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Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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MANAGING NUTRIENTS TO MITIGATE GREENHOUSE GASES

Greenhouse gases are grabbing attention. The awarding of the 2007 Nobel Peace Prize to prominent leaders in the climate change issue reflects a global surge of public concern. While agriculture emits less than 10% of the total greenhouse gases in North America, its share of the issue is still important. And it has implications for managing crop nutrients.

Crop growth absorbs the greenhouse gas carbon dioxide, but requires activities that emit it. Photosynthesis captures carbon dioxide from the air. A smaller quantity is released back into the air by tractors, trucks, and the manufacture and transport of materials moving to and from the field.

Carbon dioxide is not the only concern. Methane and nitrous oxide also contribute to global warming potential. Methane emissions can increase sharply when flooded crops like rice are grown. But the biggest part of the issue for agriculture may be nitrous oxide.

Nitrous oxide is emitted sporadically when soils are not quite soaking wet. The biological processes and controls are not fully understood. Emissions tend to increase when soils contain high levels of plant-available N – the nutrient that most often limits crop yields.

Carbon captured by crops can mitigate emissions. Crops can increase the organic carbon in the soil. Crop products can replace fossil fuels. Mitigation can be enhanced by increasing crop yields. Optimum levels of all plant nutrients therefore help capture carbon.

Since cropping systems both emit and absorb, the net balance is critical. A full greenhouse-gas balance for a cropping system requires year-round tracking of all three gases, plus life-cycle analysis for all the inputs used. The few studies available show that most systems are net sources of global warming potential, but some have smaller footprints than others.

Intensive crop management systems balance mitigation and production. Because of their increased ability to take carbon dioxide from the air and produce higher yields, they do not necessarily increase greenhouse gas emissions per unit of production. Conversion of cropland to forest usually provides a net sink for greenhouse gases. Intensive crop management makes more room for such conversion, while supplying the world's needs for food, fiber, and biofuel.

The nutrient N demands particularly careful management. It plays a critical role in plant capture of carbon and its storage in soil. But its manufacture and transport entail carbon dioxide emissions, and its use is associated with nitrous oxide emissions. Its contribution to the net balance of greenhouse gases is highly sensitive to management. Best management practices ensure it effectively supports high yields with minimum associated emissions.

Managing N is critical for intensive cropping systems. Enhanced-efficiency technologies can help manage transformations of fertilizers applied to the soil and reduce residual soil nitrate. They include controlled-release coatings, and inhibitors of urease and nitrification. They can be effective in increasing N use efficiency while maintaining or improving yields. Some show promise for cutting nitrous oxide emissions directly as well.

Is there a technological solution to the nitrous oxide issue? A specific inhibitor of conversions that produce nitrous oxide is theoretically possible. Certain pesticides have been observed to stimulate nitrous oxide production. Could a specific chemical do the opposite? Scientific information on this question is scant.

—TWB—

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Abbreviations in this article: N = nitrogen.

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INTERPRETING SOIL TEST RESULTS… A CRITICAL STAGE WHEN DEVELOPING FERTILIZER RECOMMENDATIONS

It is one thing to take soil samples and another to effectively interpret the results. Soil sample analysis results are usually reported in parts per million (ppm). That means micrograms of the nutrient per gram of soil tested (µg/g). Or, in some instances results are reported as pounds of nutrient per acre of topsoil (lb/A).

The levels of the nutrient are usually rated into categories of availability based on field calibration research results for the local area or region. For example, common categories are very low, low, adequate, high, and excess. The amount of fertilizer nutrient to be added is based on the level of nutrient availability and the probability of obtaining a crop growth and yield response. A very low test result would mean a relatively high rate of fertilizer could be added and this rate decreases in amount when the test result increases until no fertilizer is recommended when an excess test result is observed. A misinterpretation of the availability of a specific nutrient may mean that insufficient or excess amounts of a nutrient may be recommended.

Sometimes the results received from the lab are quite different than what has been observed in the past or what was expected. It is important to understand why the results are different. The advantage of taking and reviewing the results of soil testing on a specific field on a regular basis, ideally each year, is that it allows comparison of this year's results with past year's results. If the level of a specific nutrient is unusually lower or higher than observed, it is important to try to understand why the level is different. For example, if the level of NO_3-N in a soil after a wheat crop is usually between 7.5 and 15.0 ppm and if the level is very low at 3 ppm (or contrastingly very high at 40 ppm) the two unusual results might be due to the extremes in weather experienced during the growing season. An unusually low soil test result such as the 3 ppm above may be due to a very good growing season with ample precipitation and excellent crop growth that removed more N from the soil than normal. The unusually high soil test result (i.e. 40 ppm) may be due to a very dry growing season where crop growth was so limited by the lack of moisture that much of the plant available N in the soil wasn't used and remains in the soil.

