MICHIGAN Soybean
ON-FARM RESEARCH REPORT

2021

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MICHIGAN SOYBEAN COMMITTEE

ON-FARM RESEARCH

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CONTENTS

THANK YOU to the farmer cooperators for contributing their land, equipment and time during the busy planting and harvest seasons to help improve Michigan soybean production.

For more information on participating in the 2022 Michigan Soybean On-Farm Research program, contact Mike Staton at (269) 673-0370 extension 2562 or staton@msu.edu.

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Cover Photo: Michigan Farm Photos

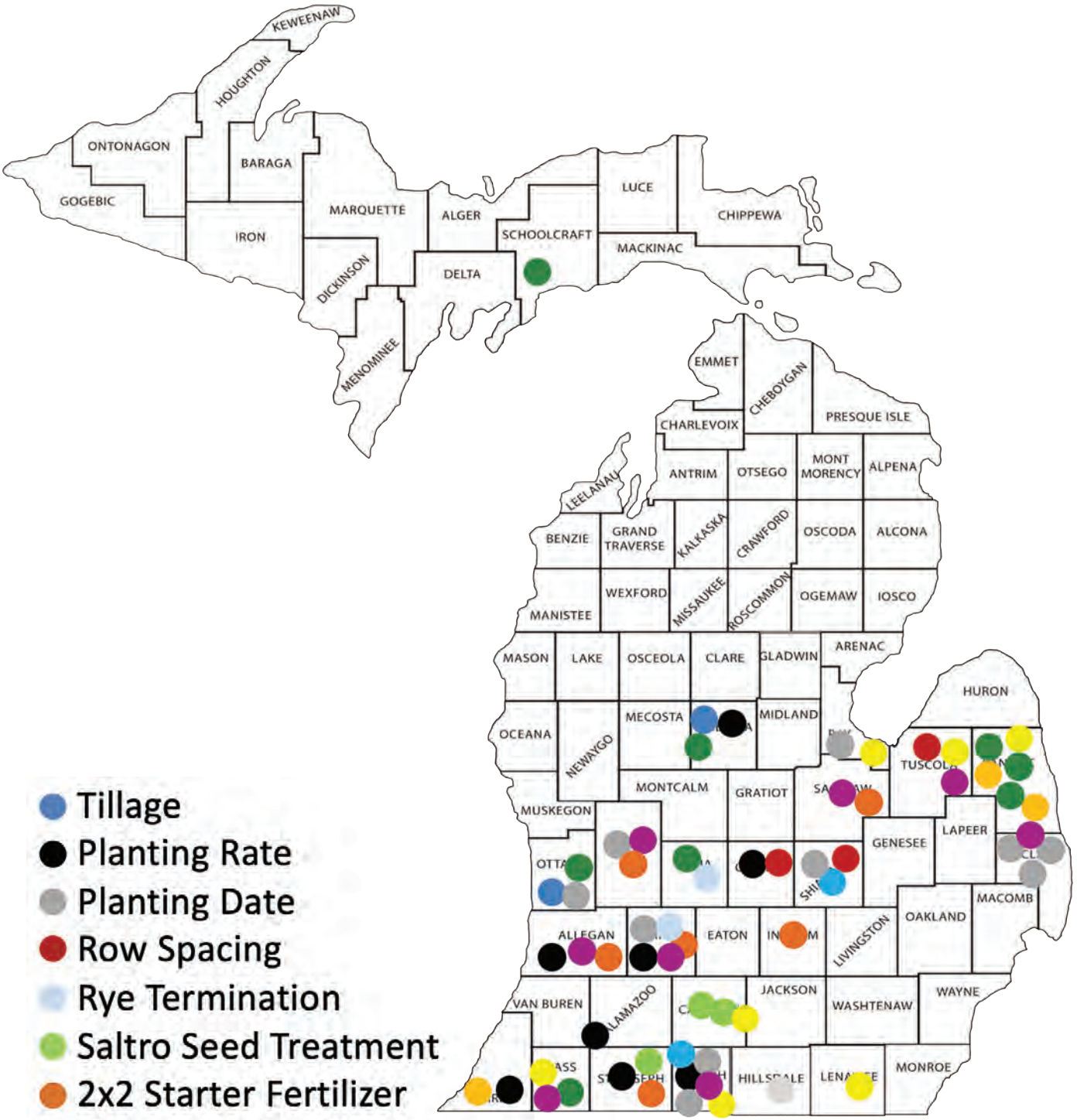
2021 marks the 11th season of the Michigan Soybean On-Farm Research program, made possible by the checkoff investment of Michigan soybean producers. This year, 45 producers around the state conducted on-farm research trials within 12 projects. Contained in this publication you'll find the results from 63 individual trial locations. The research projects were developed with producer input and represent some of the most challenging production issues confronting producers. Most of the projects were conducted at multiple locations and, in some cases, across several years, improving the reliability of the results presented in this research report.

Agronomic and economic data is presented for each treatment. Break-even yields utilized the projected USDA 2021-2022 average soybean price of $12.10 per bushel, the manufacturers' suggested retail prices for all product(s) and application costs associated with the treatments.

Conducting these trials would not be possible without the strong partnership between the Michigan Soybean Committee and Michigan State University Extension. One example is the unique collaboration between Michigan State University Extension (MSUE) and the Michigan Soybean Committee (MSC) to jointly fund Mike Staton, the MSUE state-wide soybean educator and on-farm research program coordinator. MSC has also provided funding for seven MSU Extension educators (Eric Anderson, Bruce Mackellar, Phil Kaatz, Monica Jean, Paul Gross, James Islieb and James Dedecker) who were instrumental in lining up and working with on-farm cooperators around the state. We also want to thank Kaleb Ortner, a new MSU Extension educator in Tuscola County for compiling critical background information for the trials. Also, thank you to Martin Nagelkirk for his work with cooperators in the thumb.

Dr. Arnold Saxton, Professor Emeritus, University of Tennessee, provided the SAS statistical procedure used for analyzing the 2021 trial results and provided valuable input regarding experimental design and statistical analysis.

2021 ON-FARM TRIAL LOCATIONS

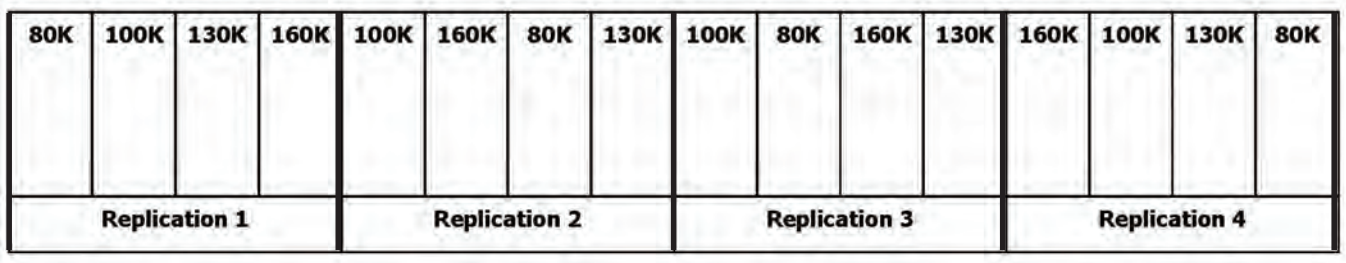


Introduction to Experimental Design, Statistical Analysis and Interpretation

The on-farm research 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. Developing and implementing trials requires sound experimental design which 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 the treatments to be compared within replications. Increasing the number of replications generally increases the sensitivity of the statistical analysis by reducing the experimental error. The on-farm research program encourages cooperators to use at least four replications but six replications is preferred for trials comparing only two treatments.

Another important aspect of a good experimental design is the concept of randomization. Randomly assigning the order of the treatments within each block removes bias from treatment averages or means and reduces experimental error. Figure 1 shows the actual RCBD design that was used in the 2021 planting rate trials and demonstrates the principles outlined above. Note how each planting rate is included and randomized within the replications. All of the 2021 trials comparing three or more treatments utilized the RCBD with four replications of each treatment, unless stated otherwise. The treatments in all the trials comparing two treatments were alternated (not randomized within each block) and replicated at least four times.

Figure 1: The randomized complete block design used in the 2021 planting rate trials.

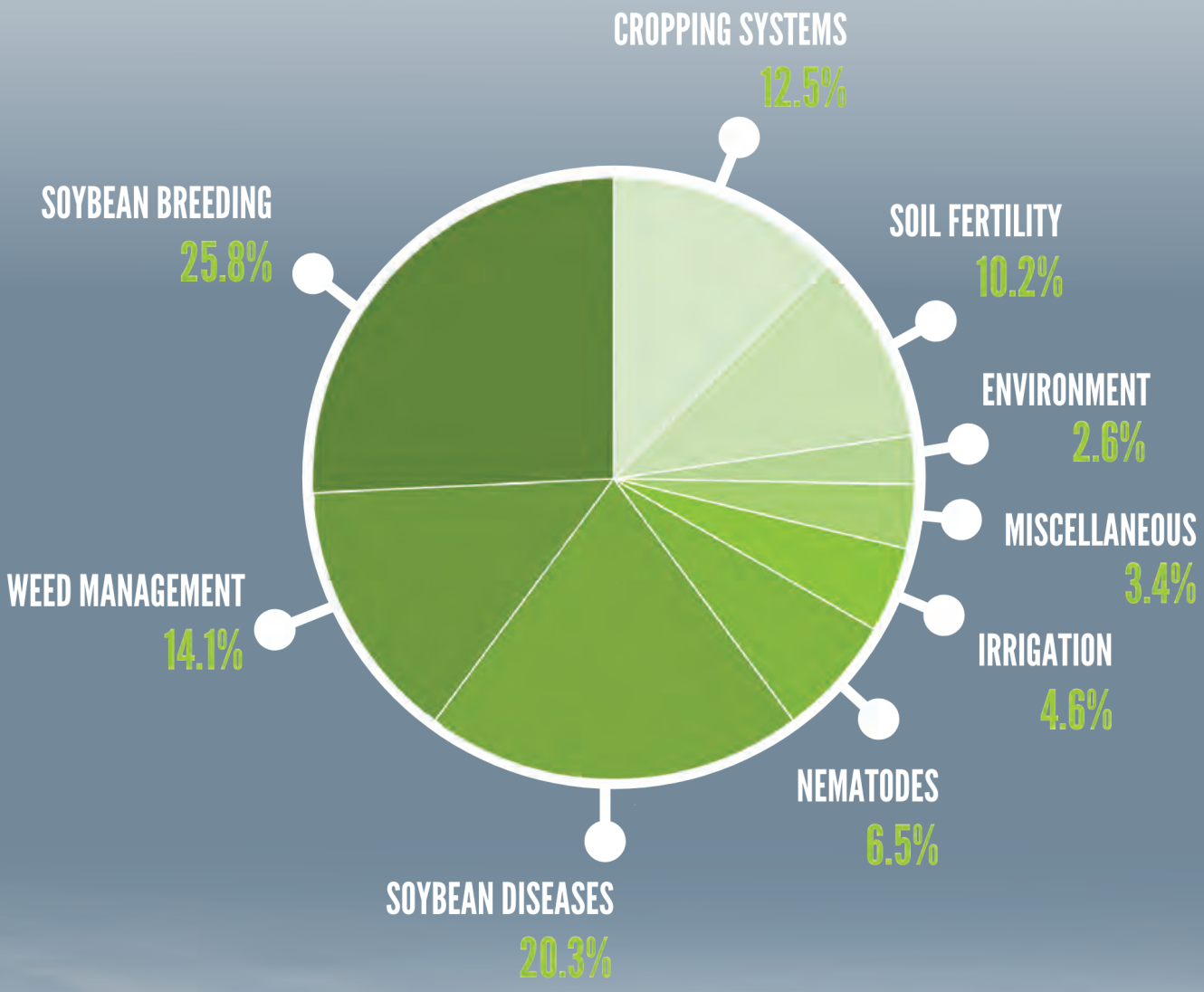


After the trials were harvested, the GLIMMIX procedure within SAS was used to determine if the differences in measurable variables such as yield were due to the treatments or other outside factors. We set our confidence level at 90 percent for all statistical analysis as designated by LSD 0.10 (Least Significant Difference). Whenever the difference between two or more yields or other measurable variables is greater than the LSD 0.10, we can say that the difference is due to the treatment. This is always true in trials comparing only two treatments. However, the LSD 0.10 can falsely indicate statistical significance whenever more than two treatments are compared. The risk of this occurring increases with the number of treatments compared. There are two examples of this situation in this publication (the Branch and Clinton sites on Page 7). If the yield of two treatments differs by less than the LSD 0.10 listed, we cannot say with a reliable degree of confidence that it is due to the treatment.

