ASSESSING TRAIT BY MANAGEMENT INTERACTION: "NO UNITARDS ALLOWED"

Shawn P. Conley, John Gaska, Mark Martinka, and Paul Esker [1/]

Though growers across WI enjoyed record soybean yields (50.5 bu/a, Source: USDA-NASS) in 2010, questions continue to be asked about the small incremental yield gain observed over time. As the WI Soybean Research program continues to investigate the main yield limiting factors affecting soybean (SCN, white mold, SDS, BSR, soybean aphid, stress, etc), it is also clear that we must also address the question of input interactions.

Currently there is no published University data that supports claims that the perceived soybean yield plateau can simply be overcome through intensive management (high/multiple input) and/or adoption of new yield/input responsive traits (i.e., RR2Y® soybean). For example, in testing fungicide alone, Swoboda and Pedersen (2009) found that fungicides applied in the absence of foliar disease did not produce non-fungicidal physiological effect or associated yield improvement. Similarly, Cooper (1989) found a fungicide yield response only in cultivars where diseases were controlled. Our own data from fungicide efficacy trials have shown that response to foliar fungicide has been greatest when disease is being controlled and also that the use of tank mixes of fungicides and insecticides is not a warranted or cost-effective approach to increasing grower profitability.

When comparing multiple input systems, Lentz et al. (1985) found that combinations of metribuzin (herbicide), insecticides, and nematicides increased plant height, however, also increased the risk of soybean injury and yield loss. In an irrigated system, Slater et al. (1991) found variable response to additional N, P, and fungicide only in an early maturity cultivar where *Phomopsis spp*. was controlled. Lastly, Bradley and Sweets (2008) also reported inconsistent yield response when combining glyphosate with multiple fungicides and fungicide application timings. The paucity of published data coupled with the lack of consistent positive responses emphasizes the need for this research.

The need to address questions about multiple inputs will continue to increase given the projected releases of multiple new traits [DHT (Dow Herbicide Tolerance® 2,4-D resistance) and dicamba-resistant soybean] and input releases (novel foliar and seed treatment fungicide, nematicide, insecticide active ingredients as well as new biological compounds) in the near future. It is critical that we begin to quantify these complex interactions and ask "do synergies actually exist?" so WI growers are provided with accurate, unbiased recommendations that allow them to choose those technologies that increase both yield and profitability and avoid those inputs that are unresponsive and unprofitable. Therefore, the objectives of our experiments are to:

1. Characterize the effect of multiple input interactions on soybean yield and grower profitability;
2. Quantify soybean trait response to intensive management.

[1/] State Soybean Specialist, Outreach Specialist, Soybean Variety Trial Program Manager, and State Extension Field Crops Pathologist, Univ. of Wisconsin-Madison. (Research funded through the WSMB).

Materials and Methods

Objective 1. Characterize the effect of multiple input interactions on soybean yield and grower profitability: The experimental design was a factorial (2^5) design with site serving as the replication (Cochran and Cox, 1957). The advantage of this design was to limit the total number of plots per site to 32 (1 block of 32 units) versus a traditional 128 plot design (32 treatment combinations x 4 reps if all factors were considered and replicated at a site). This design, with its manageable number of plots, will allow for expansion to multiple locations and allow for more intensive data collection. In Year One (2011), these experiments were located at our Arlington, Janesville, and Fond du Lac Variety Trial locations. The main factors of interest were trait (RR1 vs. RR2Y), seed treatment (ApronMaxx plus Optimize 400) (yes or no), foliar fertilization (3 gallons of 3-18-18) @ V6 (yes or no), foliar insecticide @ R2/3 (yes or no), and foliar fungicide @ R2/3 (yes or no).

Objective 2. Quantify soybean trait response to intensive management: Due to our design limitation on the number of traits/varieties we can compare in Objective 1, as well as the difficulty in testing the influence of multiple inputs on soybean yield, we also conducted a second set of experiments. The experimental design was a randomized complete block split-split-plot design with 4 replications (Cochran and Cox, 1957). The main plot effect was intensive management (+ or -), the sub-plot was trait, and the sub-sub-plot was variety. The intensive management treatment combined all the inputs used in Objective 1: no treatment (-) vs. (seed treatment + foliar fertilization @ V6 + foliar insecticide @ R2/3 + foliar fungicide @ R2/3) (+). The trait treatment tested was RR1 vs. RR2Y. The variety treatment consisted of 5 varieties of each trait. One each of the RR1 and RR2Y varieties tested was the same as those in Objective 1 to allow for comparisons among experiments and to increase our level of inference.