What factors can cause soil test results to be different than normal? The most common factor is extremes in weather, either unusually moist or unusually dry as noted above. Other factors causing an excess nutrient level may be a crop failure resulting from early frost, a planting problem, severe insect or fungal disease infestation, or severe hail damage. Sometimes a low soil test results from a mistake in soil sample collection when a deeper sample than planned and reported was taken. Possibly a 0 to 12-in. sample was collected when a 0 to 6-in. sample was wanted. This can make a difference, especially for soils with shallow topsoils. Sometimes a higher than normal soil test result can be due to taking a soil sample in an area uncharacteristic of the field. For example, if one of the 20 subsamples that were mixed together to make up the field sample is taken near the edge of a low-lying saline depression, the S soil test result for the field sample may test very high in SO_4-S (e.g. 85 lb S/A), while the average soil test level of S for the majority of the field may actually be low (e.g. 5 lb S/A). In this example, a zero S fertilizer recommendation would result and much of the subsequent crop could be S-deficient.

It can be useful to contact the laboratory. If you have difficulty in determining why a soil test is unusually lower or higher than expected and you can't figure out why, it can be helpful to contact the soil test laboratory agronomist.

If the soil test results are difficult to explain, it may be best to re-sample. In some instances, an unusual soil test result can't be explained and it is best to resample the field. Often, the second soil test will be more normal.

—TLJ—

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Abbreviations in this article: N = nitrogen; NO_3^- = nitrate; S = sulfur; SO_4 = sulfate; ppm = parts per million.

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GETTING THE MOST FROM YOUR FERTILIZER DOLLAR

Fertilizer consumption in the United States has been on a relatively flat plateau for the past 30 years. Until recently, increases in prices were relatively modest and slow. However, the combination of high crop values, rapid increases in energy costs, and booming international fertilizer demand have all boosted fertilizer prices. Higher prices should prompt everyone to review management practices to get the greatest benefit from added fertilizers. Here are some general principles for optimizing fertilizer efficiency…but local conditions will vary and may require consultation with a Certified Crop Adviser for your situation.

Soil Sampling: One of the keys to getting the most from applied fertilizer is to know exactly which nutrients are lacking and what amount is needed to bring them to non-limiting levels. Applying only what is needed will save money compared with putting a blanket application across the entire farm. Consider sampling the soil for available N before fertilizing this year in order to adjust for existing nutrients in the root zone.

Proper Equipment: Check your machinery to make sure that it is properly calibrated. Equipment malfunction or operator error too often results in the incorrect amount of fertilizer being applied. Too much fertilizer wastes money and too little can hurt crop yield and quality.

In the Right Place: Placement can make a big difference in getting the highest return from fertilizer. Know where the specific fertilizer materials you use should be placed. For example, when urea or UAN solutions are broadcast and remain on the soil surface, they can be subject to considerable ammonia volatilization losses. Phosphorus is generally most effective when it is applied close to the rootzone. Avoid P loss in runoff to minimize environmental concerns by using appropriate conservation practices. Potassium can be applied by broadcasting or banding with excellent results. There are no serious environmental impacts associated with K fertilization.

At the Right Time: Some nutrients, such as P and K, can be applied months in advance of the crop demand. Fall fertilization for spring-planted crops is a good practice for these nutrients. However, it is generally best to apply N as close to the time of plant demand as possible. Nitrogen efficiency may be boosted by making multiple fertilizer applications, using controlled-release products, and monitoring the N status of the growing crop.

Establish Realistic Yield Goals: Keep good records of how your fields have performed and then fertilize for realistic yields. Everyone wants to have record-breaking yields every year, but knowing how each field performs over time lets you know what you can reasonably expect to harvest… and then fertilize accordingly.

Improve Water Management: Water and plant nutrition are closely linked. If irrigation water is not uniformly distributed across the field, plant performance will suffer. Excessive water can move nutrients below the root zone and cause runoff of nutrients, sediment, and organic matter. Insufficient water will stunt crops and prevent the applied nutrients from being used for growth. Properly fertilized crops actually use water more efficiently and have more harvestable yield per inch of water applied compared with under-fertilized crops.

