ALABAMA A&M AND AUBURN UNIVERSITIES

Fertilizer Management To Protect Water Quality

Fertilizer Application Techniques

ANR-790-4.4.3

To minimize nutrient losses to the environment from fertilizers, farm managers must ensure that plants use fertilizer efficiently. Best Management Practices regarding fertilizer application techniques to increase fertilizer uptake efficiency include proper timing, rate, and placement.

Timing

Timing of fertilizer application may be the most critical factor in determining fertilizer uptake efficiency and crop yield. This is especially true for nitrogen fertilizer. When fertilizer is applied near the time of maximum growth, crops are able to more efficiently use the nutrients. The more nutrients that are used, the less opportunity there will be for loss.

Variables such as crop and soil type, date of planting, and climate affect the optimum timing of nutrient application. Therefore, it is crucial that individual farmers manage their fertilization schedules to best match application with the peak demands of their specific crops in their unique situations.

Timing Nitrogen Application

• Timing and application rate should leave as little residual nitrogen in the soil during the noncropped periods of the year as possible.

• Spring preplant applications provide an opportunity to apply nitrogen closer to when it is needed by the crop. All forms can be used, but incorporation is important to minimize loss.

• Spring-applied nitrogen fertilizer for spring and summer crops is superior to fall application in regions with wet soils, humid climates, and high infiltration. Spring and split applications are highly recommended where practical in the Pacific Northwest and the eastern half of the United States.

• Summer-applied urea is preferable to nitrate-N in paddy rice production because it is not as readily lost to the atmosphere in flooded anaerobic soils as is nitrate fertilizer. Rice can readily use the ammonium form of nitrogen. (Rice is not grown in Alabama.)

• Fall-applied urea can be used for crops other than rice if it is plowed under or incorporated after application. Urea should not be used on high pH soils especially at high temperatures because considerable loss can occur through the release of ammonia.

• Fall-applied anhydrous ammonia is appropriate in areas with cool, dry conditions. (This is not normally the case in Alabama.) The lower cost and stable form of nitrogen in the soil are strong advantages. Losses are minimized by applying anhydrous ammonia after soil temperatures have fallen below 50°F. A nitrification inhibitor also can be used effectively to reduce fall nitrogen losses in some areas.

• Split application of nitrogen as compared to single application can reduce potential nitrogen losses by up to 30 percent and reduce potential groundwater contamination. This is especially true for soils with a high leaching potential, such as deep sandy soils over shallow water or fractured rock. Split application is recommended where practical for all humid regions and areas of intensive irrigation.

• Sidedressed nitrogen can be very efficient with a fast-growing crop such as corn if it is applied before the corn begins tasseling; however, adequate soil moisture must be available for rapid uptake. Around 50 percent of the nitrogen for corn may be applied to the crop at planting.

• Slow-release nitrogen fertilizers can reduce N losses by as much as 95 percent as compared to conventional forms but only under certain situations. Slow-release nitrogen fertilizers are recommended for use in all regions of the United States. However, these fertilizers are quite expensive in comparison to standard urea and inorganic salts containing ammonium and nitrate forms of nitrogen.

• Nitrification inhibitors delay the microbiological transformation of ammonium to nitrate. They are typically applied with ammonium salts or ammonium-forming nitrogen fertilizers and are effective for 30 to 90 days. In this way, nitrification inhibitors as-

sist in regulating the amount and potential distribution of nitrates in the soil. These products, however, do not perform well in warm, humid regions such as the Southeastern U.S.

Rate

Extra amounts of fertilizer will not ensure better crop yields or more efficient fertilizer uptake. Excessive application will increase both the cost to the grower and the potential contamination of surface waters and groundwater. Excessive application of nitrogen fertilizer will increase the likelihood that nitrogen will be leached into surface water and groundwater. Excessive phosphorus application will cause P buildup in the soil and greater surface runoff losses of P, where soil erosion is not kept to a minimum.

Rates Of Nitrogen Application

• The rate of nitrogen should be adjusted to a reasonable yield goal for the specific crop and field or soil, based on local research. All soils do not have the same yield potential and should not receive the same fertilizer rate.

• Some states use nitrate tests to estimate the amount of nitrogen needed before planting or sidedressing. In years with extreme weather variation, and especially in the warm, humid Southeastern U.S., the estimated amounts may be inaccurate for optimum response.

• The amount of nitrogen from other sources should be accounted for when determining nitrogen application rates. Other sources include nitrogen in irrigation water, soil nitrogen mineralization, and the nitrogen provided by organic wastes, manures, or legumes such as alfalfa, soybeans, clover, and vetch.

• Soil leaching potential should be considered when determining application rates. In certain soils much of the applied nitrogen may be leached from the root zone by natural rainfall or irrigation if applied above certain rates and within a short time interval.

Placement

Proper timing and placement of fertilizer determines whether nutrients will be present when needed by the crop. This is especially true for immobile nutrients such as phosphorus and sometimes potassium. The efficient use of phosphorus is particularly affected by placement.

Many placement techniques are available for today's farm managers. Soil and crop type, tillage system, and economics all influence which placement technique the farm manager will choose.

Broadcast And Surface Incorporation. The simplest method of fertilizer application is to broadcast the material on the soil surface. The objective is uniform distribution of the nutrients and proper distribution of the herbicide if a weed-and-feed combination of herbicide and fertilizer is used. Depending on the tillage system, crop, expected weather conditions, herbicide program, and soil type, the fertilizer material may be left on the surface or incorporated after application.

