Impact of Dicamba Drift on Non-Dicamba Soybeans: Technical Report (limited to 4 pages)

Introduction:

Control of glyphosate resistant weeds with dicamba has been encouraging, which resulted in an increasing adoption of the DT-soybeans. However, the off-target movement of dicamba-based products to non-DT soybeans and other broadleaf crops is of concern. Negative impact of dicamba on non-DT soybean may vary with dicamba rates, soybean type, and soybean growth stage at the time of drift occurrence.

Since the majority of soybean acreage was (and next year will still be) planted to non-DT varieties, during 2017 season there were many cases of dicamba drift complaints, which have led to litigation. For example, the Nebraska State Department of Agriculture received over 90 complaints of dicamba drift onto non-DT soybeans with an estimated impact on 60,000 affected acres. In addition, there were over a thousand complaints across Midwestern region. It is known that dicamba spray droplets have tendency not only to drift with any air movement (even very slow wind), but also to move off target when fine aerosol droplets remain suspended during air temperature inversions (temperatures near the soil or canopy surfaces are cooler than those higher up, high humidity, little or no wind). The suspended tiny aerosol-size dicamba droplets may not evaporate for some time, and thus can drift from the target site well after the application, and in some cases even 98 hours after application. This drift can travel long distance (2-3 miles, or more) and finally be deposited onto nearby fields with various dicamba-sensitive crops including non-DT soybeans.

Study objectives:

(1) To evaluate the influence of micro-rates of dicamba products (Engenia and XtendiMax) to growth, development and yield of three sensitive soybean types (Round-up Ready, Liberty-Link and Conventional soybeans) at three different growth stages of application (second trifoliate, start of flowering, and full flowering),

(2) To establish baseline data on the potential injury and yield reduction of these sensitive soybeans to micro-rates of dicamba products,

Study procedures:

Field trials were conducted in 2017 at Haskell Ag Lab, Concord, NE. The study was laid out as a split-plot design with 6 micro rates of dicamba products (Engenia and XtendiMax), 3 application times (3 soybean growth stages) and 4 replications. The dicamba rates included: 0, 1/10; 1/50; 1/100; 1/500; and 1/1000 of products label rate (12.8oz of Engenia and 22oz of XtendiMax). Plots had four rows of each soybean types (Roundup Ready, Liberty-Link, Conventional and Dicamba-Tolerant as a check). The 3 application times were second trifoliate (V2), just before flowering (V7/R1), or at full flowering (R2). The V2 timing was chosen to simulate potential drift at an early stage of soybean growth, which would be the earliest expected time for a dicamba product application. The second and third timings were chosen to simulate potential drift at the later stages of soybean growth due to potentially different planting date differences between neighboring fields. For, example some fields might be planted earlier, some later, thus these two timings would capture potential drift among neighboring fields around flowering time. Visual evaluation of injuries was conducted at 7, 14, 21, and 28 days after treatment (DAT). Soybean morphological development including plant height, number of branches, days to canopy closure (for V2 and V7/R1 only), days to flowering (for V2 only), number of flowers (V2 and V7/R1), and days to maturity. Yields of all soybean types were harvested.

A four parameter log-logistic regression model was used to analyze the relationship between dicamba micro-rates, and soybean growth and yield variables. The regression analyses helped to estimate the dicamba micro-rates that could cause certain level of injury or yield reduction. Mean values were collected for variables which regression analyses were not possible.

Brief Summary of 2017 results (4 pages only, more details will be submitted in the formal 4th Quarter Report for Jan 1-Mar 31)

Roundup Ready, Liberty-Link, and Conventional soybeans were equally sensitive to all tested micro-rates of Engenia and XtendiMax. When micro-rates were increased, crop growth parameters were significantly impacted, including: reduction in plant height, alterations in branching pattern, delayed days to canopy closure and delayed date of flowering, a reduction in flower number, a delayed date of physiological maturity and most importantly a reduction in soybean yield. The foregoing negative impacts were dependent on correspondence of application date with the soybean growth stage, with V7/R1 stage being the most dicamba sensitive.

