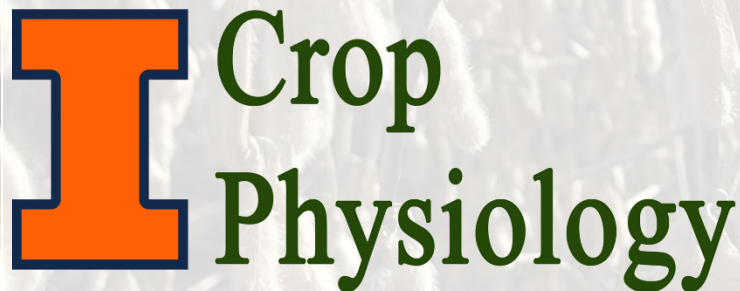


# Illinois Biological Testing for Soybean Production

## 2024 Yield Report

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## 2024 Biological Testing for Soybean Production Report

We evaluated various biological products, application methods, and agronomic systems to assess their impact on soybean growth and yield. Our goal was to assess whether soybean responses to biological products are influenced more by management or environmental conditions. Ultimately, we aimed to identify which products are most likely to succeed across the state of Illinois, and what management or variety factors may be best suited for a given biological product type.

### Research Approach

Ten unique biological products were tested in two different management systems (standard or progressive) using two genetically diverse, high yielding soybean varieties (GH3765XF and AG38XF3) at three different sites across Illinois, each with unique soil and climate conditions. This approach allows for a comprehensive assessment of product performance and helps to decide if, how, and where to use a specific biological product.

### How Biological Products were Evaluated

Based on our previous experience evaluating biologicals, we know that while some products may promote early season growth and yield potential, they ultimately do not impact final yield when other in-season factors, such as nutrient deficiencies or leaf diseases, are present. Some biological products also claim to reduce or replace the need for fertilizer applications, but there is limited evidence to support these claims. As a result, we chose to evaluate the biological products in both 'standard' and 'progressive' management systems (Table 1).

**Table 1.** Agronomic management systems used in the evaluation of biological products for soybean in 2024.

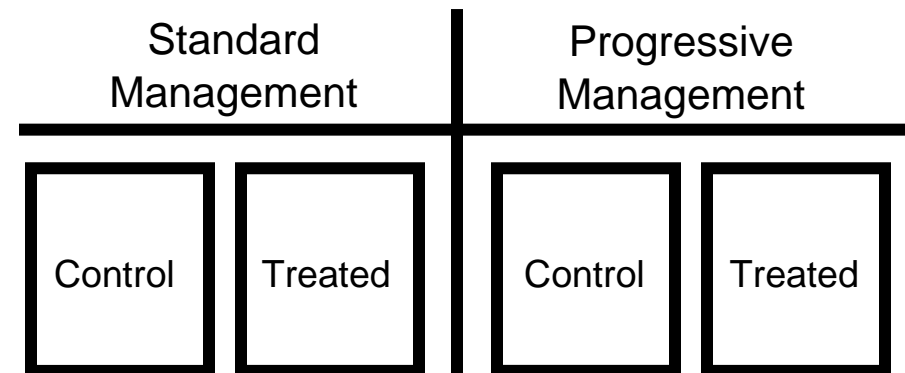
Management System	Preplant Fertility <sup>1</sup>	Foliar Protection
Standard	None	None
Progressive	17.5 lbs N/acre 20 lbs S/acre	Fungicide and Insecticide at R3

<sup>1</sup>Preplant fertility supplied as ammonium sulfate (21-0-0-24S) broadcast with a Gandy drop spreader.

The 'standard' soybean management system includes no upfront fertility with no subsequent in-season management, while the 'progressive' management system includes an at-planting fertility application of nitrogen and sulfur, along with a fungicide and insecticide application at R3 for foliar protection (Table 1). Pre-plant fertility was provided as ammonium sulfate (21-0-0-24S) and foliar protection was applied as Miravis Top (13.7 oz per acre; Syngenta) and Endigo (4 oz per acre; Syngenta). All plots were seeded to achieve a final plant population of 140,000 plants per acre.