Generally, all nutrients will be more efficiently utilized if they are incorporated after application. Incorporation makes the nutrients less susceptible to erosion and runoff loss just after application. Ammoniacal nitrogen fertilizers are usually incorporated to reduce possible losses of ammonia through volatilization. Phosphate and potash are usually incorporated to encourage more efficient utilization by the crop since soil moisture enhances their availability.

Banding. Applying fertilizer in a narrow zone or band to provide a concentrated source of nutrients is an advantage under some situations. Band application may result in more efficient use of the nutrients (1) if soil test levels are low, (2) when early season stress from cool or wet conditions is likely to limit root growth, (3) where large amounts of surface residue limit soil-fertilizer contact, or (4) in soils that have a high tendency to fix nutrients in unavailable forms throughout the soil.

Generally, all types of banding of P, K, and micronutrients result in more of the applied fertilizer material being utilized during the first cropping season. This means less residual, or buildup, for later cropping seasons. Nitrogen applications for reduced tillage systems are particularly adapted to band applications. Band placement of some sort is the single most important management tool available to improve phosphorus use by plants.

Surface Strip Or Banding. This method of fertilizer placement involves application of solid or fluid fertilizers in bands or strips of varying widths on the soil surface or on the surface of crop residues. Typically, the fertilizer material is applied in strips that represent 25 to 30 percent of the soil surface. Depending on the tillage system, the strips may be either incorporated or left on the surface. Applications of phosphate and potash should be incorporated since P and K losses are closely tied to soil erosion.

Starter. Starter fertilizer application, a form of band application close to the seed, is an important means of getting crops off to an early start. It is particularly helpful for crops planted in cool soils. Crops planted under conservation or reduced tillage conditions frequently face those conditions. Cool soil temperatures slow root development, lower plant metabolism, and diminish the amount of energy released by sugar metabolism, which is needed for nutrient uptake.

Higher concentrations of nutrients close to the developing seedlings can help overcome limitations to nutrient uptake and availability.

"Pop-up" is another term that is sometimes used in connection with starter terminology. This term means direct seed application of fertilizer material at low rates to stimulate very early growth. Many crops are very sensitive to direct seed-fertilizer contact, and rates of nutrients for pop-up must be very low. Serious injury to the seed can result if the rate of total N plus K_2O is above 7 to 10 pounds per acre, particularly for row crops.

Starter fertilizer doesn't pay every year, but it rarely causes a problem. It can get a crop off to a faster start, thus establishing the crop canopy and root system earlier. A well-established crop will reduce water erosion of the soil and make more efficient use of resources.

Deep Banding. The term "deep banding" usually refers to preplant applications of nutrients (N, P, K, and S) injected 2 to 6 inches below the soil surface. In special situations, such as lime or deep potash placement, the depth of injection may be 12 inches or more below the soil surface.

Deep banding is ususlly the least desirable and often the most expensive way of incorporating fertilizer into the soil.

Early N should not be placed deeper than 2 inches for shallow-rooted vegetable crops grown on sandy soils. Natural rainfall or irrigation could leach the nitrogen too deep to be recovered by such crops.

Point Injection Of Fluids. Point injection creates pockets or "nests" of nutrients in the soil with subsequent high nutrient concentrations. This relatively new technique employs a spoked wheel to physically inject nutrients at points about 8 inches apart to depths of 4 to 5 inches. A rotary valve in the wheel hub dispenses fertilizer to the "down" spike from a positive displacement pump.

Theoretically, the effects of these high concentrations would be about the same as those from knifed bands, and modified soil chemistry in the retention zone could be expected. Preplant or post-plant applications of fluid fertilizers for conventional and reduced tillage systems may benefit from point injection.

Conclusion

Nitrogen and phosphorus are natural parts of a large cycle in the environment and their own individual cycles in soils, plants, and animals. Both are vitally needed as fertilizers. Both can be lost from the soil and into the environment. And both can be managed in ways that serve farmers and consumers and that are compatible with the environment.

References

Best Management Practices For Profitable Nitrogen Programs. 1989. Pioneer. Des Moines, IA.

Fertilizer Management For Today's Tillage Systems. 1989. Potash and Phosphate Institution. Foundation for Agronomic Research. Atlanta, GA.

Humenik, Frank J., DeAnne D. Johnson, Jonathan M. Greglow, Steven A. Dressing, Richard P. Maas, Fred A. Koehler, Lee Christensen, William Snyder, James W. Meek, and Fred N. Swader. 1982. Best Management Practices For Agricultural Nonpoint Source Control: II Commercial Fertilizer. North Carolina Cooperative Extension Service. Biological and Agricultural Engineering Department. North Carolina State University. Raleigh, NC.

Plant Nutrient Use And The Environment: Executive Summary Of A Symposium. 1985. The Fertilizer Institute. Washington, DC.

This publication, supported in part by a grant from the Alabama Department of Environmental Management and the Tennessee Valley Authority, was prepared by James E. Hairston, *Extension Water Quality Scientist*, assisted by Leigh Stribling, *Technical Writer.*

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

UPS, **New June 1995,** Water Quality 4.4.3

ALABAMA COOPERATIVE Extension SYSTEM

ANR-790-4.4.3