



## Phosphate Fertilizer Guidelines: Is Crop Removal Information Important?

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To many, suggestions for use of phosphate fertilizer that appear after the analysis of a soil sample are a mystery. It seems logical that the rate used in a fertilizer program should match either the amount of P removed by the last crop or the amount anticipated to be removed by the next crop. In other words it seems logical to assume that recommendations for the application of phosphate should be matched to or adjusted for crop removal. This assumption, however, does not work for the reasons that are described in the paragraphs that follow.

If the use of crop removal was an accurate tool for predicting phosphate fertilizer needs, there would be no need for soil testing as a predictive tool. Results of various research projects conducted over several years, however, lead to the conclusion that there is no substitute for the analysis of a soil sample as a basis for guidelines for use of fertilizer phosphorus (P), potassium (K), and zinc (Zn). Plant analysis, widely rotating electrons, aerial images, etc. have not been successful in predicting phosphate fertilizer requirements. The substitute for soil testing has not been found.

The use of crop removal as a basis for recommendations implies that optimum rate of phosphate varies with yield achieved. While this concept might seem valid at first, results of field research with corn show otherwise (see Figure 1). In all four years of the study, optimum rate of phosphate was 69 lb. P<sub>2</sub>O<sub>5</sub> per acre. Yet, optimum yield varied from approximately 135 bu. per acre (year 4) to 175 bu. per acre (year 1). If the rate of broadcast phosphate needed by optimum economic production was nearly the same each year, why should yield goal be included in modern recommendations?

The concept that phosphate fertilizer recommendations should be based on crop removal implies that all of the applied phosphate is used by the crop. In other words, 100% of the amount applied is taken up by the crop. Research, however, has repeatedly shown that this is not what happens in soils. There's general agreement that some applied phosphate is fixed or tied up by various chemical reactions in soils. There is no research to show that 100% of the amount of phosphate applied is used by the crop.

If the concept of crop removal is used as the basis for phosphate fertilizer recommendations, there is an unstated assumption that the soil itself is not supplying any of the nutrient needs. Yet, except for the use of the Bray procedure on highly calcareous soils, results of the analysis of soil samples never show a 0 for phosphorus, potassium, or zinc. If we believe that soil testing procedures indicate the relative availability of nutrients in soils, a value other than 0 indicates that the soil is supplying some nutrients for crop production. What, then, is a good alternative for arriving at phosphate fertilizer recommendation if the crop removal concept is flawed? In Minnesota, phosphate fertilizer guidelines take both soil test values and expected yield into consideration. The expected yield component gives some consideration to crop removal. Yet, crop removal is not the entire base. More emphasis is placed on the "correlation and calibration" research that has been conducted over many years.

The “correlation and calibration” concept can be confusing to some. It’s really not that complicated. “Correlation” is the process of relating soil test values to relative yield when no fertilizer is applied. As might be expected, with phosphorus, for example, yields increase as soil test P values increase to about 20 ppm (using the Bray procedure) and 15 ppm (using the Olsen procedure). Higher soil test values do not produce higher corn yields.

“Calibration” is the process of determining the rate of phosphate fertilizer to apply when the soil test value for P is known. This ‘correlation’ and “calibration” information can only be gathered from a large number of rate studies conducted in the field. Information from numerous sites is considered before the guidelines are established.

The preceding paragraphs are an attempt to briefly describe two concepts that can be used to arrive at phosphate fertilizer guidelines. How do they compare? To arrive at an answer to this question, a study was conducted using a corn/soybean rotation at the Southern Research and Outreach Center at Waseca. Corn yield are provided in the table that follows.

For this study started in the spring of 1999, both crops were grown each year. Broadcast fertilizer was applied in the spring of each year and incorporated with a field cultivator. Potash (0-0-60) and nitrogen (46-0-0) were applied at a uniform rate to all treatments at rates adequate for high yields. The banded fertilizer was applied with the planter 2 inches below and 2 inches to the side of the seed.

The soil test P at the start of the study was 15 ppm (Bray procedure). With University of Minnesota guidelines, this value is in the medium category.

Fertilizer recommendations based on crop removal were compared to both band and broadcast recommendations from the University of Minnesota.

As would be expected, yield varied with year. In any given year, there were measured differences among the treatments being compared. However, statistical analysis shows that these differences were random and were not caused by the treatment applied.

Higher applications of phosphate fertilizer were used when recommendations were based on crop removal. Yields produced by the use of these higher rates, however, were not superior to yields produced by University of Minnesota guidelines. So, why would a grower want to spend more money to get the same yield?

This study was conducted for five years. And, results were consistent in each of those years. This consistency adds more validity to the conclusion that recommendations for use of phosphate fertilizer should not be based on crop removal.

