AGRONOMY IN ACTION

2025

RESEARCH REPORT

Golden Harvest

AGRONOMY IN ACTION

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Golden Harvest

CORN MANAGEMENT FACTORS WITH THE LARGEST IMPACT ON YIELD IN 2024

INSIGHTS

- On average, sidedressing nitrogen (N) had the largest impact on yield in 2024 trials, although response was dependent on location.
- Favorable growing conditions in 2024 resulted in consistent responses to moderate-high seeding rate increases.
- Selecting the right hybrid, matched with the optimal seeding rate, and utilizing a systems approach to management was the key to achieving high yield.

CROP MANAGEMENT PRACTICES TRIAL PARAMETERS

Corn production is a complex and dynamic process that requires farmers to make numerous critical decisions throughout the year. These decisions can significantly impact yield potential and profitability. Yearly differences in environment and weather make these decisions even more challenging.

In 2024, the Golden Harvest Agronomy in Action research team implemented a trial to understand which core crop management practices had the largest impact on corn yield across six Midwest locations. The core management practices evaluated were:

1. **Incremental Fertility:** 17 N, 35 P_2O_5, 32 K_2O, 17 S, and 0.14 Zn lbs per acre banded with the planter
2. **Sidedress N:** 60 lbs/A of N applied as 32% UAN surface-banded along the base of the plant at the V5 growth stage
3. **Fungicide:** Miravis® Neo (13.7 oz/acre) foliar fungicide applied at the R1 growth stage
4. **Seeding Rate:** 32,000, 36,000 or 40,000 seeds/A

Figure 1. Visual growth difference between base treatment (left) and combination treatment (right) at Clinton, IL in 2024. Combination treatment would have received additional fertility at planting and sidedress N when image was captured.

The fertility, sidedress N, and fungicide treatments were each individually added to the base management system at all three seeding rates to determine what impact they had on yield. In addition, all treatments were applied in combination to evaluate potential synergistic effects with intensive crop management. The fertility and sidedress N treatments were added incrementally to the grower's normal fertility program. Two hybrids were used at each location, either G01U74 and G03U08 brands or G10U97 and G13U96 brands, depending on the geography.

MANAGEMENT EFFECT ON YIELD

Yield environments ranged from 220 Bu/A at Grundy Center, IA, to 290 Bu/A at Clay Center, KS. Crop management had a significant effect on yield at all locations. When averaged across locations, 3 seeding rates, and hybrids, each management factor individually significantly increased yield. Fertility increased yield by 4 Bu/A, sidedress N by 8 Bu/A, and

	Location						
	Clay Center, KS	Clinton, IL	Grundy Center, IA	Janesville, WI	Malta, IL	Slater, IA	Average
Treatment	Yield (Bu/A)						
Base	290	264	222	270	244	260	259
+ Fertility	0	+5	+2	+3	+3	+13*	+4*
+ Sidedress N	+5	+10*	+11*	+7*	+4	+11*	+8*
+ Fungicide	+1	+10*	+2	+2	+13*	+8	+6*
+ Combination	+12*	+11*	+17*	+20*	+11*	+25*	+16*

Values represent yield difference (Bu/A) compared to the base treatment.
* significantly different than base treatment at α=0.10
Table 1. Effect of management factor on yield averaged across seeding rate and hybrid at 6 locations in 2024.

fungicide by 6 Bu/A (Table 1). The combination of all three treatments applied together had an additive effect and boosted yield by 16 Bu/A.

Slater, IA, was the only location that had a significant response to incremental fertility, increasing yield by 13 Bu/A (Table 1). It was also the only location that had low soil test potassium levels (165 ppm). All other locations were considered to have adequate phosphate and potassium soil test levels. Fertility was the single factor that provided the highest yield response when it was limited illustrating the importance of implementing a solid base fertility program before considering additional management.

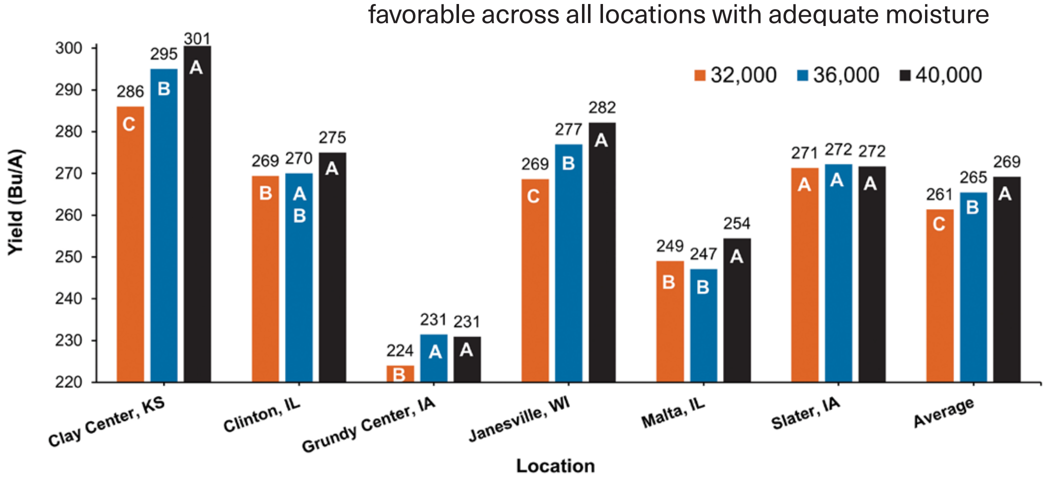
Applying an additional 60 lbs/A of N at the V5 growth stage increased yield by 4 to 11 Bu/A, depending on the location. N also provided the largest yield response of any single factor at 4 out of the 6 locations (Clay Center, KS, Clinton, IL, Grundy Center, IA, and Janesville, WI, Table 1). All locations experienced above-average precipitation during May and June, likely moving preplant N below the rooting zone. Plants benefited from additional N applied in-season.

Overall, disease pressure was low across sites. Yield response to fungicide ranged from 1 to 13 Bu/A across locations (Table 1). Only corn grown at Clinton, IL, and Malta, IL, had a significant response of 10 and 13 Bu/A, respectively. Corn at Clinton, IL had some gray leaf spot but it did not progress up the canopy. Malta, IL had tar spot but did not show visual symptoms until the late grain fill period, likely having minimal impact on yield. The response to fungicide is likely driven by the increase in plant health and stay-green effect, prolonging the grain fill period.

When all three management factors were applied in combination, yields were increased by 11 to 25 Bu/A depending on location (Table 1). 3 out of the 6 locations experienced a synergistic effect where the yield increase from the combination treatment was greater than the sum of yield gains from each individual factor. A synergistic effect often occurs because early season management can help set a higher yield potential and later season management maintains that yield potential by aiding with grain fill. A systems approach, rather than one individual management practice, is the key to achieving high yields.

SEEDING RATE EFFECT ON YIELD

When averaged across location, hybrid, and management factor, seeding rate had a significant effect increasing yield by 1 Bu/A for every additional 1,000 seeds/A from 32,000 seeds/A up to 40,000 seeds/acre (Graph 1). Overall, growing conditions were favorable across all locations with adequate moisture



Different letters within a location illustrate significant difference at α = 0.10.
Graph 1. Effect of seeding rate on yield averaged across management factor and hybrids at 6 locations in 2024.

for much of the growing season. It tended to get drier in late August and September but yield environments were still high. Favorable growing conditions this season minimized much of the stress often seen with higher plant densities, resulting in a greater response to seeding rate than what is typically seen. The Clay Center, KS, and Janesville, WI, locations were the most responsive to seeding rate, with greater yields achieved as seeding rate increased (Graph 1). Slater, IA, was the only location that had no significant response to seeding rate. Interestingly, there was no interaction between management practice and seeding rate. Regardless of management system, corn had a similar response to seeding rate.

HYBRID RESPONSE TO MANAGEMENT AND SEEDING RATE

G01U74 Brand

G01U74 responded to all three management practices, but the 16 Bu/A yield response from sidedressing N was greater than other practices (Table 2). The 22 Bu/A response from combining management practices was higher than other hybrids, implying overall responsiveness to management. Seeding rate for G01U74 was optimized at 36,000 seeds/acre, whereas other hybrids benefited more from incremental seeding rates (Graph 2). This trial suggests planting G01U74 at a moderate seeding rate and ensuring N is not limited will help maximize its potential.

G03U08 Brand

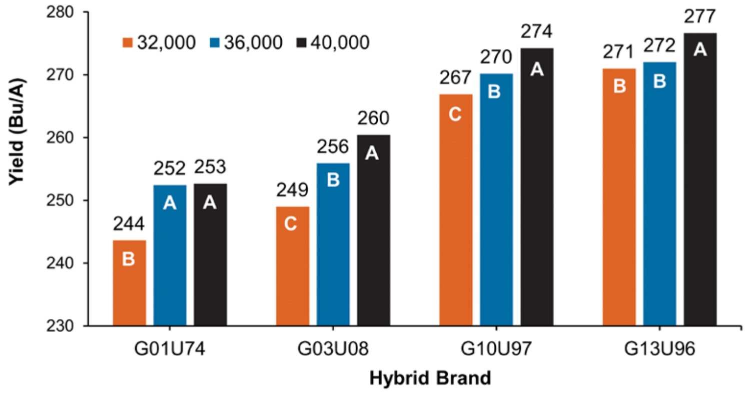
G03U08 had minimal response to individual management practices, however when combined, a significant 15 Bu/A increase was observed (Table 2). Yields steadily increased by 7 and 4 Bu/A with each increase in seeding rate (Graph 2). G03U08 yields were maximized when seeding rates were raised in combination with fertility, N and fungicide applications.

	Hybrid Brand			
	G01U74	G03U08	G10U97	G13U96
Treatment	Yield (Bu/A)			
Base	240	252	264	265
+ Fertility	+5	0	+6*	+5*
+ Sidedress N	+16*	+2	+5*	+10*
+ Fungicide	+5	0	+6*	+9*
+ Combination	+22*	+15*	+14*	+15*

Values represent yield difference (Bu/A) compared to the base treatment.

* significantly different than base treatment at α=0.10

Table 2. Hybrid yield response to management factors averaged across seeding rate and location in 2024.



Different letters within a location illustrate significant difference at α = 0.10.

Graph 2. Hybrid yield response to seeding rate averaged across management factor and location in 2024.

In these trials, G03U08 responded best to a systems approach to management.

G10U97 Brand

G10U97 had comparable 5-6 Bu/A responses from individual management practices (Table 2) and moderate yield increases from increased seeding rates (Graph 2).

G13U96 Brand

G13U96 had one of the largest responses to fungicide and sidedress N (Table 2). Its response to incremental fertility was similar to other hybrids. G13U96 was generally less responsive to small incremental seeding rates but did benefit slightly from an 8,000 seeds/A increase. Utilizing in-season supplemental N and maintaining plant health with a fungicide drove the biggest yield responses with G13U96 in this trial.

SUMMARY

In crop production, no year is considered a "normal" year when it comes to the weather. With above-average precipitation in 2024 during May and June, sidedress N provided the greatest increase in yield on average. Fungicide was also an important player in 2024 to improve plant health and prolong the grain fill period. Fertility cannot be overlooked, and is the foundation of corn production. Low soil test levels must be addressed first.

Understanding hybrid response to management and seeding rate is critical to maximizing hybrid performance. Selecting the right hybrid, matched with the optimal seeding rate, and utilizing a systems approach to management is the key to achieving high yield.

ON-FARM GENETIC × ENVIRONMENT × MANAGEMENT TRIALS

INSIGHTS

- Crop management enhancements are tightly linked to increased yield potential.
- Hybrids respond differently to enhanced management.
- Hybrid ear flex can be kernels per ear and/or kernel weight.
- Local hybrid × management system trials help place the right product on the right acre to maximize yield potential.

Positioning corn hybrids in the appropriate fields and implementing the right management practices is critically important for maximizing yield potential. Golden Harvest is committed to providing information on how our hybrids respond to different management systems and informing growers which hybrids are best for their environment.

In 2024, Golden Harvest implemented genetic × environment × management (G × E × M) on-farm replicated strip-trials at 7 locations to better understand how hybrids respond to enhanced management at a local level (Figures 1 and 2).

Trials consisted of hybrids planted in both standard management and enhanced management systems. The enhanced management system was in addition to the standard management system, which was the grower's base management program. Management practices varied depending on location. Applied treatments for each location are listed in Table 1.

G X E X M TRIAL RESULTS

Yield response to the enhanced management system ranged from 4 to 32 Bu/A, depending on location

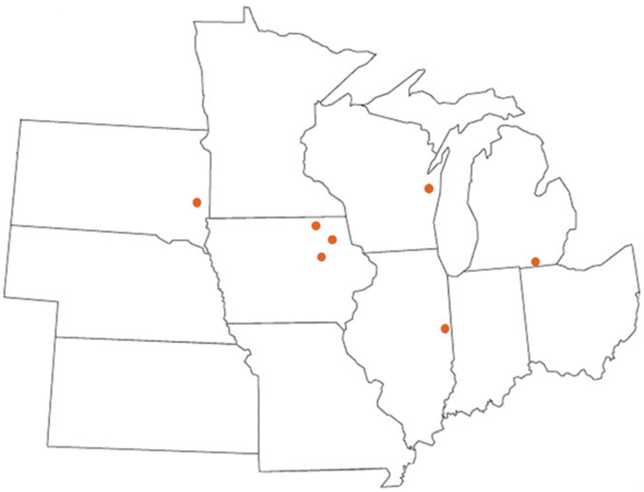


Figure 1. Locations for on-farm G x E x M trials in 2024.

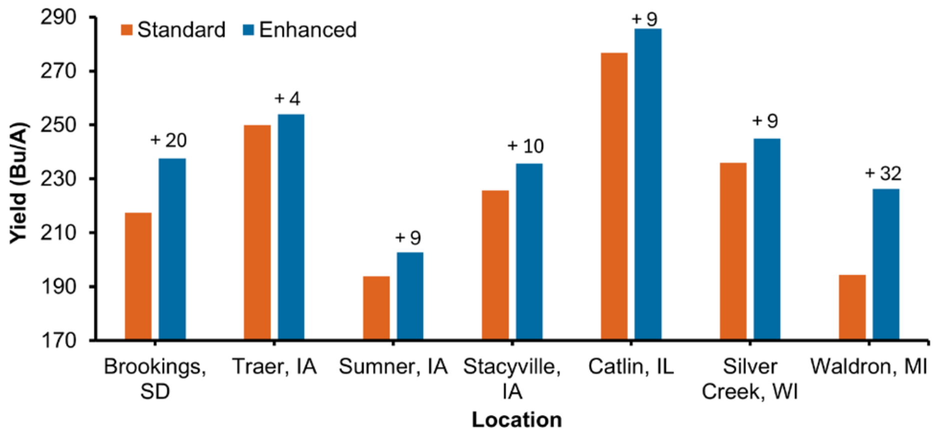
Figure 2. G x E x M strip trial with 4 Golden Harvest hybrids at Stacyville, IA in 2024.

(Graph 1). Waldron, MI and Brookings, SD were the most responsive locations, yielding 32 and 20 Bu/A greater with enhanced management compared to standard management, respectively. The level of enhanced management did not predict the degree of response, illustrating that environment, hybrid, and base management all play a role.

Location	Enhanced (Incremental to the standard management)
Silver Creek, WI	• 2x2x2 Xyway® fungicide @ 15 oz/acre • V8 EZ Drops Potassium Acetate @ 1 gal/acre + Boron @ 1 qt/acre • V14 EZ Drops 28-0-0-5S @ 10 gal/acre • VT foliar Miravis® Neo fungicide @ 13.7 oz/acre + X-Cyte @ 8 oz/acre + Potassium Acetate @ 1 gal/acre
Traer, IA	• In-furrow 4-13-17-1Zn @ 3 gal/acre • V8 Y-drop 4-13-17-1Zn @ 21 gal/acre • R3 foliar Miravis Neo @ 13.7 oz/acre
Waldron, MI	• In-furrow Season Pass® Plus with MicroCarb® @ 5 gal/acre • V3 foliar MicroNourish® Fe @ 1 qt/acre + Sweet N' Eezy® @ 2 qt/acre • V5 foliar Propaz fungicide @ 10.5 oz/acre + Source® DC @ 1 oz/acre + MicroBlitz® @ 1 qt/acre • V10 Y-drop 28% UAN @ 15 gal/acre + ATS @ 5 gal/acre + Boron @ 1 qt/acre • VT foliar Miravis Neo @ 13.7 oz/acre + Boron @ 1 qt/acre
Brookings, SD	• V5 coulter 32% UAN @ 14 gal/acre • R1 foliar Trivapro® fungicide @ 13.7 oz/acre
Catlin, IL	• In-furrow 10-34-0 @ 2.5 gal/acre + TSM® Zinc Corn Starter @ 1 qt/acre • R1 foliar Sugar Mover® Premier @ 1 qt/acre
Stacyville, IA	• R1 Y-drop 32% UAN @ 15 gal/acre
Sumner, IA	• In-furrow 7-25-3 @ 4 gal/acre + Dynahume® SW @ 2 qts/acre + Syntose FA® @ 1 pt/acre

Table 1. Enhanced treatments incremental to the grower standard program for on-farm G x E x M trial locations.

Across all locations in 2024, there was a 13 Bu/A average yield improvement with enhanced management. Similar trials conducted in 2023 averaged an 11 Bu/A response to enhanced management, suggesting there is yield potential to be gained on these farms through better crop management. In these trials, there were varying levels of standard and enhanced management systems with an array of different products. To obtain the most consistent return on investment, it is imperative to understand the most limiting yield factors on each farm and focus management strategies on those factors.



Graph 1. Average hybrid yield response to enhanced management at seven locations in 2024.

HYBRID RESPONSE TO MANAGEMENT

Hybrids responded differently to enhanced management (Graph 2). G03U08 brand was at 5 locations and was consistently one of the least responsive hybrids to enhanced management compared to other hybrids in these trials. Although it was less responsive to management, G03U08 was the highest yielding hybrid under standard management at 4 of the 5 locations. G01U74 brand was highly responsive to management at 2 out of the 3 locations where it was planted. At Stacyville, IA, it responded by 29 Bu/A to the additional 53 lbs N/A with the enhanced management (Graph 2). G12U11 brand had a solid response to enhanced management at both locations yielding 7 and 22 Bu/A greater. G10U97 brand was less consistent in response to management. At Traer, IA, and Sumner, IA, G10U97 responded well, but not at Catlin, IL. Within the full-season hybrid at Catlin, IL, G14B32 brand was the highest yielding hybrid when grown under standard management, yielding 285 Bu/A. However, when grown with enhanced management, G15U34 brand was the highest yielding hybrid producing 310 Bu/A.

HYBRID YIELD COMPONENTS

At Silver Creek, WI, ears were sampled to measure kernels per ear and kernel weight. Kernel weight is expressed as the number of kernels needed to produce a bushel. If fewer kernels are required to produce a bushel, those kernels are heavier. Enhanced management increased yield by 5 Bu/A for both

Hybrid Brand	Management	Yield (Bu/A)	Kernels/ Bushel	Kernels/ Ear
G01U74	Standard	213	63,729	444
G01U74	Enhanced	218	67,219	517
G02K39	Standard	248	56,932	472
G02K39	Enhanced	265	57,573	504
G03U08	Standard	247	66,419	503
G03U08	Enhanced	252	68,095	540

Table 2. Hybrid yield components grown under standard and enhanced management at Silver Creek, WI in 2024.

G01U74 and G03U08 brands. Both hybrids responded by producing more kernels per ear (Table 2). G01U74 had 16% more kernels per ear under enhanced management while G03U08 had 7% more kernels per ear. However, G01U74 was unable to maximize grain fill of the additional kernels, resulting in kernels weighing 6% less and requiring more kernels to produce a bushel of corn. G03U08 brand was better at filling the additional kernels and only experienced a 3% decrease in kernel weight (Table 2). Enhanced management increased G02K39 brand yield by 17 Bu/A. G02K39 produced 7% more kernels per ear while also maintaining kernel weight better than other hybrids (1% drop in kernel weight), perhaps because genetically, G02K39 produces large kernels. Enhanced management improved late-season plant health to help fill those kernels, making them heavier and requiring only 57,573 kernels to produce a bushel (Figure 3 and Table 2).

G01U74 brand has great ear flex in terms of producing more kernels per ear but the value of added kernels can be negated by lack of resources to retain normal kernel size (nutrition, water, plant health, etc.). In contrast, genetically, G02K39 produces large kernels, and yield potential is determined by the amount of available resources during grain fill to pack more starch into kernels.

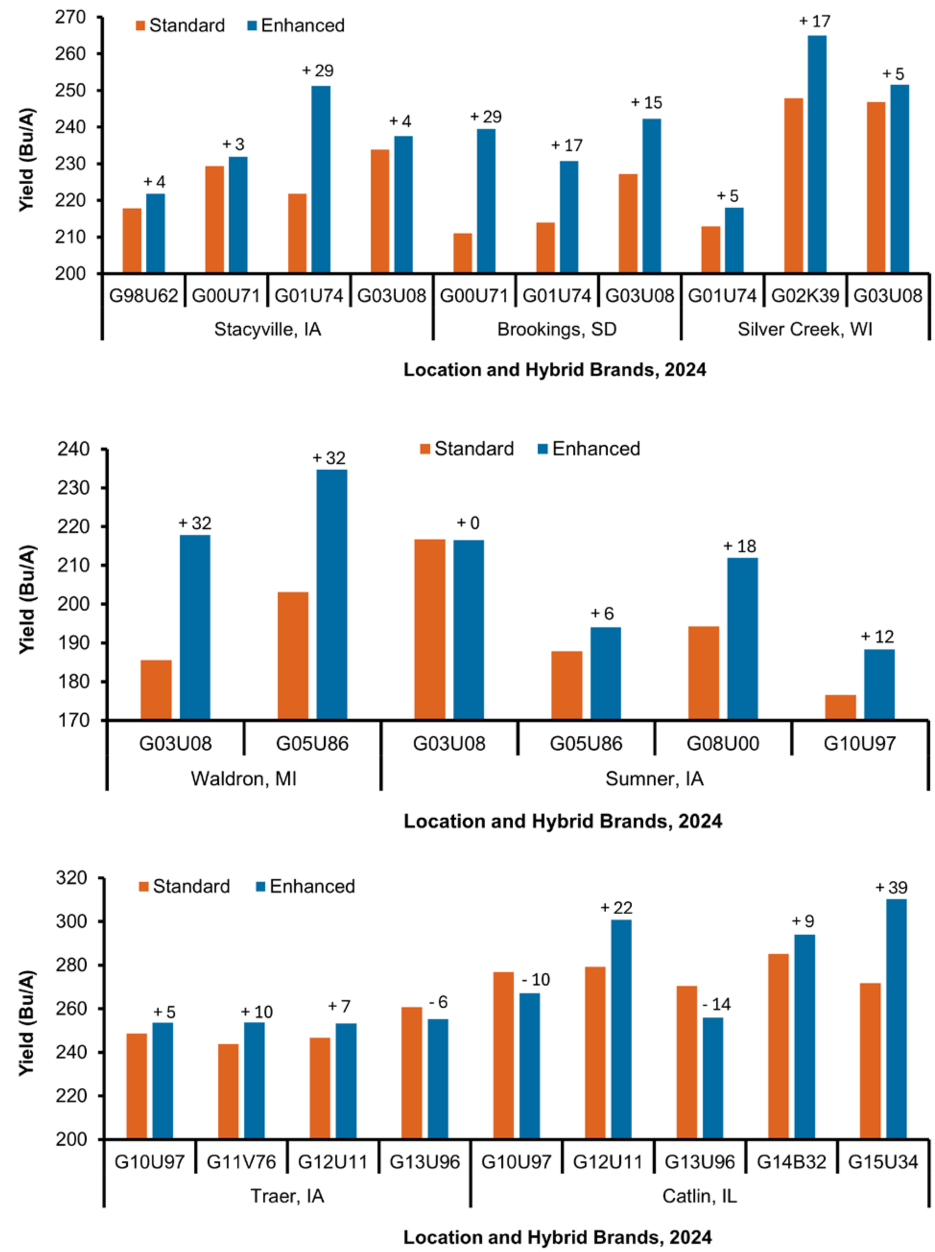
SUMMARY

Genetic × environment × management trials aim to illustrate how hybrids can respond to intensive management in specific local environments. The environment significantly influences yield potential, and by understanding the interaction between hybrid genetics and crop management practices, it becomes possible to optimize product placement and maximize yield potential.

