C A N A D A

Application of Precision Farming to Potato Production in Québec

By R.R. Simard, M.C. Nolin and A.N. Cambouris

Potato production in Québec occupies about 45,000 acres. The mean marketable yield is 205 cwt/A, and the production cost is about $1,400/A. Nutrition of the potato crop is critical. Fertilizers are usually applied at a uniform rate. However, large yield variability is normally encountered in many fields. This may be ascribed to differences in soil fertility, texture or other factors such as localized pest infestation or weeds. Producers are very interested in variable rate (VR) application of nutrients.

Variable rate application of phosphorus (P) and potassium (K) on potatoes improves yield and tuber quality, increases profitability and nutrient use efficiency, and reduces soil test variability.

Precision farming began in the province of Québec four years ago with the use of global positioning system (GPS) and yield monitors on grain combines. The mapping of soil pH for VR application of lime was initiated in 1995. Potato yield monitors have been used in the field since 1996. Precision farming in potato production aims at improving yields, tuber quality and profitability, optimizing fertilizer and pesticide inputs, and reducing environmental risks. The VR application will have particular impact on the zones of low soil fertility. The improvement in profitability will originate from yield increases from areas of higher fertilizer needs, and in decreasing over-fertilization where yield potential is limited. The environmental benefits will come from refined nitrogen (N) application and slower P accumulation from unused fertilizer.

A project was initiated in 1996 to investigate the economic and agronomic efficiency of variable rate application of P, K and lime on the potato crop. The study is being carried out at the Joseph-Rhéaume research farm of Laval University in Sainte-Croix de Lotbinière in Québec. Soil samples were collected on

TABLE 1. Distribution of soil texture, pH, and soil test values at the Sainte-Croix site (106 samples drawn from 5 acres).

	Clay	Silt	Sand	SOM	pH	pH	P	K	Ca	Mg	Al
			%		water	$CaCl_2$		lb/A			ppm
Mean	18	33	49	5.5	6.5	5.6	80	99	3,704	90	1,511
SD[1]	5	18	16	2.4	0.5	0.5	51	54	1,773	49	324
Minimum	8	11	17	0.1	5.7	4.6	7	26	868	29	692
Maximum	36	70	72	12.5	8.1	7.2	245	302	10,885	305	2,330

[1]SD refers to standard deviation, a measure of variability. Approximately two-thirds of the field area will fall within the range one standard deviation above and below the mean.

Blended fertilizer combinations, lb/A				
Blend	N	P_2O_5	K_2O	code
1	121	205	214	
2	121	205	192	
3	121	205	143	
4	121	192	214	
5	121	192	192	
6	121	192	143	
7	121	170	214	
8	121	170	192	
9	121	170	143	
10	121	129	214	
11	121	129	192	
12	121	129	143	
13	0	0	0	

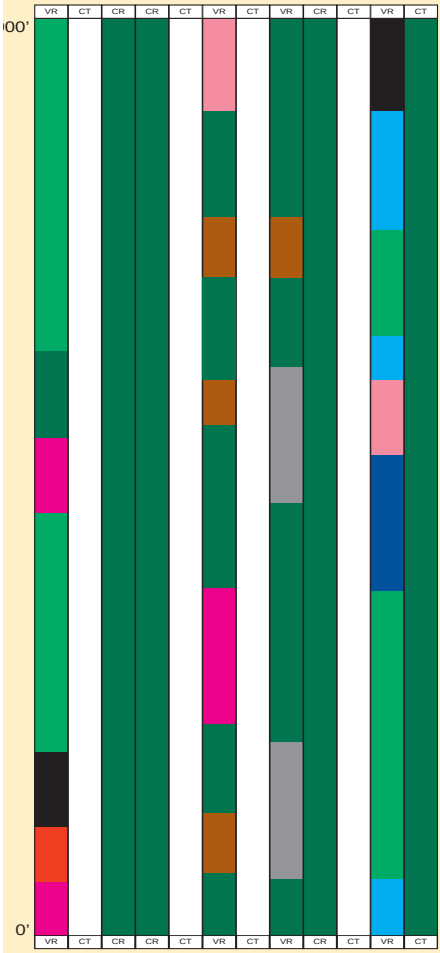

Figure 1. Map of treatments on 5-acre field in 1997.

a 50-foot grid in a 5-acre field and analyzed for pH, Mehlich 3 extractable nutrients, nitrate-N (NO_3-N) and soil texture. A soil survey was also carried out according to a 100-foot grid.

