Illinois Biological Testing for Corn Production

2022 Yield Report

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We examined different biological products, application methods, and agronomic management systems with the goal of showing which products have the greatest chance of success.

Research Approach

Eleven different biological products were tested in two different management systems (standard or progressive) with two genetically diverse corn hybrids (G15J91 and DKC65-95). This approach allows for a comprehensive evaluation of product performance and can help to decide if, how, and where to use a specific biological product.

How Biological Products were Evaluated

From our previous experience evaluating biological products, we know that a given product may enhance early season growth and the potential yield, but often not the final yield when other in-season factors like nutrient deficiency or leaf disease are present. Thus, biological products were evaluated in both 'standard' and 'progressive' management systems (Table 1)

Table 1. Agronomic management systems used in the evaluation of biological products for corn at Champaign, IL in 2022.

Management System[1]	Side-dress N	Foliar Protection
Standard	None	None
Progressive	60 lbs N/acre applied Y-drop at V6	Fungicide and Insecticide at VT/R1

[1]Both management systems received a preplant broadcast fertilizer of 160 lbs N, 75 lbs P_2O_5, and 60 lbs K_2O per acre as urea (46-0-0), MAP (11-52-0), and MOP (0-0-60).

The 'standard' system has appropriate fertilizer applications made at planting (160 lbs N, 75 lbs P_2O_5, and 60 lbs K_2O per acre) with no subsequent in-season management, while the 'progressive' system has the at-planting fertility along with an extra 60 lbs N per acre Y-drop applied at V6 and a fungicide and insecticide application at VT/R1 for foliar protection (Table 1). Pre-plant fertility was provided as urea (46-0-0), monoammonium phosphate (MAP; 11-52-0), and muriate of potash (MOP; 0-0-60), side-dress fertility as urea ammonium nitrate (UAN, 32-0-0), and foliar protection as Miravis Neo (13.7 oz per acre; Syngenta) and Warrior II (1.6 oz per acre; Syngenta). All plots were seeded to achieve a final plant population of 36,000 plants per acre.

We also know that non-uniformity within fields causes field spatial variability that can mask the yield response to both agronomic management and to the biological product application. Thus, a pair-wise field design was used where every treated plot had an adjacent untreated control, and this allows for an unbiased comparison of biological products and their efficacy under different levels of agronomic management (Figure 1). Experimental plots were arranged in a split-split block design where the main plot was the biological product, the sub-plot was hybrid, and the sub-sub-plot was the management system. All treatments were replicated six times and eleven different biological products were evaluated (Table 2).

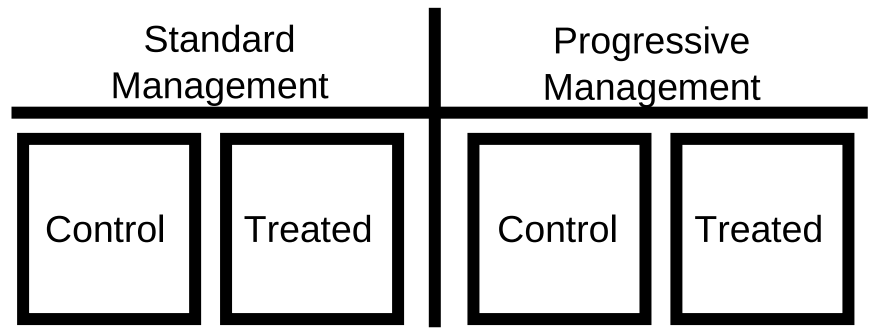

Figure 1. Pair-wise design used to evaluate biological products under two levels of agronomic management and with two different hybrids. For each biological product, plots were randomized across six replications.

