Field Pea and Dry Bean Injury Due to Dicamba and Glyphosate Drift

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In 2015 and 2016 trials were established to measure the risk that dicamba and glyphosate drift pose to field pea and dry bean. Post-emergence applied dicamba in particular will see increased use in the next several years due to the introduction of dicamba-resistant soybean. The labeled products will be dicamba or a mixture of glyphosate and dicamba which is formulated for reduced drift potential. Yet, drift will still be a concern with dicamba along with the possibility of sprayer contamination.

Field pea and dry bean are high injury risk crops with dicamba. These crops were tested at application rates ranging from 0.4-17% of typical commercial rates to assess drift (or sprayer contamination) damage to the crops. Crop yield was the primary indicator for crop damage but visual injury ratings were taken 10 and 20 days after treatment (DAT). Also at 10 and 20 DAT leaf samples were collected from all plots and sent to an analytical lab (South Dakota Agricultural Labs) to test the concentration of glyphosate and dicamba in the plants. This was done to determine an injury threshold that may translate to a reduced seed yield at the end of the season. Treatments were applied to crops at their most sensitive growth stage (beginning bloom), to measure maximum damage to the crop.

Field peas were relatively tolerant of both glyphosate and dicamba applications (Table 1). Yield was only affected with the highest rate of the combination of the two products. Visual injury for both products was also low with a maximum of 13% damage occurring, which can be difficult to detect in field peas and largely consisted of increased tendril curling and growth rate. Detected herbicide residues were low with a maximum of 12 ppb, which is too low to demonstrate any causality from the herbicide application. And in fact, there were virtually no significant relationships between herbicide residue (or visual injury levels) and yield. The exception is that dicamba residues had a moderate relationship (0.49) to yield loss with the combination of glyphosate and dicamba, however when dicamba was applied alone there was no relationship between residue levels and yield (0.02). Dicamba was a better predictor of injury than glyphosate in general, but again the level of total residue detected was too low to confidently use to estimate yield loss. The conclusion is that field peas were tolerant of the application rates used in this experiment with damage only occurring with the highest use rates of glyphosate and dicamba.

Table 1. Field pea yield, injury, and leaf residue levels following dicamba and glyphosate applications.

Treatment	Rate	Phytotoxicity 10 DAT	Phytotoxicity 20 DAT	Residue Level 10 DAT Dicamba	Residue Level 10 DAT Glyphosate	Residue Level 20 DAT Dicamba	Residue Level 20 DAT Glyphosate	Yield	Protein
	fl oz/a	%	%	ppb	ppb	ppb	ppb	bu/a	%
Check		0	0	0	0	0	0	44.1	29.74
Dicamba	0.05	1.3	0	0	0	0	0	43.8	29.62
Dicamba	0.25	1.3	1.3	4.3	0	0.7	0	44.0	29.81
Dicamba	0.5	4	3.8	4.3	0	5.0	0	45.3	29.84
Glyphosate	0.1	1.3	1.3	0	0	0	0	43.4	29.89
Glyphosate	0.5	1.5	2.5	0	3	0	0	45.7	30.13
Glyphosate	1	6.9	5.5	0	0	0	0	42.9	29.92
Glyphosate + dicamba	0.1 + 0.05	0.5	0.3	0	9.4	0	0	44.9	29.85
Glyphosate + dicamba	0.5 + 0.25	4.6	4.5	5.2	0	2.7	0	43.8	29.81
Glyphosate + dicamba	1 + 0.5	13.4	11.5	8.8	12	3.8	0	39.4	29.90
LSD (0.05)		2.7	2.3	3.3	NS	3.5	0	5.2	NS

Dry beans responded much different than field peas. Dry beans exhibited often severe injury symptoms from the tested rates in this experiment (Table 2). Visual injury levels reached ~35% with the highest rates of dicamba alone and in combination with glyphosate. Yield was affected even more than visual symptoms suggested. Yields were reduced to an average of 20% of the untreated check when dicamba was applied at its highest rate. Adding glyphosate to dicamba trended toward more severe injury than dicamba alone (though there was no statistical difference). One of the causes of yield loss was delayed maturity (data not shown). In both years, a killing frost was required to allow the beans to mature when treated with the highest rates of dicamba. This resulted in a nearly three week difference in harvest dates among treatments.

