Response of Broad Spectrum and Target Specific Seed Treatments and Seeding Rate on Soybean Seed Yield, Profitability and Economic Risk

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- The commercial base (CB) and ILeVO (CB + fluopyram) seed treatments decreased risk and substantially increase profit across a wide range of seeding rates.
- Yield response to seed treatment was environment specific, and across all environments, the yield response to ILeVO was 2.8% compared to 5.3% (WI-SDS) and 6.1% (IA) when visual SDS symptoms were present.
- At 2016 and 2017 seed and seed treatment costs, CB and ILeVO seed treatments at 140,000 seeds/a reduced risk greater than 70% of the time and increased average profit ($4 –19/a) across an array of environments and grain sale prices ($8 –11/bu).
- The CB or ILeVO seed treatments realized the lowest risk and highest average profit increase when seeding rates were lowered to the economically optimal seeding rate of 103,000 – 112,000 seeds/a.
- Increase seeding rates as grain sales prices increase to reduce economic risk and maximize profit, especially for untreated seed. CB and ILeVO seed treatments maintain higher break-even probabilities and profit margins at reduced seeding rates.
- Particularly target these seed treatments for fields with a history of SDS and damage from early season insects and pathogens to maximize economic return.

Introduction

Seed applied fungicides and insecticides have become a common component in modern soybean production for their broad spectrum of activity and the implementation of earlier planting dates. Recent studies have shown farmers can maximize their economic return on investment by lowering seeding rates alone (De Bruin and Pedersen, 2008; Epler and Staggenborg, 2008) or in conjunction with a fungicide + insecticide seed treatment (Gaspar et al., 2015). However, it is unknown if a target specific seed treatment, like ILeVO (fluopyram, Bayer CropScience AG), can be profitable when added to these seed treatment packages, especially when farmers make seed treatment choices during the winter when upcoming diseases and/or insect problems are unclear.

Therefore, the objectives of this study were to:

- Quantify the effects of various seed treatment packages and seeding rates on soybean yield.
- Assess the economic risk and profitability of seed treatments and seeding rates, including the calculated economically optimal seeding rate for each seed treatment.

Table 1. Soybean seed treatment component information

Seed treatment code†	Seed treatment trade name(s)	Active ingredients (a.i.)‡	Application rate (mg a.i. /seed)
UTC	n/a	-	-
CB (commercial base)	EverGol™ Energy +	prothioconazole (F)	0.0083
		penflufen (F)	0.0041
		metalaxyl (F)	0.0066
	Allegiance FL +	metalaxyl (F)	0.02
	Poncho®/VOTiVO®	clothianidin (I)	0.1074
		Bacillus firmus (N)	0.0218
ILeVO	EverGol™ Energy +	prothioconazole (F)	0.0083
		penflufen (F)	0.0041
		metalaxyl (F)	0.0066
	Allegiance FL +	metalaxyl (F)	0.02
	Poncho®/VOTiVO®	clothianidin (I)	0.1074
		Bacillus firmus (N)	0.0218
	ILeVO®	fluopyram (F)	0.15

† Seed treatment code represents the unique combination of active ingredients. The letters/numbers were used for coding each seed treatment.
‡ F: fungicide; I: insecticide; N: nematistat

Three seed treatments with different components and relative cost were used. The specific rates and components of these seed treatments are described in Table 1 and consist of an untreated control (UTC), a commercial base fungicide + insecticide + nematistat seed treatment (CB) and the CB seed treatment + fluopyram (ILeVO). Sudden death syndrome(SDS), caused by *Fusarium virguliforme* is the main pathogen targeted by fluopyram, while the other fungicide components of the CB seed treatment target other root rot pathogens. This study was conducted in 2015 and 2016, totaling 26 site-years across Wisconsin, Indiana, Iowa, Michigan and Ontario.