Letters are used in the tables and an asterisk (*) is used in the figures 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. Only the statistically significant yield increases are mentioned in the text in this report. All other yield differences (no matter how large) are not due to the applied treatment and should be ignored.

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.

MICHIGAN SOYBEAN COMMITTEE FY21 FUNDED RESEARCH CATEGORIES



The Michigan Soybean Committee funds nearly $600,000 in soybean production research each year using soybean checkoff dollars. Funding is divided among the categories listed above to provide well-rounded research that is relevant to Michigan soybean farmers.

Tillage Trial

Purpose: The purpose of this trial was to evaluate how a single pass of any tillage implement selected by the trial cooperators affected soybean yield and income in 2019, 2020 and 2021.

Procedure: A single tillage pass was compared to an untilled control at two locations in 2019, three locations in 2020 and two locations in 2021. A fourth trial conducted in 2020 compared a spring chisel plowing followed by a soil finisher to an untilled control. All tillage operations were performed in the spring and the tillage tools used at each site are listed in Table 1. We took stand counts to determine how the tillage operations affected final plant stands.

Results: Tillage increased soybean yield at only two of the eight locations (Table 2). Both sites were operated by the same producer. In 2020, he gained 3.5 bushels per acre and increased income by $17.00 per acre. In 2021, he increased yield by 2.8 bushels per acre and income by $34.00 per acre. However, the tillage operations were not profitable at the other six locations. When all eight sites were combined and analyzed, tillage increased yield by 1.5 bushels per acre and increased income by $4.00 per acre. However, based on this trial, the probability of an economic response to tillage is only 25 percent.

Tillage produced mixed results on final plant stands. At the Barry 20 site, the two tillage operations increased stands by 16,700 plants per acre. At the Isabella 20, a single pass of a disk reduced the final stand by 3,500 plants per acre.

Despite the lack of consistent economic returns to tillage, many producers feel that tilling the soil prior to planting soybeans offers other benefits including improved marestail control, improved planter/drill performance, and the ability to dry out the soil surface and allow earlier planting under wet soil conditions. There are conflicting reports about how spring tillage affects spring planting progress. Some producers feel that operating a high-speed disk like the Pro-Till at very shallow depths has allowed them to plant sooner. Others feel that a stale seedbed or untilled soil facilitated earlier planting.

Table 1. Background information for the tillage trials conducted in 2019, 2020 and 2021

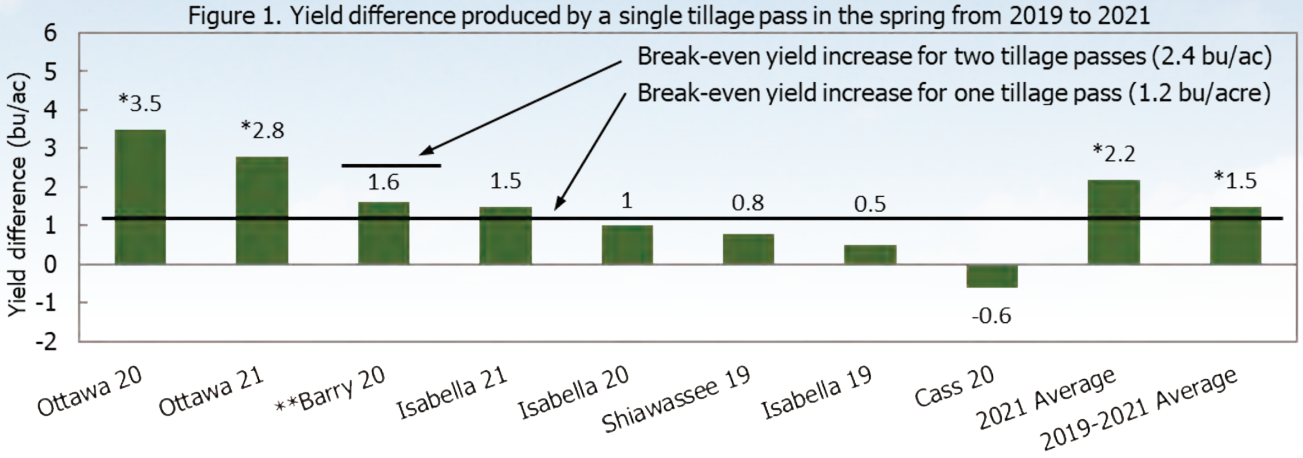
Location	Tillage tool	Planter/drill	Previous crop	Planting date	Seed treatment	Row width
Ottawa 20	Vertical tillage	JD 7000	Corn	May 25	Escalate	30″
Ottawa 21	Vertical tillage	JD 7000	Corn	April 26	Escalate SDS+	30″
Barry 20	Chisel, finisher	JD 1780	Corn	May 7	None	30″
Isabella 21	JD 230 disk	JD 750	Corn	May 18	Eclipse, Nhibit	15″
Isabella 20	JD 230 disk	JD 750	Corn	June 8	Nforce ST	15″
Shiawassee 19	Degelman Pro-Till	JD 1990	Corn	June 18	LumiGEN Tech	15″
Isabella 19	JD 230 disk	JD 750	Corn	June 8	Eclipse, Quad IM	15″
Cass 20	Soil finisher	JD 1790	Corn	May 21	None	15″

Table 2. The effect of a single spring tillage pass on soybean yield and income in 2019, 2020 and 2021

Location	Untilled control	Single tillage pass	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Ottawa 20	58.3 b	61.8 a	1.3	3.5
Ottawa 21	51.1 b	53.9 a	1.8	2.8
Barry 20	32.6	34.2	2.5	1.6
Isabella 21	49.1	50.6	6.7	1.5
Isabella 20	48.9	49.9	1.6	1.0
Shiawassee 19	55.8	56.6	1.6	0.8
Isabella 19	55.3	55.8	0.8	0.5
Cass 20	35.3	34.7	2.3	-0.6
2019-2021 Average	**48.2 b**	**49.7 a**	**0.7**	**1.5**
	---------- Income ($/ac) ----------			
Average income	**$583**	**$587**		

Cost of one tillage pass = $14.00 per acre

Figure 1. Yield difference produced by a single tillage pass in the spring from 2019 to 2021



*The yield difference was statistically significant at this location.

** Tillage at the Barry site included two passes – chisel plow followed by a soil finisher.

Table 3. The effect of a single spring tillage pass on soybean plant stand in 2019, 2020 and 2021

Location	Seeding rate	Untilled control	Single tillage pass	LSD $_{0.10}$	Stand difference
	Seeds/acre	--- Final plant stand (plants per acre) ---			Plants per acre
Ottawa 20	96,000	81,200	80,400	3,384	-800
Barry 20	120,000	54,000 b	70,700 a	15,297	16,700
Isabella 20	130,000	58,200 a	54,700 b	3,059	-3,500
Shiawassee 19	165,000	118,700	119,300	19,205	600
Isabella 19	154,000	72,800	77,300	11,606	4,500
Cass 20	156,000	107,000	108,200	4,916	1,200
Ottawa 21	120,000	88,300	91,200	3,361	2,900
Average		**87,700**	**88,400**	**2,156**	**700**

Stand counts were not taken from the Isabella 21 trial.

Degelman Pro-Till 33/40

Planting Rate Trial

Purpose: Michigan soybean producers have consistently identified planting rates as the highest priority topic to evaluate in on-farm replicated trials. Soybean producers are interested in evaluating the effect of reduced planting rates on soybean yields and income. There are two main factors driving the increased interest in reducing soybean planting rates – seed cost and white mold. The purpose of this trial was to evaluate how reducing planting rates will affect soybean yield and income across multiple years and yield environments.

Procedure: We conducted 66 planting rate trials from 2015 to 2021. Eight of these were conducted in 2021. Four target planting rates (80,000, 100,000, 130,000 and 160,000 seeds per acre) were compared in all years. Stand counts were taken at all locations in 2021, with the exception of the Isabella site, to determine actual final plant stands at each location. We used projected market prices and conservative seed costs to determine the income (gross income minus seed cost) produced by the four planting rates.

Results: In 2021, the 160,000 planting rate out-yielded the 130,000 rate at one of the nine sites, the 100,000 rate at two locations and the 80,000 rate at four locations (Table 3). When all the 2021 locations were combined and analyzed, the 160,000 rate and the 130,000 rate produced essentially the same yield, exceeding the 100,000 rate by less than two bushels per acre and the 80,000 rate by only 3.5 bushels per acre. In 2021, the 130,000 planting rate produced the most income, followed by the 100,000 rate. The 160,000 rate came in third, beating the 80,000 rate by only $9.00 per acre (Table 3).

An article summarizing all seven years (2015-2021) of the on-farm planting rate trials will be available online at https://www.canr.msu.edu/field_crops/index.

Figure 1. Planting rate effects on soybean yield and income in 2021 compared to the 7-year average (2015 to 2021)

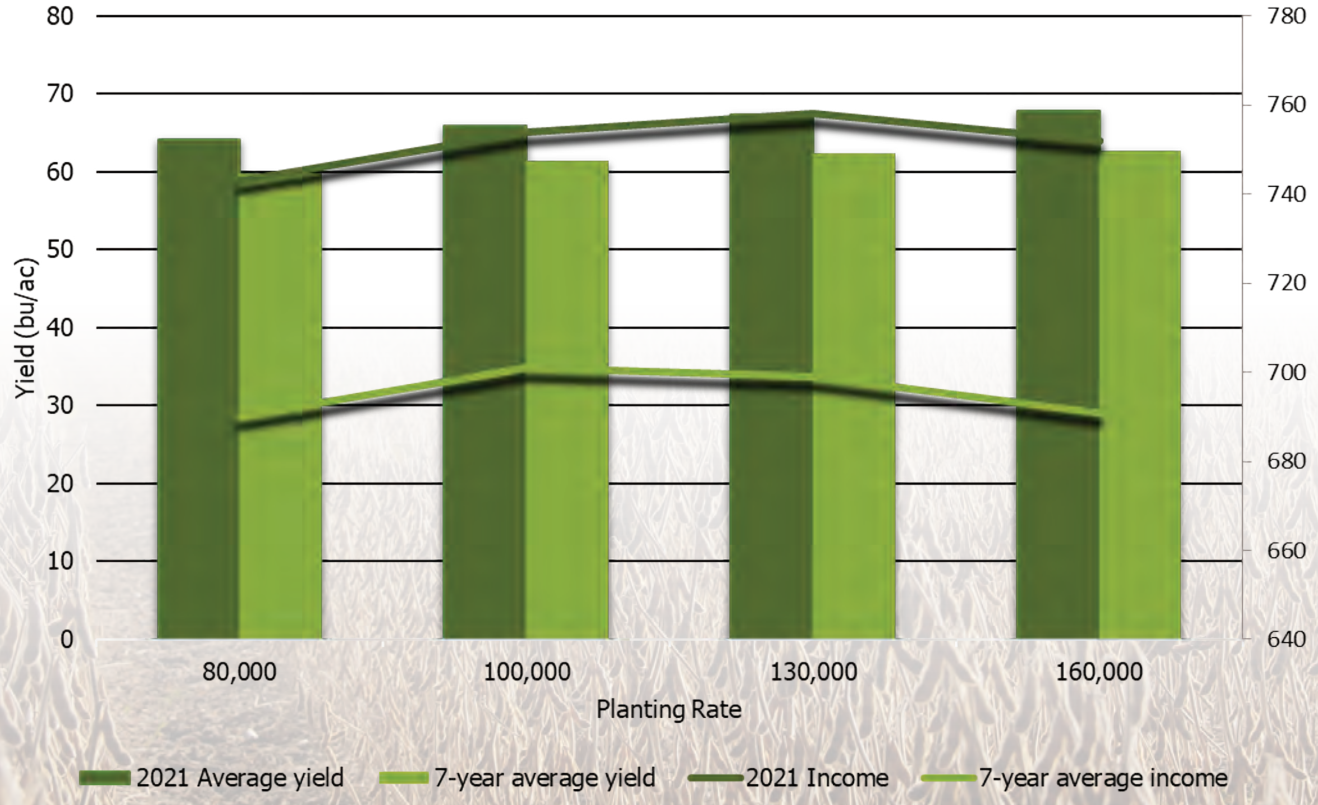


Table 1. Tillage, planting equipment, row spacing, CEC, planting date, planting depth and seed treatment in 2021

