SMaRT ON-FARM RESEARCH REPORT

2017 Part 2

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2017 Complete Seed Treatment Trial

Purpose: Soybean producers have identified seed treatments as a high priority for evaluation in SMaRT on-farm research trials. The purpose of this trial was to provide an opportunity for cooperators to evaluate the performance of the complete seed treatment (fungicides plus an insecticide) of their choosing on their farms in 2017.

Procedure: This trial compared two treatments (a complete seed treatment including multiple fungicides plus an insecticide vs. untreated seed). Eight trials were conducted in 2017. The cooperating producers worked closely with their seed dealers to ensure that all seed planted in each trial was the same variety and came from the same seed lot. All seed treatments were applied by local seed dealers. We also took final stand counts to determine the effect seed treatments had on soybean stands.

Results: Complete seed treatments increased soybean yield at two of the eight locations in 2017. The seed treatment increased soybean yields by 3.7 bushels per acre in a low-yielding field in Cass County (Cass 1) and by 2.8 bushels per acre in a higher yielding field also in Cass County (Cass 3). When all eight sites were combined and analyzed, the complete seed treatments increased soybean yields by 1.4 bushels per acre. This is about the breakeven yield required for a basic fungicide plus insecticide seed treatment costing $14.00 per acre. The seed treatments led to significantly higher final plant stands at three locations in Cass County. Final plant stands were increased by nearly 23,000 plants per acre at Cass 1, by more than 24,000 plants per acre at Cass 2 and by 21,500 plants per acre at Cass 3 (table 3). When all the sites were combined and analyzed, the complete seed treatments increased plant stands by 10,900 plants per acre.

We appreciate the help provided by local seed dealers.

Close up of soybean plants damaged by Phytophthora

Phytophthora root and stem rot damage to soybeans

Table 1. 2017 Seed treatments, varieties, phytophthora genes/tolerance rating, tillage practices and planting dates.

Location	Seed treatment	Variety	Phytophthora gene/tolerance	Tillage fall/spring	Planting date
Cass 1	Clariva PN, Equity, Mertect	Asgrow AG2336	1c/4 (1=excellent, 9=poor)	VT/VT	May 10
Cass 3	ILeVO, PPST FST/IST/2030	Pioneer P26T76 R	1k/4 (9=excellent, 1=poor)	VT/VT	May 18
Cass 2	ILeVO, Equity	Asgrow AG2336	1c/4 (1=excellent, 9=poor)	VT/VT	May 10
Tuscola	Dfender	DF 155	1k/1.3 (1=excellent, 5=poor)	NT in wheat/rye	May 12
Branch	PPST FST/IST/2030	Pioneer P32T16 R	1k/6 (9=excellent, 1=poor)	NT	April 24
Sanilac 1	Equity VIP	DynaGro S20 LL	1c/7 (9=excellent, 1=poor)	ST in wheat	May 18
Sanilac 2	Stine XP-F&I	Stine 20RD 20	1k/very good	DR/VT	May 18
Monroe	Apron Maxx	Rupp 7283 RR	1a/1.9 (1=excellent, 5=poor)	CP/FC	May 14

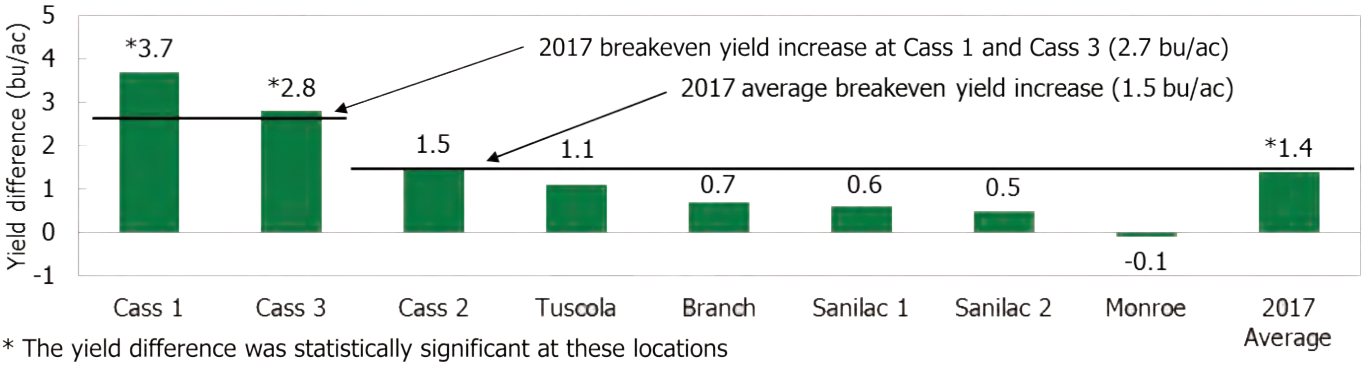
CP = chisel plow, FC = field cultivator, NT = no-till, ST = strip-till, VT = vertical tillage and DR = disc ripper

Table 2. The effect of complete seed treatments on soybean yield and income in 2017

Location	Untreated control	Treated seed	LSD $_{0.10}$	Yield difference
	------------------ Yield (bu/ac)	------------------		Yield (bu/ac)
Cass 1	26.6 b	30.3 a	2.2	3.7
Cass 3	56.7 b	59.5 a	2.4	2.8
Cass 2	32.5	34.0	2.4	1.5
Tuscola	62.5	63.6	3.1	1.1
Branch	57.7	58.4	4.9	0.7
Sanilac 1	56.4	57.0	1.5	0.6
Sanilac 2	67.0	67.5	1.6	0.5
Monroe	50.2	50.1	6.1	-0.1
Average	**51.2 b**	**52.6 a**	**0.8**	**1.4**
	------------------ Income ($/ac)	----------------		
***Average income**	**$471**	**$470**		

*Using an average cost for complete seed treatments (fungicide mix + insecticide) of $14.00 per acre

Figure 1. Yield difference produced by the use of complete seed treatments in 2017



