Light interception of soybean as influenced by row width, seeding rate, and weed competition

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Introduction:

Soybean light interception (LI) is vital for plant growth, weed suppression, and yield development. Various agronomic practices can maximize LI and more research is needed to determine the most effective combination of these practices.

Objective:

To observe the effect of soybean row width and seeding rate, along with herbicide strategies, on soybean LI and determine if a correlation exists between LI, yield, and potential for end-of-season weed escapes

Materials & Methods:

- A field study was conducted through cooperative effort with seven universities in nine different locations. Data presented here are from the Arlington, Wisconsin location only.
- The study was arranged in a randomized complete block split-plot design with row width as the main plot factor and a 3x2 factorial of seeding rate and herbicide strategy as the subplot factors.
  - (2) Row width:
    - 38 and 76 cm
  - (3) Seeding rate:
    - 173,000, 322,000, and 470,000 seeds ha^{-1}
  - (2) Herbicide strategy:
    - preemergence plus postemergence (PRE + POST) vs. POST only
    - PRE = 1.21 kg a.i. ha^{-1} S-metolachlor plus 0.27 kg a.i. ha^{-1} fomesafen plus 0.42 kg a.i. ha^{-1} metribuzin
    - POST following PRE = 0.59 kg a.i. ha^{-1} glufosinate
    - POST only = 0.59 kg a.i. ha^{-1} glufosinate plus 1.21 kg a.i. ha^{-1} S-metolachlor plus 0.27 kg a.i. ha^{-1} fomesafen
- Glufosinate-resistant soybean (Liberty Link®) was planted on May 14 and emerged on May 22.
- PRE applications were made one day after planting; POST only applications were made one week after V1 (WAV1) soybean growth stage; POST following PRE applications were made 3 WAV1.
- Digital images of each plot were taken weekly from the V1 soybean growth stage to 8 WAV1 and analyzed utilizing image analysis software (SigmaScan Pro 5®; Systat Software Inc., San Jose, CA) to provide LI percentages.
- Weeds m^{-2} were counted in each plot at soybean harvest.
- Third degree polynomial equations were estimated for each treatment's LI percentages over time and the area underneath each curve was integrated to create LI values.
- LI integrations from 1-3 WAV1 (V2-R1 soybean growth stages) were summed for each treatment to form a cumulative LI value used in data analysis.
- Soybean yield was adjusted to 13% moisture.

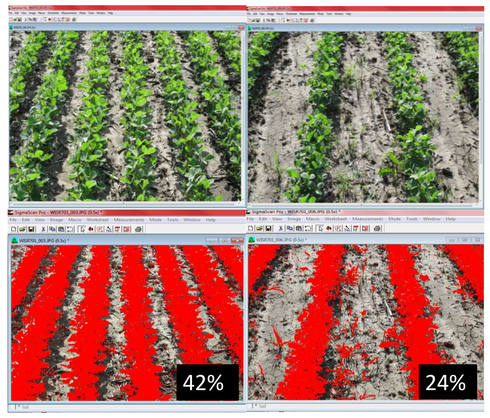

Figure 1. Demonstration of SigmaScan Pro 5® detecting and measuring the ratio of green pixels to the total pixels in the image.

Results:

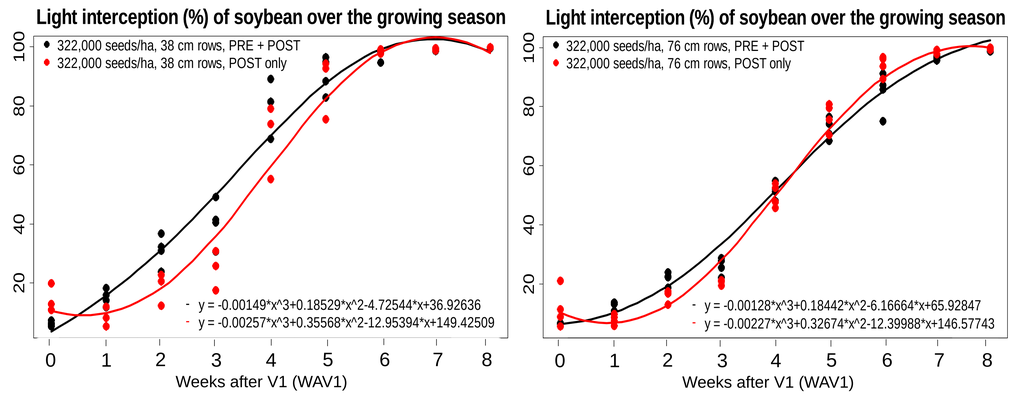

Figure 2. LI percentage of soybean over DAE. Data shown are from the middle seeding rate (322,000 seeds ha^{-1}) only.

