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Most Asked Agronomic Questions

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Chapter 3

Nitrogen

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1. What form of nitrogen should I use?

The form of nitrogen that a farmer should choose depends on several factors: (1) the availability and (2) cost of N carriers, (3) equipment needs, (4) soil properties and (5) cropping system.

Research has shown little difference in corn yield as a result of using different N sources in production systems using conventional tillage. This can probably be attributed to the quick contact between soil and fertilizer in these systems. Nevertheless, soil moisture levels often affect the amount of N loss from the various carriers. In general, on wet soils that are conventionally tilled, an ammonium form of N is preferred because it may reduce the risk of N loss due to denitrification. On dry soils, the choice of N source usually should be based on which is most economical to buy.

In no-till systems quick N-soil contact may not be possible when fertilizer is broadcast as surface residue may intercept it and cause loss of applied N. Research shows that in no-till systems the preference list of N fertilizers is: anhydrous ammonia, ammonium nitrate, N solutions, and urea.

Refer to the publications "Selecting Forms of Nitrogen Fertilizer" (OSU Extension Agronomy Fact sheet AGF-205) and "Nitrogen Fertilizers in No-till Corn Production" (AGF-202) for further information on this topic.

2. What is the most economical form of nitrogen to use?

Traditionally, anhydrous ammonia has been the cheapest N source to buy. All other N carriers are made from anhydrous, and thus they are more expensive due to the increased cost of processing. Nevertheless, in many parts of Ohio, anhydrous ammonia is not readily available; in such areas, use of either urea or 28% N solution would be recommended.

3. How do I determine rates of N application for corn?

The amount of N recommended for corn depends upon the present yield goal and the previously grown

crop. Table 9 on page 9 of *Tri State Fertilizer Recommendations for Corn, Soybeans, Wheat & Alfalfa,* Ext. Bull. E-2567, presents the current N recommendations. These are based on growth response curves obtained in N fertility experiments conducted in Ohio.

Many other factors also can influence the amount of N fertilization that is needed. The amount of N released annually from a soil, the degree of N lost from a soil, and the time of N application are a few of these factors.

4. If a farmer continually applies nitrogen for a 150 bushel corn crop, but routinely yields 115-125 bu, what are the potential dangers of nitrate problems in tile drained or ground water?

If a farmer uses a N program that has the potential to supply 25 bushels of grain more than he is actually producing, he will be applying an excess of 40-50 lbs. N/year. On coarse soils, this unused N is likely to move into tile drain or ground water, thereby raising nitrate levels. On poorly drained soils, however, much of the excess N will be lost to the atmosphere through denitrification; thus, on these soils there should be little increase in the N concentration of drainage water.

5. With the concern over ground water contamination, what guidelines should be followed for nitrogen fertilization of corn?

Currently, corn yields in Ohio are not at levels that would be expected from the amounts of N being applied. This indicates that in many cases, factors other than N rate are limiting yield. A farmer in this situation is urged to choose a yield goal based on experience with his particular soil and growing conditions and to apply only the amount of N required to reach this yield level. Fertilizing N by these guidelines will not only save money for the farmer but will also protect our groundwater from unnecessary contamination.

6. When does the corn crop actually utilize differing amounts of nitrogen during the season?

The uptake of N parallels the growth of the corn plant. It is used to make proteins. The most rapid vegetative growth of corn is from June to mid-July. As grain develops from mid-July to mid-August, the plant stores large amounts of proteins in the grain.

A corn plant takes up most of its nitrogen between June and mid-August.

Reference: Hanway, In *Modern Corn Production* by Aldrich, S.R., Scott, W.O. and Hoeft, R.G., 1986. page 101.

7. Do the highest yielding corn hybrids need nitrogen later in their development?

Research has shown that some high yielding corn hybrids do use N later in their development, but this has not been found to be generally true of all high yielding corn hybrids. At the present time, there is not enough data on this subject to justify changing N programs based on specific hybrids.

8. How late can you apply nitrogen to a deficient field of corn and get a profitable yield response?

A corn plant takes up to one-half of its N requirement after tasseling. Thus, you can expect a yield increase from any N addition applied up through early grain fill, provided the corn plants are not damaged during the application process.

9. Does it pay to use a split application of nitrogen?

On soils where there is a potential for N loss, a split application (pre-plant plus sidedress) has proven to be effective in increasing the efficiency of the N program.

In contrast, where soils are well drained and N loss is minimal, there is no advantage to a split application program.