Figure 3. Hybrid G02K39 brand grown under standard (left) and enhanced (right) management at Silver Creek, WI in 2024.

It is important to understand that in these trials there were multiple inputs used to achieve the yield responses that were seen. The yield levels reinforce that many farms still have untapped yield potential. However, a consistent return on investment depends in part on a thorough understanding of the most limiting yield factors on each farm. Identifying the limiting factors can help focus management strategies so a consistent return on investment can be attained. Local hybrid × management system trials help place the right product on the right acre to maximize yield potential.

IF YOU ARE INTERESTED IN PARTICIPATING IN LOCAL GENETIC X ENVIRONMENT X MANAGEMENT TRIALS, PLEASE REACH OUT TO YOUR LOCAL GOLDEN HARVEST AGRONOMIST OR SALES REPRESENTATIVE.



Graph 2. Hybrid yield response to enhanced management at seven locations in 2024.

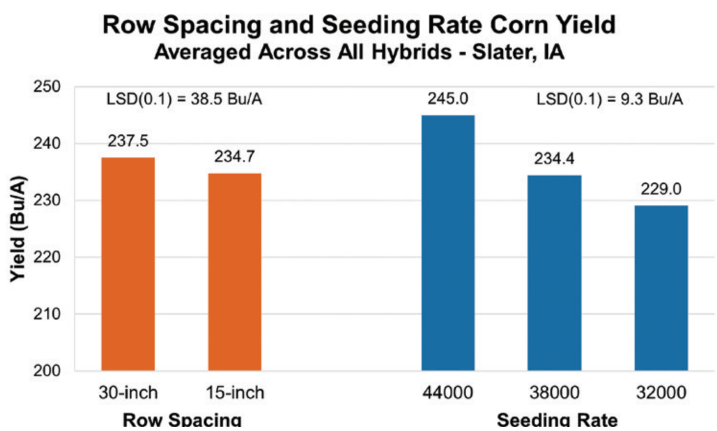
CORN YIELD RESPONSE TO ROW SPACING AND SEEDING RATE

INSIGHTS

- Narrower corn rows allow greater interplant spacing and higher planting populations.
- Planting in 15-inch rows also allows for benefits that follow from quicker canopy cover.
- Yield response to row spacing narrower than 30 inches can be variable from year to year.

INTRODUCTION

Corn row spacing can be an important factor that affects yield and profitability. The most common row spacing in corn is 30 inches but increasing seeding rate in 30-inch rows can overcrowd plants and limit water, nutrients, and root growth per plant. Interest in shifting to narrower row spacing as a way of increasing seeding rates and boosting yield potential has grown in recent years. By narrowing row spacing, it's possible to maintain the distance between individual plants within the rows and keep the same seeding rate. The larger plant-to-plant distance with narrower rows also allows an opportunity for increased seeding rates. Greater distance between plants reduces interplant competition for light, water, and nutrient resources while allowing earlier crop canopy closure. Quicker canopy closure can limit weed growth, help conserve soil moisture and maximize available light for photosynthetic activity.



Graph 1. Row spacing and seeding rate corn yields average across all hybrids.

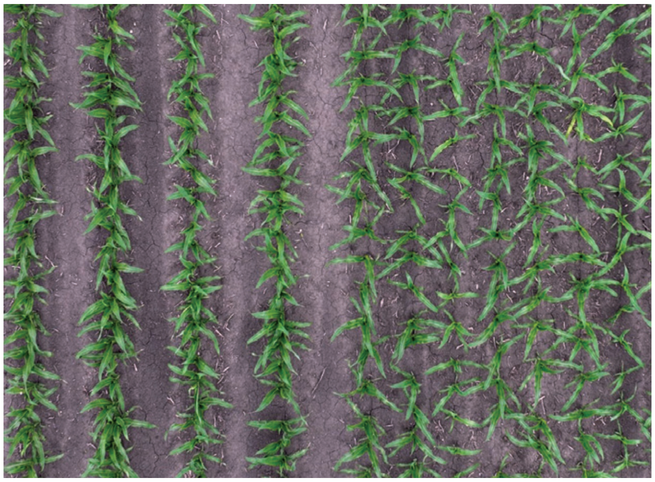


Image 1. Aerial view showing spatial arrangement of 30-inch corn rows (left) compared to 15-inch rows (right), Slater, IA in 2024.

2024 AGRONOMY IN ACTION TRIAL

An Agronomy in Action research trial was established at Slater, IA, to evaluate how hybrids respond to narrower row spacing and increased seeding rates. Four hybrids were evaluated at 15-inch and 30-inch spacings at seeding rates of 32,000, 38,000, and 44,000 plants per acre. 15-inch rows were established using two passes with a 30-inch planter, shifting the second pass 15 inches. When doing so, the first planted set of rows incurred wheel traffic, although this caused little difference in emergence or final stands.

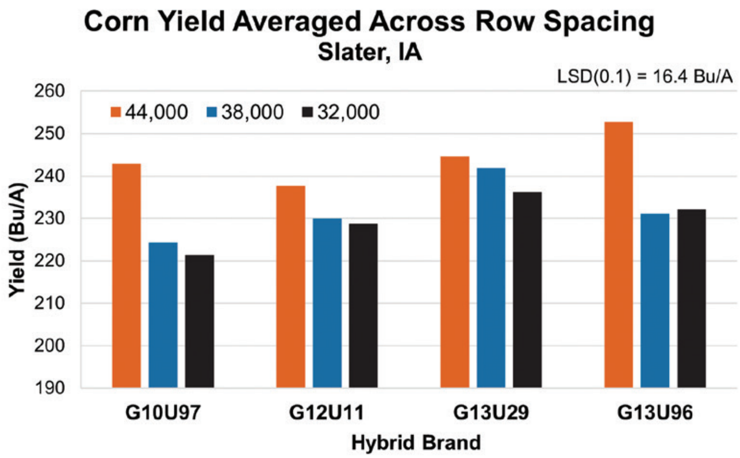
The trial received adequate fertility and above-average rainfall shortly after planting, followed by excessively dry conditions in August and September.

2024 RESULTS

Individual hybrids responded similarly to reduced row spacing, therefore responses were averaged across the 4 hybrids and 3 seeding rates. There was no yield increase in narrow row spacing in this trial (Graph 1). However, increasing seeding rates to 38,000 and 44,000 improved yields by 2.3% and 6.9% respectively over the base seeding rate of 32,000 when averaging across hybrids and row spacings.

Individual hybrid response to higher seeding rates varied (Graph 2). G10U97 and G13U96 brands responded significantly to a rate of 44,000 plants per acre but were not responsive to the 38,000 seeding rate. G12U11 and G13U29 brands were less responsive to increased seeding rates, although they did show small incremental yield increases with each seeding rate.

Previous studies that evaluated row spacing have shown there is not always a yield gain with narrower corn rows compared to standard 30-inch row widths.[1] A similar Golden Harvest® corn row spacing and seeding rate trial carried out at multiple locations in 2020 only had positive responses to 15-inch row spacing in 2 of 4 trial sites. Like seeding rate, the response to row spacing is largely dependent on environmental conditions during the growing season. In prior trials it was observed that responses to narrower row spacing was more consistent when corn was planted at seeding rates greater than a typical 30-inch row spacing seeding rate.



Graph 2. Corn yield of individual hybrids averaged across row spacing.

Row spacing narrower than 30 inches can sometimes increase corn yield by allowing increased planting populations and reducing interplant competition. Narrow row spacing may also improve weed control due to quicker canopy closure, which also maximizes sunlight capture and helps retain more soil moisture. Incorporating narrower row spacing into your operation should be part of a comprehensive management plan that focuses on hybrid selection, seeding rate, fertility, and fungicide application to maximize yield potential. Tire spacing on your current equipment should be considered, as making a switch to narrower row spacing could require the expense of a new planter, spraying equipment, or combine head. Your local Golden Harvest agronomist can help place hybrids with good disease tolerance and stalk strength, and recommend seeding rates that complement narrower row crop systems.

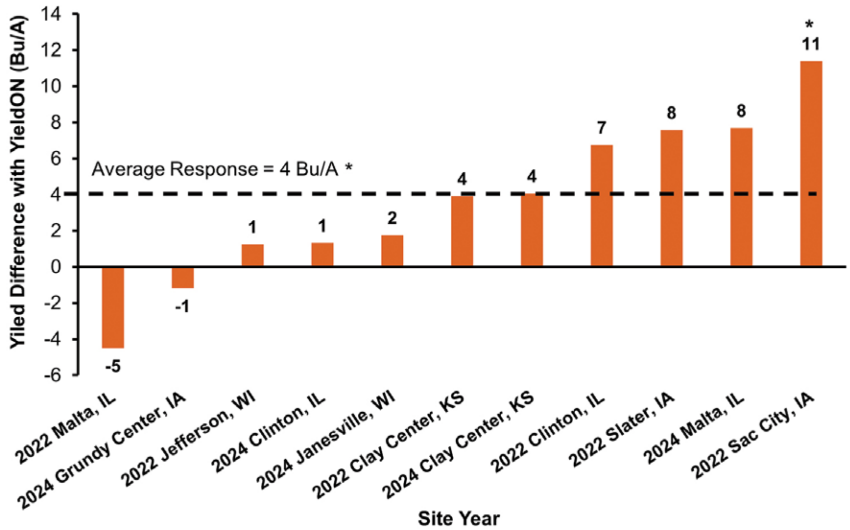
References

[1] Licht, M., Parvej, M. and E. Wright. 2019. Corn yield response to row spacing and plant population in Iowa. Crop, Forage, & Turfgrass Management. 5:0032. doi:10.2134/cftm2019.05.0032

YIELDON – A BIOSTIMULANT TO BOOST YIELDS IN CORN AND SOYBEANS

INSIGHTS

- On average, YieldON™ increased corn yield by 4 Bu/A and soybean yield by 1.5 Bu/A.
- Depending on the location, yield increases up to 11 Bu/A in corn and 6.2 Bu/A in soybeans were observed.
- YieldON can improve late-season nutrient and sugar transport, cell division, kernel/seed and pod development and retention.



*yield response with YieldON was significant at α=0.10.

Graph 1. Corn yield response to YieldON at 11 locations in 2022 and 2024.

YIELDON

YieldON, a biostumulant engineered by Syngenta Biologicals, is designed to increase row crop productivity. It was developed using innovative technologies such as genomics, phenomics, and next-generation sequencing, allowing researchers to detect expressed genes related to increasing plant productivity. YieldON contains a selection of extracts from three families of plants and seaweeds and is enriched with three micronutrients: manganese, zinc, and molybdenum. This formula aids in the efficiency of the plant's physiological processes responsible for seed development and resulting yield. YieldON has three distinct modes of action:

1. Better transport of sugars and nutrients
2. Promotion of cell division – more and larger seeds
3. Fatty acids biosynthesis and transport

YieldON up-regulates genes responsible for these mechanisms, increasing plant growth and development even during periods of crop stress.

AGRONOMY IN ACTION RESEARCH TRIALS

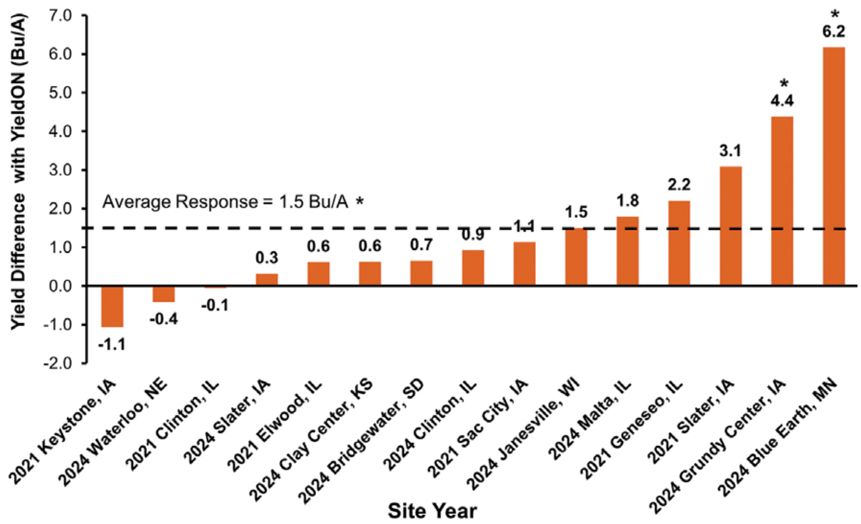
The Agronomy in Action research team implemented trials in both corn and soybeans to evaluate the effect of foliar-applied YieldON.

Corn trials were conducted in 2022 and 2024 across the Midwest. YieldON (1.5 pt/acre) was applied in combination with the fungicide Miravis® Neo (13.7 oz/acre) and compared to an application of fungicide alone. Treatments were applied at the R1 (silking) growth stage utilizing a DJI Agras T20P spray drone with 5 gallons per acre water carrier volume.

Soybean trials were conducted in 2021 and 2024. In 2021, YieldON (1.5 pt/acre) was applied in combination with the fungicide Miravis Neo (13.7 oz/acre) and the insecticide Endigo® ZC (3.8 oz/acre) and compared to the same combination of fungicide and insecticide without YieldON. In 2024, YieldON was applied with only the fungicide and compared to the fungicide alone. Treatments were applied with a ground sprayer with 20 gallons/acre carrier volume at the R3 (beginning pod) growth stage.

CORN YIELD RESULTS

On average across all site years, applications of YieldON increased corn yield by 4 Bu/A (Graph 1). The largest yield response was observed at Sac City, IA, in 2022 where yield was increased by 11 Bu/A. YieldON tended to increase yield by ≥ 4 Bu/A at 6 of the 11 locations (Graph 1).



*yield response with YieldON was significant at α=0.10.

Graph 2. Soybean yield response to YieldON at 15 locations in 2021 and 2024.

SOYBEAN YIELD RESULTS

On average across all site years, applications of YieldON increased soybean yield by 1.5 Bu/A (Graph 2). Soybeans grown at two sites in 2024, Blue Earth, MN, and Grundy Center, IA, had a significant response to YieldON, yielding 6.2 and 4.4 Bu/A greater respectively. 80% of locations showed a positive yield response to YieldON while 6 out of 15 locations responded by ≥ 1.5 Bu/A (Graph 2).

SUMMARY

YieldON added to a foliar application during the reproductive stages significantly increased yield in both corn and soybeans, on average. The three modes of action of this biostimulant makes it beneficial across a variety of environments. Utilizing YieldON in both corn and soybeans to improve crop growth can help boost yields.

HYBRID SELECTION DECISIONS FOR DRYLAND ENVIRONMENTS

INSIGHTS

- Ear flex is achieved through increases in kernel number (rows and length) and weight.
- Hybrids differ in their ability to recover yield potential when planted at suboptimal seeding rates.
- Identifying hybrids with high ear flex potential can help overcome a suboptimal seeding rate when conditions are favorable for elevated yield potential.

INTRODUCTION

The ability to provide stable yields is an important selection factor when choosing hybrids for dryland environments. Hybrid selection strategies in these environments typically places less emphasis on high-end yield potential, and more on consistency under moisture deficit stress. This strategy limits yield potential when favorable environmental conditions align for elevated yield. Golden Harvest continues to research and identify hybrids that are both highly adaptable to moisture-limited dryland environments and able to provide yield upside when conditions are favorable.

TRIALS TO CHARACTERIZE HYBRID ADAPTABILITY

Agronomy in Action research trials are conducted annually to understand how Golden Harvest® hybrids perform under "defensive" dryland seeding rates when sufficient water is present. Trials are established at irrigated sites and individual hybrids are planted at 32,000 seeds/A and 17,000 seeds/A to illustrate dryland yield potential in an above-average rainfall year (Table 1). The optimal seeding rate (32,000 seeds/A) identifies the overall yield potential of each hybrid under optimum dryland conditions. The 17,000 seeds/A seeding rate allows us to identify hybrids that are better able to maximize yield when planted at a seeding rate that is suboptimal for the above average growing conditions by comparing yields to the more optimal seeding rate yields.

	32,000 seeds/A	17,000 seeds/A	Yield Change	Yield Recovery
Hybrid Brand	Yield (bu/A)			%
G00U71	243.2	180.2	63.0	74.1
G01U74	230.6	178.3	52.3	77.5
G02K39	241.1	176.3	64.8	73.4
G03U08	249.2	193.0	56.2	77.6
G05U86	241.2	173.6	67.6	72.5
G08U00	274.9	230.2	44.6	84.5
G09B15	270.4	244.1	26.3	90.4
G09Y24	266.9	217.4	49.4	82.1
G10L16	283.2	221.7	61.4	78.7
G10U97	277.5	209.3	68.2	75.8
G12U11	275.0	197.2	77.7	71.6
G13N18	277.4	204.5	72.9	74.0
G13U29	266.9	200.2	66.7	75.2
G13U96	275.4	206.9	68.5	76.0
G14B65	279.1	205.5	73.7	74.0
G15J91	274.1	196.7	77.3	72.0
G15U34	267.2	213.0	54.2	80.0
G16K01	272.3	220.8	51.5	81.2
G16Q82	279.5	213.0	66.5	76.5
Average	265.5	204.3	61.2	77.0

Table 1. Response of nineteen Golden Harvest hybrids to suboptimal planting populations.

While raw yields in Table 1 do indicate the ability of each hybrid to maximize yield potential under optimal dryland conditions, it is still a scenario that rarely occurs naturally. Calculating yield recovery of each hybrid is a more useful indicator, as it identifies which hybrids are more effective at recapturing overall yield potential when plant population is suboptimal.

GOLDEN HARVEST HYBRID BRANDS

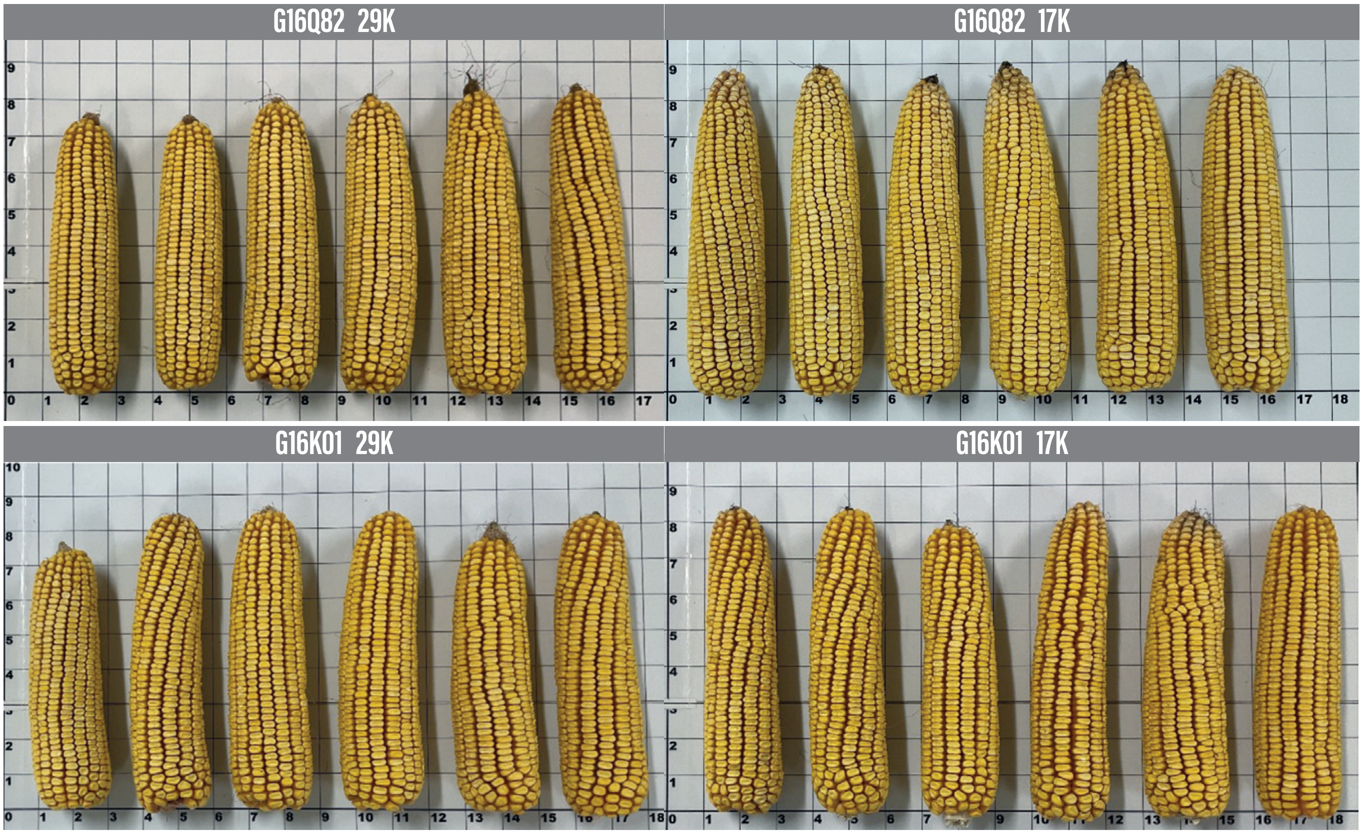
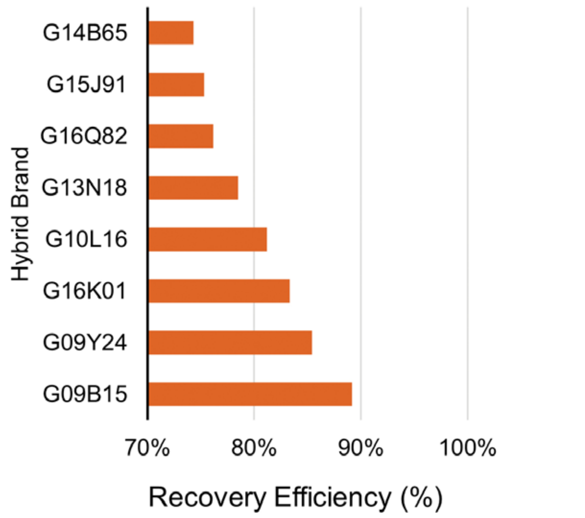


Figure 1. Ear comparisons of two hybrids at 29,000 and 17,000 seeding rates where kernel number (G16Q82 brand) and kernel weight (G16K01 brand) were the primary contributor to overall ear flex.

