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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 1

CROP NUTRITION WITH LOWER EMISSION OF NITROUS OXIDE

Nitrous oxide is one of several greenhouse gases considered responsible for the warming trend in the climate. Pound for pound, it is deemed about 300 times more effective in trapping heat than carbon dioxide. Experts recently agreed on a new approach to fertilizer stewardship to limit its emission.

Greenhouse gas inventories for the USA and Canada currently estimate that nitrous oxide from agricultural soils contributes about 3.5% of their total greenhouse gas emissions. The emissions in this category are considered to arise from application of fertilizers and manures, from organic materials in and on soils, and indirectly from N losses. Direct emissions from fertilizer application comprise roughly one-quarter of this category. Better management of N fertilizer could reduce the direct emissions of nitrous oxide—equivalent to 55 million metric tons (M t) of carbon dioxide—and also some of the even larger indirect emissions.

Farmers can achieve better management through implementation of 4R fertilizer stewardship, applying the right source at the right rate, right time, and right place. This approach starts with the definition of economic, social, and environmental sustainability goals. The 4Rs describe site-specific practices—based on sound agronomic principles and supported by objective research results—that contribute to the defined goals.

Including nitrous oxide emission reduction as one of the goals leads to the selection of practices that are "right" for reducing nitrous oxide without neglecting the remaining goals. Farmers may need to spend or invest more to implement such practices. However, the environmental benefit for the "public good" should be recognized as a carbon credit or offset in protocols for reduction of greenhouse gas emissions.

A Consultation Workshop held in Calgary, Alberta, last fall kicked off the development of a nitrous oxide emissions reduction protocol (NERP). Government, industry, and science representatives participated in a discussion process to propose levels of 4R fertilizer stewardship that would qualify for specific nitrous oxide emission reductions. The levels are differentiated by increasing management intensity in selection of source, rate, timing, and placement of N fertilizer. Work is continuing to select practices appropriate to Eastern as well as Western Canada, and to further define the appropriate practices.

Recent studies by the USDA Agricultural Research Service with irrigated no-till corn in Colorado documented reductions of 25 to 50% in nitrous oxide emissions through use of enhanced-efficiency N fertilizer sources. Similar reductions have been reported in other studies, and may be witnessed in on-going research in the USA and Canada.

Investment in and implementation of 4R fertilizer management would seem attractive not only to farmers and society, but also to carbon credit and offset trading programs. New and exciting technologies are being explored, and better crop management skills are being honed by professional agronomists, crop advisers, and farmers. As science-based nitrous oxide emission reduction protocols are developed, there may be potential for farmers to receive carbon credits to help optimize the performance of their cropping systems. Stay tuned !

– TWB/CSS –

For more information, contact Dr. Tom Bruulsema, IPNI Northeast Director. Phone: (519) 821-5519.
E-mail: tom.bruulsema@ipni.net.
Dr. Cliff Snyder, IPNI Nitrogen Program Director. Phone: (501) 336-8110. E-mail: csnyder@ipni.net.

Abbreviations: N = nitrogen.

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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 2

HIGHER YIELDS AND THE NEED TO ADJUST NUTRIENT APPLICATIONS

Yield levels have increased over time. At some winter meetings, I have heard people ask: "Why is it necessary to add supplemental nutrients in the form of fertilizer, because in the early days my Grandpa or Great Grandpa never used fertilizer and grew nice crops." In answering, it is useful to understand what has occurred in our soils and cropping systems over time. A recent summary by researchers at the Dickinson Research Extension Center in North Dakota showed the mean yield for a couple of crops over time. In the 1940s, the average yields for spring wheat and barley were 21 and 33 bu/A, respectively. But by the 1990s, these average yields increased about 100%, to 40 and 76 bu/A, respectively. The standard for what is considered an adequate yielding crop has increased. Yield improvements can be attributed to a combination of developments in agronomic practices.

Higher yields put a greater demand on the limited supply of mineral nutrients coming from soils. In the 1940s, under a crop-fallow rotation, wheat yield responded only occasionally to N fertilizer. Today, additions of fertilizers containing N, P, K, S, and occasionally some other nutrients are important to achieving higher yields. In the 1940s crop-fallow rotations, the N required for crop growth came from mineralization of soil organic matter during the year of cultivated fallow and the year of cropping. Soil organic matter mineralization can only release a certain amount of N over time. By the 1950s in much of the Northern Great Plains (NGP), the organic matter content in soils was half of the original level present when the grassland soils were plowed and brought into annual small grain cereal production. This first loss of organic matter came primarily from the most easily decomposed portion and released considerable N. The remaining portion of the soil organic matter is more resistant to decomposition, and releases smaller amounts of N.

