Western Illinois University/ Allison Organic Research Farm

Organic Dry Blended Fertilizer Study in Corn

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While most organic farmers use bulky and somewhat heterogeneous materials (e.g., manures, composts, and cover crops) as their primary nutrient sources, blended granular organic fertilizers clearly have some logistical advantages (e.g., formulated chemical and physical composition and uniformity of application). Producers of organic grains should carefully consider whether the higher cost (per unit of nutrient) of blended granular fertilizer materials can be justified. A study at the Allison Organic Research Farm (Roseville, IL) was conducted to evaluate a blended dry organic fertilizer banded 2"x2" at planting. The fertilizer was formulated by Midwestern Bio-Ag to contain a blend of macro and micronutrients based on historical soil and tissue tests. The effect of the fertilizer on yield and tissue levels of nutrients was evaluated using paired 8 row strips (with and without fertilizer) in two fields. One of the fields had a spring cover crop of oats. The economics of the fertilizer program were evaluated based on current fertilizer and grain prices.

Methods:
The two study fields (1B and 2A) were planted on 6/5/07 to corn hybrid 66P32 (Blue River Hybrids - 112 days) using a Buffalo 4 row planter. The target population was 28,000 plants/ac and 190 lbs/ac of a blended fertilizer was banded 2"x2" during planting except for in designated no-fertilizer strips. The blended fertilizer was composed of pelletized feather meal, potassium sulfate, manganese sulfate, zinc sulfate and sodium tetraborate (4-0-26 plus S and micronutrients). The actual rates of nutrients applied were as follows: N = 7.6 lbs/ac, K_2O = 49.4 lbs/ac, S = 19.0 lbs/ac, B = 0.67 lbs/ac, Mn = 1.27 lbs/ac, and Zn = 1.27 lbs/ac.

Rows 1-16 in field 1B did not have Myco Seed Treat applied to the seed, while the rest of the field and all of field 2A received 4 oz/100 lb of seed. Myco Seed Treat is a mycorrhizal inoculant supplied by AgriEnergy Resources (Princeton, IL).

Mechanical weed control consisted of one rotary hoeing and one row cultivation. A second rotary hoeing was planned, but not possible due to weather/soil conditions. A moderate stand of frost seeded red clover may have provided some allelopathic weed suppression. Spring planted oats in 40 rows of field 1B may also have provided some allelopathic weed suppression. The weed control was good in both fields.

An oat cover crop observational study was performed in the south 40 rows or 100 feet of field 1B. A John Deere 10' conventional drill was used to drill the oats on 3/28/07 over rough ground that had been disk-ripped the previous fall. The seeding rate was ~100 lbs/ac and the depth was ~ 1/4 -1/2 inch deep. The oats were incorporated with a soil finisher on 5/10/07 at a height of ~10 inches.

On 8/10/07, seven corn leaves were sampled from each strip in fields 1B and 2A during the corn's blister stage. All leaves were collected within 75 yards from the east end of the field and the sampled leaf was taken from opposite and below the main ear. Leaf samples were submitted to Key Agricultural Services (Macomb, IL) for routine tissue analysis.

Fields 1B (figure 2) and 2A (figure 1) were harvested on 10/24/07 with a John Deere STS combine equipped with a yield monitor. Yields were estimated at 15% moisture. The final stand for both fields was 24,000 plants/ac. Actual yields were calculated by multiplying yield monitor data by a correction factor (0.924) derived from the relationship between yield monitor total and weigh ticket totals.

Paired t-tests were used to evaluate if banded fertilizer had significant effects on crop yields and tissue nutrient levels.

Figure 1. Layout of strips in Field 2A (9.9 acres) **N ^**

Strip 1 (rows 153-184) north buffer = 130.1 bu/ac*
Strip 2 (rows 145-152) buffer = 131.9 bu/ac*
Strip 3 (rows 137-144) Treatment N-6 = 124.3 bu/ac*
Strip 4 (rows 97-136) Treatment F-6 = 129.5 bu/ac*
Strip 5 (rows 89-96) Treatment F-5 = 129.2 bu/ac*
Strip 6 (rows 81-88) Treatment N-5 = 130.0 bu/ac*
Strip 7 (rows 41-80) buffer = 130.7 bu/ac*
Strip 8 (rows 33-40)) Treatment F-4 = 131.9 bu/ac*
Strip 9 (rows 25-32) Treatment N-4 = 120.0 bu/ac*
Strip 11 (rows 1-24) buffer = 132.7 bu/ac*

* = Yield based on corrected data from combine yield monitor at 15% moisture. Note: The actual final yield was arrived at by multiplying the yield monitor data by a correction factor (0.924) derived from the relationship between yield monitor and weigh ticket totals.