### Trial Design

Because non-uniformity within fields creates spatial variability that can overshadow the yield response to both agronomic management and biological product application we used a pair-wise field design where each treated plot had its own adjacent untreated control plot. This design allows an unbiased comparison of biological products and their effectiveness under different levels of agronomic management (Figure 1). Experimental plots were arranged using a split-split block design, where the main plot was the biological product, the sub-plot was variety, and the sub-sub plot was management. All treatments were replicated six times. Using this design, ten distinct biological products representing five product categories were evaluated (Table 2).



**Figure 1.** Pair-wise design used to evaluate biological products under different levels of agronomic management and with two different varieties. Each biological product was evaluated in a similar approach, with ten main plots randomized across six replications.

**Table 2.** The ten biological products evaluated, including company sponsor, product category, application rate, and application method.

Product Name	Company Sponsor	Biological Category	Application Rate	Application Method <sup>1</sup>
LAL Fix ProYield	Lallemand	Bradyrhizobium	1.5 fl oz/cwt	Seed Treatment
MicroSURGE	Brandt	Bradyrhizobium	2 fl oz/unit	Seed Treatment
Biopath	Mosaic	Bacillus spp.	16 fl oz/acre	In-Furrow
PhosN	Biolevel	Bacillus spp.	1.1 fl oz/cwt	Seed Treatment
Mycosol	Helena Agri	AMF	113.4 g/acre	In-Furrow
Symvado	Valent Biosciences	AMF	0.26 fl oz/cwt	Seed Treatment
Envita	Azotic North America	N-Fixing/Assimilating	5 g/acre	Foliar
Utrisha N	Corteva	N-Fixing/Assimilating	5 oz/acre	Foliar
iNvigorate	AMVAC Chemical Corp	Non-Traditional	33.8 fl oz/acre	In-Furrow
Jumpstart	Novozymes	Non-Traditional	0.1 oz/cwt	Seed Treatment

<sup>1</sup> Seed treatments blended with water for total application volume of 6 oz/cwt or unit, dependent on label. In-furrow applications blended with water for total application volume of 12 gallons/acre. Foliar applications were applied with Petrichor surfactant at 4 oz per acre for the Envita and Utrisha N treatments. All foliar applications were blended with water for a total application volume of 15 gallons per acre.

### Trial Implementation

Replicated blocks of the experimental plots were planted using a precision plot planter (SeedPro 360, ALMACO). Preplant soil test levels are shown in Table 3 and show the differences in inherent soil fertility at each site. Plots were 36 feet in length and four rows in width. Plots were planted 31 May at Nashville, IL (38°20'19.98"N,

89°20'46.93"W), 18 April at Champaign, IL (40°3'26.59"N, 88°13'44"W), and 19 May at Yorkville, IL (41°35'57.46"N, 88°23'00.55"W). For weed control at Nashville a pre-plant application of Tendovo (48 oz per acre; Syngenta) and Liberty (36 oz per acre; BASF) was made on 31 May. In-season weed control was applied 27 June as Zidua SC (76 oz per acre; BASF) and Liberty (36 oz per acre). At Champaign, a pre-plant application of Tendovo (48 oz per acre) was followed by a post applied on 3 June as Flexstar GT (4 pt. per acre; Syngenta) and Warrant (1.75 pt. per acre; Bayer Crop Science). At Yorkville, a pre-plant weed control application was made on 19 May, which consisted of Warrant Ultra (60 oz per acre; Bayer Crop Science). An in-season application was made on 11 June, which included XtendiMax (22 oz per acre; Bayer Crop Science), Roundup PowerMAX 3 (30 oz per acre; Bayer Crop Science), Zidua SC (4 oz per acre).

**Table 3.** Preplant soil test levels at Nashville, Champaign, and Yorkville, IL in 2024.

Location	OM	CEC	pH	P	K	Ca	Mg	S	Zn
	%	meq/100g				ppm			
Nashville	2.3	8.5	6.4	40	135	1182	121	11	2
Champaign	3.5	15.9	6.8	27	164	2060	528	12	1
Yorkville	4.1	18.7	6.0	58	180	2131	496	15	3

Soil samples were taken from each replication at the 0-6 inch depth before planting and extracted using Mehlich III. Presented values are the average of the six replications.