Effects on Soybean Yield

Soybean yield was evaluated within each state across both 30 (IN, IA, MI, ON) and 15 (WI) inch row spacings. Some locations had a history of and developed foliar SDS symptoms, including locations in Wisconsin (WI-SDS), Indiana, Iowa, Michigan and Ontario, while the WI-Complete contained environments with and without SDS foliar symptoms or SDS history (Figure 1). The CB and ILeVO seed treatments both provided yield increases over the UTC, except for the CB in IA (Figure 1). However, statistical significance of these differences was only achieved in WI, IA and MI. It was apparent that sites with a history of SDS and visible SDS symptoms benefit the most from the ILeVO treatment. For example, the ILeVO seed treatment yielded only 2.1% over the CB in the WI-Complete (which included a sites with and without SDS) data set compared to 5.3% in the WI-SDS data set and 6.1% in IA (Figure 1). Therefore, farmers should expect a larger yield response to fluopyram in fields with a history of SDS and the presence of foliar symptoms, which is a similar conclusion to Kandel et al. (2016).

Figure 2 models the soybean yield response to seeding rate for the three seed treatments. Across all seeding rates, CB and ILeVO displayed a consistent yield advantage over the UTC. In comparison, the yield difference between CB and ILeVO increased as seeding rate increased, with ILeVO showing a larger yield response at 140,000 seeds/a compared to 40,000 seeds/a (Figure 1). This may be due to the reduced plant stands associated with ILeVO compared to the CB (data not shown), which at lower populations can have a larger effect on yield compared to higher seeding rates due

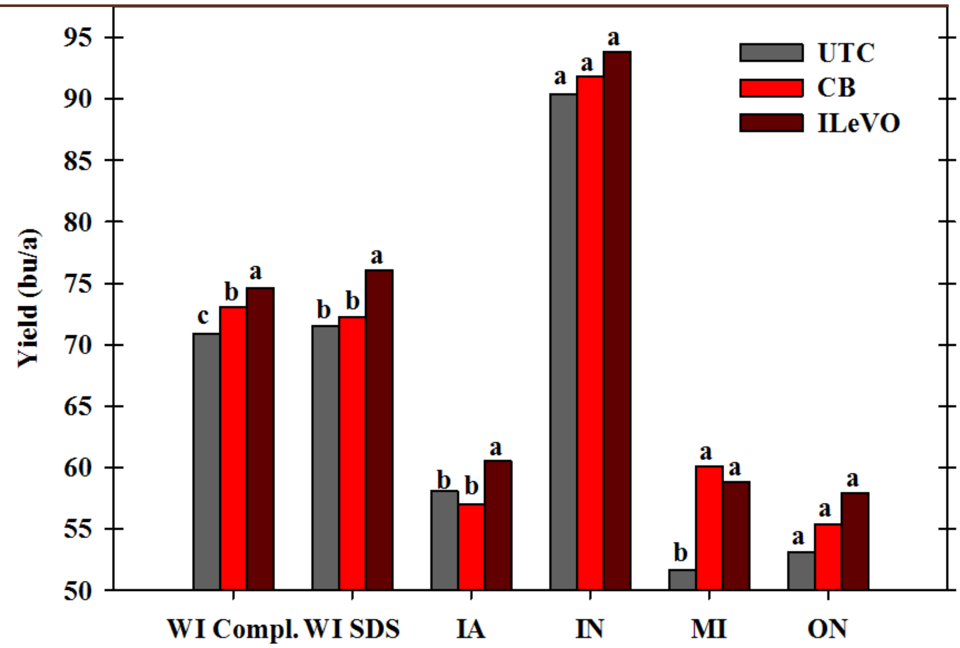


Figure 1. Yield of the three seed treatments for each data set. Within each data set bars containing different letter were significantly different at the $P = 0.05$ level. Each location in the WI-SDS, IA, IN, MI, and ON data sets displayed foliar SDS symptomology.

