

The Impact of Starter Fertilizer Additives on Corn Yield

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Introduction

Studies in North Carolina have shown that high plant populations lead to increased yield. Because ear size is determined by V6, good early growth is essential to obtain maximum ear size and yield. Recent research has shown that by combining a starter or pop up fertilizer with management practices that increase early root growth a larger root system can be developed that enhances early plant growth resulting in larger ear size, better stress tolerance, less lodging, and greater yield. With the introduction of new fertilizer additives such as Avail™ there is a possibility of further increasing root growth and boosting yield. These studies were designed to test this hypothesis.

Study Design

Ten research trails were conducted in 2007 and 2008 at locations in Pamlico, Pasquotank, Perquimans, Currituck, Guilford, Beaufort, Forsythe, and Davidson Counties on wide range of soil types (Table 1) and soil properties.

Table 1. Soil and management information for starter materials research trials in 2007 and 2008.

Location	Soil Series	Planting Date	Hybrid	Seed Rate	Row Wth.
Pamlico	Wasda L. muck	Mar 28, 2007	DKC69-71	35000	30"
Currituck	Pasquo. Silt L.	Apr. 3, 2007	Pioneer 31G98	33000	30"
Perquim.	Roanoke F. Sand	Apr. 22, 2007	Terral TV21BR40	32700	36"
Guilford	Dragston S. Loam	Apr. 20, 2007	Pioneer 31G98	33000	30"
Davidson	Kirksey C Loam	May 1, 2007	Pioneer 31G98	33000	30"
Pasquot.	Bladen S. Loam	Apr. 17, 2008	Pioneer 33M53/57	33000	30"
Beaufort	Cape Fear S. Loam	Apr. 25, 2008	Pioneer 33M53/57	33000	30"
Davidson	Kirksey C. Loam	May 2, 2008	Syngenta NK68-B8	33000	30"
Forsythe	Hiwassie C. Loam	May 2, 2008	DKC61-69	33000	30"
Guilford	Dragston S. Loam	May 3, 2008	DKC61-69	33000	30"

2007 Methods

At the Pamlico and Currituck County locations main treatments were 10-27-0, 10-27-0 with Avail, 17-17-0, and 17-17-0 deep band (Pamlico only). Each of these materials were applied using four application rates: 5, 10, 20, and 40 gallons per acre in a 2 X 2 band with the exception of the 17-17-0 which was applied in a deep band 8 in below and 2 in to the side of the seed.

At the Davidson County location the main treatments were 17-17-0, 17-17-0 with Avail, 3-18-18, and 0-0-27. The 17-17-0 and 17-17-0 with Avail were applied at 10 and 20 gal per acre in a 2 X 2 band, while the 3-18-18 and 0-0-27 were applied at 10 gal per acre in furrow. At the Perquimans and Guilford County locations the main treatments were 12-12-4 and 12-12-4 with Avail. In Perquimans County these were applied at 20 gal per acre in a 2 X 2 band, while in Guilford County these were applied at 5, 10, 20, and 40 gal per acre in a 2 X 2 band.

2008 Methods

At the Pasquotank and Beaufort locations main treatments were hybrids Pioneer 33M53 and 33M57. Both hybrids share a common genetic background with the exception that Pioneer 33M57 is a Bt variant. Subplot treatments were different starter fertilizers (0-0-27, 17-17-0, 12-12-4, 10-27-0, 10-27-0 + Avail, 30-0-0) and a no-starter check. These fertilizer blends were applied at the rate of 20 gal acre⁻¹ in a 2 X 2 band.

At the Davidson, Forsythe, and Guilford locations either 12-12-4, 12-12-4 + Avail, or no starter fertilizer was applied in a 2 X 2 band at a rate of 20 gal acre⁻¹ to each of ten plots. At layby either 30% UAN, UAN + Nutrisphere or no N was applied to the plots at rates of 40 and 50 gal acre⁻¹.