### Biological Product Applications

The pairwise design allows comparisons among biological products that are applied as a seed treatment, in-furrow, or foliar spray without biasing application method. Seed treatments were applied on 29 May, 18 April, and 17 May for Nashville, Champaign, and Yorkville, respectively, and all were applied and planted within 48 hours. In-furrow applications were mixed within an hour of application on the date of planting. Early vegetative growth stage (V4) foliar applications were made on 2 July, 10 June, and 24 June at Nashville, Champaign, and Yorkville, respectively. Foliar protection applications for the progressive plots were made at the R3 stage on 13 August, 19 July, and 2 August at Nashville, Champaign, and Yorkville, respectively.

## Application Methods

All seed treatments excluding MicroSurge were blended with water for a total application of 6 oz per cwt using a Hege11 seed treater (Wintersteiger). MicroSurge was supplied as 6 oz per unit based on label. All in-furrow biological entries were blended with water for a total application volume of 12 gallons per acre and supplied using a planter-attached liquid application system (SureFire Ag Systems). Foliar applications were blended with water for a total application volume of 15 gallons per acre and supplied using a pressurized CO<sub>2</sub> backpack sprayer.

## Growing conditions

In comparison to the previous two years, this year's growing season started off abnormally wet across the three sites, with above-average precipitation in April and May at both Nashville (+1.6 inches, 16%) and Champaign (+3.8 inches, 42%) (Table 4). Yorkville also received above average precipitation in April (+0.5 inches, 16%) but fell short of the average in May by 1.2 inches (-29%). This resulted in saturated soil conditions that caused a delay in planting at Nashville and on-time planting at Yorkville, while Champaign was planted early due to a temporary dry period in April. Nashville and Champaign experienced reduced precipitation in June (86 and 49% of normal, respectively) followed by excessive rainfall in July (+2.6 and 3.2 inches, +68 and 73%, respectively). Yorkville experienced average precipitation for June and almost double typical rainfall in July. Entering grain fill, there was below average rainfall during August at Nashville (2.1 inches below average, -64%), resulting in a period of plant stress during seed fill. In August, Champaign received precipitation well above average (1.6 inches above average, +46%), providing extended plant health and pod fill conditions. Yorkville received below average August precipitation (-0.9 inches, -25%) which may have caused decreased rate of pod fill and a shorter window of late season plant health. Overall, the growing season across Illinois was wetter and warmer than the 30-year average, as air temperatures were also higher than normal throughout the season (Table 4).

In summary, Nashville was abnormally wet to start the season and abnormally dry at the end; Champaign started wet, was dry in June, but received well above average rainfall during pod set and grain fill;

Yorkville experienced average weather from planting through early growth and ended with a dry grain-fill period.

## Data Collection, Analysis, and Interpretation

Composite in-row soil samples (0-6" deep) were collected at the R3 growth stage to evaluate biological product effects on soil activity. These samples were then analyzed for permanganate oxidizable carbon (POX-C), beta-glucosidase enzyme activity, and soil ammonium-N levels. Samples were collected from all plots, resulting in a total of 1,440 data points. Nodule dry biomass was also collected at this stage by digging 4 roots from select treatments within three replications, excluding plots that had a foliar endophyte application. The sampled roots were lightly washed, dried, and the nodules were removed from the roots and weighed (Table 5 and 6). At maturity, all plots were harvested with a two-row plot combine and grain yield is reported as bushels per acre at 13% moisture (Tables 8, 9, and 10).

Statistical analysis was performed using a linear mixed model approach with PROC MIXED in SAS (version 9.4; SAS Institute, Cary, NC) and means between treatments were separated using Fisher's protected LSD test at the 0.05 level of significance. Paired T-tests were conducted to evaluate an individual product's soil health response to its paired control for POX-C, beta-glucosidase, soil ammonium-N, nodule biomass, and grain yield.