Treatment F = Dry organic fertilizer from Midwestern Bio-Ag banded (2" x 2") at planting.
Analysis = (4-0-26) plus S and micronutrients; rate = 190 lbs/ac or N = 7.6 lbs/ac, K_2O = 49.4 lbs/ac, S = 19.0 lbs/ac, B = 0.67 lbs/ac, Mn = 1.27 lbs/ac, Zn = 1.27 lbs/ac

Treatment N = No added fertilizer (control).

Note: This field has Myco Seed Treat (mycorrhizal fungal inoculant) from AgriEnergy Resources applied at 4 oz/100 lb of seed. Also, all the buffers have the same fertilizer application as treatment F, except for the north 40 rows. The fertilizer emptied out on this end.

Figure 2: Layout of strips in field 1B (7.9 acres) **N ^**

Strip 1 (rows 105-112) north buffer = 129.2 bu/ac*	No spring cover crop in this section (rows 41-112).
Strip 2 (rows 97-104) Treatment F-3 = 138.4 bu/ac*	
Strip 3 (rows 89-96) Treatment N-3 = 135.5 bu/ac*	
Strip 4 (rows 73-88) buffer = 136.0 bu/ac*	
Strip 5 (rows 65-72) Treatment F-2 = 136.4 bu/ac*	
Strip 6 (rows 57-64) Treatment N-2 = 132.8 bu/ac*	
Strip 7 (rows 41-56) buffer = 133.1 bu/ac*	
Strip 8 (rows 33-40) buffer = 136.9 bu/ac*	Oats incorporated into rows 1-40 in spring.
Strip 9 (rows 25-32) Treatment F-1 = 133.4 bu/ac*	
Strip 10 (rows 17-24) Treatment N-1 = 131.9 bu/ac*	
Strip 11 (rows 9-16) Treatment X = 136.4 bu/ac*	
Strip 12 (rows 1-8) south buffer = 141.1 bu/ac*	

* = Yield based on corrected data from combine yield monitor at 15% moisture. Note: The actual final yield was arrived at by multiplying the yield monitor data by a correction factor (0.924) derived from the relationship between yield monitor and weigh ticket totals.

Treatment F = Dry organic banded (2X2) fertilizer from Midwestern Bio-Ag applied at planting.
Analysis = (4-0-26) plus S and micronutrients; Rate = 190 lbs/ac or N = 7.6 lbs/ac, K_2O = 49.4 lbs/ac, S = 19.0 lbs/ac, B = 0.67 lbs/ac, Mn = 1.27 lbs/ac, Zn = 1.27 lbs/ac

Treatment N = No added fertilizer (control).
Treatment X = Fertilized the same as treatment F, but without Myco Seed Treat (mycorrhizal fungi) from AgriEnergy Resources

Note: Rows 1-16 do not have Myco Seed Treat applied, while the rest of the field has 4 oz/100 lb of seed. Also, all the buffers have the same fertilizer application as treatment F.

Results:

The effect of fertilizer on yield was not significant in field 2A alone but was significant in field 1B and across both fields when the data was pooled (Table 1). Yields were higher in fertilized strips in 5 out of the 6 paired comparisons.

The plant tissue analyses found no effects on N, Mn and Zn and some effects on K, B and S (Tables 2-4). Potassium and boron levels were significantly higher in fertilized plants in field 1B. Sulfur and boron levels were significantly higher in fertilized plants when samples from both fields were pooled.

There was a strong positive relationship between crop yield and % potassium in leaf tissue (Figure 3). Interestingly, corn plants in field 2A had lower levels of tissue K than plants in field 1B (below critical in all but one strip vs. all strips above critical) but tissue levels of K were only responsive to K in field 1B.

The section of field 1B that included a spring oat cover crop did not out yield the rest of the field. There appeared to be fewer weeds in this section of the field, but weed pressure was low throughout the field. The strip in field 1B that did not include the MycoSeed treatment yielded as well as the comparable strip that received the MycoSeed treatment. Without replication, no conclusions can be drawn. Significant yield improvements have been observed in the past.