Table 1. A comparison of cumulative LI, weed counts, and yield of each treatment in 2013. The seeding rate (high) and interactions between row width (narrow) and herbicide strategy (PRE+POST) each increased cumulative LI (P<0.0001 and P=0.0110, respectively).

Treatment			Cumulative LI[a]	Weed Counts at Harvest[b]		Yield[a]
Row Width	Herbicide Strategy	Seeding Rate	1 – 3 WAV1	Powell amaranth	giant foxtail	
—cm—		Seeds ha^{-1}		——Weeds m^{-2}——		
38	PRE + POST	173,000	237 defg	<1	<1	4400 ab
38	PRE + POST	322,000	418 b	0	0	4320 ab
38	PRE + POST	470,000	531 a	0	0	4540 a
38	POST only	173,000	181 fg	1	3	4130 abc
38	POST only	322,000	260 defg	2	7	3340 c
38	POST only	470,000	390 bc	1	2	4540 a
76	PRE + POST	173,000	133 g	0	<1	4140 ab
76	PRE + POST	322,000	255 def	0	0	4210 ab
76	PRE + POST	470,000	286 cd	0	0	4230 ab
76	POST only	173,000	134 g	1	2	3680 bc
76	POST only	322,000	186 efg	2	4	3420 c
76	POST only	470,000	263 de	<1	4	3960 abc

[a] Means within the column followed by the same letter are not different according to Fisher's Protected LSD at α = 0.05.
[b] Back transformed data are presented for clarity.

Table 2. Correlations (R^2) of LI integrations with yield and weed counts at soybean harvest of Powell amaranth (*Amaranthus powelli*) and giant foxtail (*Setaria faberi*).

Soybean Growth	Yield	Weed Counts at Harvest	
WAV1[a]		Powell amaranth[c]	giant foxtail[c]
	R^2		
1	0.2495	0.1003	0.0863
2	0.2938	0.1047	0.0894
3	0.2983	0.0806	0.0968
4	0.2163	0.0058	0.0049
5	0.1459	0.0045	0.0036
1-2	0.2940	0.1049	0.0898
1-3[b]	***0.3008***	***0.0945***	***0.0945***
1-4	0.2729	0.0440	0.0429
1-5	0.2494	0.0201	0.0201
2-3	0.3066	0.0915	0.0945
2-4	0.2702	0.0382	0.0381
2-5	0.2443	0.0158	0.0163
3-4	0.2540	0.0246	0.0267
3-5	0.2264	0.0072	0.0085
4-5	0.1911	0.0002	0.0002

[a] Abbreviation: WAV1, Weeks after V1 soybean growth stage
[b] WAV1 used for cumulative LI value comparison in Table 1.
[c] Square root transformed data were used to satisfy the equal variance assumption for the regression.

Conclusions:

LI integrations summed for 1-3 WAV1 (cumulative LI) provided consistently high correlations with yield and weed counts at soybean harvest compared to other WAV1 timing comparisons. Cumulative LI increased by 297% in 38 cm wide rows with PRE+POST herbicide strategy seeded at 470,000 seeds ha^{-1} in comparison to 76 cm wide rows with PRE+POST herbicide strategy seeded at 173,000 seeds ha^{-1}. However, those same two treatments did not produce different levels of yield. In comparison, similar differences in LI at 1-3 WAV1 were significantly different in yield where a PRE+POST herbicide strategy was not used. Additionally, LI was negatively correlated with weed counts at soybean harvest. These relationships suggest an important connection between agronomic practices to increase LI during the critical weed free period (cumulative LI) to enhance soybean yield without a PRE herbicide, but increased LI during 1-3 WAV1 may still be important to minimize weed populations by decreasing end-of-season weed escapes.

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