



# SOYBEAN PRODUCTION SYSTEMS

## Effect of Soybean Row Spacing and Fungicide Application Timing on Spray Canopy Penetration and Grain Yield

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### Objectives:

- To quantify the effect of crop row spacing, fungicide spray application timing, and carrier volume on soybean canopy coverage.
- To quantify the impact of fungicide application timing on crop yield.
- To characterize sprayer wheel track injury on soybean yield.

### Materials and Methods:

Field studies were conducted during the 2005 soybean growing season at 3 Purdue Agricultural Centers: DPAC, NEPAC, and SEPAC. The experimental design at each location was a randomized complete block with 3 replications. The main plot factors were crop row spacing (7.5, 15, and 30 inches) and spray application timing (unsprayed or applications at growth stage R1, R3, R5, R3+R5, or R1+R3+R5). Plots with 30-inch rows were planted with a John Deere 1750 planter. Plots with 15, 7.5, and 7.5-inch rows with tramlines were planted with a John Deere no-till grain drill.

Soybean was planted no-till into corn stubble at the state recommended population for each row spacing. The soybean cultivar Diener 2615 RR was seeded at DPAC and NEPAC and Pioneer 94B13 was seeded at SEPAC. Herbicide and insecticide were applied as needed according to Purdue University Extension recommendations. Plots were sprayed with Quilt fungicide (14 fl oz/A) and crop oil concentrate (0.5%) at 20 GPA at each application time using Apache and Spra-Coupe applicators fitted with TeeJet TJ60-11006 spray tips spaced at 15-inches. Plots measured 45 by 300 ft.

Syngenta water-sensitive spray cards measuring 2 x 3 inches were mounted on wooden standards to quantify spray canopy coverage at 12-inch height increments throughout the soybean canopy. Three spray coverage sub-samples were collected from each height. After spraying, the cards were collected, scanned, and then analyzed for percent spray canopy coverage using Assess image analysis software. At physiological maturity plots were harvested with commercial class IV combines fitted with 15 ft grain heads. Yield was recorded using Ag Leader yield monitors calibrated with a weigh wagon. Two passes for yield were made per plot.



At DPAC and SEPAC, one pass contained no wheel tracks and one contained both wheel tracks. Both passes contained wheel tracks at NEPAC due to logistical constraints. Statistical analysis was conducted utilizing SAS.

The effect of carrier volume on spray canopy penetration was also examined at the DPAC location. Four carrier volumes (10, 15, 20, and 25 GPA) were tested at the R1 and R3 growth stages on soybean planted at 7.5-in row spacing. Spray coverage data were collected as described above.

**Results and Discussion:**

At DPAC, spray coverage 12 inches within the canopy was only slightly less than coverage at the top of the canopy at each growth stage (Table 1). Coverage dropped off substantially at 24 inches or more below the top of the canopy. Crop row spacing had no effect on spray canopy coverage, but did have an effect on yield. Plants at 30-inch row spacing yielded less than plants at other row spacings in the non wheel track area (Table 2). Plants at all row spacings yielded the same in the wheel track area. There was a difference in yield between the wheel track and non wheel track areas for 7.5-inch and 15-inch row spacing; however, 30-inch row spacing yielded the same in the wheel track area as in the non wheel track area, because the sprayer could drive between the 30-inch rows. Fungicide application timing had no effect on yield (Table 3).

Table 1. Effect of fungicide application timing on spray canopy coverage at 12 inch height increments in soybean planted at DPAC.

Height below canopy (in)	Application Timing		
	R1	R3	R5
	-----Spray Coverage (%)-----		
0	56 a	75 a	68 a
12	56 a	54 b	56 a
24	26 b	18 c	30 b
35	-	5 d	12 c
47	-	-	3 d

Means followed by the same letter within growth stage are not different (p < 0.05)

Table 2. Effect of wheel track damage on soybean yield for 4 row spacings at DPAC.

Row spacing (in)	wheel track	non wheel track	track vs. non track
	-----Yield (bu/ac)-----		P-Value
7.5	57.6	69.3	**
15	56.5	66.3	**
30	55.4	56.8	NS
7.5 with tram lines	58.0	70.4	**
LSD (0.05)	5.1	5.1	--

Table 3. Effect of fungicide application timing on soybean yield for 6 application timings at DPAC.

Application timing (growth stage)	wheel track	non wheel track	wheel vs. non wheel
	-----Yield (bu/ac)-----		P Value
R1	59.0 a	69.7 a	< 0.01
R3	57.0 a	64.7 a	< 0.01
R5	56.5 a	64.1 a	< 0.01
R3 + R5	57.2 a	65.3 a	< 0.01
R1 + R3 + R5	54.0 a	63.9 a	< 0.01
Untreated	57.6 a	66.3 a	< 0.01
LSD	6.3	6.3	

At DPAC, when fungicide was applied at the R1 growth stage, spray coverage within the canopy was greater when carrier volume was at least 15 GPA compared to 10 GPA (Table 4). Spray carrier volumes of 20 or 25 GPA did not improve coverage or canopy penetration over that provided by 15 GPA. There was a similar trend when fungicide was applied at the R3 growth stage (Table 5).

Table 4. Effect of spray volume on spray coverage at 12-inch height intervals in the R1 soybean canopy at DPAC.

Volume (GPA)	Height below canopy (in)		
	0	12	24
	----- % Spray Coverage-----		
10	34 b	21 b	4 a
15	41 b	48 c	28 b
20	53 b-c	58 c	29 b
25	82 c	66 c	26 b

Means followed by the same letter within height are not different ( $p < 0.05$ )

Table 5. Effect of spray volume on spray coverage at 12-inch height intervals in the R3 soybean canopy at DPAC.

