

Last Year's Residue, This Year's Nutrients

Maximizing Residue Breakdown, Nutrient Release and Nutrient Mineralization with Biochemical Technology

Introduction

The nutrients in crop residue are a valuable addition to a grower's fertility program, but accessing them can be a challenging process. With today's large harvests and high-residue continuous corn systems, as well as soybean on corn rotations, it requires a great deal of time and energy before nutrients are released from crop residues in the field through the natural process of decomposition. It's important to keep in mind that the primary limiting factor for residue decomposition is cooler temperatures (below 50° F), which significantly slow down the microbial activity that breaks residue down. This means that, if harvest happens late, there's only a short window for natural decomposition processes to take place before spring planting, and growers will miss the opportunity to utilize a large portion of the valuable nutrients locked in the stover. Not only can this impact their fertilizer costs, it can also affect the performance of their plants and their yields at harvest.

These issues were very relevant in the fall of 2013, when many growers across the U.S. faced a dual challenge: record high yields left high amounts of residue in the fields, and a late harvest meant there would be little time for natural microbial processes to break it down before cooler weather set in. One way that growers are addressing these challenges is through the use of agricultural biologicals that deliver concentrated, microbial-derived biochemistry. Such products can enhance natural residue decomposition and nutrient release processes. Accomplish LM, manufactured by Agricen and distributed by Loveland Products and Crop Production Services, is a biochemical additive that can be used to maximize residue decomposition, nutrient release and nutrient mineralization for the benefit of next seasons' crops, even when temperatures drop.

Residue Breakdown and Ugly Corn Syndrome

Corn residue from a 200 bushel crop contains approximately 116 units of nitrogen (N), 27 units of phosphorous (P) and 209 units of potassium (K) (a sample nutrient removal chart is shown in Table 1). Nutrients in the residue, which are not in a plant-available form, must be mineralized by soil microorganisms prior to plant utilization. When temperatures drop below 50° F, these microbial processes slow down significantly. When there is a lot of residue and/or little time before cooler temperatures arrive—such as in a high-residue or late harvest situation—natural decomposition processes are not adequate to release valuable nutrients from the stover for the benefit of crops grown the next season, a lost opportunity for growers to improve the efficiency of their operations. Further, once warmer temperatures come and microbial activity resumes again, the digestion process (during which microbes use N as a food source) can tie up applied N, making it unavailable for plant growth. This creates the conditions for a phenomenon known as "ugly corn syndrome" to occur.

Nutrient Values from Residue

Must access "bound" nutrients to increase productivity

Sector Contractor			Mar Harris Martin Land		
Crop	Bu/Acre	N*	P ₂ O ₅ *	K₂O	Total/Acre*
Corn	200	200	70	50	320
Stover		100	50	210	360
Total Corn		300	120	260	680
Soybeans	70	266	59	91	416
Stover		77	17	70	164
Total Bean		343	76	161	570
Wheat	80	120	48	27	195
Straw		56	13	96	165
Total Wheat		176	61	123	360

Source: Michigan State

Table 1. Nutrient removal chart for 200 bushel corn residue (University of Michigan). Note: Nutrient values are estimates and will vary according to factors including location, season, growing practices, and time of harvest.

Ugly corn syndrome—in which a lack of plant-available N causes corn seedlings (emergence to V3-V4) to turn yellow—is familiar to many corn growers, especially for those with continuous corn operations. Due to the buildup of organic matter from multiple years of corn-on-corn rotations, the carbon-to-nitrogen (C:N) ratio can be more than double the optimal ratio¹ for crop residue decomposition on continuous corn acres. Even if a grower has applied N during the previous fall or at spring planting, soil microbes are able to out-compete seedling corn plants for N whenever excess carbon is present.

One effective way to prevent ugly corn syndrome on high residue fields is to lower soil C:N ratios by baling corn stalks for winter cow feed. Unfortunately, this is really only practical for row crop farmers that have cows—and most do not. In addition, complete removal of corn residue also takes away a significant amount of the N, P and K that comprises corn stover and could be used to benefit the next season's crop.

