



Identification and confirmation of natural tolerance to off-target dicamba damage in non-Xtend soybeans

Pengyin Chen and Caio Canella

MSSB Project Meeting

September 2021

University of Missouri
Delta Center Soybean Breeding



When it all started...

- Severe off-target exposure to dicamba in SE-Missouri (2017-present)
- Differential responses among non-Xtend soybean breeding lines and PIs

2019 Advanced Trials – differential response across plots



2019 Progeny Rows; sister lines





... and it continued in 2020...

- Consistent observations across years and locations





... and for the 3rd year in 2021!

- Symptoms observed in conventional, RR1/RR2, LL, and E3 genotypes





Large-scale screening over 10,000 plots

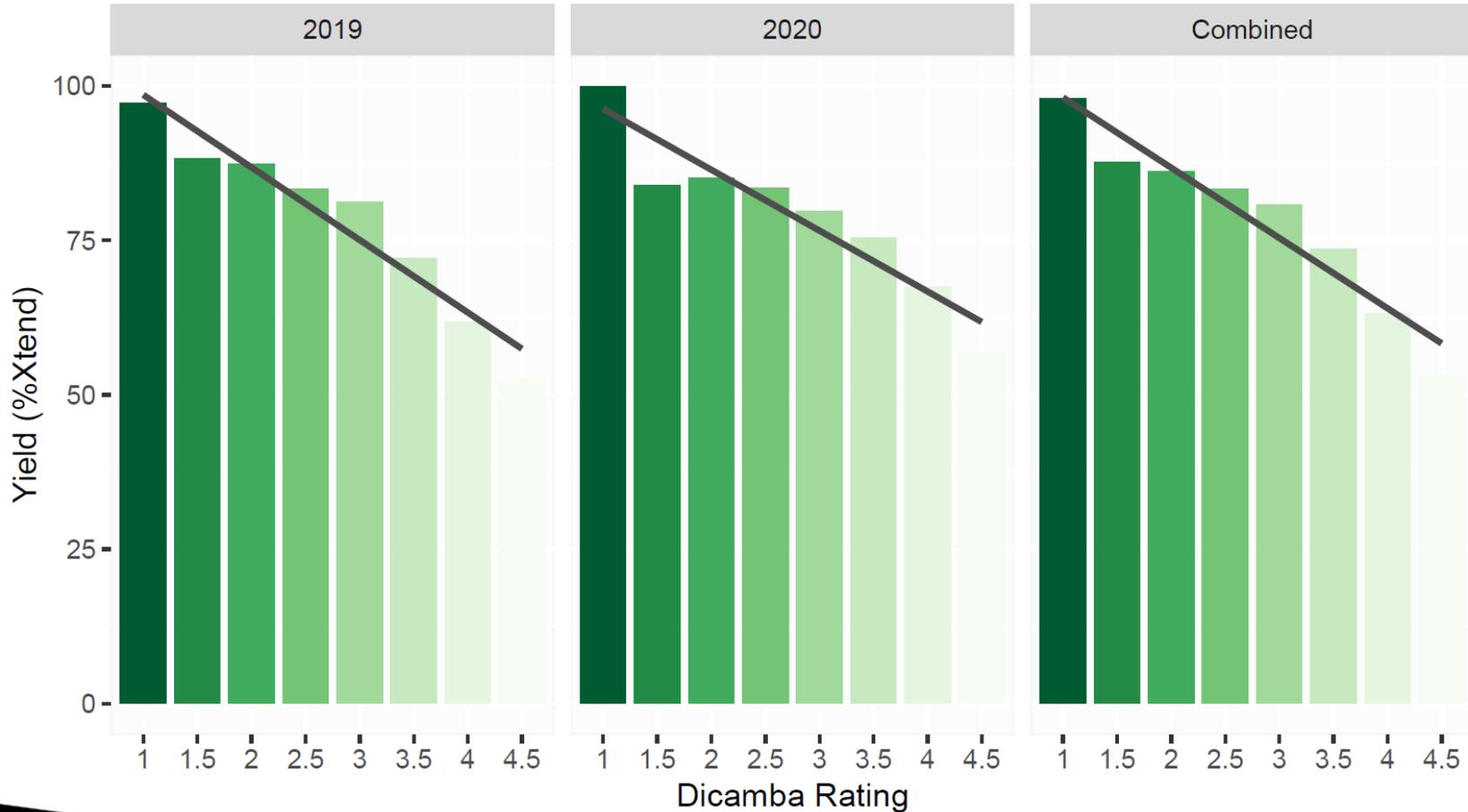
- 450 high-yielding breeding lines developed at the University of Missouri - FDRC
- 480 mapping lines derived from 3 bi-parental populations
- 340 exotic soybean accessions (PIs – MG 3 to 6)
- Visual and digital scoring (UAV-based RGB), Yield Performance





