Do Fertilizer Additives Help In Increasing Root Mass and Yields?

Studies are mixed indicating more work needs to be done in this area.

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Summary: *Over a period of three years, five individual studies evaluated the effects of the fertilizer additive Avail™ on corn root growth and stalk diameter while the effect of the additive on corn grain yield was evaluated for eight site-years. There were no significant differences at the 5 percent level in root ball depth or width due to inclusion of the additive with starter fertilizer, although relatively consistent numerical differences were measured. However, root mass was significantly increased in two of the five site years. Additionally, the use of the additive significantly increased stalk diameter in three of the five site-years. Corn grain yield was increased in five of the eight site-years with the addition of the additive to the starter fertilizer, although the difference was statistically significant at the 5 percent level at only one site. However, when averaged across all site years, the additive significantly increased corn yield when compared to the use of starter fertilizer alone. In other studies, while significant location-by-nitrogen (N) rate and timing-by-Nutrisphere™ additive interactions were measured, the addition of the additive to UAN solution resulted in a significant yield increase of 0.74 t/ha-1 compared to UAN alone. Additionally, there was a significant yield increase ($p = 0.0152$) of 0.93 t/ha^{-1} resulting from the use of the additive whenever starter fertilizer was applied (either 12-12-4 or 12-12-4 with Avail™).*

Two new fertilizer additives recently released have the potential to increase nitrogen (N) and phosphorus (P) concentrations in the root zone, reduce leaching of these nutrients, reduce volatilization losses of N, and decrease P fixation in the soil resulting in a better match between the availability of N and P and crop nutrient demand when compared with conventional fertilizers. Avail™ and Nutrisphere™ are both long-chain branched polymers with a large negative charge (1,800 meq 100 g^{-1}). This charge makes the molecule stable at high ionic concentrations, allowing it to hold other molecules in suspension. When Avail is added to either a liquid or solid phosphate fertilizer and applied to the soil the negative-charged polymer interacts with positive cations such as Ca^{++} and Mg^{++}, preventing them from interacting with and fixing phosphate. Likewise, when added to urea and/or ammonium containing or forming fertilizers, it is thought that the polymer reacts with multivalent cations that are required by the urease enzyme and/or soil microbes involved in nitrification.

While comparative research on corn performed at Kansas State University, the University of Illinois, and other institutions indicates that each of these additives improved crop yield on a wide variety of soil types, other studies have not found improvements in yield or nutrient use efficiency (NUE). Clearly, more information is needed to determine when each additive is most effective in increasing plant growth, yield, and fertilizer use efficiency in highly productive cropping systems.

The objectives of this research are to:

- Examine the impact of the fertilizer additives on yield in high population corn systems

- Determine if Avail improves root growth in corn
- Determine if Nutrisphere influences tissue N concentration, plant biomass, or N uptake.

Location results

Plant growth. When data were combined across locations there were significant location-by-starter interactions for root ball mass, root ball depth, and stalk diameter. In most cases these significant differences were between one or more of the starter materials and the no-starter treatment (data not shown). Comparisons between the same starter material with and without Avail found significant differences in root mass at both locations in 2007 and differences in stalk diameter at Pamlico07, Beaufort08, and Pasquotank08 (Table 1). There were no significant differences in root ball depth or width between the same starter material with and without the additive. In 2009, no differences were found between the 10-27-0 with or without the additive in any of the plant or root properties measured.

"Root mass was significantly increased."

Table 1. Measured root and stalk properties from starter treatments with (Yes) and without (No) Avail. Letters in the same row within each root or stalk property indicate significant differences at p = 0.05.

Location - Year	Root Properties						Stalk Properties	
	Depth (in)		Width (in)		Mass (oz)		Diameter (in)	
	No	Yes	No	Yes	No	Yes	No	Yes
Pamlico – 07	5.3	6	5.8	6.1	7.5a	8.7b	0.95a	1.0b
Currituck – 07	3.6	3.7	5	5	9.0a	11.2b	0.93	0.95
Beaufort – 08	2.6	2.6	4	4.3	2.6	2.8	0.74a	0.78b
Pasquotank - 08	3.7	3.8	5.8	5.6	4.7	3.8	0.79a	0.83b
Hyde – 09	6.9	7.1	5.2	5.4	3.1	3.2	0.95	0.95

Yield. When data were combined across locations there were significant location and fertilizer source main effects on yield. In four of eight site years, starter fertilizer significantly increased grain yield when compared to the untreated check, resulting in a significant yield advantage in using of starter fertilizer with or without Avail. Table 2 shows the impact of starter materials on corn yield, with or without the additive, across the eight site-years tested. In six of the eight years the use of the additive resulted in numerically higher yields. However, only at Guilford07 was this increase significant at the 5% level. When these results were combined across site years, the additive significantly increased yields when compared to the use of the blended fertilizer alone.