Common Methods

At all locations except Davidson, Forsythe, and Guilford in 2008, 30% UAN was applied at layby at rates adjusted within each starter treatment to provide a total of 180 lbs of N per acre. Bicep applied at planting and Roundup and atrazine applied at layby provided excellent weed control. Insects and diseases (with the exception of the Pamlico County location) were not a factor.

Root and stalk measurements were taken from at four locations, Pamlico, Currituck, Beaufort, and Pasquotank, prior to R1. Five consecutive plants from the outside row of each plot were excavated by digging a 12-in deep trench on each side of the plant and carefully removing the root ball from the soil. At the same time stalk diameter was measured at the internode below the ear leaf. The root ball was then separated from the plant by clipping above the highest brace root. Roots were washed to remove soil and the depth and the width at the widest point was measured. The root ball was then dried and weighed. Plots were harvested in September using a Gleaner K2 combine with a Harvestmaster system that recorded plot weight, moisture, and test weight. All data were analyzed using PROC ANOVA in SAS (SAS Institute, Cary, NC). Mean separations were done using Fisher's protected LSD at $p=0.10$.

Results from Root and Stalk Measurements

When the data were combined across locations there were significant location by starter interactions for root mass, root depth, and stalk diameter. There were significant differences among the starter treatments in within all three of these plant properties. In most cases the key differences were between one or more of the starter materials and the no-starter treatment. In 2007, all of the starter materials resulted in root mass and stalk diameters that were greater than the measurements taken in the check (Fig. 1). In 2008, 10-27-0 and 17-17-0 had larger root mass and stalk diameter than the no-starter check at Pasquotank but only the 10-27-0 with Avail had more root mass than the no-starter check at the Beaufort location (Fig. 2).

Comparisons between the same starter material with and without Avail found significant differences in root mass in 2007 at both locations and differences in stalk diameter at Pamlico in 2007 and Beaufort and Pasquotank locations in 2008 (Table 2). There were

no significant differences between the same starter material with and without Avail in any of the other root or plant properties measured.

Results from Yield Comparisons

When the data were combined across locations there was a significant location by starter interaction and starter main effect on yield and grain moisture and a significant starter effect on test weight. At most locations starter fertilizer with or without Avail increased grain yield, moisture, and test weight significantly when compared to the untreated check. While there were significant differences among starter materials, the best material differed by location.

Pamlico and Currituck - 2007

The key differences among starter treatments occurred at the Pamlico location where the 10-27-0 plus Avail resulted in a significantly higher grain yield compared to the other treatments (Figure 3). Yield was increased by 10bu/acre when Avail was added to 10-27-0 at the Pamlico location. The impact of the Avail may have been enhanced by the cool, wet conditions at the Pamlico site. At the Currituck location differences among treatments were small with only a 3 bu/acre increase in the Avail treatment compared to 10-27-0 without Avail.

Davidson County:

The only significant differences at the Davidson County location occurred among the control treatment (no starter applied) and the high rates of 17-17-0 (data not shown). There were no differences among treatments with or without Avail. While the two starter materials with potassium did not improve yield, they did reduce the amount of stalk lodging observed in the plots. The use of these materials in furrow did impact the rate of plant emergence and this probably resulted in the lack of yield response observed with these materials.

Perquimans and Guilford Counties- 2007

At both of these locations a significant yield increase was observed between the plots receiving 12-12-4 and those where Avail was added to the 12-12-4 (Figure 4). The 11 to 14 bu/acre yield increases observed at these locations were similar in magnitude to the yield increase found in Pamlico County. Both of these locations had low soil test indexes for phosphorus (P index below 37) and high pH (> 6.4)

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and the starter material used had less P compared to most of the materials used at the other locations. The use of Avail at these locations may have increased the amount of P available to the crop.

Beaufort and Pasquotank Counties - 2008

There were no significant differences in grain yield among any of the starter treatments in either Beaufort or Pasquotank Counties in 2008 (Table 3). Early growth and development favored treatments receiving some P in the starter fertilizer, but dry weather during late June damaged treatments which promoted earlier silking and rainfall on 7 July favored late development.

