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

Fall 2008, No. 1

MANAGING PLANT NUTRIENTS FOR THE WORLD FOOD CRISIS

Price increases in crop commodities have precipitated a world food crisis. The forces driving the price increases call for ecological intensification of cropping systems. A recent scientific conference in Montreal, Canada, featured four leading minds who brought out important implications for managing plant nutrients.

1. Better crops demand better science. Professor Ken Cassman, University of Nebraska, pointed out that current rates of gain in crop yields are not adequate to meet the expected demand for food, feed, fiber, and fuel. Future yield increases need to be achieved in the context of declining supplies of water for irrigation, and a higher relative cost of N fertilizer. Expansion of crop area is limited by lack of good quality soils and by concerns about loss of wildlife habitat and biodiversity. Ecological intensification—accelerated yield gain while reducing agriculture's environmental footprint—is the path forward, but depends on getting scientific breakthroughs in basic plant physiology, ecophysiology, agroecology, and soil science.

2. Healthy ecosystems are crucial. Professor Cal DeWitt, University of Wisconsin, spoke on plant and soil management in the context of the biosphere – the layer of life in the soil, water and air that surrounds the globe. Exploring the issue of climate change, he showed how healthy ecosystems are central to the aspirations of humankind, and that a combination of science, ethics, and praxis is needed to conserve the biosphere. Science explains how the world works, ethics describes what ought to be, and praxis defines what we must do. The triad of science, ethics, and praxis applies to the management of plant nutrition.

3. Biofuels link energy and climate change. Professor Don Smith, McGill University, noted that biofuels address two great challenges of the 21st century: energy and climate change. Climate change is an energy issue since it is largely driven by use of fossil fuels. Science and technology are striving to improve biofuel crops to produce more energy per unit of energy consumed in their production. The design of biofuel production systems requires rigorous life-cycle analysis.

4. Are we "starving Peter to drive Paul"? Professor Tom Powers, University of Delaware, discussed the ethical questions that biofuels provoke, including violation of distributive justice, political instability, and harm to the interests of future generations. Our inability to resolve these problems may waste the precious social and political momentum that is attempting to address the challenge of global climate change. Moving beyond a "zero-sum game" requires that crops be more productive.

So what are the implications for managing plant nutrients? The linkages among food, fuel, and climate change mean that a choice between producing food and fuel is not realistic. Ecological intensification of cropping systems will be the path forward, and plant nutrient management needs to support it. The key is to work with a nutrient management system that appropriately applies global scientific principles to local crop management; a system that seeks to apply the right nutrient source at the right rate, time, and place. Crop producers and their advisers need to be selecting practices, on a site-specific basis, for their ability to preserve natural ecosystems by growing more on less land, with less loss of nutrients, recognizing longer-term effects on the soil ecology, and supporting profitable production.

As cropping systems intensify, plant nutrient management will need to adapt. What's right for past cropping systems will not suffice. As crop genetics, rotations, and end-uses change, agronomists, crop advisers, and producers must apply science to assess best management practices for their contribution to an intensification that is ecological and sustainable.

—TWB—

For more information, contact Dr. Tom Bruulsema, Northeast Director, IPNI, 18 Maplewood Drive, Guelph, Ontario N1G 1L8, Canada. Phone: (519) 821-5519. E-mail: Tom.Bruulsema@ipni.net.

Abbreviations in this article: 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

Fall 2008, No. 2

CROP ROTATIONS CAN HELP UTILIZE PLANT NUTRIENTS MORE EFFECTIVELY

Rotating crops on a field can be beneficial for a number of reasons. Plant disease organisms (e.g. fungal, bacterial, and/or viral) and damaging insects are usually specific to a certain crop species. By changing the crop species in a field, the amount and degree of infestation of a pest can be reduced. Another reason is that growing different crops can sometimes allow planting operations to proceed more easily as each crop type leaves different amounts and types of crop residues. For example, it is easier to no-till plant (direct seed) spring wheat into a field pea or lentil residue than into a continuous wheat residue. Also, changing crop species allows different options for weed control. In the case of winter wheat, weeds with a similar life cycle (winter annual), will tend to increase if there is winter wheat grown continuously in the rotation. By rotating with a spring-seeded crop, the winter annual weeds can be controlled with a pre-seeding spring tillage or non-selective herbicide applications. Yet another reason is that by rotating, a grower diversifies crops and can reduce marketing risks as one crop type may have depressed prices while other crops in the rotation may have steady or improved prices.

