5. NITROGEN (N)-The Big Guy

Because of its overriding importance in agriculture, nitrogen has been studied more than any other nutrient. No attempt will be made here to give a detailed picture of nitrogen nutrition; some salient points will be discussed:

Nitrogen Fertilizers

Advantages and disadvantages of some of the more common N fertilizers are given below:

Anhydrous Ammonia (NHs) 82%IM

ADVANTAGES:

High %N; easy to apply; no residue; little danger of leaching,

DISADVANTAGES:

Uneven distribution and losses in irrigation water with some systems;

can't be used with sprinklers; loss potential with dry injection; possible

toxicity to plants; potentially hazardous to eyes.

Ammonia solution (aqua ammonia) 20%N

ADVANTAGES:

Easy to apply; no residue

DISADVANTAGES:

Same as for anhydrous.

Ammonium sulfate 21 %N

ADVANTAGES:

Acid residue for alkaline soils; minimal leaching loss; easy to han- dle; *S* boost, if needed. DISADVANTAGES:

Acid residue for acid soils. Delayed availability during nitrification; high loss potential on calcareous soils if not incorporated.

Ammonium nitrate 33%N

ADVANTAGES:

High %N; no residue; half available now, half later; minimal

volatilization loss potential.

DISADVANTAGES:

Some volatilization loss on calcareous soil if not incorporated

(much less loss potential than am. sulfate).

Ammonium phosphate-sulfate (16-20-0) 16%N

ADVANTAGES:

Same äs am. sulfate; high P content where needed; S boost, if needed.

DISADVANTAGES;

Same as for am. sulfate + higher cost; relatively low analysis.

Ammonium phosphates (11-48, 18-46, 10-34) 10+%N

ADVANTAGES:

High P content where needed.

DISADVANTAGES:

Same as for am. sulfate; low %N (can be advantage in some cases).

Calcium nitrate 15½%IM

ADVANTAGES:

Calcium residue good on acid and sodic soils and for calcium stress; immediately available; no volatilization losses; very soluble (for water runs).

DISADVANTAGES:

Susceptible to leaching loss; can clump in moist weather; •relatively high cost per unit of N.

Urea 42% INI

ADVANTAGES: High %N; no residue. DISADVANTAGES:

Can be toxic at high amounts in some situations; high loss potential if not incorporated or watered in.

UIM-32 Solution (half am. nitrate, half urea) 32%N

ADVANTAGES:

High %N; some available now, some later; easy to handle.

DISADVANTAGES:

Same as for urea.

Sodium nitrate 16%N

ADVANTAGES:

Immediately available; no volatilization.

DISADVANTAGES:

Sodium detrimental to soils if not countered by calcium; relatively low analysis.

Significant nitrogen losses can occur from volatilization of ammonium compounds when applied to the surface of soils. These losses are greatest on calcareous soils or when soil pH is above 7.0. Incorporating ammonium-N fertilizers reduces volatilization losses. (Urea is different from other N fertilizers; it is rapidly converted to the ammonium form after application but can be watered in rather than incorporated; if it is watered in immediate- ly after application volatilization losses will be minimal). The table below compares volatilization loss potential of different N fertilizers:

POTENTIAL VOLATILIZATION LOSS OF N FROM DIFFERENT FERTILIZER MATERIALS

H = Over 40% Loss L = 5 to 20% Loss

M = 20 to 40% Loss V = Less than 5% Loss

	Applied to soil Surface and not incorporated		Broadcast	Applied to soil surface and watered in		Applied in irrigation water		Banded
Nitrogen Source	Soil pH below 7 (Acid)	Soil pH above 7 (Alkaline)	on soil and disced under	Soil pH below 7 (Acid)	Soil pH above 7 (Alkaline)	Soil pH below 7 (Acid)	Soil pH above 7 Alkaline)	at least 4 inches below soil surface
Aqua-NH_3	H	H	L	H	H	H	H	V
Ammonium Sulfate	L	H	L	L	H	L	H	V
Ammonium Phosphate	L	H	L	L	M	L	M	V
Ammonium Nitrate	V	L	V	V	L	V	L	V
Calcium Nitrate	V	V	V	V	V	V	V	V
Sodium Nitrate	V	V	V	V	V	V	V	V
Urea	M	H	L	V	L	V	V	V
UN 32	V	M	V	V	V	V	L	V

As the above table shows, the potential for N loss from ammonium materials is much greater at pH levels above 7.0. If lime is applied to the surface of an acid soil (as it often is) it can greatly increase the potential of N volatilization loss on that soil.

