Effect of 2,4-D Drift on Roundup-Ready Soybean Yield Components

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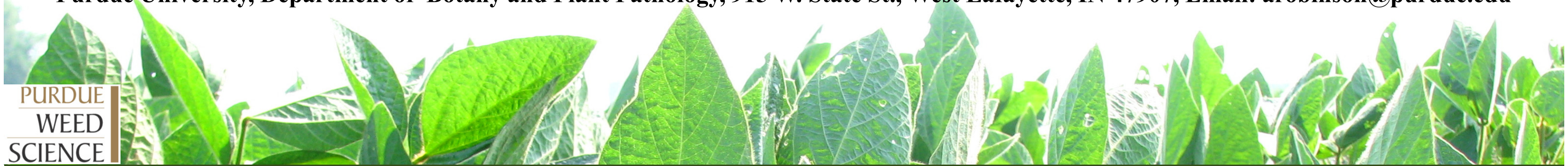

Introduction

Background:

New trait technologies incorporating 2,4-D tolerance in corn, soybean, and cotton increase the use of 2,4-D. This may result in a greater potential for drift to non-transformed crops. There is clear evidence that 2,4-D drift reduces soybean yield, however the impact of 2,4-D drift on soybean growth and yield components on glyphosate-tolerant soybean cultivars has not been reported.

Objective:

Our objective was to quantify 2,4-D drift on glyphosate-tolerant soybean growth, yield components, and seed composition.

Materials and Methods

Experimental procedure:

- Location: Fowler, IN
- Randomized complete block
- Planted 38 cm rows at 350,000 plants ha^{-1}

Treatment:

- 2,4-D
  - 0, 0.112, 1.12, 11.2, 560, 1120, 2240,4480 g ae ha^{-1}
- Application timing
  - R1 on Becks 342NRR
  - R2 and R4 on Croplan RC 2057

Measurements:

- Crop injury visual rating
  - 14 DAT
  - 30 DAT
- Yield components
- Machine harvested yield
- Plant growth characteristics
- Protein and oil concentration measured by near-infrared reflectance spectroscopy

Statistical analysis:

- Fishers LSD *t*-test ($P \leq 0.05$)
- Path analysis

Results

Soybean Growth and Reproduction

Table 1. Effect of eight 2,4-D rates on soybean yield components, growth, and seed composition. Within columns means followed by the same letter are not significantly different ($P < 0.05$) using Fisher's LSD *t*-test.

2,4-D (g ae ha^{-1})	Yield (Mg ha^{-1})	Seed mass (g 100 seeds)	Seed pod^{-1}	Pod no. m^{-2}	Percent reproductive nodes (%)	Node no. m^{-2}	Plant ht. (cm)	Oil concentration (g kg^{-1})	Protein concentration (g kg^{-1})
0	3.19a	13.9abc	2.45a	782a	85.0a	258b	57.6a	187a	347b
0.112	3.09ab	14.6ab	2.50a	868a	85.5a	323ab	58.4a	183a	348b
1.12	3.00ab	14.8a	2.44a	858a	82.7a	328a	58.6a	180a	350b
11.2	2.86b	14.4abc	2.42a	800a	82.6a	320ab	56.8a	179a	351b
560	1.20c	12.5bcd	2.17b	474b	56.6b	353a	36.4b	166b	357a
1120	0.18d	10.6de	1.69cd	50c	28.7c	80c	24.7c	-	-
2240	0.01d	12.3cd	1.93bc	7c	2.2d	24cd	4.9d	-	-
4480	0.00d	10.0e	1.63d	1c	1.9d	2d	2.4d	-	-

Key Results:

- 560 g ae ha^{-1} decreased soybean yield by 60% and reduced pods m^{-2} and plant height by 40%
- 2240 and 4480 g ae ha^{-1} were detrimental to plant growth
- 0.112 to 11.2 g ae ha^{-1} did not change seed composition

Yield Reduction by Visual Rating

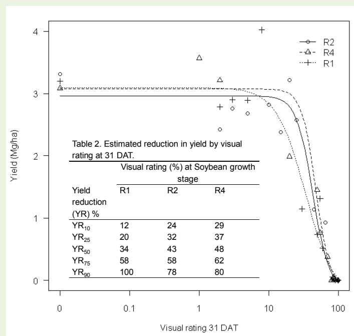

Table 2. Estimated reduction in yield by visual rating at 31 DAT.

Yield reduction (YR) %	Visual rating (%) at Soybean growth stage R1	R2	R4
YR_{10}	12	24	29
YR_{25}	20	32	37
YR_{50}	34	43	48
YR_{75}	58	58	62
YR_{90}	100	78	80

Fig. 1. Reduction of yield × visual rating 31 DAT. 2,4-D applied on soybean at three growth stages R1, R2, and R4.

Key Results:

- Drift at R1 reduced yield slowly at visual ratings between 10 and 50%, but a visual rating of 90% reduced yield 100%
- Drift at R4 reduced yield at a greater rate than drift at R1 or R2
- Visual ratings of 90% reduced yield by 78 to 100%

Application Timing

Table 2. Three-way path coefficient analysis of direct and indirect effects of 2,4-D application timing on soybean yield components averaged across application timing (R1 Becks 342NRR, R2 CropLan RC2057, R4 CropLan RC2057).

	Application timing R1	R2	R4
Indirect effect			
Seed mass and seeds pod^{-1}	0.81	0.89	0.61
Seed mass and pods m^{-2}	0.76	0.84	0.76
Seed pod^{-1} and pods m^{-2}	0.92	0.80	0.92
Direct effect			
Seed mass → yield	0.38	1.11	-0.36
Seeds pod^{-1} → yield	-0.17	-0.37	0.57
Pods m^{-2} → yield	0.74	0.17	0.72

Key Results:

- Pods m^{-2} always had a positive direct influence on yield
- Pods m^{-2} had the greatest impact on yield at R1 and R4 applications
- Seed mass influenced yield most at the R2 application

Conclusions

- **Low rates of 2,4-D (0 to 11.2 g ae ha^{-1}) did not change yield components**
- **1120 to 4480 g ae ha^{-1} reduced yield components and plant growth**
- **Pods m^{-2} was one of the most important yield components**
- **Visual ratings can be used to determine soybean yield loss from 2,4-D drift**