## Biological Influence on Soil and Plant Health Indicators in 2024

Soil health has always been an important component of our agronomic systems, and incentives and numerous programs have been introduced over the years in attempts to improve it. While it is likely to take years to observe a management-induced change in soil health across broad acres, targeted sampling in the application zone may elucidate biological product activity in the season of application. Therefore, we used POX-C and beta-glucosidase enzyme activity to determine if the biologicals had any effect on carbon cycling within the soil of the rootzone. POX-C is often referred to as labile, or "active", carbon, although the test has been questioned as to its actual meaning (Margenot et al., 2024). While its direct interpretation has yet to be confirmed, differences in POX-C induced by biological product application would infer that there was product activity. For broad

insights into how the biological products influenced soil carbon cycling, responses in POX-C and beta-glucosidase enzyme activity were averaged across managements and varieties. Overall, the biological influence on carbon cycling (POX-C or beta-glucosidase) varied by product and location (Table 5). There were no consistent influences of biological treatments on the two carbon indicators, nor any effects or trends due to management when analyzed for control plots that did not receive a biological treatment (data not presented).

Soil ammonium-N levels were measured to assess the potential of biologicals to enhance N cycling, and at Nashville, there was a clear trend of biologicals increasing soil ammonium-N levels (7 out of 10 products) (Table 6). At Champaign, 2 products had no effect, 5 out of 10 tended to increase soil ammonium-N, and 3 products tended to reduce it, while at Yorkville, 6 of the 10 products showed numerical increases. Across locations, the product category that had the most consistent effect on soil ammonium-N was the *Bradyrhizobium* spp., where the Nashville site exhibited a greater magnitude in ammonium-N improvements compared to the other two sites. These data suggest that *Bradyrhizobium*-induced improvement in soil-N availability was greatest at the site with the lowest soil organic matter, while sites with higher soil organic matter may naturally mineralize more N, and as such be less impacted by the biological enhancement in soil-N mineralization.

Because nodules and biological fixation provides a large fraction of the 4 to 5 lbs of N per bushel that soybeans need to accumulate, nodule biomass can be used as an indicator of plant health. Nodule biomass was measured for 8 of the 10 products and increases or decreases in total nodule biomass were equally split among products and sites with no clear indication of biologicals either improving or hindering nodule development (Table 6). Nodule biomass was not measured for the two foliar applied products, Envita and Utrisha, as they were not expected to directly affect root nodule development. While many biological products are purported to improve soil and/or plant health, more testing is needed to determine their ability to do so. Our findings presented here suggest that biologicals have greater activity on soil-N cycling than they do on soil-C, and that the magnitude of response is greatest at sites with lower OM and lower inherent fertility.

### **Soybean Yield Response to Management in 2024**

Across the three locations, agronomic management only improved grain yields at Champaign (average of 6.4 bushels per acre), where the response was numerically greater for the Asgrow (7.3 bushels) than the Golden Harvest (5.1 bushels) variety (Table 7.) The Asgrow variety also yielded higher than the Golden Harvest variety at Champaign and Yorkville (1.6, and 2.2 bushels per acre higher, respectively), while the varieties yielded similarly in Nashville. Yields of both varieties were highest at Champaign, which was also the first site to be planted. There have been numerous studies from universities in recent years, in addition to farmer testimonials, that emphasize the value of early planted soybean (three to four weeks ahead of normal) to improve field average yields.

### **Response to Biologicals was Site and Management Dependent**

Yield responses to biologicals varied across the three sites as well as across managements and varieties. There were both positive and negative responses observed between treated plots and their paired controls. Overall biologicals seemed to have a more negative response at Nashville when compared to Champaign and Yorkville. At Nashville, biologicals had the greatest magnitude of response -7.3 to +5.9 bushels, while Champaign responses ranged from -2.0 to +2.1 and Yorkville between -2.3 to +2.3 (Tables 8, 9, 10). In total, Nashville had only 15 positive yield increases out of 40 comparisons (and thus 25 negative), while Champaign exhibited 19 positive responses, and Yorkville 22 positive responses. This trend suggests that the use of biologicals has more potential to improve yield at locations with higher inherent soil fertility, which conflicts with much of the marketing claims.

