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Optimizing N Management Without Ammonium Nitrate

Nitrogen-use efficiency coming more into focus with the gradual phasing out of ammonium nitrate.

Higher N prices and changes in materials available to crop producers have focused attention on NUE and management practices that can improve that efficiency. Surface N application in high-residue crops, particularly forages and topdressed small grains, has potential for significant losses by volatilization of ammonia. For years AN has been considered the standard as far as solid N sources are concerned and the choice of many producers faced with topdressing or surface applications in general on high-reside crops and reduced-till row crops. With transportation and storage of solid AN becoming a concern because of national security issues, a review of how other N sources (including UAN) can replace AN is in order.

SUMMARY

Summary: Nitrogen (N) management options are changing as solid ammonium nitrate (AN) gradually is phased out of the supply chain for crop producers. For many individuals, AN has been the N source of choice for surface applications with high potential for ammonia volatilization. Several options are available for producers in those high-residue situations, including urea-ammonium nitrate solutions (UAN), N stabilizers, coated urea, and ammonium sulfate (AS). Specific placement of UAN has proven to be a highly valuable tool for improvement of N-use efficiency (NUE). Urea coatings and additives have also proven valuable in improving NUE by decreasing ammonia volatilization, controlling N immobilization on residues, slowing nitrification, and/or lowering leaching and denitrification losses.

Placing it right

Surface band. It's time to remind growers and dealers that strip placement of UAN for high-residue crops can be a valuable tool for improving NUE. Dribbling UAN as a surface band for forage crops, small grains, or no-till crops is a management option that has sometimes been overlooked and has several advantages, including:

- Lowered possibility of foliage burn
- Better responses to applied N
- Lower volatility than broadcast urea or UAN
- No soil disturbance
- A widely available, economical N source.

Cool season grasses, warm season grasses, and small grains all benefit from surface strip or dribble UAN applications. Just how much better strip applications may compare to broadcast applications depends on a number of factors:

- Amount of surface residue
- Type of residue

• Prevailing temperatures
• Moisture
• Soil type.

But, regardless of these factors, surface strip applications usually equal or exceed broadcasting as shown in Table 1, and often are similar to AN.

Subsurface banding is even better than surface strip because it brings in the added advantage of reduced positional availability from dry surface soils and eliminates the possibility of volatilization losses. A response of corn to the different application methods is depicted in Figure 1.

Multiple-nutrient applications in surface or subsurface strip applications may have even more benefits. Including ammonium thiosulfate (ATS) in UAN can affect urea hydrolysis and nitrification with improvements in NUE as well as providing plant nutrient sulfur (S) as shown in Table 2. Combinations of UAN and 10-34-0 have long been recognized as an improved mechanism for delivering both N and P to plants through stimulated ammonium N absorption and slowed P fixation reactions. N-P_2O_5 ratios of at least 1:1 seem to be a key in these benefits.

UAN additives

UAN additives admittedly increase N costs but the improved use efficiency offsets that additional investment.

Agrotain. UAN is half urea so additives such as Agrotain (NBPT), which is a urease enzyme inhibitor and slows urea hydrolysis, can produce advantages in N management. It keeps N in the urea form longer and provides greater opportunity for incorporation by rainfall or irrigation, an advantage for surface applications that may be subject to ammonia volatilization losses and immobilization. Length of time additive affects urea hydrolysis is related to the amount of material coated on urea or added to UAN. One distinct advantage of this product is it increases the safety margin for broadcast. At the same time, there are a couple of disadvantages in using this product:

• Cost ($3 to $6/A)
• Limited protection time (5-14 days).

N-GUARD is another UAN additive that can increase NUE with both broadcast and strip UAN applications in high-residue situations (Table 3). This high-charge density dicarboxylic copolymer is also effective coated on urea and is theorized to provide suppressive effects on the urease enzyme through sequestration of the nickel ions in urease. Recommended concentrations are 1 percent in UAN and 0.25 percent coated on urea.

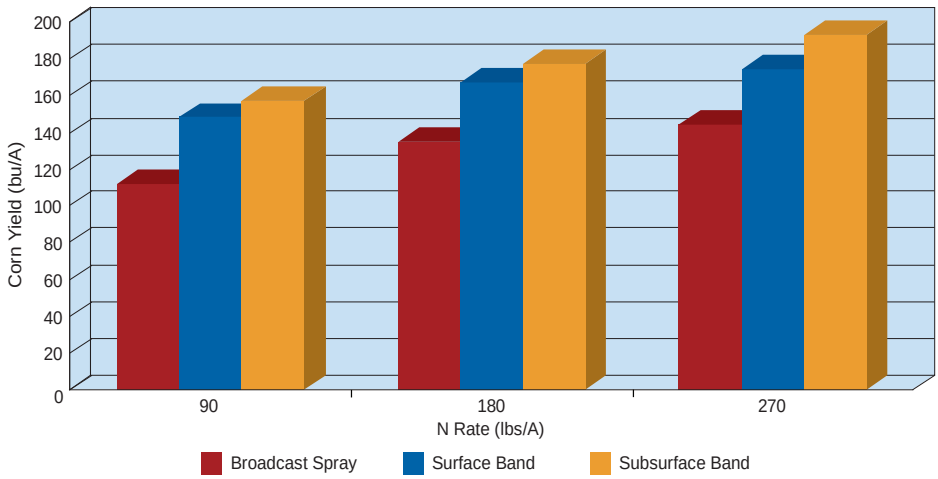

Figure 1. Corn response to UAN application methods. *Touchton, Hargrove, 1982*

Table 1. UAN placement compares favorably with ammonium nitrate for fescue at a rate of N at 120 lbs/A.