Take Fertilizer Credit: There are nutrient sources that are sometimes given inadequate credit. With higher fertilizer prices, all sources should be valued. For example, know the analysis of any manure being applied to the soil and calibrate the manure spreader to accurately and uniformly apply nutrients across the field. Irrigation water may contain enough nitrate to supply a significant amount to the crop requirement. An analysis of irrigation water quality may be a useful guide.

Fertilizer application is still a great investment for growing high yielding and profitable crops. There is no substitute for supplying the basic nutritional building blocks required for plants to grow. However, do not use more fertilizer than the crops can use. Proper fertilization is good for your wallet and safe for the environment.

—RLM—

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Abbreviations in this article: N = nitrogen; UAN = urea ammonium nitrate; P = phosphorus; K = potassium.

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STARTER FERTILIZER: CONSIDERATIONS FOR CORN FOLLOWING CORN

Corn following corn is on the rise. Compared to corn following soybean, corn following corn will be planted in heavier residue cover. Crop residues act as an insulating layer over the soil surface. In the spring, soils with higher residue can be slower to warm up.

Soils under no-till are more dense near the surface than tilled soils. This higher density can make soils slower to dry as well as slower to warm.

Cooler, wetter soils slow down the mineralization of N and P from the soil. They also slow the rate of corn root and shoot development.

Starter fertilizers can boost corn growth early in the season. Early in its development, corn has roots that grow down and to the side, at approximately a 45-degree angle. Nutrients placed 2 in. to the side and 2 in. below the seed are well placed for access by the young root system. Such placement is the standard against which all other starter placements are measured. It usually provides greater chances of yield response than other placement options as well as greater responses when they do occur.

Nitrogen and P work together. Starter formulations that contain the NH_4^+ form of N can increase P uptake by the corn plant. This happens because when the plant takes up NH_4^+, the soil right around the root becomes more acid than the surrounding soil. This more acid environment enhances P availability. The synergistic effect of NH_4^+-N and P occurs only when the two nutrients are banded together. A band of NH_4^+-N separated from a band of P does not enhance P uptake.

Both N and P proliferate roots. This means when the root system finds a concentrated area of these nutrients, more root branching will take place, and a larger proportion of the root system will be in the band of nutrients.

The N and P in starter fertilizer count as a part of the total amount of these nutrients applied for corn. It is important to include them to ensure the total rates applied match those recommended.

Starter fertilizer is very efficiently used. Because of its excellent positional availability early in the season, efficiency of use can be higher than other placement methods. It is important to remember, however, that corn needs both a concentrated zone of nutrients early in the season as well as nutrients more distributed through the rooting zone to maximize yield.

—TSM—

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Abbreviations in this article: N = nitrogen; P = phosphorus; NH_4^+ = ammonium.

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IS SWITCHGRASS A LOW NUTRIENT INPUT CROP OR NOT?

Switchgrass is being promoted as one of the primary candidates for cellulosic ethanol production. It is a warm-season, perennial grass that is projected to have good biomass yield potential (up to 10 dry tons/A), fairly high ethanol yield (about 100 gal/ton of hay), and good ecological suitability for many areas.

Switchgrass is also commonly cited as having relatively low nutrient input requirements. Popular articles describe switchgrass as a "thrifty" crop that can be grown with little or no additions of fertilizer, and still maintain productivity. However, several studies have demonstrated that switchgrass can be very responsive to nutrient additions (especially N) and also remove large quantities of nutrients (particularly K) from the soil.

Typical N recommendations for established switchgrass range between 50 and 100 lb N/A/yr. However, most of the published fertility recommendations for switchgrass are based on the crop being grown for grazing or hay production. In these situations, maximum forage yield is sometimes compromised in favor of improved forage quality. Research focused on maximizing biomass production is scarce and reported optimum N rates have varied. A study in Texas concluded that switchgrass production would be sustainable with N applications of 150 lb N/A/yr, while researchers in Alabama reported increasing forage yields up to 200 lb N/A/yr. Nitrogen removal for switchgrass averages 22 lb N/ton, which is less than the N removal reported for corn silage and several other warm-season forage grasses like hybrid bermudagrass, eastern gamagrass, and johnsongrass, but very similar to the amount removed in the grain from a 180 bu/A corn crop.