Fertilizers can be used to supplement the supply of nutrients available from soil. It was fortunate that as cropping continued on the NGP soils that had been depleted of soil organic matter, and the original easily used portion of nutrient pools, the availability of nutrients in the form of commercial fertilizers (primarily N, P, K, and S) increased. The adequate use of fertilizers, along with larger yield potentials, enabled growers to increase yields and gradually rebuild some of the lost soil organic matter.

Determining which nutrients are required and how to best apply them is important to a successful crop management program. Applying sufficient but not excessive amounts is important to achieving desired yields, while avoiding adverse environmental effects. Ideally, each field and even portions of fields can be managed to maximize net economic returns per acre. Year to year nutrient management is a process of first estimating what the soil will supply, shown primarily through soil sampling and analysis. Secondly, assess how much of the various nutrients are needed based on realistic and yet progressive yield targets. Lastly, supply nutrients in effective forms at right rates, timing, and placement to optimize crop uptake and utilization (4R stewardship).

Improved crop yield potentials increase the need for supplemental nutrient sources. Usually, the higher the potential yield target, the higher the required amount of supplemental nutrients. Using the mean wheat yields from the North Dakota work mentioned above, the average nutrient removals in the harvested grain for N, P_2O_5, K_2O, and S for the 20 bu/A crop of 1940 were approximately 30, 10, 7, and 4, respectively. Compare this to removals of 60, 20, 14, and 8, respectively, for the 40 bu/A crop of 2007. The increase in potential crop yields puts more demand on the nutrient supplying capacity of the soil. Fortunately, well planned additions of nutrients in the form of fertilizers helps soils to meet this increased demand.

– TLJ –

For more information, contact Dr. Thomas L. Jensen, Northern Great Plains Director, IPNI, 102-411 Downey Road, Saskatoon, SK S7N 4L8. Phone: (306) 652-3535. E-mail: tjensen@ipni.net.

Abbreviations: N = nitrogen; P = phosphorus; K = potassium; S = sulfur.

Note: ***Plant Nutrition TODAY*** articles are available online at the IPNI website: www.ipni.net/pnt

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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 3

WATCH EMERGING POTASSIUM DEFICIENCY WITH DRIP IRRIGATION

The use of drip irrigation continues to expand to cover more acres and more crops. This conversion may be driven by labor costs, a need for improved water management, fertilizer efficiency considerations, or a quest for higher yields. Whatever the reason, there are important differences to consider with your nutrient management program when making this change.

Yields have soared for many crops as the transition continues from surface irrigation to drip irrigation. For example, average yields for California processing tomatoes have climbed from 30 tons/A to over 40 tons/A in the past 10 years … with yields well over 50 tons/A becoming common. Table grape vineyards that previously produced 400 boxes/A now produce more than 1,000 boxes/A with drip irrigation, while using less water.

When plants are irrigated with drip irrigation, root growth is concentrated in the soil zone where frequent wetting occurs. This limited zone contains most of the water and nutrients that the plant will extract for growth and development. When the drip emitters are buried 6 to 12 in., much of what is happening is hidden from view.

A recent study conducted by the University of California measured the nutrient demand of drip-irrigated processing tomatoes. In eight high-yielding fields, they measured an uptake of 80 lb P_2O_5/A in the entire plant and a removal of 60 lb P_2O_5/A in the 57 tons of harvested fruit. In these same fields, the plants accumulated a total of 350 lb K_2O/A, and the harvested fruit removed 290 lb K_2O/A. The average application rate on these fields was only 9 lb K_2O/A!

Plants require a large amount of K to support high yields. In these trials, it is clearly not sustainable to remove 290 lb K_2O/A in the fruit while returning only 9 lb K_2O/A, but similar examples of nutrient mining are common with many crops. Processing tomatoes are particularly sensitive to potassium shortages since they can cause undesirable fruit disorders such as yellow shoulder and internal white tissue. Potential nutrient deficiency problems are compounded with drip irrigation since the root system is extracting nutrients from a small zone of soil.

Soil sampling is the best way to estimate the need for supplemental K fertilization, but remember to sample in the zone where the roots are most active, which may be 10 to 20 in. deep with a buried drip irrigation system. If soil samples are taken only from areas without many roots, misleading results may indicate the presence of sufficient nutrients, while the nutrient concentration is actually quite low in the zone of active uptake.