Location	Tillage operations (fall/spring)	Planter/drill	Row spacing	CEC	Planting date	Planting depth	Seed treatment
Berrien	DR/FC	JD 1790 16/31	15	13.0	April 28	1.25	None
St. Joseph	CP/D	JD 1770NT	30	6.3	May 8	1.5	LumiGEN Technologies
Clinton	NT	Kinze 2000	30	9.2	May 1	1.5	DFender
Barry	CP/SF	JD 1780	30	7.8	April 7	1.0	Equity VIP + Dynastart
Allegan	HSD/HSD	JD 1795 16/32	15	8.1	May 4	1.5	LumiGEN Technologies
Kalamazoo	NT (long-term)	JD 1770NT	30	7.5	June 6	1.5	None
Branch	CP/D	JD 1770NT	30	4.6	May 1	1.75	None
Isabella	CP/FC	JD N540C	15	10.1	April 28	1.5	Escalate, nemasect, SDS+

FC - field cultivator, NT - no-till, VT - vertical tillage, D - disk, CP - chisel plow, DR - disk ripper, HSD - high-speed disk, DR - disk ripper

Table 2. Target planting rates and actual plant stands in 2021

	---------- Target planting rate (seeds/ac) ----------			
Location	**80,000**	**100,000**	**130,000**	**160,000**
	---------- Actual plant stands (plants/ac) ----------			
Berrien	80,800	97,500	126,500	152,200
St. Joseph	71,900	91,000	115,400	138,100
Clinton	74,000	90,600	123,500	145,300
Barry	45,500	55,200	72,300	85,900
Allegan	61,700	80,800	100,300	114,500
Kalamazoo	72,000	87,400	109,400	137,100
Branch	45,200	58,800	74,700	99,600
2021 Average	**64,400**	**80,200**	**103,200**	**124,700**
	---------- Average stand loss (%) ----------			
	20	20	21	22

Stand counts from the Isabella location were not included.

Table 3. Soybean planting rate effects on yield and income

	---------- Target planting rate (seeds/ac) ----------				
Location	**80,000**	**100,000**	**130,000**	**160,000**	**$LSD_{0.10}$**
	---------- Yield (bushels/ac) ----------				
Berrien	77.0	79.7	79.2	81.4	4.5
St. Joseph	75.7	76.4	74.0	75.8	3.1
Clinton	64.9	66.6	67.8	67.0	2.7
Barry	74.4 b	73.8 b	82.6 a	80.4 a	5.5
Allegan	40.5 b	43.9 a	45.8 a	45.1 a	3.1
Kalamazoo	66.5	67.8	68.5	66.8	2.7
Branch	51.1	53.4	53.4	58.0	6.0
Isabella	65.3	66.0	65.0	65.0	1.7
2021 Average yield	**64.2 c**	**65.9 b**	**67.3 ab**	**67.8 a**	**1.5**
	---------- Income ($/ac) ----------				
Average income	**$743**	**$754**	**$758**	**$752**	

Seed cost = $60 per 140,000 seed unit

The highest two planting rates at the Isabella site were 120,000 and 140,000 seeds per acre so this site was not included in the 2021 average.

Planting Date Trial

Purpose: Early planting is an important management practice for producing high-yielding soybeans. However, many Michigan soybean producers believe that planting early is risky and have not fully adopted the practice. The question is, do the benefits of early planting outweigh the risks? The purpose of this trial was to evaluate the yield and income benefits of early-planted soybeans in 2019, 2020 and 2021.

Freeze damaged soybean plant producing new shoots

Procedure: This trial compared soybeans planted at an early date for the area vs. soybeans planted at a normal date for the area. There were three locations in 2019, eight locations in 2020 and 10 locations in 2021. The early planting dates at seven of the locations are considered very early, whereas the early planting dates at the other locations are consistent with the current MSU recommendations for planting soybeans during the last week of April and the first week of May if soil conditions are conducive (Table 1). All other factors were kept the same to isolate the effect of planting date in these trials.

Results: Early planting increased soybean yield by an average of 3.5 bushels per acre at 10 of the sites (Table 2). However, early planting reduced yield by 6.5 bushels per acre at one site in 2021 (Branch 21-1). Yield was not affected by planting date at the other 10 sites. When all 21 sites were combined and analyzed, early planting increased soybean yield by 2.3 bushels per acre. These results support the recommendation for planting soybeans early, as they demonstrate the potential for producing higher yields without significantly increasing the risk of experiencing yield reductions. This information should increase producers' confidence in planting soybeans earlier and help them manage weather risk in the spring by extending the soybean planting window.

We want to thank Dr. Manni Singh and the North Central Soybean Research Program (NCSRP) for their role in making this research possible.

Table 1. Background information for the planting date trials conducted in 2019, 2020 and 2021

Location	Early planting date	Normal planting date	Tillage Fall/Spring	CEC (meq/100g)	Planter	Previous crop	Seed treatment	Row width
Bay 21	April 18	May 18	DR/FC	12	JD 1790	Corn	None	20
Shiawassee 21	May 9	May 23	CP/SF	5.5	JD 1790	Corn	None	15
St. Clair 21-2	May 10	May 30	DR/VT	15.4	Case IH 950	Corn	Quad, N Force, N Hibit	22
Branch 19-1*	April 4	May 5	VT/--	4	JD 1790	Corn	LumiGEN Tech, ILeVO	15
St. Clair 20-2	May 4	May 30	NT	6	JD 1990	Corn	Cruiser Maxx, Vibrance	7.5
St. Clair 21-1	May 2	May 19	NT	10.5	JD 1990	Corn	LumiGEN Technologies	15
Cass 20-1	April 28	May 16	--/D (2x)	4	JD 490**	Corn	Escalate, ILeVO	Twin 12
St. Clair 20-3	May 7	May 22	D/VT	10	Case IH 850	Corn	Quad IM, Nhibit	22
Barry 21	April 26	May 17	NT	--	JD 1780	Barley	Equity VIP + Dyna Start	30
St. Clair 20-1	April 26	May 23	NT	7.5	JD 1795	Corn	LumiGEN Technologies	15
Kent 21	April 21	May 17	DR/D,R	7.2	Case 500 T	Corn	None	20
Bay 20	April 18	May 18	DR/FC,R	14	JD 1790	Corn	None	20
St. Clair 21-3	May 2	May 18	NT	11.5	JD 1795	Corn	LumiGEN Technologies	15
Branch 21-2*	April 7	May 16	D/SF,R	5.2	JD DB60	Seed corn	LumiGEN Technologies	20
Branch 20*	April 11	May 6	VT/--	5	JD DB60	Seed corn	LumiGEN Tech, ILeVO	20
Ottawa 21*	April 26	May 15	NT	6.2	JD 7000	Corn	None	30
Bay 19	April 25	May 15	DR/FC,R	14	JD 1790	Corn	Agrishield	20
Branch 19-2	March 29	May 5	NT	5	JD 1790	Corn	LumiGEN Tech, ILeVO	15
Cass 20-2	April 28	May 16	--/D (2x)	4	JD 490**	Corn	Escalate, Nemasect	Twin 12
Lenawee 20	May 7	June 2	NT	--	Kinze	Wheat	None	30
Branch 21-1	April 8	May 5	NT	7.4	JD 1690	Corn	LumiGEN Technologies	15

CP - chisel plow, FC - field cultivator, NT - no-till, VT - vertical tillage, SF - soil finisher, DR - disk ripper, D - disk and R - roller

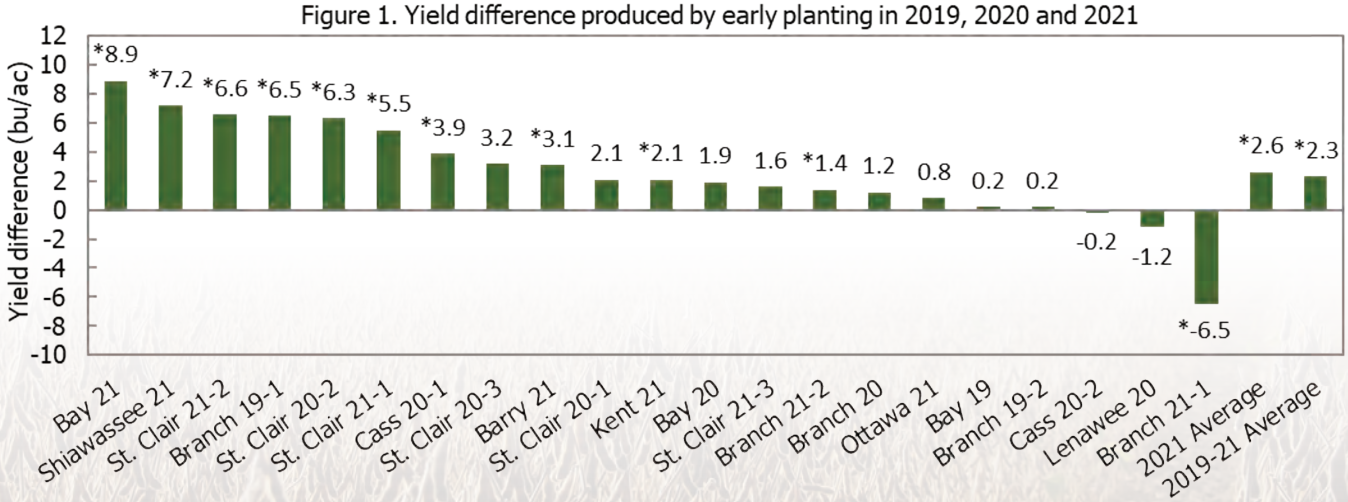
* These were irrigated sites.

** This planter has been modified to plant twin 12" rows on 36" centers.

Table 2. The effect of planting date on soybean yield and income in 2019, 2020 and 2021

Location	Early planting date	Normal planting date	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Bay 21	66.3 a	57.5 b	4.5	8.9
Shiawassee 21	61.5 a	54.3 b	5.0	7.2
St. Clair 21-2	59.7 a	53.1 b	3.7	6.6
Branch 19-1	74.3 a	67.8 b	1.7	6.5
St. Clair 20-2	54.6 a	48.3 b	4.2	6.3
St. Clair 21-1	51.5 a	46.0 b	3.3	5.5
Cass 20-1	44.3 a	40.4 b	1.2	3.9
St. Clair 20-3	68.2	65.0	3.5	3.2
Barry 21	58.1 a	55.0 b	2.8	3.1
St. Clair 20-1	64.7	62.6	5.2	2.1
Kent 21	74.1 a	72.1 b	1.6	2.1
Bay 20	73.3	71.4	2.2	1.9
St. Clair 21-3	47.0	45.4	4.4	1.6
Branch 21-2	70.7 a	69.3 b	1.3	1.4
Branch 20	76.7	75.5	4.3	1.2
Ottawa 21	53.0	52.2	1.4	0.8
Bay 19	43.9	43.7	1.7	0.2
Branch 19-2	57.9	57.7	3.1	0.2
Cass 20-2	34.9	35.1	1.5	-0.2
Lenawee 20	53.2	54.4	1.6	-1.2
Branch 21-1	45.9 b	52.4 a	4.0	-6.5
2019 - 2021 Average	**58.6 a**	**56.3 b**	**0.8**	**2.3**
	---------- Income ($/ac) ---------			
Average income	**$709**	**$681**		

Figure 1. Yield difference produced by early planting in 2019, 2020 and 2021



*The yield difference was statistically significant at these locations.