1. Soybean Height, Branch Number and Canopy Closure

Engenia and XtendiMax reduced soybean height by as much as 30 inches, depending on the herbicide rate. For example, at 28 days after treatment (DAT), there was about 4-12 inch reduction in soybean height by Engenia at a rate of 0.06 – 0.20 oz/A (label rate is 12.8oz), and by XtendiMax at a rate of 0.07 – 0.33 oz/A (the standard label rate for DT varieties is 22oz). This height reduction was observed across all dicamba-sensitive soybean varieties and the growth stage of herbicide application.

Total number of branches was not significantly affected by these two dicamba products; however, the products did have an influence on the pattern of branching. For example, when soybeans were sprayed at V2 application time with 1/10 to 1/100 rate (i.e., 0.128-1.28 oz/A of Engenia; 0.22-2.2 oz/A of XtendiMax), the main stem growing point (apical meristem) was killed, which resulted in an observable "fork-like" pattern of branching in all non-DT soybeans (data not shown).

The impact of Engenia and XtendiMax on dicamba-sensitive varieties was either a delayed, or completely prevented canopy closure. Application at the V2 stage with Engenia at a 1/10 rate (1.28 oz/A), 1/50 rate (0.256 oz/A) and 1/100 rate (0.128 oz/A) delayed days to canopy closure by 21, 14, and 7 days respectively. In contrast, when applied at the V7/R1 stage, almost all Engenia rates (1/500 to 1/10) (0.0256-1.28 oz/A) prevented canopy closure throughout the whole growing season. Similar trends were observed with XtendiMax at 1/100 to 1/10 rates (0.22-2.2 oz/A) applied at V2, and at 1/500 to 1/10 rates (0.044-2.2 oz/A) applied at V7/R7.

2. Flowering Time, Number of Flowering Nodes, and Physiological Maturity

Almost all rates (1/500 to 1/10) of Engenia and XtendiMax applied during early vegetative stage (V2) delayed soybean flowering by 10 days, across all soybean types.

Based on ratings conducted at 65 days after planting, an Engenia rate of 1/10 (1.6 oz/A) applied at V2 stage led to a 56% reduction in flower numbers and as much as 92% when applied at V7/R1 stage.

Both dicamba products delayed soybean maturity by 5-25 days depending on the growth stages of dicamba application and the dicamba rate. For example, XtendiMax rates of 1/10 (2.2 oz/A) or 1/100 (0.22 oz/A) applied at V2 stage delayed soybean physiological maturity by 18 and 11 days respectively. For Engenia rates

of 1/10 (1.28 oz/A) and 1/100 (0.128 oz/A) applied at V7/R1 and R2 stages, the delay in physiological maturity was 22 and 14 days respectively, across all soybean types.

3. Visual Injury, Yield and Yield Losses

Both Engenia and XtendiMax injured non-DT soybean varieties in a similar fashion. The visual injuries ranged from 20-80%, depending on the growth stage of application and dicamba rate (Table 1). The visual injury was about 50% when Conventional, Liberty Link and Roundup Ready soybeans were subjected to to Engenia rates of 0.01-0.04 oz/A applied at any of the three application stages. Similarly, an XtendiMax dose of 0.02-0.09 oz/A caused 50% visual injury in all three non-DT soybeans.

Yields of all non-DT soybeans were significantly REDUCED by both herbicides (Table 2) irrespective of application time. However, the V7/R1 stage appears to be the most dicamba-sensitive stage, followed by the R2, and then the V2 stages. For example, Conventional, Liberty-Link and Roundup-Ready soybeans yielded 58, 60, 60 bu/A in non-sprayed control plots. However, when the same soybeans were sprayed at V2 stage with 1/10 of Engenia rate, they yielded considerably less, i.e., 24, 22, and 27 bu/A, respectively. Yields were further lowered to 18, 15 and 25 bu/A, respectively, when the spraying occurred at R2. However, extremely low yields of only 3, 2 and 4 bu/A were measured when the spraying occurred at V7/R1 stage. Similar yield responses were measured in plots sprayed with XtendiMax (Table 2).