* The yield difference was statistically significant at these locations

Table 3. The effect of complete seed treatments on final plant stands in 2017

Location	Untreated control	Treated seed	LSD $_{0.10}$	Stand difference
	----------- Plant stand (plants/ac)	-----------		Plant stand (plants/ac)
Cass 1	114,000 b	136,800 a	9,239	22,800
Cass 3	126,800 b	148,300 a	16,503	21,500
Cass 2	112,800 b	137,000 a	7,404	24,200
Tuscola	87,100	87,100	8,028	0
Branch	--	--	--	--
Sanilac 1	94,700	87,600	13,994	-7,100
Sanilac 2	87,900	91,800	8,018	3,900
Monroe	92,700	103,600	16,824	10,900
Average	**102,300 b**	**113,200 a**	**4,234**	**10,900**

2016 and 2017 Field Rolling Trial

Purpose: Field rolling is a common practice on many farms in Michigan. Its appeal is largely due to the fact that rolling reduces stone damage to combines and operator fatigue and enables lower cutting heights during harvest operations. Most producers roll soybeans after planting and prior to emergence. This is a very narrow window in some years and producers are wondering if they can safely roll soybeans during the early vegetative stages. There is also growing speculation that rolling soybeans between the V1 and V3 stages may stress the plants and actually increase yield. The purpose of the field roller trials was to determine the effect of field rolling at various growth stages on soybean yields in 2016 and 2017.

Pre-emergence rolling under ideal soil conditions

Procedure: Field rolling trials were conducted at six locations in 2016 and seven locations in 2017. The cooperating producers were encouraged to choose the rolling treatments they wanted to compare on their farms (table 1). Stand counts were taken in all treatments at most of the locations to determine how rolling affected final stand.

Too wet to roll when soil builds up on the roller

Results: Field rolling did not adversely affect soybean yields at 10 of the 11 locations that included an unrolled control treatment. However, rolling at the V2 growth stage decreased soybean yields by 1.4 bushels per acre at the Van Buren 17 site. In contrast to this, rolling at the V1 stage increased yields by 3.9 bushels per acre at the Bay 16 location and by 2.8 bushels per acre at the Lenawee 16 site (table 1). The pre-emergence treatment also increased yields by 3.6 bushels per acre over the unrolled control in the Lenawee 16 trial. Table 2 and figure 1 summarize the results from the nine sites that compared an unrolled control to rolling at the V1 stage. When all nine sites were combined and analyzed, rolling at V1 increased soybean yields by 1.1 bushels per acre and income by $2.60 per acre. Final plant stands were not affected by rolling at six of the seven sites for which this information was collected (table 2). However, rolling at the V1 growth stage decreased stands by 5,200 plants per acre at the St. Joseph 17-1 location and by 5,300 plants per acre when all seven sites were combined.

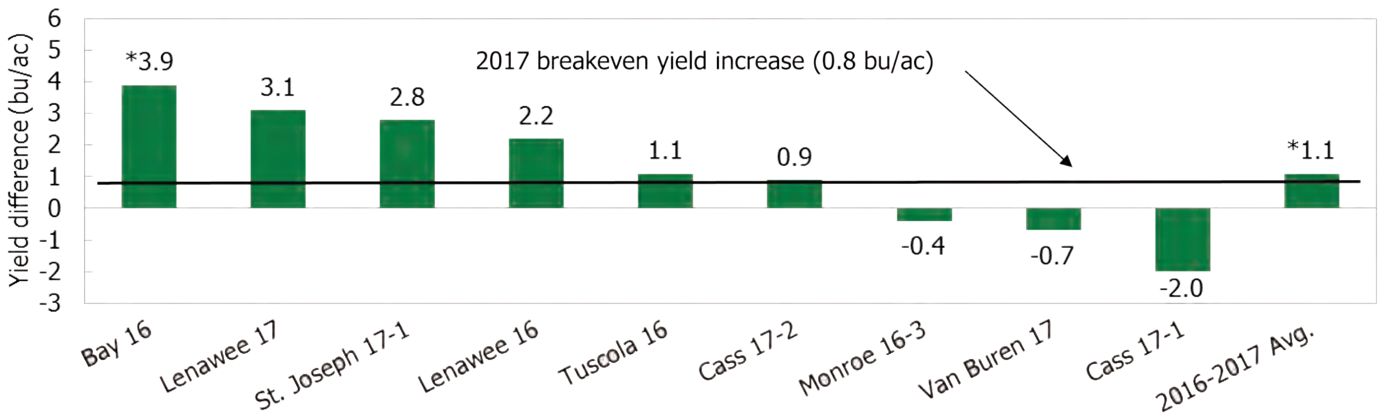
We want to thank the Center for Excellence for their participation.

Example of what field rollers do to stones

Table 1. The effect of field rolling at various growth stages on soybean yield in 2016 and 2017

Location	Unrolled control	Pre-emerge	First trifoliate	Second trifoliate	Third trifoliate	Sixth trifoliate	LSD $_{0.10}$
	------------------------- Yield (bu/ac) -------------------------						
Bay 16	68.0 b	68.0 b	71.9 a				1.9
Lenawee 16	60.0 b	63.6 a	62.8 a				2.4
Monroe 16-1	54.7			55.6			7.8
Monroe 16-2	54.3				54.8		1.2
Monroe 16-3	70.2		69.8				3.2
Tuscola 16	78.7	79.6	79.8				1.7
Bay 17		63.5				62.9	1.5
St. Joseph 17-1	73.7		76.5				6.7
St. Joseph 17-2	69.9			67.1			4.4
Van Buren 17	44.3 a		43.6 ab	42.9 b			1.3
Lenawee 17	57.5	57.9	60.6		60.7		4.2
Cass 17-1	88.6		86.6				2.9
Cass 17-2	51.1		52.0				4.5

Figure 1. Yield difference produced by field rolling at the V1 growth stage in 2016 and 2017



* The yield difference was statistically significant at this location

Table 2. The effect of field rolling at the V1 growth stage on soybean yield, income and final stand in 2016 and 2017