2024 trials tested nineteen Golden Harvest hybrids at sites in Nebraska and Kansas and found that, on average, they yielded 77% of their genetic yield potential when planted at the suboptimal population. As expected, a wide gradient in yield recovery existed among hybrids, ranging from 71% (G15J91 brand) to 90% (G09B15 brand) (Table 1). These responses indicate that there is significant variability in the ability of a hybrid to adapt to conditions that support high yield when it is planted at a suboptimal population.



Graph 1. Recovery efficiency off eight Golden Harvest hybrid brands tested in 2023-24.

EAR FLEX IS CRITICAL FOR YIELD RECOVERY

By ensuring that sufficient water is available through the use of irrigation at these sites, the observed hybrid responses are likely a result of phenotypic characteristic differences (i.e., ear flex) rather than how well they withstand drought stress. Ear flex occurs either through an individual increase in kernel number, kernel weight, or a combination of the two (Table 1). The timing of favorable or unfavorable growing conditions influences the type and degree of ear flex, especially in dryland environments. For example, total kernel number (through row number and ear length) is determined during vegetative growth stages. The maximum number of kernels is maintained when favorable conditions persist throughout vegetative stages. In comparison, maximizing kernel weight (via depth or density) through starch accumulation during grain fill stages can further increase yield potential after kernel number has been determined.

IDENTIFYING ADAPTABLE HYBRIDS WITH YIELD UPSIDE

Multi-year testing is critical for confidently characterizing the ability of a hybrid to adapt to favorable environmental changes through ear flex. Eight hybrids ranging from 109-116 day relative maturity (RM) were tested within this trial in both 2023 and 2024. The multi-year results identified several hybrids such as G09B15, G09Y24, G10L16, and G16K01 brands as hybrids that are highly capable of recovering overall yield potential under optimum growing conditions when planted at suboptimal populations (Graph 1). Understanding which hybrids can maximize yields at normal dryland seeding rates when rainfall is adequate (Graph 1) and pairing these learnings with locally adapted hybrids that have agronomic characteristics suitable for dryland, such as drought tolerance (Table 2), can be great tools for dryland hybrid selection.

Hybrid Brand	Yield Change	Yield Recovery
G09B15	Semi-Flex	2
G09Y24	Semi-Flex	1*
G10L16	Semi-Flex	1*
G13N18	Semi-Flex	3
G14B65	Semi-Flex	2
G15J91	Semi-Flex	2
G16K01	Flex	2
G16Q82	Semi-Flex	1*

*Hybrid contains Artesian® technology

Table 2. Flex type and drought tolerance ratings of eight Golden Harvest hybrids tested in 2023-24.

SUMMARY

Planting dryland-adapted hybrids with high ear flex potential provides yield stability while also offering an opportunity to capitalize on potential yield when conditions allow. While these results do indicate potential hybrid candidates that can offer this upside, contact your local Golden Harvest seed advisor, sales representative, or agronomist to help select the best hybrids for your dryland strategy.

ELEVATING CORN YIELD WITH INCREMENTAL FERTILITY AND HYBRID SELECTION

INSIGHTS

- Incremental application of nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) resulted in a 13.5 Bu/A yield increase across 38 trials over a 4-year period.
- Observed yield responses were related to weather-induced nutrient deficiency correction, enhanced early-season growth, and extended grain fill window.
- Hybrid-specific responses to incremental fertility were characterized through multi-site testing over multiple years.

INTRODUCTION

The availability of several key soil nutrients is dictated by weather conditions, especially during periods of emergence and early growth. Initial plant deficiencies can slow early-season growth and development as well as impact yield if they persist into later growth stages. Unfortunately, it is difficult to predict weather-induced nutrient deficiencies until the plant shows symptoms. Supplemental, incremental fertility provides an opportunity to reduce the risk of nutrient loss. It also builds an additional nutrient pool near seedlings that plants can pull from if yield potential and nutrient demand simultaneously increase later in the season.

Understanding how hybrids respond to various management decisions (e.g., seeding rate, fungicide, nitrogen, fertility) helps to match appropriate hybrids to distinct management styles. Golden Harvest conducts annual research trials to analyze how the corn portfolio responds to incremental fertility management.

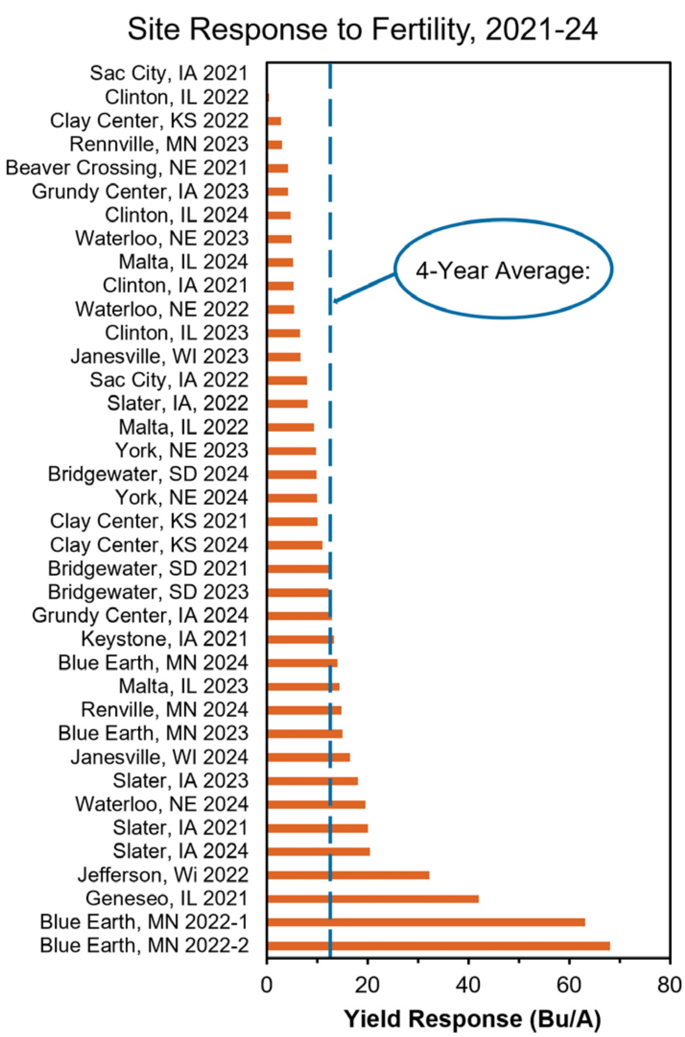
TESTING RESPONSES TO INCREMENTAL FERTILITY

Since 2021, the Agronomy in Action research team has tested how incremental fertility impacts individual hybrid performance. These trials have applied 70, 36, 32, 17, and 0.15 lbs N/A, P2O5, K2O, S, and Zn, respectively, through in-furrow, 2×2×2, and surface dribble methods. This approach differs from traditional starter fertilizers like 10-34-0 because individually applied nutrient quantities are high enough to help overcome minor nutrient deficiencies or elevate yield when conditions allow.

Individual hybrids ranging from 80- to 118-day relative maturity (RM) are tested across multiple sites to characterize how Golden Harvest® hybrids respond to incremental fertility. Specifically, twelve to eighteen hybrids are tested at each location, depending on the RM range. Soil types, soil nutrient status, planting dates, and yield levels vary considerably, thus providing an opportunity to understand how individual hybrids respond to incremental fertility across an array of environmental conditions. Each hybrid is planted into a base and incremental fertility program. The base program consists of the grower's usual fertility program and is typically designed to support selected yield goals and/or address expected nutrient removal. The incremental program combines the base program with the additional fertility package. It is designed to mimic increased nutrient availability through zone placement practices such as strip-till or banding, not a specific method or timing. This allows for the characterization of hybrid responses to nutrient availability rather than any particular application method or nutrient rates.

VALUE OF INCREMENTAL FERTILITY

Across 38 trials conducted in a 4-year period, incremental fertility has resulted in a 13.5 Bu/A response over the base program (Graph 1). Additionally, 82% of the sites exhibited responses greater than 5 Bu/A (31 of 38). Since several nutrients varied in availability across trials, individual location responses were likely driven by a unique nutrient for each trial. For example, early planted sites, such as Slater, IA, in 2024, exhibited greater early-season vigor with the incremental fertility program, presumably from greater plant-available N or P uptake (Figure 1A). Other sites, like Clinton, IL, in 2023 and Janesville, WI, in 2024, experienced S-induced fertilizer responses due to cool spring temperatures slowing soil mineralization (Figure 1B). A third example, Clay Center, KS, in 2024, utilized the additional nutrients placed near the root system to maintain late-season photosynthesis and extend grain fill, resulting in greater yield (Figure 1C).



Graph 1. Site yield responses to incremental fertility averaged across hybrids, 2021-24 (*n* = 38).

A common assumption is that incremental fertility management is most valuable in intensively managed, high-yield scenarios. Results from these trials do not support this assumption, however, positive yield responses occurred across a range of yield levels. Specifically, environments with base yield levels of 200 Bu/A or less produced a 28.8 Bu/A response to the incremental fertility treatment (Graph 2). In comparison, yield responses of 11.4 and 8.6 Bu/A were observed with 200-250 and 250+ Bu/A yield levels, respectively. These results indicate that incremental fertility through zone placement may be applicable across various yield environments.

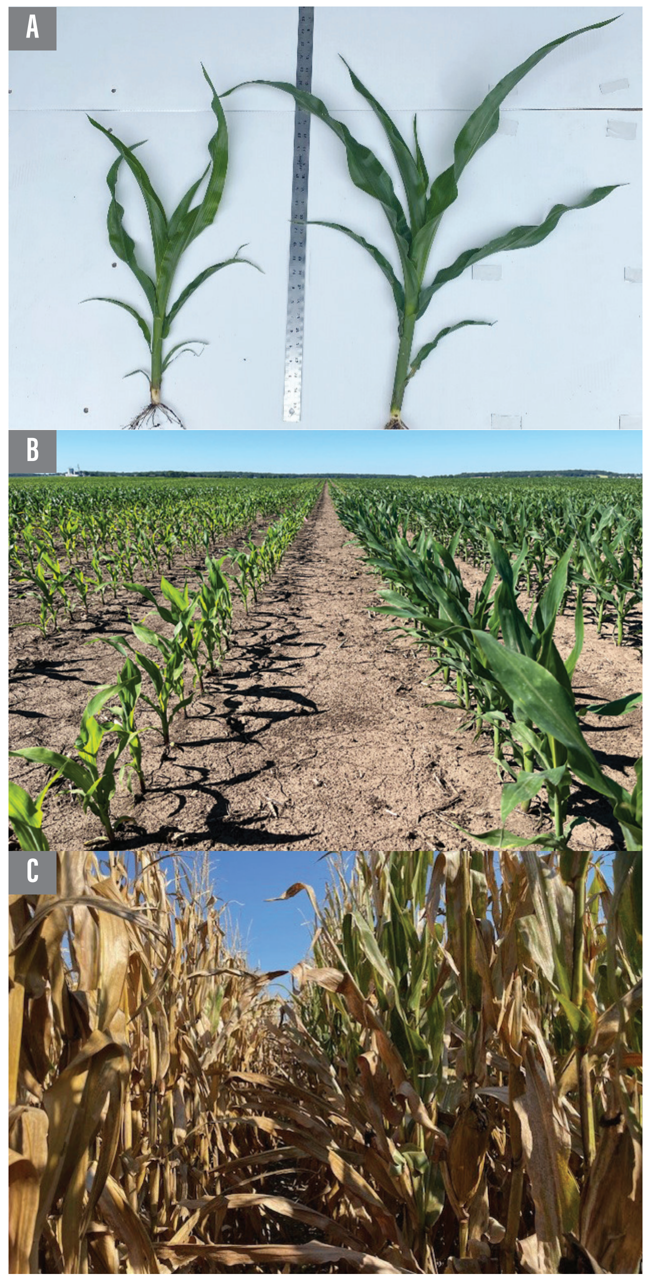
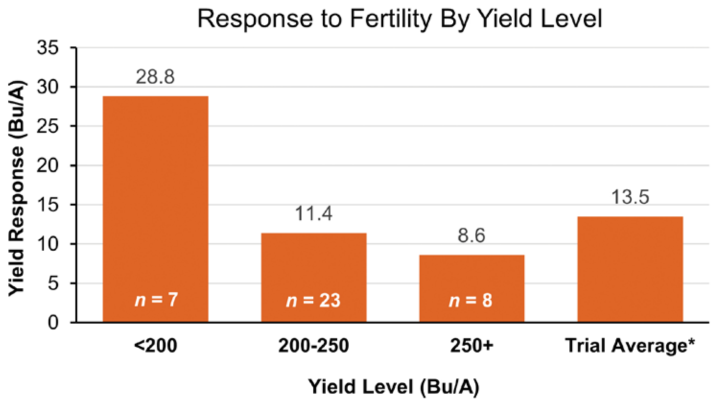
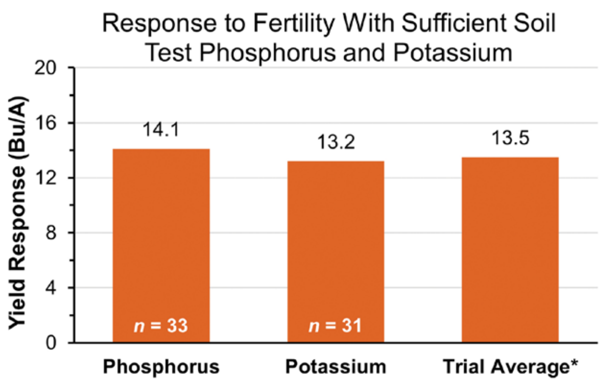


Figure 1. Increased early season growth (A), sulfur deficiency correction (B), and extended photosynthetic window (C) associated with incremental fertility (right) vs the base program (left).



* Indicates yield response averaged across 38 sites, 2021-24.

Graph 2. Yield response to incremental fertility within three different yield levels.



* Indicates yield response averaged across 38 sites, 2021-24.

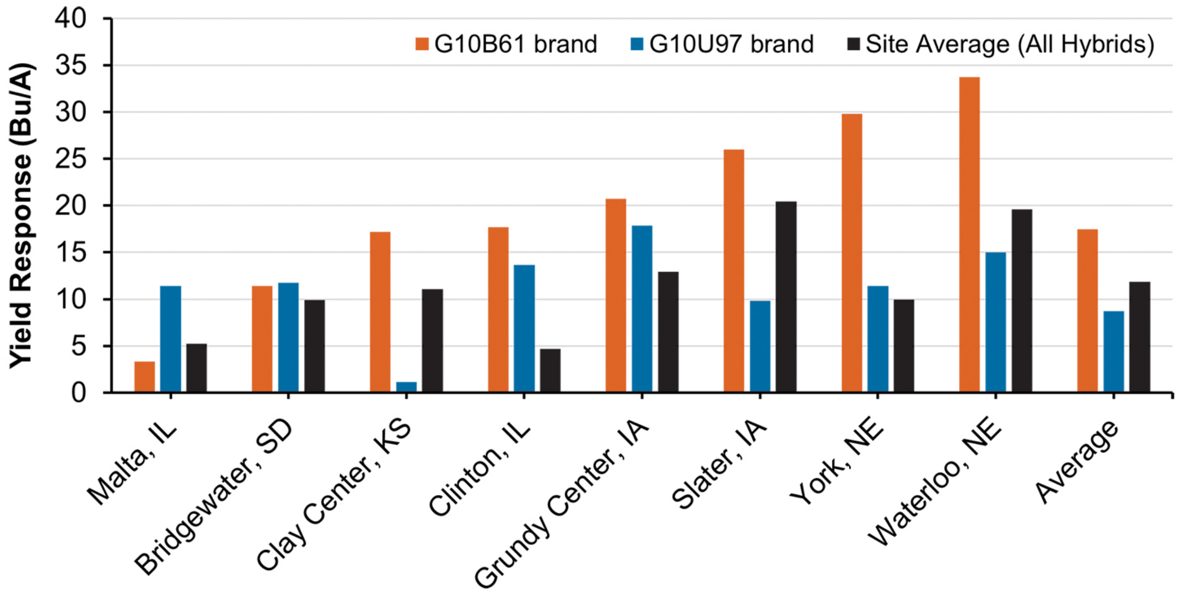
Graph 3. Yield response to incremental fertility under sufficient soil test phosphorus (20 ppm) and potassium (175 ppm) levels.

The majority of trial sites had sufficient P and K soil test levels prior to planting, although these sites still experienced positive responses from incremental fertility. Yields increased 14.1 and 13.2 Bu/A at locations with sufficient pre-plant P (20 ppm) and K (175 ppm) levels, respectively (Graph 3). These responses may be better explained by the proximity of the nutrients for uptake rather than the soil test levels themselves. P and K have low mobility in the soil and require root interception or diffusion via water for plant uptake. If root growth is inhibited or soil is dry and diffusion is negatively impacted, plant nutrient uptake can still be affected in soils with sufficient nutrient levels. The incremental fertility treatment used in this trial placed all nutrients except nitrogen belowground and in regions that helped with root interception. Placing concentrated bands of nutrients in areas where root growth occurs increases the likelihood that it will be utilized by the plant.

EFFECT OF INCREMENTAL FERTILITY ON GRAIN MOISTURE

One concern of intensive crop management (e.g., fungicide application) is its potential effect on slower grain dry down. Despite the improved stay green prior to maturity associated with the incremental fertility treatment observed within several hybrids (Figure 1C), it did not result in greater grain moisture. Instead, the inverse occurred with most hybrids, as 80% (20 of 25) of all tested hybrids had lower grain moisture with incremental fertility compared to the base treatment, with an average reduction of 0.39% across all 20 hybrids (range of 0.1 to 1.2%). In some cases, hybrids that had lower grain moisture with incremental fertility also had lower ear placement (Figure 2). There are two theories that may explain this grain moisture reduction. First, increased starch deposition, leading to higher yields, may have replaced water within the kernel,[1] leading to an overall lower water content. Second, the highly available banded nutrients from the fertilizer may have promoted faster, more efficient nutrient uptake that allowed plants to reach physiological maturity sooner than the base treatment where those plants relied more on root growth through nutrient pools located deeper in the soil profile.[2] The lower ear height was caused by ear initiation on the subsequent lower node. This may be attributed to a more readily available nutrient supply during the early vegetative stages responsible for ear determination promoting fast growth and faster ear initiation, since any nutrient-induced stresses were further minimized with incremental fertility. This faster vegetative growth coincides with academic research that has observed shorter days to silking with starter fertilizer.[2,3]

Figure 2. Lower grain moisture (0.5%) and ear placement associated with incremental fertility (left) vs the base program (right) of G03U08 brand at Slater, IA, in 2024.



Graph 4. Responses of G10B61 and G10U97 brands to incremental fertility against the overall site average across all hybrids at eight sites in 2024.

HYBRID LEVEL RESPONSE TO INCREMENTAL FERTILITY

Characterizing how individual hybrids respond to incremental fertility helps identify which ones are best suited to intensive management. It is critical that hybrids are tested at many locations across multiple years to ensure that a wide range of environments dictated by soil attributes and weather conditions are represented.

Repeated trials across multiple locations provide a better understanding of how repeatable individual hybrid responses are. Response trends can be used to characterize individual hybrids with response ratings. For example, when comparing G10B61 and G10U97 brands' responses to incremental fertility across the same trial locations, G10B61 brand responded more often and at a greater magnitude than the average trial response (Graph 4). However, G10U97 brand responded more similarly to the trial average at most locations. Although both hybrids responded to incremental fertility, G10B61 brand appeared to be the more responsive of the two hybrids.

SUMMARY

Agronomy in Action Research trials at 38 sites over a four-year period have found that a comprehensive incremental fertility program provided value across a wide range of environments and yield levels. This is related to its ability to correct an array of weather-induced fertility deficiencies as well as provide additional nutrients that can be utilized later in the season if needed. This research also serves as the foundation for understanding the degree of hybrids' responses to intensive fertility management. By characterizing these responses over a wide range of environments across multiple locations and years, it deepens our understanding of individual hybrid placement and identifies candidates that are well suited for intensive management styles.

References

[1] Saini, H.S. and W.E. Westgate. 2000. Reproductive development in grain crops during drought. Advances in Agronomy 68:59-96.

[2] Kaiser, D.E., J.A. Coulter, and J.A. Vetsch. 2016. Corn hybrid response to in-furrow starter fertilizer as affected by planting date. Agronomy Journal 108:2493-2501.

[3] McGrath, J.M., and B.G. Binford. 2012. Corn response to starter fertilizer with and without AVAIL. Crop Management doi:10.1094/CM-2012-0320-02-RS.

FACTORS TO CONSIDER IN CORN SULFUR APPLICATION

INSIGHTS

- Responses to sulfur (S) fertilizer can be obtained regardless of planting date.
- In general, hybrids responded similarly to S applications.
- S applications can mitigate weather risks associated with the dynamic nature of plant-available S in the soil.

TRENDS IN SULFUR AVAILABILITY IN CORN

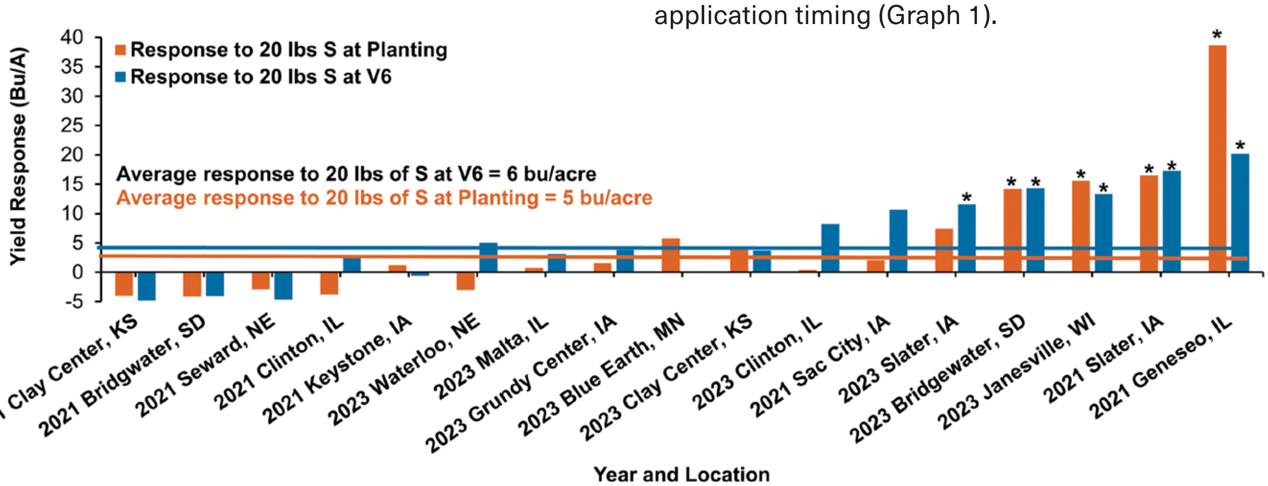
Sulfur deficiencies in corn have become increasingly prevalent in recent years primarily due to some key trends:

1. Reduction in atmospheric S deposition from improved air emission standards: in the last two decades much of the Midwest went from receiving 15-25 lbs/acre/year of S from atmospheric deposition to almost none today.
2. Higher yielding crops require more S: in general, corn will accumulate 0.1 lbs. of S/bushel. Crop demand for S is higher now than it was 5-10 years ago. Over half of the S accumulated by corn is removed in the grain.
3. Earlier planting reduces soil temperature and S mineralization: farmers continue to plant earlier because they have more acres to cover and want to capture yield benefits. High organic matter soils can help maintain adequate soil S levels, as it is mineralized into a plant-available sulfate form. However, soils are typically cooler with early planting and mineralization is slowed, resulting in sulfur deficiencies often observed in early vegetative corn.