Table 1. Effect of banded fertilizer on yield

Field	Strips	Unfertilized yield (bu/ac)	Fertilized yield (bu/ac)	p-values for paired t-tests
2A	2 vs. 3	120	131.9	0.138*
2A	5 vs. 6	130	129.2	
2A	8 vs. 9	124.3	129.5	
1B	2 vs. 3	131.9	133.4	0.0248*
1B	5 vs. 6	132.8	136.4	
1B	9 vs. 10	135.5	138.4	
2A and 1B	All strips	All pairs compared		0.03568*

* impact of banded fertilizer assumed to be significant effect when $p<0.05$

Table 2. Effect of fertilizer on K content of corn leaf tissue

Field	Strips	% K in corn leaf tissue (unfertilized)	% K in corn leaf tissue (fertilized)	p-values for paired t-tests
2A	2 vs. 3	1.2	1.45	0.3448
2A	5 vs. 6	1.96	1.51	
2A	8 vs. 9	1.42	1.34	
1B	2 vs. 3	1.75	1.82	0.0207*
1B	5 vs. 6	2.23	2.34	
1B	9 vs. 10	2.13	2.28	
2A and 1B	All strips	All pairs compared		0.4689

* impact of banded fertilizer assumed to be significant effect when $p<0.05$

Table 3. Effect of fertilizer on B content of corn leaf tissue

Field	Strips	ppm B in corn leaf tissue (unfertilized)	ppm B in corn leaf tissue (fertilized)	p-values for paired t-tests
2A	2 vs. 3	12	14	0.1127
2A	5 vs. 6	13	14	
2A	8 vs. 9	12	12	
1B	2 vs. 3	11	12	0.0371*
1B	5 vs. 6	12	15	
1B	9 vs. 10	11	13	
2A and 1B	All strips	All pairs compared		0.0086*

* impact of banded fertilizer assumed to be significant effect when $p<0.05$

Table 4. Effect of fertilizer on S content of corn leaf tissue

Field	Strips	% S in corn leaf tissue (unfertilized)	% S in corn leaf tissue (fertilized)	p-values for paired t-tests
2A	2 vs. 3	0.21	0.22	0.1254
2A	5 vs. 6	0.22	0.23	
2A	8 vs. 9	0.21	0.27	
1B	2 vs. 3	0.22	0.24	0.1127
1B	5 vs. 6	0.23	0.24	
1B	9 vs. 10	0.23	0.23	
2A and 1B	All strips	All pairs compared		0.0448*