The acidifying properties of ammonium fertilizers are a concern on non-calcareous soils, since pH levels should be maintained above 6.0 for optimum growth of most crops. The acidifying properties of some N fertilizers are given in the following table:

		Equivalent Lbs of Sulfuric Acid or Lime Produced per 100 units of N	
Material	**%N**	**sulfuric acid**	**calcium carbonate (lime)**
Ammonium nitrate	33	188	-
Ammonium phosphate sulfate	16	550	-
Ammonium sulfate	21	524	-
Anhydrous ammonia	82	179	-
Aqua ammonia	20	180	-
Calcium nitrate	15½	-	129
Sodium nitrate	16	-	181
Urea	45	158	-
UN-32	32	178	-

In any one year, the acidifying property of any given N fertilizer is not of concern, however over a period of 20 or more years, acidifying N fertilizers can have a significant effect on soil pH. The following table shows how sulfuric acid can affect pH of various textured soils that do not contain lime:

	Lbs. of sulfuric acid per acre ft. of soil to lower pH (once all lime has been neutralized)		
Soil texture	from 6.5 - 5.5	from 5.5 - 4.5	from 4.5 - 3.5
Loamy sand	3000	2400	2000
Sandy loam	5400	3400	2400
Loam	7200	5000	4000
Clay loam	9600	8000	5600

Under a drip irrigation system that wets 1/4 of the total soil, acidifying effects will take place 4 times as fast with a given amount of material as under conventional irrigation.

Nitrogen-Water Relationship

The amount of nitrogen needed for a specific crop is not a constant but varies depending on how much water is applied to the crop. With the optimum amount of water applied, the crop will need and use the optimum amount of nitrogen fertilizer. If irrigation is short of crop needs, then the nitrogen requirement is reduced. If irrigation is significantly in excess of crop needs, then the nitrogen requirement is increased to compensate for leaching losses and for possible unwanted growth. If irrigation intervals are short, the crop will draw most of it's water and nitrogen from the top soil; if irrigation intervals are long, the crop can draw most of it's nitrogen from lower soil depths. Different individual crop responses to N fertilizers can usually be traced to differences in irrigation management.

When reading reports of fertilizer trials, always look for details on the irrigation program - how much water was applied, what was the irrigation interval and what was the initial moisture content of the soil? Unfortunately, this information is not always available.

Nitrogen-Temperature Relationship

Nitrification (the conversion of ammonium-N to the more usable nitrate form) is a biological process. As such, it takes place very slowly when soil temperatures are low, but increases rapidly as soils warm up. Since plants take up most of the N in the nitrate form, this is an important consideration. At 50°F there is little nitrification. The rate of nitrification can double for each 18°F in- crease in soil temperature between 50°F and 90°F. At 90°F, nitrate is produced (from ammonium) 3 times as fast as it is at 50°F.

Nitrogen Toxicity

Excess nitrogen can adversely delay maturity of crops and on sugar beets will cause a reduction in sugar %. Too much N on grapes can increase shattering of the berries, thus reducing yields. On pecans, too much N can induce potassium deficiency. With current emphasis on nitrate pollution control and energy conservation, every effort should be made to use N efficiently.

Soil and Plant Analysis

Soil tests for nitrate have gained favor in recent years and can provide good supplemental information when planning fertilizer programs for row and field crops. Because of the transitory nature of nitrogen and nitrogen forms in the soil, caution should be used in interpretation of soil nitrogen levels.

Plant analysis can be very useful in adjusting nitrogen fertilizer rates for crops. N in plant tissue varies during the growing season so it is important to take samples at the proper time, where standardized reference values exist. Ideally, crops should be sampled 2 or more times a year for N analysis so that a better handle can be obtained on N nutrition for a particular crop.

Nitrification Inhibitors

There are a number of nitrification inhibitors on the market, the major one being sold under the name of N-Serve. Nitrification inhibitors slow the conversion of ammonium-N to nitrate-N thus getting longer use out of a fertilizer application and possibly saving a subsequent application. There have been many reports on the benefits of these materials; there have been some reports that show no benefits. Because of the variables that affect the efficacy of these materials they should be tested on a particular piece of ground for a particular crop to see whether they will benefit that crop.

Nitrite Toxicity

Nitrite is an intermediate on the conversion of ammonium to nitrate. The microrganisms responsible for the conversion of nitrite to nitrate can be inhibited by high pH, high lime and high ammonium concentrations with the result that nitrite can ac- cumulate in the soil to the point where it becomes toxic to plants. (The nitrification inhibitors described above inhibit the conversion of ammonium to nitrite, a separate process). Field reports of nitrite toxicity are uncommon, but it undoubtedly occurs and fieldmen should be aware of this possibility. Another advantage of the nitrification inhibitors is that they reduce, and probably eliminate, the possibility of nitrite toxicity.

General Reference

Bartholomew, W.V. and F.E. Clark (Editors): **Soil Nitrogen.** A monograph published by the Amer. Soc. of Agronomy, 677 S. Segoe, Rd., Madison Wis. 53711. 1965.