Soybeans handle early season stress surprisingly well.

Growthful™ Soil Amendment Trial

Purpose: The purpose of this trial was to evaluate how a single application of Growthful, a new soil amendment from Aqueus, affected soybean yield and income in 2021.

Procedure: A single application of Growthful was compared to an untreated control at two locations in 2021. Growthful was applied at a rate of 2 gallons per acre in a tank-mix with the cooperators' pre-emerge herbicides. Soil samples were collected from each of the treatments after product application to determine the effect of Growthful on soil pH levels.

Results: The Growthful application increased soybean yield by 2.1 bushels per acre at the Branch County site but did not significantly affect soybean yield in Shiawassee County. Growthful increased income by $7.40 per acre at the Branch location. When both sites were combined, the Growthful did not affect yield and reduced income by $12.00 per acre.

The Growthful treatment did not significantly affect soil pH levels at either location in 2021 (Table 3). We plan to evaluate the performance of Growthful again in 2022.

Table 1. Soil test levels at the Growthful soil amendment trial locations

Location	Organic matter	CEC	Phosphorus	Potassium	Sulfur	Zinc	Manganese	Soil pH
	Percent	meq/100g	---------- Parts per million ----------					1:1
Branch	2.7	12.2	35	172	**3.9**	4.4	49.7	5.9
Shiawassee	1.9	6.8	33	134	7.3	4.4	42.6	6.9

Bold figures indicate low or very low soil test levels.

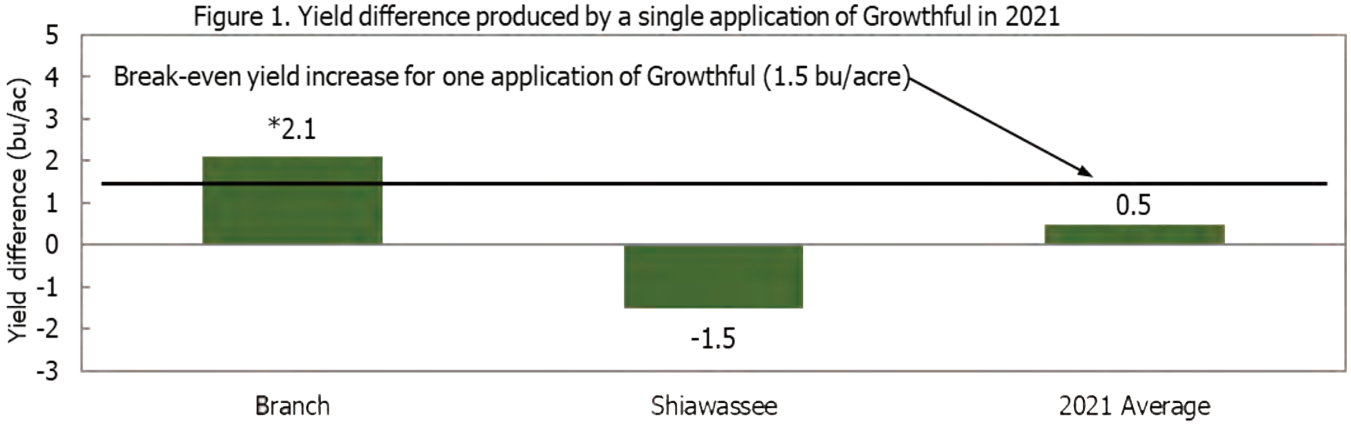
The yield effect from Growthful was inconsistent in 2021.

Table 2. The effect of a single application of Growthful soil amendment on soybean yield and income in 2021

Location	Untreated control	Growthful	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Branch	72.8 b	74.9 a	1.6	2.1
Shiawassee	54.7	53.2	2.8	-1.5
2021 Average	**63.7**	**64.2**	**1.6**	**0.5**
	---------- Income ($/ac) ----------			
Average income	**$771**	**$759**		

Cost of Growthful soil amendment = $18.00 per acre

Figure 1. Yield difference produced by a single application of Growthful in 2021



*The yield difference was statistically significant at this location.

Table 3. The effect of a single application of Growthful soil amendment on soil pH in 2021

Location	Untreated control	Growthful	LSD $_{0.10}$	Difference
	---------- Soil pH (1:1) ----------			--- Soil pH (1:1) ---
Branch	6.0	5.9	0.4	-0.1
Shiawassee	6.9	6.9	0.3	0
Average	**6.4**	**6.4**	**0.18**	**0**

Stand counts were not taken at the Sanilac 20 location.

Saltro® Seed Treatment Trial

Purpose: Soybean Sudden Death Syndrome (SDS) is spreading in Michigan and the most effective management tactics are variety selection and seed treatment. The purpose of this trial was to evaluate the effect that Saltro, a relatively new seed treatment from Syngenta, had on SDS foliar disease symptoms, yield and income.

Procedure: This trial compared two treatments (base seed treatment with Saltro vs. the same base seed treatment without Saltro). This trial was conducted at two sites in 2020 and three sites in 2021. All sites had a history of having SDS. We sampled all fields to determine the soybean cyst nematode (SCN) population levels and rated each treatment for SDS.

SDS foliar symptoms

Results: Sudden Death Syndrome was more prevalent in the 2020 trials than in the 2021 trials. In fact, visible SDS symptoms were difficult to detect in any of the trials conducted in 2021.

The Saltro seed treatment significantly increased soybean yields at the Calhoun 20-1, Calhoun 20-2 and Calhoun 21-2 sites and when all five sites were combined and analyzed. With a product cost of $13.00 per acre, the Saltro was also profitable at the Calhoun 20-1, Calhoun 20-2 and Calhoun 21-2 locations and when all five were combined. The 2020 to 2021 average yield increase was 2.6 bushels per acre, generating more than $18.00 of additional income per acre.

There were two additional points that these trials demonstrated. The first is that the Saltro seed treatment increased yields even though SDS-tolerant varieties were planted at both sites. The second point is that SCN was not detected at three of the sites, supporting the concept that SDS can occur in fields without detectable SCN populations.

We want to thank Syngenta for providing the Saltro for these trials and the seed dealers that treated the seed.

Table 1. Key background information for the Saltro seed treatment trials

Location	Planting date	Tillage (Fall/ Spring)	Variety	SDS tolerance	SCN resistance source	Base seed treatment	Baseline SCN population
Calhoun 20-2	April 24	HSD	Stine 30EA23	Very good	PI88788	Vibrance Trio	Zero detected
Calhoun 20-1	April 24	HSD	Stine 28EA02	Good	PI88788	Vibrance Trio	Zero detected
Calhoun 21-2	April 26	HSD	Stine 26EB02	Good	PI88788	Seed Shield	Zero detected
Calhoun 21-1	April 27	HSD	Stine 24EA12	Average/good	PI88788	Seed Shield	Risk level 1
St. Joseph 21	May 1	D/D	Pioneer P25A04X	7 (9=excellent, 1=poor)	Peking	LumiGEN	Risk level 1

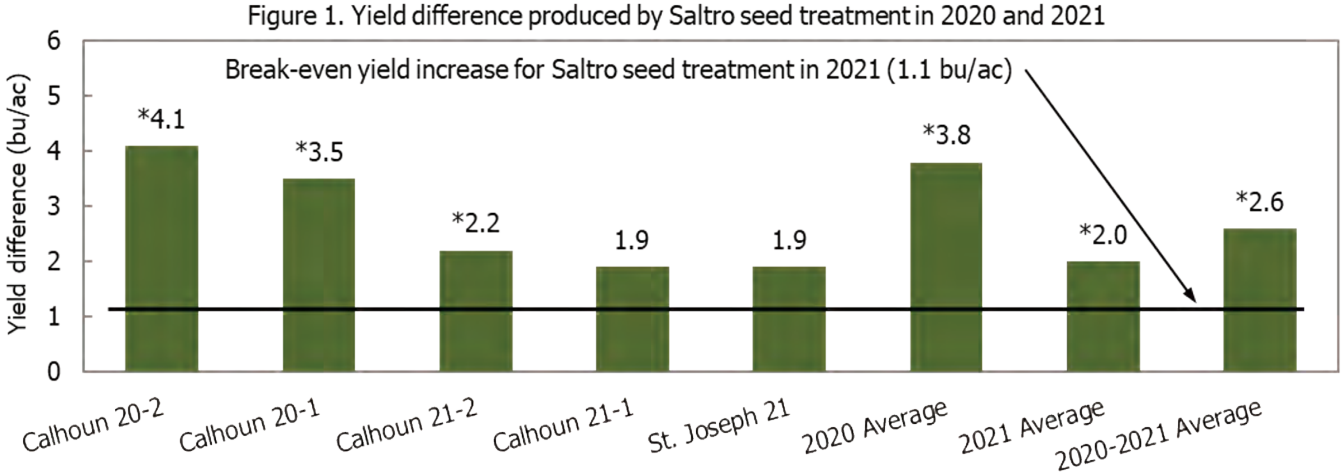
D - disk, HSD - high speed disk

Table 2. The effect of Saltro seed treatment on soybean yield and income in 2020 and 2021

Location	Base seed treatment without Saltro	Base seed treatment with Saltro	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Calhoun 20-2	61.2 b	65.3 a	2.4	4.1
Calhoun 20-1	59.4 b	62.9 a	2.0	3.5
Calhoun 21-2	60.0 b	62.2 a	1.3	2.2
Calhoun 21-1	76.9	78.8	2.0	1.9
St. Joseph 21	84.5	86.4	2.7	1.9
Average	**68.5 b**	**71.1 a**	**0.8**	**2.6**
	---------- Income ($/ac) ---------			
Average income	**$829**	**$847**		

Saltro cost in 2021 = $13.00/140,000 seeds

Figure 1. Yield difference produced by Saltro seed treatment in 2020 and 2021



*The yield difference was statistically significant at these locations.

SDS trial (left side is treated)

In fields where SDS is expected, Saltro seed treatment has increased yields.

Row Spacing Trial


Shiawassee Row Spacing Trial

Purpose: Many of the soybean acres in the state are planted in 15-inch rows using split-row planters. These planters are significantly more expensive than planters of comparable width set up for 30-inch rows, and producers want to know if the extra expense is justified. The purpose of this trial was to evaluate how two common row spacings affected soybean yield and income in 2019, 2020 and 2021.

Procedure: Two row spacings (15 inches and 30 inches) were compared at two sites in 2019, six sites in 2020 and three sites in 2021. All trials were planted with split-row planters and planting rates were kept the same (approximately 130,000 seeds/acre) regardless of row spacing, except for the Saginaw 20 site. Stand counts were taken to determine the effect row spacing would have on final plant stands.

Results: The 15-inch rows significantly increased yields at four of the eleven sites. When all locations were combined, the 15-inch rows produced 2.8 bushels per acre more than the 30-inch rows. Row spacing affected final plant stands at four sites (Table 3). Operator and equipment error were responsible at two of these sites. At the Tuscola 20 site, the guidance system was off, causing some of the 15-inch rows to be planted directly on the previous year's corn rows. At the Saginaw 20 site, the planting rate was not adjusted when moving from 15-inch to 30-inch rows. The 30-inch rows may perform better in fields with a history of white mold or prone to crusting.