* impact of banded fertilizer assumed to be significant effect when $p<0.05$

Figure 3. Relationship between tissue K and crop yield

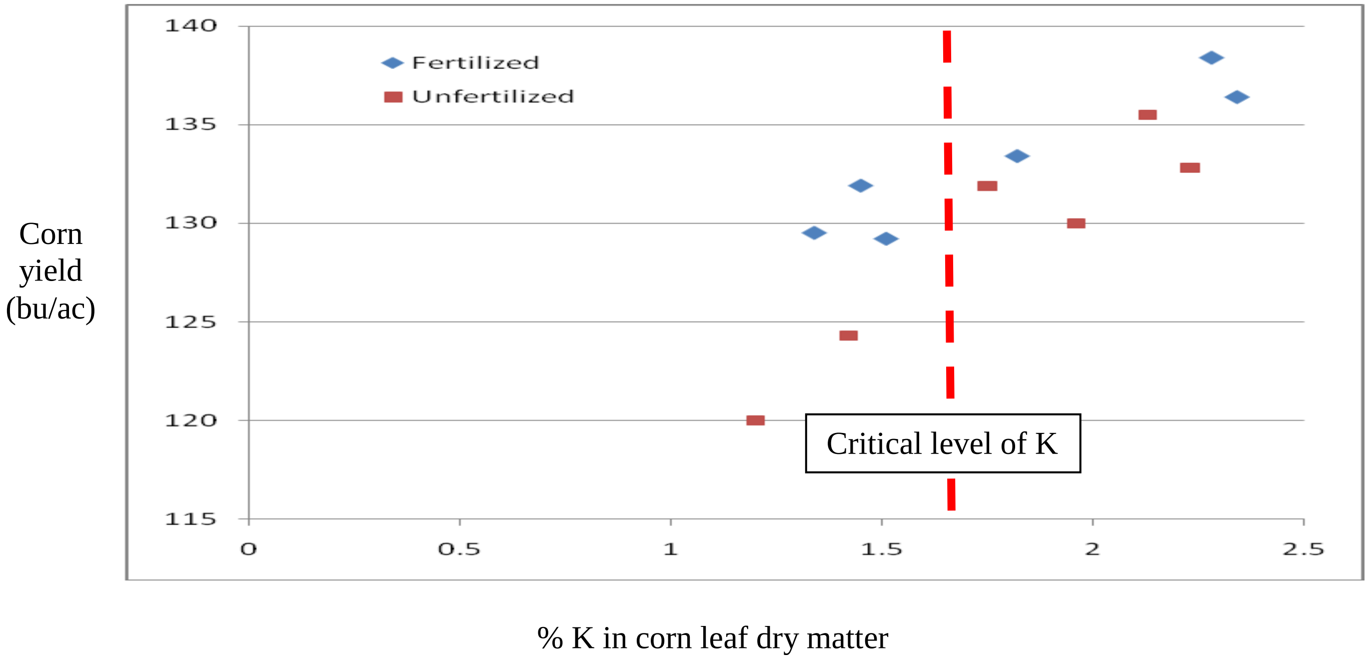

Table 5. Economics of Added Organic Dry Banded Fertilizer

Field	(Bu/ac) Average yield response to banded fertilizer	Fertilizer Cost ($/ac)*	Application Cost ($/ac)**	($/bu) Paid for Corn	Net Dollar Amount (increase/decrease)
1B	2.7	$64.70	$0.90	$8.52	- $42.60
2A	5.4	$64.70	$0.90	$8.52	- $19.60

* = Includes freight cost of $50/ton.
** = The extra cost to band dry fertilizer at planting according to 2007 Iowa Farm Custom Rate Survey.

Discussion and Conclusions:

This study found that the banded fertilizer program resulted in some significant yield increases, however these increases were not large enough to pay for the cost of the fertilizer program (table 5).

The retail price of the fertilizer at the time of this study was $631/ton with $50/ton for freight. At an application rate of 190 lbs/ac the cost of the fertilizer program including application ($0.90) was $65.60/ac.

In field 1B, the fertilizer program resulted in a loss of $42.60/ac as compared to a loss of $19.60/ac in field 2A (based on the average differences in yield between paired strips). With a corn price of $8.52/bu, a yield gain of 7.7 bushels would have been needed to pay for the fertilizer program.

If this same study had been repeated in 2008 with a fertilizer cost of $838/ton ($50/ton freight) and a corn price of $9.90/bu (USDA Market News), a yield increase of 8.6 bu/ac would have been needed to pay for the program.

When using a blended fertilizer containing many different nutrients, it is difficult to know which nutrient(s) contributed to observed yield responses. The strong relationship observed between tissue K and yield suggests that the added K may have been most beneficial but as discussed earlier, fertilizer did not result in a significant yield increase in the field (2A) with lower potassium levels.

One critical concern when using blended dry fertilizers is segregation. If a blended fertilizer's components start to segregate during the course of trips across the field, the rates of nutrients applied will not be uniform. This particular batch of fertilizer contained components with widely differing particle sizes and segregation may have been a serious issue. Uniformly spraying large granule bulk materials with micronutrients in solution is an increasingly common way to avoid problems with segregation of dry fertilizer components. Foliar application of micronutrients is another option for improving uniformity of application.

In conclusion, banding of dry granular fertilizer at planting can contribute to yield increases but the yield increases may not pay for the cost of the program. We recommend that farmers consider the following key points when considering dry blended multi-nutrient programs similar to the program we evaluated.

1) How low are your soil test levels? Yield responses to fertilizers banded at planting are most likely when soil test levels are low.
2) What is your tillage program? Yield responses to fertilizers banded at planting are most likely in no-till/minimum-till systems.
3) Are all the components of a multi-nutrient blend needed? Micronutrients tend to be expensive… higher rates of 1 or 2 most limiting nutrients may be a better investment.
4) Is your application system likely to result in uniform application of the intended rate? Segregation is a serious issue with dry blends.