### **Biological Yield Response in Nashville**

At Nashville, biologicals applied in the standard management system induced negative responses in 14 of the 20 comparisons and in 11 of the 20 comparisons under the progressive system (Table 8). Both the *Bacillus* and AMF biological categories performed the weakest in Nashville, with only 6 of the 16 pairings inducing a positive response. The strongest performing biological category at this site was the N-Fixers/Assimilators with 6 of the 8 comparisons inducing a positive yield response. This may be due to the lower percentage of organic matter

present at Nashville, and the expectation of less readily mineralizable nitrogen for the plant. These N-Fixating/Assimilating microbes can convert atmospheric nitrogen into a plant usable form, making up for either the lack of nitrogen provided by the soil or supplementing what soil N was leached given the abnormally wet growing season. Regarding biological product interactions with variety, AG38XF3 in the progressive management system resulted in 6 of the 10 comparisons exhibiting a yield improvement over the paired control plots. In total Nashville had just 15 positive yield responses out of 40 comparisons, and with 25 negative responses, especially for the seed treatment or in-furrow placed treatments suggesting that biologicals were not conducive to yield improvement for the conditions experienced at this site in 2024.

### Biological Yield Response in Champaign

The Champaign site resulted in the opposite interaction of biologicals with management when compared to Nashville. In the standard management system 13 of the 20 comparisons resulted in a positive yield response while the progressive system just 6 of the 20 comparisons resulted in a positive yield response (Table 9). When looking at yield response averages across managements and varieties the strongest response from biologicals came from products that were categorized as *Bacillus* or Non-Traditional. *Bacillus spp.* are bacteria that can enhance soil nutrient availability, including phosphorus which can be a limiting nutrient during grain fill. *Bacillus* can also enhance plant tolerance to biological stressors, such as disease, that the soybean may have faced with the wet and warm early season conditions (disease ratings were not conducted). For this location the AG38XF3 variety grown with standard management had the greatest positive yield response to biologicals, with 7 of the 10 comparisons resulting in a yield improvement over the controls. The GH3765XF variety also had a positive overall yield response within the standard management system with 6 of the 10 products resulting in a positive yield response. Champaign showed improvement over Nashville, with 22 of 40 comparisons resulting in a positive yield response.

### Biological Yield Response in Yorkville

At Yorkville, response to biologicals was equally positive and negative under standard management. Both varieties resulted in 11 of 20 comparisons leading to a numerically positive response, with no clear trend across managements (Table 10). The category with the strongest response at Yorkville was the *Bacillus* biological, and these bacteria enhance nutrient availability by converting phosphorus and nitrogen into simpler more plant available forms. They can also promote root development and growth and mitigate stress. In comparison to the southern sites, this location was drier in the early season, w. Adequate establishment of *Bacillus* with rather dry conditions going into the grain fill period may have given the crop an added advantage through this time. In total Yorkville had 22 yield increases out of 40 comparisons, similar to Champaign.

### Conclusions

This study indicates that the efficacy of biological products varies across environments and management systems. At Nashville, the site with the lowest organic matter percentage and lowest inherent fertility, response to biologicals exhibited the greatest magnitude of response, with most being negative, and this was the only site to show a statistically significant yield response to a biological compared to its paired control. At Champaign, yield potential was not maximized as indicated by response to management, yet biological use was best when supplied to a standard management system. At Yorkville there was no response to management, nor clear trends in biological response. There were trends across all three sites that the AG38XF3 variety was more positively responsive (52% positive, 48% negative) to biologicals than the GH3765XF variety (42% positive, 58% negative).

Biologicals are a new input sector with much potential as tools to improve yield. However, more research is needed to provide greater confidence in terms of which biologicals can positively impact soybean productivity across broad acres of the farm.

**Table 4.** Temperature and precipitation data for trial sites at Nashville, Champaign, and Yorkville, IL in 2024.

Month	Precipitation (inches)		Temperature (°F)	
	2024	Normal <sup>1</sup>	2024	Normal
<b>Nashville</b>				
April	5.1	5.0	60	57
May	6.6	5.1	70	66
June	3.7	4.3	77	75
July	6.4	3.8	77	78
August	1.2	3.3	76	76
September	5.1	3.6	70	69
Total	28.1	25.1	-	-
<b>Champaign</b>				
April	6.6	4.0	55	53
May	6.2	5.0	67	63
June	2.4	4.7	75	72
July	7.6	4.4	74	75
August	5.1	3.5	74	74
September	2.5	3.3	69	67
Total	30.4	24.9	-	-
<b>Yorkville</b>				
April	3.7	3.2	51	49
May	2.9	4.1	64	60
June	4.8	4.0	72	70
July	6.3	3.4	71	72
August	2.7	3.6	69	70
September	1.6	3.2	65	63
Total	22	21.5	-	-

<sup>1</sup>Refers to the average climate data from 1991-2020. Data obtained from the Illinois State Water Survey.