MSU Farm Management educator Roger Betz generated a partial budget comparing the economics of purchasing a 12/24 split-row planter vs. a 12-row 30-inch planter. This analysis showed that the 15-inch rows increased income by $4,700 per year over the life of the planter. The assumptions used in the analysis are listed below:

- 15 percent rate of return on investment
- 2.8 bushels per acre yield increase
- Soybean market price of $9.80 per bushel (10-year projection)
- 500 acres of soybeans per year
- Planter life of 10 years
- $50,000 higher cost for the split-row planter
- $7,500 salvage value

Table 1. Background information for the row spacing trials conducted in 2019, 2020 and 2021

Location	Tillage Fall/spring	Planter/drill	Previous crop	Planting date	Variety	Plant type/canopy width
Shiawassee 21	CP/SF	JD 1790 12/24	Corn	May 9	GH 2610E3	Medium
Shiawassee 20-1	CP/SF	JD 1790 12/24	Corn	May 7	GH 2610E3	Medium
Tuscola 19	CP/FC, R	JD 1790 12/23	Corn	May 11	Pioneer P24A80	5 (9=bushy, 1=narrow)
Shiawassee 19	CP/FC	JD 1790 12/24	Corn	May 15	LG 2942	Medium Bush
Tuscola 21	CP/FC	JD 1790 12/23	Corn	April 22	DF 227	Medium
Tuscola 20	NT	JD 1790 12/23	Corn	May 6	DF 5173 NR2Y	Medium
Clinton 21	NT	Kinze 3600 12/23	Soybean	May 13	Stine 19EA33	Medium Bush
Shiawassee 20-3	DR/FC	JD 1795 16/32	Wheat	May 12	Dyna Gro 2409	Moderately bushy
Shiawassee 20-2	CP/SF	JD 1790 12/24	Corn	May 7	GH 2041X	Medium
Monroe 20	--/D	JD 1780 12/23	Corn	April 28	Wellman 6928E	2.4 (1=narrow, 5=bushy)
Saginaw 20	NT	JD 1790 16/32	Corn	May 4	Dairyland 2259E	4 (1=bushy, 9=narrow)

CP - chisel plow, FC - field cultivator, NT - no-till, VT - vertical tillage, SF - soil finisher, DR - disk ripper, D - disk and R - roller


Tuscola Row Spacing Trial Harvest

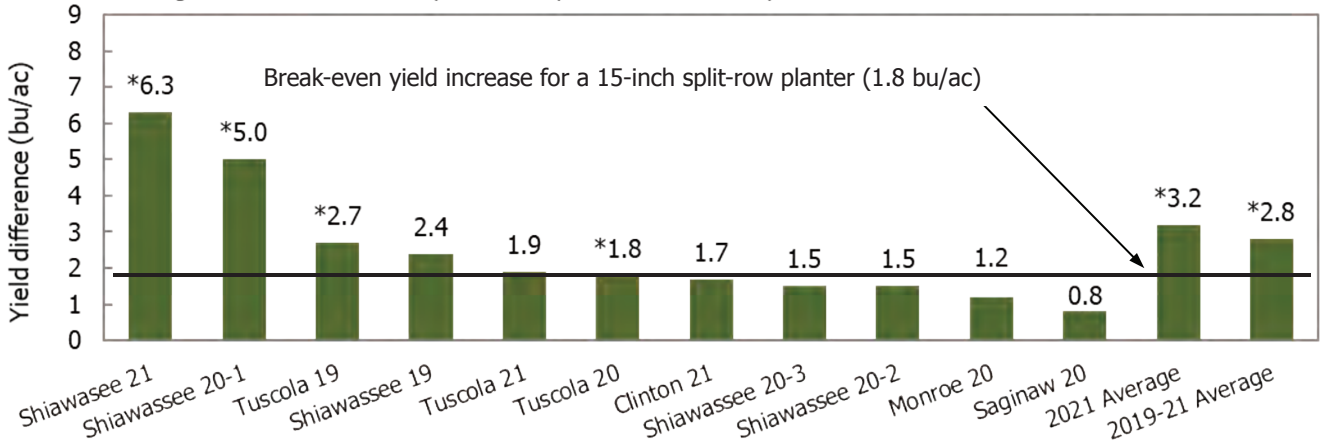
Table 2. The effect of row width on soybean yield and income in 2019, 2020 and 2021

Location	15-inch rows	30-inch rows	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Shiawassee 21	68.2 a	61.9 b	4.8	6.3
Shiawassee 20-1	49.3 a	44.3 b	2.1	5.0
Tuscola 19	59.2 a	56.5 b	1.3	2.7
Shiawassee 19	32.8	30.4	3.6	2.4
Tuscola 21	67.1	65.2	2.5	1.9
Tuscola 20	63.0 a	61.2 b	0.8	1.8
Clinton 21	74.0	72.3	3.9	1.7
Shiawassee 20-3	64.1	62.6	2.4	1.5
Shiawassee 20-2	62.5	61.0	2.2	1.5
Monroe 20	49.9	48.7	2.6	1.2
Saginaw 20	66.5	65.7	1.7	0.8
2019-2021 Average	**58.6 a**	**55.8 b**	**0.9**	**2.8**
	---------- Income ($/ac) ---------			
Average income	**$691**	**$675**		

Increased cost per acre to own and operate a 12/24 15-inch split-row planter given 500 acres of soybeans per year for 10 years = $18.00 per acre.

The Tuscola 20 and Saginaw 20 sites were not included in the 2019-2021 average due to planting rate errors.

Figure 1. Yield difference produced by 15-inch rows compared to 30-inch rows in 2019, 2020 and 2021



*The yield difference was statistically significant at these locations.

Table 3. The effect of row spacing on final plant stands in 2019, 2020 and 2021

Location	15-inch rows	30-inch rows	LSD $_{0.10}$	Stand difference
	----- Plant stand (plants/ac) -----			Plant stand (plants/ac)
Shiawassee 21	127,500	125,400	8,801	2,100
Shiawassee 20-1	110,200	104,600	5,979	5,600
Tuscola 19	114,200	111,500	2,912	2,700
Shiawassee 19	95,100 a	85,300 b	6,904	9,800
Tuscola 21	120,500	114,000	5,021	6,500
Tuscola 20	83,500 b	104,500 a	7,142	-21,000
Shiawassee 20-3	124,200	126,400	4,949	-2,200
Shiawassee 20-2	90,900 a	86,000 b	2,019	4,900
Saginaw 20	102,800 a	57,300 b	9,906	45,500
2019-2021 Average	**111,700 a**	**107,700 b**	**1,928**	**4,000**

Stand counts were not taken at the Monroe 20 and Clinton 21 locations.

Stand counts from the Tuscola 20 and Saginaw 20 locations were not included in the 2019-2021 average.

In-Furrow Biological and Humic Acid Trial

Purpose: Producers having in-furrow application capability on their planters or drills are looking for a product or combination of products that are safe and profitable. Wilbur Ellis recommends that two of their products, Nutrio Unlock® (biological) and Puric™ Prime Max (humic acid) be combined and applied in-furrow. The purpose of this trial was to evaluate how these products affected soybean yield and income in 2020 and 2021.

Procedure: Two treatments (Nutrio Unlock plus Puric Prime Max applied in-furrow vs an untreated control) were compared at seven sites in 2020 and seven sites in 2021. Both products were applied at 1 pint per acre. Soil samples were collected at all sites prior to planting or in unfertilized strips.

Results: The in-furrow application increased soybean yields by 4.5 bushels per acre at the Cass 21 site and 1.6 bushels per acre at the Saginaw 20 and Sanilac 20-1 sites. However, the in-furrow treatment reduced yields by 4.5 bushels per acre at the Allegan 21 site and by 1.1 bushels per acre at the Cass 20 site. When all 14 sites were combined and analyzed, there was no clear advantage or disadvantage to the in-furrow application. This trial demonstrates that the performance of products and practices is highly site dependent.

We want to thank Wilbur Ellis for donating the products for these trials.

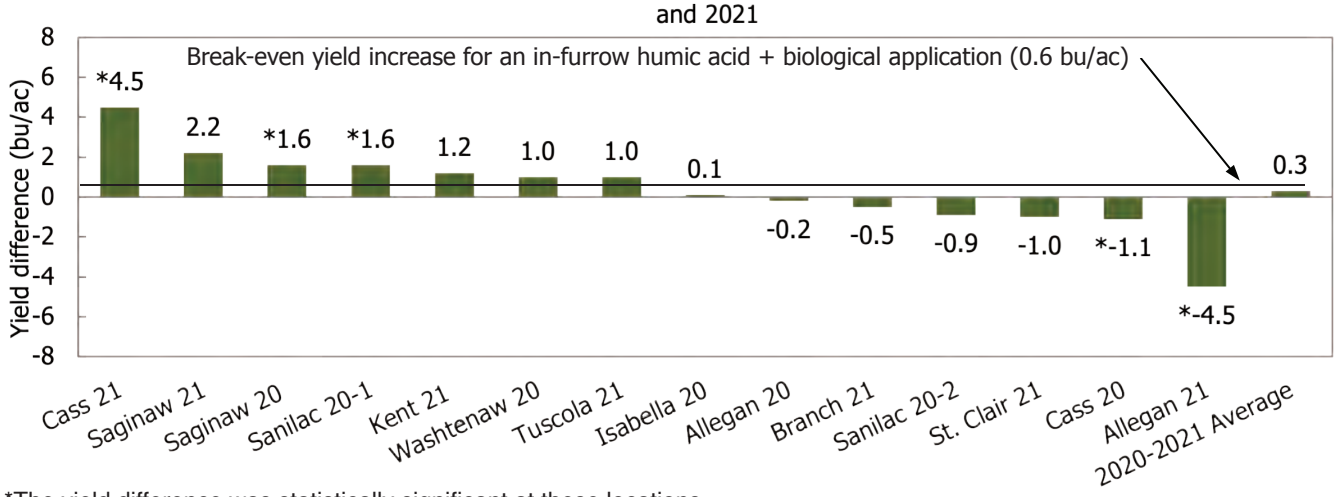
Table 1. Soil test levels at the 2020 and 2021 in-furrow trial locations

Location	Organic matter	Phosphorus	Potassium	Magnesium	Calcium	Soil pH	CEC
	Percent	---------- Parts per million ----------				1:1	meq/100g
Cass 20	1.1	73	135	60	350	**5.7**	3.8
Saginaw 20	2.0	60	139	230	1050	6.7	8.7
Sanilac 20-1	2.0	64	122	85	700	6.7	4.5
Sanilac 20-2	2.3	**9**	131	265	1150	6.8	8.6
Allegan 20	2.6	115	161	105	650	6.2	5.7
Washtenaw 20	1.2	77	204	115	600	6.7	4.5
Isabella 20	3.5	25	143	335	1550	7.4	10.9
Allegan 21	2.7	70	181	196	1024	6.6	7.7
Kent 21	2.3	38	148	140	900	6.3	7.2
Branch 21	1.5	38	227	75	550	5.4	6.4
St. Clair 21	7.0	48	334	305	2300	6.8	15.4
Tuscola 21	2.3	28	153	175	1269	6.9	8.7
Saginaw 21	2.8	48	150	370	2050	7.1	13.7
Cass 21	1.5	64	**90**	50	450	6.2	4.1
Barry 21	2.5	49	150	58	787	6.4	6.0

Bold figures indicate low or very low soil test levels.

Field-specific factors may influence the effect of biological products. Additional research is warranted to further evaluate these effects.

Figure 1. Yield difference produced by Nutrio Unlock + Puric Prime Max applied in-furrow in 2020 and 2021



*The yield difference was statistically significant at these locations.

Table 1. The effect of Nutrio Unlock and Puric Prime Max applied in-furrow on yield and income in 2020 and 2021

Location	Control	In-Furrow	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ---------			Yield (bu/ac)
Cass 21	38.7 b	43.3 a	2.5	4.5
Saginaw 21	65.6	67.8	2.4	2.2
Saginaw 20	66.3 b	67.9 a	1.2	1.6
Sanilac 20-1	71.1 b	72.8 a	0.9	1.6
Kent 21	74.1	75.3	1.5	1.2
Tuscola 21	55.6	56.6	1.8	1.0
Washtenaw 20	56.7	57.7	1.7	1.0
Isabella 20	63.1	63.2	1.2	0.1
Allegan 20	57.8	57.6	3.3	-0.2
Branch 21	56.4	55.9	6.3	-0.5
Sanilac 20-2	67.2	66.3	2.5	-0.9
St. Clair 21	44.0	43.0	3.7	-1.0
Cass 20	43.3 a	42.2 b	0.6	-1.1
Allegan 21	64.1 a	59.6 b	3.6	-4.5
2020 - 2021 Average	**58.9**	**59.2**	**0.7**	**0.3**
	---------- Income ($/ac) ----------			
Average income	**$713**	**$710**		

Nutrio Unlock cost = $4.00 per acre and Puric Prime Max cost = $2.75 per acre

2x2 Starter Fertilizer Trial

Purpose: Producers having planters equipped to apply starter fertilizer in a 2x2 band are looking for the most profitable fertilizer and rate for this application method. The purpose of this trial was to evaluate how various 2x2 starter fertilizers affected soybean yield and income in 2021.