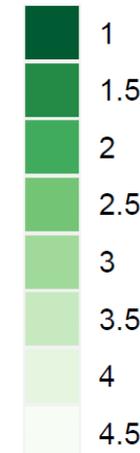
Dicamba x Yield (2 Years of AYT)

- Genotypes showing consistent dicamba response (T or S) across multiple locations
- One increment in dicamba damage in R5 reduces yield potential by approximately 9%.



$$Y_{nmijcr} = D_n + M_m + G_i + E_j + (D \times M)_{nm} + (D \times G)_{ni} + (D \times E)_{nj} + (G \times E)_{ij} + (D \times Col \times Row)_{ncr} + \epsilon_{nmijcr}$$

Dicamba



Predictors	Estimates	Yld_Xtend	
		CI	p
(Intercept)	100.28	95.07 – 105.49	<0.001
Dic_R5	-8.72	-10.55 – -6.88	<0.001
MG [MG_4L]	-3.95	-10.36 – 2.45	0.226
MG [MG_4M]	-1.02	-8.55 – 6.52	0.791
MG [MG_5E]	-4.78	-10.71 – 1.14	0.114
Dic_R5 * MG [MG_4L]	2.54	0.21 – 4.88	0.033
Dic_R5 * MG [MG_4M]	0.74	-1.99 – 3.47	0.596
Dic_R5 * MG [MG_5E]	5.43	3.27 – 7.60	<0.001

Score	MG 4-E	MG 4-M	MG 4-L	MG 5-E
1	91.6	91.3	90.2	92.2
2	82.8	83.3	84.0	88.9
3	74.1	75.3	77.8	85.6
4	65.4	67.3	71.6	82.3
5	56.7	59.4	65.4	79.1



Selected extreme genotypes (2-Yr data)

2019 F1	2019 F2	2019 F3	2019 F4	2019 AVG	2020 F1	2020 F2	2020 AVG	Combined	2-Yr Diff	2019 F1	2019 F2	2019 F3	2019 F4	2019 AVG	2020 F1	2020 F2	2020 AVG	Combined	2-Yr Diff
1.0	1.0	1.7	1.3	1.3	1.2	1.2	1.2	1.2	-0.1	2.8	3.0	3.3	3.8	3.3	1.5	2.2	1.8	2.8	-1.4
1.3	1.5	1.0	1.5	1.3	1.7	1.8	1.8	1.5	0.4	3.2	3.2	3.3	3.2	3.2	2.0	2.7	2.3	2.9	-0.9
1.2	1.0	2.2	1.5	1.5	1.5	1.5	1.5	1.5	0.0	2.8	2.7	3.8	3.7	3.3	2.3	2.2	2.3	2.9	-1.0
1.0	1.2	1.7	1.3	1.3	1.8	2.0	1.9	1.5	0.6	3.0	3.3	2.8	3.0	3.0	2.3	3.2	2.8	2.9	-0.3
1.5	1.3	1.7	1.7	1.5	1.3	2.2	1.8	1.6	0.2	2.8	3.7	3.2	3.0	3.2	2.3	2.8	2.6	3.0	-0.6
1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.7	0.0	3.2	3.0	3.3	3.2	3.2	2.5	2.8	2.7	3.0	-0.5
2.0	1.3	1.5	2.0	1.7	1.7	1.8	1.8	1.7	0.0	2.8	2.5	4.7	3.7	3.4	2.0	2.7	2.3	3.1	-1.1
1.5	1.8	1.5	1.7	1.6	1.8	2.2	2.0	1.8	0.4	3.3	3.2	3.5	3.3	3.3	2.3	2.8	2.6	3.1	-0.8
1.7	1.5	2.0	1.8	1.8	1.7	2.0	1.8	1.8	0.1	3.2	3.2	3.0	3.3	3.2	2.5	3.3	2.9	3.1	-0.3
1.3	2.0	1.7	1.7	1.7	2.2	2.2	2.2	1.8	0.5	2.5	3.0	3.8	3.7	3.3	3.0	2.7	2.8	3.1	-0.4
2.2	1.3	2.2	2.3	2.0	1.3	1.8	1.6	1.9	-0.4	3.2	3.0	3.0	3.5	3.2	2.7	3.5	3.1	3.1	-0.1
1.3	1.0	3.2	2.2	1.9	1.5	2.0	1.8	1.9	-0.2	2.8	2.7	3.7	3.7	3.2	3.0	3.3	3.2	3.2	0.0
1.7	1.3	2.8	1.8	1.9	1.7	2.0	1.8	1.9	-0.1	3.0	3.7	2.8	3.2	3.2	3.0	3.5	3.3	3.2	0.1
1.3	1.8	2.0	2.3	1.9	1.8	2.3	2.1	1.9	0.2	3.0	3.3	4.2	4.3	3.7	2.0	2.5	2.3	3.2	-1.5
1.0	1.0	2.8	2.5	1.8	2.2	2.2	2.2	1.9	0.3	3.0	4.0	3.3	3.0	3.3	2.8	3.3	3.1	3.3	-0.3
1.8	1.7	1.8	1.8	1.8	2.2	2.5	2.3	2.0	0.5	3.2	3.7	3.0	3.2	3.3	3.0	3.7	3.3	3.3	0.1
1.8	1.3	2.8	2.3	2.1	1.8	1.8	1.8	2.0	-0.3	3.3	3.2	3.5	3.7	3.4	2.8	3.3	3.1	3.3	-0.3
2.7	1.3	2.0	2.7	2.2	1.7	2.2	1.9	2.1	-0.3	3.3	3.3	3.7	3.3	3.4	2.8	3.5	3.2	3.3	-0.3
1.5	2.0	3.5	2.3	2.3	1.5	1.8	1.7	2.1	-0.7	3.7	3.8	4.0	3.8	3.8	2.7	2.8	2.8	3.5	-1.1
2.0	1.7	3.2	2.7	2.4	2.2	1.7	1.9	2.2	-0.5	3.7	4.0	4.3	4.2	4.0	2.5	2.8	2.7	3.6	-1.4

