SUGARBEET SENSITIVITY TO DICAMBA AT LOW DOSE

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SUMMARY

1. Sugarbeet is not as sensitive to dicamba as some other rotational crops.
2. Sugarbeet leaves will lay flat on the ground within a few hours of exposure to dicamba.
3. Leaves may remain more prostrate than normal for the remainder of the growing season.
4. New leaf growth will generally resume around 6 to 10 days after exposure.
5. Dicamba accumulates in roots but metabolizes over time.
6. 1/10x rate (0.05 lb ai/A) was the dicamba rate at which sugarbeet root yield and quality losses were typically observed.

INTRODUCTION

Dicamba is a growth-regulator herbicide consisting of the auxin transport inhibitor compound benzoic acid. It is widely used to control perennial and annual broadleaf weeds in agricultural crops, fallow land, pastures, turfgrass, and rangeland. Dicamba can move in the xylem and phloem to areas of new plant growth; herbicide uptake is primarily through the foliage, but root uptake can occur as well. Dicamba was first registered for use in the United States in 1967. Common formulations of dicamba currently in use include Engenia by BASF, FeXapan plus VaporGrip by DuPont Crop Protection, and XtendiMax plus VaporGrip by Bayer Crop Protection.

The Environmental Protection Agency (EPA) first registered dicamba formulations for 'over-the-top' use on dicamba-tolerant cotton and soybean in 2016. An alarming number of complaints alleging dicamba off-target movement from dicamba tolerant soybean to neighboring sensitive crops were reported to Minnesota and North Dakota Department of Agriculture officials in 2017. To minimize potential future damage to neighboring sensitive crops, EPA and registrants agreed on label changes, implementation of detailed record keeping requirements, and implementation of additional spray drift mitigation measures for the 2018 growing season.

Dicamba-tolerant soybean are commonly grown in the sugarbeet growing areas of the Red River Valley in Minnesota and eastern North Dakota. However, information on the effect of dicamba off-target movement on sugarbeet is insufficient. Experiments were conducted to determine sugarbeet sensitivity to dicamba at low doses simulating off target movement. Experiment objectives were a) to determine sugarbeet injury from dicamba at low doses to simulate off-target movement; b) to determine if dicamba residues accumulate in leaf or root tissue and if they are present at harvest, and c) to determine the impact of dicamba dose on root yield and sugarbeet quality.

MATERIALS AND METHODS

Amenia, North Dakota

Sugarbeet experiments were conducted near Amenia, ND, in 2017 and 2018. The experimental area was prepared with a Kongskilde 's-tine' field cultivator with rolling baskets before sugarbeet planting. 'SES 36271RR' sugarbeet on May 2, 2017 and 'Crystal 981RR' sugarbeet on May 14, 2018 were seeded 1.25-inch-deep in 22-inch rows at 60,825 seeds per acre. Sugarbeet seed was coated with seed treatments for control of soil borne insects and diseases. Dicamba treatments were applied on August 11, 2017 and June 26, 2018 with a backpack sprayer in 17 gpa spray solution through 11002 Turbo Tee (TT) nozzles in 2017 and 11002 Turbo Tee Induction (TTI) nozzles in 2018 pressurized with CO_2 at 40 psi in 2017 and 50 psi in 2018 to the center four rows of six row plots 30 feet in length. For these experiments, the 1x rate of dicamba was 0.5 lb ai/A.

Sugarbeet visual growth reduction and /or malformation injury was evaluated approximately weekly after application. Evaluations were a visual estimate of sugarbeet injury in the four treated rows compared to the adjacent untreated strip. Sugarbeet leaf blade and petiole (plant) and root samples were collected at two time points to simulate preharvest and harvest. Samples were collected beginning with the untreated check plot and ending with the highest dicamba rate to prevent contamination. Five roots were randomly sampled from the treated area of the plot and cleaned with water. The largest and smallest roots were discarded. Roots were cut into pieces and immediately stored in a cooler on wet ice. Samples were shipped in cooler with dry ice to SGS Brookings, Brookings, SD for analysis of dicamba residue.

Sugarbeet were harvested for yield and quality measurement in 2018. Sugarbeet were defoliated with a four-row topper and harvested with a two-row sugarbeet harvester. The sugarbeet roots were weighed to determine root yield (tons/acre). Approximately 25 lbs. of roots were then sampled from each plot and taken to American Crystal Sugar Company Quality Lab, East Grand Forks, MN and analyzed for percent sucrose and sugar loss to molasses (SLM). Purity (%) and recoverable sucrose (lb/acre) were then calculated. Experiment design was an unreplicated strip in 2017 and a randomized complete block design with two replications in 2018. Data were analyzed with the ANOVA procedure of ARM, version 2018.5 software package.

