Site Specific Management of Potatoes
Progress Report
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Background

Traditionally, individual fields of many crops, including potatoes, have been managed as one unit. Variability of fertility and soil within the field were not taken into account. As a result, crop yields and crop quality varied within a field. In southern Alberta, potato fields often yield more than 50 t/ha, however these high average yields from a specific field are made up of even higher yields in some areas of the field, and much lower yields in other portions. The technology now exists to manage small portions of a field individually with the objective of producing uniform optimum yield and quality throughout the field. This process is called site specific management.

Site specific agriculture has received a lot of interest in the USA, Canada and NW Europe in the past 3 or 4 years. Since 1991, use of Global Positioning System (GPS) technology has made it possible to develop detailed yield maps of various crops. In the USA this technology has drawn interest from farmers as a method to increase profits by optimizing fertilizer applications. In Western Europe, it has been used as a method to avoid environmental contamination from excess use of fertilizers. Several groups in the NW USA have developed yield monitors for potato harvesters which can be used with global positioning technology to develop yield maps. Other computer technology, such as Geographic Information Systems (GIS), makes it possible to manage or overlay on maps large amounts of data on field conditions and production.

Potatoes are a high value crop with high input requirements. Excess nitrogen fertilizer will delay maturity, reduce storage quality, contribute to ground water contamination and increase the cost of production. Insufficient nitrogen will reduce yield and will increase the severity of early blight. Potatoes are often grown on coarse textured soils which have a low nutrient holding capacity and high field variability. Under small plot conditions, traditional research does not describe this variability. Consequently, current management of potatoes does not account for this variability.

In 1993, an Alberta team commenced site specific research projects. In 1995 crop specialists cooperating with farmers started site specific management projects in several areas of Alberta. Fields were subdivided based on interpretation of aerial photographs. These subdivided units were sampled separately to determine fertilizer requirements. Global positioning technology used on

- New in 1997 is to develop a relationship between soil and crop characteristics and processing quality. Tuber samples will be collected and quality determined at about 50 points per field from a field of Russet Burbank, which are used for production of french fries and from a field of Snowden, a variety used for chipping.

Progress To Date

Two potato field were monitored during 1996. Each field consisted of half of a centre pivot and was about 26 ha. The initial plan was to monitor one 50 ha field. One field (Rosendaal) had hummocky topography and was 11 km south of Hays with a soil texture which varied from sand to clay loam. The average clay content in the 0-.60 m depth varied from 5% to 50%. The other field (Stolk) was a gently sloping field 8 km north of Purple Springs with a texture varying from loamy sand to silt loam and the average clay content varied from 9 to 25% for the 0-0.60 m depth. Both fields had a higher clay content from 0.60-0.90 m than from 0-0.60 m.

Forty neutron meter access tubes were set out at the Hays field and 8 access tubes were set out at the Purple Springs field. Soil texture was determined for 0.30 m increments to 0.90 m at each access hole site. Soil moisture readings were taken weekly from June 1 until September 9, 1996. Potato petiole tissue samples were taken near each neutron meter access tube on July 3 or 4th, July 30 and August 20, 1996.

The Hays field had the cultivar Snowden, a medium-late chipping potato on about 23 ha and 3 ha of Atlantic, an early to mid-season cultivar. The Purple Springs potato field had Frito-Lay 1625, a late chipping cultivar.

A yield monitor was used on two potato combines and yields were recorded and positioned with differential GPS. Due to wet weather and delayed harvest, part of the harvest of the two fields occurred at the same time. With only one yield monitor, this meant not all of the harvest of each field was yield mapped. This was the first year the yield monitor has been marketed. Difficulties were encountered and yield data collected was not uniformly reliable for the entire field.

A strip of wheat 800 m long (Hays) and 2 strips of barley 750 m long (Purple Springs) were harvested with a plot combine from prospective potato fields for 1997. Grain yields were weighed each 6-10 metres and the combine location at each weighing point was found by surveying or GPS methods. This will estimate variability within the fields. The CAESA precision agriculture project

Soil and fertilizer nitrogen and phosphorus are based on farmer's records for the two sites (Table 2).