Davidson, Forsythe, and Guilford Counties – 2007

There were no significant differences among the treatments with 12-12-4, 12-12-4 with Avail, and the no-starter check at the Davidson location. A soil test

at this site indicated very high levels of P and K. While yield was increased by using Avail at both the Forsythe and Guilford locations only the Guilford location had a significant increase in grain yield associated with the use of Avail (Figure 5). At both of these locations the use of starter fertilizer resulted in significant yield increases compared to the no-starter check.

While there were locations where the use of Avail resulted in a significant yield increase, an analysis across locations did not find a significant yield improvement from the use of Avail (Table 3). This indicates that the benefits from the use of Avail are site-specific and may be related to soil properties such as high pH or to management practices which enhance the effects of this product. Further research is needed to clarify the conditions under which the use of Avail results in yield increases in corn.

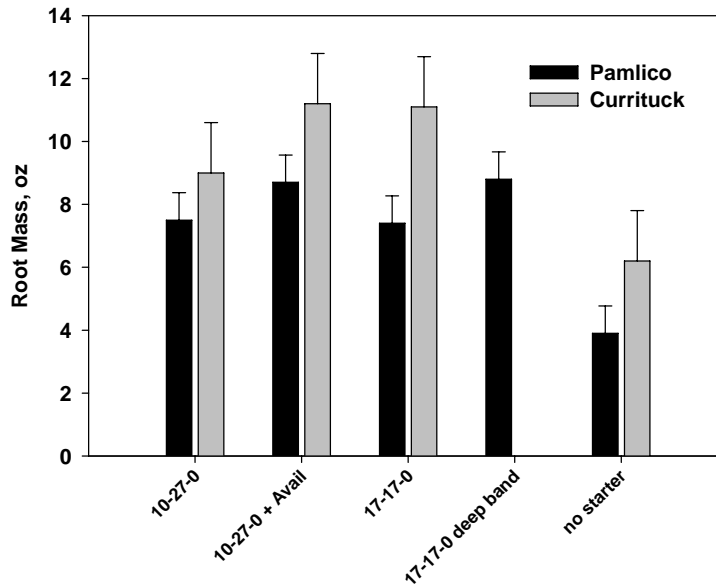


Figure 1. Root mass measured from plots where the highest rate of starter material was applied. Error bars indicate the LSD (p=0.05) for determining differences within a location.

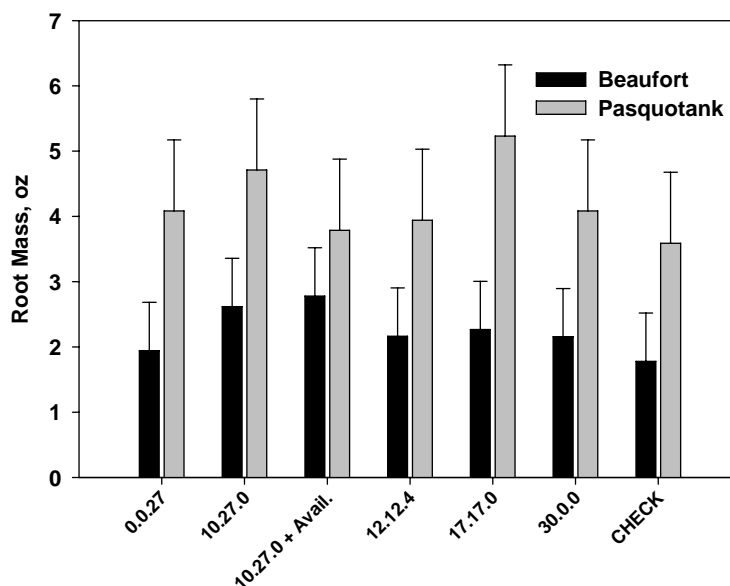


Figure 2. Root mass measured from plots where different starter materials were applied. Error bars indicate the LSD ($p=0.05$) for determining differences within a location.