Location	Unrolled control	First trifoliate	LSD $_{0.10}$	Yield difference	Unrolled control	First trifoliate	LSD $_{0.10}$
	----- Yield (bu/ac) -----			Yield (bu/ac)	Final stand (plants/ac)		
Bay 16	68.0 b	71.9 a	2.4	3.9	127,200	123,900	6,874
Lenawee 17	57.5	60.6	4.6	3.1	116,700	105,900	14,767
St. Joseph 17-1	73.7	76.5	6.7	2.8	157,800 a	152,600 b	2,591
Lenawee 16	60.0	62.2	3.1	2.2	98,100	103,000	31,269
Tuscola 16	78.7	79.8	1.1	1.1	87,900	85,500	7,606
Cass 17-2	51.1	52.0	4.5	0.9	178,300	170,500	14,009
Monroe 16-3	70.2	69.8	3.2	-0.4	--	--	--
Van Buren 17	44.3	43.6	0.9	-0.7	122,800	113,500	13,701
Cass 17-1	88.6	86.6	2.9	-2.0	--	--	--
2016-2017 Average	**65.8 b**	**66.9 a**	**0.9**	**1.1**	**127,200 a**	**121,900 b**	**3,876**
	------- Income ($/ac) -------						
2016-2017 Average	**$605**	**$608**					

Field rolling cost = $7.50 per acre

2017 Foliar Fungicide and Insecticide Trial

Purpose: Soybean producers are trying to improve soybean yields and many are willing to manage the crop more intensively to achieve this goal. There is a lot of interest in applying foliar tank mixtures which include a fungicide and an insecticide. The purpose of this trial was to provide an opportunity for interested producers to evaluate the yield and income performance of the fungicide and insecticide tank mixture of their choosing on their farm in 2017.

Procedure: Cooperating producers were given the opportunity to select the foliar fungicides and insecticides they wanted to evaluate on their farms. As a result, a tank mixture of Priaxor™ (fungicide) and Fastac™ (insecticide) was applied at five of the six locations. Stratego® YLD (fungicide) and Mustang® Maxx (insecticide) was applied at the Ionia location. Priaxor was applied at 4 ounces per acre and Fastac was applied at 3.8 ounces per acre. Stratego YLD was applied at 6 ounces per acre and Mustang Maxx was applied 3 ounces per acre. The foliar applications were made at R3 and the sprayers were driven through the untreated control treatments to prevent tire tracks from being a factor.

Results: The foliar fungicide-insecticide application increased soybean yields by 4.4 bushels per acre and increased net income by nearly $12.00 per acre at one of six sites in 2017. However, the fungicide-insecticide application did not increase soybean yields and was less profitable than the untreated control at the other five locations. When all six locations were combined and analyzed, the foliar fungicide and insecticide tank mixture produced an average yield increase of 1.5 bushels per acre which is less than half the yield increase required to breakeven.

Foliar fungicide and insecticide
increased yield
(1.5 bushels) but not enough to
pay for the expense

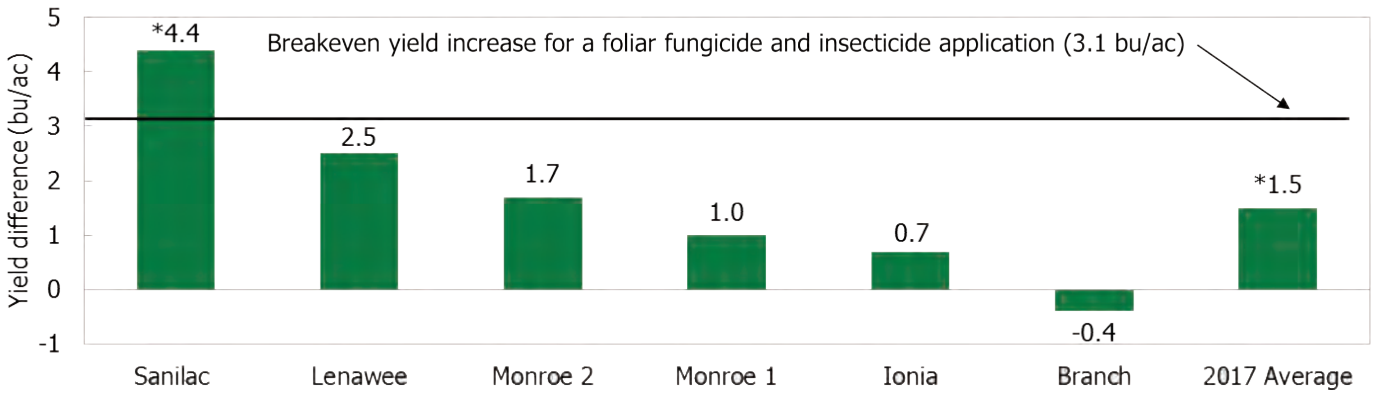
Foliar fungicide and Insecticide application in R3 soybeans

Table 1. The effect of a foliar fungicide and insecticide application on soybean yield and income in 2017

Location	Untreated control	Foliar fungicide and insecticide	LSD $_{0.10}$	Yield difference
	------------------ Yield (bu/ac)	------------------		Yield (bu/ac)
Sanilac	39.3 b	43.7 a	2.6	4.4
Lenawee	59.8	62.3	3.7	2.5
Monroe 2	46.1	47.8	5.1	1.7
Monroe 1	60.3	61.3	2.9	1.0
Ionia	46.6	47.3	0.8	0.7
Branch	54.5	54.1	7.7	-0.4
Average	**51.2 b**	**52.7 a**	**1.2**	**1.5**
	------------------ Income ($/ac)	------------------		
***Average income**	**$471**	**$457**		

*Using the cost for a foliar application of Priaxor and Fastac
Priaxor fungicide cost = $16.80 per acre
Fastac insecticide cost = $4.00 per acre
Application cost = $7.50 per acre

Figure 1. Yield difference produced by a foliar fungicide and insecticide application in 2017



* The yield difference was statistically significant at these locations

Self-propelled sprayer equipped with a 120 foot boom

2017 White Mold Foliar Fungicide Comparison Trial

Purpose: *Sclerotinia Stem Rot* or white mold can cause significant yield reductions in soybeans grown in Michigan. The purpose of this trial was to determine the effect of two commercially available foliar fungicides on soybean yields.

Procedure: This trial was conducted at four locations and consisted of three treatments: Omega®, Propulse® and an untreated control. Both fungicides were applied at the lowest recommended rates for white mold (12 ounces per acre for Omega and 6 ounces per acre for Propulse) about one week after the appearance of the first blossoms. All sprayers were equipped and operated to optimize spray droplet deposition in the canopy. Sprayer tracks were eliminated from being a confounding factor by driving the sprayer through the untreated strips or using a spray boom wide enough that none of the harvested strips contained tire tracks. White mold incidence was determined at all locations by counting 100 consecutive plants and recording the number of diseased plants.