Comstock, Minnesota, and Norcross, Minnesota

Sugarbeet experiments were conducted near Comstock, MN, in 2017 and near Norcross, MN, in 2018. The experimental area was prepared with a King Kutter gear-driven rotary tiller. 'Hilleshög 4062RR' sugarbeet on May 13, 2017, and 'Betaseed 70RR99' sugarbeet on May 15, 2018, were seeded 1.25-inch-deep in 22-inch rows at 63,360 seeds per acre. Sugarbeet seed was coated with seed treatments for control of soil borne insects and diseases. Dicamba treatments were applied on June 19, 2017, and June 20, 2018, with a backpack sprayer in 15 gpa spray solution through XR8002 nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 25 feet in length. For these trials, the 1x rate of dicamba was 0.5 lb ai/A.

Sugarbeet canopy was photographed using a DJI Phantom 3 Series drone within 72 hours of treatment and approximately two weeks after treatment. Images were used to calculate Leaf Area Index (LAI). LAI is a dimensionless quantity that characterizes plant canopies; it is defined as the one-sided green leaf area per unit ground surface area in broad leaf canopies (LAI = leaf area / ground area, m2 / m2). Sugarbeet leaf blade and petiole (plant) and root samples were collected at two time points to simulate preharvest and harvest in 2018. Samples were collected beginning with the untreated check plot and ending with the highest dicamba rate to prevent contamination. Three roots were randomly sampled from the treated area of the plot and cleaned with water. Roots were cut into pieces and immediately stored in a cooler on wet ice. Samples were shipped in cooler with dry ice to SGS Brookings, Brookings, SD for analysis of dicamba residue.

Sugarbeet were harvested for yield and quality measurement on September 29, 2017, and September 22, 2018. Sugarbeet were defoliated with a six-row topper and harvested with a three-row sugarbeet harvester. The sugarbeet roots were weighed to determine root yield (tons/acre). Approximately 30 lbs. of roots were then sampled from each plot and taken to Minn-Dak Farmers Cooperative Quality Lab, Wahpeton, ND, and analyzed for percent sucrose and percent purity. Recoverable sucrose as lb/ton and lb/acre were calculated. Experiment design was a randomized complete block design with four replications in 2017 and six replications in 2018. Data were analyzed with the ANOVA procedure of ARM, version 2018.5 software package.

RESULTS AND DISCUSSION

Sugarbeet Injury. Visual sugarbeet injury from dicamba treatments increased over time at Amenia, ND in 2017 (Table 1). Sugarbeet injury from the lowest dicamba rate (1/1000x) increased 6%, injury from 1/100x increased 15%, and injury from 1/10x increased 20%. At both evaluation timings, sugarbeet injury was greatest from the

Table 1. Sugarbeet malformation injury from XtendiMax at 10 days after treatment (DAT) and 35 DAT at Amenia, ND, 2017.

Dicamba Rate[1]	Percent of labeled rate	Sugarbeet injury – 10DAT	Sugarbeet injury – 35 DAT
lb ai/acre		*%*	*%*
0.05	1/10x[1]	35	55
0.005	1/100x	5	20
0.0005	1/1000x	0	6

[1]A 1x rate equals 0.5 lb ai/A dicamba.

highest rate and decreased as dicamba rate decreased. Likewise, visible sugarbeet malformation and growth reduction was greater with increased dicamba rate at Amenia in 2018 (Table 2). Plot canopy estimated as leaf area index (LAI) was greatest in the untreated control and with the lowest dicamba rate and was least with the highest dicamba rate. Plot canopy increased as dicamba rate decreased.

Table 2. Sugarbeet visible malformation and growth reduction injury in response to dicamba off-target movement, 12 DAT at Amenia, ND, and plot canopy, 15 DAT, Norcross, MN, 2018.

Dicamba Rate[1]	Malformation	Growth Reduction	Plot Canopy (LAI)
	%	*%*	*cm^2*
High	100 a	100 a	210,000 c
Medium	60 b	50 b	256,900 b
Low	0 c	15 c	289,100 a
Untreated	0 c	0 c	303,300 a
LSD (0.10)	**30**	**17**	**31,400**

[1]High = 1/2x or 1/10x rate; Medium = 1/20x or 1/33x rate; Low = 1/200x or 1/100x rate. A 1x rate equals 0.5 lb ai/A dicamba.

Root yield, sucrose content and recoverable sucrose. Sugarbeet were harvested approximately three months after dicamba application at each location except at Amenia in 2017. Root yield and quality decreased as dicamba rate increased across locations and years (Tables 3, 4 and 5). Differences in sucrose content were not statistically significant in 2017 (Table 3). However, yield and recoverable sucrose were affected by the 1/10x rate dicamba as compared to the untreated check and the 1/100 and 1/33 dicamba rate in 2017.

Table 3. Sugarbeet canopy, root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Comstock, MN, 2017.

