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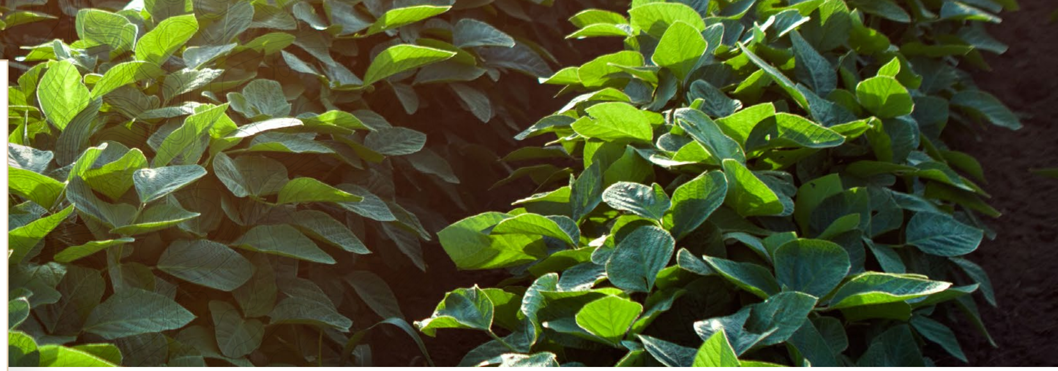


The best soybean management practices by Extension researchers from across the United States

Foliar Fertilizers Rarely Increase Yield in U.S. Soybean

Foliar Fertilizer Overview

There is interest among farmers and agronomists to test different fertilizer products to improve soybean yield. With increasing soybean yields across the U.S., there are concerns that fields with higher yields may need supplemental fertilizer. Soybean farmers are interested in foliar products that apply a mixture of micronutrients and macronutrients and can be tank-mixed with insecticides and fungicides and applied during early reproductive growth (R1-R4). This timeline corresponds with a period of high nutrient uptake for soybean (Gaspar et al., 2017).

Foliar fertilizers enter the plant through the leaves, first passing through the waxy cuticle, then the cell wall, and finally the cell membrane. Foliar fertilizers enter leaves more quickly when stomata are open, since stomata aid passage past the waxy cuticle (Fageria et al., 2009). Macronutrients are more mobile than micronutrients in plant tissues, with the exceptions of Ca and S (Fageria et al., 2009). For immobile nutrients, foliar fertilization may help distribute essential nutrients to deficient plant parts.

Take Home Messages

- This coordinated study was conducted in 16 states at 46 sites.
- The tested prophylactic foliar fertilizers did not increase soybean yield.
- Foliar fertilizers did not change grain protein and oil concentration.
- Some tested prophylactic foliar fertilizers decreased profitability, and no tested products increased profitability.

This paper is Open Access! More details about the trial, including individual site results, are available in the full publication at: https://doi.org/10.1002/agj2.20889

Past Foliar-applied Macronutrient Trials

Past foliar fertilizer research has shown inconsistent impacts on soybean yield, with soybean yield increases associated with N-P-K-S application of up to 8 bu/A observed in Iowa in the 1970s (Garcia L. & Hanway, 1976) despite a contemporaneous study in Wisconsin showing much smaller yield increases associated only with N application (Syverud et al., 1980). In a Minnesota study, the yield benefit to N-P-K-S foliar fertilization was only observed in one out of 16 trial site-years, and no yield benefit to micronutrient application (Poole et al., 1983).

Larger studies in the 1990s in Iowa showed small, inconsistent increases in yield with early-season prophylactic foliar fertilizer application, including yield increases in plots treated with N-P-K of less than 1 bu/A at 10 out of 48 site-years (Haq & Mallarino, 1998). In a subsequent on-farm strip trial testing N-P-K fertilization, there was a 0.5 bu/A increase in soybean yield at one out of eight sites (Mallarino et al., 2001). The associated small-plot trial tested a wider range of nutrient rates and had two responsive locations out of 18 with a 1.4 to 5.3 bu/A increase in soybean yield when N, P, and K were applied (Mallarino et al., 2001).

Agronomists in Michigan have performed extensive foliar fertilizer trials in soybean since 2000. Out of the 51 location N-P-K product trials, four locations had increased yield in fertilized plots. Three of 18 locations in Michigan had higher yield in N-treated plots than control plots (Staton, 2019).