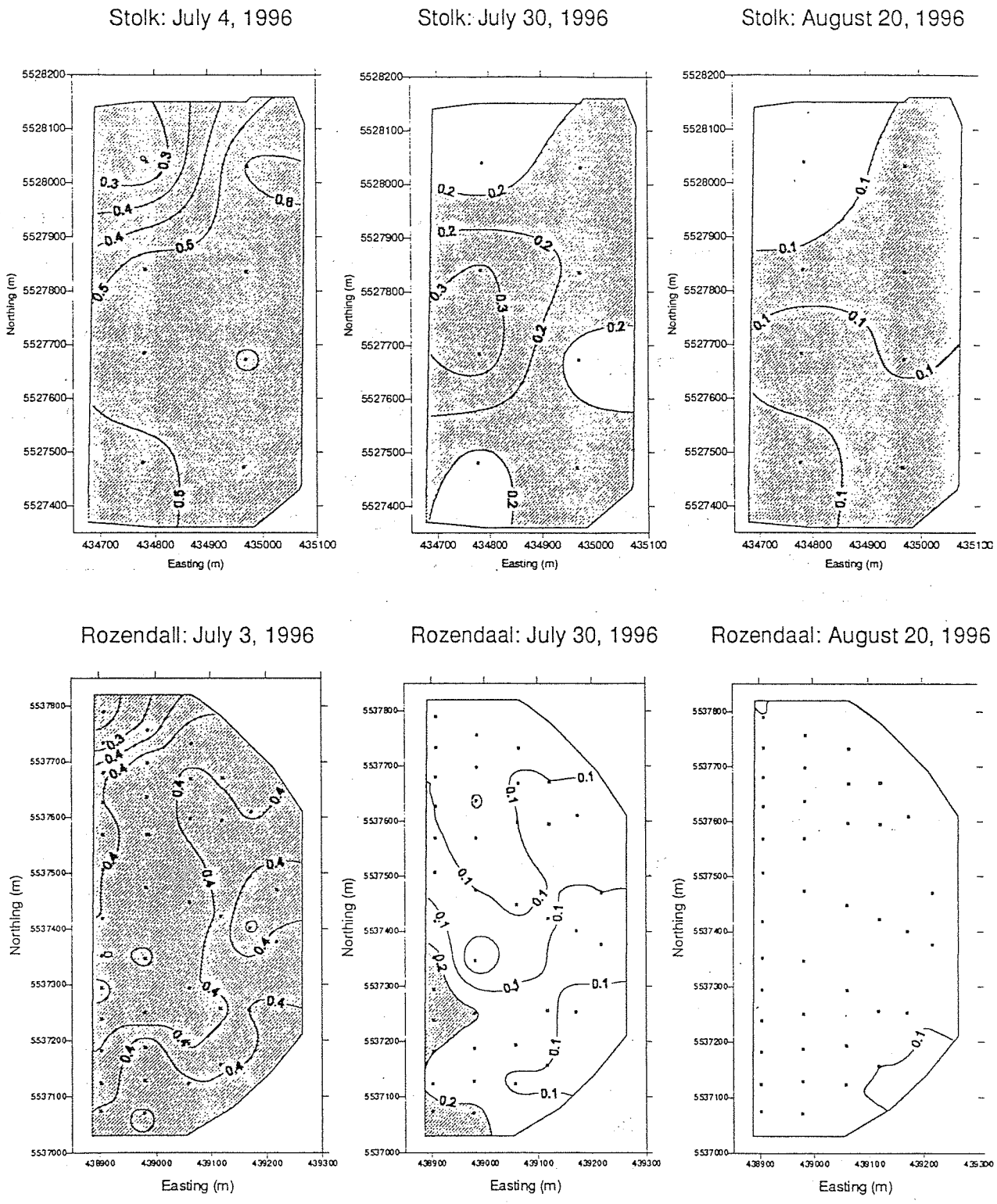
Table 2. 1996 Soil Fertility on 1996 Potato Fields		
	Purple Springs	**Hays**
Soil N (kg/ha)	73 (0-0.60)	29 (0-0.30)
Fert N (kg/ha) prior to seeding	59	120
Banded N (kg/ha) at hilling		34
Fertigated N (kg/ha)	11	58
Total N (kg/ha)	144	241
Soil P (kg/ha)	67 (0-0.30)	35 (0-0.30)
Fert P_2O_5 (kg/ha)	73	109
Total P (kg/ha)	99	83

Tissue nitrogen was deficient on all sampling dates at the Purple Springs field (Table 1, Figure 1). The farmer kept the nitrogen low because it is believed that this variety, Frito-Lay 1625, will produce excess vines and few tubers if it has the normal levels of nitrogen provided to potatoes. The Hays field had an adequate supply of tissue nitrogen on July 3 but by July 30 most of the field was deficient and by August 20 all the field was deficient. This occurred despite the farmer adding 58 kg/ha nitrogen by fertigation and a total soil plus fertilizer nitrogen of 241 kg/ha. The Hays field received from 310 to 390 mm of rainfall and precipitation from June 25 to September 9. This compares to 290 to 320 mm on the Purple Springs field from June 28 to September 9. The irrigation on the Hays field was in excess of consumptive use and will have contributed to leaching and loss of nitrogen.

Petiole phosphorus (% P) (Table 1 and Figure 2) was adequate on both sites on July 3 and 4. It declined on the Hays site and by July 30 most of the field was deficient and by August 20 all of the field was deficient. The Hays site had a low level of soil phosphorus (35 kg/ha) but received 107 kg/ha P_2O_5 fertilizer. The Purple Springs site remained near adequate level on July 30 and August 20. This site had a moderately high level of soil phosphorus (67 kg/ha).

Irrigation and precipitation maps of both fields indicate an uneven distribution of water by the pivots with a higher application near the center and less to the outside. The Hays field showed excess water in the 50-100 cm depth in areas near the pivot centre. The Purple Springs field was deficient in water

Figure 2. 1996 Petiole Phosphate Phosphorus (%)



Yield monitoring was only successful on portions of the field. Changes in the design of the power supply for the yield monitor should improve its performance in 1997. Yield monitoring of potatoes will prove to be more difficult than grain. Current yield monitors will need to be attended all the time. The yield monitor weighs what comes over the belt of the potato harvester, which on wet or fine textured soils includes soil and these areas will need to be deleted from yield maps.

Improved yield monitoring will permit doing regression or covariance analysis between yield and quality measurements versus soil and crop factors. This analysis can include digital values of remote sensing data.

Quality is the major concern for the potatoes produced for the processing industry. Data on the variability of quality will be related to soil and crop characteristics in 1997. Measurements of nitrogen movement below the root zone will be made in 1997. This will permit measuring some of the environmental impact of potato production.