Soil tests do not always account for in-season S mineralization, which can make predicting soil sulfur levels challenging.

PREVIOUS AGRONOMY IN ACTION SULFUR RESEARCH SUMMARY

In 2021 and 2023, trials were established at 17 locations across the Midwest to evaluate the effect of S application timing on corn yield. Sulfur was applied at 20 lbs/A either with the planter or sidedressed at the V6 growth stage. Five of the 17 sites had a significant response to S fertility regardless of application timing (Graph 1).



*significant difference between S treatment and the check at α = 0.10

Graph 1. Yield response to S treatment averaged across 2 hybrids at 17 locations in 2021 and 2023.

Figure 1. Twenty pounds per acre of sulfur applied at planting (left) compared to none (right) in 2024 trial.

PLANTING DATE EFFECT ON SULFUR RESPONSE

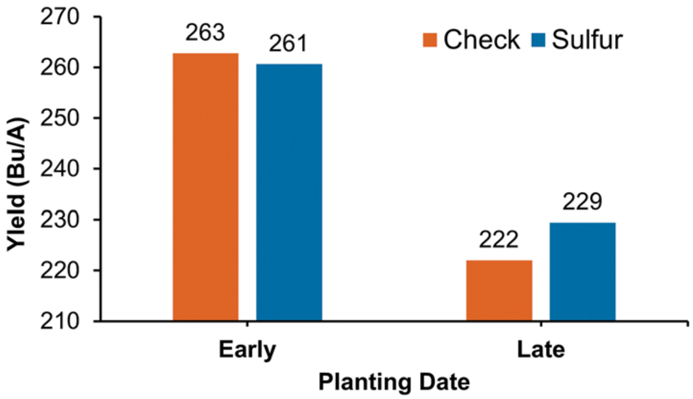
In 2024, the Golden Harvest Agronomy in Action team expanded on previous S trials to evaluate if corn would have a greater response to S applications with earlier planting dates compared to later planting dates.

A trial was conducted with two planting dates at Malta, IL, (4/25/2024 and 5/13/2024) and Slater, IA, (4/12/2024 and 5/15/2024). On each planting date, ammonium thiosulfate (ATS) 12-0-0-26S was planter-applied 2×2×2 at 20 lbs S/A compared to the check, which did not receive any S. The check received 9 lbs N/A as urea ammonium nitrate (UAN 32-0-0) applied 2×2×2 with the planter to balance for N across all treatments.

YIELD RESULTS

The effect of planting date on yield was significantly different between locations, with the later planting date yielding 18 bu/A less at Malta, IL, and 53 bu/A less at Slater, IA, when averaged across all treatments and hybrids (data not shown). However, the effect of planting date on S response and hybrid was similar for both locations, so all data shown is averaged across both locations.

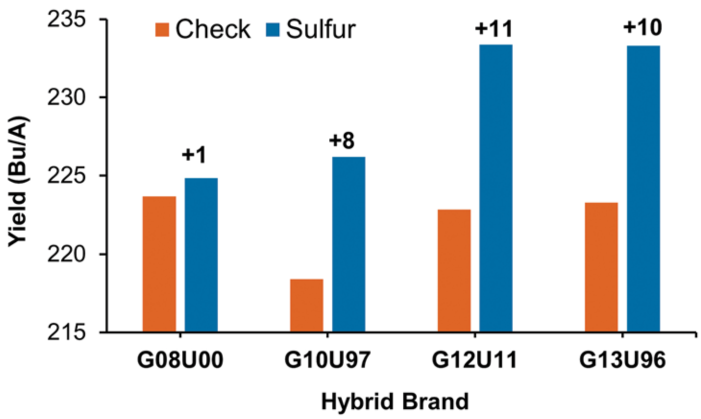
When averaged across all hybrids and locations, 20 lbs/acre of S applied with the planter did not significantly affect yield at either planting date. Sulphur applied at the later planting date tended to increase yields slightly more than earlier planting dates, although neither were statistically significant (Graph 2). The lack of response within the early planting dates may have been caused by warmer spring conditions with high organic matter soils providing sufficient available S to the plants within the trial area.



LSD (0.10) Sulfur Application = NS

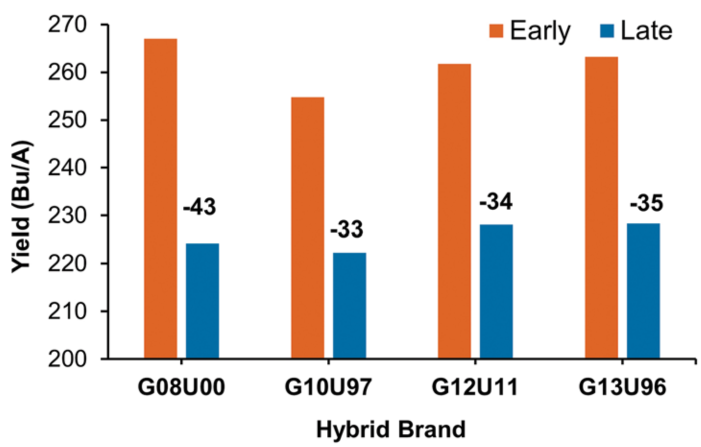
LSD (0.10) Planting Date = 15

Graph 2. Effect of planting date and sulfur application on yield averaged across 4 hybrid brands and 2 locations in 2024.



LSD (0.10) Sulfur Application = NS

Graph 3. Effect of sulfur application on yield at the later planting date for 4 hybrids averaged across 2 locations in 2024.



LSD (0.10) Planting Date = 15

LSD (0.10) Planting Date x Hybrid = NS

Graph 4. Effect of planting date on yield for 4 hybrids averaged across 2 locations in 2024.

For the later planting date, statistically there were no differences in hybrids, however, G08U00 brand tended to be less responsive to the S application with only a 1 bu/A increase in yield compared to the other three hybrids, which ranged from 8-11 bu/A (Graph 3).

Planting later tended to penalize G08U00 brand more than other hybirds, reducing yield potential by 16% compared to the other three hybrids that only had a 13% reduction in yield potential (Graph 4). However, G08U00 brand had the highest yield potential of all hybrids with the earliest planting date.

SUMMARY

Results from this study highlight the dynamic nature of S availability in corn. Temperature, moisture, organic matter, and soil pH levels all affect plant-available S, making crop needs hard to predict. Even during later planting windows when soils are warmer and likely mineralizing more S, crop demand for S can still exceed what the soil can supply. If S deficiencies are apparent during early vegetative stages, S applications can prevent additional yield loss, but yield potential can never fully recover. Having an S management plan and taking a proactive approach to S fertility is important to mitigate weather risks regardless of planting date.

Figure 2. Corn planted on 4-25-2024 (left) and 5-13-2024 (right) at Malta, IL.

MAXIMIZING SIDEDRESS NITROGEN EFFICIENCY IN CORN

INSIGHTS

- Additional planter-applied nitrogen (N) sidedressing improved yield by 7.7 Bu/A over the normal preplant rate.
- There was no yield difference between surface and subsurface planter N application.
- N use and yield is maximized when sidedress N application aligns with rapid nutrient uptake.
- Adding a N stabilizer to a sidedress N application was only effective when planter-applied.

INTRODUCTION

The annual yield potential of a field is a continuously evolving number dependent on changing weather conditions prior to and during the growing season. Yet nitrogen (N) fertilizer rates selected for specific fields are often identified well before planting and frequently aren't adjusted to account for favorable or unfavorable conditions that influence N availability and yield potential. When all N is applied preplant, this creates scenarios where N supply may not meet crop demand. Timely nitrogen sidedressing can provide the opportunity to address N shortages. To determine the effectiveness of this approach, the Agronomy in Action (AIA) research team conducted multiple trials to gauge the value of various forms of at-planting or post-N application and identify methods to maximize its effectiveness.

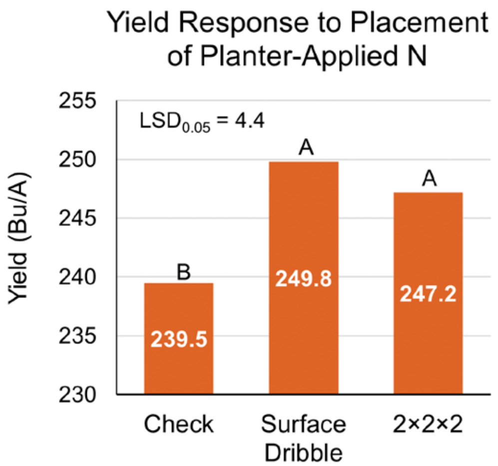
EVALUATION OF PLANTER-APPLIED N PLACEMENT

The first trial evaluated placement methods of a supplemental planter-applied N application. While this is not a widely common type of application, it does offer the opportunity to eliminate a potential pass across the field and unlike later sidedress timings, there is no risk of excessive rainfall preventing the application from being made. The trial was designed to determine whether there was an advantage to either applying a sidedress subsurface 2×2×2 placement or surface dribbling. A total of 20 trials were conducted in 2023 and 2024 at eight Agronomy in Action sites with sidedress rates of 40 and 60 lbs N/A as UAN (32-0-0) in 2023 and 2024, respectively. A base preplant N rate was applied evenly across all trials based on individual site yield goals, and incremental N was applied to specified plots during planting.

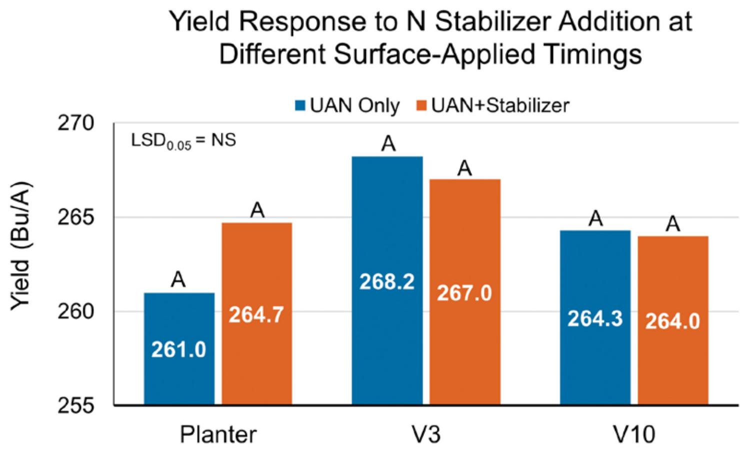
Planter-applied N sidedressing provided value, as evident by an overall 7.7 Bu/A yield response (Table 1). Additionally, 18 of the 20 sites exhibited

	Check	Planter N	Yield Change
Trial	Yield (bu/A)		
Blue Earth, MN			
2023	209	214	5.2
Bridgewater, SD			
2023	181	210	29.5
Clay Center, KS			
2023	262	262	-0.9
2024-1	287	293	6.6
2024-2	284	291	7.7
Clinton, IL			
2023	238	245	6.4
2024-1	232	248	15.7
2024-2	246	258	12.3
Grundy Center, IA			
2023	202	217	14.6
2024-1	221	224	3.0
2024-2	229	226	-3.3
Janesville, WI			
2023	226	234	8.1
2024-1	271	281	9.8
2024-2	266	272	6.6
Malta, IL			
2023	254	259	5.9
2024-1	241	246	4.7
2024-2	239	250	11.0
Slater, IA			
2023	269	274	4.5
2024-1	220	229	9.1
2024-2	234	237	3.0
Average	240	247	7.7

Table 1. Yield response to planter N in 20 AIA research trials, 2023-24.



Graph 1. Response of yield to planter-applied N placement across 20 AIA research trials, 2023-24. Different letters indicate statistical differences at P<0.05.



Graph 2. Yield response to supplemental N timing (surface application of 60 lbs N/A) at five AIA trials in 2024. Different letters indicate statistical differences at P<0.05.

positive responses to sidedressed N, with 14 of the 18 responsive sites producing ≥ 5 Bu/A responses. The mechanisms driving these positive responses differed by location. For example, 2024 sites such as Clinton, IL, Malta, IL, and Slater, IA, received well above average precipitation in early May that likely led to preplant N fertilizer loss, and reduced overall N supply. In comparison, 2024 trials at Clay Center, KS, experienced ideal planting conditions and above-average early-season temperatures, which contributed to an increased overall yield potential at the site.

Another component of this trial was evaluating whether there is an agronomic advantage to subsurface (2×2×2) versus surface dribble planter-applied N. Theoretically, subsurface placement of N reduces the ability for loss via runoff, volatilization, or immobilization by residue in continuous corn and/or no-till situations. Results from this trial found a slight, nonsignificant 2.6 Bu/A advantage to surface dribble over subsurface application (Graph 1). All trials within the experiment were conventionally tilled (except Clay Center, KS, which was no-till) and were either irrigated or received ample rainfall following planting, which may have minimized N loss potential associated with surface application.

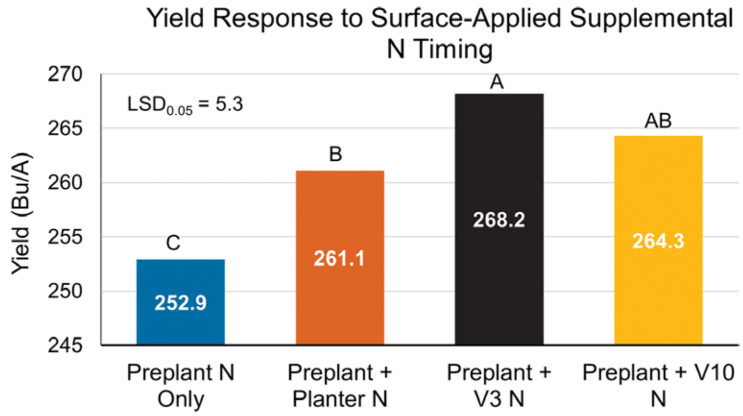
Although there was a marginal yield advantage with surface dribble compared to subsurface placement, individual trial-to-trial responses varied greatly. The combination of these responses suggests that there is no definitive agronomic advantage to either planter-applied N placement method. Instead, it should be based on the grower's preference and used as a complement to, not replacement for, the current starter fertilizer planter setup, if present.

IMPORTANCE OF SIDEDRESS TIMING

A second experiment conducted in 2024 at five Agronomy in Action research sites (Clay Center, KS, Clinton, IL, Grundy Center, IA, Janesville, WI, Malta, IL, and Slater, IA) was performed to evaluate the importance of N sidedress timing when N supply from preplant N application is inadequate. The experiment evaluated surface application of 60 lbs N/A as UAN (32-0-0) at three different timings (planter dribble, Y-drop at V3, and Y-drop at V10). There was an 8.2 Bu/A positive response to planter-applied N applied to the soil surface (Graph 2). There was an incremental 7.1 and 3.2 Bu/A advantage from applying N at V3 and V10 respectively as compared to planter applications. This response coincides with plant N uptake by growth stage, as rapid nutrient uptake by corn begins around V3/V4 and typically peaks between V8 and R1. Since time between application and uptake is the greatest with planter application, it creates the greatest opportunity for potential loss, thus reducing its availability. This experiment also evaluated the value of utilizing an N stabilizer with surface sidedress applications. The selected N stabilizer provided activity against both volatilization (NBPT) and denitrification/leaching (DCD). The greatest value of the N stabilizer was realized with planter-applied N through a 3.7 Bu/A response, though it was not statistically significant (Graph 3). In comparison, there was no agronomic value to using an N stabilizer with the V3 and V10 timings, as no yield response occurred.

SUMMARY

Nitrogen sidedressing provides an opportunity to reduce the amount of N fertilizer subject to potential loss and reallocating a portion to a period when plant N demand is greatest. It also provides an opportunity to modify or increase the overall N supply when yield potential increases or unexpected loss to the initial N supply occurs. These Agronomy in Action research trials showed that supplemental N application, even when planter-applied, provides agronomic value across a wide range of environments with varying N demands. The results also showed that the efficiency of sidedress N fertilizer is maximized when it occurs during the period of rapid plant N uptake and that a stabilizer was only agronomically valuable with planter-applied N since it reduced its loss potential.



Graph 3. Yield response to N stabilizer containing DCD & NBPT at three different application timings at five AIA trials in 2024 (surface application of 60 lbs/A of N).

EFFECTS OF ADDING POTASSIUM TO A SIDEDRESS APPLICATION

INSIGHTS

- Certain soil characteristics and dry weather conditions can limit potassium (K) availability.
- Sidedressed N fertilizer in addition to base rates increased yield by 7.7 Bu/A.
- K sidedressing as a standalone or paired with N did not enhance yield.

Location	Organic Matter (%)	Soil pH	CEC (meq/100g)	Phosphorus (ppm)	Potassium (ppm)
Clay Center, KS	2.3	6.6	10.4	34	280
Clinton, IL	3.7	6.3	18.7	28	215
Grundy Center, IA	4.1	5.5	18.9	54	208
Janesville, WI	2.9	6.7	17.3	46	195
Malta, IL	4.5	5.7	20.1	39	180
Slater, IA	4.8	6.5	27	34	165

Table 1. Soil test information at six AIA research sites in 2024.

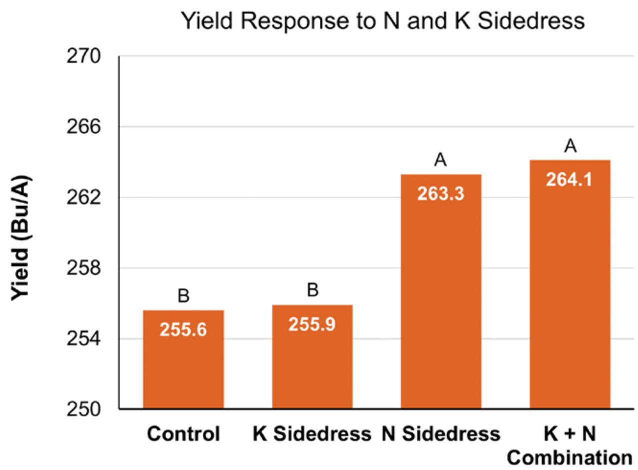
INTRODUCTION

Potassium is a critical element for corn, which requires approximately 0.8 lbs. K_2O to produce every bushel of grain.[1] Its true availability to plants can differ due to soil moisture, soil texture, clay mineralogy (e.g., 2:1 clay soils), or soil structure issues (i.e., compaction). Since it is such a critical nutrient for high-yield corn production, there is curiosity around whether adding K fertilizer to a sidedress nitrogen (N) application is a time- and cost-effective practice that can further elevate yield.

AGRONOMY IN ACTION RESEARCH TRIAL

A trial was performed at six Agronomy in Action (AIA) research sites in 2024 to quantify the value of sidedressing K as a standalone application and combined with UAN. Specifically, trials attempted to understand if adding K to a planned N sidedress trip could reduce the impact of drought- or compaction-induced K deficiencies on yield. The locations exhibited a range of yield levels, organic matter content, pH levels, and CECs, but had sufficient K per soil testing (Table 1). Two hybrids with varying degrees of overall response to fertility that matched the RM range of the respective sites (G03B19 and G03UO8 brands at Grundy Center, IA, and Janesville, WI; G10B61 and G10U97 brands at Clay Center, KS, Clinton, IL, Malta, IL, and Slater, IA) were sidedressed using Y-drop tubes at the V4 growth stage.

The standalone K treatment consisted of 10.2 lbs/A (4 gal/A) of potassium acetate (0-0-24). The standalone N treatment consisted of 56 lbs/A (16 gal/A) of UAN (32-0-0). The K+N combination treatment used these same individual nutrient rates to understand if there were any potential synergistic affects when combined. Due to the



Graph 1. Yield response to sidedress K and N at six Agronomy in Action research sites in 2024. Different letters indicate differences between treatments (P<0.05).

lack of compatibility to mix higher rates of K with a normal sidedress rate of N, a lower K rate was used. A 4:1 N/K ratio was the lowest achievable ratio that would allow for proper fertilizer mixing without compatibility issues.

Figure 1. Corn trial after application of treatment in 2024.

RESULTS

The individual N sidedress application resulted in a significant yield increase of 7.7 Bu/A over the control, indicating all sites were responsive to additional in-season fertility (Graph 1). The trial saw marginal value of the standalone K sidedress treatment over the control (+0.33 Bu/A) or adding K to the UAN treatment (+0.8 Bu/A), and these results coincide with other K sidedress trials in Iowa, Illinois, and Wisconsin.[2,3] The data also did not show any significant differences in the response to K between hybrids with varying degrees of overall fertility responses.

SUMMARY

The original intent of this trial was to understand if sidedressing K in compacted soils or drought conditions could help mitigate K deficiencies caused by these stresses. Potassium fertilization as a standalone sidedress or in combination with N did not increase yield across six Agronomy in Action research sites in 2024. This is likely because of adequate soil test K and ample precipitation promoting plant K uptake. Situations may exist where K sidedressing may be advantageous, particularly when dry soils limit its uptake. However, it will likely be difficult for surface-applied K to move deep enough into the soil profile for uptake by roots when conditions are dry. In addition, it will be challenging to conveniently apply a sufficient K rate in the same trip as a previously planned N application. The total amount of K that was applied via sidedress in this trial was very low (10.2 lbs/A) due to N compatibility, thus likely limiting responses. These are important constraints to consider before applying K and N sidedress combinations.

References

[1] Bender, R.W., J.W. Haegele, M.L. Ruffo, and F.E. Below. 2013. Nutrient uptake, partitioning, and remobilization in modern, transgenic insect-protected maize hybrids. Agronomy Journal 105:161-170.

[2] Mallarino, A. P., L.B. Thompson, D.L. Maxwell. 2020. Corn and Soybean Response to Sidedressed Liquid Potassium Fertilizer in Southwest Iowa. Iowa State University Research and Demonstration Farms Progress Reports 2019.

[3] Miller, R.D. 2017 Sidedressing potassium and nitrogen on corn. The Fluid Journal 25:7-10.

NANOPRO: AN ADJUVANT TO IMPROVE PESTICIDE UPTAKE

INSIGHTS

- NanoPro® is an innovative product to support plant uptake of pesticide active ingredients.
- Yield response to NanoPro in corn and soybeans varied by location.
- Environmental or application conditions that limit the uptake of fungicide may amplify the importance of NanoPro.

NANOPRO

NanoPro is a carrier adjuvant manufactured by Aqua Yield Operations, LLC, designed to improve plant uptake and pesticide efficacy. NanoPro can be added to herbicides, insecticides, fungicides, and plant growth regulators to improve active ingredient absorption. The active ingredients in NanoPro are humic acids that utilize nanoparticles to attract ions in pesticides as a delivery mechanism.

AGRONOMY IN ACTION RESEARCH TRIALS

In 2024, the Golden Harvest Agronomy in Action Research team implemented trials in both corn and soybeans to evaluate the effect adding NanoPro to a fungicide has on yield. Trials were implemented at 5 locations in corn and 9 locations in soybeans through the Midwest. Treatments were similar for both corn and soybean trials.