Past Foliar-applied Micronutrient Trials

Prophylactic application of micronutrients has shown similarly minimal effects on soybean yield. Between the 1980s and today, trials in Iowa, Minnesota, and Michigan have not shown a yield increase in soybean associated with Fe, Zn, B, Co, Cu, Zn, Mn, or Mo foliar prophylactic application (Mallarino et al., 2001; Poole et al., 1983). Rare response to micronutrients has been observed in Ohio, where less than 2% of Mn trials have seen an increase in yield when fertilizer was applied and less than 5% of trials treated with a mixture of Mn, Fe, Cu, Mo, and B fertilizers had an observed soybean yield increase (Sharma et al., 2018). In Michigan fields with high pH lakebed soils that are likely to respond to Mn application, foliar Mn application only increased yield when it was applied after visual symptoms of nutrient deficiency began, but not when Mn was applied prophylactically (Staton, 2019).

Trial Objectives

Past foliar fertilizer research indicates that yield increases are infrequent. This study was a coordinated effort across 16 states to test the effects of macronutrient and micronutrient foliar fertilization across the primary soybean producing region of the U.S. and includes a broad range of commercially available foliar fertilizer products. The objectives of this study were to:

- Identify soybean grain yield response to prophylactic foliar fertilizer application across a broad range of environments.
- Determine if foliar fertilizer application changes soybean grain composition.
- Conduct economic analyses on the value of these products in U.S. soybean production.

Tested Products

Foliar fertilizer products vary based on the nutrients they contain and their relative concentrations, the formulation of the product, the recommended product rate, and other application recommendations. In this trial, we selected six commercially available foliar nutrient products that are marketed nationwide for soybean production. These products included different nutrients at different rates (Table 1).

Each product label included different application instructions, including recommended rates and application timings. We applied all treatments at the R3 soybean growth stage (beginning pod) and used an application rate within the range specified on each product label (Table 2.)

Table 1. Nutrients applied for each treatment in lb./A.

Treatment Name	N	P	K	S	Mn	Fe	Mo	Zn	B	Other
FertiRain™	3.5	0.9	0.9	0.5	0.02	0.03	-	0.03	-	-
Sure-K®	0.6	0.3	1.7	-	-	-	-	-	-	-
Harvest More® Urea Mate	0.1	0.25	-	-	0.01	-	0.002	0.01	-	Ca, Mg, B, Co, Cu
BRANDT® Smart B-Mo	-	-	-	-	-	-	0.006	-	0.07	-
BRANDT® Smart Quatro® Plus	-	-	-	0.04	0.08	-	0.003	0.08	0.06	-
MAXIMUM N-PACT® K	1.9	-	1.9	-	-	-	-	-	-	-
Untreated Control	-	-	-	-	-	-	-	-	-	-

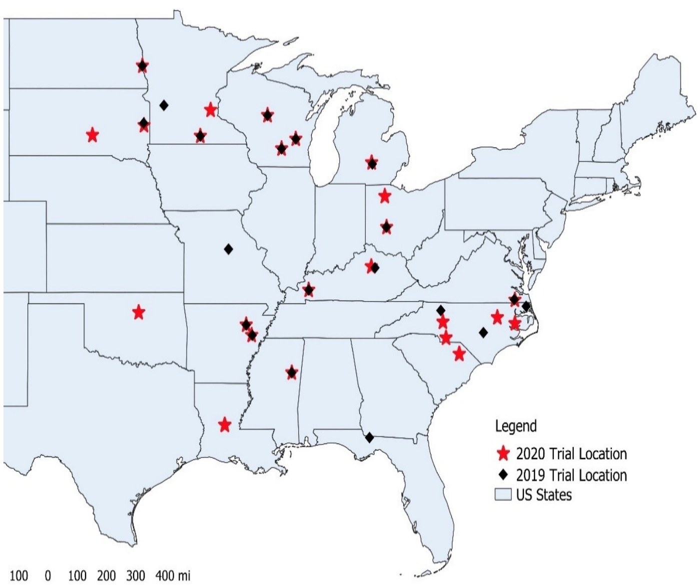
Table 2. List of foliar products names, brands and application rate.

Treatment Name	Company	Application Rate
FertiRain™	AgroLiquid	3 gal/A
Sure-K®	AgroLiquid	3 gal/A
Harvest More® Urea Mate	Stoller	2.5 lbs/A
BRANDT® Smart B-Mo	BRANDT	1 pt/A
BRANDT® Smart Quatro® Plus	BRANDT	1 qt/A
MAXIMUM N-PACT® K	Nutrien	1.5 gal/A
Untreated Control	-	-

Trial Methods

Small-plot field trials took place in 2019 and 2020 at a total of 46 sites in 16 states (Figure 1). The six foliar nutrient products (Table 2) and an untreated control were applied in a randomized complete block design with four to eight replications depending on site. Products were applied at soybean growth stage R3 to align with commonly used fungicide and insecticide application timing. Site soil properties and management practice are summarized in Supplemental Table 1.