Because of differences in N rate and application timing, results were combined within years with the exception of locations Guilford08 and Forsythe08, which were analyzed as a unit due to the fact that they included starter fertilizer treatments with and without Avail. In both 2007 and 2008, the combined analysis found a location-by-rate interaction ($p = 0.0022$ and 0.0059 in 2007 and 2008, respectively) and a significant rate effect ($p < 0.0001$ and 0.0055, respectively). In 2008, when N was applied at lay-by, there was significant source effect ($p = 0.0067$).

"Corn yield increased in five of eight site years."

The addition of Nutrisphere resulted in a significant yield increase of 0.74 t/ha^{-1} compared with 30 percent UAN alone (Table 3). While the source-by-rate interaction was not significant in either 2007 or 2008, contrast statements indicated that there were differences in corn yield between 30 percent UAN and 30 percent UAN plus the additive at one or more N rates. In 2009 there were strong location-by-rate ($p < 0.0001$) and application timing-by-source ($p = 0.0124$) interactions. When the additive was added to 30 percent UAN and applied at planting there was a significant yield increase of 0.37 t/ha^{-1} and contrast statements found a significant yield increase when the additive was applied with 30 percent UAN at an N rate of 101 kg/ha-1 (Table 3). In 2009, no significant yield differences between 30 percent UAN and 30 percent UAN plus the additive were found when the applications were made at lay-by.

When Forsythe08 and Guilford08 were combined, statistical analysis found a strong treatment effect ($p = 0.0011$). Contrast statements were

Table 2. Yield results from eight locations across two years comparing treatments with no starter, starter (10-27-0, 12-12-4, or 17-17-0) without Avail, and the same starter treatment with Avail. Different letters within each row indicate locations or overall average where the use of Avail resulted in a significant yield increase compared to the use of the same starter material without Avail at p=0.05.

Location - Year	Blended Fertilizer	Soil P Level	Corn Yield (t ha^{-1})		
			No Starter	Starter only	Same Starter with Avail
Pamilico 07	10-27-0	Med	11.6a	12.1ab	12.8b
Currituck 07	10-27-0	Med	12.0a	12.6a	12.6a
Davidson07	17-17-0	Med	7.8a	9.1b	8.2ab
Guilford07	12-12-4	Low	9.0a	8.9a	10.4b
Perquimans07	12-12-4	Low	8.2a	9.1ab	10.1b
Pasquotank08	10-27-0	High	10.4a	9.6a	10.1a
Beaufort08	10-27-0	High	8.1a	7.7a	8.0a
Hyde09	10-27-0	High	14.0a	14.2a	14.0a
Average			9.9a	10.5b	11.0c

Table 3. Corn yield response to different rates of 30 percent UAN applied with and without Nutrisphere™ at either planting or layby.							
		Nitrogen Rate Code†					
Timing/Year	Nitrogen Treatment	0	1	2	3	4	Average
		t ha^{-1}					
Plant 07	30% UAN	8.65	11.02a‡	11.06a	11.88a	12.06a	10.93A§
	UAN + Nutrisphere™	8.65	10.58a	11.86b	12.55a	12.86b	11.30A
N Rate Averages		8.65a¶	10.80b	11.46c	12.21d	12.46d	
Layby 08	30% UAN	5.54a	6.28a	6.12a	6.89a	7.19a	6.40A
	UAN + Nutrisphere™	6.40a	6.79a	7.22b	8.08b	7.23a	7.14B
N Rate Averages		5.97a	6.54ab	6.67bd	7.48c	7.21cd	
Plant 09	30% UAN	7.41	11.02a	11.68a	13.24a	13.18a	11.30A
	UAN + Nutrisphere™	7.41	11.71b	12.15a	13.61a	13.50a	11.67B
N Rate Averages		7.41a	11.37b	11.91c	13.42d	13.34d	
Layby 09	30% UAN	7.11	11.37a	12.51a	13.39a	13.44a	11.09A
	UAN + Nutrisphere™	7.11	11.51a	12.32a	13.62a	13.87a	11.14A
N Rate Averages		7.11a	11.44b	12.42c	13.50d	13.65d	