Treatment[1]	Percent of Labeled Rate	Plot canopy - July 5	Root Yield	Sucrose	Recoverable Sucrose
		cm^2	*ton/acre*	*%*	*lb/acre*
XtendiMax	1/10x	16,400 b	23.9 b	15.3	5,682 b
XtendiMax	1/33x	28,000 ab	27.7 a	15.8	6,889 a
XtendiMax	1/100x	32,500 a	29.9 a	16.1	7,678 a
Untreated		29,700 a	28.4 a	15.0	6,761 ab
LSD (0.10)		**12,900**	**2.6**	**NS**	**1,151**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Dicamba at 1/10x to 1/2x rate decreased sugarbeet root yield, sucrose content and recoverable sucrose compared to the untreated check at Amenia and Norcross in 2018. Dicamba at 1/00x and 1/33x rate reduced root yield and quality compared to the untreated check at Norcross (Table 5). However, dicamba at 1/200x and 1/20x rate did not affect root yield and quality compared to the untreated check at Amenia in 2017 (Table 4). Root yield and recoverable sugar losses were much greater between 1/10x and 1/2x rate than between 1/200x and 1/20x rate at Amenia and Norcross in 2018 (Tables 4 and 5).

Table 4. Sugarbeet root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Amenia, ND, 2018.

Treatment[1]	Percent of Labeled Rate	Root Yield	Sucrose	Recoverable Sucrose
		ton/acre	*%*	*lb/acre*
XtendiMax	1/2x	20.9 c	13.3 b	4,597 c
XtendiMax	1/20x	39.1 a	15.6 a	10,666 a
XtendiMax	1/200x	35.8 b	15.4 a	9,639 b
Untreated		37.8 ab	15.4 a	10,121 ab
LSD (0.10)		**3.2**	**1.4**	**833**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Table 5. Sugarbeet root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Norcross, MN, 2018.

Treatment[1]	Percent of Labeled Rate	Root Yield	Sucrose	Recoverable Sucrose
		ton/acre	*%*	*lb/acre*
XtendiMax	1/10x	9.2 d	16.2 b	2,452 d
XtendiMax	1/33x	22.7 c	17.6 a	6,755 c
XtendiMax	1/100x	25.3 b	17.7 a	7,578 b
Untreated		28.0 a	18.4 a	8,856 a
LSD (0.10)		**2.1**	**1.1**	**578**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Residue Analysis. Dicamba residue level in leaves and roots decreased as the dicamba rate decreased (Table 6). Leaf tissue had greater levels of dicamba residue than root tissue. Except for leaf tissue at the labeled dicamba rate, the amount of residue in tissues declined between the first and second sampling date. Dicamba treatments were not applied until August 11 at Amenia in 2017 or much later than mid to late June or typical soybean application timing.

Sampling was timed to simulate August sugarbeet preharvest (58 to 69 DAT) and full harvest in October (84 to 94 DAT) and followed dicamba application to simulated off target movement from application in soybean in 2018. Dicamba was virtually undetectable in leaf and root across sampling timings and locations in 2018 (Tables 7 and 8). There was no dicamba residue detected in the roots 84 to 94 DAT.

Table 6. Dicamba residue measured in sugarbeet leaf and root tissue, 17 and 38 DAT, Amenia, ND, 2017.

		17 DAT		38 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		---------------------------------*ppm*---------------------------------			
0.5	1x	0.57	0.48	1.40	0.47
0.05	1/10x	0.11	0.07	0.07	0.06
0.005	1/100x	0.12	0.01	0.01	0
0.0005	1/1000x	0	0.001	0	0
0		0	0	0	0

Table 7. Dicamba residue measured in sugarbeet leaf and root tissue, 58 and 84 DAT, Amenia, ND, 2018.

		58 DAT		84 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		---------------------------------*ppm*---------------------------------			
0.25	1/2x	0.165	0.110	0.027	0
0.025	1/20x	0.045	0	0	0
0.0025	1/200x	0	0	0	0
0	Untreated	0	0	0	0

Table 8. Dicamba residue measured in sugarbeet leaf and root tissue, 69 and 94 DAT, Norcross, MN, 2018.

		69 DAT		94 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		---------------------------------*ppm*---------------------------------			
0.05	1/10x	0.014	0.030	0	0
0.165	1/33x	0.012	0	0	0
0.005	1/100x	0	0	0.003	0
0	Untreated	0	0	0	0

CONCLUSION

Sugarbeet is not as sensitive to dicamba as other crops including soybean or sunflower. Sugarbeet injury following dicamba off target movement will occur within a few hours of exposure. Sugarbeet leaves will lay flat on the ground, regardless of rate, but a higher dosage will lead to greater visible injury. Leaves may remain more prostrate than normal for the remainder of the growing season, especially if the injury is severe. Leaf petioles will exhibit twisting, also called epinasty. New leaf growth generally resumes six to ten days after exposure and the new leaves will often be malformed with wrinkled leaf margins, parallel veins, or leaf strapping. Dicamba is rapidly metabolized by sugarbeet and it is unlikely dicamba residue will be detected in the roots at harvest.