Figure 1. Trial locations in 2019 and 2020, displayed with red stars and black diamonds, respectively. South Carolina and Louisiana have two nearby sites each that appear as a single marker due to the scale of this map.



Products were applied to plots using backpack sprayers at the R3 growth stage. Leaf tissue samples were taken before foliar products were applied at R3 and two weeks following application. At both sampling time points, the newest fully expanded trifoliate leaf was collected from 20 plants per plot and dried in paper bags before being shipped to the North Carolina Dept. of Agriculture & Consumer Services Agronomic Division (Raleigh, North Carolina) for analysis.

Yield data were collected using plot combines at each site and adjusted to 13% moisture. Grain protein and oil concentrations were measured via near-infrared spectroscopy (NIR) and reported at a standard moisture of 13%.

Analysis Methods

Cost of foliar fertilizer products were assessed by calling retailers in the study region in 2019 and averaging the cost of product per acre at the application rate used in the study (Table 2). Partial profits were calculated by multiplying yield by the price of soybean grain and subtracting the cost of the foliar fertilizer product. Application costs were not considered since these products are frequently applied by farmers as part of a tank-mix with foliar fungicides and insecticides. Calculations were performed at \$10 and \$15 per bushel to be reflective of recent soybean prices.

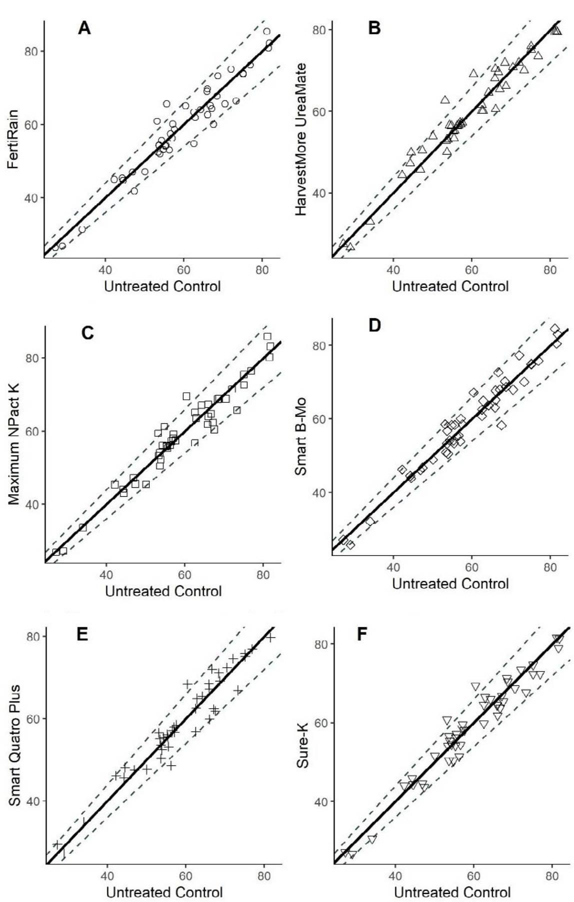
Change in tissue nutrient concentration was calculated by subtracting nutrient concentration from the pre-application samples from the nutrient concentration from the two-week post-application samples. Details on the statistical analysis used can be found in the scientific publication.

Results

The treated plots and untreated control plots yielded similarly. Each subplot in Figure 2 compares yield in a fertilized treatment to yield in the untreated control. When points fall above the solid line, it indicates that the fertilized plots yielded higher than the untreated control plots at a particular site. Points falling below the solid line indicate a site where the untreated control plots yielded higher than the fertilized plot. When points are between the solid line and dashed line, the treated and untreated plots at that site yielded within 10% of each other. The few points that fell above the 10% yield increase line tended to have average yields near 60 bu/A. All sites with average yields higher than 80 bu/A had mean treated plot yield within 10% of the untreated control plots for all foliar fertilizer products (Figure 2). Observed differences in yield among treatments were not statistically significant ($F=0.23$, $p=0.9663$). There was not a significant interaction between site and treatment, which indicates that all products performed similarly across all sites.

Given the uniformity of the response across these 46 sites, there is no evidence that foliar fertilizers increase soybean yield in the absence of visual symptoms of nutrient deficiency. Similar results were observed in a smaller geographic area in past trials from Iowa and Michigan, where micronutrient and macronutrient foliar fertilization did not consistently increase soybean grain yield (Mallarino et al., 2001; Staton, 2019).