Trial Implementation

Plots were planted at Champaign, IL (40°4'10"N, 88°14'08"W) on 29 April using a precision plot planter (SeedPro 360, ALMACO). Preplant soil test levels are shown in Table 3. Plots were 37.5 feet in length and four rows in width, with rows 1 and 4 serving as border and rows 2 and 3 harvested for yield. For below-ground insect protection, Force 6.5G soil insecticide was applied in-furrow (2.3 oz per 1000 ft; Syngenta) at planting. For weed control, pre-plant applications of Acuron (96 oz per acre; Syngenta) and Atrazine (12 oz per acre) were made on 27 April. In-season weed control was applied 1 June as Laudis (3 oz per acre; Bayer), Zidua SC (4 oz per acre; BASF), Infantry (32 oz per acre; Growmark), Diflexx (6 oz per acre; Bayer), Roundup Powermax3 (60 oz per acre; Bayer), and Broadloom (2 pt per acre; UPL).

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

Company Sponsor	Product Name	Biological Category	Application Rate	Application Method[1]
Acadian Plant Health	Envoy	Algae Extract	2 oz / acre & 11.2 oz / acre	In-Furrow & V6 Foliar
ADM	NeoVita 43	Sugar	1 gal / acre	In-Furrow
Biolevel	Maize*NP*	Microbial Inoculant	100 g / acre	In-Furrow
Groundwork BioAg	Rootella	Mycorrhizal Fungi	9 g / acre	In-Furrow
Plant Response	BioPath	Microbial Inoculant	16 oz / acre	In-Furrow
Verdesian	‘Experimental’	N-Fixing Microbe	2.1 oz / acre	In-Furrow
Agrocete	Amyno 15, Organo Top	Amino Acid, Humic Acid	13.5 oz / acre, 27 oz / acre	V6 & VT/R1 Foliar
ADM	NeoVita 43	Sugar	1 gal / acre	V6 Foliar
Plant Response	BioPath	Microbial Inoculant	16 oz / acre	V6 Y-Drop
Sanovita	Classic, Flusian, Humin	Micronutrient, Algae Extract, Algae Extract	0.6 lb / acre, 0.5 oz / acre, 1.4 oz / acre	V6 (C & H) & VT/R1 (C & F) Foliar
Talc USA	Microsurge	Microbial Inoculant	2 oz / unit	Planter Box

[1]In-furrow as 4 gallons/acre of ammonium polyphosphate (APP; 10-34-0) blended with water for total application volume of 12 gallons/acre. Foliar applications were applied with Masterlock surfactant (3.4 oz per acre, Winfield United) and blended with water for total application volume of 15 gallons per acre at V6 and 20 gallons per acre at VT/ R1.

Table 3. Preplant soil test levels for trial site at Champaign, IL.

OM	CEC	pH	P	K	Ca	Mg	S	Zn
%	meq/100g		ppm					
4.1	20.9	6.8	14	110	3218	464	8	6

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 unique pairwise design allows for the unbiased comparisons among biological products that are applied as a seed treatment, in-furrow, Y-drop, or foliar spray. Seed/planter box treatments were treated 18 April and in-furrow applications were mixed within an hour of application on date of planting. Y-drop treatments were applied at the V6 growth stage on 4 June, the same day as the early vegetative (postemergence herbicide timing) foliar sprays. The late vegetative/early reproductive (VT/R1) foliar applications of individual biologicals and the foliar protection of the progressive management plots were applied on 14 July.

In-Furrow vs. Alternative Application Methods

All in-furrow biological entries were applied with 4 gallons per acre of ammonium polyphosphate (APP; 10-34-0) to supply 16 lbs P_2O_5 per acre, and the respective control plot received the same rate of APP. APP starter was included with all the in-furrow applications based on our earlier findings showing a greater response to in-furrow biologicals when they are placed with fertilizer. Biological product applications that were not placed in-furrow did not receive APP as these product placements would be representative of growers that do not have in-furrow capability on their planters.

Growing conditions

The season started wet with frequent precipitation events during April and early May, where most of the corn in the area was planted between 10-25 May (Table 4). The earlier planting of the trial (29 April), and the good weather and soil conditions in early May resulted in rapid, uniform emergence and a strong start to early season vegetative growth (Figure 2). Although May had near-normal precipitation, the months of June and July were well below average (3.9 and 2.0 inches below average, respectively), resulting in a moderate drought during the vegetative and early reproductive growth stages (Figure 2). However, August received adequate rainfall during seed fill and slightly lower temperatures (especially during the second half of the month), resulting in extended plant health and improved kernel weights, with a final trial average yield of 281 bushels per acre.

