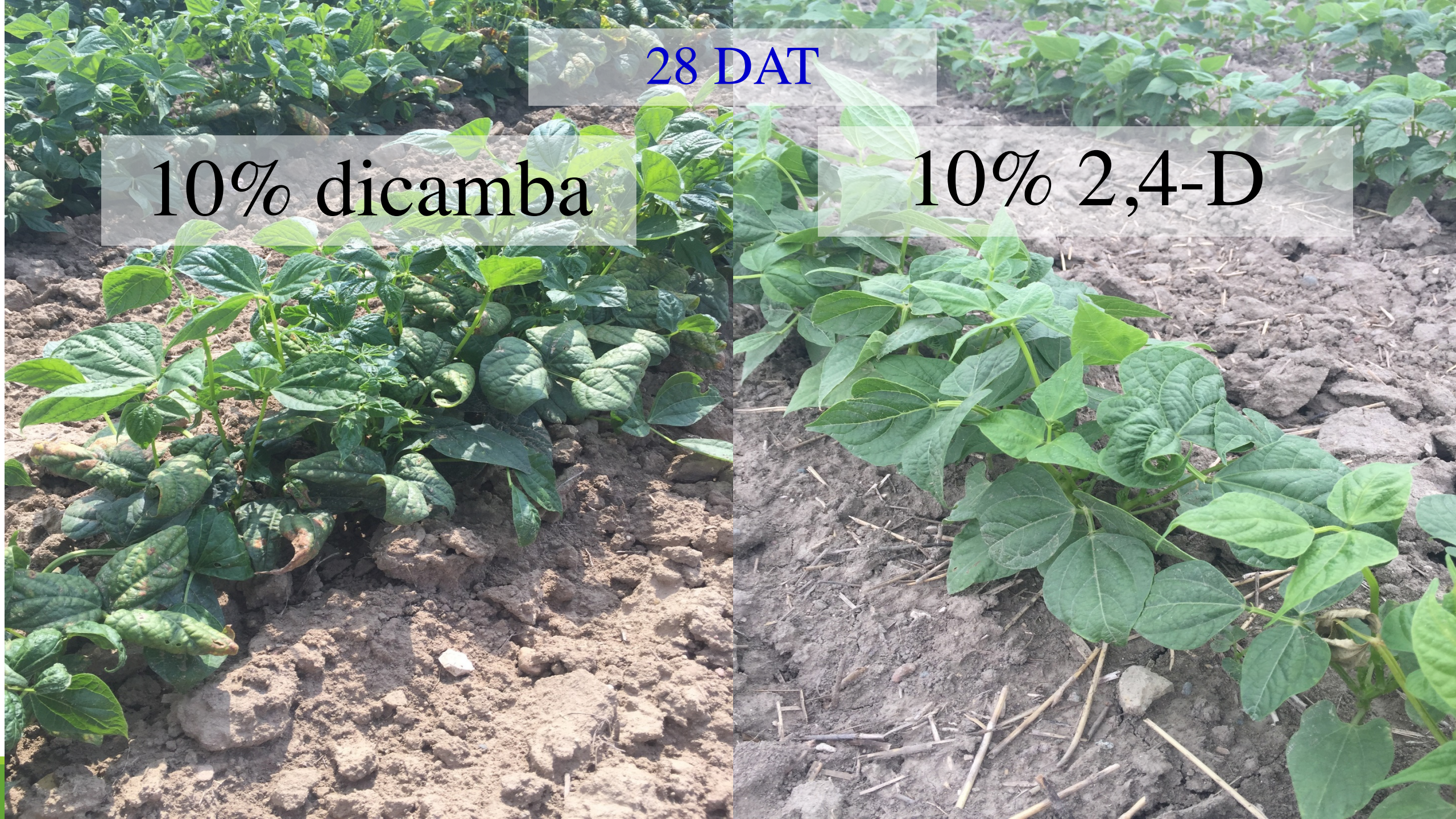

7 DAT
Untreated
0.1% dicamba

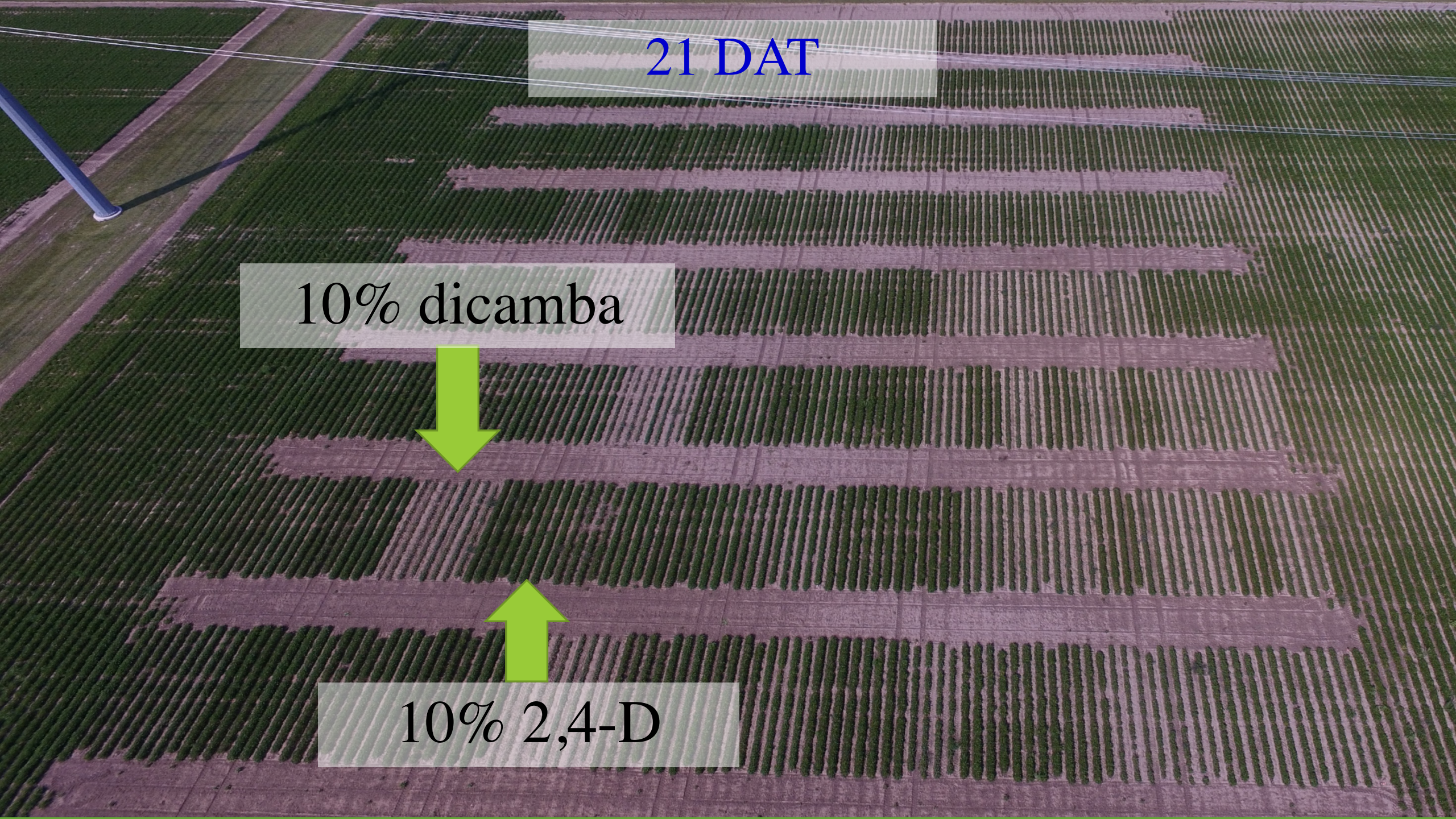

7 DAT
1% dicamba
10% dicamba


10% dicamba
14 DAT

10% dicamba

28 DAT


28 DAT
10% dicamba
10% 2,4-D


21 DAT
10% dicamba
10% 2,4-D

Dry Bean Yield

PGRs had minimal effects on dry bean yield with few exceptions

SVREC

Black beans

Herbicides	Rate	V2 timing	V8 timing
	% of field rate	kg/ha	
Control	0	2901 a-d	2878 ab
Dicamba	0.1	2646 cd	2709 b
	1.0	2537 d	2857 ab
	10	3170 a	1975 c
2,4-D choline	0.1	2699 b-d	2781 ab
	1.0	2950 a-c	2811 ab
	10	3088 ab	2932 ab

