FERTILIZER RECOMMENDATIONS: FACT OR FICTION?

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Fertilizers are an important and expensive part of the crop production system in Indiana. Indiana farmers spend nearly a half billion dollars each year on fertilizer and lime. The question is. is this expense really necessary? Farmers obtain fertilizer recommendations from a number of sources. Soil testing labs. fertilizer dealers. crop consultants and extension all make fertilizer recommendations. In many cases the recommendations are quite different. Is there a valid reason for these differences or are the fertilizer recommendations commonly used based only on personal bias?

Making Fertilizer Recommendations. The process of making fertilizer recommendations should consider both the technical aspects of soil chemistry and nutrient response, and also the economic and personal concerns of the farmer. The goals and objectives of each individuals operation are different and consequently the fertilizer program should reflect these individual differences.

There are three main approaches or philosophies used to make fertilizer recommendations. All have advantages and disadvantages. The Nutrient Sufficiency Approach, or feed the crop system, is designed to minimize the cost of fertilizers in a given year. The focus of the system is short-term and only is concerned about the fertilizer needs for that year. The objective is to use all the tools available to determine the nutrients required for a crop and provide only that amount. This system ignores the effect of the fertilizer program on soil fertility level, demands a high level of management skill, and gives no credit or assess no cost for time spent implementing the program. Farmers who subscribe to the nutrient sufficiency philosophy will be required to soil test frequently and eventually fertilize annually.

The Build-Up and Maintenance Approach, or feed the soil system. is designed to ensure that immobile nutrients are always present in the soil in amounts adequate to meet the needs of the crops. Fertilizer is not needed in any one year for optimum crop growth and is added only to maintain nutrient levels in this adequate range. Farmers who use this system have more flexibility in when they soil test and fertilize, since the soil will contain the nutrients needed for at least a year or two. Thus this system allows farmers to postpone fertilizer applications for a year or two to weather tough economic conditions or to skip fertilizer applications in bad springs when field work is difficult.

Both the Nutrient Sufficiency and Build-Up and Maintenance approaches call for fertilizer applications on nutrient deficient soils that will result in an increase in soil test levels. The difference is generally in the rate at which the soil tests go up. On soils with soil tests above the critical level, no fertilizer would be applied using a Nutrient Sufficiency Approach. while maintenance applications may be recommended using the Build-Up and Maintenance system. One important factor to consider in using the build-up and maintenance system is the point to build to, and how high should soil tests be maintained.

The Cation Saturation Approach. The Cation Saturation Approach is a version of the Build-Up and Maintenance system that also looks at the "Balance" of cations on the exchange sites. As normally applied, a build-up and maintenance approach is used for immobile anions such as P.

and the quantities of cations on the CEC are modified to attain an "ideal" ratio of 65% Ca. 15% Mg and 3% K.

The system currently used in Indiana was developed for use in the highly weathered soils of the lower Mississippi Valley. In Indiana, the system works very well on the older silt loam soils of the Southern half of the state. On these soils which are inherently low in magnesium, maintaining a 65% Ca and 15% Mg saturation ensures proper pH and adequate Mg for both crops and cattle which utilize the crops as forage.

However the system is not as well suited to the magnesium rich soils of the northern half of Indiana, or to soils with extremes in CEC. Generally in "younger" soils of Northern Indiana, Mg levels in soils approach 25 to 30% of the CEC. While no problems of "excess Mg" have been demonstrated in this range, strict adherence to the system would require that the Ca levels be raised and Mg levels decreased. Since most local lime in the region is dolomitic with high Mg content, this requires importing calcitic lime at some additional cost. Current K response data would also suggest that 3% K would be inadequate on soils with CEC less than 7, and well above the amounts required for most crops on soils with CEC greater than 20.

