

Soil Facts

Alternative Synthetic Nitrogen Fertilizer Products for Row Crop Production

Nitrogen fertilizer products are being developed and marketed as having the potential to increase yields and nutrient use efficiency, and decrease volatilization (gas). How do these products actually perform on different soils and row crops, under various climatic conditions? This publication summarizes findings from recent studies that investigated alternative nitrogen fertilizer products for row crops in four North Carolina regions.

What Alternative Nitrogen Fertilizer Products Are Being Marketed in North Carolina?

Two nitrogen (N) fertilizers traditionally used in North Carolina are urea ammonium nitrate and urea. Their use is mostly due to availability, cost, and ease of transportation. Generally, about 50 percent of the fertilizer N applied to grain and stover agronomic crops is used by the crops. The remaining N stays in the soil and can leach into waterways or volatilize into ammonia gases. Some controlled-release fertilizers, fertilizer enhancers, and other synthetic fertilizers are being marketed as potential solutions for low N use efficiency and to increase yields. It is not yet clear, however, that these products actually increase N uptake or efficiency.

The following fertilizers have been studied in North Carolina field trials:

- Ammonium nitrate is a granular fertilizer that contains 33 – 34 percent N.
- ESN® polymer-coated urea is a urea granular coated with a semipermeable polymer. It contains 44 percent N, and its N release is thought to be temperature controlled.
- Urea contains 46 percent N and is granular. This is a traditional N source in North Carolina, mostly due to availability, cost, and ease of transportation.
- Urea ammonium nitrate (UAN) contains 30 percent N and is a water-soluble liquid. It is also a traditional N fertilizer for the state.

- Urea formaldehyde polymer is a water-soluble liquid containing 30 percent N. The controlled-release N mechanism is microbial controlled.
- Urea-2820 is a urea treated with N-(n-butyl) thiophosphoric triamide (“NBPT”). It contains 46 percent N. The manufacturer claims it has the potential to reduce volatilization.
- YaraLiva™ UCAN™-23 is a clear liquid N fertilizer plus calcium. It contains 23 percent total N and 4 percent calcium. It is designed to immediately supply available nitrate and ammonium and to gradually supply urea for continued feeding. The water-soluble calcium is thought to reduce ammonia volatilization from urea.

The following fertilizer additives have been studied in North Carolina field trials:

- Agrotain® is a commonly used urease inhibitor. It is used with surface broadcast applications of urea or urea ammonium nitrate. Higher yield from the use of this material might occur under conditions of high N volatilization potential.
- NutriSphere-N™ is a water-soluble fertilizer enhancer that according to the manufacturer creates an active shield around liquid fertilizers to protect N from volatilization and leaching. When mixed with urea ammonium nitrate, the solution contains 30 percent N.

Alternative Nitrogen Fertilizer Field Trials in North Carolina

Corn and Wheat

A 2-year corn and wheat field study (2008 – 2009) was conducted with Nutrisphere-N, ESN, UCAN, and UAN at five to six different N rates on soils in the four regions of North Carolina (tidewater or lower coastal plain, coastal plain, piedmont, and mountains). Corn received all ESN and Nutrisphere-N at planting (based on label recommendations), and UAN and UCAN were applied at approximately 30 lb N per acre (ac^{-1}) at planting with the remainder at growth stages V4 – V6 (14 to 25 days after emergence). There was no difference in corn grain yield among the four products (Figure 1). However, in 3 of the 6 site years, Nutrisphere-N and ESN had higher stover yields than UAN; whereas in 2 of the 6 years, UCAN produced higher stover yields than UAN (data not shown).

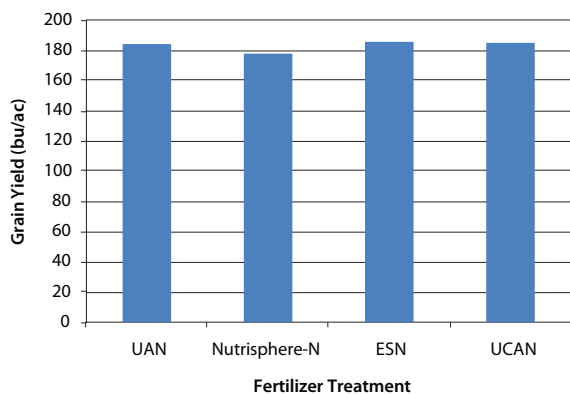


Figure 1. N.C. mountains corn grain yield (bu/ac) in response to four N fertilizers (Cahill et al., 2009).