A deeper rooting crop can utilize nutrients that have moved below the rooting depth of shallow-rooted crops. Some shallow rooted crops such as potato effectively remove nutrients from only about a 2 ft. (0.6 m) depth, yet potato crops receive quite high rates of N, P, and K fertilizers. Some nutrients can be leached below the rooting depth during the year of potato growth, especially the N. Following potatoes in rotation with a deeper rooted crop such as wheat or sunflowers can utilize the leached nutrients.

Some crops can better access certain nutrients from the soil. For example, flax is able to better acquire P from a soil compared to wheat. This may be due to a more acidic rhizosphere near flax roots compared to wheat roots that cause less soluble forms of P in the soil to be more available. If wheat is planted after flax in a rotation, some of the P left in flax surface residues and decaying roots can be utilized by the wheat crop.

Certain crop species have the ability to allow mycorrhizal fungi to infect their root system. The fungal hyphae from the fungi spread out in the soil and are able to acquire nutrients that it shares with the infected crop. The combined soil contact of the crop roots plus fungal hyphae can be much greater than just the crop's root-soil contact. Also, these mycorrhizzal fungi have been shown to exhibit greater uptake of P and other immobile nutrients compared to crop roots. The crop in turn supplies photosynthetic sugars to the fungi, thus a beneficial symbiotic relationship exists. If a mycorrhizal compatible crop is followed by another mycorrhizal compatible crop, the existing fungal hyphae network can remain somewhat intact and the subsequent crop benefits. However, some crops do not form root-fungal associations (e.g. *Brassica sp.* crops such as canola) and mycorrhizal compatible crops such as wheat or corn following canola may exhibit early season P deficiencies that decrease in intensity as mycorrhizal infections begin and hyphae growth is reestablished.

Different nutrient demands by crops in rotation can be managed to a grower's advantage. For example, some crops naturally require greater amounts of specific nutrients in their growth. Canola and mustard require more S from soils compared to small grain crops such as wheat and barley. The S fertilizer supplied to a canola crop is often supplied in a seed-row blend application. But if an ammonium sulfate (21-0-0-24S) S-source is used in the seed-row blend to supply a common rate of 20 lb S/A (22.4 kg/ha), the accompanying 17.5 lb N (20 kg N/ha) may supply excessive ammonium-N (NH_4^+) and reduce canola seed germination and emergence. Some growers use the greater tolerance of wheat and barley to seed-row N in rotation with canola by supplying more S than required in the seed-row blends of wheat or barley preceding canola. The unused and residual S in the soil from the cereal crops allows less seed-row 21-0-0-24S to be required and avoid adverse NH_4^+ toxicity. It is important to understand the nutrient requirements of a specific crop, the ability of a crop to acquire nutrients, and the effects of residual nutrients on subsequent crops to help in planning crop rotations and fertilizer applications.

—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 in this article: N = nitrogen; P = phosphorus; K = potassium.

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

Fall 2008, No. 3

GET THE MOST FROM FERTIGATION

Fertigation continues to grow in popularity as the advantages of applying nutrients with the irrigation water become clear. One advantage of fertigation through microirrigation systems is the ease with which nutrients can be added to water and directed to the soil where root density is greatest. However, fertilizing through microirrigation systems requires that the operation be carefully managed in order to deliver the nutrients in the right place, the right rate, the right time, and in the right form.

Uniformity: One critical aspect for effective fertigation is achieving uniform application of water and nutrition across the field. Attention should be given to variation in emitter discharge rates, constant nutrient injection into the system, and knowing the travel time required for the dissolved nutrients to move to the furthest point in the irrigation system. The travel time is commonly measured by injecting a fairly high rate of fertilizer and then measuring the electrical conductivity in the water coming from the last emitter in the line furthest from the pump. Alternatively, liquid chlorine (bleach) can also be added to the irrigation system and then detected at the end point with a chlorine test kit used to measure swimming pool water.