Procedure: Two treatments (2x2 starter fertilizer vs. an untreated control) were compared at six locations in 2021. This project is different than most of our on-farm research projects in that the cooperators selected the fertilizer and application rates they wanted to evaluate on their farms (Table 2). We collected baseline soil samples from each site (Table 1). We also took stand counts at four sites to determine if the starter fertilizer reduced stand.

Results: Starter fertilizer increased soybean yields by more than 3 bushels per acre at two of the six locations (Saginaw and St. Joseph). However, yield at the other four locations was not significantly affected by the starter fertilizer applications. Starter fertilizer increased income by $4.50 per acre at the Saginaw and St. Joseph sites but decreased income at the other four locations (Table 3). Final plant stands were not affected by the starter fertilizers at the four sites where stand counts were taken.

Table 1. Soil test levels at the 2x2 starter fertilizer trial locations

Location	Organic Matter	CEC	Phosphorus	Potassium	Soil pH
	Percent	meq/100g	--------- Parts per million ---------		1:1
Saginaw	2.8	13.7	48	150	7.1
St. Joseph	1.1	5.2	53	161	**5.8**
Allegan	1.2	4.4	56	121	**5.8**
Kent	2.3	7.2	38	148	6.3
Ingham	1.5	4.8	91	135	6.3
Barry	2.5	6.4	30	**49**	5.3

Bold figures indicate low or very low soil test levels.

Table 2. Background information for the 2x2 starter fertilizer trials conducted in 2021

Location	Tillage Fall/spring	Planting date	Starter fertilizer analysis	Starter fertilizer application rate	Broadcast fertilizer analysis and application rate
Saginaw	NT	April 30	10-34-0, Mn	8.5 gal/ac, 2 qt/ac	None
St. Joseph	--/CP,SF	May 8	15-15-2	15 gal/ac (150 lbs)	0-0-60 at 125 lbs/ac
Allegan	NT	May 19	4.7-15-6-4, Mn	8 gal/ac	None
Kent	DR/D,R	April 24	7-23-5, Zn	2 gal/ac, 1qt/ac	None
Ingham	NT	May 9	9-15-30	80 lbs/ac	None
Barry	NT	April 7	10-34-0	3 gal/ac	10.5-21-60-12 at 100 lbs/ac

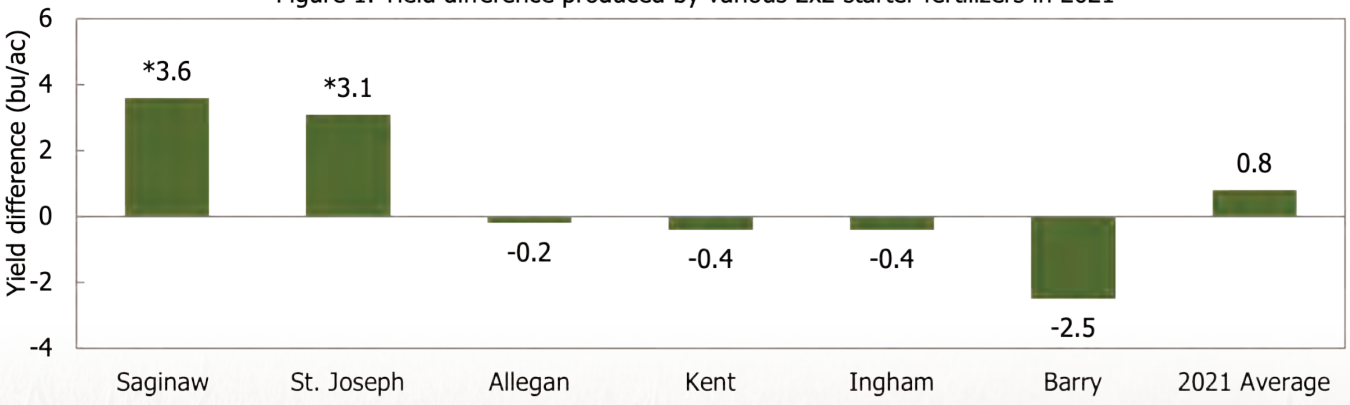
CP - chisel plow, NT - no-till, VT - vertical tillage, SF - soil finisher, DR - disk ripper, D - disk, and R - roller

Table 3. The effect of various 2x2 starter fertilizers on yield and income in 2021

Location	Control	2x2 Starter	LSD $_{0.10}$	Yield difference	Net return to starter fertilizer
	---------- Yield (bu/ac) ---------			Yield (bu/ac)	$/acre
Saginaw	61.5 b	65.1 a	0.9	3.6	$4.50
St. Joseph	65.6 b	68.7 a	2.0	3.1	$4.50
Allegan	39.5	39.3	1.1	-0.2	-$33.00
Kent	74.1	73.7	1.9	-0.4	-$17.40
Ingham	47.2	46.8	2.7	-0.4	-$19.50
Barry	68.3	65.8	9.9	-2.5	-$11.50
2021 Average	**59.2**	**60.0**	**1.2**	**0.8**	**-$12.07**

Net return is based on the specific 2x2 starter fertilizer and application rate for each location.

Figure 1. Yield difference produced by various 2x2 starter fertilizers in 2021



*The yield difference was statistically significant at these locations.

Table 4. The effect of 2x2 starter fertilizer final plant stands in 2021

Location	Control	2x2 Starter	LSD $_{0.10}$	Stand difference
	------- Plant stand (plants/ac) -------			Plant stand (plants/ac)
Saginaw	80,700	83,300	8,252	2,600
St. Joseph	108,000	107,800	6,208	-200
Allegan	135,200	133,100	11,116	-2,100
Ingham	83,900	80,200	8,430	-3,700
2021 Average	**101,950**	**101,100**	**3,697**	**-850**

Stand counts were not taken at the Barry and Kent locations.

Rye Termination Timing Trial

Purpose: Cover crop acres are increasing in Michigan and cereal rye is one of the most popular covers. Planting soybeans prior to terminating rye cover crops is gaining popularity as it has been shown to help manage herbicide-resistant marestail and may also reduce the severity of white mold infestations. The purpose of this trial is to evaluate rye cover termination timing effects on soybean yield and income in 2020 and 2021.

Procedure: This trial compared two treatments (planting before terminating a rye cover crop vs. planting after terminating the rye cover). Three rye cover crop termination trials were conducted in 2020 and two more were conducted in 2021. We took final stand counts to determine the effect that rye termination timing had on soybean stands.

Roller-Crimper effect on a rye cover crop

Results: Rye termination timing did not affect soybean yields at four of the five sites. However, terminating the rye after planting reduced yield by 6.6 bushels per acre at the Ionia site in 2021. Plant stands were also adversely affected by the later termination timing at this location. When all five sites were combined and analyzed, terminating rye prior to planting increased yield by 2.2 bushels per acre and income by $27 per acre. Final plant stands were not affected by rye termination timing when all five sites were combined. The results from these trials are mixed and demonstrate the importance of termination timing when managing rye cover crops.

Table 1. Planting dates, planting rates, planter/drill, rye termination dates and burndown herbicides

Location	Planting date	Planting rate	Planter/drill	Early rye termination date	Late rye termination date	Burndown herbicide
Jackson 20-1	May 21	140,000	White 9936	May 4	May 22	Glyphosate
Sanilac 20	May 31	155,000	Kinze 3500	May 26	June 1	Roundup, Antaris, Metribuzin
Jackson 20-2	May 21	140,000	White 9936	May 4	May 22	Glyphosate, Zidua Pro
Barry 21	May 18	120,000	JD 1780	May 4	May 18	Glyphosate
Ionia 21	May 2	180,000	JD 1990 CCS	April 24	May 16	Glyphosate + 2,4-D LV6

Table 2. The effect of rye cover crop termination timing on soybean yield and income in 2020 and 2021

Location	Controlled prior to planting	Controlled after planting	LSD $_{0.10}$	Yield difference
	---------- Yield (bu/ac) ----------			Yield (bu/ac)
Jackson 20-1	48.3	48.8	2.1	0.5
Sanilac 20	59.8	57.3	2.6	-2.5
Jackson 20-2	57.1	55.3	3.9	-1.8
Barry 21	79.0	79.1	5.7	-0.1
Ionia 21	80.9 a	74.3 b	4.2	-6.6
Average	**65.1 a**	**62.9 b**	**1.6**	**-2.2**
	---------- Income ($/ac) ---------			
Average income	**$788**	**$761**		

Figure 1. Effect of rye termination timing on soybean yield in 2020 and 2021

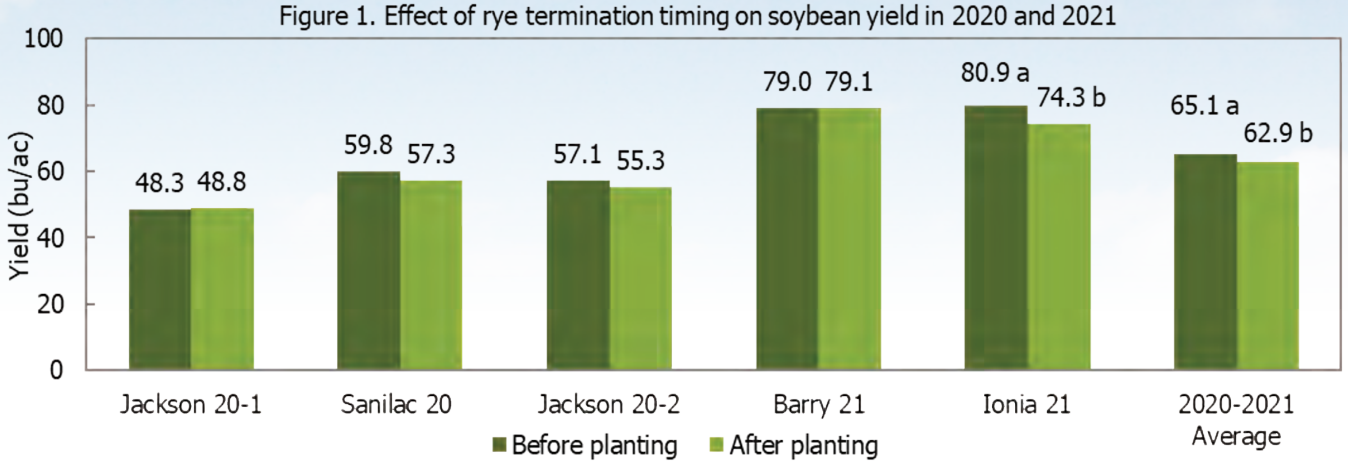


Table 3. The effect of rye cover crop termination timing on final plant stands in 2020 and 2021

Location	Controlled prior to planting	Controlled after planting	LSD $_{0.10}$	Stand difference
	------- Plant stand (plants/ac) -------			Plant stand (plants/ac)
Jackson 20-1	78,200	77,400	4,272	-800
Sanilac 20	118,900	121,500	9,159	2,600
Jackson 20-2	73,100	76,300	6,651	3,200
Barry 21	108,600	109,700	3,763	1,100
Ionia 21	144,700 a	122,700 b	10,021	-22,000
Average	**105,400**	**100,800**	**4,867**	**-4,600**

Ionia County rye termination timing trial

Roller-Crimper

NDemand® 88 Foliar Fertilizer Trial

Purpose: NDemand 88 is a liquid fertilizer marketed by Wilbur Ellis® that is compatible with the post-emergence herbicides labeled in Michigan. The purpose of this trial was to evaluate how tank mixing the foliar fertilizer with various post-emergence herbicides affected soybean yield and income in 2020 and 2021.