Wheat received 30 lb N ac^{-1} at planting and a second application in the spring. For ESN and Nutrisphere-N, the second application occurred in early February (based on label recommendations). The second urea ammonium nitrate and UCAN treatments were applied to wheat in early March. The wheat grain yield data showed that the three alternative fertilizers performed similarly to UAN (Figure 2). Wheat straw yields with ESN were consistently lower than with the other products. For example, in the tidewater region, ESN straw yields were 1,693 lb ac^{-1} , while UAN yielded 1,846 lb ac^{-1} , Nutrisphere-N yielded 1,896 lb ac^{-1} , and UCAN 1,845 lb ac^{-1} of straw. Examination of performance using different N rates did not indicate significant yield differences at any of the rates tested on either crop. As the alternative N fertilizer products did not produce higher yields, their use in corn or wheat production would be heavily influenced by fertilizer pricing.

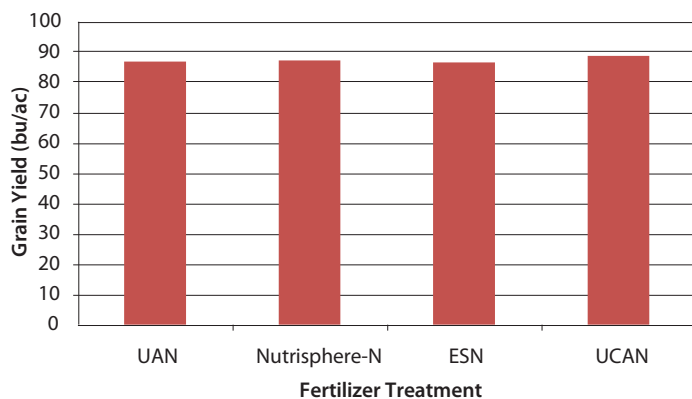


Figure 2. N.C. tidewater wheat grain yield (bu/ac) in response to four N fertilizers (Cahill et al., 2009).

A 1-year field study was performed to determine the effects of urea-2820 on corn yield and various plant parameters. When compared with urea and UAN, the urea-2820 did not consistently affect yield, earleaf tissue nitrate concentration, plant tissue color, plant height, grain and stover N concentrations, N uptake, or N use efficiency under the field conditions in the coastal plain, piedmont, or mountains of North Carolina (Figure 3 shows coastal plain grain yields). Based on these results, urea-2820 performs similarly to urea and UAN and does not offer an agronomic advantage.

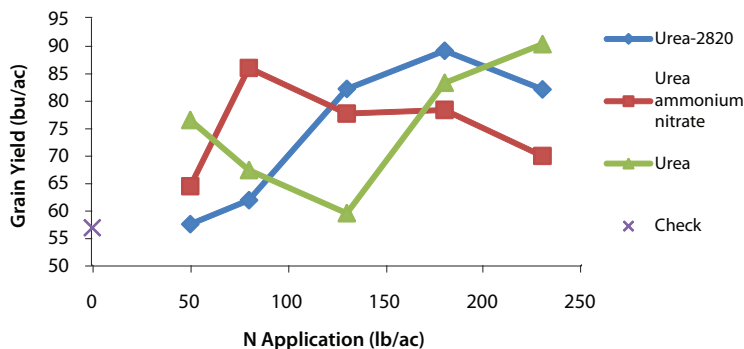


Figure 3. N.C. coastal plain corn grain yield (bu/ac) in response to three N fertilizers at five rates (Cahill et al., 2009).

In another corn and wheat study in North Carolina (2004 – 2006), crops were grown on sandy and mineral organic loamy soils. Treatments were urea formaldehyde polymer and UAN. There were six N rates for corn and five rates for wheat. Both N sources were band-applied as a split application for wheat; 30 lb N ac^{-1} at planting and a second application in the spring. Corn received urea formaldehyde polymer at planting and a split application of urea ammonium nitrate (30 lb N ac^{-1} at planting and a second application at stages V4 – V6), which is the current standard practice. For both crops and both sites, grain yield with UAN was statistically similar to or better than urea formaldehyde

polymer (Figure 4 shows corn yields). Applying all urea formaldehyde polymer to corn at planting and split applying to wheat did not significantly improve yield. The use of urea formaldehyde polymer may depend on price.