There are a number of excellent K fertilizer sources that can be added to water and applied through a drip irrigation system. Depending on what additional nutrients are needed, growers successfully use products such as potassium chloride, potassium sulfate, potassium nitrate, potassium thiosulfate, and mono-potassium phosphate through drip irrigation systems. Whatever source is used, pay attention to the soil zone where the roots are actually growing and remember that high-yielding crops must have an adequate nutrient supply to support their growth.

– RLM –

For more information, contact Dr. Robert Mikkelsen, Western North America Director, IPNI, 4125 Sattui Court, Merced, CA 95348. Phone: (209) 725-0382. E-mail: rmikkelsen@ipni.net.

Abbreviations: K = potassium.

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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 4

SKIPPING A PHOSPHORUS OR POTASSIUM APPLICATION

A farmer may ask: What happens if I skip a P or K application this year? The answer to that question depends a lot on the starting point. What are your soil test levels? Have you built them up and been maintaining them or have you been keeping them lower in order to capture short term gains from annual applications?

Listed below are some warning signs that skipping an application could result in yield losses this year:

- **You've been using half to a third of the recommended rate, applied as a band.** This practice relies on the increased plant use efficiency of the banded nutrients to reduce rates. These rates are often below those needed to maintain soil fertility levels. Following this recommendation for many years can deplete soils of P and K. It can also limit yield unless combined with an occasional higher rate broadcast application.
- **You've been banding lower rates of nutrients for only some of the crops in your rotation.** An example is banding low rates of P and K for corn, but not applying any additional fertilizer to the rotational soybean crop. This practice draws down fertility, particularly in the soil between the bands. Problems can especially show up when the row spacing of a crop doesn't match the spacing of the fertilizer bands. An example is soybeans planted in 7.5 in. rows in a field where 30 in. wide bands of fertilizer were applied for corn. Soybeans between the bands won't be able to access the banded nutrients and have to rely mostly on the depleted soil between the bands.
- **You've skipped one or more applications before.** Soil supplies can last only so long before they need to be replenished.
- **You've just rented a new piece of ground.** The fertilization history is probably unknown and previous management may not have been up to par. After all, the previous renter isn't farming it anymore.
- **It's been awhile since you've taken soil tests.** If you can't find the last report, it's probably time to reassess. You don't want to fly blindly, especially considering the costs now.

On the other hand, if you've been keeping up with maintenance applications and your soil tests are higher, your soil may already have all the P and K the crop needs this year – allowing you to skip. **Just remember that what comes out must eventually go back in to sustain fertility.**

– TSM –

For more information, contact Dr. T. Scott Murrell, Northcentral Director, IPNI, 2422 Edison Dr., West Lafayette, IN 47906. Phone: (765) 463-1012. E-mail: smurrell@ipni.net.

Abbreviations in this article: P = phosphorus; K = potassium.

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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 5

ON-THE-GO MANAGEMENT OF COTTON INPUTS

On-the-go, optical sensing technologies have some advantages over aerial images. Both tools allow growers to identify variability in their fields, but with the sensor-based systems there is no need to acquire an image from an outside provider and the sensors are not weather dependent. There is also no time lag between in-field analysis using the sensors and variable-rate application of PGRs, fertilizers, or harvest aids.

Cotton growers in the MidSouth and Southeast have used GreenSeeker sensors to make variable-rate PGR applications. GreenSeeker sensors measure reflected light at wavelengths that correspond to crop vigor. An on-board computer calculates the PGR requirement based on the sensor measurements and changes the applied rate as the applicator moves through the field. University research has demonstrated savings of 40 and 33% on PGRs and harvest aids, respectively, using GreenSeeker variable-rate application. However, for sensor-based systems like GreenSeeker to be even more economical for cotton farmers, variable-rate N needs to be part of the package.

Variable-rate N applications in cotton have not been developed as rapidly as in other crops like wheat and corn. However, beginning in 2008, Cotton Incorporated named sensor technology as its precision agriculture research focus. In addition to the internal work being conducted in their core program, Cotton Inc. is coordinating university research in 13 states across cotton producing regions of the USA. As part of this program, various methods to determine cotton N requirement using optical sensors are being evaluated.

Nitrogen rates can be determined based on estimated yield potential. This approach has been used successfully in wheat and corn in several states. States evaluating this method for cotton include Louisiana, Oklahoma, South Carolina, and Texas. This method requires in-field, high-N reference areas for calibration. The South Carolina work has shown that different calibration values need to be established for different soil types.