Results: All four sites had a history of white mold and environmental conditions favoring disease development occurred at the Allegan 2, Berrien and Sanilac locations. At the Berrien and Sanilac sites, approximately 50% of the plants were infested with white mold. However, white mold incidence was extremely low at Allegan 1. This trial demonstrates how the foliar fungicides affect soybean yields and income in the absence of white mold pressure. Propulse increased soybean yields over the untreated control at both Allegan locations and at the Berrien location. Omega increased yields at the Allegan 2, Berrien and Sanilac county locations. The performance of the two products was similar at all locations except for the Allegan 1 site where Propulse increased soybean yield by 2.5 bushels per acre.

Each fungicide reduced disease incidence relative to the control at two locations. However, at the Sanilac location, Omega was more effective than Propulse in reducing disease incidence. Both fungicides were profitable at the Berrien location and when all four sites were combined and analyzed.

We want to thank Bayer Crop Science for providing the Propulse and Syngenta for providing the Omega.

Apothecia

Sclerotia

Effect of variety selection on white mold

Table 1. Planting dates, planting rates, row spacing and fungicide application dates at the trial locations

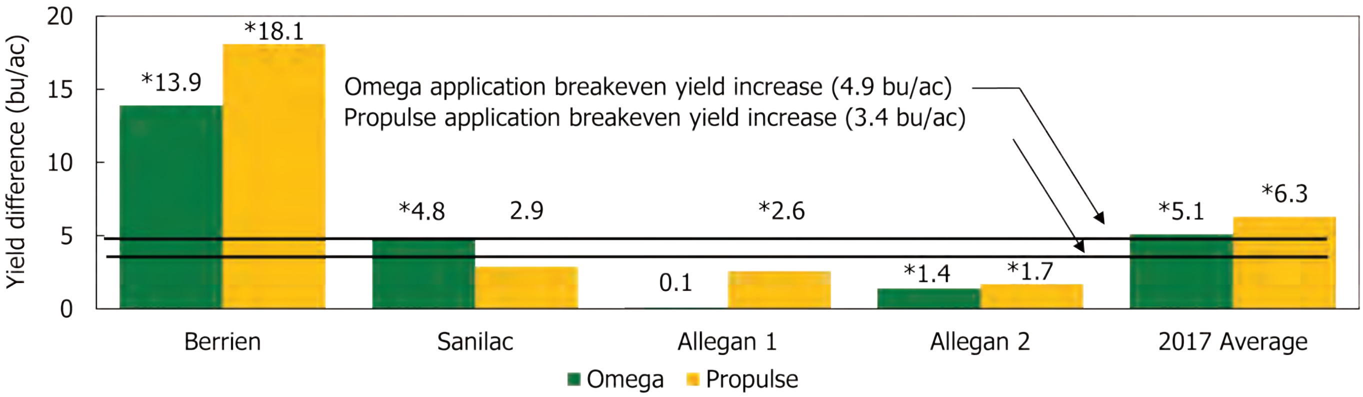
Location	Soybean variety	White mold resistance/tolerance of soybean variety	Planting date	Planting rate	Row spacing	Application date
Berrien	NuTech 7240-DA26	6 (1=excellent and 9=poor)	May 18	130,000	30″	July 15
Sanilac	DynaGro DG21XT 77	6 (9=excellent and 1=poor)	May 15	130,000	20″	July 10
Allegan 1	DF 155	0.8 (1=excellent and 5=poor)	May 15	150,000	Twin 7″	July 18
Allegan 2	Great Lakes 2939R2	8 (9=excellent and 1=poor)	May 22	155,000	20″	July 16

Table 2. White mold foliar fungicide effect on soybean yield and income in 2017

Location	Untreated control	Omega	Propulse	LSD $_{0.10}$
	------------------- Yield (bu/ac) ------------------			
Berrien	51.6 b	65.5 a	69.7 a	4.7
Sanilac	53.7 b	58.5 a	56.6 ab	2.9
Allegan 1	63.2 b	63.3 b	65.8 a	1.7
Allegan 2	62.6 b	64.0 a	64.3 a	1.3
Average	**57.8 b**	**62.8 a**	**64.1 a**	**2.3**
	------------------ Income ($/ac) ----------------			
Average income	**$532**	**$533**	**$559**	

Omega cost = $37.50 per acre, Propulse cost = $23.45 per acre, application cost = $7.50 per acre

Figure 1. Yield difference produced by two white mold foliar fungicides in 2017



*The yield difference between the fungicides and the control was statistically significant at these locations
The yield difference between the two fungicides was statistically different at only the Allegan 1 location

Table 3. Foliar fungicide effect on white mold incidence in 2017

Location	Untreated Control	Omega	Propulse	LSD $_{0.10}$
	-------------- White mold disease incidence (% infected) --------------			
Berrien	47.0 a	26.6 b	12.6 b	17.8
Sanilac	56.5 a	31.9 b	49.4 a	8.3
Allegan 1	1.4	1.0	1.0	1.3
Allegan 2	11.5 a	7.5 ab	3.8 b	4.5
Average	29.8 a	16.2 b	16.6 b	7.3

2016 and 2017 Prescription Foliar Fertilizer Trial

Purpose: Soybean producers identified prescription foliar fertilization based on soil or plant tissue sampling as a high priority for the 2016 and 2017 SMaRT trials and the AgroLiquid Company collaborated on this project. The purpose of this trial was to determine the effect of field-specific prescription foliar fertilization on soybean yield and income in 2016 and 2017.

Procedure: Field-specific prescription foliar fertilizer mixtures were compared to an unfertilized control at nine locations in 2016 and 11 locations in 2017. The foliar fertilizer mixtures (tables 3 and 4) were developed by AgroLiquid and based on the soil nutrient levels at each of the trial locations (tables 1 and 2). The application timing was also determined by AgroLiquid and was based on row spacing and weather conditions. The application dates for the 2017 trials are listed in table 6. This information was not collected in 2016. In 2017, the fertilizer was applied when the air temperatures were between 60° and 80° F and the relative humidity was above 50% at all locations except Cass 3 and Sanilac. At these sites, the relative humidity was between 40 and 50%. Foliar fertilizers were applied at V4 (fourth trifoliate leaf) where the row spacing was 15 inches or less and at R1 (one open flower on 50% of the plants) where row spacing was more than 15 inches. Sprayer tracks were eliminated from being a confounding factor by driving the sprayer through both treatments or using a spray boom wide enough that none of the harvested strips contained tire tracks.