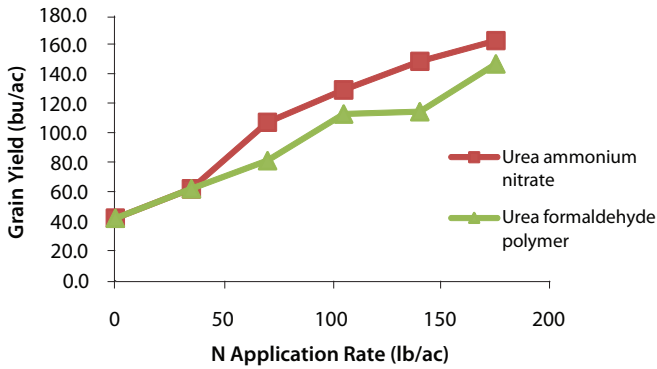


Figure 4. Sandhills (N.C. coastal plain) corn grain yields (bu/ac) in response to urea ammonium nitrate and urea formaldehyde polymer when years are combined (Cahill et al., 2007).

A 1-year, on-farm corn trial with Nutrisphere-N was conducted in Beaufort County (N.C. tidewater) on a Portsmouth soil. Treatments were UAN and UAN plus Nutrisphere-N, and rates were 0, 50, 100, 150, and 200 pounds of N per acre. As Figure 5 shows, corn yield increased as the N fertilizer rate increased, but the Nutrisphere-N treatment did not significantly increase yields compared to UAN.

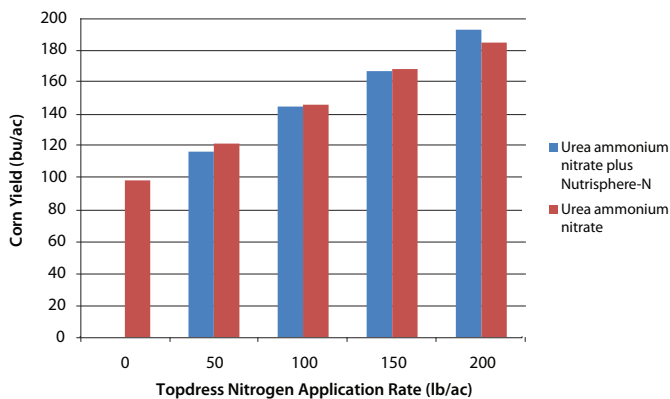


Figure 5. N.C. tidewater (Beaufort County) corn grain yields (bu/ac) at different N rates with urea ammonium nitrate or urea ammonium nitrate plus Nutrisphere-N (Ambrose, 2009).

Other corn yield studies in North Carolina have also indicated that alternative N fertilizers do not perform better than traditional N sources such as UAN and urea. For example, a 2008 corn study in the piedmont indicated that UAN plus Agrotain and UAN plus Nutrisphere-N-treated plots did not yield higher than UAN plots (Figure 6a). Lastly, in a 2008 coastal plain corn study, plots were treated with 124 lb

ac⁻¹ of UAN or UAN plus Nutrisphere-N. No yield difference was observed between treatments (Figure 6b).

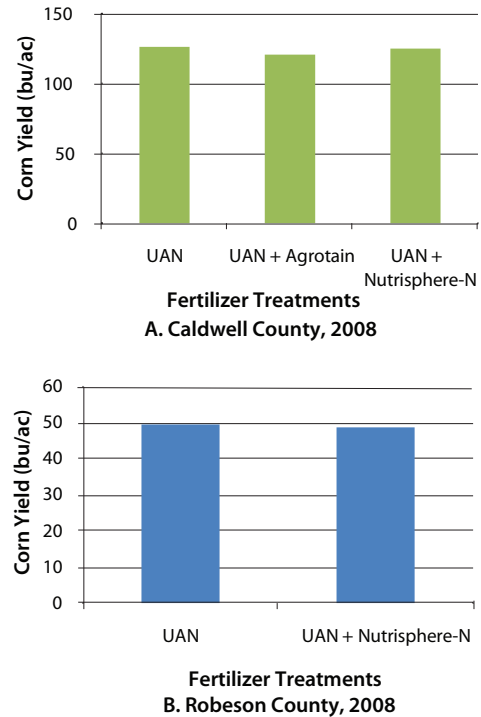


Figure 6. N.C. piedmont (A) and coastal plain (B) corn yields with various N fertilizer treatments (Nagy, 2008; Dycus et al., 2008).

Cotton and Tobacco

A two-year study (2007 – 2008) in the N.C. piedmont compared yields of cotton when treated with 90 lb ac⁻¹ of Nutrisphere-N plus urea, Agrotain plus urea, UCAN, and urea. UCAN was not included in the study in 2007. The soil was a well-drained, silt loam. Lint yields suggest there were differences between years, but N fertilizers performed similarly within each year (Figure 7).