Contrasting approaches to phosphate recommendations have an effect beyond crop yield. As might be expected, there was also an impact on soil test values for P. This impact will be described and discussed in a future issue of Minnesota Crop e-News.

**Corn yield as affected strategy used for phosphate use.**

Strategy	Phosphate Rate lb.P <sub>2</sub> O <sub>5</sub> /acre	Year				
		1999	2000	2001	2002	2003
--	0	179a	151a	151a	188a	159a
crop removal	60 <sup>1j</sup>	180a	151a	165a	192a	167a
U of M (broadcast)	40	174a	144a	163a	191a	165a
U of M (band)	30	173a	145a	154a	192a	161a

<sup>1j</sup> For each year, yields followed by the same letter are not significantly different at the .05 confidence level.

<sup>1j</sup> Rate of phosphate applied prior to the corn production year in the corn/soybean rotation. Rates were different in the soybean year.

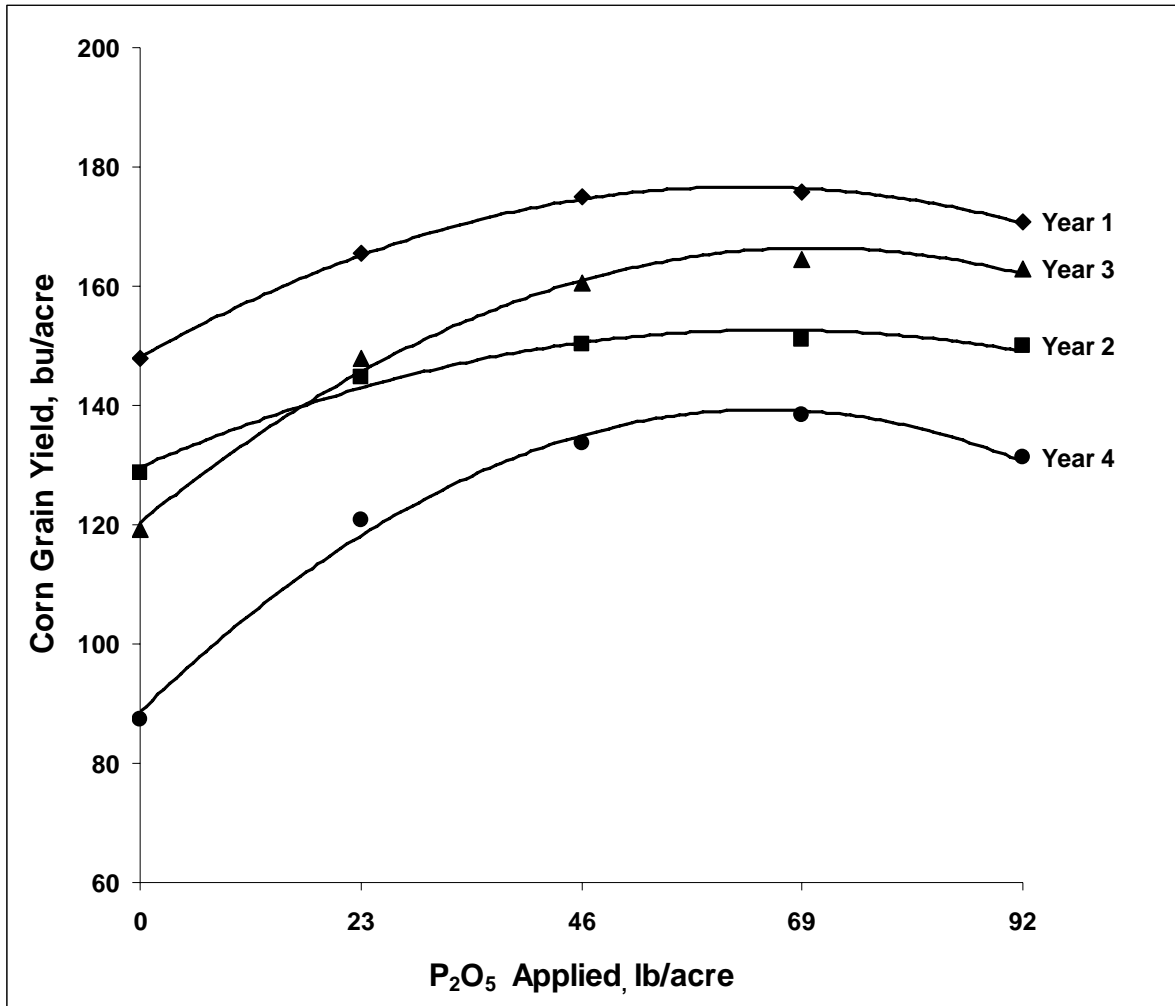


Figure 1. Corn yield as affected by broadcast rate of phosphate in four consecutive years.

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