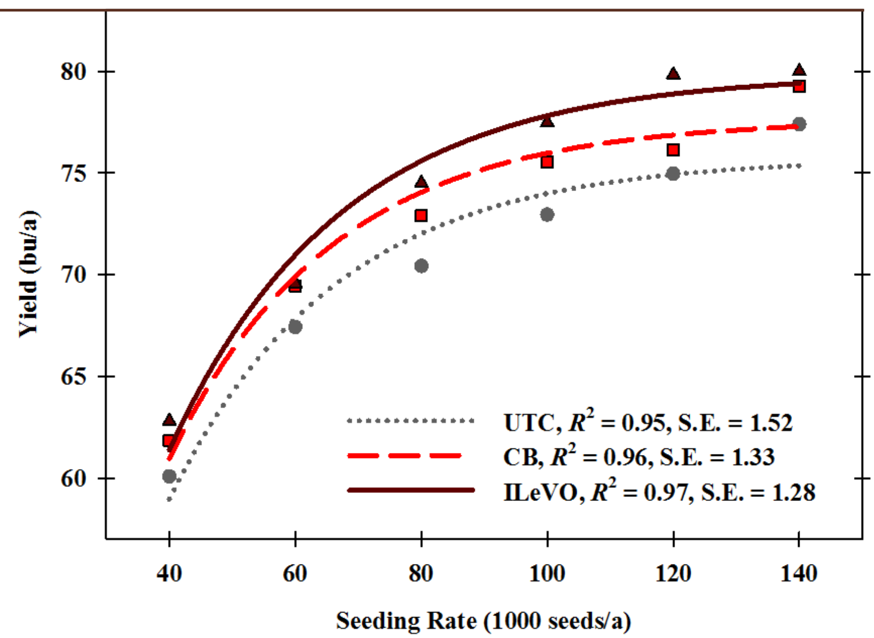


Figure 2. Yield (bu/a) of the three seed treatments across all seeding rates.

to the soybean plants compensatory ability. Overall, a consistent comparison can be made at the maximum modeled yield (140,000 seeds/a), where CB and ILeVO increased yield over the UTC by 2.8% and 5.6%, respectively.

Profitability and Economic Risk

Partial profit was calculated as follows: (Yield x Grain Sale Price) – (Seed Price + Seed Treatment Price). The CB and ILeVO seed treatments increased profit at each grain sale price and across all seeding rates compared to the UTC (Figure 3). The economically optimal seeding rates (the high point on the profit curves) for the three seed treatments and two grain sale prices were calculated and are displayed in Table 3.

Economic risk analysis was applied to the profit curves (Figure 2) to quantify the uncertainty of a seed treatment increasing profit when selected in January with no knowledge of spring disease and insect levels. Risk was measured as the break-even probability (the probability of breaking even relative to the base case of UTC

at 140,000 seeds/a) (Table 2). For example, in Table 2, ILeVO at 140,000 seeds/a had an 87% chance of breaking even over the base case and on average for all outcomes (all environments) increased profit by $7/a.

At a grain sale price of $8/bu (Table 2), a seeding rate reduction of the untreated seed to 120,000 seeds/a provided substantial risk benefits (99%), but profit was only increased on average $4/a. In comparison, the same seeding rate reduction for the CB maintained similar risk benefits (93%) but also provided a larger average profit increase ($9/a) with limited downside potential (-$3/a) only 7% of the time. Gaspar et al. (2015) found similar break-even probabilities for CruiserMaxx (a.i.; thiamethoxam, mefanoxam, fludioxynil), a fungicide + insecticide seed treatment and slightly higher average profit increases at a grain sale price of $9/bu. Furthermore, the addition of fluopyram at 120,000 seeds/a improved the risk benefits of CB to an almost identical level as the UTC (98%) and provided considerably greater average profit increases for all outcomes ($14/a) (Table 2). Not only were the benefits of CB and ILeVO present at slightly reduced seeding rates (120,000 seeds/a) but across a wide range of seeding rates from 80,000 –140,000 seeds/a. The opposite was true for the UTC, in which seeding rates below 100,000 seeds/a and approaching 80,000 seeds/a were risk adverse (4%) and resulted in profit loss. Across all seeding rates and seed treatments, however, the lowest risk (99%) and largest average profit increase for all outcomes ($16/a) was ILeVO at its economically optimal seeding rate of 103,000 seeds/a.