Procedure: This trial compared two treatments (post-emergence herbicide(s) mixed with NDemand 88 vs. the same post-emergence herbicide(s) applied without NDemand 88) at ten locations in 2020 and 7 more in 2021. NDemand 88 was applied at one quart per acre. The analysis of NDemand 88 is 10-8-8 plus 2% sulfur, 0.25% boron, 0.06% copper, 0.25% manganese and 0.25% zinc. Soil samples were collected from each location prior to application, and key nutrient levels for each site are presented in Table 1. Planting dates, fertilizer applications, herbicide names and rates and application dates for each site are listed in Table 2.

Results: The NDemand 88 produced a statistically significant yield increase at two locations (Sanilac 20-1 and Cass 21) and when all 17 individual trial sites were combined and analyzed. Due to the low cost of the product ($4.12 per acre) and the fact that we did not add an additional application cost, the NDemand 88 application was profitable at the Sanilac 20-1 and Cass 21 sites and when all sites were combined. However, the frequency of a profitable response from NDemand 88 was only 12 percent (two out of 17 trials).

We want to thank Wilbur Ellis for contributing the NDemand 88 for this trial.

Manganese deficient soybeans

Table 1. Soil test levels at the 2020 and 2021 NDemand 88 trial locations

Location	CEC	Phosphorus	Potassium	Sulfur	Zinc	Soil pH
	meq/100g	---------- Parts per million ----------				1:1
Cass 21	6.8	19	120	**5**	2.2	5.9
Branch 21	5.6	66	219	12	4.4	5.7
Sanilac 21	9.3	26	120	**--**	--	7.0
Calhoun 21	9.7	82	176	**7**	7.9	6.7
Lenawee 21	10.2	21	130	--	--	6.4
Bay 21	19.0	42	226	**6**	2.7	7.8
Tuscola 21	5.4	**7**	192	--	--	6.8

Bold figures indicate low or very low soil test levels.

Table 2. Planting dates, fertilizers applied, herbicides and application dates at the trial locations

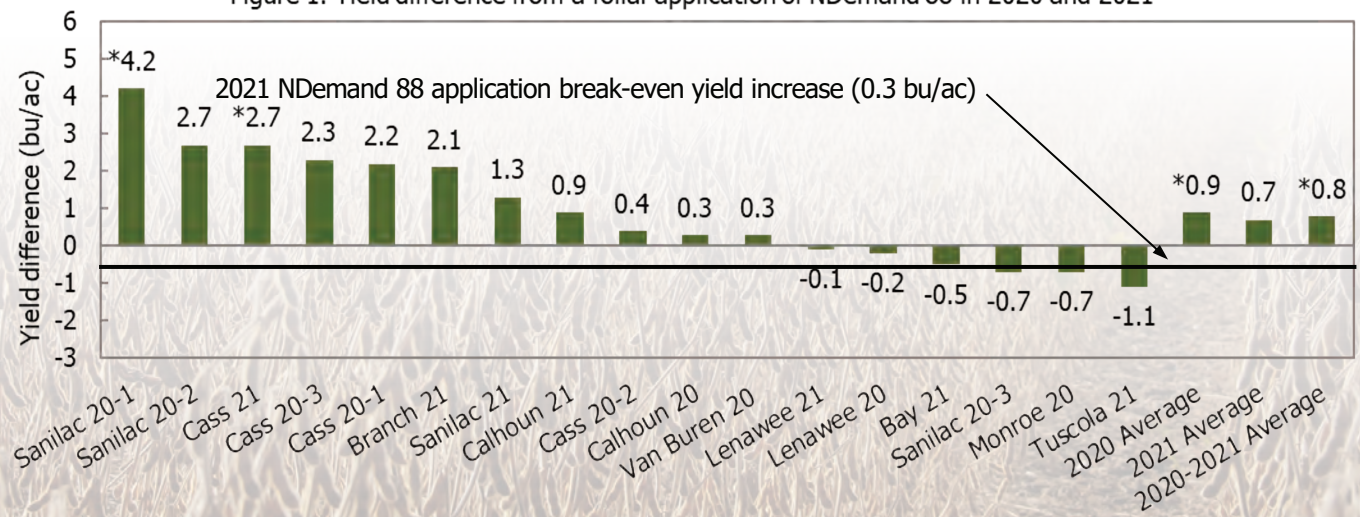
Location	Planting date	Fertilizer applied, rate	Herbicides, rates per acre	Application date
Cass 21	May 13	0-0-60, 100 lbs/ac 18-46-0, 100 lbs/ac	Roundup 32oz/ac	June 14
Branch 21	May 1	0-0-60, 80 lbs/ac 11-52-0, 50 lbs/ac	Cloran, 0.6 oz, Clethodim, 8 oz	June 15
Sanilac 21	May 11	0-0-60, 100 lbs/ac, 11-52-0, 100l bs/ac	Liberty 32 oz/ac	July 9
Calhoun 21	May 3	21-0-0-24, 100 lbs/ac	Liberty, 29 oz/ac	June 20
Lenawee 21	May 18	0-0-60, 100 lbs/ac 11-52-0, 150 lbs/ac	Flexstar, 1 pt, COC, 1 qt.	June 15
Bay 21	April 22	None	None	July 20
Tuscola 21	April 24	0-0-60, 150 lbs/ac	Roundup Powermax, 32 oz/ac, Liberty, 32 oz/ac	June 20

Table 3. The effect of a single application of NDemand 88 on soybean yield and income in 2020 and 2021

Location	Untreated control	NDemand 88	LSD $_{0.10}$	Yield difference
	------- Yield (bu/ac) ---------			Yield (bu/ac)
Cass 21	55.7 b	58.4 a	2.2	2.7
Branch 21	61.5	63.6	3.4	2.1
Sanilac 21	61.2	62.5	2.6	1.3
Calhoun 21	45	45.9	2.1	0.9
Lenawee 21	48.7	48.6	1.8	-0.1
Bay 21	72.3	71.8	1.2	-0.5
Tuscola 21	32.0	30.9	2.3	-1.1
2021 Average	**53.8**	**54.5**	**0.5**	**0.7**
	---------- Income ($/ac) ---------			
Average income	**$651**	**$655**		

NDemand 88 cost = $4.12 per acre

Figure 1. Yield difference from a foliar application of NDemand 88 in 2020 and 2021



*The yield difference was statistically significant at these locations.

Miravis® Neo Foliar Fungicide Trial

Purpose: Miravis Neo is a new foliar fungicide from Syngenta® that is being promoted as having broader disease control and promoting better plant health. The purpose of this trial was to evaluate how a foliar application of Miravis Neo affected soybean yield and income in 2020.

Procedure: A foliar application of Miravis Neo was compared to an untreated control at 14 locations in 2020 and eight locations in 2021. The Miravis Neo was applied at 13.7 ounces per acre at the R3 growth stage. Application dates, application characteristics and rainfall information for each site was gathered and is presented in Table 1. To eliminate sprayer tracks from affecting the results, tracks were either present or absent in all the harvested strips in each trial.

Results: The foliar application of Miravis Neo increased soybean yields at nine of the 22 individual trial locations. When all 22 locations were combined and analyzed, the fungicide application increased soybean yields by 2.2 bushels per acre.

After accounting for product and application costs, the fungicide was profitable at eight of the locations and was not profitable when all the sites were combined. The lack of a consistent economic response to the foliar fungicide is probably because foliar diseases such as Frogeye leaf spot are not common in Michigan.

We want to thank Syngenta for donating the products for these trials.

Table 1. Application dates, volume, pressure, ground speed and rainfall information for the Miravis Neo trial locations

					*Rainfall totals and hours of rain for July and August	
Location	**Application date**	**Spray volume (GPA)**	**Nozzle pressure (PSI)**	**Groundspeed (mph)**	**Rainfall (inches)**	**Hours of rain (hrs)**
Isabella 21	July 26	17	45	10	6.60	111
Sanilac 21-3	July 23	18	50	8	6.05	62
Schoolcraft 21	August 10	15	40	10	5.10	72
Cass 21	July 14	16	45	4.8	9.68	58
Sanilac 21-1	July 22	20	55	9	6.05	62
Ionia 21	July 14	15	30	9	3.50	41
Sanilac 21-2	July 19	15	40	6.5	6.05	62
Ottawa 21	July 15	20	60	7	4.72	49

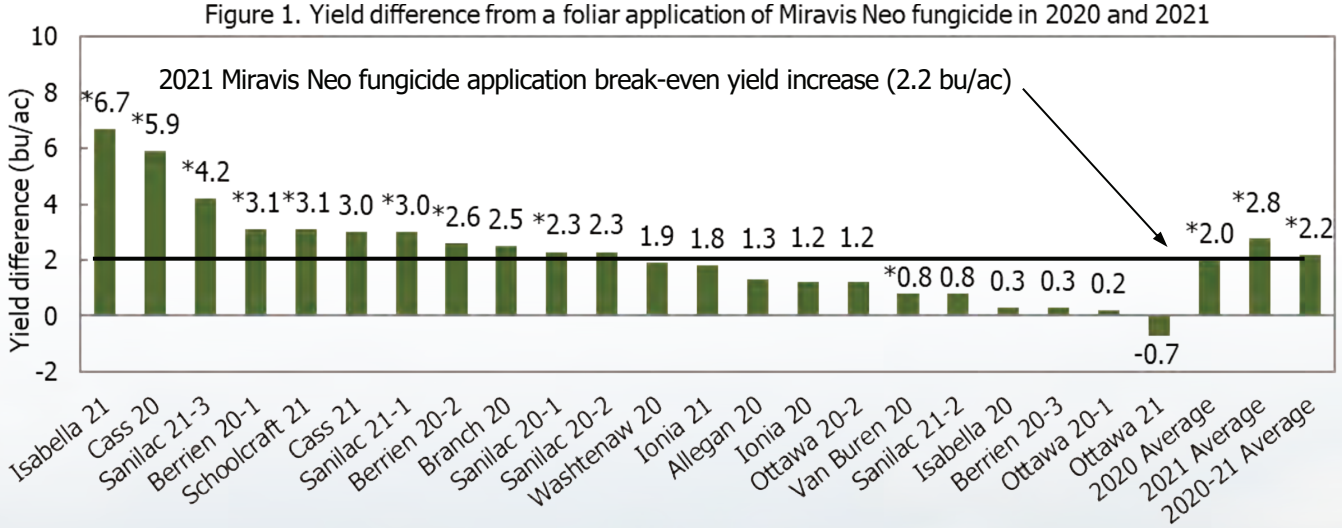
*Rainfall data was obtained from the nearest MSU Enviroweather station

Table 2. The effect of a single application of Miravis Neo on soybean yield and income in 2021

Location	Untreated control	Miravis Neo	LSD $_{0.10}$	Yield difference
	-------- Yield (bu/ac) ----------			Yield (bu/ac)
Isabella 21	61.0 b	67.7 a	1.5	6.7
Sanilac 21-3	57.9 b	62.1 a	1.9	4.2
Schoolcraft 21	41.7 b	44.8 a	2.4	3.1
Cass 21	61.6	64.6	3.2	3.0
Sanilac 21-1	57.0 b	60.0 a	0.1	3.0
Ionia 21	70.0	71.8	2.9	1.8
Sanilac 21-2	48.1	48.9	2.6	0.8
Ottawa 21	67.0	66.3	4.0	-0.7
2020 – 2021 Average	**57.1 b**	**59.3 a**	**0.5**	**2.2**
	---------- Income ($/ac) ----------			
Average income	**$691**	**$690**		

Miravis Neo cost = $19.25 per acre Application cost = $8.00 per acre

Figure 1. Yield difference from a foliar application of Miravis Neo fungicide in 2020 and 2021



*The yield difference was statistically significant at these locations.

White Mold Fungicide Application Timing Trial

Purpose: Foliar fungicides can be an important tactic for reducing yield loss from white mold, especially when combined with other effective management practices such as resistant or tolerant varieties, wide rows, reduced planting rates, tillage decisions and irrigation water management. Properly timing fungicide applications is essential for success but challenging for producers. The purpose of this trial was to determine the effect of fungicide application timing on soybean yield and income in 2021. Another goal was to use the yield data from this trial to validate Sporecaster, a relatively new white mold apothecia prediction application for smartphones.