Table 4. Temperature and precipitation data for the trial site in 2022.

	Precipitation		Temperature	
Month	**2022**	**Average[1]**	**2022**	**Average[1]**
	inches		°F	
April	3.2	4.0	50	53
May	3.2	5.0	66	63
June	0.8	4.7	75	72
July	2.4	4.4	76	75
August	4.9	3.5	73	74
September	4.6	3.3	67	67
Total	19.1	24.9	-	-

[1]Refers to the average climate data from Champaign, IL from 1989-2020. Data obtained from the Illinois State Water Survey.

Data Collection, Analysis, and Interpretation

At maturity, plots were harvested with a two-row plot combine (R1, Almaco) and grain yield is reported as bushels per acre at 15.5% moisture (Table 5). Statistical analysis was performed using a linear mixed model approach with PROC MIXED in SAS (version 9.4; SAS Institute, Cary, NC) and means were separated using Fisher's protected LSD test at the 0.10 level of significance. The biological product response was determined by the yield difference from paired control plots and significance tested using a paired t-test at alpha=0.1.

Figure 2. Good early season vegetative growth (top), followed by drought stress at the V8 growth stage (middle left), and by extended plant health into the second half of the season (middle right) resulting in high kernel set and heavy ear weights (bottom).

Management Mattered in 2022, but not Much

Although yields were affected by agronomic management the responses were much lower than we typically observe. The largest difference was from hybrid selection, where hybrid G15J19 averaged 287 bushels per acre compared to 274 bushels for DKC65-95 (Table 5). For both hybrids, progressive management increased yield over standard management, but the increase was only 10 bushels per acre (Table 5). This lower than expected management increase was likely due to extremely dry and warm conditions in June and to abnormally dry conditions in July (Table 4). We theorize that the dry conditions in June minimized any weather-induced losses of N, while at the same time enhancing soil N mineralization, and as a result the crop's N supply was adequate and the extra side-dress N application was not needed. Similarly, the dry conditions in July reduced the infection and development of foliar diseases, resulting in extended late-season leaf health, and a low response to the foliar fungicide application. Also atypical from our normal observations, was the average 3.5 bushel per acre decrease in yield from the APP starter fertilizer application which occurred for both hybrids and with both management systems (Table 5). Why APP starter decreased yield is not clear, especially given the relatively low soil P test values at this site (Table 3), and since we observed no negative impacts of starter fertilizer application on emergence or final plant stands. Interestingly, the inclusion of in-furrow biologicals tended to mitigate the negative impact of APP starter fertilizer, especially for hybrid GH15J91 (Table 6).

The Response to Biological Products was Small and Inconsistent

Yield responses to the biological products were variable with both positive and negative responses observed between the treated plots and their paired controls (Table 6). Eleven of the 20 product yield comparisons were numerically negative for the foliar, Y-drop, or planter box applied products (non in-furrow), with foliar applied NeoVita 43 significantly decreasing yield by 7 bushels per acre for hybrid G15J91 receiving standard management. Averaged over hybrids and management levels, all non in-furrow products numerically decreased yield (from -0.5 to -2.7 bushels), expect for Amyno 15 and Organo Top which numerically increased yield by an average of 2.3 bushels. Amyno 15 and Organo Top was the only non in-furrow treatment to significantly increase yield in some of the paired comparisons, although the increases were not consistent for management level or hybrids. For hybrid DKC65-95, Amyno 15 and Organo Top significantly increased yield by 5.4 bushels with standard management, while numerically decreasing yield (-3.1 bushels) with progressive management, while hybrid G15J91 was numerically higher with standard management (2.4 bushels) and significantly higher (4.4 bushels) with progressive management (Table 6). For the non in-furrow products, the foliar and Y-drop applications were made in early June (the 4th), right at the time when the crop was becoming drought stressed (Figure 2), and this timing may have enhanced the activity of some products while minimizing the activity of others.