1. Check – no fungicide or NanoPro applied
2. Fungicide
3. Fungicide + NanoPro

The fungicide used was Miravis® Neo at 13.7 oz/acre and the NanoPro use rate was 4 oz/acre for both crops. Treatments were applied at the R1 (silking) growth stage in corn utilizing a DJI Agras T20P spray drone with 5 gallon per acre (gpa) water carrier volume. In soybeans, a ground sprayer was used with 20 gpa carrier volume at the R3 (beginning pod) growth stage.

Corn		Soybean		
Early RM Brands	Late RM Brands	Early RM Brands	Mid RM Brands	Late RM Brands
G00U71	G10U97	GH1875E3	GH2775E3	GH3035E3
G00A97	G11V76	GH2004XF	GH2745XF	GH3225XF
G01U74	G12U11			
G03U08	G13U96			

Table 1. Corn hybrids and soybean varieties planted at each location based on relative maturity (RM).

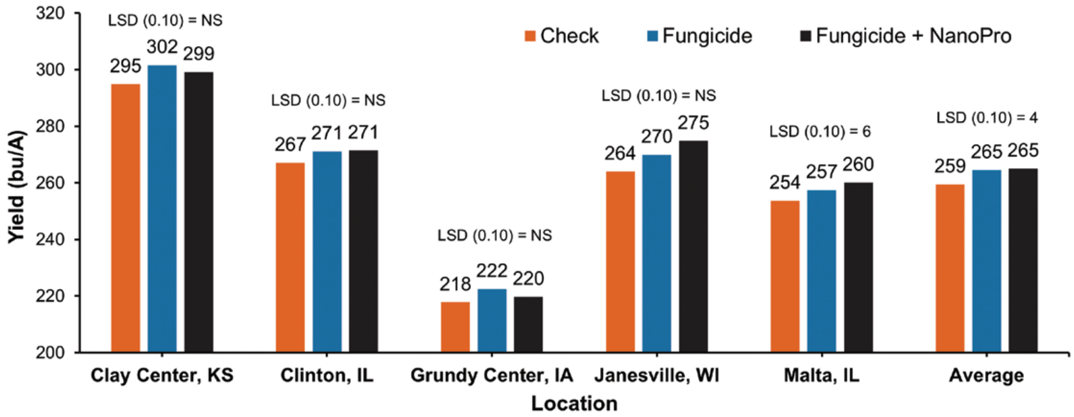
Four hybrids or two varieties were used depending on the trial location (Table 1). All treatments were replicated four times at each location.

CORN YIELD RESULTS

At all locations, disease pressure was minimal. Both Clinton, IL, and Malta, IL, had some gray leaf spot lesions, but it did not progress up the canopy. Malta, IL, also had tar spot appear late in the season near the end of grain fill stages and likely did not affect yield. Treatment responses were similar across all hybrids, therefore results were averaged across the four hybrids at each location.

On average across all locations and hybrids, fungicide significantly increased yield by 6 Bu/A (Graph 1). Since overall disease pressure was low, better plant health and stay-green likely drove the yield increase. Fungicide responses at individual locations ranged from 4 to 7 Bu/A (Graph 1).

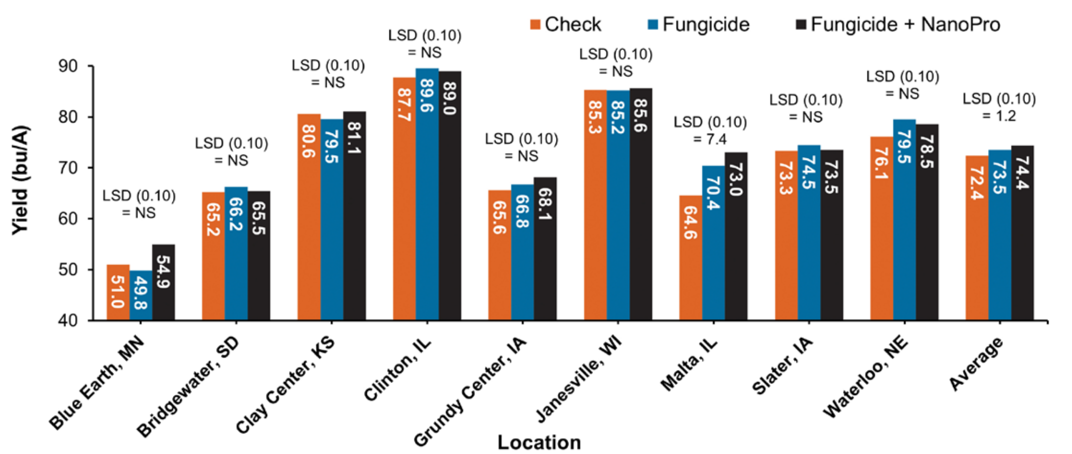
When averaged across all locations and hybrids, adding NanoPro to the fungicide did not impact yield (Graph 1). Adding NanoPro did increase the fungicide response at 2 of the 5 locations by 5 Bu/A at Janesville, WI, and 3 Bu/A at Malta, IL. At Janesville, WI, the combination of fungicide and NanoPro significantly increased yield over the untreated check by 11 Bu/A (Graph 1).



Graph 1. Corn yield response to foliar fungicide and NanoPro at 5 locations averaged across 4 hybrids in 2024.

SOYBEAN YIELD RESULTS

Disease pressure was also minimal in soybeans across all locations. Soybeans grown at Malta, IL, did have some sclerotinia stem rot (white mold) which likely impacted yield. Janesville, WI, also had septoria brown spot but symptoms did not progress up the canopy. All varieties responded similarly to applied treatments, so results were averaged across the 2 varieties at each location.



Graph 2. Soybean yield response to foliar fungicide and NanoPro at 9 locations averaged across two varieties in 2024.

On average across all varieties and locations, fungicide tended to increase yield by 1.1 Bu/A (Graph 2). Soybean yield response to fungicide was as high as 5.8 Bu/A and varied by location.

When averaged across varieties and locations, adding NanoPro to fungicide tended to increase yield by 0.9 Bu/A over fungicide alone (Graph 2). The combination of fungicide and NanoPro statistically yielded 2 Bu/A greater than the check on average. Similarly, at Malta, IL, fungicide alone did not statistically increase yield over the check, but when combined with NanoPro it did significantly increase yield by 8.4 Bu/A more than the check. The range in response from adding NanoPro to fungicide applications was between -1.0 and 5.1 Bu/A depending on the location (Graph 2).

SUMMARY

NanoPro is an innovative product with a unique delivery mechanism to improve pesticide uptake. In these trials, response to NanoPro varied between locations and crops. On average, yield benefits from adding NanoPro to a fungicide application was minimal for both crops, yet there were a few times responses were quite significant. There was very little crop stress during times of application at these locations. Yield response to NanoPro may be greater under stressful crop conditions that are potentially limiting fungicide uptake. Similarly, low disease environments at most locations may have limited any potential benefits from adding NanoPro to fungicide applications in these trials. In elevated disease environments the value of NanoPro may be higher.

BEST TIME OF DAY FOR CORN AND SOYBEAN FUNGICIDE APPLICATIONS

INSIGHTS

- Changing weather conditions throughout the day can impact fungicide efficacy.
- Minimal yield increases were noticed with applications made at cooler times of day.
- Targeting fungicide applications to the crop stage and disease pressure will influence yield more than time of day.

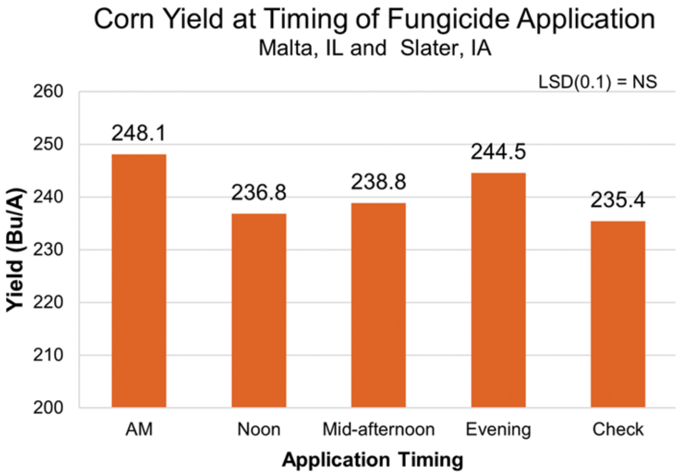
INTRODUCTION

Routine fungicide applications have gained popularity, and ideally applications should be made just prior to favorable disease development conditions to minimize infections. In addition, applying just prior to growth stages in which the crop starts to become more vulnerable to infection can also improve results. Because of these factors, most corn and soybean fungicides are applied at the R1 and R3 growth stages respectively. The narrow window for applying fungicides at the right crop stage prevents most growers from even considering potential benefits from spraying at specific times of the day to improve efficacy. If you own a sprayer and have the flexibility to spray at specific times, there may be some benefit to adjusting your application time.

APPLICATION FACTORS INFLUENCING FUNGICIDE EFFECTIVENESS

Maximizing fungicide uptake into the leaf will undoubtedly increase the potential for yield response. Weather conditions associated with the specific time of day applications are made can play an important role in dictating how well a fungicide is taken up by the leaf. Consider the following factors related to the time of day applications are made:

1. **Wind Speed:** Calm to low wind speeds help maximize leaf coverage and minimize drift. Light winds can also help prevent driftable fine spray particles from being trapped in temperature inversion layers and drifting away.
2. **Leaf dryness:** Heavy morning dew on leaves could facilitate fungicide runoff, reducing its uptake by the plant. Dry leaves minimize this, however light morning dew could still be advantageous when spray gallons per acre are very low, acting to spread fungicide across the leaf surface more evenly.
3. **Temperature/drying conditions:** High temperatures that promote fast drying of spray solutions may increase evaporative losses and reduce leaf uptake. Calm, cloudy days and cooler late afternoon to dusk conditions can help leaf stomates stay open longer after application, potentially enhancing uptake of fungicides.



Graph 1. Corn yield response to different fungicide time-of-day application timings averaged across trial locations in 2024.

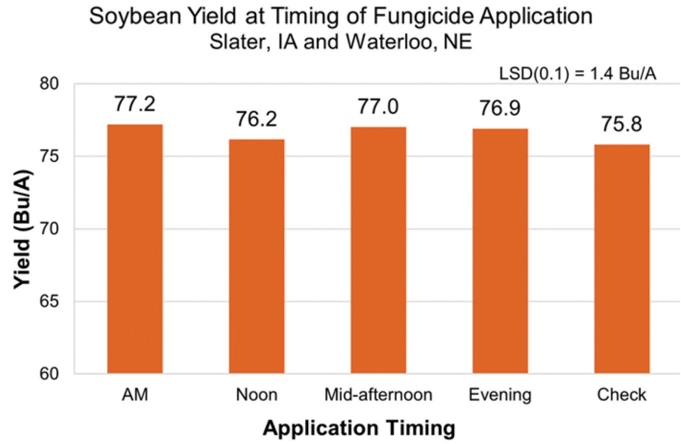
2024 TIMING OF FUNGICIDE APPLICATION TRIALS

The Agronomy in Action research team implemented trials designed to investigate corn and soybean responses to the impact of the time of day the fungicide application was made. Corn trials were carried out in Malta, IL, and Slater IA, and soybeans trials were at Slater, IA, and Waterloo, NE. Trials were designed to compare the effectiveness of early morning, noon, mid-afternoon, and evening/night application times to an untreated check. Fungicide applications were made over the duration of the same day at each site, using Miravis® Neo fungicide at a rate of 13.7 oz/A. Treatments were applied by ground at the R3 stage in soybean trials (20 GPA) and with a DJI Agras T20P spray drone at the R1 stage in corn trials (5 GPA).

RESULTS

When averaged across locations, corn yields increased to some degree with all fungicide application timings as compared to the untreated checks (Graph 1). The largest fungicide application timing responses in corn yield were observed with early morning (12.7 Bu/A) and late evening (9.1 Bu/A) application timings. Noon and mid-afternoon applications tended to be somewhat less responsive to fungicide applications, although the results were not statistically significant.

When averaged across soybean trial locations, there were similar fungicide timing responses for morning, mid-afternoon and evening applications (1.1 to 1.4 Bu/A). The noon timing was the least responsive (0.4 Bu/A) of the four timings (Graph 2). Interestingly, when looking at Slater, IA, and Waterloo, NE, responses independently, Slater was the most responsive when applied in the evening (2.1 Bu/A), whereas Waterloo



Graph 2. Soybean yield response to different fungicide time-of-day application timings averaged across trial locations in 2024.

was most responsive with morning applications (3.2 Bu/A, data not shown). For both locations, noon application responses continued to be the least responsive of all timings.

SUMMARY

This study showed a potential for better yield response to fungicide by making applications in the early or later parts of the day when temperatures and wind speed are typically lower. Low disease pressure and dry conditions during late summer likely reduced overall fungicide response in both 2024 trials. While there was a slight yield advantage to early morning and evening applications, data across all timings in both studies indicate very small yield differences across the duration of a single day. As mentioned earlier, factors such as temperature, leaf dryness and wind speed are dynamically related and difficult to predict. Timely fungicide applications targeting proper crop growth stage and applied just prior to disease onset will likely have a greater influence on yield than the time of day the application is made.

TIMING VOLUNTEER CORN MANAGEMENT IN SOYBEANS

INSIGHTS

- Volunteer corn can reduce soybean yield if left untreated.
- Minimizing harvest loss and opportunities for germination can help reduce volunteer corn.
- Early control of volunteer corn in soybeans preserves maximum yield potential.

INTRODUCTION

Lodged corn can result in dropped ears and harvest loss. In addition to lost yield potential, ears or individual kernels emerging in the following year's soybean crop can cause additional loss if not managed properly. Like other weeds, volunteer corn needs to be controlled quickly to prevent competition with soybeans for available resources. Volunteer corn can also attract egg laying insects that otherwise would not have been present, potentially elevating insect pressure in the next season. For example, corn rootworm beetles may be attracted to feed on pollen and silks of volunteer corn plants and then lay their eggs, potentially threatening the following year's corn crop.

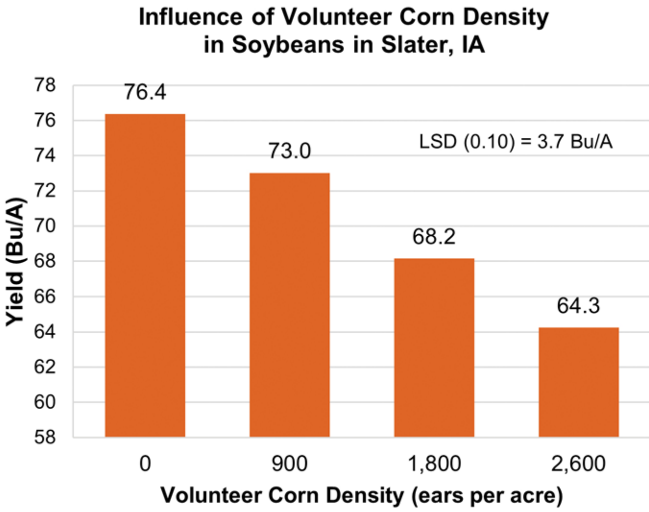
2024 AGRONOMY IN ACTION TRIAL

A soybean trial was planted in 30-inch row spacings at Slater, IA to evaluate the impact of volunteer corn on soybean yield when present at specific densities and herbicide application timings. Corn ears were soaked in water to promote germination prior to being placed directly on top of soybean rows (Figure 1). Volunteer corn densities were established at a rate of 900, 1,800, and 2,600 ears per acre. In selected plots, the corn was sprayed at either 4- or 12-inch corn heights with Fusilade® DX herbicide at 8 oz/A and crop oil concentrate at 1% v/v. Soybean yield of each volunteer corn density and application timing was measured at harvest.

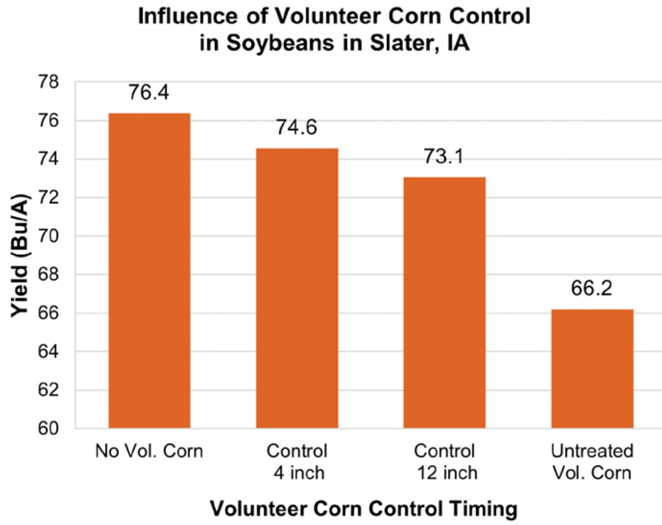
Figure 1 Volunteer corn clump emerging in soybean field trial evaluating impact on yield, Slater, IA 2024.

RESULTS

Soybean yield was reduced by 4-15% if volunteer corn was left uncontrolled, and the higher volunteer corn ear densities had the most significant losses (Graph 1). Yield loss from volunteer corn was significantly reduced when the volunteer corn was controlled with herbicide application. Earlier application control of volunteer corn further reduced soybean yield loss from 4.3% to 2.3% with 12- and 4-inch applications respectively (Graph 2). Additionally, the 4-inch timing application resulted in a1.5 Bu/A increase in yield compared to the 12-inch timing.



Graph 1. The influence of volunteer corn density on soybean yield in the 2024 trial in Slater, IA.



Graph 2. The influence of volunteer corn control timings in soybeans averaged across volunteer corn densities in the 2024 trial.

Volunteer corn was established directly on the soybean row in this trial (Figure 2), creating a more severe level of yield reduction. If it had been placed between soybeans rows it might not have reduced yield as much, although volunteers would still compete with soybeans for resources and likely have a negative impact on yield.

Figure 2. High volunteer corn density at establishment (left) and at harvest (right) in the 2024 trial.

DISCUSSION

This trial affirms that early control of volunteer corn in soybeans provides the best chance of preserving soybean yield potential. Identifying corn fields with lodging or ear dropping can help prioritize soybean fields that may need timely volunteer corn herbicide applications the following year. It is important to understand the corn trait technology present in the prior grown corn hybrids to help determine if glyphosate or glufosinate may be effective for controlling emerging volunteer corn in that specific field. Fall and late spring tillage prior to planting in fields with large amounts of previous season corn harvest loss can help germinate and eliminate significant amounts of volunteer corn. No-till planting can sometimes minimize the amount of volunteer corn that germinates too. Volunteer corn should be monitored and managed to set the soybean crop up for the best yield potential.

EVALUATING SOYBEAN FUNGICIDE APPLICATION TIMING DURING VEGETATIVE GROWTH STAGES

INSIGHTS

- Fungicide applied at R3 consistently increased soybean yield in the trial.
- Yield response to a fungicide applied at the V4 growth stage was minimal.
- Soybean varieties responded similarly to foliar fungicide applications.

FUNGICIDE APPLICATIONS IN SOYBEANS

Foliar fungicide application timing in soybeans is a critical aspect of crop management that can significantly influence disease control efficacy and overall yield potential. Historically, the R3 growth stage (beginning pod) has been the optimal timing to apply fungicide (Figure 1). At this critical stage, soybeans are particularly vulnerable to various fungal pathogens. Applying fungicides at R3 maximizes spray coverage of the plant canopy, effectively protecting both existing and newly forming pods. This timing has consistently demonstrated yield improvements.

Recent changes to soybean production including higher yield potential, earlier planting dates, rising disease pressure, and advancements in fungicide technology has prompted growers and agronomists to ask if there is a potential yield benefit to applying a fungicide earlier during vegetative growth stages.

AGRONOMY IN ACTION RESEARCH TRIAL

In 2024, the Golden Harvest Agronomy in Action Research team implemented a trial at six locations across Illinois, Iowa, Kansas, Nebraska and Wisconsin to evaluate the effect of a fungicide application during the V4 growth stage (four unfolded trifoliate leaves, Figure 1). The fungicide application at V4 was compared to a traditional application timing at R3 and a no fungicide or untreated check. A combination treatment of a fungicide applied at V4 and R3 was also included. All fungicide applications used Miravis® Neo fungicide applied at 13.7 oz/acre.

1. Check – no fungicide applied
2. V4 Fungicide
3. R3 Fungicide
4. V4 + R3 Fungicide

Figure 1. Soybeans at V4 growth stage on left and R3 growth stage on right from 2024 trials.

Early RM Brands	Mid RM Brands	Late RM Brands
GH1875E3	GH2775E3	GH3035E3
GH1922E3	GH2745XF	GH3225XF
GH1973E3S	GH2925XF	GH3415E3S
GH2004XF	GH3035E3	GH3445XF

Table 1. Variety groups planted at each location based on relative maturity (RM).

Four soybean varieties were planted at each location depending on geography (Table 1).

YIELD RESULTS

Despite environmental conditions conducive for disease for much of the growing season, overall disease pressure was low at all sites. Sclerotinia stem rot (white mold) was present at Malta, IL and was likely the reason soybean yields were lower there. Janesville, WI had septoria brown spot but symptoms did not progress up the canopy.

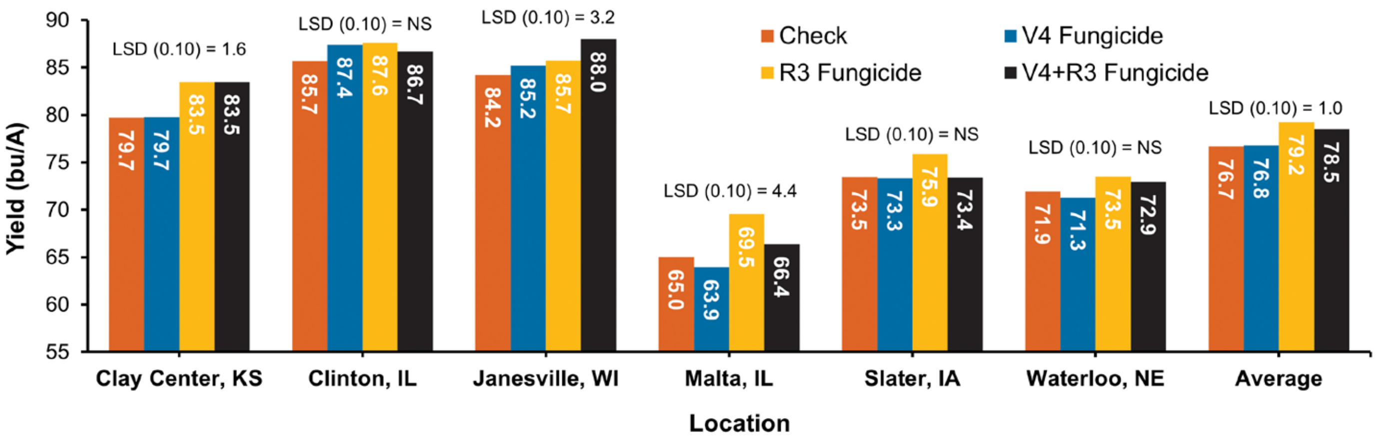
Yield environments ranged from 66 Bu/A at Malta, IL to 87 Bu/A at Clinton, IL. There was no interaction between variety and fungicide treatment, so all results are averaged across varieties. On average across all locations, fungicide applied at the R3 growth stage significantly increased yield by 2.5 Bu/A compared to the untreated check (Graph 1). Fungicide at R3 statistically increased yield at 2 out of the 6 locations with a 3.8 Bu/A response at Clay Center, KS and 4.5 Bu/A response at Malta, IL. Yield response to R3 fungicide applications ranged from 1.5 – 4.5 Bu/A depending on the location.