Nitrogen: There are many excellent N fertilizers used for fertigation...liquids or dissolved solid materials containing urea, ammonium, or nitrate alone or in some combination. Urea and nitrate are very mobile and move with the irrigation water in the soil. Ammonium is held by soil on cation exchange sites and therefore far less mobile than urea and nitrate. Ammonium initially accumulates near the dripper or microsprinkler as it leaves the irrigation system. Of course, all of these N forms are subject to a variety of biological transformations that will influence their behavior and availability for plant uptake.

Phosphorus: Phosphorus fertilization through microirrigation systems can be a very effective way to deliver nutrients during critical times of plant demand. Since P has very limited mobility in most soils, the fertilizer needs to be delivered in close proximity to the roots. A variety of soluble P fertilizers can be used for fertigation. However, when P fertilizer is added to an irrigation water that contains elevated concentrations of calcium or magnesium, the pH must be maintained low enough (generally below pH 5) to prevent precipitation of insoluble salts. A fertilizer compatibility test with the irrigation water should be conducted before injecting any soluble P fertilizer into an irrigation system. Failure to do this properly can result in severe plugging problems.

Potassium: A number of K fertilizers are well suited for fertigation. Dry K fertilizers can be dissolved or a liquid source can be successfully used. Potassium has limited mobility in soil, but moves more readily than P. Since fertigation directs nutrients to a relatively small area of the soil, avoid high single doses of nutrients to prevent salinity problems for sensitive crops.

Nutrients are commonly added to the irrigation water during the middle third or middle half of the irrigation cycle. This allows the added nutrients to be distributed through the wetted soil and then provides for clean rinse water to follow the fertilizer. It is important to flush the irrigation system with clean water after the nutrients have passed through the system to minimize the growth of microorganisms and prevent chemical precipitation. Avoid flushing the system with excessive amounts of water that can move the added N fertilizer out of the rootzone.

As the urgency grows for getting the maximum production from the minimum inputs of water and nutrients, the increased use of fertigation will likely continue. Since successful fertigation requires knowledge of fertilizer chemistry, soil science, and engineering, it is recommended to have an experienced professional help to get you started.

—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 in this article: N = nitrogen; 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

Fall 2008, No. 4

AVERAGE NUTRIENT REMOVAL RATES FOR CROPS IN THE NORTHCENTRAL REGION

The following table provides average nutrient removal rates for field crops commonly grown in the northcentral USA. To use the values in the table, simply multiply the table value by the yield of the crop, making sure that the yield units match those in the table. For instance, to estimate the amount of K_2O removed by 200 bu/A of corn grain, multiply 200 by 0.27 to get 54 lb K_2O/A.

		Removal, lb/unit[1]				
Crop	**Unit**	**N**	**P_2O_5**	**K_2O**	**Mg**	**S**
Alfalfa	ton	51	12	49	5.4	5.4
Corn grain	bu	0.90	0.38	0.27	0.09	0.08
Corn stover	bu	0.45	0.16	1.1	0.14	0.07
Corn stover	ton	16	5.8	40	5.0	3
Corn silage	bu	1.6	0.51	1.2	0.33	0.18
Corn silage	ton	9.7	3.1	7.3	2.0	1.1
Soybean grain	bu	3.8	0.84	1.3	0.21	0.18
Soybean stover	bu	1.1	0.24	1.0	0.22	0.17
Soybean stover	ton	40	8.8	37	8.1	6.2
Soybean hay	ton	45	11	25	9	5
Wheat grain	bu	1.5	0.60	0.34	0.15	0.1
Wheat straw	bu	0.7	0.16	1.2	0.1	0.14
Wheat straw	ton	14	3.3	24	2	2.8

[1] Moisture for reported units is based on marketing conventions or on a hay or wet silage basis. Values are limited to Northcentral regional publications whenever possible.

Stover or straw values in the table are reported on a ton or a bushel basis. The bushel basis is used when the grain yield is known but the amount of stover removed is not. This value assumes that all of the stover is recovered during harvest. In reality, only a percentage of the stover is harvested. Therefore, if the bushel basis is used, the percent recovery must be factored in. For instance, assume 200 bu/A of corn is harvested and about 50% of the stover is removed later. First, if all of the stover could have been harvested from the field, the amount of K_2O removed would be 200 bu/A times 1.1 lb K_2O per bushel, or 220 lb K_2O/A. However, since only 50% of the stover was removed, we multiply 220 lb K_2O/A by 0.50 to get 110 lb K_2O/A. This is the amount of K_2O estimated to be removed by harvesting 50% of the stover remaining after a 200 bu/A corn grain crop.

