Kick-Off the Fall Season with Fertilization Management / Fall 2005

Fertilizing for the Crop Rotation…Coming up Short?

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Every farmer knows that not all crops are created equal. Some crops have lower heat unit requirements, others are more tolerant of temporary drought stress, while some exhibit tolerance to certain nematodes and root diseases.

Several logical questions about plant nutrition and phosphorus (P) and potassium (K) management are related to these crop differences.

Q-Do different crops have different nutrient requirements?

A- Yes, definitely.

Q-Is it really practical to try to adjust soil fertility levels each year to the needs of different crops with different fertility demands?

A- No. The soil has what is known as a "buffering capacity", or resistance to a change in soil fertility. The higher the buffer capacity, the more difficult it is to increase soil fertility levels per unit of fertilizer input. It is usually not cost-effective, nor practical, to try to raise soil test levels from low to high in a given year; raising soil test levels over a 4- to 8-year period may be practical on many farms. Research has shown there are some exceptions, and that raising soil test levels over a few years is economically beneficial (e.g. perennial crop systems such as alfalfa and tree crops).

Q-So…should one manage for the average crop demand of the crop rotation?

A- The answer to this question depends a lot on whether the land is owned or rented, and on the length of the rental agreement. However, the straightforward answer is that managing for the average demands will short-change the most demanding crops and limit the opportunity to capitalize on years with high-yielding environments…like many experienced in 2004. Fertilizing for the most demanding crop is probably the best approach to avoid nutrient limitations in achieving realistic yield goals.

Q-Once optimum soil fertility levels have been met for the most demanding crops in the rotation system, how does one estimate the nutrient requirements necessary to sustain good yields?

A- All good nutrient management plans consider the soil test levels and historic trends in soil test levels, an estimate of the nutrient uptake demands by each crop during the growing season, and an estimate of the nutrient removal by harvested crops.

Q-If one fertilizes with high nutrient rates for one crop, will the residual nutrients be as effective as "fresh" nutrients in providing the needs of the successive crop?

A- Research has shown that for corn-soybean rotations, it is possible to fertilize the corn crop with the P and K at rates needed for both crops. Soybeans appear to respond fairly well to residual fertility. Similarly, peanuts appear to respond fairly well to residual fertility in corn, cotton, and peanut rotation systems. However, reliance on residual fertilizer effects alone may not be a good idea on soils with low initial fertility levels, because the soil can bind a large portion of the applied P and K in unavailable forms before the soybean root system enlarges and becomes effective in nutrient acquisition.

Q-Can you show an example of how one can estimate the nutrient demands and gauge the fertilizer P and K applications needed from year to year, with different crops which have different demands in a rotation system ?

A- Let's first consider the nutrient uptake in a cotton/corn/peanut rotation at prevailing yield levels, summarized in **Table 1**.

Q-How do crops obtain such large quantities of nutrients?

A- Fortunately, good soil fertility enables roots to grow and function well in absorbing water and nutrients from the soil solution. If soil fertility levels are not maintained in the high range (usually considered optimum), annual fertilization at research-calibrated rates becomes more critically important in providing what the soil can not.

Table 1. Example of 3-year rotation plant food uptake and harvest removal.

Crop	Yield	N	P_2O_5	K_2O	Mg	S
		Plant nutrient uptake, lb/A				
Cotton (lint)	1,000 lb/A	160	48	140	21	24
Corn	180 bu/A	240	102	240	58	30
Peanuts	4,000 lb/A	240	39	185	25	21
3-year rotation total		640	189	565	104	75
		Plant nutrient removal with harvest, lb/A				
Cotton (lint)	1,000 lb/A	67	29	42	7	5
Corn	180 bu/A	135	79	52	10	12
Peanuts	4,000 lb/A	140	22	34	5	10
3-year rotation total		342	130	128	22	27
		Crop harvest removal of nutrients taken up by these specific crops in 3 years, %				
3-year rotation total		53	69	23	21	36

Note: Mg and S removal data taken from Zublena, J.P. 1991. SoilFacts-Nutrient removal by crops in North Carolina. AG-439-16. N.C. State University.

Because large quantities of nutrients are removed with crop harvests, appropriate fertilization can prevent nutrient mining of the soil, improve water use efficiency, and raise yield potential. In this particular 3-year crop rotation example (**Table 1**), one-fifth to two-thirds of the nutrients taken up are removed with crop harvests.

Q- What happens to the nutrients that are not removed at harvest, and which are returned to the soil in crop residues?

A- Unharvested crop residues are returned to the soil, where they are subject to microbial breakdown, recycling, and potential environmental loss. For P, K, and magnesium (Mg)…except on very sandy soils, the majority of these nutrients released from crop residues are held in the soil, and a portion is available for uptake by subsequent crops. Recycling of K from crop residues is unlike that of other nutrients because K is not bound in organic forms in plant cells. So, leaching of K on sandier soils is a real concern. Nitrogen and sulfur (S) returned in crop residues must be converted to specific available forms (nitrate and ammonium for N; sulfate for S) before roots can absorb them.

If soil fertility levels are not kept in the medium to high range, it may be difficult for roots to daily obtain adequate amounts of the essential nutrients, especially during peak uptake demand. Inadequate nutrient supplies during peak uptake periods can result in a significant loss in yield potential…in a fairly short time.

In the South, many peanut farmers and their crop advisers recognize that research has shown that peanuts do not normally respond as well as other crops to direct fertilization. As a consequence, many farmers choose not to fertilize peanuts during the peanut production year. Unfortunately, there are also a number of farmers that do not fertilize rotational crops to achieve optimum yields. Sadly, because of this "peanut mentality", the yield potential of each crop in the rotation may be short-changed. Similar nutrient management challenges occur in soybean and rice systems, corn and soybean systems, and corn-soybean-wheat systems.

Problems can be avoided by doing a few simple calculations this fall to estimate the nutrient uptake demand and the nutrient harvest removal for your cropping system. Pay close attention to the soil test reports and recommended fertilizer rates for your fields, or specific field areas. Take action to avoid short-changing the nutrition of your crop rotation this coming year, to increase your profit potential…and to get the greatest return possible from other crop nutrient inputs. You will be glad you did! ■

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