**Table 5.** Biological product effects on soil health indicators, averaged over two levels of management and two soybean varieties at Nashville (NV), Champaign (CU), and Yorkville (YV), IL in 2024.

Biological Product	Biological Category	$\Delta$ POX-C <sup>1</sup>			$\Delta$ beta-glucosidase		
		NV	CU	YV	NV	CU	YV
		ppm C			$\mu\text{mol pNP g}^{-1} \text{soil h}^{-1}$		
LAL Fix ProYield	Bradyrhizobium	+12.9	- 18.9	+9.7	- 1.9	- 2.0	+ 0.2
Microsurge	Bradyrhizobium	- 20.5	+13.5	- 13.5	+ 2.6	- 2.0	+ 0.5
Biopath	Bacillus	- 10.9	+19.1	+17.0	+ 3.2	+0.9	- 1.1
PhosN	Bacillus	- 3.5	- 23.9	- 2.2	+ 4.2*	- 1.4	+ 0.7
Myco-Sol	AMF	- 65.5*	+49.2*	+26.6	- 3.0	- 0.4	- 2.0
Symvado	AMF	- 35.5	- 1.3	- 19.2	- 1.1	+ 0.5	- 2.3
Envita	N-Fixing/Assimilating	+25.0	+2.8	- 3.4	- 0.3	- 0.7	+ 2.6
Utrisha N	N-Fixing/Assimilating	+19.9	- 31.5	- 14.4	+ 0.7	+ 0.7	- 0.7
iNvigorate	Non-Traditional	+12.0	- 27.1	+5.0	- 3.7	+ 0.7	+ 1.1
Jumpstart	Non-Traditional	+10.0	+11.0	- 27.6	- 1.8	- 0.6	+ 0.3
LSD ( $P \leq 0.05$ ) <sup>2</sup>		NS	NS	NS	NS	NS	NS
P > F		0.3832	0.1019	0.6591	0.4919	0.3677	0.8293

<sup>1</sup>Presented values show the difference between the biological products and their adjacent untreated controls.

<sup>2</sup>Statistics refer to the differences between biological products within each of the locations.

\*Statistically different from paired control using a paired t-test at  $\alpha = 0.1$ .

**Table 6.** Biological product effects on indicators of nitrogen cycling averaged over two levels of management and two soybean varieties at Nashville (NV), Champaign (CU), and Yorkville (YV), IL in 2024.

Biological Product	Biological Category	$\Delta$ Soil $\text{NH}_4^+\text{-N}^1$			$\Delta$ Nodule biomass <sup>2</sup>		
		NV	CU	YV	NV	CU	YV
		ppm $\text{NH}_4\text{-N}$			grams		
LAL Fix ProYield	Bradyrhizobium	+ 0.8	+ 0.2	- 0.3	+ 0.1	- 0.1	+ 0.1
Microsurge	Bradyrhizobium	+ 0.1	+ 0.1	+ 0.2	+ 0.2	+ 0.1	- 0.1
Biopath	Bacillus	- 0.3	+ 0.3*	- 0.2	+ 1.1*	$\pm$ 0.0	+ 0.3
PhosN	Bacillus	+ 0.3	$\pm$ 0.0	+ 0.7	- 0.1	+ 0.2	- 0.6*
Myco-Sol	AMF	- 0.9	+ 0.2	- 0.1	+ 0.1	- 0.1	$\pm$ 0.0
Symvado	AMF	+ 0.9	- 0.1	+ 0.4	- 0.1	+ 0.1	- 0.1
Envita	N-Fixing/Assimilating	+ 0.4	+ 0.1	- 0.7	-	-	-
Utrisha N	N-Fixing/Assimilating	+ 0.8	- 0.1	+ 0.6	-	-	-
iNvigorate	Non-Traditional	$\pm$ 0.0	$\pm$ 0.0	+ 0.8	$\pm$ 0.0	+ 0.1	+ 0.5*
Jumpstart	Non-Traditional	+ 0.4	- 0.1	+ 0.2	+ 0.4	+ 0.2	- 0.2
	LSD ( $P \leq 0.05$ ) <sup>3</sup>	NS	NS	NS	NS	NS	0.6
	P > F	0.5641	0.8633	0.3039	0.0775	0.4218	0.0202