One ton of switchgrass will remove approximately 9 and 46 lb P_2O_5 and K_2O/A, respectively. Comparing a 6-ton switchgrass yield to a 180-bu corn crop, the P_2O_5 removal would be about 26 lb/A less for the switchgrass, but K_2O removal would be 224 lb/A greater for the switchgrass than the grain. Some of the nutrients taken up can be recycled back to the soil by delaying harvest until after senescence, when minerals can leach from the fallen leaves. However, a significant portion of these nutrients will need to be replaced through fertilization. Soil testing and estimated crop nutrient removal are the best methods for determining fertilizer needed to maintain productive levels of P and K in the soil, but mining of soil nutrients (particularly K) that leads to declining yields is not uncommon in major warm-season forage grass production regions. Some states indicate that over 50% of the soil samples tested for warm-season grass production are in need of K fertilization.

Sustainable production of switchgrass for the biofuel industry without fertilization will not likely be feasible. Whether switchgrass can be grown as a "low-input" crop remains to be determined. Harvesting for energy after senescence could conserve K and possibly reduce fertilizer inputs, but more research on production strategies is needed. More research is also needed to identify optimum N rates across diverse production areas.

—SBP—

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Abbreviations in this article: N = nitrogen; K = potassium.

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ANOTHER LOOK AT THE IMPACT OF PRICES

Over the past several years we have spent lots of time talking about the effect of prices on crop production practices. In the late 1990s, we were addressing what seemed to be chronic low commodity prices. Then in the early 2000s, natural gas price dramatically increased with N fertilizer prices quickly following. The prevailing question in these circumstances was: “Just how much do shifts in commodity and/or fertilizer prices affect optimal rates of fertilizer applications?” Or, put another way: “How much should I adjust my fertilizer application in response to changing prices and costs?”

A lot has changed over the past few months. Due to the biofuels frenzy and other factors, the grain price situation has significantly improved. However, fertilizer prices are in general at near record levels. Therefore, now is a good time to again review some of the basic principles of fertilizer economics.

There are four primary factors affecting profitability: crop price, production costs, yield level, and crop quality (as it affects price). Typically, producers are price takers and thus have little control over prices. However, they do have control over variable costs, which directly impact yield and quality. In this sense, yield level is a controllable factor influencing profit. Once a decision has been made to plant a certain crop, it becomes a matter of making the most of the opportunity. This requires planning an efficient program designed to produce maximum returns per acre...in other words, to produce yields that maximize profit.

Greater profits come from higher yields since costs are spread over more units (bushels, bales, pounds, etc.), resulting in lower cost per unit of production. Efficient and profitable production involves lowering unit cost to a point of maximum net return. Analysis of a long-term irrigated corn study conducted in western Kansas has demonstrated the relationships among yield, cost per unit of production, and profit. In this study, several N fertilizer rates were evaluated with (40 lb P_2O_5/A) and without P fertilization. When averaged over 30 years, the profit maximizing N rate (or economic optimum N rate) where P was applied was approximately 147 lb N/A (assumes $0.45/lb N and $3.50/bu corn). The yield produced at this level of fertilization was slightly lower than the maximum yield that required 167 lb N/A. Phosphorus fertilizer increased profit by about $170/A at the optimum N rate (assumes $0.50/lb P_2O_5). Cost per unit of production was near minimum at the optimum N rate where P fertilizer reduced cost by $0.58/bu.

Crop and fertilizer prices have a lesser effect on optimum levels of fertilization than one might anticipate. This is because in determining profitability, yield level tends to have an overshadowing effect on crop and fertilizer price. An Excel budgeting tool created by economists at Kansas State University demonstrates this effect. For irrigated corn (220 bu/A yield goal) where N is $0.45/lb, the difference in the optimum N rate when corn price goes from $3/bu to $4/bu is 22 lb (from 233 to 255 lb N). Similarly, if corn price is $3.25 and N price ranges from $0.30 to $0.50, the optimum N rate differs by only 20 lb N/A (from 255 to 235 lb N/A). Many other assumptions (defaults) were made in this analysis. In addition to corn, this tool has options for analyzing other crops and is available online at this URL: >**www.agmanager.info/crops/budgets/proj_budget/decisions**<.

Balanced and complete crop nutrition is critical to system profitability, even with higher fertilizer prices. Best management practices for application of right nutrient rate, source, time, and placement are especially important in today’s environment. Keeping soil test information up-to-date, identifying profitable fields or field areas, using all nutrient sources available, and adopting nutrient management practices grounded in proven scientific principles assure the greatest chances for success.

—WMS—

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Abbreviations in this article: N = nitrogen; lb = pounds; bu = bushels; A = acres.

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