ALTERNATIVE APPROACHES TO MAKING FERTILIZER RECOMMENDATIONS

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The objective of this research project was to evaluate, both agronomically and economically, some common alternative methods of making fertilizer recommendations for corn, soybeans, and soft-red winter wheat used in Indiana. Over a period of six years (1992-1997) the effect of seven alternative fertilizer recommendation philosophies on soil test levels, crop yields, plant tissue analysis, and fertilizer additions were measured in an attempt to determine differences in performance between these alternative approaches. The specific approaches tested were:

1. No fertilizer control
2. Nitrogen on corn and wheat only (Nutrient sufficiency since all sites had high P and K levels)
3. Buildup/maintenance fertilizer program using a moderate yield goal
4. Buildup/maintenance fertilizer program using an aggressive yield goal
5. Buildup/maintenance fertilizer program using an aggressive yield goal plus micronutrient fertilizers based on soil tests
6. Basic cation ratios (Ca 65%, Mg 15%, K 5%) using calcitic or dolomitic lime for necessary adjustments in ratios and pH
7. Basic cation ratios (Ca 65%, Mg 15%, K 5%) using calcium sulfate or magnesium sulfate for necessary adjustments in ratios while using lime to maintain pH only

Several questions have been posed by farmers that this project might answer. First, will yields be affected by the different approaches to making fertilizer recommendations? Second, are micronutrient soil test interpretations and recommendations accurately assessing the needs of our crops? Third, does measuring and adjusting the ratios of basic cations (Ca:Mg:K) improve yield and quality of our primary crops? If so, is the increase in yield a function of altered ratio or from higher pH? Fourth, how do the costs and returns from each system compare? Are the systems producing the highest yields the most economical, when application and input costs are considered? And finally, what are the long-term effects of these systems on soil test levels?

Materials and Methods

A field study was established in the fall of 1991 at four locations in Indiana, using the crops and rotations common in each region. Initial soil tests from each area indicated pH, P and K levels all adequate for high yield crop production using current soil test interpretations (Table 1). A common randomized complete block design was used at each location using seven recommendation systems as treatments replicated four times. A standard plot size of 15 foot by 130 foot was used at all locations. All crops in the rotation were present at each site each year, though the design did not allow statistical comparison of the relative response of the crops. At two locations. the Northeast Purdue Ag Center (NEPAC), and Southeast Purdue Ag Center (SEPAC) rotations used were corn, soybeans and wheat. At the Pinney Purdue Ag Center (PPAC) in Northwest Indiana. continuous corn was grown under irrigation. At the Purdue Agronomy Research Center (ARC). in the west-central portion of the state, a corn soybean rotation was used.

The dominant soils at each research site were:

NEPAC. Glynwood Loam, Fine, illitic. mesic. Aquic Hapludalf
SEPAC. Avonburg Silt Loam. Fine-silty, mixed, mesic Aeric Fragiaqualf
PPAC, Tracy Sandy Loam, Coarse-loamy, mixed, mesic, Ultic Hapludalf
ARC, Raub-Brenton Complex, Fine-silty, mixed, mesic Aquic Argiudoll.

Tillage also varied between sites, with no-till being the dominant system at NEPAC and SEPAC and chisel plowing used at ARC and PPAC. Corn hybrids. and soybean and wheat varieties were selected for adaptation to the local environmental conditions. Planting populations used were adjusted for both local conditions and genetics chosen.

Yield data was collected from each site starting with the 1992 growing season and continued through the 1997 season, with the exception of PPAC which was terminated at the end of the 1994 season. Soil and tissue samples were collected from all sites throughout the study. Soil samples were taken from plots at a standard depth of 8 inches with hand probes. Samples were normally collected in the fall from soybean or wheat plots rotating to corn in the following spring. Ten to twelve soil cores per plot were collected in a plastic bucket, mixed, and put into a standard soil sample bag. Samples were air dried and ground before sending to a contract lab for analysis.

Tissue sampling consisted of collecting 10 earleaves per plot for corn at silking, 50 flagleaves per plot at Feekes stage 10.5, flowering, in wheat and 20 sets of uppermost fully developed trifoliolates per plot at R4 to R5 in soybeans. In addition, stover samples were collected from corn at physiological maturity to estimate total dry matter production. All plant samples were dried at 140 degrees F prior to grinding. Most leaf samples were analyzed for N, P. K, Ca, Mg. and micronutrients at commercial laboratories.