PGRs had minimal effects on dry bean yield with few exceptions

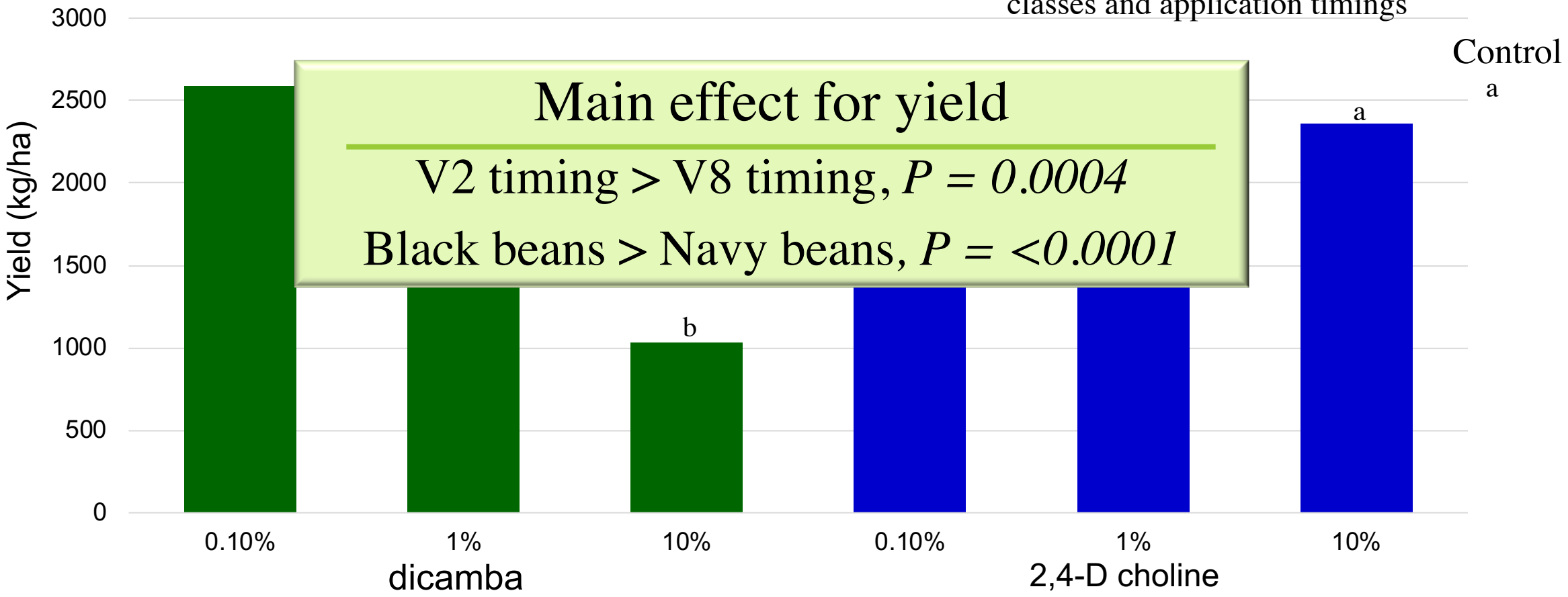
SVREC

		Black beans		Navy beans
Herbicides	**Rate**	**V2 timing**	**V8 timing**	**V2 & V8**
	% of field rate	kg/ha		kg/ha
Control	0	2901 a-d	2878 ab	2433 bc
Dicamba	0.1	2646 cd	2709 b	2245 c
	1.0	2537 d	2857 ab	2578 b
	10	3170 a	1975 c	2523 b
2,4-D choline	0.1	2699 b-d	2781 ab	2620 b
	1.0	2950 a-c	2811 ab	2560 b
	10	3088 ab	2932 ab	2970 a