Other work has identified a link between sensor measurements and leaf N. Researchers at Mississippi State University have established strong relationships between leaf N and sensor measurements across a range of cotton growth stages. The ability to use sensors to indirectly determine leaf N can result in accurate N rate recommendations without having to collect and analyze leaf tissue samples.

Another approach being evaluated in Tennessee uses known field history and current sensor measurements. For example, a field with historically high yield potential resulting in high sensor readings would be considered typical and N fertilizer would be applied normally based on expected yield. The same would be true for low sensor readings in a known low-yielding field. Using this approach, changes in fertilizer management will be needed only if the sensor measurements and field history don’t match. For example, a typically low-yielding field giving high sensor readings could indicate rank growth and N rates might need to be reduced.

Variable-rate N management in cotton using ground-based sensors still needs to be refined, but the potential for success is evident. Several states have not advanced past small-plot research work, but those that have taken the technology to grower fields are encouraged by the results. To learn more about on-the-go cotton sensing and other topics in precision agriculture, make plans now to attend InfoAg 2009 scheduled for July 14-16 in Springfield, Illinois. Visit the website at: **<www.infoag.org>**

– SBP –

For more information, contact Dr. Steve Phillips, Southeast Director, IPNI, 3118 Rocky Meadows Rd., Owens Cross Roads, AL 35763. Phone (256) 533-1731. E-mail: sphillips@ipni.net.

Abbreviations: PGR = plant growth regulator; N = nitrogen.

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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Summer 2009, No. 6

FERTIGATION CONSIDERATIONS

Fertigation, or application of fertilizer with irrigation water, is a long-established and sound practice. For example, application of N through center pivot systems in cotton production has been practiced for many years in the Texas South Plains, and more recently the use of subsurface drip systems in this region has increased substantially. The potential advantages of fertigation include reduced labor and energy cost compared to conventional application, the ability to “spoon feed” the crop, higher yields, and greater nutrient use efficiency. Of course, the topic of fertigation is very broad; nevertheless, a few things to remember when considering fertigation are listed below.

Water quality. The practice of fertigation requires an appropriate irrigation system and an adequate supply of water. Water quality is also a factor to consider, especially in drip systems or anywhere else small emitters are involved. Addition of fertilizers to irrigation water needs to be done carefully to avoid precipitation with minerals or other added chemicals. Thus, care must be taken to avoid plugging orifices or otherwise fouling systems. This is particularly a concern with P fertilizer in water high in calcium. A “jar" test can be a simple way to check fertilizer-water compatibility.

Fertilizer compatibility. There are many fertilizer materials suitable for use in fertigation. It is important to know though that some materials cannot be mixed. Product compatibility charts are available to use for guidance.

Hardware compatibility. Fertilizer and other injected chemicals can be corrosive and thus injurious to irrigation equipment. Operators should be familiar with the limitations of certain types of equipment when it comes to fertigation.

Uniformity. A crucial requirement for effective fertilizer injection into irrigation water is system uniformity. Nutrients applied through the irrigation system cannot be delivered to the crop in the right amount unless the water delivery is predictable and uniform.

Yield boost. In many studies there have been demonstrable and significant yield and quality benefits resulting from fertigation. One example of this was reported in *Better Crops* magazine (2005, No. 3) where multiple applications of P through center pivot irrigation (in a sandy soil) boosted both cotton yield and quality.

Nutrient use efficiency. Delivery of fertilizer with irrigation has the potential to significantly increase nutrient recovery efficiency, especially with more efficient delivery systems. An example of this can be found in work from the south plains of Texas reported in *Better Crops* magazine (2008, No. 4). Cotton N recovery efficiency in this work was as high as 75% with multiple in-season applications through a subsurface drip system.

Interest in fertigation technologies and methodologies will likely continue to grow as the need for improving efficiency of water and other inputs increases. There are several good sources of information for guidance in fertigation decisions. Among these are publications such as *Fertigation* (by Charles M. Burt, et al.), and experienced extension and industry professionals.

– WMS –

For more information, contact Dr. W.M. (Mike) Stewart, Southern and Central Great Plains Director, IPNI, 2423 Rogers Key, San Antonio, TX 78258. Phone: (210) 764-1588. E-mail: mstewart@ipni.net.

Abbreviations in this article: CO_2 = carbon dioxide; N = nitrogen; P = phosphorus; K = potassium.