Comparison of Phosphorus and Potassium Utilization with Conventional and Variable Fertility Management

By Max W. Hammond

Studies in Washington state show that use of grid sampling and variable rate fertility management can reduce errors in fertilizer application rates.

VARIABLE RATE application of fertilizers to accommodate spatial variations of soil phosphorus (P) and potassium (K) in potato fields of the northern Columbia Basin of central Washington began in 1986. Due to the sandy, arid soils in this area, these spatial variations are best defined by intensive sampling on a 200 ft x 200 ft grid basis. The soil analysis data are then analyzed via geostatistics to delineate the nutrient variations in the fields. Variable rate fertilizer applications are made utilizing Soilection(TM) technology.

Washington Studies

In a previous study, an analysis was made of variable fertility management for P and K utilizing three nutrient content levels . . . high, medium and low. The results indicated that fertilizer input on a per field basis was generally the same . . . but the fertilizer was placed where it was needed. The study did reveal significant errors of over and under-application of P and K when applied on a conventional basis.

To further study fertilizer application efficiency, six fields were selected from those grid sampled and mapped in 1993 and 1994. These fields can be considered average for farm management in the area.

The field variations for P and K were mapped into five management levels based on nutrient content . . . very high, high, medium, low and very low. Fertilizer recommendations for potato production were made for each of the management levels and total amounts of P_2O_5 and K_2O were calculated for acreages of each management level. Overall field averages were calculated from all of the grid sample test results for each field, corresponding fertilizer recommendations were made for each field and the total amounts of P_2O_5 and K_2O per field calculated.

Results

The effect of variation management on total pounds of P_2O_5 and K_2O used across the six fields studied is shown in **Table 1**. Four of the six fields had an increase in P application. However, only one out of six

Table 1. Change in amounts of P_2O_5 and K_2O recommended due to variable application technology.

Field	Acres	P_2O_5, lb/field[1]	P_2O_5, lb/A	K_2O, lb/field	K_2O, lb/A
1	135	(637)	(4.7)	(1,038)	(7.7)
2	150	1,528	10.2	8,367	55.8
3	153	5,216	34.1	(614)	(4.0)
4	142	2,392	16.8	(4,918)	(34.6)
5	130	(5,054)	(38.9)	(1,355)	(10.4)
6	140	247	1.8	(3,692)	(26.4)
Average per-acre change over 6 fields			3.2		(4.6)

[1]Values equal conventional application minus variable application. Numbers in parentheses ( ) indicate a decrease in total application, others represent increases due to variable application management.

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Table 2. Examples of application error due to use of conventional fertilizer application.

Field	Acres	Under-application	Over-application
1	135	60 lb/A P_2O_5 on 34.9A 100 lb/A K_2O on 18.3A	70 lb/A P_2O_5 on 29.2A 45 lb/A P_2O_5 on 26.7A
2	150	105 lb/A P_2O_5 on 14.8A 80 lb/A K_2O on 84A	
3	153	75 lb/A P_2O_5 on 47.4A 85 lb/A P_2O_5 on 33.8A 45 lb/A K_2O on 87.9A	155 lb/A K_2O on 20.1A
4	142	55 lb/A P_2O_5 on 37.7A 85 lb/A P_2O_5 on 18.8A	175 lb/A K_2O on 13.3A 75 lb/A K_2O on 25.5A
5	130		120 lb/A P_2O_5 on 12.1A 95 lb/A P_2O_5 on 23.3A
6	140	70 lb/A P_2O_5 on 39.1A 40 lb/A K_2O on 83.1A	

had an increase in K application. When the changes were calculated on a per acre basis, the changes were minor and support the findings of the previous study.

Of more significance is the reduction in application rate error. A comparison of efficiency between conventional and variable application was made across all five management levels.

The results of this comparison revealed the most serious errors using conventional application were under-application of P and K in the low and very low testing zones. Under-application errors in these zones will contribute to yield loss and, more importantly, quality reductions in potatoes. Over-application is neither economically nor environmentally acceptable. While there were over-application errors in some fields in the high and very high testing zones, in most cases the acreage involved was small. Examples of application rate errors are provided in **Table 2**.

The utilization of five levels of nutrient management gave more versatility to accommodating field variation.

While the average across the six fields showed little change in fertilizer usage, some fields did show appreciable changes in application rates of P and/or K. Thus, there are fields which will require more . . . or . . . less P and K due to variable fertility management.

Comparison of total P and K utilized may be of interest in nutrient management budgeting. However, it is more important to demonstrate the reduction in application error that occurs through the use of variable rate fertility management. ■

Field Scale . . . from page 21

Summary

The previous statements, if accurate, are rather disturbing. A majority of fertilizer recommendations from soil tests are made from a composite soil sample from a field and a calibration relationship obtained from research plots selected for uniformity (i.e., low spatial variability of soil test). The results may also help explain why many farmers and fertilizer dealers insist they get an economical increase in yield with fertilizer application rates higher than those predicted by such calibration relationships. If they have a variable field, the theory presented here suggests they will get economic yield increases with higher rates. This does not invalidate the calibration relationship. It just suggests that we have to utilize the calibration relationship in a different manner. In fact, because of the spatial variability problem, it is more important than ever to have accurate calibration relationships among soil test, yield response, and applied fertilizer. The challenge is to combine these calibrations with additional knowledge about the spatial distribution and field scale variability of soil test values. ■