In most cases, the 1/50 and 1/100 of the labels rates reduced soybean yields by 13-16 bu/A when applied at the V2 stage. For example, 1/100 of label rate of Engenia reduced yields by about 14 bu/A in Conventional, 16 bu/A in Liberty-Link, and 13 bu/A in Roundup-Ready soybean. The same rate applied at V7/R1 stage reduced yields by about 26 bu/A in Conventional, 18 bu/A in Liberty-Link and 26 bu/A in Roundup-Ready soybean.

Yields were also reduced even with “very low” exposures of 1/500 and 1/1000 of the label rate. For example, the 1/1000 of label rate of Engenia applied at V2 stage reduced yields by about 4 bu/A in Conventional, 2 bu/A in Liberty-Link ,and 4 bu/A in Roundup-Ready soybean. The same rates applied at V7/R1 stage reduced yields by 11 bu/A in Conventional, 3 bu/A in Liberty-Link and 8 bu/A in Roundup-Ready soybean (Table 2).

Conclusion:

Both Engenia and XtendiMax had very similar effects on the growth and development of all non-DT soybeans. This was evident by measuring various growth and development parameters, including final yields. Soybean yields were most sensitive to dicamba at V7/R1 growth stage compared to R2 and V2 stages. High sensitivity of soybean yield at V7/R1 may be attributed to relatively high injury levels and the abortion of flowers recorded after application of dicamba. These results clearly showed that non-dicamba tolerant soybeans were sensitive to even very low micro-rates of Engenia and XtendiMax, hence, efforts should be made to avoid drift of dicamba onto sensitive soybeans.

Table 1: Dose of dicamba products that resulted in 50% injury of Conventional, Liberty-Link and Roundup-Ready soybeans sprayed at three growth stages

Soybean type	App/stage	Injury	
		Engenia	XtendiMax
		ED50 (SE) in oz/A	
Conventional	V2	0.01 (0.00)	0.05 (0.01)
	V7/R1	0.01 (0.00)	0.02 (0.00)
	R2	0.04 (0.01)	0.09 (0.02)
Liberty-Link	V2	0.02 (0.00)	0.02 (0.00)
	V7/R1	0.02 (0.01)	0.02 (0.01)
	R2	0.05 (0.01)	0.09 (0.01)
Roundup Ready	V2	0.02 (0.01)	0.03 (0.00)
	V7/R1	0.01 (0.00)	0.01 (0.00)
	R2	0.05 (0.01)	0.08 (0.01)

Table 2: Grain yield of Conventional, Liberty-Link and Roundup-Ready soybeans as influenced by dicamba micro-rates sprayed at three growth stages

Dicamba	Soybean type	App/stage	Grain yield (Bu/A)					
			0	1/10	1/50	1/100	1/500	1/1000
Engenia	Conventional	V2	58	24	39	44	51	54
		V7/R1	62	3	26	36	45	51
		R2	58	18	46	50	56	57
	Liberty-Link	V2	60	22	38	44	52	58
		V7/R1	59	2	24	41	52	56
		R2	61	15	52	51	55	57
	Roundup Ready	V2	60	27	40	47	56	56
		V7/R1	64	5	26	38	49	52
		R2	64	25	52	58	61	59
XtendiMax	Conventional	V2	58	25	40	37	47	50
		V7/R1	58	3	25	37	52	54
		R2	60	11	48	52	57	56
	Liberty-Link	V2	61	27	46	50	59	61
		V7/R1	52	2	26	40	52	55
		R2	63	20	53	56	60	61
	Roundup Ready	V2	63	33	48	51	58	57
		V7/R1	65	6	32	45	53	57
		R2	65	23	58	61	63	61