Figure 2. Average yield (bu/A) at each site for each treatment plotted against the average yield of the untreated control at the same site for treatments (A) FertiRain™, (B) Harvest More® Urea Mate, (C) MAXIMUM N-PACT® K, (D) BRANDT® Smart B-Mo, (E) BRANDT® Smart Quatro® Plus, and (F) Sure-K®. Solid lines represent x=y, and the dashed lines represent ±10% of yield.



The sites tested in this trial included a wide range of soil chemical and physical properties (Supplemental Table 1). When analyzed individually, four of the 46 site-years had significantly different yield between treatments, but there was not a discernable reason for those four sites to respond when 42 did not. Soil properties were not necessarily predictive of yield response. Sites such as Princeton, Kentucky (2020) and Fargo, North Dakota (2019), had soil test P concentration below 15 ppm, but did not have a yield response to treatment. Site soil pH ranged from 4.7 to 8.3, and generally sites with pH higher than 7.5 or 8 have lower micronutrient availability. All four responsive sites had soil pH between 6.5 and 7.3, and pH was not predictive of site responsiveness.

Average protein and oil content across all sites and treatments was 37.6% and 20.6%, respectively. Differences in grain protein and oil content were observed among sites but not treatments. At nutrient application rates currently recommended by foliar fertilizer manufacturers, there is no evidence that fields that receive foliar fertilizer should be expected to have different grain protein or oil content as compared to fields that do not receive foliar fertilizer.

Across all sites and treatments, average leaf tissue Ca, Mn, and B concentration increased slightly between the pre-application sampling and the two weeks after application timepoint. Leaf tissue S concentration did not change between sampling timepoints, and concentration of N, P, K, Mg, Fe, and Cu decreased by less than 10% between the pre-application sampling timepoint and the two weeks after application timepoint. This is likely due to soybean plants partitioning an increasing proportion of their nutrient uptake to seeds relative to other plant parts after R4 (Gaspar et al., 2017). Across all nutrients tested, there was a significant difference in leaf tissue nutrient content among sites. Leaf tissue Mn, Cu, and B content varied among treatments.

Cost of foliar fertilizer products ranged from $3.64 to $22.27 per acre. Partial profits were different among treatments and sites at both tested soybean grain prices ($10 and $15 per bushel), and there was no interaction between treatment and site at either tested soybean grain price. At $15 per bushel, plots treated with MAXIMUM N-PACT® K had $24 per acre lower profits than the untreated control and at $10 per bushel, plots treated with MAXIMUM N-PACT® K, Sure-K®, and FertiRain™ had lower profits than the untreated control by $23, $21 and $21 per acre, respectively (Table 3). While other treatments did not have statistically lower profits than the untreated control at the tested grain prices, application of foliar fertilizer products included in this study would not increase profit since foliar fertilizer treatments did not statistically increase soybean grain yield. Further reductions in profit may occur when applying foliar fertilizer using a ground-based applicator since wheel damage can reduce soybean yield by 3%-5% after R1 (Hanna et al., 2008).

Table 3. Mean partial profit at two soybean grain prices and mean grain yield, oil concentration, and protein concentration among foliar fertilizer treatments.

Treatment	Mean partial profit at soybean grain price of $15 per bu	Mean partial profit at soybean grain price of $10 per bu
	USD per acre	USD per acre
Untreated Control	891 a*	595 a
BRANDT® Smart B-Mo	890 ab	593 a
Harvest More® Urea Mate	888 ab	591 a
BRANDT® Smart Quatro® Plus	878 ab	584 ab
FertiRain™	871 ab	574 b
Sure-K	870 ab	574 b
MAXIMUM N-PACT® K	867 b	572 b

*Means not sharing common letters within each column denote statistical differences among treatments (α = .05). Bonferroni adjustments were used to adjust for multiplicity.

Recommendations

Prophylactic foliar fertilizer applications did not consistently increase soybean yield or alter grain composition when applied at rates recommended by their manufacturer. Based on the results of this study and the current body of published agronomic research, there is no scientific evidence to support the use of foliar fertilizer products on soybeans in the absence of visual symptoms of nutrient deficiency.

Learn More

Further information on this trial, including individual site results, is available in the full publication at: https://doi.org/10.1002/agj2.20889.

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Supplemental Table 1. Planting date, management information and soil test result at each site. Phosphorous was extracted using Bray1-P ICP methods unless otherwise specified. Tillage and Irrigation were summarized as yes (Y) or no (N) variables. Soil texture for sites that did not measure soil particle size distribution was reported by each site using soil survey records.