Dicamba Score	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	Total Obs.
2019 Yield Average	67.2	60.6	58.8	58.6	52.9	49.4	44.0	30.0	684
2020 Yield Average	65.4	56.0	50.0	49.1	47.2	44.5	36.5	-	288
2-Yr Yield Average	66.8	58.9	54.7	53.7	51.6	48.2	43.5	30.0	972



PI Panel: possible sources of tolerance?



Response	Date 1	Date 2	Date 3
Tolerant	1.5	1.5	1.5
Tolerant	1.5	1.8	1.5
Tolerant	1.0	1.8	2.0
Recovery	3.3	2.3	2.0
Recovery	3.5	2.5	1.8
Recovery	3.8	2.5	1.8
Moderate	3.0	3.0	3.0
Moderate	3.0	3.0	3.0
Moderate	3.0	3.0	3.0
Worsening	2.3	4.3	3.8
Worsening	2.5	4.3	4.0
Worsening	2.5	4.5	4.3
Susceptible	3.5	4.3	4.3
Susceptible	3.5	4.3	4.3
Susceptible	4.0	4.3	4.0



PI Panel: possible sources of tolerance?



Identify the genetics regulating the tolerance and make them available to farmers growing non-Xtend varieties!

Mapping studies on-going

PI Accessions panel - 340 entries for GWAS

AYT breeding panel - 600 entries for GWAS

Segregating parents - 3 Bi-parental population

2 Bi-parental populations (PI x Elite) under development



Selected extreme genotypes (Field Demo)

2020-Field Demo





2021 Dicamba field trials

Test Name	# Entries	Source	# Env	# Reps	Plot layout	Data collected	Marker
Dicamba Field Demo AYT-Screening	8	AYT (19)	1	1	4-row strip, field length	UAV, Dicamba	Soy6K
S400-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S410-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S420-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S460-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S470-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S480-21	28	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S490-21	21	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S500-21	20	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S510-21	12	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S511-21	15	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
S512-21	12	2020 PYT	5	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
GS-SW	340	PI Subset	2	2	1-row plot, 7 ft long	Time-series UAV, Dicamba	Soy50K
DIC-4YT	24	4-YT (20)	2	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
DIC-5YT	24	5-YT (20)	2	3	4-row plots, 12 ft long	UAV, Yield, Dicamba	Soy6K
DIC-Screening:							
DPS-3	160	DPS (20)	2	2	1-row plot, 7 ft long	UAV, Dicamba	Soy6K
DPS-4	120	DPS (20)	2	2	1-row plot, 7 ft long	UAV, Dicamba	Soy6K
DPS-5	120	DPS (20)	2	2	1-row plot, 7 ft long	UAV, Dicamba	Soy6K



What's next for FY22?

- **Map the regions of the soybean genome regulating tolerance**
 - *Genotyping with Soy6K on-going*
 - *2nd year of data for PIs*
- **AI/ML combined with UAV to quickly identify tolerant lines**
 - *2nd year of data collection on-going*
 - *Time-series data to identify recovery patterns*
- **Deployment of high-yielding non-Xtend varieties with superior tolerance**
 - *S16-12774C entered in 2021 Uniform Trials*
 - *Many promising lines in 2021 AYT to be entered in 2022 Uniform Trials*

A large blue harvester is shown from a rear perspective, moving through a vast field of mature, golden-brown soybean plants. The sun is low on the horizon, creating a dramatic sunset with warm orange and yellow light filtering through scattered clouds. The harvester's silhouette is dark against the bright sky.

Thank you!



canellavieirac@mail.missouri.edu



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(573) 379-5431