	Locations				
	1	2	3	4	5
	yield – lbs/A				
Check	4,707	1,257	615	3,664	4,017
UAN broadcast	6,412	4,758	3,274	6,002	6,911
UAN dribbled	6,925	5,787	4,064	5,900	6,872
AN broadcast	6,301	5,389	3,893	6,144	6,658

Kansas

Table 2. Effects of UAN + ATS on no-till grain sorghum yields, 10 percent ATS by volume, Kansas.

N rate lbs/A	Method of application	Yield lbs/A	Tissue N %
0		3,584	1.57
50	Broadcast	5,488	2.06
50	Broadcast + ATS	5,768	2.17
50	Dribble	5,544	2.13
100	Broadcast	6,720	2.52
100	Broadcast + ATS	7,504	2.68
100	Dribble	7,280	2.70

Lamond and Whitney, KSU

ESN, a polymer coated urea, has been quite effective compared to uncoated urea and other N sources. This technology slows the dissolution and hydrolysis of the urea granule by encapsulating urea in a polymer shell, quite different from Agrotain. This slowed solubility makes possible the placement of ESN in direct seed contact without seedling damage as would occur with uncoated urea. Slowed solubilizing of urea also allows a gradual supply of N to reach the plants, limiting the speed of nitrification and, subsequently, nitrate leaching and denitrification. Broad application of this technology to small grains, forages, row crops, and specialty crops has been documented (Figure 2).

Old standbys

Ammonium sulfate, acidic by nature, is subject to very few problems in terms of NUE. Volatilization of ammonia is less likely and the material is both a good source of ammonium N and sulfate sulfur. Disadvantages include a more serious effect on soil acidity and a relatively low N content.

Anhydrous ammonia does not really fit in the same class of the other N materials discussed. Subsurface placement means that volatilization losses are low when

Table 3. N-GUARD effects in UAN on no-till corn yields, Maryland, 2005.

N rate lbs/A	Method of application	Grain yield bu/A
0		71
90	Band	104
90	Band + 1% N-GUARD	131
130	Band	130
130	Band + 1% N-GUARD	158

Mattapeake loam soil Ron Mulford, Univ. of Maryland

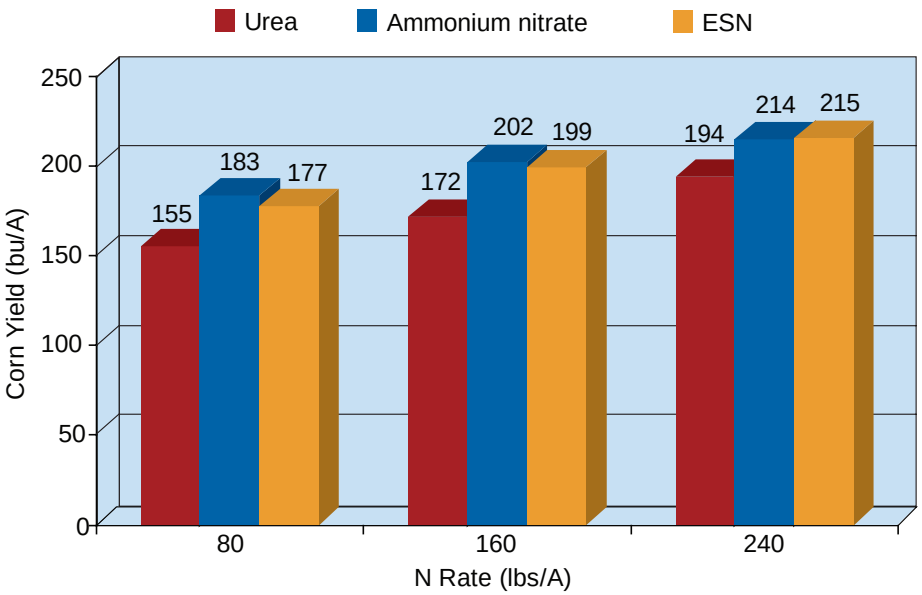

Figure 2. Volatilization reduction using ESN in no-till corn, Gordon, KSU, 2003-05.

applied at proper depth and in soil conditions that ensure a good soil seal around the ammonia knife and over the retention zone. High concentrations of ammonia act as its own nitrification inhibitor and have positive effects on P that is injected in proximity to the ammonia retention zone. However, anhydrous is difficult to use in high-residue situations unless applied in strip-till systems or with a coulter close to the seeding zone. Ammonia, while a low cost fertilizer and an excellent N fertilizer agronomically, has a high cost of application, cannot be blended with other fertilizers, and is also under scrutiny because of safety and handling concerns.

Managing volatilization

The goal in managing volatilization should be to minimize time of exposure of urea and/or ammonium N forms. Obviously, incorporation is the best protection but may be impossible in many situations. If incorporation is not possible, consider some of these options:

- Band UAN instead of broadcast
- Watch the weather and apply before rain
- Use less volatile sources
- Monitor crop and add additional N if necessary.

Conclusion

In the final analysis, there are a variety of options available for N management where ammonium nitrate has been a preferred N source. Careful management of conventional fertilizers, such as appropriate placement and timing, can enhance their effectiveness. New products on the market, such as coated fertilizers and additives, provide opportunities for high efficiency of urea-containing products, efficiencies that rival that of ammonium nitrate. Some of these practices and products are inexpensive, some are more costly, but all have the ability to be a good investment for crop production through improved NUE.

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