Year	Site	Tillage	Irrigation	Planting Date	Harvest Date	Seeding Rate	Previous Crop	Relative Maturity	Row Space	pH	Buffer pH	Organic Matter	P	K	Mg	Ca	Na	CEC	Sand	Silt	Clay	Texture Class
						1000 s/A			in			%	-------------- ppm			--------------		cmol $100g^{-1}$	------- %		------	
2019	Newport, AR	Y	Y	1-Jul	17-Oct	150	corn	4.6	15	6.3	6.9	1.6	101	127	128	621	18	5.7	.	.	.	Silt Loam
2019	Pine Tree, AR	Y	Y	15-Jun	17-Oct	150	soybean	4.6	15	6.7	7.0	2.0	23	76	208	1175	234	8.9	.	.	.	Silt Loam
2019	Florida	Y	Y	18-Jun	14-Nov	.	winter oats	7.6	36	6.0	7.3	0.6	63	39	28	350	.	2.1	88	6	6	Sand
2019	Lexington, KY	N	Y	21-May	3-Oct	120	corn	3.8	15	.	.	.	.	.	.	.	.	.	.	.	.	Silty Clay Loam
2019	Princeton, KY	N	N	28-May	4-Oct	140	corn	4	15	6.5	6.9	2.2	5	117	87	1530	13	9.7	8	62	29	Silty Clay Loam
2019	Michigan	Y	N	16-May	23-Nov	130	corn	2	15		6.9	2.1	45 *	111	145	1227	9	9.5	42	34	24	Loam
2019	Danvers, MN	Y	N	2-Jun	17-Oct	140		1.7	30	8.1	.	4.4	54	320	870	5533	40	35.9	51	27	22	Sandy Clay Loam
2019	Minnesota Lake, MN	Y	N	16-May	16-Oct	140		2.1	30	6.0	6.7	4.8	20	151	411	2325	13	20.0	28	36	35	Clay Loam
2019	Mississippi	Y	Y	2-Jul	24-Oct	130	corn	4.8	38	8.3	.	2.6	95 *	167	64	7344	15	37.8	35	28	38	Clay Loam
2019	Missouri	N	N	20-May	28-Oct	160	corn	4.1	30	5.8	.	2.4	21	125	.	.	.	.	12	69	19	Silt Loam
2019	Currituck, NC	Y	N	9-May	25-Oct	120	corn	5.4	15	5.9	6.9	1.6	23	51	189	613	21	6.4	31	51	18	Silt Loam
2019	Sampson, NC	Y	N	22-May	24-Oct	120	corn	5.6	15	6.0	6.9	1.0	113	62	46	325	17	3.5	80	14	7	Loamy Sand
2019	Yadkin, NC	N	N	21-May	7-Nov	120	soybean	6.4	30	5.5	6.9	1.9	66	68	54	338	12	3.6	65	20	16	Sandy Loam
2019	North Dakota	N	N	17-May	29-Oct	185	spring wheat	0.8	14	7.8	.	5.3	14	383	.	.	.	.	10	39	51	Clay
2019	Ohio	Y	N	22-May	10-Oct	150	corn	3.3	15	5.8	6.7	3.1	34 *	122	351	1995	.	17.1	20	52	28	Clay Loam
2019	South Dakota	N	N	8-Jun	26-Oct	150	corn	1.4	30	6.1	6.7	4.9	24 *	157	638	2763	.	23.1	21	49	31	Silty Clay Loam
2019	Virginia	Y	N	26-Jun	25-Nov	220	winter wheat (double crop)	5.6	15	6.3	.	1.1	34 §	130	115	973	.	3.9	.	.	.	Sandy Loam
2019	Arlington, WI	Y	N	13-May	9-Oct	140	corn	2	15	7.0	.	3.9	62	146	601	1825	36	14.7	24	48	29	Silt Loam
2019	Fond du Lac, WI	Y	N	7-Jun	12-Nov	140	corn	2	15	7.3	.	3.1	30	169	476	1463	18	11.9	16	60	25	Silt Loam
2019	Marshfield, WI	Y	N	17-May	27-Oct	140	corn	2	15	6.7	.	4.3	28	219	423	1150	37	10.7	23	56	21	Silt Loam
2020	Newport, AR	Y	Y	2-Jun	3-Nov	150	corn	4.5	15	5.5	6.7	1.9	36	114	100	957	.	9.4	.	.	.	Silt Loam
2020	Pine Tree, AR	Y	Y	16-Jun	21-Oct	150	rice	4.5	15	7.1	7.2	2.2	18	99	264	1324	.	9.2	.	.	.	Silt Loam