A second option for making sure seedling corn has enough N is to apply more N to meet the needs of both the soil-microbe system and the seedling corn. A common approach in the Corn Belt is to broadcast 10-15 gallons of 28% UAN on corn residue after harvest, with the idea that the extra N will facilitate rapid microbial activity and decomposition of the corn residue. However, because the rate-limiting factor for residue decomposition is temperature, and not available N, applying more N isn't necessarily the answer to avoiding N immobilization and ensuring that the plants will have the N they need in the spring.

Using Biochemical Technology to Maximize Residue Breakdown, Nutrient Release and Nutrient Mineralization

Untreated -

To solve residue breakdown, nutrient release and nutrient mineralization issues in high-residue conditions, growers can use Accomplish LM in their operations. Accomplish LM is a concentrated biochemical product that contains no N and isn't dependent on soil microbial activity to function. Applied in the fall (preferably) or along with a grower's standard spring N application, Accomplish LM can hasten residue decomposition, effectively releasing nutrients tied up in the stover and improving the mineralization and uptake of soil and applied nutrients.

Typically, Accomplish LM residue applications are made in October, when the ambient air and soil temperatures are cooling. The concentrated biochemistry in Accomplish LM is not temperature sensitive and will continue to decompose corn residue, even in colder soil temperatures. Figure 1 shows the significant stalk breakdown associated with a fall Accomplish LM treatment in a cooler growing area.



Treated with **Accomplish**∟M

Figure 1. Corn residue - Breckenridge, Michigan (2013). In fall 2012, 2 quarts of Accomplish LM + 2 gallons of 28% UAN + water was applied to standing corn stalks. This picture, taken March 2013, shows the difference between treated and untreated parts of the field in a colder growing area (a latitude north of Madison, WI).

The effects are rapid, with visible deterioration seen in as little as two weeks (Figures 2 & 3).



Figure 2. Corn residue - Northeast Iowa (2013). Visible residue deterioration two weeks after Accomplish LM application (right) compared to no treatment (left).



Figure 3. Corn residue - Southwest Indiana (2013). Three weeks after a fall-applied Accomplish LM residue application. Visible residue deterioration with Accomplish LM (right) compared to no treatment (left).

Corn Trials: More Nutrient Availability and Uptake, Higher Yields with Accomplish LM

The practice of using Accomplish LM to increase nutrient efficiencies in high-residue fields is also supported by data that includes the findings from a large corn trial conducted in five Northeast Iowa locations in 2010 and 2011. The trial examined the effects of using additional spring-applied N or Accomplish LM to address ugly corn syndrome in corn on corn operations. Four different N sources were used², applied at 40 units of N per acre in late March, 30 days prior to planting. The Accomplish LM treatment was applied at 3 pints per acre with water and no additional N. These applications were in addition to the grower's standard N application (200 units of N as anhydrous ammonia [NH₃]), which had been applied in the fall.

Soil nitrate levels were recorded for each treatment 60 days after planting, and stalk nitrate levels were taken after harvest. The soil nitrate concentration of Accomplish LM (20.6 ppm) was almost three times that of the grower standard (7 ppm) (Table 2). In addition, the Accomplish LM treatment was associated with the lowest stalk nitrate reading of all the treatments.

Soil and Stalk Nitrate Tests

Сгор	28% UAN	AMS	MESZ	Urea	Accomplish LM	Check
Additional Nitrogen Added	40 lbs.	40 lbs.	40 lbs.	40 lbs.	0 lbs.	0 lbs.
Avg. Late Spring Nitrate Test – ppm NO_3	10.2	8.8	8.8	18.8	20.6	7
Avg. End of Season Stalk Nitrate Test – ppm NO_3	5716	6435	6435	8938	5519	5990

Table 2. Soil and corn stalk nitrate tests. Improved P availability when Accomplish LM is combined with a standard fertility program.

In 2010, Accomplish LM had the highest yield (221 bushels/acre) over all treatments, with an 11.8 bushel per acre increase compared to the check (Figure 4). In 2011, Accomplish LM again had the highest yield at 255 bushels per acre, a 15 bushel/acre increase vs. check. Moreover, while nitrogen use efficiency (units of N/yield in bushels) was not improved for the additive fertilizer applications versus grower standard (0.96 units N/bushel in 2010 and 0.83 units in 2011), it was increased with Accomplish LM (0.90 units N/bushel in 2010 and 0.78 units in 2011).