Volume (GPA)	Height below canopy (in)			
	0	12	24	35
	----- % Spray Coverage-----			
10	53 b	32 b	12 b	4 a
15	67 b-c	47 b	18 b	7 a
20	62 b-c	41 b	19 b	6 a
25	81 c	49 b	16 b	4 a

Means followed by the same letter within height are not different ( $p < 0.05$ )

At NEPAC, coverage 12 inches within the canopy was less than at the canopy top, but still good (Table 6). Coverage decreased substantially at 24 inch or more below the top of the canopy. Crop row spacing had no effect upon spray canopy coverage nor on yield (Table 7). Data were not collected for wheel track/non wheel track comparison at this site. Fungicide

application timing had no effect on crop yield (Table 8). The lack of yield response to narrow row spacings at this location may be explained by the drought stress present at this location during seed development (R5 through R6 growth stages).

Table 6. Effect of fungicide application timing on spray canopy coverage at 12 inch height increments in soybean planted at NEPAC.

Height below canopy (in)	Application Timing		
	R1	R3	R5
	-----Spray Coverage (%)-----		
0	69 a	64 a	68 a
12	54 b	25 b	56 b
24	14 c	5 c	30 c
35	-	2 c	12 d
120	-	-	3 d

Means followed by the same letter within growth stage are not different ( $p < 0.05$ )

Table 7. Effect of row spacing on soybean yield at NEPAC.

Row Spacing (in)	-----Yield (bu/ac)-----
7.5	35.8 a
15	36.9 a
30	36.8 a
LSD (0.05)	1.3

Table 8. Effect of fungicide application timing on soybean yield for 6 application timings at NEPAC.

Application timing (growth stage)	-----Yield (bu/ac) -----
R1	35.3 a
R3	36.6 a
R5	37.2 a
R3 + R5	36.7 a
R1 + R3 + R5	36.7 a
Untreated	36.6 a
LSD (0.05)	1.8

At SEPAC, row spacing had no effect upon spray canopy coverage at the R1 and R5 spray timings, but there was significant row spacing by spray canopy coverage interaction at the R3 timing. Spray coverage 12 inch below the canopy was slightly less than coverage at the top of the canopy at each growth stage (Table 9). There was a substantial reduction in coverage at 24 inch or more below the canopy. Crop row spacing did have an effect on yield. Yield was less at 30-inch row spacing than at other row spacings in the non wheel track area. Yield was the same among all row spacings in the wheel track area. Wheel track areas yielded less than non wheel track areas for 7.5-inch and 15-inch row spacing, but not at 30-inch row spacing because

the sprayer could drive between rows without crop damage (Table 10). Fungicide application timing had no effect upon crop yield (Table 11).

Table 9. Effect of row spacing on spray canopy coverage at 12 inch height increments in R3 soybean canopy at SEPAC.

Height below canopy (in)	Application Timing		
	R1	R3 †	R5
	----- Spray Coverage (%)-----		
0	91 a	60 a	70 a
12	62 b	21 b	50 b
24	9 c	3 c	4 c
35	-	2 c	1 d
47	-	-	1 d

Means followed by the same letter within growth stage are not different ( $p < 0.05$ )

† Spacing x R3 Timing interaction  $p \leq 0.01$

Table 10. Effect of wheel track damage on soybean yield for 3 row spacings at SEPAC.

Row spacing (in)	wheel track	non wheel track	wheel vs. non wheel
	-----Yield(bu/ac)-----		P-Value
7.5	64.6 a	70.2 a	P<.0001
15	66.0 a	70.5 a	P<.0001
30	64.1 a	65.6 b	P>0.05
LSD (0.05)	2.3	2.3	--

Table 11. Effect of fungicide application timing on soybean yield for 6 application timings at SEPAC.

Application timing (growth stage)	wheel track	non wheel track	wheel vs. non wheel
	-----Yield (bu/ac)-----		P-value
R1	65.8 a-b	67.9 a	$P \geq 0.05$
R3	65.5 a-b	70.5 a	$P < 0.0001$
R5	63.1 b	68.0 a	$P < 0.0001$
R3+R5	63.1 b	69.8 a	$P < 0.0001$
R1+R3+R5	65.4 a-b	69.0 a	$P > 0.0017$
Untreated	66.9 a	67.4 a	$P \geq 0.61$
LSD (0.05)	3.3	3.3	--

At both DPAC and SEPAC, sprayer tracks reduced yield, as measured in a 15-ft swath centered over the wheel tracks. Damage over the entire field would depend on boom width (Table 12).

Table 12. Effect of spray boom width on soybean yield loss at DPAC and SEPAC.

Boom width (ft)	Location			
	DPAC		SEPAC	
	-----Yield Loss-----			
	bu/ac	% Total	bu/ac	% Total
30	8.8	14.7	3.8	6.3
60	4.4	7.4	1.9	3.2
90	2.2	3.7	1.0	1.6
120	1.1	1.8	0.5	0.8

**Conclusions:**

- Our results indicate spray coverage and canopy penetration is the same regardless of row spacing. At all growth stages, penetration of spray to a depth of at least 12 inches was reasonably good, but coverage fell off substantially at depths of 24 inches or greater. If a fungicide were applied as soon as rust began to develop in a field, as it should, penetration of 12 inches may reach the site of most primary infections. There seems to be no reason for growers to move to 30-inch rows solely for the purpose of improving fungicide performance.
- Wheel tracks decreased grain yield in soybeans planted in 15-in or narrower rows. The damage will be small if sprayers with wide booms are used. Second or third trips over a field will do no additional damage if the sprayer drives in the original wheel tracks.
- A spray volume of 15 GPA is required for good coverage and canopy penetration.
- Quilt fungicide did not improve yield in any of these trials, at any timing, despite presence of frogeye leaf spot at two locations.

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