Estimating nutrient removal helps farmers and advisers assess whether nutrient applications are exceeding or are falling short of what the crops take off when they are harvested.

Pocket-sized, field-ready cards containing this information as well as many more field crops may be ordered for US$0.20 (20 cents) each by calling IPNI Circulation at (770) 825-8082, or e-mail: circulation@ipni.net.

—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.

Abreviations in this article: N = nitrogen; P = phosphorus; K = potassium; Mg = magnesium; S = sulfur.

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

Fall 2008, No. 5

CONSIDERATIONS FOR CONDUCTING ON-FARM RESEARCH

Rising input costs and high commodity prices have considerably increased the risk associated with making a wrong decision on the farm. To minimize these risks, many farmers are becoming more analytical regarding their inputs and are showing more interest in conducting their own on-farm research to help guide decisions.

There are several specific things that on-farm research can address, but the most common question farmers want answered is: "Does an alternative practice work on my farm and make me more profitable?" Research can provide answers to previously unanswered questions, validate previously drawn conclusions, and help predict crop responses to changes in management, but unless the farmer sees the results on his own land, he is often reluctant to make the change. It is not possible for university or industry researchers and extension personnel to conduct trials on every farm, but by following a few simple guidelines, farmers can conduct their own valid and useful research.

To obtain the most reliable results, farmers need to plan to replicate their research. Replicating or repeating the practice being tested at multiple locations in the field will help average across the "background noise" associated with soil and landscape variability on the farm. It also allows farmers to make a statistical determination of "real" differences among the practices being tested. Farm management software packages are available that provide simple spreadsheet approaches for analyzing on-farm research. Farmers should also plan on conducting their research over more than one growing season to minimize the affect of variable weather patterns.

Farmers should establish a baseline performance level for comparisons. Yield is the variable most often used for evaluating the results of on-farm research; however, yield can fluctuate greatly from year to year in a field. Several years of data should be used to establish the baseline so the year being tested can be classified as high, low, or average. Some practices have been found to perform differently in better or worse growing seasons compared to an average year. Establishing baselines can also help the farmer test new practices in different yielding areas of the field to identify those strategies that are best implemented in a site-specific manner.

Application equipment and yield monitors must be calibrated properly. The adage is "garbage in, garbage out". The point of conducting on-farm research is to be more profitable. However, if the research is conducted in a sloppy manner by not being accurate and precise when applying treatments or collecting yield data, it is a waste of money, time, and energy. It is just as critical to conduct good research to evaluate something simple like a new variety as it is to conduct a more complex trial such as testing several rates of a new fertilizer material.

On-farm research can help answer questions important to growers, but requires sound planning and attention to detail. Current production economics make "getting it right" more important than ever. By following simple guidelines, farmers can conduct their own on-farm research to supplement information coming from university and industry research programs to make a more educated decision regarding their farming practices.

—SBP—

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

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

Fall 2008, No 6

THE INCREASING DEPTH OF CROP NUTRITION

Traditional soil sampling may not be providing a complete picture of the soil nutrients available to crops. The standard sample for Midwestern states has been taken at 6 to 7 in. deep. For example, 6-2/3 in. is the official recommended sampling depth in the Illinois Agronomy Handbook. This sampling depth represents the plow layer, which is estimated at approximately 2 million lb of soil for a silty clay loam. This makes conversion of units easy, since 1 ppm would be equivalent to 2 lb/A, so that conversion from ppm to pounds per acre is done by simply multiplying ppm by 2. It is also important to remember that the calibration data for soil tests is based on this same sampling depth. Some laboratories base recommendations on a 10-in. sampling depth. So it is important to sample at the correct depth for the laboratory you are using.