<sup>1</sup>Presented values show the difference between the biological products and their adjacent untreated controls.

<sup>2</sup>Weight in grams refers to total nodule dry weight from four plants.

<sup>3</sup>Statistics refer to the differences between biological products within each of the locations.

\*Statistically different from paired control using a paired t-test at  $\alpha = 0.1$ .

**Table 7.** Management and variety interaction effects on soybean grain yield at Champaign, Illinois in 2024. Yields are presented as bushels per acre and standardized to 13% moisture.

Location	Variety	Management		Variety Average
		Standard	Progressive	
		bushels per acre <sup>1</sup>		
NV	GH3765XF	78.4	78.6	78.5
	AG38XF3	77.4	77.4	77.4
	Management Avg.	77.9	78.0	
CU	GH3765XF	85.0	90.1	87.6 <sup>B</sup>
	AG38XF3	85.3	93.2	89.2 <sup>A</sup>
	Management Avg.	85.2 <sup>B</sup>	91.6 <sup>A</sup>	
YV	GH3765XF	72.3	72.1	72.3 <sup>B</sup>
	AG38XF3	74.0	74.9	74.5 <sup>A</sup>
	Management Avg.	73.2	73.5	

<sup>1</sup>Yields are the average of all control plots (n=60 for interaction, n=120 for main effects). Capital letters within a main effect of management or variety for a given site are statistically different from each other at the 0.05 significance level, while the absence of letters represent a non-significant effect

**Table 8.** Biological product effects on soybean grain yield at Nashville, Illinois in 2024. Individual biological responses are the change in yield compared to the adjacent management control for a given variety.

Biological Product	Biological Category	Application Method	Biological Yield Response (difference from untreated, bushels per acre) <sup>1</sup>				
			GH3765XF		AG38XF3		Average
			Standard	Progressive	Standard	Progressive	
LAL Fix ProYield	Bradyrhizobium	Seed Treatment	- 0.1	- 0.9	+ 2.7	- 2.2	- 0.1
Microsurge	Bradyrhizobium	Seed Treatment	- 2.5	+ 3.9	- 3.2	+ 0.9	- 0.2
Biopath	Bacillus	In-Furrow	- 3.1	- 3.0	- 4.5	- 0.5	- 2.8
Phos N	Bacillus	Seed Treatment	- 0.6	- 3.2	- 3.3	+ 5.6*	- 0.4
Myco-Sol	AMF	In-Furrow	- 7.3*	- 3.3	- 3.0	- 5.7*	- 4.8
Symvado	AMF	Seed Treatment	+ 0.4	- 5.9*	- 1.8	+ 5.9*	- 0.4
Envita	N-Fixing Endophyte	Foliar	+ 0.9	- 1.7	+ 1.1	+1.3	+ 0.4
Utrisha N	N-Fixing Endophyte	Foliar	- 3.3	+ 2.0	+ 4.7*	+ 3.4	+ 1.7
iNvigorate	Non-Traditional	In-Furrow	- 1.2	- 4.1	+ 3.7	+ 1.9	+ 0.1
Jumpstart	Non-Traditional	Seed Treatment	- 2.9	+ 0.5	- 2.0	- 3.0	- 1.9
<b>LSD (<math>P \leq 0.10</math>)</b>			NS	NS	NS	NS	NS
<b>P &gt; F</b>			0.3160	0.2059	0.1316	0.1152	0.0806

<sup>1</sup>Biological responses are the average of n=6 observations and presented as the change in yield from an adjacent untreated control within the respective management and variety combination.

\*Product response is significantly different from paired control plot using a paired T-Test at alpha=0.1.