2020	Lexington, KY	N	Y	26-May	14-Oct	120	corn	3.9	15	6.4	6.9	4.2	150 *	84	191	2214	.	14.5	12	73	15	Silt Loam
2020	Princeton, KY	N	N	22-Apr	22-Oct	150	corn	4.6	15	4.7	6.8	1.8	8 *	206	82	1527	.	.	.	.	.	Silt Loam
2020	Chambers-East, LA	Y	N	22-Apr	16-Sep	123	soybean	4.5	38	8.1	.	0.8	21	67	183	2758	14	15.6	.	.	.	Silt Loam
2020	Chambers-West, LA	Y	N	22-May	8-Oct	123	corn	4.9	38	7.9	.	1.2	23	94	234	2408	19	14.3	.	.	.	Silt Loam
2020	Michigan	Y	N	13-May	20-Oct	130	corn	2	15	7.4	.	2.3	16	67	260	1200	.	8.4	53	30	17	Loam
2020	Minnesota Lake, MN	Y	N	1-May	6-Oct	140	corn	2	30	.	.	.	.	.	.	.	.	.	.	.	.	Clay Loam
2020	St. Paul, MN	Y	Y	26-Apr	30-Sep	140	corn	1.6	30	.	.	.	.	.	.	.	.	.	.	.	.	Silt Loam
2020	Mississippi	Y	Y	14-May	1-Oct	130	cotton	4.6	38	6.2	6.8	2.2	53	144	72	2110	.	.	.	.	.	Silty Clay Loam
2020	Beaufort, NC	Y	N	15-May	3-Nov	100	corn	5.6	30	5.8	6.4	5.0	74	148	286	1250	.	15.8	47	33	20	Loam
2020	Nash (Rocky Mount), NC	Y	N	26-May	15-Oct	117	cotton	4.7	36	6.5	7.1	1.2	35	100	98	483	.	3.5	63	28	8	Sandy Loam
2020	Rowan (Salisbury), NC	N	N	8-May	20-Oct	120	cereal rye cover crop	5.2	30	6.7	6.9	5.4	207	242	290	2000	.	13.7	38	35	27	Clay Loam
2020	Union, NC	N	N	26-Jun	6-Nov	140	soybean	5.5	15	5.9	6.9	4.6	63	85	180	733	.	7.0	18	66	17	Silt Loam
2020	North Dakota	N	N	20-May	2-Oct	185	spring wheat	0.6	14	7.7	.	5.5	31	426	1489	3906	36	33.2	12	28	60	Clay
2020	Hoytville, OH	Y	N	12-May	2-Oct	140	corn	3.3	15	7.0	.	4.3	55 *	160	501	2562		17.4	24	28	48	Clay
2020	South Charleston, OH	Y	N	7-May	14-Oct	140	corn	3.3	15	5.9	.	5.4	63 *	211	595	3245		26.5	20	34	46	Clay
2020	Oklahoma	Y	Y	12-May	15-Oct	97	wheat/fallow	4.8	30	7.2	.	1.1	147*	110	751	2259	.	.	.	.	.	Clay loam
2020	Dargan Pond, SC	Y	N	15-May	6-Nov	120	peanut	8	30	6.2	7.2	0.7	227	26	41	288	.	1.8	.	.	.	Loamy Sand
2020	Rock Rd, SC	Y	N	5-Jun	6-Nov	120	cotton	6.9	30	6.6	7.0	0.5	84	44	50	225	.	1.7	.	.	.	Loamy Sand
2020	Brookings, SD	Y	N	20-May	2-Oct	150	corn	1.4	30	6.9	.	3.8	21 *	124	465	2813	.	18.8	42	32	26	Clay Loam
2020	Reliance, SD	N	N	11-May	12-Oct	150	corn	1.4	30	5.9	.	3.3	18 *	300	662	2108	.	21.0	13	52	35	Silty Clay Loam
2020	Virginia	N	N	4-Jun	25-Nov	140	corn	4.9	15	.	.	.	.	.	.	.	.	.	.	.	.	.
2020	Arlington, WI	Y	N	1-May	8-Oct	140	corn	2.0	15	7.2	7.2	4.3	53	237	520	1588	.	12.9	.	.	.	Silt Loam
2020	Fond du Lac, WI	N	N	1-May	9-Oct	140	corn	2.0	15	7.4	7.2	4.1	57	222	495	1550	.	12.5	.	.	.	Silt Loam
2020	Marshfield, WI	Y	N	5-May	15-Oct	140	corn	2.0	15	7.2	7.2	4.5	34	256	458	1275	.	10.9	.	.	.	Silt Loam