When the grain sale price increased to $11/bu (Table 2), reducing the seeding rate below 120,000 seeds/a for the UTC decreased the break-even probabilities well below 50%, resulting in profit losses across all outcomes of increasing magnitude as the seeding rate was lowered further. In contrast, CB was able to maintain high break-even

Table 2. Seeding rate by seed treatment economic risk table for all environments with a grain sale price of $8 or $11/bu

	Break-even probability (%)§			**Average profit increase over the base case** ($/a)‡		
Seeding rate	**UTC†**	**CB**	**ILeVO**	**UTC**	**CB**	**ILeVO**
$8						
140,000	.	70	87	.	4	7
120,000	99	93	98	4	9	14
100,000	97	97	99	3	11	16
80,000	4	76	95	-5	4	9
60,000	0	1	1	-32	-20	-17
40,000	0	0	0	-96	-83	-83
$11						
140,000	.	85	98	.	9	19
120,000	99	95	99	2	13	24
100,000	38	94	99	-1	13	23
80,000	0	50	90	-15	0	9
60,000	0	0	0	-54	-37	-31
40,000	0	0	0	-145	-127	-126

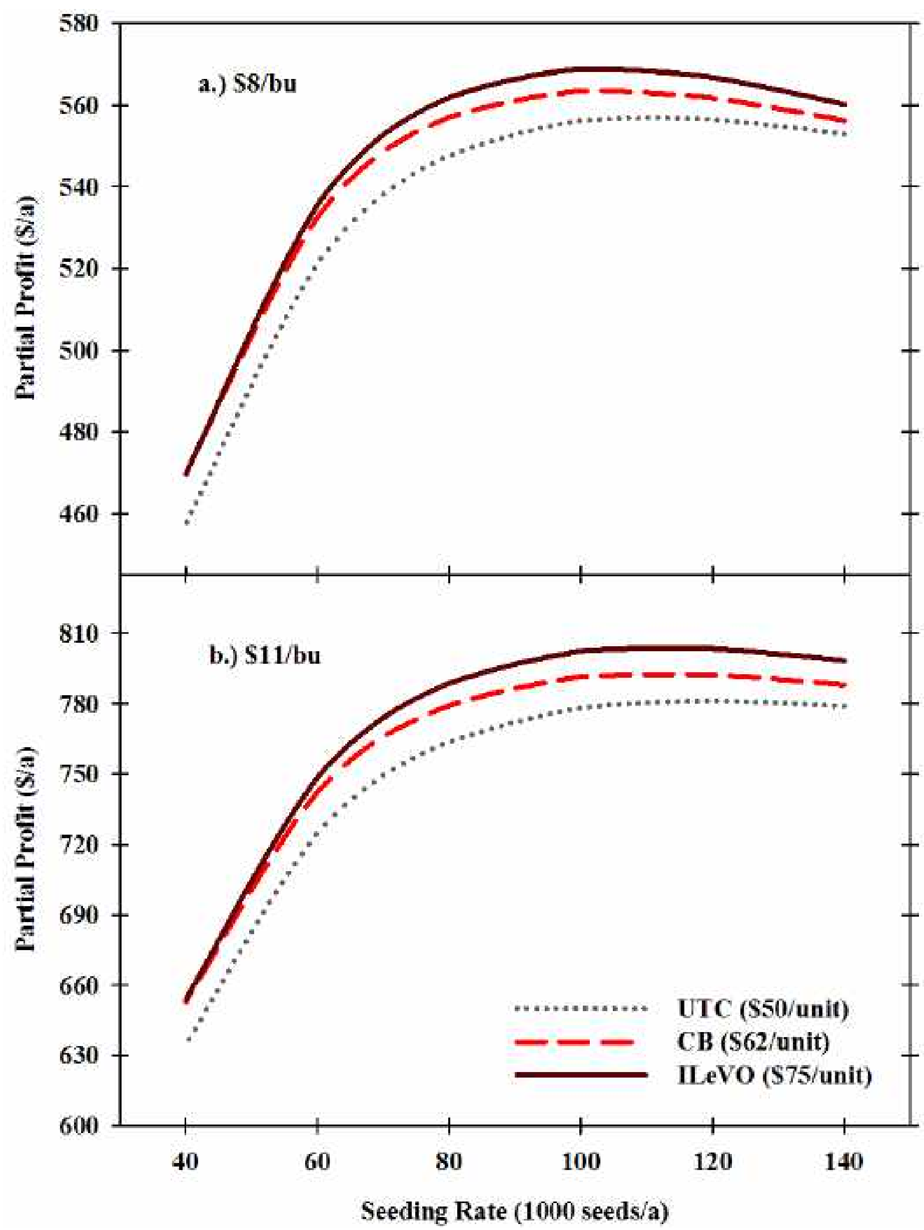
†UTC = untreated control, CB = commercial base, ILeVO = commercial base + fluopyram
‡Base case is untreated seed (UTC) at 140,000 seeds/a
§Break-even probability is the probability that a treatment combination will at least provide the same profit ($/a) as the base case