Results: The prescription foliar fertilizer treatment increased soybean yields at two of the nine locations in 2016 and one of the 11 locations in 2017. However, only the yield increase found at the Ingham site in 2017 was large enough to cover the cost of the foliar fertilizer mixture at these sites (figure 2). The low probability of a profitable response to foliar fertilization in these trials is most likely due to the medium to high soil test levels for most of the nutrients at the trial locations. However, potassium was low at one site, sulfur levels were low at three sites and manganese levels were low or very low at 15 sites. These results are consistent with previous university research trials conducted over the past 40 years showing that foliar fertilization of soybeans is rarely profitable. The exception is when foliar applications of manganese are applied to plants displaying visible manganese deficiency symptoms.

Close-up of manganese deficiency symptoms

Manganese deficient areas in a soybean field

We want to thank AgroLiquid for providing and delivering the products for these trials.

2016 Table 1. Soil test levels at the 2016 prescription foliar fertilizer trial locations

Location	O.M.	P	K	Mg	Ca	pH	CEC	S	Zn	Mn
	%	--------------- ppm ---------------				1:1	meq/100g	--------- ppm --------		
Cass	1.4	93	172	93	1057	6.7	6.5	**8**	2.1	**4**
Ionia	2.1	50	152	241	1243	6.6	9.3	**8**	1.9	**7**
Gratiot	2.8	27	165	248	1593	7.0	10.6	17	2.4	**4**
St. Joseph	1.0	64	99	79	665	6.0	5.1	23	1.8	**7**
Van Buren	1.5	29	162	81	719	5.9	5.7	13	1.4	16
Lenawee 2	2.1	99	177	179	975	6.1	8.0	**10**	1.7	**3**
Monroe	2.4	49	177	193	1131	6.0	9.2	13	2.5	**4**
Lenawee 1	2.7	16	141	254	1712	6.2	12.6	15	1.4	**5**
Sanilac	3.7	31	244	227	2460	7.9	14.9	20	1.8	**2**

Bold figures indicate low or very low soil test levels.

2017 Table 2. Soil test levels at the 2017 prescription foliar fertilizer trial locations

Location	O.M.	P	K	Mg	Ca	pH	CEC	S	Zn	Mn
	%	--------------- ppm ---------------				1:1	meq/100g	--------- ppm --------		
Ionia	2.0	17	**80**	124	1473	6.8	8.7	16	**0.8**	**6**
Sanilac	3.6	18	216	239	2206	7.8	13.7	22	2.1	**4**
Bay	2.2	48	178	216	1969	7.2	12.2	18	6.5	**4**
Presque Isle	1.0	134	116	68	833	6.2	5.8	16	2.6	**4**
Cass 3	2.5	115	243	206	1409	6.3	10.6	23	6.1	15
Cass 1	3.6	52	150	207	1488	6.2	10.9	18	1.6	**3**
Ingham	1.7	25	122	142	985	6.3	7.3	16	1.8	10
Lenawee	3.3	101	375	203	1740	6.4	12.5	19	2.3	10
Monroe	2.5	40	131	223	1351	6.6	9.6	15	1.6	**5**
Van Buren	1.6	102	181	80	816	5.4	7.4	79	2.4	9
Cass 2	1.3	62	109	113	741	6.0	5.9	14	1.1	**4**

Bold figures indicate low or very low soil test levels.

2016 Table 3. Prescription foliar fertilizer products, application rates and costs for each location in 2016

Location	Foliar fertilizer products and application rates	Fertilizer cost
		----- $/ac -----
Cass	1.5 gal/ac of FertiRain, and 1 qt/acre of Manganese	$19.10
Ionia	1.5 gal/ac of FertiRain, 2 qt/acre of Manganese, and 2 qt/ac of LiberateCa	$28.70
Gratiot	1.5 gal/ac of FertiRain, and 1 qt/acre of Manganese	$19.10
St. Joseph	1.5 gal/ac of FertiRain, and 1 qt/acre of Manganese	$19.10
Van Buren	1.5 gal/ac of FertiRain, 1 qt/acre of Manganese, and 1 qt/ac of LiberateCa	$19.50
Lenawee 2	1.5 gal/ac of FertiRain, 2 qt/acre of Manganese, and 2 qt/ac of LiberateCa	$28.70
Monroe	1.5 gal/ac of FertiRain, 2 qt/acre of Manganese, and 1 qt/ac of LiberateCa	$20.80
Lenawee 1	1 gal/ac of FertiRain, 1 gal/ac of Sure-K, and 2 qt/acre of Manganese	$21.40
Sanilac	1.5 gal/ac of FertiRain and 1 qt/acre of Manganese	$19.10

Analyses of the foliar fertilizer products are listed below:
FertiRain: 12-3-3 plus 1.5% S, 0.10% Fe, 0.05% Mn, and 0.10% Zn
LiberateCa: 3% calcium from calcium sulfate
Manganese: 4% manganese from manganese sulfate
Sure-K: 2-1-6

Prescription Foliar Fertilizer Trial continued

2017 Table 4. Prescription foliar fertilizer products, application rates and costs for each location in 2017

Location	Foliar fertilizer products and application rates	Fertilizer cost
		----- $/ac -----
Ingham	1.5 gal/ac of FertiRain, 0.5 gal/ac of Sure-K and 2 qt/acre of Manganese	$20.80
Cass 2	1.25 gal/ac of FertiRain, 0.5 gal/ac of Sure-K, 1 qt/ac Manganese and 1qt/ac of Micro 500	$18.40
Presque Isle	1.5 gal/ac of FertiRain, and 2 qt/acre of Manganese	$18.30
Lenawee	1.25 gal/ac of FertiRain, 0.5 gal/ac of Sure-K, 1 qt/ac Manganese and 1qt/ac of Micro 500	$19.10
Sanilac	1.5 gal/ac of FertiRain, 0.5 gal/ac of Sure-K and 2 qt/acre of Manganese	$20.80
Cass 1	1.25 gal/ac of FertiRain, 0.5 gal/ac of Sure-K, 1 qt/ac Manganese and 1qt/ac of Micro 500	$19.10
Cass 3	1.25 gal/ac of FertiRain and 0.5 gal/ac of Sure-K	$11.40
Ionia	0.5 gal/ac of FertiRain, 1.5 gal/ac of Sure-K, and 2 qt/acre of Manganese	$18.90
Bay	1.5 gal/ac of FertiRain, 0.5 gal/ac of Sure-K and 2 qt/acre of Manganese	$20.80
Van Buren	1.25 gal/ac of FertiRain, 0.5 gal/ac of Sure-K, 1 qt/ac Manganese and 1qt/ac of Micro 500	$19.10
Monroe	1.5 gal/ac of FertiRain, 0.5 gal/ac of Sure-K and 2 qt/acre of Manganese	$20.80