Supplemental Table 2. Treatment mean soybean grain yield, standard deviation in bushels per acre and the number of replications (Reps) per treatment at each site. BRANDT Smart Quatro® Plus was not applied at four Wisconsin sites, and Harvest More® Urea Mate was not applied at the Lexington, Kentucky, site in 2019. Individual site-year ANOVAs were calculated, and p-values represent the probability that yield differed between treatments at that site year.
Least significant differences were calculated only for sites with ANOVA p-values < 0.05.

Year	Reps	Site	Control		FertiRain		HarvestMore UreaMate		Maximum NPact K		Smart B-Mo		Smart Quatro Plus		Sure-K		P-value	LSD
			Yield	SD	Yield	SD	Yield	SD	Yield	SD	Yield	SD	Yield	SD	Yield	SD		
2019	6	Newport, AR	53.7	4.7	54.4	4.5	53.2	7.0	54.2	8.2	53.4	7.9	53.6	8.4	56.7	6.3	0.95	.
2019	5	Pine Tree, AR	62.7	7.0	63.5	6.8	60.3	6.2	65.2	4.1	62.6	2.3	62.6	6.4	64.7	5.5	0.38	.
2019	4	Florida	53.7	5.4	54.4	11.3	50.1	10.2	50.5	8.6	56.8	5.2	50.4	8.1	50.5	14.6	0.68	.
2019	6	Lexington, KY	67.6	4.8	60.1	8.9	--	--	60.5	7.6	58.3	9.6	61.9	16.2	65.6	6.8	0.32	.
2019	6	Princeton, KY	55.7	3.3	65.7	3.4	55.3	4.8	55.5	4.3	58.5	4.0	53.3	7.3	57.2	5.4	<0.01	507
2019	5	Michigan	34.1	4.4	31.4	4.6	33.0	9.9	33.6	5.4	32.2	7.3	35.0	4.8	30.6	5.7	0.79	.
2019	6	Danvers, MN	34.1	5.6	44.9	4.6	50.0	6.7	43.1	9.1	44.0	6.7	48.2	6.2	44.4	10.3	0.68	.
2019	6	Minnesota Lake, MN	53.4	1.2	52.5	0.4	52.8	3.0	53.3	3.2	51.0	4.4	55.2	2.7	54.3	3.7	0.14	.
2019	6	Mississippi	27.2	3.1	26.4	3.5	27.5	3.1	26.8	2.8	27.2	2.4	29.4	1.3	27.2	3.0	0.8	.
2019	6	Missouri	64.3	2.4	64.2	3.9	64.7	1.8	67.3	2.9	63.7	3.4	65.5	1.8	66.1	2.4	0.36	.
2019	6	Currituck, NC	77.0	2.1	76.4	2.1	73.6	3.0	76.7	4.5	75.9	2.4	77.0	3.9	72.5	3.3	0.09	.
2019	6	Sampson, NC	73.4	3.9	66.6	3.3	70.2	3.5	65.9	7.8	70.2	4.9	67.0	5.4	67.8	4.9	0.18	.
2019	6	Yadkin, NC	29.0	7.1	26.9	2.8	26.6	4.6	27.2	4.2	25.8	1.4	27.2	1.9	26.8	5.0	0.93	.
2019	8	North Dakota	53.9	5.7	52.1	5.9	53.1	5.3	52.3	4.8	50.6	7.4	52.5	7.7	55.4	4.5	0.5	.
2019	6	Ohio	75.2	3.5	73.9	3.2	76.1	3.4	75.7	3.3	75.1	4.4	75.2	4.6	74.8	3.0	0.85	.
2019	6	South Dakota	55.5	2.9	54.4	6.7	53.5	5.1	56.1	5.2	53.5	3.8	55.6	2.8	56.4	3.3	0.65	.
2019	6	Virginia	62.6	4.8	54.9	9.2	61.8	3.8	56.8	7.1	60.9	2.7	56.9	7.0	60.0	7.0	0.21	.
2019	6	Arlington, WI	81.9	4.7	82.5	6.6	79.5	7.3	83.3	4.7	83.1	4.1	--	--	81.5	6.9	0.84	.
2019	6	Fond du Lac, WI	54.8	4.7	53.2	6.7	56.5	7.3	61.4	6.8	58.4	5.4	--	--	50.5	6.9	0.03	433
2019	6	Marshfield, WI	47.5	7.1	41.9	6.3	50.5	8.9	45.6	10.2	46.8	8.2	--	--	43.7	6.8	0.51	.