Table 3. Economically optimal seeding rates for seeding rate by seed treatment options with a grain sale price of $8 to $11/a

	Economically optimal seeding rates (seeds/a)		**Average profit increase over the base case** ($/a) ‡	
Seed treatment†	**$8/bu**	**$11/bu**	**$8/bu**	**$11/bu**
UTC	110,500	119,000	4	2
CB	103,750	112,000	11	14
ILeVO	103,250	112,000	16	25

†UTC = untreated control, CB = commercial base, ILeVO = commercial base + fluopyram
‡Base case is untreated seed (UTC) at 140,000 seeds/a.

Figure 3. Partial profit per acre of the three seed treatments across all seeding rates for grain sale prices of a.) $8/bu and b.) $11/bu.



probabilities and profit margins down to 100,000 seeds/a, while ILeVO did so down to 80,000 seeds/a. One key finding is that as grain sales prices increase, so should seeding rates to reduce economic risk and maximize profit, especially for untreated seed; whereas CB and ILeVO treated seed could still maintain higher break-even probabilities and profit margins at reduced seeding rates. Yet, seeding rate adjustments were still warranted with the CB and ILeVO seed treatments to maximize profit and reduce risk as grain sale price changed. For instance, CB at 80,000 seeds/a with a grain sale price of $8/bu had a break-even probability of 76% compared to 50% when the grain sale price increased to $11/bu. The average profit increase for all outcomes also declined from $4 to $0/a (Table 2). Like the lower grain sale price ($8/bu), simply adjusting the seeding rate for CB and ILeVO to the highest seeding rate (140,000 seeds/a) at the higher grain sale price did not maximize the average profit increase across all outcomes nor did it provide the greatest risk benefit (Table 2). This was again achieved at the economically optimal seeding rate, which was approximately 112,000 seeds/a for the $11/bu grain sale price for both CB and ILeVO (Table 3).

Conclusion & Recommendations

This study built upon the work done by Gaspar et al. (2015) to determine if a target specific seed treatment (fluopyram) could be an economically viable option for farmers. Kandel et al. (2016) found that ILeVO could increase soybean yield, but yield responses were related to SDS disease levels. Our study confirmed these findings in that the yield response was 2.8% compared to 5.3% and 6.1% when visual SDS symptomology was present in the WI-SDS and IA data sets, respectively. In addition, across all environments, profit and economic risk benefits were substantial for CB and to a further extent ILeVO, compared to the UTC, when considering all associated costs. The CB and ILeVO seed treatments were able to decrease risk and substantially increase profit across a wide range of seeding rates. At current seed and seed treatment costs, CB and ILeVO at 140,000 seeds/a reduced economic risk by at least 70% and increased average profit ($4 –19/a) across environments and grain sale prices. However, to realize the lowest risk and highest average profit increase with CB or ILeVO, farmers should consider lowering their seeding rate to the economically optimal seeding rate of 103,000 – 112,000 seeds/a according to their expected grain sale price. In addition, fields with a history of SDS and damage from early season insects and pathogens should particularly be targeted to maximize the economic return.

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This research is currently under review:

*Gaspar,A.P, D.S. Mueller, K.A. Wise, M.I. Chilvers, A.U. Tenuta, S.P. Conley. 2017. *Response of broad spectrum and target specific seed treatments and seeding rate on soybean seed yield, profitability, and economic risk across diverse environments*. Crop Sci. In review.

Acknowledgements

The authors wish to thank the soybean checkoff through North Central Soybean Research Program and Wisconsin Soybean Marketing Board, as well as Bayer CropScience AG, and the University of Wisconsin-Madison, College of Agricultural and Life Sciences for funding this research. Ontario's funding provided by the Grain Farmers of Ontario through Growing Forward 2 (GF2) funding which is a federal-provincial territorial initiative. The Agricultural Adaptation Council assists in the delivery of GF2 in Ontario.