In contrast, in-furrow product applications trended numerically higher in 16 of the 24 product comparisons, with NeoVita 43 significantly increasing yield of G15J91 receiving standard management by 8 bushels per acre (Table 6). Averaged over hybrids and management, all in-furrow products, except the Verdesian experimental, numerically increased yield (from 0.6 to 3.0 bushels). Only NeoVita 43 exhibited numerical positive increases for both hybrids and management systems.

There were no consistent responses, or lack of responses, associated with management level for any of the biological products. While the yield responses were also not consistent among hybrids, in-furrow MaizeNP and Rootella were consistently positive for hybrid G15J91 (each product averaging +5.0 bushels across managements) and negative, or unaffected for DKC65-95 ((Table 6).

Summary

Despite the stringent pairwise experimental design, and the biological product evaluation at two levels of agronomic management and with two different hybrids, the impacts of management and biological product application on corn yield were minimal. These findings highlight the large impact that weather has on crop growing conditions and as a result the response to both agronomic management and to the biological product applications.

Table 5. Management and hybrid interaction effects on corn grain yield at Champaign, Illinois in 2022. Management yields are presented as bushels per acre and standardized to 15.5% moisture.

In-Furrow Fertility[2]	Management Yields (bushels per acre)[1]			
	G15J91		DKC65-95	
	Standard	Progressive	Standard	Progressive
None	284	296	270	280
4 gallons of APP per acre	280	290	268	278

[1]Management yields are the average of n=36 observations.
[2]APP; Ammonium polyphosphate (10-34-0).
LSD ($P \leq 0.10$): Hybrid (H), 1.8; In-Furrow (IF), 1.8; Management (M), 1.8; IF x M, NS; H x M, NS; H x IF, 2.6; H x IF x M, NS

Table 6. Biological product effects on corn grain yield at Champaign, Illinois in 2022. Individual biological responses are the change in yield compared to the adjacent management control for a given hybrid.

In-Furrow Fertility[2]	Biological Product	Application Method	Biological Yield Response (difference from untreated, bushels per acre)[1]				
			G15J91		DKC65-95		
			Standard	Progressive	Standard	Progressive	Average
None	Amyno 15 and Organo Top	V6 and VT/R1 Foliar	+ 2.4	+ 4.4*	+ 5.4*	- 3.1	+ 2.3
	NeoVita 43	V6 Foliar	- 2.9	- 7.0*	- 0.5	+ 2.5	- 2.0
	BioPath	V6 Y-Drop	+ 0.2	- 5.8	- 4.9	+ 0.1	- 2.6
	Classic, Flusian, and Humin	V6 (C & H) and VT/R1 (C & F) Foliar	- 1.9	+ 1.3	- 1.7	+ 0.4	- 0.5
	Microsurge	Planter Box Treatment	+ 0.6	- 7.5	- 1.7	- 2.3	- 2.7
4 gallons of APP per acre	Envoy	In-Furrow and V6 Foliar	- 1.7	+ 2.7	+ 2.3	+ 3.1	+ 1.6
	NeoVita 43	In-Furrow	+ 8.0*	+ 1.2	+ 2.3	+ 0.4	+ 3.0
	Maize*NP*	In-Furrow	+ 2.8	+ 7.1	- 2.5	- 4.2	+ 0.8
	Rootella	In-Furrow	+ 5.8	+ 4.2	- 1.0	+ 0.8	+ 2.4
	BioPath	In-Furrow	- 4.9*	+ 5.3	+ 4.6	- 2.6	+ 0.6
	Verdesian 'Experimental'	In-Furrow	+ 3.9	- 3.1	+ 0.6	- 2.9	- 0.4

[1]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 hybrid combination.
[2]APP; Ammonium polyphosphate (10-34-0).
*Product response is significantly different from paired control plot using a paired t-test at alpha=0.1.