10. What is the best placement (row middle or near row) for sidedress nitrogen on corn, both no-till and conventional.

Sidedressed N should be applied near the actively feeding roots of the crop. Research has shown that roots tend to grow laterally at about the same rate that top growth of the plant occurs. Therefore, if sidedressed N is applied to corn plants that have not yet experienced much top growth, it is preferable to place the N rather close to the row. On the other hand, when sidedressed N is applied to plants that are at least 14-16 inches in height, a middle of the row placement should be adequate.

11. What is the relative effectiveness of dribbling 28% solution versus sidedress injection?

Most research shows that, in general, these two methods of sidedressing are equal in their effectiveness. Nevertheless, when conditions are excessively dry after application, the preferred method is injection. The reason for this is that injection places the N deep below the soil surface where moisture conditions are favorable for plant uptake. In contrast, when a dribbled (surface) application of 28% N is followed by a period of dry weather, little of the applied N is carried down to where the roots are actively feeding, and thus the application tends to be inefficient.

12. What is your opinion of urea (granular or prilled) as a sidedress for corn?

Broadcasting urea as a sidedress for corn, whether in a granular or prilled form, will often result in burn to plant tissue. Provided they can be applied without substantial damage to the plants, both granular urea and prilled urea have been found to be equally effective as a sidedress application of N for corn.

13. Can nitrogen be fall applied?

Yes, but fall application of N should be restricted to well drained, low organic matter soils. All fall applied nitrogen should be anhydrous ammonia with N-Serve. (See 'Nitrification Inhibitors Potential Use in Ohio', OSU Extension Agronomy Fact sheet AGF-201.)

14. How much loss can result from the fall application of nitrogen?

The amount of N that will be lost from fall application is highly variable. It depends to a large extent on the internal drainage of the soil and the weather conditions during a particular year. Long term research has shown that, on average, 40-80 pounds of N are lost from a fall application as compared to a spring application.

15. Explain the economics of N-Serve and similar products.

N-Serve is the trade name for the chemical nitrapyrin. This product works by reducing the number of Nitrosomonas bacteria. These are the bacteria that are responsible for the conversion of NH_4-N to $N0_3$-N (nitrification). Use of N-Serve has been found to delay nitrification for a period of approximately 4-6 weeks. Keeping N in the NH_4 form is important because it can substantially reduce the loss of fertilizer N due to denitrification.

Denitrification usually accounts for approximately 80% of the N lost from most soils. In this process,

nitrates are biochemically reduced to N gases (N_2 or N_2O), which are then lost through volatilization. Wet soils and warm temperatures are conditions that promote denitrification. When spring weather favors the presence of such conditions, use of N-Serve can prove to be very economical because NH_4-N can not undergo denitrification, thus potential N losses will be reduced. How great can these losses be? It has been estimated that once nitrification has occurred and the $N0_3$-N form exists in the soil, there will be a 50% loss of applied N after 7 days of continuously wet soils. After 10 days of wet soils, there will be a 100% loss of $N0_3$-N. N-Serve can be good insurance against such drastic losses. Nevertheless, during a dry spring when denitrification is unlikely, N-Serve will be of no benefit in reducing N losses, thus it will be of no economic value.

16. Are there new additives on the market that can reduce N losses?

Ammonium thiosulfate is a new product that is claimed to cut N losses by reducing both nitrification and surface volatilization. These claims are supported by limited data. Most research suggests that it has little effect on these two processes.

DCD is another new nitrification inhibitor. It has been found to be relatively effective in delaying nitrification; nevertheless, use of it may not be economically practical that it must be applied in large quantities for it to be beneficial.

17. Is there a benefit of NH_3 over 28% N? If so, how much added 28% N does it take to offset the difference?

Long term research has shown that, on average, anhydrous ammonia is approximately 10% more effective as a N carrier in corn production than are urea based fertilizers. The reason for this difference in effectiveness is that anhydrous tends to have less N loss from denitrification, surface volatilization, and leaching than the urea products. If, however, conditions are such that little N loss will occur, urea based fertilizers are equivalent to anhydrous ammonia in their efficiency.

18. What is the nutrient loss from various sources of surface-applied nitrogen?

When urea based N products (urea or 28% N) are used, one can expect, on average, a 3% loss/day for N left on the soil surface. If the soil surface has a high pH (>6.5) or if the soil surface is moist when the urea product is applied, losses can be substantially higher. In addition, warm temperatures can accelerate the loss of surface applied nitrogen.