²The four N sources were: urea ammonium nitrate (UAN), 28-0-0; ammonium sulfate (AMS), 21-0-0-24S; MicroEssentials[®] SZ (MESZ), 12-40-0-10(S)-1(Zn) (Mosaic Company); urea, 46-0-0.



Figure 4. Corn on corn yield results in 2010 (left bars) and 2011 (right bars). Accomplish LM was associated with the highest average yields in both years. The grower's standard practice was 200 units of N as fall-applied NH₃. Abbreviations: GSP, grower's standard practice; MESZ, MicroEssentials[®] SZ (Mosaic Company); UAN, urea ammonium nitrate; AMS, ammonium sulfate.

Those data points tell a compelling story that the application of Accomplish LM on the residue created more available N (i.e., higher soil nitrate) than applying 40 additional units of N—resulting in improved mineralization of nutrients—and that it delivered that N to the grain (i.e., lower stalk nitrate and higher yield).

Additional evidence of improved nutrient release and availability was seen in 2011, when soil phosphorous levels (P1 & P2) were examined. Just 60 days after application, all of the Accomplish LM treated plots showed increased soil phosphorous levels (Table 3). On average, P1 levels increased by 18% and P2 levels by 31% compared to the check. It requires 8-10 pounds of P_2O_5 to raise a P1 soil analysis by 1 ppm; a 13 ppm increase, which was achieved with the Accomplish LM treatment, is equal to applying 100 - 130 lbs of P_2O_5 .

Location	Check P2	Check P1	Accomplish LM P2	Accomplish LM P1
Garnavillo, IA	51	37	76	47
Lamont, IA	172	108	195	124
Nora Springs, IA	82	54	89	35
Ossian, IA	40	31	48	35
Waverly, IA	214	124	325	150
Average	112	71	147	84

Soil P (ppm)

Table 3. Improved P availability when Accomplish LM is combined with a standard fertility program.

In summary, adding just three pints of Accomplish LM 30 days prior to spring planting increased the efficiencies of soil N and soil P, resulting in the highest overall corn yields both years.

Numerous other studies also demonstrate yield increases after a residue application of Accomplish LM. In a split field trial on corn in Dana, Indiana, a fall residue application of 16 gallons/acre 28% UAN was compared to a fall application of Accomplish LM applied at 2 quarts/acre + 3 gallons 28% UAN + 8 gallons of water. The Accomplish LM treatment out-yielded 16 gallons of 28% UAN by 9.3 bushels per acre (Figure 5). (Note: If UAN is part of a grower's nutritional program, the applied N should not be cut or lowered. In this trial, the 16 gallons of UAN was applied for stalk breakdown, not plant nutrition.)

Corn - Dana, IN (2012)

Accomplish LM fall-applied at 2 quarts per acre + 3 gallons 28% UAN and 8 gallons water



Sprayed 9/30/11

Figure 5. Continuous Corn - Increased yield with fall-applied Accomplish LM in a split field corn residue trial. All results were obtained despite an historic drought.

In a corn on soybean trial conducted in White Hall, Illinois, a fall residue application Accomplish LM (2 qts/acre + 2 gals 28% UAN + 8 gals water) on soybean stubble provided a 22.8 bushel/acre advantage over 28% UAN (2 gals/acre) (Figure 6).

Corn - White Hall, IL (2013)

Accomplish LM fall-applied at 2 quarts per acre + 2 gallons 28% UAN and 8 gallons water on soybean stubble



2 gals 28% UAN applied as grower's standard residue practice; sprayed fall 2012

Figure 6. Soybean-corn rotation - Increased corn yield with fall-applied Accomplish LM in a soybean residue trial.

Other featured studies from Iowa, Illinois and Ohio (Figures 7-9) tell a similar story about the power of incorporating this biochemical technology into residue management programs to improve the next season's yields.