Fungicide application at V4 did not significantly increase yield at any location. Clinton, IL (1.7 Bu/A) and Janesville, WI (1.0 Bu/A) were the only locations with a numerical response of at least 1 Bu/A (Graph 1). On average across all locations, combining V4 and R3 fungicide timings did not out yield R3 application alone (Graph 1). Although not statistically different, only Janesville, WI, observed greater yields with two application timings compared to the R3 timing alone.

SUMMARY

Results from this study confirm the consistency in yield response from R3 fungicide applications and why it should be considered as part of a comprehensive soybean management program. Even in environments with low disease pressure, positive responses to fungicide at the R3 timing was observed. In contrast, fungicide applied during the vegetative stage of V4 had minimal effect on yield. There may be environments and situations where an early season fungicide application is necessary to prevent heavy disease pressure, however this timing should not be a widely used management strategy.

Fungicide application timing in soybeans is critical and the R3 growth stage continues to be the optimal timing to maximize spray coverage and protect soybeans from disease at the most vulnerable period in their life cycle.



Graph 1. Soybean yield response to foliar fungicide timing at six locations averaged across four varieties in 2024.

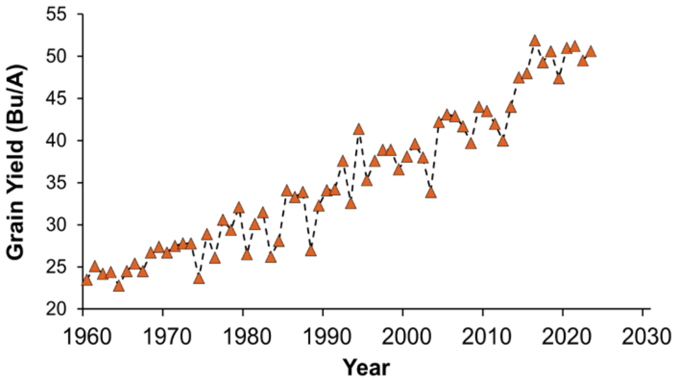
SOYBEAN MANAGEMENT FACTORS WITH LARGEST IMPACT ON YIELD IN 2024

INSIGHTS

- Variety selection had the biggest impact on yield.
- Foliar protection applied at the R3 growth stage was the management practice that most consistently increased soybean yield.
- Some locations had a significant response to the combination treatment but did not respond to individual management factors, suggesting a synergistic effect.
- Consider the local environment such as soil properties, yield potential and pest pressure when making a management plan.

INTRODUCTION

Over the past six decades, U.S. soybean grain yields have seen a remarkable upward trajectory. In 1960, farmers harvested an average of 24 bushels per acre; by 2020, this more than doubled to 51 bushels per acre (Graph 1). While genetic advancements in soybean varieties have been the primary driver of this historical yield increase, significant improvements in crop management practices have also played a crucial role.



Source: USDA-NASS[1]

Graph 1. Historical U.S average soybean grain yield.

IDENTIFYING THE MANAGEMENT PRACTICES WITH THE MOST INFLUENCE ON YIELD

Today's farmers have access to a diverse array of tools and techniques to optimize soybean production. The Golden Harvest Agronomy in Action team implemented a trial at 8 locations across the Midwest to identify which core, in-season management practices had the largest impact on yield in 2024. The trial was designed to assess the individual value of each management practice when added to a standard base program. In addition, all inputs were applied in conjunction to evaluate the potential to improve yield by combining multiple management factors. The list of treatments included:

1. **Base Program:**
   Farmer's normal fertility program with no additional inputs planted at 140,000 seeds/acre.
2. **Fertility:**
   Planter-applied 2×2×2 placement of 7 lbs. N, 22 lbs. P_2O_5, 29 lbs. K_2O, and 2 lbs. S per acre.
3. **Foliar Plant Growth Regulators (PGRs) and Micronutrients:**
   Foliar-applied Ascend® SL (3.4 oz/acre) and MAX-IN® Ultra ZMB (2 qt/acre) at V4 and R3 growth stage.

Early RM Brands	Mid RM Brands	Late RM Brands
GH1875E3	GH2674E3	GH3023XF
GH1922E3	GH2745XF	GH3035E3
GH1973E3S	GH2775E3	GH3043E3
GH2004XF	GH2814E3S	GH3225XF
GH2315E3	GH2884XF	GH3415E3S
GH2335E3	GH2925XF	GH3445XF

Table 1. Variety groups planted at each location based on relative maturity (RM).

	Location								
	Bridgewater, SD	Clay Center, KS	Clinton, IL	Grundy Center, IA	Janesville, WI	Malta, IL	Slater, IA	Waterloo, NE	Average
Treatment	Yield (bu/A)								
Base	68.6	83.0	86.7	59.8	81.4	57.0	79.0	73.0	73.6
Fertility	-0.4	-2.8	1.0	1.7	0.5	-0.9	-0.1	-0.2	-0.2
PGRs & Micros	0.9	-0.9	-2.8	-1.9	0.8	-0.7	1.1	0.1	-0.5
Foliar Protection	2.1*	5.9*	1.7	3.4*	-0.6	3.5	0.7	1.0	2.2*
Combination	0.1	-1.5	3.3*	0.2	0.3	5.7*	1.6*	0.5	1.3*

* Significantly different than base treatment at α=0.10

Table 2. Change in yield with each management factor compared to the base treatment averaged across six varieties at 8 locations in 2024.

4. **Foliar Protection:**
   Foliar-applied Miravis® Neo (13.7 oz/acre) and Endigo® ZCX (4 oz/acre) at R3 growth stage.
5. **Combination:**
   All treatments implemented together.

Six location-appropriate varieties were planted in each plot (Table 1).

EFFECT OF MANAGEMENT ON YIELD

Base yield levels ranged from 57.0 Bu/A at Malta, IL, to 86.7 Bu/A at Clinton, IL (Table 2). There was no interaction between variety and response to management in any of the relative maturity groups, so all results are averaged across the six varieties at each location. On average across all locations and varieties, only the foliar protection and combination treatments had a significant impact on yield. Foliar protection increased yield by 2.2 Bu/A and combining all inputs increased yield by 1.3 Bu/A, suggesting the greater yield was likely driven by the foliar protection (Table 2).

Individual location response to foliar protection ranged from -0.6 to 5.9 Bu/A (Table 2). Three out of the eight locations had a significant response to the foliar protection including Bridgewater, SD (2.1 Bu/A), Grundy Center, IA (3.4 Bu/A), and Clay Center, KS (5.9 Bu/A). At Clinton, IL, Malta, IL, and Slater, IA, the highest yields were achieved with the combination treatment (Table 2). Interestingly, at Clinton, IL, and Malta, IL, adding the combination of all the inputs provided a greater yield increase than the sum of adding each treatment individually, suggesting there was a synergistic effect between the management practices at those locations. Soybeans grown at these locations likely set a higher yield potential early in the season from the planter-applied fertility, but required additional in-season management from PGRs, micronutrients, and foliar fungicide/insecticide to maintain that high yield potential.

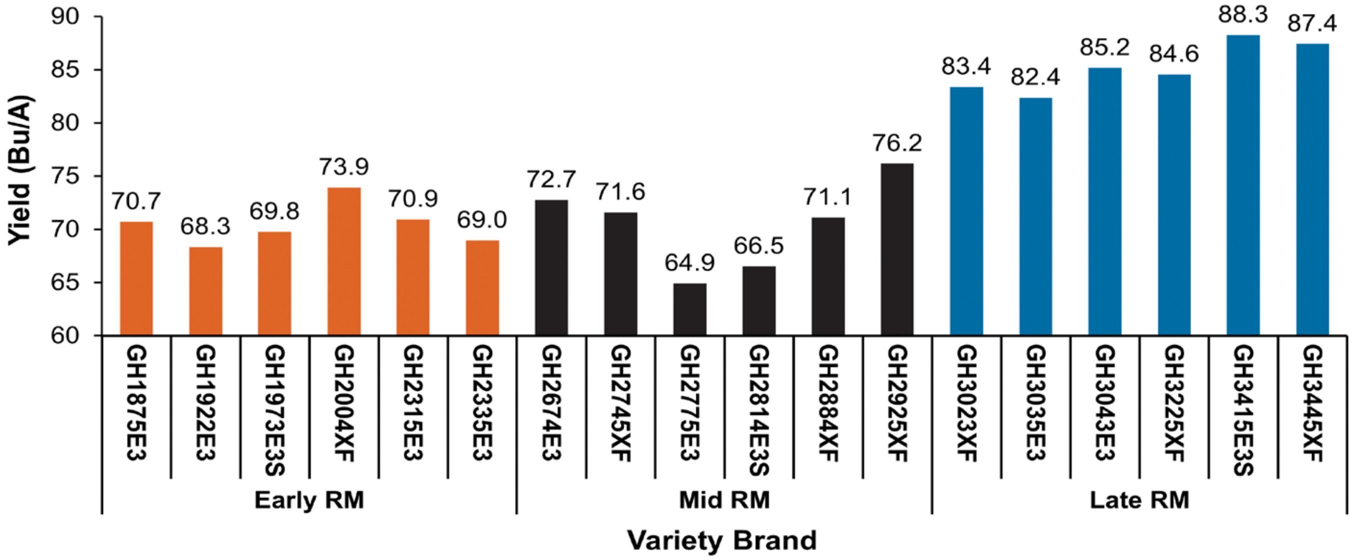
Overall, there was no individual effect from fertility at the majority of locations (Table 2). Only at Clinton, IL and Grundy Center, IA was there a numerical yield increase greater than 1 bu/A when fertility was applied. Both locations had lower phosphorus (P) soil test values so the soybeans may have responded to the additional 22 lbs of P2O5 applied with the planter (Table 3). Surprisingly, Slater, IA, and Waterloo, NE, had low potassium (K) and P soil test values, respectively, but did not show a yield response to the fertilizer.

		Organic Matter	CEC	P†	K††	S	Zn	Mn	B
Location	pH	%	meq/100g	ppm	ppm	ppm	ppm	ppm	ppm
Bridgewater, SD	6.2	3.1	21.4	22	183	12	1.4	15	0.7
Clay Center, KS	6.5	2.0	14.3	27	295	16	1.1	3	0.4
Clinton, IL	6.4	3.0	17.8	21	180	7	2.9	5	0.3
Grundy Center, IA	5.5	3.6	18.7	18	213	9	1.5	16	0.3
Janesville, WI	6.2	2.8	16.3	106	304	9	5.7	11	0.2
Malta, IL	6.1	5.3	22.6	44	224	10	5.0	5	0.5
Slater, IA	5.3	3.8	27.2	41	137	6	1.1	9	0.4
Waterloo, NE	6.5	2.7	18.1	9	296	7	0.8	5	0.4

† Weak bray test (20-30 ppm considered adequate)

†† Ammonium acetate test (175-250 ppm considered adequate)

Table 3. Soil test values for 8 locations across the Midwest in 2024.



LSD (0.10) Early RM =1.9

LSD (0.10) Mid RM =2.0

LSD (0.10) Late RM =2.5

Graph 2. Variety yield within each relative maturity group averaged across all management factors and locations in 2024.

No location had a significant response to the foliar PGRs and micronutrients applications (Table 2). Only soybeans grown at Slater, IA, tended to have a positive response (1.1 bu/A) with the foliar application.

VARIETY SELECTION MATTERS

In this study, the factor that had the biggest impact on yield was not a crop management decision but rather what variety to plant. The range in yield between varieties within a maturity group was 5.6 bu/A for the early set, 11.2 bu/A for the mid set, and 5.9 bu/A for the late set (Graph 2). Selecting the highest yielding variety was more vital to yield than any yield potential gained from better crop management.

LOCAL MANAGEMENT DECISIONS

While results varied by location, foliar protection emerged as the most consistent and beneficial management practice on average. Late-season plant health tended to be the most critical component in yield potential. At locations where the combination of management practices was the highest yielding treatment, it appears there was a synergistic effect where yields were greater than the additive of single treatments. Getting the soybeans off to a strong start and protecting plants throughout the season was needed to achieve the greatest yields.

The mixed results across locations from this trial highlight the importance of considering local conditions when preparing and implementing a crop management strategy for the season. Working with your local Golden Harvest sales representative and agronomist to select the best variety for your farm is the first step to a successful crop.

Figure 1. Varietal differences in senescence at Clinton, IL in 2024.

References

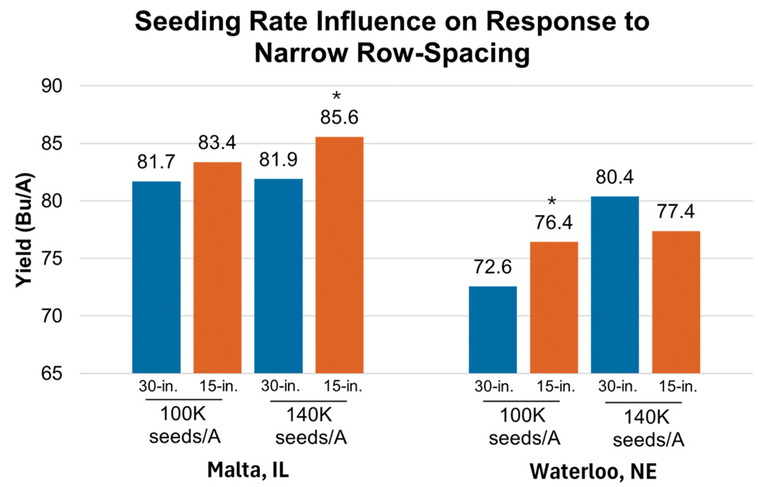
[1] USDA -National Agricultural Statistical Service (USDA-NASS). 2021. Soybeans. Grain Yield. United States, 1960 to date. USDA-NASS, Washington, DC.

AGRONOMY IN ACTION

COMBINED STUDY OF SOYBEAN ROW SPACING AND SEEDING RATE

INSIGHTS

- Planting soybeans in narrow rows takes advantage of light utilization and can provide improved weed control.
- The benefit of planting soybeans in narrow rows at a lower seeding rate may not always be as great as when planting 140,000 seeds/A.
- Varying levels of yield increases at both seeding rates were seen in 30-inch and 15-inch rows.



* = significant (P=0.10) row spacing response within the specified seeding rate

Graph 1. Soybean yield response to seeding rate and row spacing from 2024 trials.

INTRODUCTION

The majority of soybean acres are planted in either 15-inch or 30-inch row spacing across the growing regions, but the predominant row spacing varies significantly by state. For example, 69% of the soybean acres in South Dakota are typically planted in 30-inch rows compared to 5% in Ohio, whereas these states plant 15% and 89% of their acres in row spacings of 15-inches or less, respectively.[1]

Row spacing trends are often influenced by factors other than yield. Equipment purchases in areas where cropping options are more diverse are often more aligned to crops with unique row spacing like cotton or sugar beets, which favor wide and narrow rows respectively. Areas with disease complexes that thrive in moist, wet environments often encounter white mold more frequently and likewise tend to use wider row spacing as a preventive measure. Yet numerous trials often demonstrate yield benefits from narrow row spacings in areas predominantly planting wide rows. This preference is likely driven by the desire to achieve maximum light interception prior to early reproductive stages (Figure 1).[2]

2024 SOYBEAN ROW SPACING TRIALS

To better understand seeding rate influence on row spacing response, trials were planted at Waterloo, NE, and Malta, IL, in 2024. These trials compared four varieties planted at 100,000 and 140,000 seeds/acre in both 30-inch and 15-inch row spacing. Both trials were planted in the last week of April. Varieties with differing plant height and canopy type were intentionally chosen to help understand if varietal responses differ.

RESULTS

Narrowing row spacing from 30 to 15 inches resulted in varying levels of yield increases at both low (100,000) and normal (140,000) seeding rates. At Malta, there was a 1.7 and 3.7 bushel per acre (Bu/A) response to narrow rows within the low and normal seeding rates respectively (Graph 1). A response to narrow rows was only observed within the lower seeding rates at Waterloo, NE (3.8 Bu/A, Graph 1). The two locations responded very differently to overall reductions in seeding rates. Both seeding rates yielded similarly in wide rows at Malta, although there was a 2.2 bushel yield penalty with reduced seeding rates in narrow row configuration. However, at Waterloo there was a yield loss of 7.8 Bu/A with reduced seeding rates in wide rows, whereas reduced and normal seeding rates yielded similarly in narrow rows.

Figure 1. Canopy closure differences between 30-inch and 15-inch row spacing on July 31, 2024 at Malta, IL.

Individual variety responses to narrow rows ranged from zero to 5.9 Bu/A depending on the variety and location (Table 1). There was no repeatable trend across locations to indicate specific varieties were more likely to respond to narrow rows.

Variety Response to 15-inch Rows

	Malta	Waterloo
Brand	Bu/A	
GH2544XF	1.6	5.9*
GH2674E3	3.1	-3.0
GH2722XF	4.1*	3.3
GH2745XF	1.8	-4.6*

* = significant at p=(0.10) level

Table 1. Soybean variety yield response averaged across seeding rates in 15-inch rows in 2024 trial.

CONCLUSIONS

Like historic trials, these trials demonstrated incremental yield potential through narrow row spacing. They also indicate that yield benefits from narrow rows can still be observed at lower seeding rates, yet the benefit may not always be as great as when using more normal seeding rates (140,000). There are multiple factors going into equipment purchase decisions that may outweigh yield benefits seen in this trial. However, in addition to yield, growers should also consider the added benefits associated with narrow rows such as faster crop canopy, improved leaf-light interception, improved weed control and weed soil seed bank management.

References

[1] USDA-NASS, 2015 Crop Production Survey.

[2] Board, J.E., and B.G. Harville. 1992. Explanations for greater light interception in narrow- vs. wide-row soybean. Crop Sci. 32:198-202.

AGRONOMY IN ACTION

PLANTING DATE EFFECT ON SOYBEAN YIELD IN 2024

INSIGHTS

- Favorable planting conditions on April 5 resulted in significant yield benefits in this 2024 trial.
- Yield penalties increased significantly when planting after May 15.
- Seeding rates greater than 110,000 plants per acre maximized yield within each planting date.

INTRODUCTION

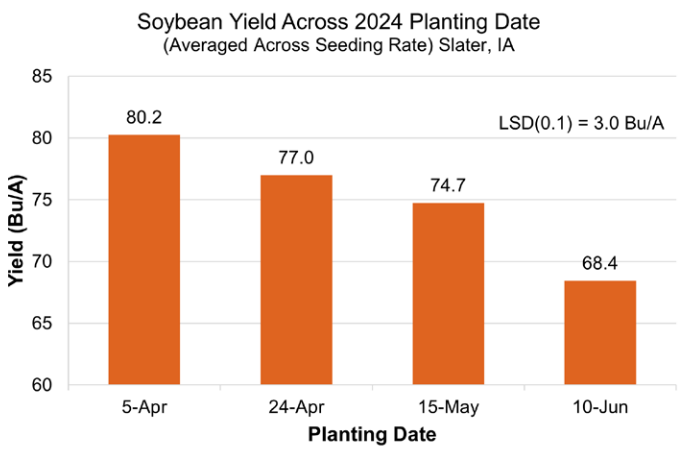
In recent years there has been more focus on early-planted soybeans. Even though colder soil temperatures in early spring limit growth rate, soybeans can benefit from early planting dates because it can help capitalize on photoperiod and maximize growth and development in vegetative and reproductive stages. This allows plants to have more time accumulating nodes and filling pods, which both contribute to higher yields.

2024 AGRONOMY IN ACTION TRIAL

An Agronomy in Action research trial was established in Slater, IA, to examine the effect of planting date on soybean yield. Two varieties, GH2884XF and GH2925XF brands, were selected and established at seeding rates of 170,000, 140,000, 110,000, 80,000, and 50,000 seeds per acre. The two varieties and 5 seeding rates were planted on 4 dates: April 5, April 24, May 15, and June 10. Due to similar responses to planting date and seeding rates, results were averaged across varieties.

PLANTING DATE RESPONSE

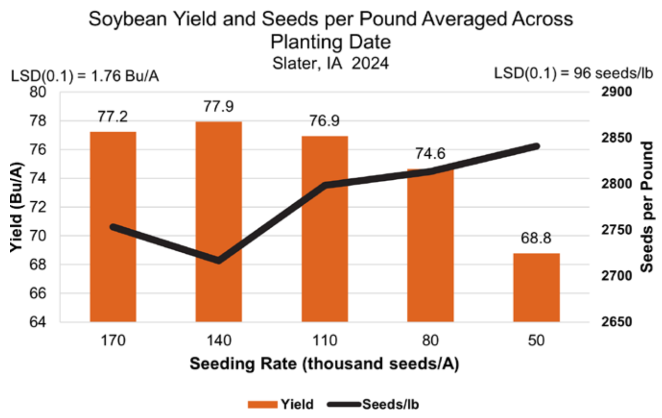
Weather conditions in early 2024 were generally wetter than in previous years. The April 5 planting date was the first date when soil moisture levels allowed tillage. The following weeks were cold and wet, and conditions were not conducive for planting again until April 24. Despite these conditions, on average the early April planting date yielded 3.9% and 6% better than the following two planting dates respectively (Graph 1). April 24 planting date yields were 3.2 Bu/A less than the April 5 planting date. Delaying planting until mid-May resulted in an additional 2.3 Bu/A decrease in yield compared to the late April planting date. The last planting date on June 10 resulted in the largest yield penalty of 6.3 Bu/A less than the May planting date and 11.8 Bu/A less than the April 5 planting date.



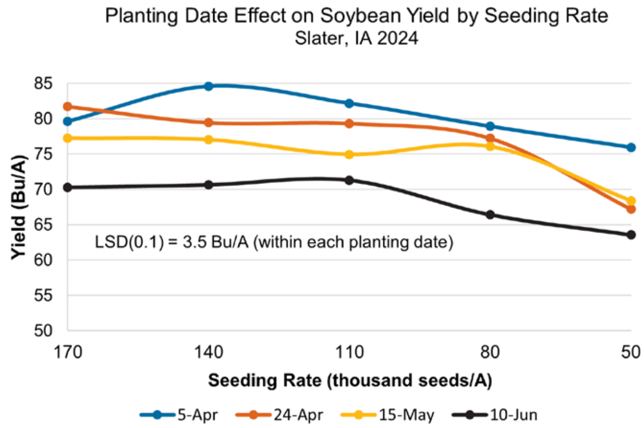
Graph 1. Soybean yields averaged across 5 seeding rates in 2024.

SEEDING RATE RESPONSE

When averaging across planting dates, seeding rates of 110,000 or greater yielded similarly, however the 80,000 and 50,000 seed per acre rates lost 4% and 11.7% of their yield potential respectively (Graph 2). In general, delaying planting had a more negative effect than reducing plants per acre. The optimal



Graph 2. Soybean yield and seeds per pound averaged across planting date.



Graph 3. Planting date effect on soybean yield by seeding rate.

seeding rate of ≥110,000 seeds per acre did not change with later planting dates (Graph 3). In previous trials however, late planting dates have been shown to be more responsive to increased seeding rates due to a reduced ability to branch and develop the same number of nodes compared to earlier planting dates.