In a 1981 study, Fox and Hoffman found that NH_3 volatilization loss from ureabased carriers (urea and U.A.N.) ranged from 0 to 35%. Rainfall after fertilizer application was found to affect the amount of NH_3 volatilization. Their results showed that:

(1) If at least 10 mm of rain falls within 2 days after urea application, no NH_3 volatilization loss will occur.

(2) If 10 mm or more rain falls 3 days after urea application, volatilization losses will be minor (<10%).

(3) If 3-5 mm of rain falls within 5 days, or 7-9 mm within 9 days, volatilization losses will be moderate (10-30%).

(4) If no rain falls within 6 days, the loss can be substantial (>30%).

Reference: Fox, R.H. and L.D. Hoffman. 1981. The Effect of N Fertilizer Source on Grain Yield, N Uptake, Soil pH, and Lime Requirement in No-till Corn. Agron. J. 73:891-894.

19. How much incorporation is required for urea?

Urea must come into direct contact with the soil if surface volatilization is to be minimized. Usually light discing is adequate to mix urea into the soil. If the soil surface is covered with heavy residue, more tillage will be needed.

20. What is the best way to fertilize no-till corn using urea as the nitrogen source?

Use of urea on no-till fields may cause serious problems in certain years. Many of the problems can often be overcome by proper application. To reduce the amount of ammonia volatilization from urea, the urea must come into direct contact with the soil.

Banding urea between corn rows and below residue is one way to avoid N loss from urea. If a farmer chooses to broadcast urea instead, he is urged to do so prior to anticipated rains, which will wash the urea into the soil. Generally, urea should only be broadcast with no-till production if one-half inch of rain is assured within 7 days after application. Also, farmers should broadcast urea early in the season (early April) as cooler temperatures will slow N loss. Urea should never be broadcast over freshly limed soils because high pH can greatly accelerate N losses. If the surface pH is greater than 6.5, another source of N should be used.

21. How much nitrogen do I lose when broadcasting urea or ammonium nitrate on wheat/pasture?

As mentioned above, several factors (moisture, pH, temperature, etc.) will influence the amount of N that will be lost from a broadcast application of urea. In general, losses of surface applied N are not substantial in wheat because urea is typically broadcast in March when temperatures are low. In contrast, a large N loss may be expected if urea is broadcast on pasture during mid-summer.

When ammonium nitrate is the carrier, you should not expect N losses from surface volatilization.

22. Should I apply urea (N) by airplane to growing corn? If so, how much?

An aerial application of urea will cause some burn to the corn plants. The degree of plant burning is usually less, however, with urea than with other N products. If the N rate is kept below 50 lb./A, the burn is often minimal. Even at higher N rates, the burn is normally not so severe that it outweighs the benefits received from the N addition.

23. What is the evaporation rate of liquid nitrogen when applying in heat such as 90 degrees (F) or higher?

As mentioned previously, Fox and Hoffman found approximately a 3% loss per day that urea based products were left on the soil surface. Their research was conducted during the spring when temperatures averaged 70 degrees (F). Thermodynamic studies have shown that a chemical reaction will double for every 18 degrees (F) increase in temperature. Therefore, at 90 degrees (F), there should be approximately a 6% loss/day.

Reference: Fox, R.H. and L.D. Hoffman. 1981. The Effect of N Fertilizer Source on Grain Yield, N Uptake, Soil pH, and Lime Requirement in No-till Corn. Agron. J. 73:891-894.

24. What are the reasons to use ammonium sulfate?

Under most circumstances, ammonium sulfate is not the fertilizer of choice because there are some major disadvantages to the use of it. First, it has a low analysis of N (approximately 21-22% N). This means that, compared to other N carriers, a larger volume of fertilizer is needed to apply the same rate of nitrogen. A second disadvantage to ammonium sulfate is that there is a large amount of acidity associated with it; as a result of this, more lime is normally needed to keep the soil neutralized.

Nevertheless, there are at least four situations in which ammonium sulfate would be the preferred nitrogen source for crop production:

(1) Soils which need corrective measures for high pH. Ammonium sulfate has 3 times the acid supplying power compared to other N sources.

(2) Soils which need supplemental sulfur. Ammonium sulfate is approximately 25% sulfate (SO_4^{2-}); sulfur in this form is available for plant uptake.

(3) No-till systems where surface volatilization of urea would be expected.

(4) Whenever the cost of ammonium sulfate per pound is cheaper than the other N carriers.