**Table 9.** Biological product effects on soybean grain yield at Champaign, Illinois in 2024. Individual biological responses are the change in yield compared to the adjacent management control for a given variety.

Biological Product	Biological Category	Application Method	Biological Yield Response (difference from untreated, bushels per acre) <sup>1</sup>				
			GH3765XF		AG38XF3		Average
			Standard	Progressive	Standard	Progressive	
LAL Fix ProYield	Bradyrhizobium	Seed Treatment	- 0.4	- 0.8	+ 1.0	- 0.5	- 0.2
Microsurge	Bradyrhizobium	Seed Treatment	- 0.2	- 2.0	+ 1.4	- 1.5	- 0.6
Biopath	Bacillus	In-Furrow	+ 2.1	- 0.8	- 0.5	+ 1.1	+ 0.5
Phos N	Bacillus	Seed Treatment	+ 0.7	± 0.0	+ 1.1	- 0.2	+ 0.4
Myco-Sol	AMF	In-Furrow	- 1.1	+ 0.5	- 0.4	- 1.2	- 0.6
Symvado	AMF	Seed Treatment	+ 1.9	- 1.1	- 1.4	- 0.3	- 0.2
Envita	N-Fixing Endophyte	Foliar	- 0.3	+ 1.2	+ 0.2	- 1.8	- 0.2
Utrisha N	N-Fixing Endophyte	Foliar	+ 1.8	- 1.0	+ 0.5	+ 0.3	+ 0.4
iNvigorate	Non-Traditional	In-Furrow	+0.8	- 0.9	+ 0.2	+ 0.5	+ 0.2
Jumpstart	Non-Traditional	Seed Treatment	+ 0.4	+ 1.3	+ 0.5	- 1.1	+ 0.3
<b>LSD (<math>P \leq 0.10</math>)</b>			NS	NS	NS	NS	NS
<b>P &gt; F</b>			0.3039	0.4725	0.7248	0.4238	0.5936

<sup>1</sup>Biological responses are the average of n=6 observations and presented as the change in yield from an adjacent untreated control within the respective management and variety combination.

**Table 10.** Biological product effects on soybean grain yield at Yorkville, Illinois in 2024. Individual biological responses are the change in yield compared to the adjacent management control for a given variety.

Biological Product	Biological Category	Application Method	Biological Yield Response (difference from untreated, bushels per acre) <sup>1</sup>				
			GH3765XF		AG38XF3		Average
			Standard	Progressive	Standard	Progressive	
LAL Fix ProYield	Bradyrhizobium	Seed Treatment	- 1.2	+ 0.1	- 2.2	+ 0.7	- 0.7
Microsurge	Bradyrhizobium	Seed Treatment	+ 1.0	- 1.1	- 1.3	- 0.2	- 0.4
Biopath	Bacillus	In-Furrow	+ 0.6	+ 1.3	+ 1.1	+ 1.8	+ 1.2
Phos N	Bacillus	Seed Treatment	- 0.3	+ 0.4	+ 0.1	+ 2.3	+ 0.6
Myco-Sol	AMF	In-Furrow	- 0.8	+ 1.4	- 0.5	- 1.0	- 0.2
Symvado	AMF	Seed Treatment	+ 0.6	- 0.2	+ 1.1	+ 0.1	+ 0.4
Envita	N-Fixing Endophyte	Foliar	+ 1.4	- 1.0	+ 0.1	+ 1.0	+ 0.4
Utrisha N	N-Fixing Endophyte	Foliar	+ 1.3	- 0.3	- 0.5	+ 2.1	+ 0.7
iNvigorate	Non-Traditional	In-Furrow	- 0.4	- 1.1	- 1.8	- 0.3	- 0.9
Jumpstart	Non-Traditional	Seed Treatment	+ 0.5	+ 0.7	- 2.3	+ 0.5	- 0.1
<b>LSD (<math>P \leq 0.10</math>)</b>			NS	NS	NS	NS	NS
<b>P &gt; F</b>			0.7057	0.7686	0.1794	0.5663	0.3529

<sup>1</sup>Biological responses are the average of n=6 observations and presented as the change in yield from an adjacent untreated control within the respective management and variety combination.