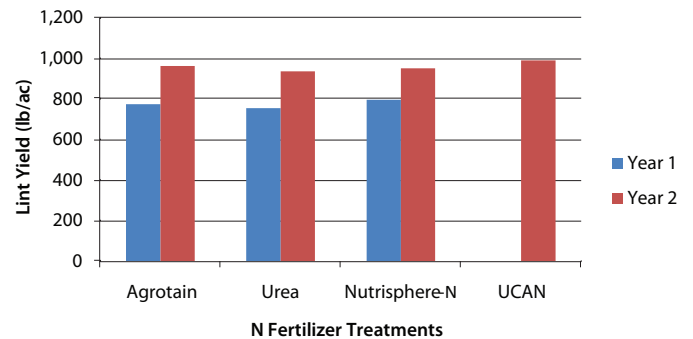


Figure 7. N.C. piedmont cotton lint yields (bu/ac) from plants grown with four N fertilizers over 2 years (Braswell, 2007 – 2008).

A 2008 burley tobacco yield study also in the N.C. piedmont compared Nutrisphere-N, ammonium nitrate, and urea. The soil was a well-drained, clay loam. We observed that yields were highest with ammonium nitrate. Nutrisphere-N and urea had similar yields (Figure 8).

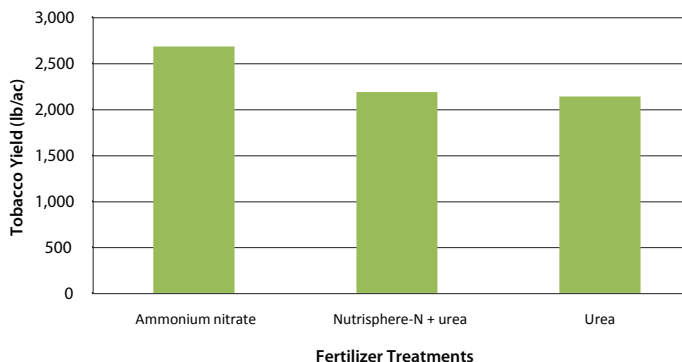


Figure 8. N.C. piedmont burley tobacco yields (lb/ac) with three N fertilizer treatments (Fisher et al., 2008).

Summary

Alternative synthetic N fertilizers are often marketed as management tools for increasing crop yields and N use efficiency. Various field studies across North Carolina, on many different soil types, show that these products rarely increase yields when compared to UAN or urea. Use the nitrogen fertilizer that best matches your production system.

The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by North Carolina Cooperative Extension nor discrimination against similar products or services not mentioned.

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References

Ambrose, G. 2009. On-farm-test report—2009. Raleigh: N.C. State University, N.C. Cooperative Extension, Beaufort County Center. .

Braswell, S. 2008. Nitrogen efficiency enhancement studies. Raleigh: N.C. State University, N.C. Cooperative Extension, Stanly County Center. (unpublished)

Cahill, S., D. Osmond, and D. Israel. 2010. Nitrogen release from coated urea fertilizers in different soils. *Communications in Soil Science and Plant Analysis*. 41:1–12.

Cahill, S., D. Osmond, R. Weisz, and R. Heiniger. 2009. Evaluation of nutrient efficiency and yield in corn and winter wheat produced with new fertilizers. Raleigh: N.C. State University. (unpublished)

Cahill, S., A. Johnson, D. Osmond, and D. Hardy. 2008. Response of corn and cotton to starter phosphorus on soils testing very high in phosphorus. *Agron. J.* 100:537-542.

Cahill, S., D. Osmond, C. Crozier, D. Israel, and R. Weisz. 2007. Winter wheat and maize response to urea ammonium nitrate and a new urea formaldehyde polymer fertilizer. *Agron. J.* 99:1645-1653.

Dycus, D. 2009, Dec.. Corn fertility test in Anson County, 2008 – 2009. Raleigh: N.C. Department of Agriculture & Consumer Services, Agronomic Division.

Fisher, L., J. Priest, and S. Whitley. 2008. On-farm fertilizer study with NutriSphere on burley tobacco—2008. Raleigh: N.C. State University.

Nagy. 2008. NutriSphere-N & Agritain Corn Trial—2008. Raleigh: N.C. State University, N. C. Cooperative Extension, Caldwell County Center. (unpublished)