This sampling plan also represents the zone from which most of the nutrients are taken up by a growing corn crop. But changes in tillage systems, crop rotations, and fertilizer placement in recent years may mean this sampling plan needs to be revised. Reduced tillage has meant that nutrients have a tendency to become stratified, with accumulations near the surface due to reduced mixing by tillage. Many years of cropping, and increasingly aggressive root systems, have had a tendency to take up more nutrients from deeper in the profile where they are not readily replenished by fertilizer applications. All of these factors mean that we may be mining nutrients from lower in the soil profile, but not recognizing the depletion with traditional soil tests.

To test whether general practices are maintaining nutrient profiles, or depleting them, we have done some preliminary sampling of selected soils from throughout Illinois, and comparing the results with data from deep sampling done statewide in the late 1960s. These tests showed that current soil test P and K levels at the 18 in. to 2 ft. depth tend to be lower than they were 40 years ago, especially for K. Based on these results, a new study is looking at a similar comparison with archived soil samples taken in the 1908 to 1911 time period to be compared with new samples collected from the same sites. This rare opportunity to compare historic soil samples with current ones from the exact sampling sites will be a guide for future nutrient management and research into better practices. We can thank the scientists who catalogued and saved the archived samples for making this comparison possible.

Today's farmers and researchers can prepare for tracking nutrients supplied in the soil profile by taking benchmark samples now for comparison to future samples to track trends in nutrients over time. We need to plan ahead so that we can protect the valuable soil nutrient profile resource.

—HFR—

For more information, contact Dr. Harold F. Reetz, Jr., Director of External Support and FAR, 107 S. State Street, Suite 300, Monticello, IL 61856-1968. Phone 217-762-2074. Fax: 217-762-8655. E-mail: hreetz@ipni.net .

Abbreviations in this article: ppm = parts per million; 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

Fall 2008, No. 7

NUTRIENT INPUTS AND COOL SEASON FORAGE GRASSES

Cool season grass species can provide high quality forage and pasture for the fall and spring months. The digestibility of dry matter of cool season grasses is generally higher than warm season grasses, and annuals tend to be higher than perennials. The yield and quality of cool season grasses can be significantly affected by nutrient inputs, hence it is a good idea to carefully evaluate fertility programs for these systems going into the fall. This is especially true with today's fertilizer prices, in that we need to do everything possible to assure application of the appropriate balance and rates of nutrients to achieve the desired goal.

It is well known that N fertilizer can dramatically affect forage grass yield. For example, when averaged over 31 site-years, N alone (120 lb N/A) increased bromegrass forage yield by about 1,400 lb/A in a long-term Kansas study. Nitrogen nutrition also influences forage quality. The primary effect of N on forage quality is usually that of increased crude protein. Up to a point, N application increases protein where other nutrients are not limiting. A good example of this was seen in an irrigated ryegrass study in Texas where N fertilizer increased crude protein from 12 to 23%.

Higher N fertilizer prices make mixing legumes in cool season grass pasture an increasingly attractive option. Legumes are not a cure-all, but with proper management they can certainly enhance forage production systems and provide additional N. Local extension and seed industry professionals can help in identifying suitable species and establishment practices for specific environments.

The application of P can also significantly impact cool season grass yield. In the above mentioned ryegrass study, the application of P fertilizer increased yield by over 180%. Phosphorus is most often associated with early root development, but it also affects winter-hardiness, disease resistance, drought tolerance, early growth, and seedling vigor. It can also impact N and water use efficiency. Winter forages usually have higher P content than summer forages. Phosphorus application can increase P tissue levels, thereby impacting forage mineral quality.

The K level in cool season forage tissue is about the same as N. Where soil levels are low, K can dramatically improve pasture and forage crop performance. Other nutrients may also be needed for optimal cool season grass nutrition. Deficiency of S is not uncommon in cool season production. Yields may be increased and forage digestibility may be enhanced by application of S where deficient.

Finally, remember that nutrient release from organic matter in soils tends to be reduced during cool season production because of reduced soil temperatures, thus increasing the probability of need for input from external sources. A good soil test is usually a good foundation upon which to make nutrient input decisions. Complete and balanced fertility is key to producing optimal yielding and high quality winter pasture and forages.

—WMS—

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.

Abbbreviations in this article: N = nitrogen; P = phosphorus; K = potassium; S = sulfur.