Table 2. Measured root and stalk properties from starter treatments with (Yes) and without (No) Avail. Numbers in bold indicate significant differences.

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	6.0	5.8	6.1	7.5	8.7	0.95	1.0
Currituck – 07	3.6	3.7	5.0	5.0	9.0	11.2	0.93	0.95
Beaufort – 08	2.6	2.6	4.0	4.3	2.6	2.8	0.74	0.78
Pasquotank - 08	3.7	3.8	5.8	5.6	4.7	3.8	0.79	0.83

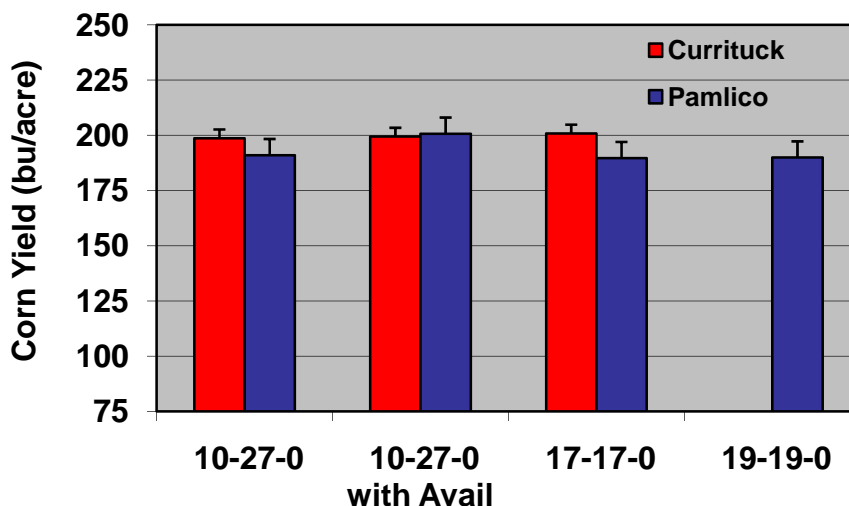


Figure 3. Corn yield response to starter fertilizer treatments in Currituck and Pamlico Counties. Anything between the top of the colored bar to the top of the error bar would not be considered statistically different at $p < 0.10$.

Table 3. Yield results from ten 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. Rows highlighted in bold indicate locations 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	Soil P Level	Corn Yield (bu acre ⁻¹)		
		No Starter	Starter only	Starter with Avail
Pamlico -07	Med	185.1	191.0	200.7
Currituck - 07	Med	190.8	198.6	199.4
Beaufort - 08	High	128.0	122.7	127.5
Pasquotank - 08	High	165.3	153.7	160.0
Perquimans - 07	Low	131.3	155.0	167.8
Guilford - 07	High	143.3	142.2	160.9
Davidson - 07	Med	123.7	151.0	133.5
Davidson - 08	High	161.3	164.6	164.0
Forsythe - 08	Med	105.6	110.4	120.3
Guilford - 08	High	106.6	107.0	121.8