2020	6	Newport, AR	56.7	9.8	57.5	8.4	56.7	9.2	57.3	7.3	55.6	6.6	57.2	7.3	54.5	5.2	0.89	.
2020	6	Pine Tree, AR	63.0	3.6	62.0	1.8	60.2	2.3	63.6	3.8	65.0	3.1	64.9	2.6	66.6	2.2	<0.01	190
2020	6	Lexington, KY	70.6	4.9	65.7	4.0	70.9	8.5	69.0	4.7	68.1	7.8	72.5	7.9	68.8	6.5	0.27	.
2020	6	Princeton, KY	68.8	5.3	73.4	8.4	66.3	12.0	69.0	6.2	68.8	5.9	69.2	7.3	70.6	8.6	0.8	.
2020	6	Chambers-East, LA	47.0	4.4	47.1	4.3	45.8	3.1	47.3	4.0	46.1	0.9	47.6	4.7	44.6	2.2	0.81	.
2020	6	Chambers-West, LA	60.5	4.7	65.3	5.2	69.2	4.7	69.6	9.1	67.3	5.4	68.5	13.2	69.6	4.7	0.35	.
2020	5	Michigan	56.3	14.5	53.2	12.3	56.5	14.5	56.1	9.4	55.3	16.0	48.6	8.3	51.5	10.5	0.83	.
2020	6	Minnesota Lake, MN	55.4	5.6	54.2	4.1	55.2	5.1	55.9	3.3	54.3	5.2	56.2	5.6	52.8	6.0	0.93	.
2020	6	St. Paul, MN	66.1	8.5	62.8	8.1	60.7	10.0	64.2	9.9	65.2	9.0	60.0	8.0	62.0	7.8	0.38	.
2020	6	Mississippi	57.1	3.3	56.4	2.7	57.4	4.5	58.2	4.9	54.0	3.9	58.0	3.7	58.7	5.1	0.51	.
2020	6	Beaufort, NC	44.3	4.5	45.4	2.8	47.3	3.7	44.2	1.4	44.6	4.0	45.8	3.4	46.0	2.9	0.57	.
2020	6	Nash (Rocky Mount), NC	67.2	7.2	64.4	8.8	65.5	8.0	62.4	7.6	68.1	10.1	62.5	8.4	66.9	13.5	0.84	.
2020	6	Rowan (Salisbury), NC	75.2	8.0	74.1	4.5	75.2	3.6	72.8	6.0	74.9	7.2	75.9	3.6	72.5	4.5	0.94	.
2020	6	Union, NC	54.4	7.1	55.8	4.8	56.7	7.7	56.2	9.3	54.3	6.0	55.4	7.2	54.6	5.8	0.88	.
2020	8	North Dakota	57.7	3.4	58.8	3.3	57.3	5.7	57.6	2.5	58.6	3.1	58.6	3.1	58.2	1.7	0.94	.
2020	6	Hoytville, OH	68.5	2.8	67.9	3.0	72.0	3.3	68.9	5.4	70.3	3.9	71.2	3.5	71.5	3.5	0.02	185
2020	6	South Charleston, OH	81.7	2.6	57.1	3.3	79.7	2.6	80.3	4.1	80.6	2.8	79.8	4.2	79.1	3.7	0.65	.
2020	7	Oklahoma	66.8	3.5	65.3	3.4	69.8	8.0	64.9	4.4	72.8	12.8	72.1	11.3	63.9	8.8	0.6	.
2020	4	Dargan Pond, SC	50.1	4.4	47.2	9.6	53.9	4.3	45.5	10.3	49.0	2.3	47.7	9.3	51.7	12.3	0.76	.
2020	4	Rock Rd, SC	53.2	6.8	61.0	1.8	62.7	0.5	59.5	7.2	58.6	3.4	56.7	6.6	60.9	0.8	0.27	.
2020	6	Brookings, SD	57.2	3.9	60.2	4.7	56.9	3.3	59.2	2.2	60.2	3.9	56.8	2.1	59.7	4.5	0.36	.
2020	6	Reliance, SD	42.2	5.6	45.1	3.8	44.4	6.0	45.4	5.4	46.3	2.8	46.2	4.9	44.1	3.6	0.39	.
2020	6	Virginia	66.1	3.5	69.9	3.0	70.5	5.3	67.5	4.5	67.8	6.6	67.3	6.8	64.6	6.2	0.3	.
2020	6	Arlington, WI	81.2	4.1	85.6	8.1	79.6	3.8	86.1	6.5	84.6	5.8	--	--	81.8	7.2	0.45	.
2020	6	Fond du Lac, WI	65.9	7.6	69.2	3.7	68.2	7.6	61.9	1.9	63.2	5.6	68.5	4.0	64.6	4.4	0.15	.
2020	6	Marshfield, WI	72.1	4.3	75.2	7.9	72.1	3.1	71.6	6.9	77.4	3.2	74.6	4.1	73.6	3.9	0.44	.
		All Sites	**59.5**	**13.6**	**59.7**	**14.0**	**59.6**	**13.7**	**59.3**	**14.0**	**59.7**	**14.2**	**59.1**	**13.4**	**59.4**	**13.9**		

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