Table 2. Dry bean yield, injury, and leaf residue levels following dicamba and glyphosate applications.

Treatment	Rate	Phytotoxicity 10 DAT	Phytotoxicity 20 DAT	Residue Level 10 DAT Dicamba	Residue Level 10 DAT Glyphosate	Residue Level 20 DAT Dicamba	Residue Level 20 DAT Glyphosate	Yield
	fl oz/a	%	%	ppb	ppb	ppb	ppb	lb/a
Check		0.0	0.0	0.0	0.0	0.0	0.0	1801
Dicamba	0.05	5.0	2.5	9.3	0.0	123.0	0.0	1551
Dicamba	0.25	19.1	17.5	39.0	11.3	2536.0	1.6	1440
Dicamba	0.5	31.6	33.0	550.7	374.1	1317.0	43.4	408
Glyphosate	0.1	7.8	5.8	21.9	21.0	647.0	7.7	1537
Glyphosate	0.5	23.3	21.6	119.1	1674.6	888.0	226.9	994
Glyphosate	1	17.5	13.8	0.0	762.1	170.0	72.1	1218
Glyphosate + dicamba	0.1 + 0.05	13.3	12.5	9.8	379.0	95.0	165.9	1506
Glyphosate + dicamba	0.5 + 0.25	34.1	30.5	157.5	851.7	1336.0	54.6	927
Glyphosate + dicamba	1 + 0.5	26.6	29.5	416.9	1031.9	809.0	252.1	380
LSD (0.05)		15.7	20.1	387	930	2015.2	160	798

Herbicide residue levels were much higher with the dry beans than field peas. Residue levels reached 2500 ppb with dicamba and 1600 ppb with glyphosate. These levels should be sufficient to measure causality, however, the highest detected concentrations often did not correspond to the highest application rates. Once again, the relationships between ppb and yield are only moderate at best across herbicide dose. Dicamba ppb poorly correlated with yield 10 DAT but had a better relationship to yield 20 DAT (0.18 vs 0.48). Glyphosate residue was more predictive of yield 10 DAT than 20 DAT (0.51 vs 0.43). Overall, by 20 DAT dicamba residues had a better relationship to yield than glyphosate but glyphosate was more predictive than dicamba at 10 DAT. To conclude, without the visual injury and yield information, the herbicide residue data would not mean much in this study, representing a challenging situation to producers who may have been affected by drift.

How to collect samples for pesticide residue analysis

The following are suggestions for collecting leaf samples for lab analysis. See page 106 in the North Dakota Weed Control Guide (2016) for a list of labs that test for herbicides. In our trial the top 4" was collected from many plants to get a total of 40 grams of plant per product that was tested (glyphosate + dicamba = 80 g total needed). This represents the part of the plant that is most vigorously growing and would be the most affected by herbicides. To ensure an accurate test, samples should first be collected from an area that has not been affected by an herbicide. Samples should then be collected from an area with only minor damage, followed by areas with more damage. Between each sampling group, be sure to change gloves to make sure there is no contamination between groups. Send the samples to the lab as quickly as possible to prevent the leaves from molding or deteriorating. Samples should be taken soon after injury is evident.

Labs have a unique test that is used for each herbicide, so it will cost twice as much to check for two herbicides and three times as much to test for three herbicides; so it is important to have an idea about which product caused damage. Once you get the results back, it is important to know that a single test result does not mean anything. You have to compare test results from healthy parts of the field to results from the affected areas. This is because many lab procedures may show that a product is present when it may actually be something called "background noise" from the equipment which means that even plants never exposed to an herbicide may appear to have an herbicide concentration present. Tests will come back as either ppm (parts per million) or ppb (parts per billion). What does this mean? Again, that number on its own does not explain much as there is no standard concentration that will or will not cause plant injury, which is why you can only compare an affected plant to a healthy one.

In our studies, we have found that visual injury is a more conclusive method to determine herbicide injury than testing plants for herbicide residue. Herbicide residue information would be better suited as information used to substantiate visual evidence of injury rather than as a stand-alone method for showing injury. As seen in the results injury can occur with very little residue detected, but at the same time little or no injury may occur even though high residue levels are seen. Overall, there was a relationship between the amount of product applied and the amount detected in the leaves, but it was not strong enough to prove causality.