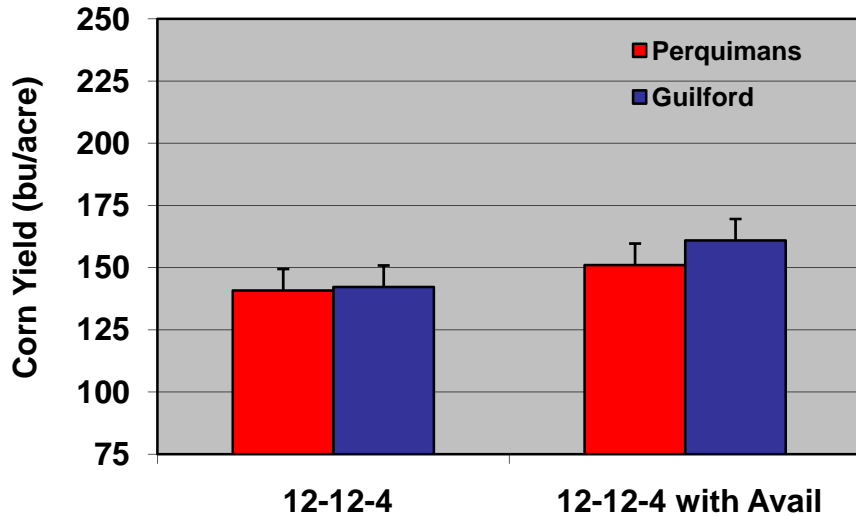


Figure 4. Corn yield response to starter fertilizer treatments in Perquimans and Guilford Counties. Anything between the top of the colored bar to the top of the error bar would not be considered statistically different at $p < 0.10$.

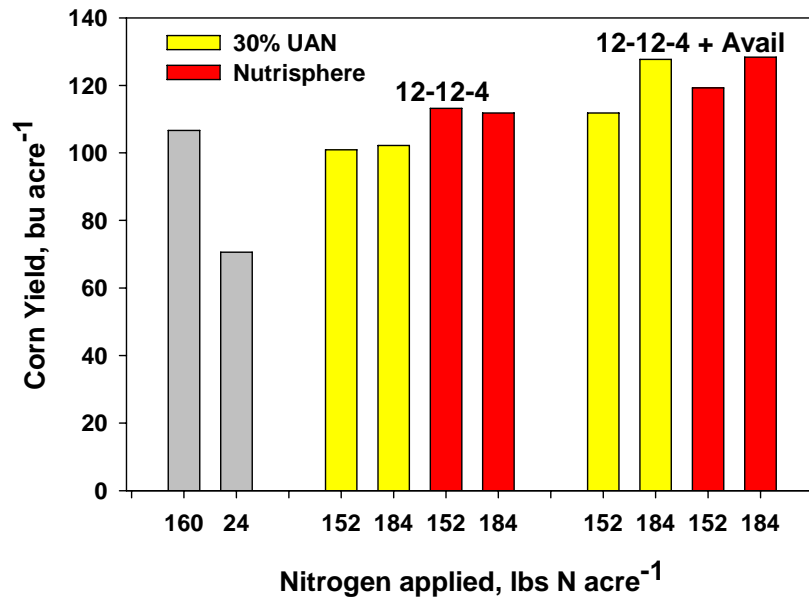


Figure 5. Corn yield response to starter fertilizer and nutrisphere treatments in Guilford County in 2008. Contrast statements found a significant difference between the treatments receiving 12-12-4 without Avail and the same treatments with Avail at $p < 0.05$.

Conclusions Based on These Results

1. **Is there a benefit to using starter fertilizer on corn?** These tests support previous work that shows a benefit to using starter fertilizer on corn. In most of these studies there was a significant yield increase from at least one of the starter materials compared with the no-starter check. The starter benefit in Perquimans County in 2007 and Guilford County in 2008 only occurred when Avail was added.
2. **What blend of starter fertilizer results in the best yield?** No starter material resulted in a consistent advantage across all locations in both years. At some locations an equal blend of N and P resulted in the best yield (17-17-0 or 12-12-4 being good examples). At others the use of 30% UAN as a starter material improved yield. Dry weather at the two sites which had a wide range of starter products and blends reduced yield resulting in poor comparisons. Further work is needed to help answer this question.
3. **Did the addition of Avail to starter fertilizer improve plant properties and yield?** Avail did show some consistency in improving stalk diameter and root mass. Unfortunately, when all ten site-years were considered together there was no significant yield advantage to using Avail as a fertilizer additive. However, there were locations where Avail added to starter fertilizer did increase yield by as much as 14 bu/acre. It appears that Avail was effective under certain conditions such as wet, cool soils, low soil P levels, or high pH. Growers should consider their soil and environmental conditions when deciding whether or not to apply Avail. Clearly, the cost of Avail must be factored into the potential yield response to determine if this treatment has an economic advantage.