Analyses of the foliar fertilizer products are listed below:
FertiRain: 12-3-3 plus 1.5% S, 0.10% Fe, 0.05% Mn, and 0.10% Zn
Manganese: 4% manganese from manganese sulfate
Micro 500: 0.02% B, 0.25%, Cu, 0.37% Fe, 1.20% Mn, 1.80% Zn
Sure-K: 2-1-6

2016 Table 5. The effect of a single application of a prescription foliar fertilizer on soybean yield in 2016

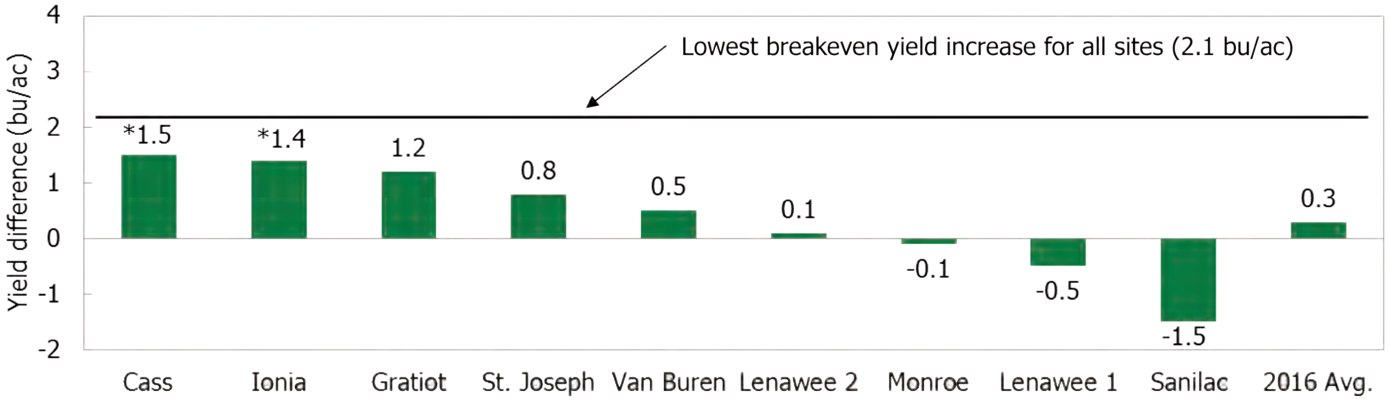
Location	Unfertilized control	Foliar fertilizer	$LSD_{0.10}$	Yield difference
	Yield (bu/ac)			Yield (bu/ac)
Cass	27.2 b	28.7 a	1.3	1.5
Ionia	65.4 b	66.8 a	1.0	1.4
Gratiot	71.9	73.1	1.5	1.2
St. Joseph	57.2	58.0	2.2	0.8
Van Buren	61.7	62.2	4.1	0.5
Lenawee 2	45.3	45.4	6.9	0.1
Monroe	67.0	66.9	1.0	-0.1
Lenawee 1	75.2	74.7	1.4	-0.5
Sanilac	54.1	52.6	5.2	-1.5
Average	**58.4**	**58.7**	**0.9**	**0.3**

2017 Table 6. The effect of a single application of a prescription foliar fertilizer on soybean yield in 2017

Location	Application date	Unfertilized control	Foliar fertilizer	$LSD_{0.10}$	Yield difference
		Yield (bu/ac)			Yield (bu/ac)
Ingham	June 29	54.9 b	57.9 a	1.3	3.0
Cass 2	July 17	35.5	38.4	3.7	2.9
Presque Isle	July 10	31.0	32.2	1.4	1.2
Lenawee	July 26**	55.7	56.9	7.1	1.2
Sanilac	July 5	46.9	47.4	0.7	0.5
Cass 1	July 22	61.8	62.0	0.6	0.2
Cass 3	July 9	67.2	66.9	1.9	-0.3
Ionia	July 9	48.5	47.9	4.7	-0.6
Bay	July 7	61.0	59.8	1.7	-1.2
Van Buren	July 24**	43.9	42.7	2.0	-1.2
Monroe	July 15	58.9	57.5	1.8	-1.4
Average	**--**	**51.3**	**51.8**	**0.7**	**0.5**

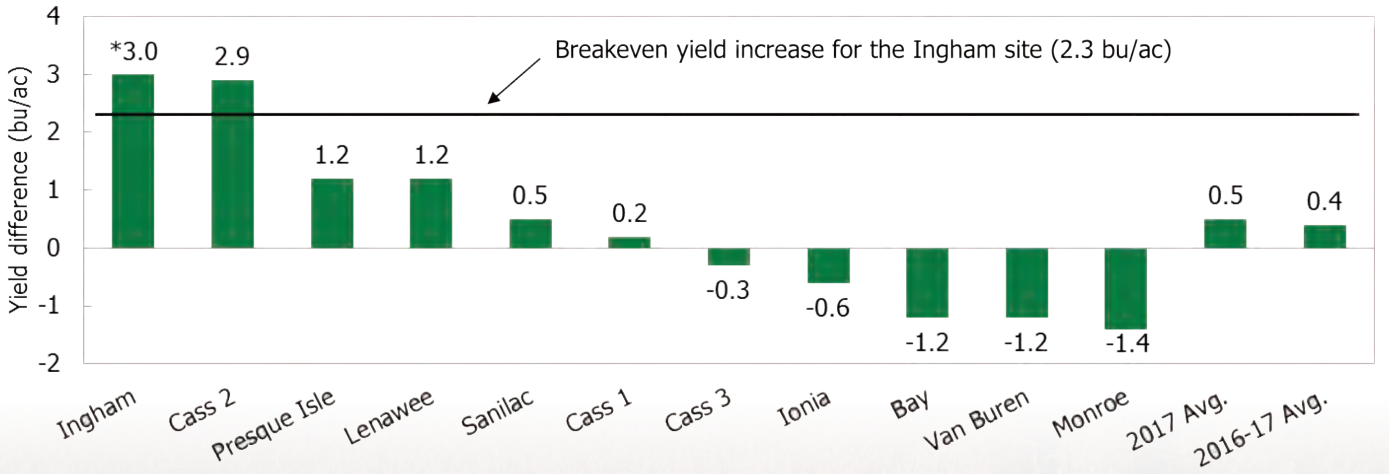
** The fertilizer was applied later than the recommended growth stage (R1) at these sites.