The Philosophy Plots, a verification study. A project was initiated in 1991 to determine if there was an advantage to using any of the major approaches for making fertilizer recommendations. Field trials were established at four locations in Indiana: the Agronomy Research Center near West Lafayette, using a corn/soybean rotation; Pinney-Purdue Ag Center near Wanatah using continuous corn; and the Southeast Purdue Ag Center near North Vernon using a corn/soybean/wheat rotation. An additional site was added at the Northeast-Purdue Ag Center near Columbia City in 1992 using a corn/soybean/wheat rotation. At each location seven treatments were used. The treatments were:

1. No fertilizer control
2. Nitrogen only using a conservative yield goal.
3. Purdue N,P,K and lime recommendations at conservative yield goals
4. Purdue N,P,K, and lime recommendations at 25 bushel per acre higher yield goals
5. Treatment 4 plus secondary and micronutrients based on soil tests
6. Cation saturation system using dolomite and calcite as Ca and Mg sources and Purdue recommendations for N and P.
7. Cation saturation system using gypsum or Epsom salts as Ca and Mg sources to avoid over liming

Initial soil test levels (Table 1) were generally good, with nearly all soil tests above current critical levels. In essentially all cases no response to applied P or K would have been expected with corn or soybeans. The effects of 1992 and 1993 treatments on soil tests are also shown in Table 2. In general, the treatments used to adjust calcium and magnesium ratios resulted in slightly higher calcium saturations than desired, 75% vs. 65%. At all sites except SEPAC, where variability was quite high, soil test levels were still above the accepted critical levels for pH, P and K. At SEPAC, soil test K levels were slightly below the current critical level of 105 ppm exchangeable K.

The results from the 1992 and 1993 corn, soybean and wheat production, averaged across years and locations, are given in Table 2. In corn, a large response to nitrogen was obtained at all locations, with little response to the other nutrients regardless of the system used. Average yield of the unfertilized check plots was 93 bu/A, while the fertilized plots averaged 163 bu/A. No significant difference in yield was observed between fertilizer treatments however. All of the systems did the job and provided the nutrients needed to grow corn.

Table 1. Soil test levels at ARC, SEPAC, Pinney PAC and NEPAC, initially and in fall 1993.

Soil Test	ARC	Pinney	SEPAC	NEPAC
Initial				
pH	6.1	6.5	6.5	6.8
P ppm	82	39	27	20
K ppm	164	155	105	155
CEC (summation)	16.3	8.5	8.0	14.0
Ca%	45	38	58	77
Mg%	24	20	16	17
Fall 1993, normal recommendations				
pH	6.2	6.3	5.9	
P ppm	95	54	14	
K ppm	202	144	89	
Ca%	57	38	77	
Mg%	24	24	20	
K%	3.0	5.2	3.7	
Fall 1993, cation saturation				
pH	6.7	6.6	6.0	
P ppm	84	70	30	
K ppm	179	134	104	
Ca%	71	74	79	
Mg%	25	21	18	
K%	2.7	5.0	4.3	

Similar results are noted with soybeans. No response to any fertilizer treatments or residual effects from N on corn were seen. Yields were good at all three locations, confirming that residual nutrients in the soil as indicated by soil test can provide all the nutrients needed for soybean production.

A slightly different case is noted with wheat. A good response to applied N was noted, but additional response to other nutrients, probably due to P effects on tillering and winter survival was found. In Indiana, a small amount of P at planting is recommended for winter wheat irregardless of soil test levels. So, these results are not inconsistent with current recommendations.

Of special interest is treatment 5, where micronutrients were applied. Soil tests for zinc, manganese, boron and sulfur were used to measure crop needs. In every case the tests indicated low levels in the soil, but yields were not increased in corn or soybeans when these nutrients were added. This raises an important question as to the reliability of some soil tests. Our suggestions in Indiana are to use soil tests to make fertilizer recommendations for P, K, and lime but to rely on plant analysis for secondary and micronutrient recommendations.

Summary. The bottom line of this study is that while a set of fertilizer recommendations may produce a good crop, are they doing it in an economic and environmentally sound manner. Are the recommendations based on research (Fact), or are you placing a heavy emphasis on philosophy (Fiction). These are important questions to ask the person providing your recommendations.

Table 2. Effect of fertilizer recommendation philosophy on crop yields, 1992-93 at ARC, SEPAC. Pinney-PAC, and NEPAC.

Treatment	Corn Yield	Soybean Yield	Wheat Yield
	bu/A	bu/a	bu/A
Control	93	55	54
N only	160	56	63
N,P,K	162	55	66
Higher Yield Goal	164	54	68
plus micros	163	56	70
Cation saturation by lime	164	55	69
Cation saturation by salts	165	54	63

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