Procedure: The trial compared two different fungicide application timings to an untreated control at three locations previously infested with white mold. The application timings were R1 (one open flower on 50 percent of the plants and R3 (one pod >3/16" long on any of the upper four nodes on the main stem). Propulse® fungicide was applied at a rate of 6 ounces per acre for both application timings. We entered the dates for the R1 and R3 applications into the Sporecaster app to determine the apothecia risk level for the dates and locations. White mold incidence was also determined at all locations.

Results: White mold did not occur at the Berrien or Sanilac 2 sites but was present at low levels at Sanilac 1. As expected, the fungicide performed best at the Sanilac 1 site where both application timings increased soybean yields and income compared to the untreated control. At this site, yield increases ranged from 4.6 bushels per acre for the R1 timing to 6.8 bushels per acre for the R3 timing. Income was increased by $30 per acre at the R1 timing and by $57 per acre at the R3 timing. Neither fungicide application timing increased yields over the untreated control at the other two locations. When the product and application costs were subtracted from the gross income for each treatment, the income ranking for the treatments averaged across all three sites was R3 > R1 > control.

White mold apothecia

Bird's nest apothecia (Commonly confused with white mold apothecia)

The Sporecaster app did not recommend spraying for white mold at either application date at any of the locations in 2021. However, the risk was greater at the R3 application timing than at the R1 at all locations.

We want to thank Bayer CropScience for providing the Propulse fungicide and Dr. Martin Chilvers for his input and photos.

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

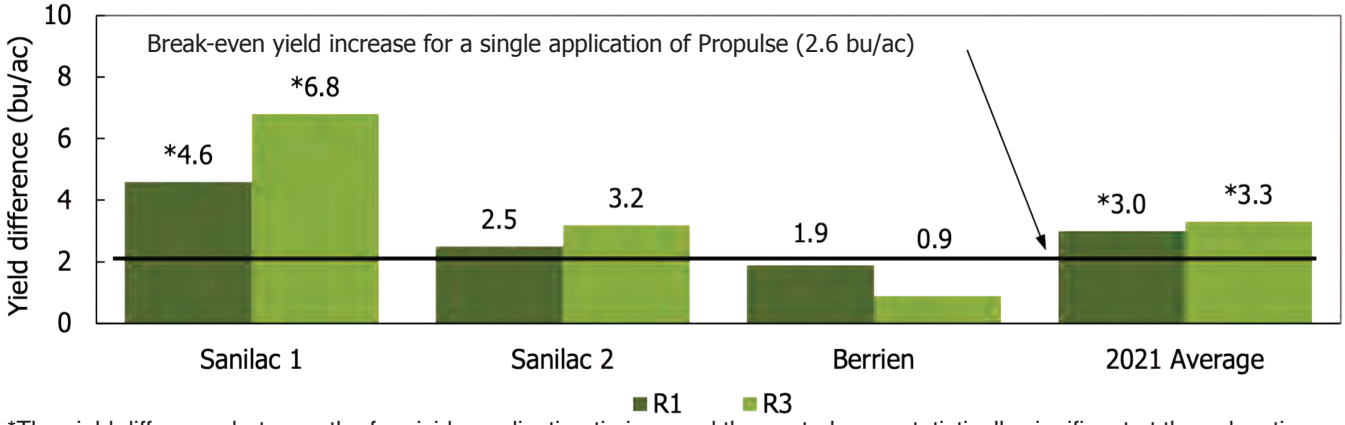
Location	Soybean variety	White mold resistance/tolerance of soybean variety	Planting date	Planting rate (seeds/ac)	Row spacing	Application dates
Sanilac 1	Asgrow AG18FX1	5 (1=excellent and 9=poor)	April 26	130,000	20	July 1 and July 13
Sanilac 2	Renk 61950E	8 (9=excellent and 1=poor)	May 5	160,000	7.5	July 3 and July 19
Berrien	Credenz 3099GTLL	4 (1=excellent and 9=poor)	May 2	140,000	15	July 7 and July 27

Table 2. White mold foliar fungicide application timing effect on soybean yield and income in 2021

Location	Untreated control	R1	R3	LSD $_{0.10}$
	---------- Yield (bu/ac) ----------			
Sanilac 1	69.3 b	74.0 a	76.1 a	2.3
Sanilac 2	35.2	37.7	38.4	3.2
Berrien	64.3	66.1	65.2	7.1
Average	**56.3 b**	**59.3 a**	**59.9 a**	**2.5**
	---------- Income ($/ac) ----------			
Average income	**$681**	**$692**	**$699**	

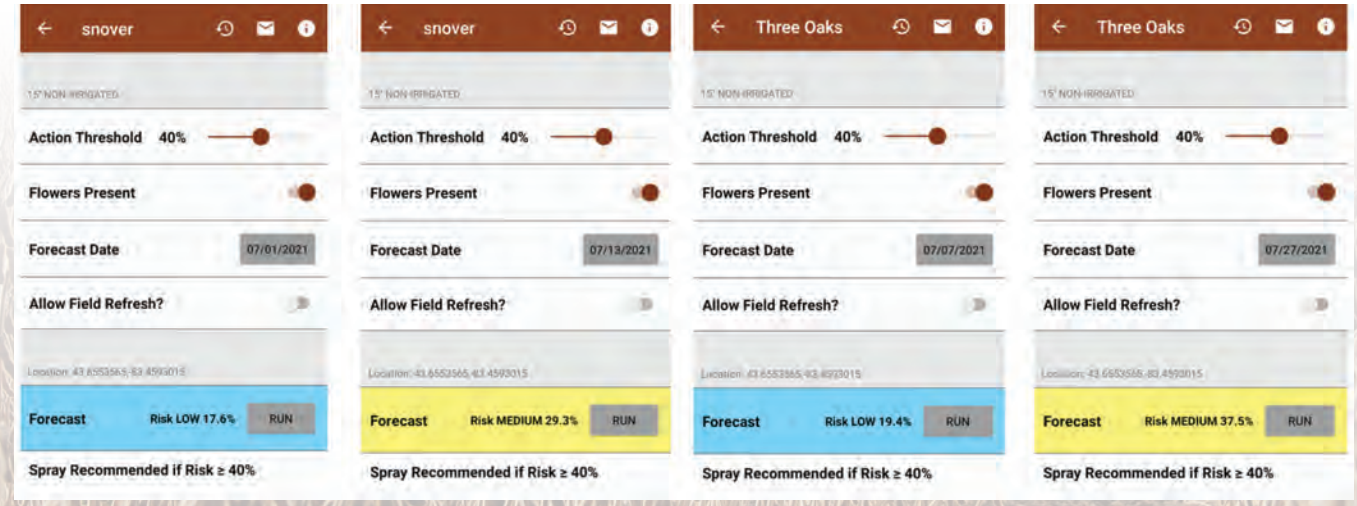
Propulse fungicide cost for a single application = $17.30 per acre, application cost = $8.00 per acre

Figure 1. Yield difference produced by a single fungicide application at two different timings when compared to the untreated control in 2021



*The yield difference between the fungicide application timings and the control were statistically significant at these locations.

Screenshots generated by running the Sporecaster app for the Snover and Three Oaks sites.



Sporecaster is a free app available for download in the App Store and Google Play.

Rumored herbicide shortages in 2022: What should we consider?

Christy Sprague, Professor and Weed Extension Specialist, Michigan State University

Supply chain disruptions have impacted almost all aspects of our lives, including the crop protection industry. While a majority of these disruptions caused only minor issues for farmers during the 2021 growing season, speculations on herbicide shortages appear to be a major concern for 2022. In fact, some of these herbicides are currently scarce, and many have become more expensive. The two main herbicide active ingredients that are rumored to be in short supply (and where prices have increased substantially) are glyphosate (Roundup, others) and glufosinate (Liberty, others). While there are other herbicide active ingredients that will likely also have limited supply, shortages of glyphosate and glufosinate will pose some major weed management challenges in soybeans. To help minimize these effects, below are some considerations on how best to overcome potential glyphosate and glufosinate shortages.

- **Resources to choose alternative herbicides.** The MSU Weed Control Guide for Field Crops (E0434) will be a crucial tool in searching for alternatives to glyphosate and glufosinate when planning your weed control program. The 2022 edition will be available starting December 20 at https://shop.msu.edu/collections/msu-extension-bookstore and will be provided at several MSU Extension Pest and Crop Management Update meetings. Additional weed control information can be found at www.MSUweeds.com.
- **Choosing a soybean technology that gives you more than one option for glyphosate- and multiple-resistant weed control.** Planting Enlist E3 or XtendFlex soybeans provides additional options for controlling resistant weeds that do not solely rely on glufosinate (Liberty).
- **Spring tillage as an alternative to a herbicide burndown.** Tillage needs to be done when weeds are small and soil conditions are conducive. Waiting to till large weeds can lead to survivors that will be harder to control with a postemergence (POST) herbicide. Vertical tillage tools are not effective for weed removal.
- **Burndown applications without glyphosate.** If glyphosate is omitted from the burndown, grasses become a bigger issue than broadleaf weeds. Alternative options for grass control include Gramoxone and the ACCase herbicides (clethodim and quizalofop). ACCase herbicides need 60° F days and work best when applied alone. Reduced rates of glyphosate (0.38 lb ae/A) will control most annual grasses.
- **Effective soil-applied (PRE) residual herbicide programs are necessary.** The use of a good soil-applied program will reduce the number of weeds that will need to be controlled by a POST herbicide program. Focusing PRE herbicide selection on herbicide-resistant and hard to control broadleaf weeds will be important. There are several POST options available for grass control.
- **POST options for weed control.** Herbicide-resistant weeds limit our options for POST weed control. Most POST herbicide options will focus on trying to manage these weeds.
- **Where is your limited glyphosate or glufosinate supply most beneficial?** It is important to consider where you will get the most benefit from the limited supplies of these herbicides that you may be able to secure. This may include using glyphosate in a different crop (i.e., sugarbeet) or applying reduced labeled rates for easier to control weeds (i.e., grasses).

Fertilizer Management Considerations When Prices Are High

Kurt Steinke, Associate Professor, Soil Fertility and Nutrient Management, Michigan State University

With the 2021 growing season behind us, we now turn our attention towards 2022, and fertilizer prices seem to be dominating the discussion. While several factors worldwide have contributed to tightened supply chains and increased prices, now is a great time to think about some options to reduce costs for the upcoming growing season. Here are some considerations to ponder over the coming months regarding soil fertility and fertilizer management.

1. If there ever was a time to get an updated soil test report or perhaps increase the precision or frequency of your soil sampling program, now may be the perfect time. Research has shown maintaining soil nutrient levels above critical concentrations is key to maximizing economic returns.

2. Consider whether you actually need to apply fertilizer. When soil test levels are high, the likelihood of a yield response significantly declines. Utilize what has been applied over previous years to build up soil test levels and allow the soil to supply those nutrients to the plant. While a plant biomass response may still occur in response to a fertilizer application, it is important to not confuse a biomass response with a grain yield response. View the soil as a bank in which deposits in the form of P or K for example have been made, and now may be the perfect time to withdraw some of that investment and reduce or eliminate fertilizer applications for the coming year.

3. If you have the desire to apply something, consider whether fertilizer is the best option. Soil pH is a property that has been forgotten through the years or labeled as less important in modern production agriculture. This couldn't be further from the truth! In fact, some of the nutrient deficiencies you may be observing in soybean fields may be tied directly to soil pH. Other problem areas including nodulation and soybean cyst nematode may also correlate with soil acidity. If you haven't analyzed soil pH recently or have that one troublesome, poor-yielding area in a field, take a look now - you may be surprised by how low the soil pH has become.

4. Be mindful of distractions. There are bound to be additional product availability disruptions, pricing volatility, and of course spring weather variability as we do live in Michigan after all. Have a plan in place and calmly be able to pivot when something changes your plans. Read product labels and understand what and how much is being applied. Despite many claims of improved efficiencies at low application rates, research has shown utilizing low fertilizer application rates to improve nutrient use efficiency does not consistently increase yield, and soybeans have not been responsive to these low at-plant nutrient rates.

Ionia County Rye Termination Timing Trial

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