High rate of dicamba reduced yield 60%*

East Lansing

*Results combined over dry bean classes and application timings



Main effect for yield

V2 timing > V8 timing, *P = 0.0004*

Black beans > Navy beans, *P = <0.0001*

Dry Bean Maturity


14 days before initial harvest
Sept. 14
Untreated
10% dicamba


10% dicamba
Untreated

Dicamba and 2,4-D delayed dry bean maturity

*Days to 50% Maturity**

Herbicide rate	Dicamba	
% of field rate	V2 timing	V8 timing
	——— days delayed ———	
0.1	0 a	3 b
1.0	10 b	25 c
10	29 b	45 c

*Results combined over classes and locations

Dicamba and 2,4-D delayed dry bean maturity

*Days to 50% Maturity**

Herbicide rate	Dicamba		2,4-D	
% of field rate	V2 timing	V8 timing	V2 timing	V8 timing
	——— days delayed ———		——— days delayed ———	
0.1	0 a	3 b	0 a	2 b
1.0	10 b	25 c	2 b	5 c
10	29 b	45 c	7 c	33 d

*Results combined over classes and locations

Delayed maturities would impact harvest date and yield

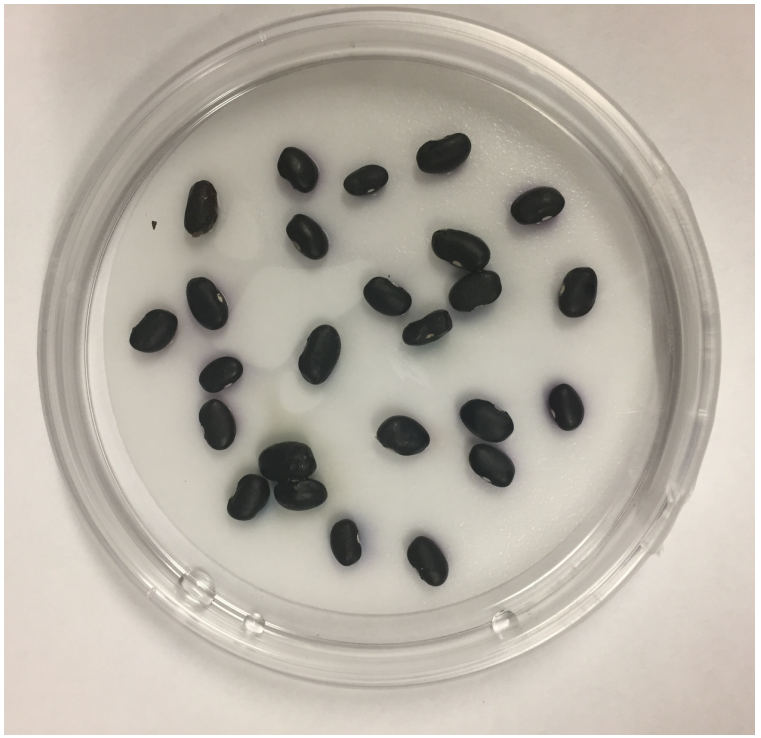
Harvest dates			
SRVEC		East Lansing	
Initial harvest	Final harvest	Initial harvest	Final harvest
September 28th	October 20th	October 5th	November 11th

Low rates of PGRs affected dry beans

Dicamba	2,4-D
• Rates of 1% (5.6 g/ha) and above caused significant injury to dry beans	• By 21 DAT dry bean injury was 10% or less with all rates

Conclusions and Additional Research

- Off-target applications of dicamba had a greater impact on dry beans than 2,4-D
- Both classes of dry beans responded similarly to PGR herbicides
- Exposure of PGRs at later dry bean growth stages were more detrimental
- We are currently examining if off target contact with these herbicides impacts dry bean seed quality, germination and growth of progeny



Implications for dry bean producers

- While yield was not always affected by PGR herbicides there were long delays in maturity could have an negative impact on dry bean yield and quality
  - Harvestability issues (desiccation; shattering of earlier maturing plants)
- These results may also be weather dependent


Thank you!