†Nitrogen rates for each year were: 2007 0 = 0, 1 = 56, 2 = 91, 3 = 161, and 4= 303 kg N ha^{-1}; 2008 – 0 = 34, 1 = 90, 2 = 202, 3 = 258, and 4 =314 kg N ha^{-1}; 2009 – 0 = 0, 1 = 101, 2 = 146, 3 = 202, and 4 = 258 kg N ha^{-1}.
‡ Different letters within each year and rate code column indicate significant differences at $p < 0.10$.
§ Different letters within each year under the Average column indicate significant differences between 30% UAN and 30% UAN plus Nutrisphere™ at $p < 0.10$.
¶ Different letters within each row showing the N rate averages indicate significant differences at $p < 0.10$.

used to examine differences between 30 percent UAN and 30 percent UAN with Nutrisphere. There was a significant yield increase ($p = 0.0152$) of 0.93 t/ha^{-1} resulting from the use of Nutrisphere whenever starter fertilizer (either 12-12-4 or 12-12-4 with Avail) was applied (Figure 1). However, when Columbus10 and Robeson10 were combined, there were no significant yield differences between the use of Avail or starter without Avail nor the use of Nutrisphere and 30 percent UAN without Nutrisphere.

Methodology

Plots. At all sites, a split plot experimental design was used. Subplots consisted of different rates of application in a 2 x 2 band.

Fertilizer. Main treatments consisted of a no-starter check, a blended fluid fertilizer, and the same fluid fertilizer with an additive. At all locations, 30 percent UAN was applied at lay-by at rates adjusted within each treatment to provide N at a total of 202 kg/ha^{-1}.

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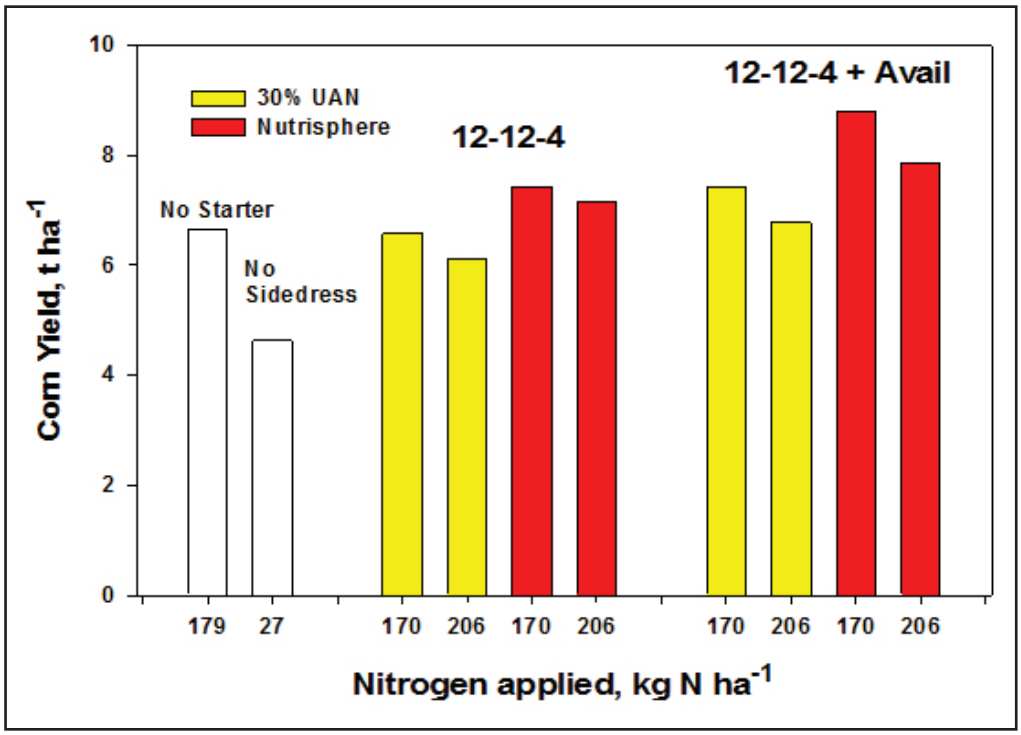

Figure 1. *Grain yield measured with various treatments including: applied in a 2 x 2 band at planting and a lay-by application of either 30% UAN or 30% UAN with Nutrisphere™ added. Contrast statements found that when either 12-12-4 or 12-12-4 with Avail™ was used Nutrisphere™ added to 30% UAN significantly increased corn yield compared to the use of 30% UAN alone at $p = 0.0152$.*