SEEDING RATE INFLUENCE ON SEED SIZE

To better understand how increasing or decreasing the number of plants per acre affects yield components such as seed mass, grain samples were collected to determine seeds per pound across seeding rates. Graph 2 shows the relationship of seeds per pound to yield at each seeding rate. In general, seed mass decreased (more seeds per pound) as seeding rates decreased. Increased seed mass combined with a lack of change in yield at higher seeding rates indicates that fewer seeds per acre are being produced when population increases. This is a great example of how dynamic soybean yield components can be. Changes in seed size is just one way that soybeans compensate for poor stands.

SUMMARY

This trial demonstrates the importance of planting soybeans early to maximize yield potential. With early planting dates, soybeans can maximize time in vegetative and reproductive growth stages. Earlier planting dates can also aid in weed control and moisture retention through quicker canopy and row closure. When delaying planting date, there are fewer days available for plant growth and development, and soybeans can lose the ability to maximize yields. The small differences in yield between different seeding rates within each planting date demonstrate the plasticity of soybean yield components to compensate for stand reductions.

Risk of stand loss and emergence issues from crusting or planting into excessively wet soil early in the spring are also risk factors. Compared to soybeans, a delay in planting corn acres would likely result in higher economic losses. This risk should be balanced against the weather forecast and the total time required to plant all corn and soybean acres.

REPLANTING STRATEGIES FOR SOYBEANS

INSIGHTS

- The decision to replant an existing soybean stand can be complex where if estimated yield loss from a later replanting date exceeds the loss from a reduced stand, it may be more beneficial to keep the original stand and consider interplanting.
- Accurate assessment of the original plant stand is important, as replanting may not always be the best option.

INTRODUCTION

Unpredictable weather events can impact the timing of soybean emergence and influence stand establishment (Figure 1), and assessment of early season soybean stands sometimes leads to a question of whether to replant or fill in an existing stand. Previous studies suggest that a final soybean stand greater than 100,000 plants per acre usually produces the highest yield potential. Soybeans can compensate for reduced stands to a certain degree through branching, and often later-planted soybeans have a reduced capacity to maximize yield potential. Significantly reduced plant stands can increase problems with weed control and often lead to lower yields, making the decision to keep an existing stand complicated. If stands are found to be inadequate for maximum yield potential, common approaches to increase stands are filling-in existing stands or removing existing plants with herbicide or tillage and replanting. Both methods may increase plants per acre, but interplanting an existing stand can create differences in soybean maturation and increase grain moisture at harvest.

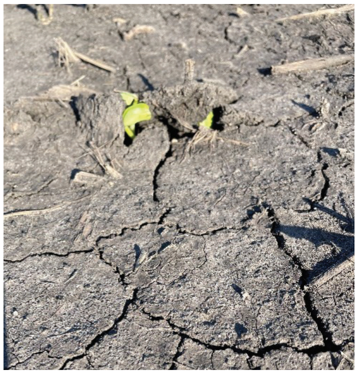
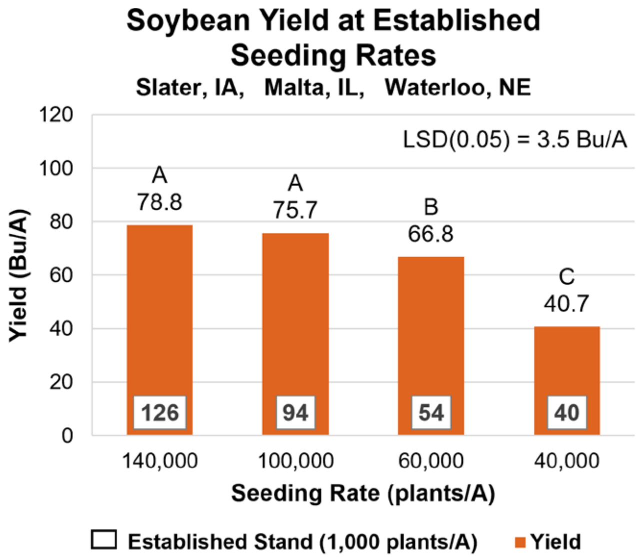


Figure 1. Soybean plant emerging through heavily crusted soil.

An accurate assessment of the existing stand is an important first step in making a replant decision. Visual assessments of existing soybean stand can sometimes be unreliable, as narrower row spacings may increase the space between individual plants and give the appearance of a poor stand. Existing stands can be measured using a hula hoop or by measuring linear feet of row and converting to plants per acre for a more accurate estimate.

2024 SOYBEAN REPLANT STRATEGY TRIALS

Agronomy in Action research trials were established in Malta, IL, Slater, IA, and Waterloo, NE, to compare soybean yield response of interplanting into poor stands as compared to tilling up a reduced stand and replanting. Established stands were compared to stands replanted at the unifoliate growth stage. Plant stands of 140,000, 100,000, 60,000, and 40,000 plants per acre were established in 30-inch rows to understand yield penalties of a possible reduced stand if deciding not to replant. To understand the effect of gaps in final stands, devitalized seed was mixed at various ratios with viable seed prior to planting to



Graph 1. Soybean yields at established seeding rates in 2024.

achieve similar final stands as the reduced stand plots mentioned earlier, only with gaps. Replanted plots were established with GPS by shifting the guidance line 6 inches from the previous row. Delayed planting date plots at 140,000 and 180,000 plants per acre were also established to simulate a scenario where an original stand was removed completely with tillage and replanted.

IMPACT OF REDUCED STANDS

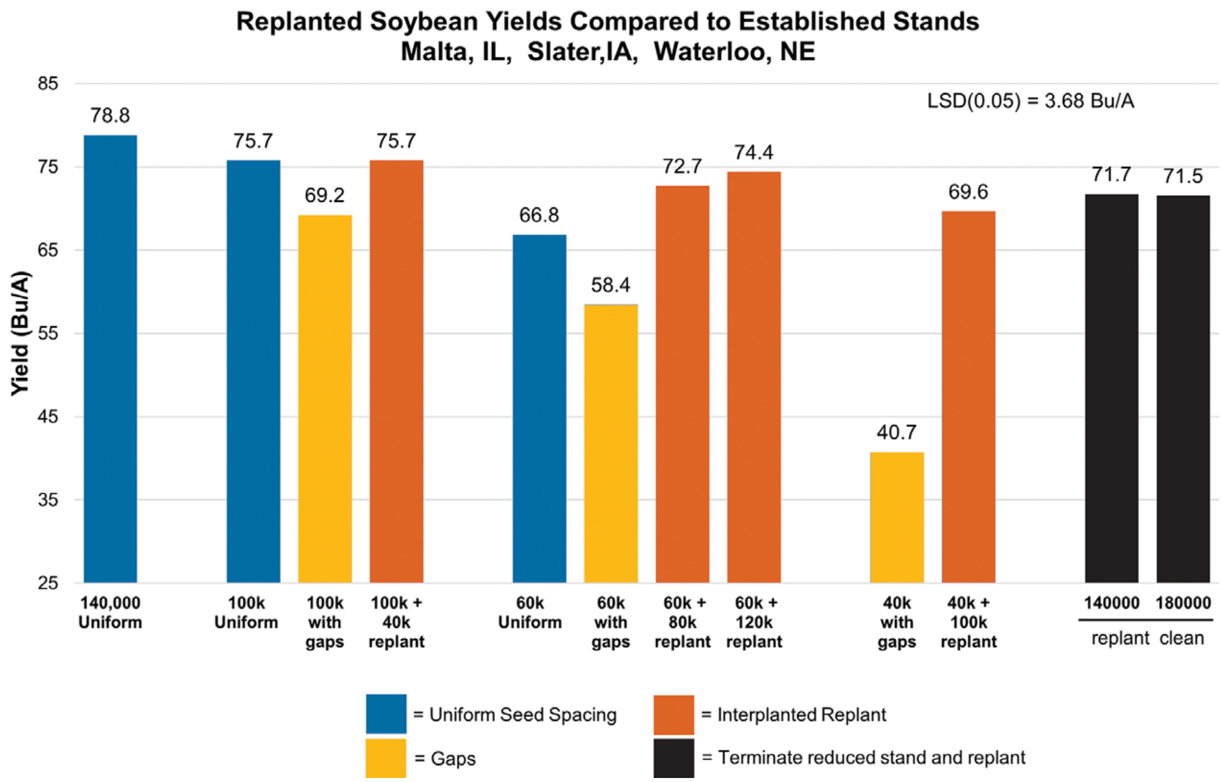
Established seeding rates of 140,000 and 100,000 plants per acre produced statistically similar yields (Graph 1), showing that established stand levels were adequate to maximize yield. Yields of seeding rates below 100,000 were significantly lower indicating there weren't enough plants per acre to maximize yield. Overall, gaps in plant stands reduced final yields 8-12% less than similar plant per acre populations with even plant spacing (Graph 2). Previous multiyear trials have shown a similar 8% yield loss associated with gaps.[1] Although stand gaps can have negative impacts, unlike corn, soybeans are better able to compensate for small gaps by branching and bushing out into the gaps to better utilize all available sunlight.

The reduced stand and various replant strategy yield responses can be compared to the 140,000 seeding rate that was established early in the season to better understand which strategy recovered the most yield potential (Graph 2). Replanting by termination of the original stand or by filling in the existing stand was unwarranted when the original stand levels were 100,000 or greater. Interplanting stands that were 60,000 or lower yielded similarly to stands that were terminated and completely replanted. Attempting to improve the final stand above 140,000 did not prove beneficial in this trial, however previous trials have shown a benefit to an increase in seeding rate at later planting dates.

PLANTING DATE EFFECT ON YIELD

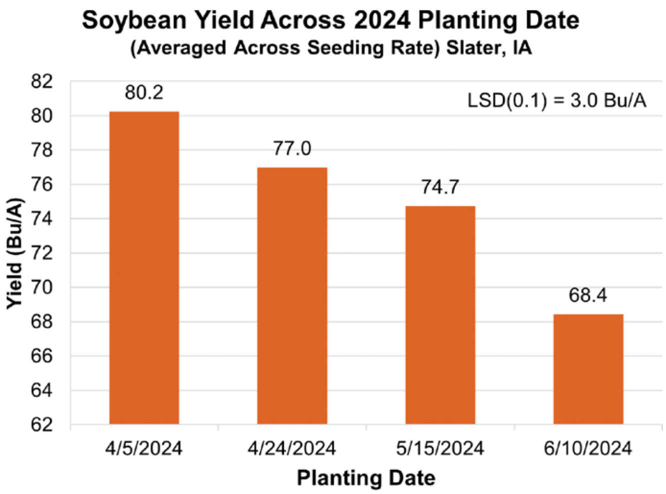
Planting date is another important factor to consider in replant scenarios. The average replanting date across these three trials was 4 weeks after the original planting date. Complete replanting at a rate of 140,000 plants per acre yielded less than stands of 100,000 plants per acre that were established early. Increasing the seeding rate to 180,000 plants per acre at the complete replanting date showed no benefit.

In our trials the average delay was 4 weeks, but ultimately the actual calendar date planted on can have larger impacts. A separate 2024 planting date trial at Slater, IA, showed different rates of yield



Graph 2. Soybean yields across all trial treatments in 2024.

loss than observed in earlier years and locations (Graph 3). Planting in early April brought the highest yielding soybeans. Late-April and mid-May planting dates produced similar yields, and there was significant yield loss by delaying planting until June. Yield response to early planting dates is most likely due to node accrual and the longer period in vegetative and reproductive growth stages compared to later planting dates.[2]



Graph 3. Soybean yield response to planting date in 2024.

SUMMARY

Replanting may not be needed unless stands fall below 100,000 plants per acre or large gaps are present. If estimated yield loss from a later replanting date exceeds the loss from a reduced stand, it may be more beneficial to keep the original stand and consider interplanting. If the decision is made to replant, this trial indicates interplanting instead of completely replanting may not be as concerning as previously anticipated. Accurate early stand assessment can help determine whether replanting would be a viable option. Replanting or interplanting existing stands might also increase costs of tillage, seed, and herbicide product per acre, and those considerations should be weighed against the potential for increased yield.

References

[1] Moore, S.H. 1991. Uniformity of Plant Spacing Effect on Soybean Population Parameters. Crop Science, 31: 1049-1051, cropsci1991.0011183X003100040041x

[2] Iowa State Extension publication, Soybean Replant Decisions. PM1851.

UTILIZING MICROBES TO ACCELERATE CORN RESIDUE DECOMPOSITION

INSIGHTS

- On average, broadcast treatments designed to increase soil microbial activity had minimal effect on yield in this trial.
- Mechanically sizing corn residue with a chopper or disk significantly increased yield, however accelerated decomposition could not be confirmed.
- University research concluded that residue decomposition was influenced more by soil moisture and temperatures above 50°F that supported the microbes involved in residue decomposition.

AGRONOMICS OF CORN RESIDUE

Corn residue from the previous year can have many positive agronomic benefits. It can provide ground cover to reduce soil erosion, conserve soil moisture, moderate soil temperature, enhance nutrient cycling, suppress weeds, sequester carbon, increase organic matter, and promote microbial activity. However, depending on the geography, some of these benefits from corn residue may have a negative effect on crop production. The high ratio of carbon to nitrogen in corn residue can immobilize soil nitrogen and make it less available that season. Colder and wetter soils can slow emergence and increase the risk of seedling disease and stand loss. Cooler spring soils can also delay mineralization and availability of other nutrients such as sulfur (S). Residue can also harbor pathogens from previous years that can develop into diseases. Corn residue has even been believed to have an allelopathic effect that can slow early season growth of the following corn crop. At planting, heavy levels of residue also create a physical barrier for seedlings to grow through (Figure 1).

Figure 1. Heavy residue cover in continuous corn field that can reduce stand establishment, decrease nitrogen availability, and increase pest pressure.

In recent years, the level of corn residue remaining in the spring has increased significantly in many fields, which can be attributed to higher yields. Intensified management with better fertilization and increased plant populations has not only boosted yield but also led to more stover production. For perspective, a corn crop yielding 180 bushels per acre typically produces about 4.3 tons of stover per acre. As yields push towards 300 bushels per acre, stover accumulation can exceed 7 tons per acre. This trend highlights the growing importance of effective residue management.

MANAGING RESIDUE

Historically, growers have utilized many options to manage residue. Corn residue can be physically removed by baling corn stalks. However, removing residue can also remove nutrients such as nitrogen (N) and potassium (K) that must eventually be replaced. Another option is to incorporate residue into the soil with tillage to speed up residue breakdown, as the smaller pieces increase the surface area and allow the microbes to break down biomass faster. Vertical tillage or chopping stalks with a mower can reduce residue size, but also requires an extra pass in the field. Attachments for corn heads can help break down residue while harvesting. Chopping corn heads, residue managing stalk rolls, and aggressive stalk stompers are combine attachments that can create more corn residue surface area for microbes to enter. There are also biological products on the market that either contain microbes or catalysts to increase the activity of microbes already present in the soil to accelerate the decomposition process. Corn stover contains a much higher amount of carbon than nitrogen (60:1) relative to other crop residues like soybeans (20:1), which break down much faster. Soil microorganisms need a C:N ratio diet of 24:1 to be able to survive and stay active. In cases where residue C:N ratios are greater than 24:1, such as with corn, soil microorganisms will seek out additional nitrogen to consume the extra carbon. This results in soil nitrogen being immobilized and unavailable until those microbes die.

AGRONOMY IN ACTION RESEARCH TRIAL

In 2024, the Agronomy in Action research team implemented a trial focusing on products to increase microbial activity to accelerate corn residue degradation. Three products with three different modes of action were evaluated. Urea Ammonium Nitrate (UAN) was used to decrease the C:N ratio and increase microbial consumption of carbon. Feed grade dextrose was used as a sugar source to stimulate the microbe population already present in the soil. Meltdown™, by BW Fusion, is a product containing 1% nitrogen, 4.1% fulvic acid, and 4.9% mixture of six microbial strains designed to feed, stimulate, and add to the soil microbial population. All treatments were broadcast applied in the fall or spring.

1. Check – no treatments were applied
2. Fall UAN at 60 lbs/A of N
3. Fall Meltdown at 32 oz/A
4. Fall Sugar at 4 lbs/A
5. Spring Meltdown at 32 oz/A
6. Spring Sugar at 4 lbs/A

Trials were established in Waterloo, NE, and Slater, IA. At Waterloo, NE, treatments were either applied on October 24, 2023 or March 26, 2024 to no-till corn stalks. At Slater, IA, a mechanical residue sizing component was added to the trial. All treatments were applied to corn stalks after using a John Deere stalk chopper or running a Case IH disk implement on September 20, 2023 to compare mechanically sized residue to the check (Figure 2). The Slater, IA, broadcast treatments were either applied on September 22, 2023 or April 23, 2024. At Slater, neither the check nor the stalk chopper received any pre-plant tillage, whereas the fall disking was the only tillage pass for the disked treatment. Corn hybrid G05U86 brand was planted at Slater, IA, on April 25, 2024 and hybrid G13B17 brand was no-till planted at Waterloo, NE, on April 23, 2024. All treatments were replicated four times.

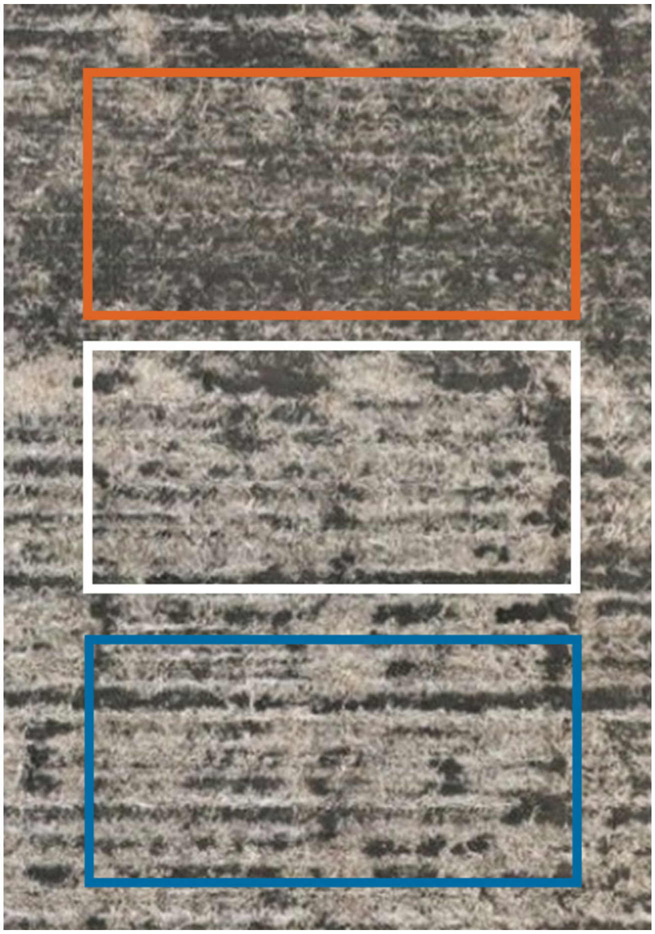
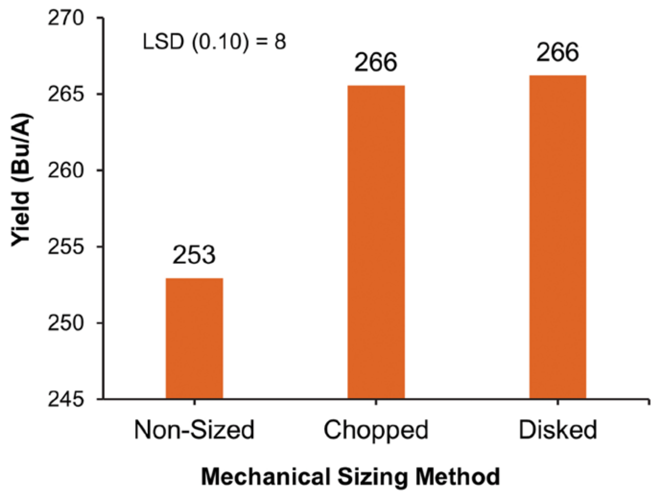


Figure 2. Aerial photo of one replication of disked (orange), non-sized (white), and chopped (blue) residue blocks at Slater, IA in 2024.

TRIAL RESULTS

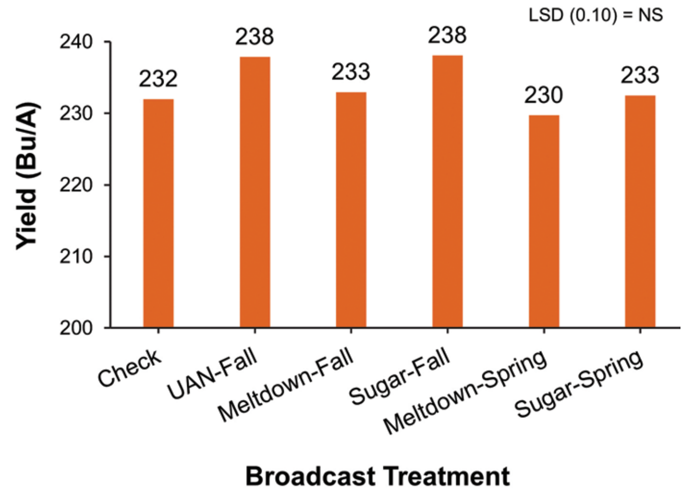
Physical residue degradation was not measured due to the challenging nature of the collection process. Stand establishment was similar across all treatments. Yield was recorded using a research plot combine. At Slater, IA, mechanically sizing the residue had a significant effect on yield when averaged across all broadcast treatments. Using the stalk chopper or disk



Graph 1. Effect of mechanical sized residue method on yield averaged across broadcast treatment at Slater, IA in 2024.

implement increased yield by 13 Bu/A compared to non-sized residue (Graph 1), but it cannot be assumed that the yield increase resulted from accelerated residue degradation. Mechanical treatments may have provided a better seedbed for rooting or reduced the physical residue barrier for seedlings to grow.