Data collection for both sets of experiments:

- Stand counts at V3 and R8
- Leaf tissue analysis for (N, P, K) @ V6 and R3 (objective 1 only)
- Disease incidence and severity at R3 and R5
- Soybean aphid counts at R3 and R5
- Reflectance measurements using a crop canopy sensor @ V6, R3
- Grain yield and quality

Data analysis: Initial analyses focused on comparing the effect of different treatments using standard methods of ANOVA and LSD values.

Results and Discussion

Preliminary results from 2011 of this multi-year experiment suggested that variety selection and foliar fungicide were the primary contributors to yield in 2011 ($P < 0.05$) (Table 1). No yield differences were observed between RR1 and RR2Y traits in Objective 2 (Table 2). Furthermore, we did not observe any trait by input interactions (Tables 1 and 2). Given the lack of interactions in objective one and the similar yield increases between the fungicide only treatment in objective one and the overall yield increase in the intensive management treatment in objective two, we can speculate that this yield response was also likely due to the fungicide application. These preliminary results suggest that no "synergies" were attained by adding or deleting inputs in these experiments. These results further emphasize our recom-mendations that variety selection is the most valuable tool in increasing soybean yield followed by scouting and timely application of a pesticide when needed to control soybean pests.

Table 1. Main effect and interactions for soybean seed yield from objective one.

Main effect	Grain yield	P-value
Trait (variety)		0.0043
Pioneer 92Y30 (RR1)	70.0	
Dairyland DSR-2375/R2Y (RR2Y)	66.7	
Seed treatment		0.57
UTC	68.1	
ApronMaxx (1.5 fl oz/cwt) + Optimize 400 (2.4 fl oz/cwt)	68.6	
Foliar fertilizer		0.54
UTC	68.0	
3-18-18 (3 gal/a @ V6)	68.7	
Foliar insecticide		0.86
UTC	68.5	
Warrior w/Zenon (3.0 fl oz @ R2/3)	68.3	
Foliar fungicide		0.03
UTC	67.1	
Quilt Xcel (14 fl oz @ R2/3)	69.6	

† No interactions were significant at the 0.05 probability level.

Table 2. Main effect and interactions for soybean seed yield from objective two.

Main effect	Grain yield	P-value
Trait†		0.56
RR1	73.0	
RR2Y	74.1	
Management ‡		0.01
UTC	72.2	
Intensive	75.0	
Trait by management		0.12

† (RR1 varieties: Pioneer 92Y30 and 92Y51, NK Brand S21-N6 and S19-A6, Dairyland DSR-2011; RR2Y varieties: FS HiSoy HS24A01, Dairyland DSR-2375/R2Y, Renk RS241R2, Asgrow AG2631 and AG2431)
‡ Intensive management = ApronMaxx (1.5 fl oz/cwt) + Optimize 400 (2.4 fl oz/cwt) + 3-18-18 (3 gal/a @ V6) + Warrior w/Zenon (3.0 fl oz/a @ R2/3) + Quilt Xcel (14 fl oz/a @ R2/3)

Literature Cited

Bradley, K.W., and L.E. Sweets. 2008. Influence of glyphosate and fungicide coapplications on weed control, spray penetration, soybean response, and yield in glyphosate-resistant soybean [electronic resource]. Agron. J. 100:1360-1365.

Cochran and Cox. 1957. Experimental design. Wiley publications in Statistics. p. 244-292.

Cooper, R.L. 1989. Soybean yield response to benomyl fungicide application under maximum yield conditions. Agron. J. 81:847-849.

Lentz, G.L., A.Y. Chambers, and R.M. Hayes. 1985. Interactions of insecticide--nematicides, metribuzin, and environment on soybean injury and yield. J. Econ. Entomol. 78:1217-1221.

Slater, G.P., R.B. Ferguson, B.L.J. Doupnik, and R.W. Elmore. 1991. Soybean cultivar yield response to benomyl, nitrogen, phosphorus, and irrigation levels. Agron. J. 83:804-809.

Swoboda, C., and P. Pedersen. 2009. Effect of fungicide on soybean growth and yield [electronic resource]. Agron. J. 101:352-356.