Spring soil test values were highly variable (**Table 1**). The distributions were also somewhat skewed, as is typical for soil properties, so that the median values for P and K were 67 and 88 lb/A, respectively, much lower than the mean values. Maps of pH showed that liming was unnecessary.

The soil is poor in P and K and has a very high P sorption capacity, as indicated by high aluminum (Al) levels. Where soil Al levels exceed 1,600 parts per million (ppm), P recommendations are usually increased by 15 to 20 percent. About 40 percent of this field would fall in the high Al category.

The P and K maps derived from 106 sampling points were examined. Based on existing recommendations and the limitations imposed by equipment, combinations of 2 rates of P and 3 rates of K were chosen for the VR treatment. Rates of 170 and 190 lb/A P_2O_5 were combined with rates of 140 to 210 lb/A K_2O. The range of P_2O_5 rates was widened to 130 to 205 lb/A P_2O_5 in 1997. The detailed soil map showed that four different soil series (soil types) were present. Neubois loam has a high CEC, is rich in Al and is highly erodible. Le Bras humic loam, located in a small depression, is very rich in organic matter and P, but has poor drainage and a high Al content. Valère sandy loam has low CEC and nutrient availability, while Sainte-Croix sandy clay loam has high pH.

In both years, three treatments were imposed on the field in strips 6 rows wide and 1,000 ft. long (**Figure 1** shows the 1997 treatments). In 1996, the constant rate (CR) treatment was 155 lb/A of N, 190 lb/A of P_2O_5 and 190 lb/A of K_2O.

The VR application resulted in a $11/A saving in fertilizers. The marketable yield of the VR treatment was not different from the CR treatment, but was much larger than in the control treatment (CT), (**Figure 2**). The VR also had equivalent yields to CR for different tuber categories: Canada #1 small, Canada #1 and Canada #1 large. However, the VR had higher N and P concentrations but less K than in CR. Calculations of the compositional nutrient diagnostic (CND) index showed that VR had the best nutrient equilibrium among treatments and that K was the most yield limiting nutrient at this site. The VR application increased the uniformity of soil test levels sampled at harvest. In 1997, the marketable potato yield was 30 cwt/A greater in the VR than in the CR treatment (**Figure 2**).

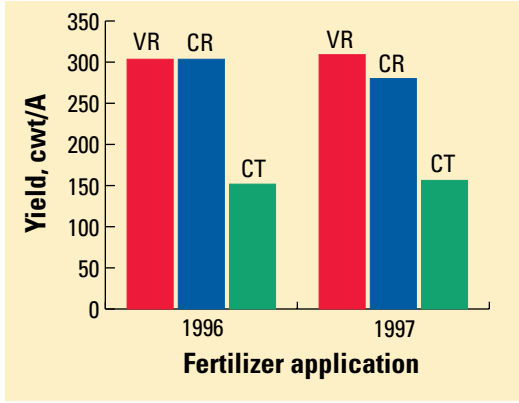

Figure 2. Marketable yield of potato as affected by variable rate (VR), constant rate (CR) or control (CT) fertilizer application.

At this site, variable rate application of P and K gave potato yields equal to or greater than those with constant rate. Potassium was the most limiting nutrient. The fertilizer savings the first year were almost equal to the commercial cost of mapping the site. The agronomic and economic benefits of precision fertilizer application in potato production are very encouraging. .BC

R.R. Simard , M.C. Nolin and A.N. Cambouris are scientists with Agriculture and Agri-Food Canada and the Horticultural Research Center, Laval University, Ste-Foy, Québec.

Starter Fertilization... *(continued from page 21)*

of the broadcast P is not available to corn seedling roots because of the intimate contact between soil and P, while banding P minimizes fixation and immobilization by reducing P and soil contact. Therefore, size of root system is not important when the band is near the seed under these circumstances. However, at warm temperatures in soils with high residual P or those that do not fix P, hybrids with larger root systems may not respond to starter P. In cold soils, hybrids with larger root systems may respond to starter N as well as P because root growth of all hybrids is reduced by low temperature.BC

Dr. Rhoads is Professor of Soil and Water Science and Dr. Wright is Professor of Agronomy, Institute of Food and Agricultural Sciences, North Florida Research and Education Center, Quincy.