Figure 1. Yield difference produced by a single application of a prescription foliar fertilizer in 2016



* The yield difference was statistically significant at these locations

Figure 2. Yield difference produced by a single application of a prescription foliar fertilizer in 2017



* The yield difference was statistically significant at this location

Summary of the Michigan Soybean Benchmarking and Yield Gap Surveys (2014 and 2015)

Summarized by Mike Staton, MSU Extension soybean educator

Michigan is participating in a multi-state, checkoff-funded project to identify soybean yield gaps and the management practices responsible for them. To accomplish this, we asked soybean producers to provide field-specific information regarding management practices, crop inputs and yields from four fields in 2014, 2015 and 2016. Information was collected from 149 fields in 2014, 168 fields in 2015 and 340 fields in 2016. Only the 2014 and 2015 surveys for rain-fed fields in Michigan have been summarized and included in this article.

Producers were also asked to provide the location for each field. The field location information was used solely to identify regions having similar soil and climatic conditions and group the surveyed fields within the identified regions. The four factors used to identify the regions have a significant effect on soybean yield potential and are listed below:

- Annual growing-degree day accumulation
- Annual precipitation
- Annual temperature fluctuations
- Plant available water-holding capacity in the rooting zone

The surveyed fields from Michigan were grouped into two regions (1R, green and 4R, yellow) based on these factors as shown in figure 1. The R and I following the number indicate rain-fed and irrigated regions.

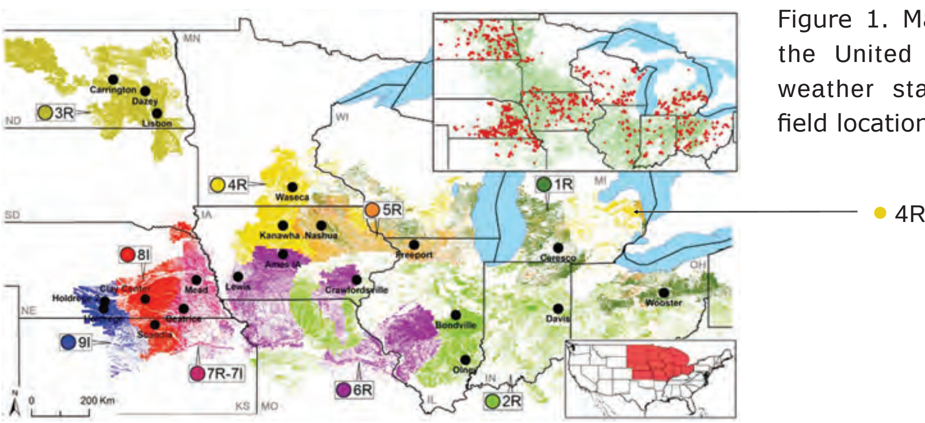


Figure 1. Map of the North Central region of the United States showing the 10 regions, weather station locations and the surveyed field locations (top insert).

Soybean yield gap is defined as the difference between the yield potential for a given region and the yield reported by producers from that region. The yield potential for each region was estimated using actual daily weather data collected from 2-3 weather stations located near the highest concentration of surveyed fields. The average yield gap for both years in each region is presented at the top of the bars in figure 2. The top of the colored portion of each bar in the figure represents the actual reported yields and the top of each bar is the yield potential. The bad news is that the yield gaps for the two regions in Michigan rank the highest of all 10 regions. The good news is we have more opportunity to produce higher yields through management.

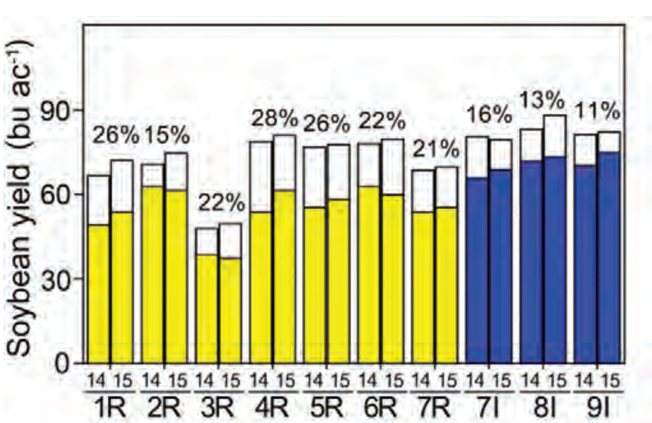


Figure 2. Comparison between the actual reported yields and crop model estimates for yield potential in 10 regions within the North Central United States. Yellow = rain-fed and blue = irrigated.

In order to identify the management practices responsible for the yield gap within a region, the fields were ranked by yield and then divided into a high-yield group (HY) and a low-yield group (LY). The HY group represented the top 1/3 of the fields and the LY group represented the bottom 1/3 of the fields in a given region. The management practices implemented by the two groups were compared and statistically analyzed. Five practices (planting date, tillage, foliar fungicide and/or insecticide, drainage system and soybean maturity group) were identified as having a 90% probability of explaining the yield gap in half or more of the 10 regions. In region 4R, the high-yield group had 25% more tilled fields, planted 8 days earlier, planted 20% more fields in wide rows, planted varieties that were 0.1 of a maturity group later and applied a foliar fungicide and/or insecticide in 31% more fields than the low-yield group (table 1). In region 1R, the high-yield group planted 10 days earlier and planted varieties that were 0.2 of a maturity group earlier than the low-yield group.

Table 1. Comparison of producer yield, selected management practices and applied inputs between the top 1/3 (HY) and the bottom 1/3 (LY) fields in two regions in Michigan. The values listed in the last two columns reflect the difference between the HY and LY groups for each of the management practices.