25. How much credit for N can I expect from a good crop of soybeans?

You can expect approximately 1 pound N per bushel of soybeans produced.

26. Should I apply a little nitrogen (starter fertilizer) with my soybean and alfalfa fertilizer program? Does it make any difference if the field has not grown soybeans or alfalfa previously?

On cold, wet soils that are low in nitrogen, a little N fertilizer may help insure good, early growth of these two crops. These conditions, however, are not typically found in Ohio. Thus, the use of starter nitrogen is not usually recommended for soybeans grown in our state, especially since it will tend to delay modulation. A small quantity of N is recommended with the starter fertilizer when seeding alfalfa.

If the field does not have a history of soybeans or alfalfa, use of starter N may be a good idea. Normally, in such fields it will take several weeks to establish a strong Rhizobia population. (These are the bacteria responsible for nitrogen fixation.) If adverse conditions (low nutrient levels, low pH, etc.) occur, the establishment of Rhizobia may be delayed even longer. Therefore, if you hope to maximize yields during the first year of establishment, a N application should be considered.

27. What are the prospects of producing corn with nitrogen fixing bacteria?

The native N fixing bacteria of the soil will normally only produce 3-25 lbs. N/A/yr. Whenever a bacterium is added to the soil, it must compete with the native bacteria that are already present in the field. To date, no new N fixing bacterium has been found that can survive under field conditions and can fix N in amounts adequate for high corn yields.

28. High fertility (N) for high yield wheat. What kind and how much? When should it be applied?

Research has shown that good, uniform distribution of N throughout the wheat field is more critical than the form (carrier) of the N. Liquid N programs normally tend to give a more even distribution than granular programs.

The amount of N that should be used is dependent upon yield potential. Refer to Table 9, page 9, of *Tri State Fertility Recommendations*, Ext. Bull. E-2567, for recommended rates of N fertilization for wheat.

For stiff strawed, short varieties, rates of 100 pounds of N or more are commonly applied. When thin strawed, tall varieties are grown, the N rate should be kept below 100 pounds N per acre to prevent excessive lodging.

Our research indicates that maximum wheat yields can be produced by a fertilizer program that has a small amount of N applied in the fall with the remainder top dressed in the spring. Programs that use a spring application of split N have not proven to be any better than spring programs using a single application.

29. How much N should I put on in fall for wheat?

When using a split N program (fall application plus spring top dress), it is recommended that no more than 20 pounds N per acre be applied in the fall. If the total N program is to be applied in the fall, the N rate would be the same as a spring program. We recommend that a total fall program be used only on well drained, light colored soils; also, suitable N stabilizers should be applied along with the N.

30. We have a competitor making his own liquid nitrogen by combining urea and water or ammonium sulfate and water. What is the highest nitrogen solution he can make? Will this cause burn to emerged crops like wheat and corn? Will there be more loss of nitrogen with these products than with 28% U.A.N. and/or NH_3?

Based on the water solubility of these two N carriers, the highest N content of a urea based solution would be approximately 30% (N) while for an ammonium sulfate solution the highest N concentration would be approximately 14% (N).

At high concentrations, N solutions will cause burn to green tissue. In general, rates in excess of 50 pounds N per acre will result in tissue burn.

A substantial amount of N loss should be expected to occur when urea solution is applied. Some surface volatilization should also result from an application of an ammonium sulfate solution. In general, the N loss from both of these solutions should be greater than what would be expected from use of 28% N. Since NH_3 is not applied foliar, a direct comparison can not be made as to the amount of N that will be lost from it.

31. Does anhydrous kill the earthworms in my soil?

Yes. When anhydrous ammonia is knifed into the soil, approximately 15% of the earthworm population is initially killed. Nevertheless, the anhydrous ammonia does increase the amount of available nutrients; as a result, earthworms will gradually move back into the application zone where they will multiply rapidly due to the fertile conditions. Consequently, 6-8 weeks after injection of anhydrous ammonia, the total number of earthworms is usually larger than what was originally present.

32. If my corn/soybeans are yellow, does this mean I should add more nitrogen even though I followed fertilizer recommendations?

When corn or soybean plants are yellow, this usually indicates a lack of chlorophyll development. It is true that N deficient plants normally have poor chlorophyll development and thus have a yellow color; however, many other plant deficiencies and diseases have similar signs of yellowed tissue. Thus, the total production program should be evaluated so that the exact cause of the problem can be discovered. Adding more N may or may not be the correct solution.

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