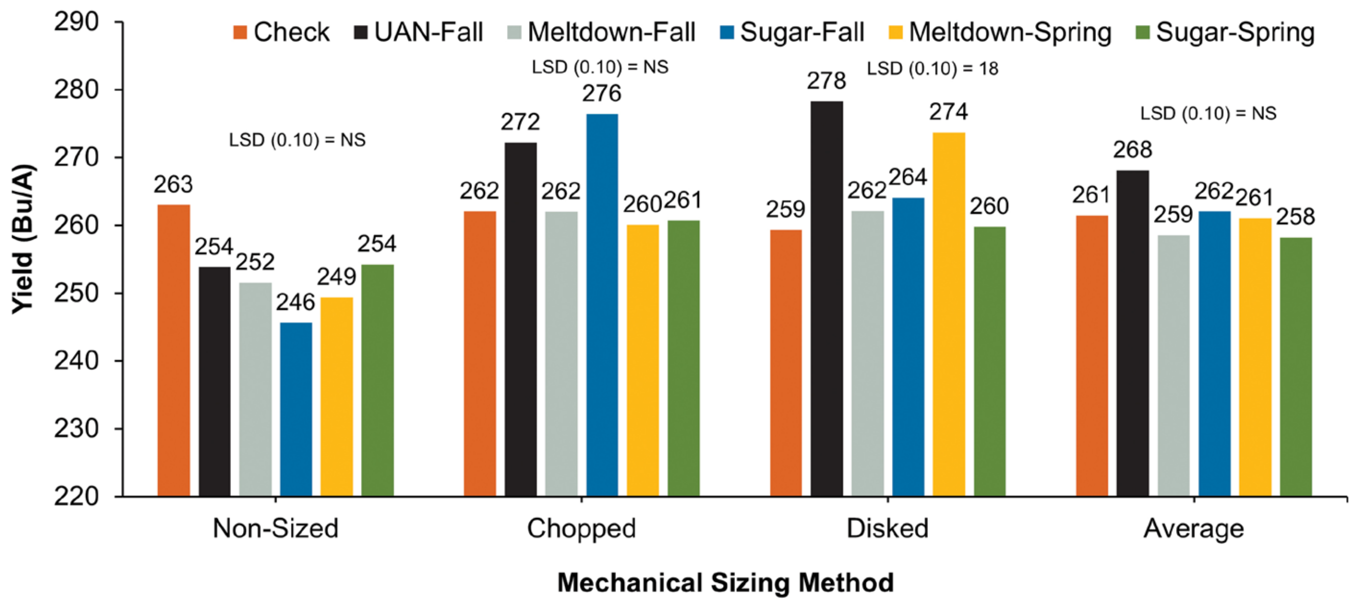
At Slater, there was no significant interaction between mechanical sizing method and broadcast treatment. When averaged across non-sized and the two mechanical treatments, none of the broadcast treatments significantly increased yield compared to the check (Graph 2). Only when the residue was sized with a disk did fall broadcast UAN significantly increase yield by 19 Bu/A (Graph 2). It cannot be assumed the



Graph 3. Effect of broadcast treatment on yield at Waterloo, NE in 2024.

additional N increased microbial consumption of carbon, as it is plausible that N was available during early spring for the crop to utilize. Disking potentially allowed the N to move into the soil when broadcast compared to the non-sized or chopping treatments where the N may have been absorbed by the residue and subjected to loss through volatilization. It is difficult to determine the direct agronomic cause of the yield increase.

At Waterloo, NE, there was no significant difference in yield between any of the broadcast treatments and the check (Graph 3). UAN and sugar applied in the fall tended to slightly increase yield but not significantly.



Graph 2. Effect of broadcast treatment and mechanical sizing method on yield at Slater, IA in 2024.

UNIVERSITY FIELD AND LAB TRIALS

Previous university field and lab trials found no difference in residue breakdown resulting from tillage type, nitrogen application at various rates, or previous corn trait.[1,2] They concluded from controlled lab studies that residue decomposition was influenced more by soil moisture and temperature. These environmental factors directly impact both the biological processes and chemical activities necessary to breakdown the lignin, cellulose, hemicellulose, and macro- and micro nutrients in residue. A wide variety of microorganisms control these biological and enzymatic processes. Environmentally controlled lab studies showed that soil moisture at field capacity and warmer temperatures (above 50°F) increased microbial activity and decomposition and that microbial levels doubled for every 10°F increase in temperature.

Unfortunately, planting full season hybrids for a given area to maximize yield potential delays plant maturity and harvest dates to a point in time where temperatures favorable for microbial activity that would help break down corn residue begin to diminish.

SUMMARY

Overall, the Agronomy in Action research trials showed minimal effect on yield resulting from UAN, Meltdown, or sugar applied in the fall or spring. Mechanically sizing the residue with a chopper or disk significantly increased yield over non-sized residue. However, the physiological reason for the yield increase could not be identified.

University results illustrate that residue decomposition is a dynamic process and is highly dependent on both temperature and moisture. Methods to increase or extend microbial activity present in the soil is the best opportunity for faster residue degradation.

References

[1] Al-Kaisi, M.M. and J.G. Guzman. 2013. Effects of tillage and nitrogen rate on decomposition of transgenic Bt and near-isogenic non-Bt maize residue. Soil Tillage Res 129:32–39. https://doi.org/10.1016/j.still.2013.01.004

[2] Al-Kaisi, M. M., D. Kwaw-Mensah, E.Ci. 2017. Effect of nitrogen fertilizer application on corn residue decomposition in Iowa. Agronomy Journal 109(5): 2415–2427. https://doi.org/10.2134/agronj2016.11.0633

EFFECTS OF SOLAR RADIATION INTENSITY ON CORN AND SOYBEAN YIELD

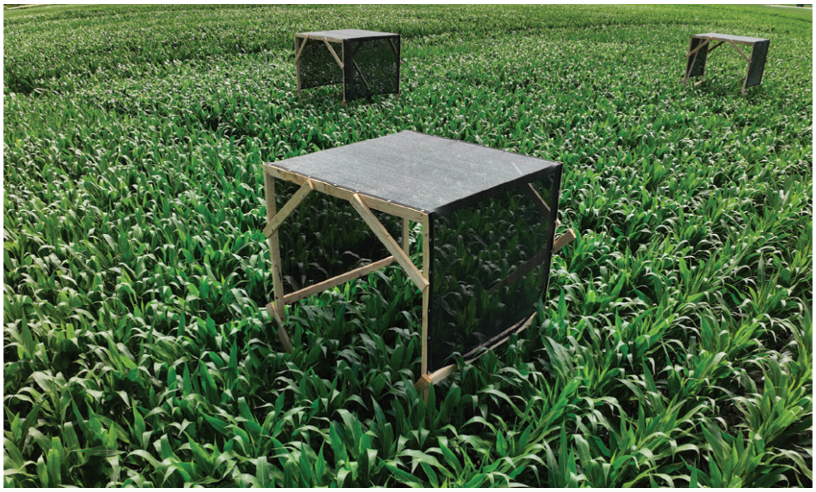


Figure 1. Shade cloth applied during vegetative stage in corn in 2024 trial.

INSIGHTS

- Shade significantly decreased yield in both crops.
- The impact of shade on yield was greater during reproductive growth stages compared to vegetative stages in corn.
- Methods to increase light in the lower canopy tended to have a minimal or negative effect on yield for both crops.

PHOTOSYNTHESIS

The photosynthetic rate of both C3 (soybean) and C4 (corn) plant species is affected by numerous environmental and internal factors. Light, CO2, and water are the three substrates for photosynthesis and have a direct effect on photosynthetic rate and dry matter production. Light provides all the energy needed for photosynthesis. Both the duration and intensity of light striking the plant affects photosynthesis. As light intensity increases, the rate of photosynthesis also increases, but with decreasing efficiency, until the light saturation level is reached. At the point of saturation further increases in light no longer increase photosynthesis. C4 plants have a higher light saturation, point than C3 plants, meaning C4 plants can utilize light up to a more intensive level. However, C3 plants have a lower light compensation point than C4 plants. The light compensation point is the lowest level of light intensity needed for a plant to begin photosynthesis. In other words, corn (C4 plant) requires greater light intensity to begin photosynthesis but can also increase photosynthesis at more intensive light levels compared to soybeans (C3 plant), which can begin photosynthesis under lower light levels but cannot utilize as intensive light.

RECENT SMOKE FROM WILDFIRES

In recent years, much of the Midwest has experienced smoke or haze in the air due to wildfires in Canada or the western U.S. A common concern from growers is whether smoke affects crop development and yield. This is a challenging question to answer because it depends on many factors such as smoke intensity, duration, crop stage, and other environmental stresses. Recent publications from Iowa State University[1], Ohio State University[2], and Purdue University[3] highlight the potential effects of smoke in a few key points:

- Negative effects of smoke
  - Reduction in light, which can reduce photosynthesis
  - Increase in ground-level ozone, which can harm plant tissue during respiration
- Positive effects of smoke
  - Scatters sunlight, allowing light to penetrate deeper into crop canopy, increasing photosynthesis

Figure 2. Mylar applied between the corn rows designed to reflect light. Corn turned a lighter green during early vegetative stages (left). As the season progressed the mylar became dirty and became less reflective (right) in a 2024 trial.

  - Lowers leaf surface temperature and reduces transpiration, decreasing water stress
- Corn is more susceptible to smoke because it's a C4 plant with a higher light saturation point than soybeans.
- Smoke during grain fill will affect yield more than during the vegetative period.

In summary, the consensus is that smoke from wildfires in recent years had minimal effects on crop yield. However, much more research is needed to better understand the impact of smoke on crop growth as wildfires continue to become more common.

AGRONOMY IN ACTION RESEARCH TRIALS

In 2024, the Golden Harvest Agronomy in Action research team implemented trials in both corn and soybeans at Malta, IL, Slater, IA, and Waterloo, NE, to evaluate the effect solar radiation intensity has on yield. The main objective was not to quantify changes in yield potential based on specific levels of solar radiation but rather to understand which growth stages in corn and soybeans are most impacted by changes in light intensity.

Shade cloth was used to provide a 50% reduction in light (Figures 1 and 4). In the Midwest, smoke from wildfires has been shown to reduce solar radiation by up to 50%, however, it varies greatly by smoke intensity and other environmental factors. Even throughout the day at a given location, the level of solar radiation reduction from smoke can range considerably, making it difficult to mimic artificially. Frames were built, surrounded by shade cloth, and placed over the crop canopy during different timings throughout the season.

Mylar film was used in the field to increase the intensity of solar radiation (Figures 2 and 4). Mylar, typically used in greenhouses, can reflect 95% of the sun's light. It was laid on the soil surface between the crop rows to reflect light up into the canopy at different growth stages.

CORN TRIALS

Two different trials were established in corn. One trial used mylar placed between the rows to increase light in the lower canopy at different timings.

1. Check – no mylar
2. Mylar V5 – placed at V5 and removed at black layer
3. Mylar Canopy – placed once corn canopied and removed at black layer
4. Mylar Pollination – placed 1 week prior to tassel and removed at R2 growth stage

The second trial focused on reducing solar radiation using shade cloth at different times. All timings had shade for 3 weeks.

1. Check – no shade cloth
2. Shade Vegetative – shade applied 4 weeks before silking and removed 1 week before silking
3. Shade Pollination – shade applied 1 week before silking and removed 2 weeks after silking
4. Shade Reproductive – shade applied 2 weeks after silking and removed 5 weeks after silking

Ten ears from the shade treatments were hand harvested, shelled, and weighed to measure grain per ear. One thousand kernels were weighed to determine average individual kernel weight and kernels per ear.

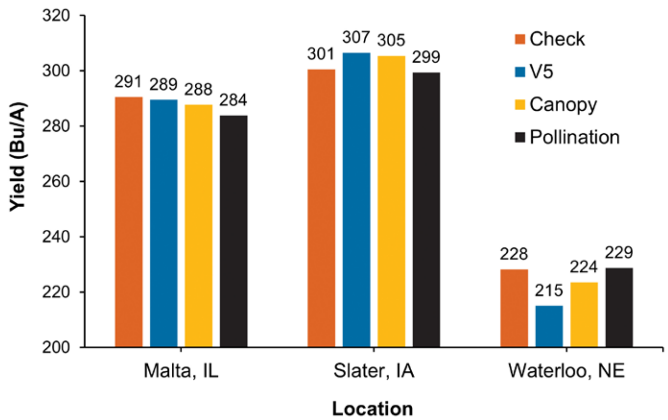
CORN RESULTS

Mylar applied at the V5 and canopy growth stages reflected a tremendous amount of light into the canopy, causing the leaves to turn a light green color (Figure 2). It is likely the mylar increased the leaf surface temperature at these timings. As the inner rows became more shaded, less light was reflected and the leaves darkened up. Rain events caused water and soil to pool up on the mylar, making the surface dirty and much less reflective as the season progressed (Figure 2). It was also observed that the mylar helped reduce soil evaporation and preserve soil moisture.

Across the three locations, none of the mylar treatments had a significant effect on yield (Graph 1). All treatments tended to decrease yield at Malta, IL, while the early timings tended to decrease yield at Waterloo. Corn grown at Slater, IA, tended to increase yield when mylar was applied at V5 and the canopy timing. These yield trends were inconsistent across locations. The environment likely played a major role in how the corn responded to the increase in light intensity. If it was cool and cloudy the corn likely benefited from the additional solar radiation. But during hot and sunny days the increased light intensity may have stressed the plant, especially during the earlier timings.

Treatment	Yield (Bu/A)	Kernel Number (kernels/ear)	Kernel Weight (oz/1000 kernels)
Check	284 A	655 A	280
Vegetative	163 B	342 C	215
Pollination	137 C	283 D	180
Reproductive	137 C	534 B	165

Table 1. Effect of shade timing on corn yield, kernel number, and kernel weight averaged across two locations in 2024.



LSD (0.10) = NS for all locations.

Graph 1. Corn yield response to mylar applications during different timings at three locations in 2024.

A wind event at Waterloo, NE tore the shade cloth, so yields were only recorded for Malta, IL, and Slater, IA. Corn grown at both locations responded similarly and results were averaged across both locations. Three weeks of shading significantly decreased yield by 43% at the vegetative timing and by 52% at both the pollination and reproductive timing (Table 1). Shade significantly decreased kernel number per ear during all timings with the largest impact coming around silking timing due to reduced pollination and kernel set (Figure 3 and Table 1). During the vegetative stages when ear length is being determined, shade decreased kernel number per ear by 313 kernels. Shade during the reproductive stages reduced the number of kernels per ear due to kernel abortion. Due to yield component compensation, both the vegetative and silking shade times had significantly heavier

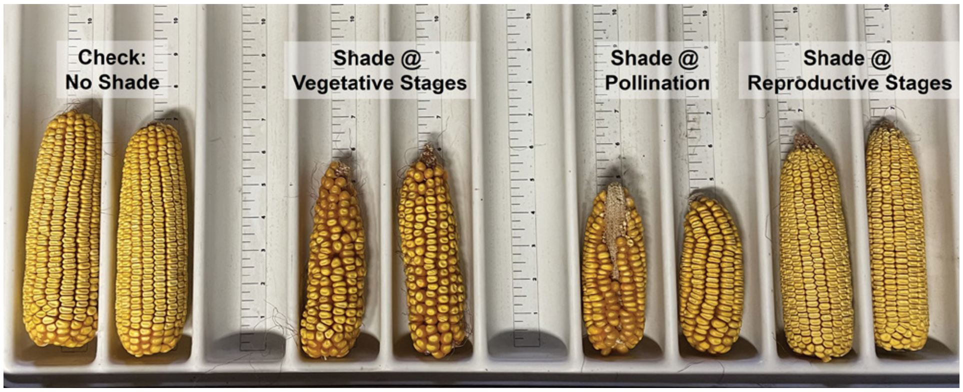


Figure 3. Effect of shade timing on corn ear size. Order of shade timing in photo is check, vegetative, pollination, reproductive.

kernels compared to the check (Table 1), as there were simply less kernels the plant had to fill. Despite having a small reduction in kernels to fill, shade during the grain fill period significantly decreased kernel weight by 41%. Photosynthesis was limited and the plant could not produce enough assimilates to fill the ear.

SOYBEAN TRIAL

In soybeans, one trial was established at all three locations to evaluate the effect of both reduced solar radiation and increased light intensity on yield.

1. Check – no shade cloth or mylar
2. Mylar V5 – placed at V5 and removed at senescence
3. Mylar Canopy – placed once soybean canopied and removed at senescence
4. Shade R3-R4 – shade applied at R3 (beginning pod) and removed after R4 (full pod)

SOYBEAN RESULTS

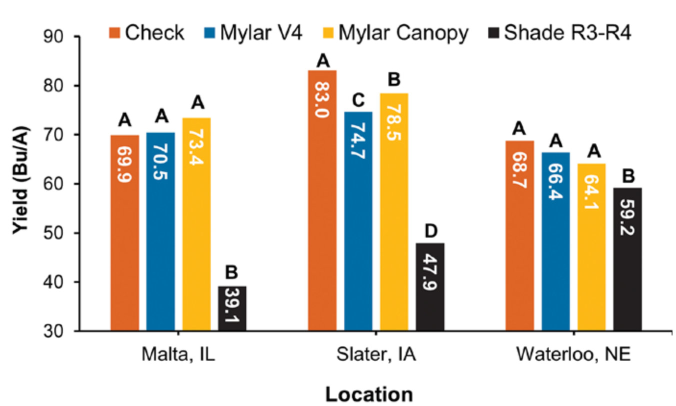
Solar radiation treatments had a significant effect on soybean yield at all three locations. Shade during the R3 and R4 growth stages reduced yield by 44% at Malta, IL, 42% at Slater, and 14% at Waterloo, NE (Graph 2). A windstorm at Waterloo, NE destroyed the shade cloth and was removed 10 days earlier than the other locations which minimized the negative impact of the shading. Pod development is a critical time in the life cycle of a soybean plant in determining yield potential. Visually, plants under the shade cloth tended to stay green longer and mature later.

Mylar treatments did not significantly affect yield at Malta, IL, or Waterloo, NE, however, at Slater, IA, both timings significantly reduced yield. Mylar decreased yield by 8.3 Bu/A when applied at the V4 growth stage and 4.6 Bu/A at canopy timing (Graph 2), as soybeans cannot utilize as intensive a light level as corn. Soybeans become CO_2 limited before becoming light limited. It is suspected that the additional reflected light and heat was detrimental to crop growth. The longer the mylar was in the field, the more significant the yield penalty.

SUMMARY

Light is one of the most important components in plant photosynthesis. Manipulating light intensity using reflective mylar tended to have a minimal or negative effect on yield in both corn and soybeans.

Figure 4. Mylar applied to soybean at the V4 growth stage (top). Shade cloth applied to soybeans at R3 and removed at R4 growth stage (bottom).



Different letters represent statistical difference at α=0.10 for each location.

Graph 2. Effect of solar radiation treatment on soybean yield at three locations in 2024.

Any benefits from increased light in the lower canopy were likely negated from higher canopy and leaf surface temperatures. Mylar also became dirty and less reflective later in the season when the crop canopy was denser and may have been light limited.

Not surprisingly, shade had a significant effect on yield for both crops. During the critical period of pod setting in soybeans, yield potential was reduced by over 40% at some locations. Shade timing was also important when it came to corn yield potential. Shade during vegetative growth stages had significantly less effect on yield than shade around pollination or reproductive growth stages. Using shade cloth that provided 50% light reduced solar radiation far more than what has been seen with recent wildfire smoke. Shade cloth provided a more consistent and prolonged reduction in solar radiation than smoke created. However, it's also valuable to understand what crop growth stages may be more impacted by smoke.

These studies demonstrate the impact a reduction in photosynthesis can have on yield. Any factor that causes crop stress or reduces crop growth will decrease photosynthesis. Drought stress, pest pressure, nutrient deficiencies, etc. all have the same effect on yield as shade. In most cases, a nutrient deficiency will not correct itself during the season and will affect photosynthetic potential all season long compared to smoke reducing solar radiation for a 2- to 3-week period. Focusing on crop management and minimizing crop stress for factors that can be controlled is key to maximizing yield potential.

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WEATHER INFLUENCE

CORN YIELD RESPONSE TO SIMULATED HAIL

INSIGHTS

- Hail damage can affect corn yield differently depending on crop growth stage.
- Results from this trial were similar to previous research showing the greatest impact of hail was at tassel and early reproductive stages.

INTRODUCTION

Hail damage can be unpredictable, resulting in defoliation and stalk damage that can cause varying levels of yield loss depending on damage severity and timing. While visual assessments of leaf area loss can appear devastating, corn plants can recover quickly in some cases and maintain much of their original yield potential. Plant growth stage at the time of a hail event has the greatest impact on the level of resilience the corn plants will exhibit.

Hail events prior to the V6 growth stage typically have little effect on yield, as the growing point of the corn plant is still protected.[1] In early growth stages, leaf whorls may become twisted and bent over from hail damage, making new leaf emergence difficult. Corn yields are increasingly sensitive to hail damage from the V6 stage until tassel, when hail damage can have the greatest impact on corn yield. For example, an 80% reduction in leaf area at the V10 growth stage results in only an 11% reduction of potential yield. The same reduction in leaf area at tasseling can reduce yield potential almost 70% (Table 1).

2024 AGRONOMY IN ACTION TRIAL

Agronomy in Action research trials were established in Malta, IL, Slater, IA, and Waterloo, NE to simulate leaf area and stalk injury from hail at different crop growth stages and to assess the effect on corn yield. Various tools such as a gas-powered string trimmer were used to simulate leaf shredding and loss. Additionally, stalk bruising was simulated using a golf ball attached to a cable that was spun in a circular pattern while striking stalks. Damage at V3, V6, V12-V15, or R2 growth timings were compared to undamaged treatments (check, Figure 1). Defoliation during the corn vegetative growth stages targeted 90-100% leaf removal while defoliation at R2 growth stage timing attempted to remove 70% of the leaf area at or above the ear leaf.

TRIAL RESULTS

Trial results in 2024 were very similar to prior research on this topic.[2] Simulated hail treatments carried out at V3 or V6 timings only resulted in a 7% yield loss. Simulated hail treatments occurring in late vegetative stages caused the most yield loss of 45%. Simulated hail occurring during reproductive (R2) crop stages reduced yields by 24%, which was significantly less than pre-pollination simulated hail

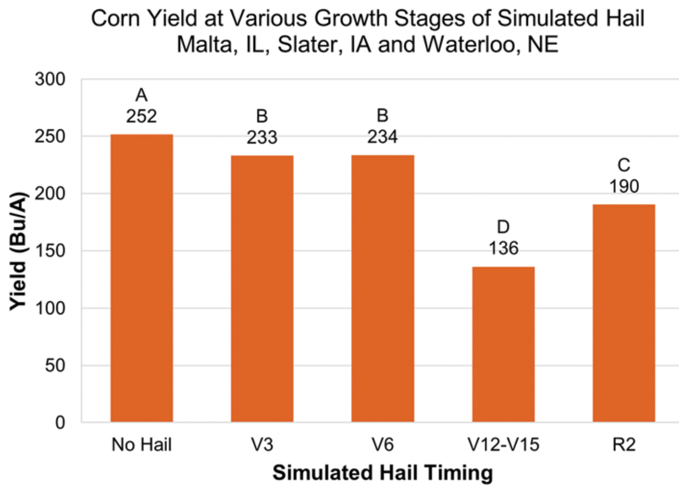
Stage	% Leaf Area Destroyed				
	20	40	60	80	100
V7	0	1	4	6	9
V10	0	4	8	11	16
V13	1	6	13	22	34
V16	3	11	23	40	61
V18	5	15	33	56	84
VT-Tassel	7	21	42	68	100
R1-Silk	7	21	42	68	100
R2-Blister	5	16	30	50	73
R3-Milk	3	12	24	41	59
R4-Dough	2	8	17	29	41
R5-Dent	0	4	10	17	23
R6- Maturity	0	0	0	0	0

Table 1. Estimated percent yield loss at different stages and severity of leaf loss caused by hail damage.[2]

(Graph 1). During vegetative growth stages, corn can quickly produce new leaves, helping minimize yield losses. As vegetative growth begins to transition to reproductive functions, corn is no longer able to grow additional leaves and is at a disadvantage for capturing sunlight and carrying out photosynthesis needed to support developing kernels.

SUMMARY

Hail events tend to impact yield more than other events. Assessment of the amount of leaf area affected and identification of growth stage at the time of a hail event can help determine possible yield loss. In some cases, fungicide applications may be considered after a hail event to minimize disease development and improve late-season standability. Crop assessment should occur after the plants have had some time to recover to provide better perspective on leaf regrowth and allow a grower to make more accurate management decisions.



Graph 1. Yield response of corn when simulated hail treatment applied at various growth stage timings in 2024 trial.

Figure 1. Pictures of simulated hail damage inflicted on corn plants at V3 (far left), V6 (center left), V12 (center right), and after pollination (far right) in 2024 trial.

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