Fertilizer and lime recommendations were developed using information from soil tests collected once during the rotation, and estimates of yield potential. Rate equations were used from the Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa, Michigan State Extension Bulletin E-2567.

Phosphorous, potassium, and micronutrient fertilizer and all lime applications were made prior to planting and prior to secondary tillage. Most of the nitrogen for corn was applied as 28% UAN or 82% anhydrous ammonia sidedress injected and the wheat was topdressed with 28% UAN using streamer bar nozzles.

The center of each corn plot was harvested for grain yield using the combine available at each University farm and a weigh buggy. Wheat and soybeans were harvested using a Wintersteiger plot combine after end trimming.

Results and Discussion

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. . After treatment, calcium saturation's were approximately 75% at all sites except ARC and pH, P and K were above the critical levels.

The effect of these treatments on crop yields for the period of 1992 through 1996 are summarized in Table 2. A large response of corn to nitrogen was obtained at all locations, with little response to the other nutrients regardless of the system used. No significant difference in yield was observed between other fertilizer treatments however. All of the systems did the job and provided the nutrients needed to grow corn.

Soil tests for zinc, manganese, boron and sulfur were used to measure crop needs in treatment 5. 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. One exception to this general rule would be zinc. The soil test did reflect the addition of zinc in subsequent years. While questions exist as to the appropriate zinc critical level for corn, the test does reflect accumulations in the soil.

No significant response to adjusting the cation balance using lime or sulfate salts was observed at ARC, NEPAC or PPAC. At SEPAC there has been a consistent trend towards higher yields where the calcium and magnesium levels were adjusted through additions of lime or salts. The problem in interpreting this data is that on portion of the plot areas dolomite or MgSO4 was used while on the remainder calcite lime or CaSO4 was called for. It is difficult to believe that the ratios are so precise that minor deviations will create significant differences.

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 trend to higher yields where the pH was increased through lime applications was noted at SEPAC. However unlike corn, no effects of the salt treatments were noted.

A slightly different case is noted with wheat. A good response to applied N was observed, but additional response to other nutrients, probably due to P effects on tillering and winter survival was also found. In Indiana, a small amount of P at planting has traditionally recommended for winter wheat at high P soil test levels. So, these results are not inconsistent with historic recommendations. As with the other crops, a trend towards higher yields at higher pH was also observed with wheat at SEPAC.

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, or are you placing a heavy emphasis on philosophy. These are important questions to ask the person providing your recommendations.

The results from this study indicate that current University fertilizer recommendations for corn and soybeans produce economically optimum yields, with no consistent additional response to micronutrients or balancing the nutrients on the cation exchange complex. The results also indicate that there may be a need to take a second look at our lime recommendations, with a need to maintain a higher pH on some low exchange capacity soils. This has been seen in some other work and a project to recalibrate our current lime recommendations was initiated in 1997.

Table 1. Initial soil test levels at each field location, sampled fall 1991.

Soil Test	ARC	PPAC	SEPAC	NEPAC
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

Table 2. Average Crop Yields (bushels/acre) from all Fertilizer Treatments at Each Location During the Years of 1992-1996 (1992-94 at PPAC)

Treatment	ARC		NEPAC			SEPAC			PPAC
	Corn	Soybeans	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat	Corn
1	96b	43ab	122b	57a	57d	86c	48cd	31e	80c
2	143a	42ab	151a	58a	67c	148ab	48d	40d	181b
3	148a	43ab	152a	58a	70bc	151ab	50cb	47c	184b
4	145a	41ab	153a	56a	75a	147b	50bcd	51bc	196a
5	149a	42ab	148a	57a	72ab	154ab	51cb	54ab	199a
6	148a	44a	149a	56a	74ab	157ab	53a	56a	199a
7	149a	41b	149a	56a	73ab	159a	51b	50bc	203a

PROCEEDINGS OF THE TWENTY-SEVENTH

NORTH CENTRAL EXTENSION-INDUSTRY

SOIL FERTILITY CONFERENCE

Published for
The North Central Extension-Industry Soil Fertility Conference
by
Potash & Phosphate Institute
772 - 22nd Avenue, South
Brookings, SD 57006
605-692-6280

November 19-20, 1997

St. Louis Westport Holiday Inn
St. Louis, Missouri

Volume 13

Program Chairman and Editor:

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North Platte, NE 69101