Management practice	Units	Region	
		1R (HY – LY)	4R (HY – LY)
Tillage	% tilled fields	-3	25***
Planting date	days	-10***	-8***
Row spacing	% planted in wide rows	11	20*
Maturity group	Unit less	-0.2*	0.1*
Foliar fungicide and/or insecticide	% treated fields	10	31***

Asterisks indicate statistical significance at $p < 0.1$(*), $p < 0.05$ (**) and $p < 0.01$ (***).

Planting date was the main management practice identified for explaining the yield gap in both regions in Michigan. For region 1R, yields decreased by 0.5 of a bushel per acre for each day that planting was delayed after May 1st. In region 4R, yield losses of 0.4 of a bushel per acre per day were found. These values are consistent with the results obtained from replicated planting date trials conducted in Wisconsin and Michigan.

This summary of the 2014 and 2015 soybean benchmarking and yield gap producer surveys indicates that the soybean yield gap for Michigan producers is between 26% and 28%. This is among the highest for the 10 identified regions in the North Central U.S. The summary also identifies key management practices responsible for the yield gap which can be implemented to increase soybean yields in the future. We will ask producers to complete and submit surveys again for 2017.

The information presented in this article was extracted from two, more comprehensive and detailed publications which are listed below. Both publications are available online at http://fieldcrop.msu.edu/soybeans/.

References:

Rattalino Edreira, J.I., Mourtzinis, S., Conley, S.P., Roth, A.C., Ciampitti, I.A., Licht, M.A., Kandel, H., Kyveryga, P.M., Lindsey, L.E., Mueller, D.S., Naeve, S.L., Nafziger, E., Specht, J.E., Stanley, J., Staton, M.J., Grassini, P. (2017) Assessing causes of yield gaps in agricultural areas with diversity in climate and soils. Agricultural and Forest Meteorology 247:170-180.

Rattalino Edreira, J.I., Mourtzinis, S., Conley, S.P., Roth, A.C., Ciampitti, I.A., Licht, M.A., Kandel, H., Kyveryga, P.M., Lindsey, L.E., Mueller, D.S., Naeve, S.L., Nafziger, E., Specht, J.E., Stanley, J., Staton, M.J., Grassini, P. (2017) Key management practices that explain soybean yield gaps across the North Central US.

Introduction to Experimental Design, Statistical Analysis and Interpretation

Producers will often evaluate new products or practices by comparing them side-by-side in two strips or by splitting a field in half. This practice can introduce a tremendous amount of experimental error and may not produce reliable information regarding the performance of the product or practice. The information generated is heavily influenced by factors other than the practice or product being evaluated. Good experimental design followed by careful statistical analysis can eliminate much of the experimental error and help determine the actual performance of the new practice, equipment, or product.

Developing and implementing a sound experimental design is the first step to generating meaningful and reliable results from on-farm research trials. One of the most common and effective designs is called the randomized complete block design (RCBD). The RCBD is also one of the easiest for cooperators to implement. The RCBD reduces the experimental error by grouping or blocking all of the treatments to be compared within replications. This design improves the likelihood that all the treatments are compared under similar conditions. Blocking the treatments together and replicating the blocks across the field is a simple and effective way to account for variability in the field. Increasing the number of replications generally increases the sensitivity of the statistical analysis by reducing the experimental error. The SMaRT program encourages cooperators to use at least four replications.

Another important aspect of a good experimental design is the concept of randomization. Randomly assigning the order of the treatments within each block is critical to removing bias from treatment averages or means and reducing experimental error. Figure 1 shows the actual RCBD design that was used in the 2017 planting rate trials and demonstrates the principles outlined above.

Figure 1. The randomized complete block design used in the 2017 SMaRT planting rate trials.

80K	100K	130K	160K	100K	160K	80K	130K	100K	80K	160K	130K	160K	100K	130K	80K
Replication 1				Replication 2				Replication 3				Replication 4			

Note how each planting rate is included and randomized within the replications. All of the 2017 trials comparing three or more treatments utilized the RCBD with four replications of each treatment unless stated otherwise in the procedure section. The treatments in all of the trials comparing two treatments were alternated (not randomized within each block) and replicated at least four times.

After the trials were harvested, the GLIMMIX procedure within SAS was used to determine if the differences in measureable variables such as yield are due to the treatments or a result of other outside factors. It is important to look at the Least Significant Difference (LSD 0.10) when you interpret the information contained in the tables and graphs in this publication.

The LSD 0.10 is a calculated figure that producers can use to determine with a confidence level of 90% that the difference between two or more treatments is due to the treatments and not other factors. We are again using an LSD 0.10 for 2017. If the yield of two treatments differs by less than the LSD listed, the difference cannot be statistically attributed to a difference in the treatments.

Letters are used in the tables and an asterisk (*) is used in the graphs in this publication to identify yields or other measurements that are statistically different. When no letters are listed or the same letter appears next to the yield or other measurable condition, the difference between the treatments is not statistically significant.

The SMaRT program designs and analyzes field research trials enabling Michigan soybean producers to reliably evaluate the performance and profitability of new products, equipment and practices on their farms. In many cases, a given trial like the planting rate trial will be conducted at multiple locations and over multiple years. This greatly improves the reliability of the information produced.

SMaRT

Soybean Management and Research Technology

The SMaRT program (Soybean Management and Research Technology) provides Michigan soybean producers with a statistically sound method for evaluating the yield and income benefits of new products, management practices and equipment. Producers across Michigan help identify new products, management practices or equipment of interest to them and conduct field scale research trials using a common protocol. The data is collected, subjected to statistical scrutiny, summarized across locations and years and shared with soybean producers. The cooperating producers are never identified to maintain confidentiality.

Please provide the following information if you are interested in conducting a SMaRT on-farm research project in 2018

Name:____

Address:____

____

Phone:___________________________ Cell phone:_______________________

Email:____

Please use the space below to list the soybean topic(s) that you would like to see evaluated in on-farm trials and return this form by U.S. mail, email or fax before February 1, 2018. Please complete this section even if you do not plan to conduct a trial on your farm in 2018. We will use your input when we identify the 2018 on-farm research projects.

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Picture taken at a white mold trial.
See pages 22-23 for data.

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