Corn - Central Iowa (2012)

Accomplish LM fall-applied at 2 quarts per acre + 2 gallons 32% UAN and 8 gallons water



2 gals 32% UAN applied as grower's standard residue practice; sprayed fall 2011

Figure 7. Continuous corn - Increased yield with fall-applied Accomplish LM in a corn residue trial.

Corn, Split Field Trial (Wyffels Hybrids 8681) - Jacksonville, FL (2012)

Accomplish LM applied to corn stalks at 2 quarts per acre + 2 gallons 28% UAN and 8 gallons water

Late January 2012

V2



Figure 8. Continuous corn - Improved residue breakdown, root development, emergence and yield after a fall-residue application of Accomplish LM in a split field corn residue trial. (Note: Half of the field did not receive any fall residue application; both sides of the field received the grower's standard fertility application in the spring.)

No-Till Corn – Ottawa, OH (2010)

Accomplish LM fall-applied at 2 quarts per acre + 2 gallons 28% UAN and 8 gallons water



Sprayed: 11/09; planted: 4/10; photo taken: 5/10

Figure 9. Continuous corn - Improved residue breakdown, root development, emergence and yield after a fall-residue application of Accomplish LM in no-till corn.

Soybean Trials: Higher Yields & Better Plant Performance in Soybean Grown on Corn Residue Treated with Accomplish LM

With corn prices trending lower, many growers will move from a corn on corn rotation to producing soybeans, relying on nutrients remaining from their previous corn crop to help fertilize their soybeans. Given the high potassium levels in corn stover and the high potassium demand for a soybean crop, this is a perfect situation for improving plant performance (Figures 10-12) and gaining a yield advantage in the coming soybean crop (Figure 13).

Soybeans - Wimbledon, ND (2011)

Accomplish LM fall-applied at 2 quarts + 1 gallon 28% UAN and 10 gallons water per acre on corn stubble



Untreated

Treated with **Accomplish**

Figure 10. Corn-soybean rotation - Improved nutrient uptake in soybean plants treated with fall-applied Accomplish LM (right) compared to check (left).

Soybeans - Wimbledon, ND (2011)

Accomplish LM fall-applied at 2 quarts + 1 gallon 28% UAN and 10 gallons water per acre on corn stubble



Figure 11. Corn-soybean rotation - Improved nutrient uptake and root growth during the growing season with a fall residue application of Accomplish LM (right) compared to check (left).

Soybeans - Wimbledon, ND (July, 2011)

Accomplish LM fall-applied at 2 quarts + 1 gallon 28% UAN and 10 gallons water per acre on corn stubble



Untreated





Soybeans - Wall Lake, IA (2008)

Accomplish LM fall-applied at 2 quarts per acre + 2 gallons UAN 28% and 8 gallons water



Figure 13. Corn-soybean rotation - Accomplish LM was associated with the highest yield compared to check (average yield from two check strips adjacent to the Accomplish LM-treated strip) in this trial of soybean grown on corn residue.

Conclusions

Valuable nutrients for next season's crops are locked up in crop residues, but releasing them can be a challenge. Growers can use Accomplish LM to speed residue breakdown, release valuable nutrients and improve nutrient mineralization for better plant performance and a higher corn or soybean yield in the next season.

Accomplish^{LM}

At a Glance				
Application	 Liquid fertilizers and broadcast 			
Target nutrients	 Broad spectrum Macronutrients (NPK) + Micronutrients 			
Functioning components	 Viable microorganisms Biochemical byproducts (e.g., enzymes, organic acids, proteins) 			
Primary mode(s) of action	 Mineralizes nutrient sources to increase nutrient availability Enhances root growth & improves nutrient & water uptake 			
Features	 Effective in a wide variety of soil types Compatible with a wide variety of liquid fertilizers, herbicides, fungicides, & other chemicals Shelf stable Registered organic by Washington State Department of Agriculture (WSDA) 			

Uses and Rates

Application	Recommended Rate
Residue	2 quarts/acre (with 1-2 gallons of 28% or 32% UAN + 8.5 gallons of water)
Manure	2-4 quarts/acre (injected or applied broadcast)
Broadcast	2-4 quarts/acre
Starter	1-2 pints/acre
28% or 32% UAN	1-2 quarts/acre

Based on Nature. Built on Science.

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