# SAP TESTING FOR FERTILITY MANAGEMENT IN POTATOES

Dr. D. Waterer
Horticulture Science Department
University of Saskatchewan

Effective monitoring of crop fertility status is critical to fertilizer use efficiency in potatoes. Recently, Cardy Testing Technologies has developed inexpensive ($400 CDN), fast (30 seconds/reading) and accurate (+/- 1 %) hand held, field ready meters for measuring concentrations of NO3 and K in sap extracted from the leaves.

This study evaluated sap testing as a means for monitoring of crop nitrogen status in research plots and commercial field trials during 1993 and 1994. Stepwise regression techniques were used to develop yield prediction equations from the crop nitrogen data.

## Trial 1. Nitrogen gradient

**This trial was** conducted in Saskatoon, on the University of Saskatchewan Potato Research Plots. The soil is a heavily manured sandy loam, pH 7.3, E.C. < 1.0 $dS/cm^2$ with moderately high levels of residual NO3 (23 ppm 0- 12").

A nitrogen gradient was established in both 1993 and 1994 using the following treatments;
NO = no added nitrogen
N100, N200 and N400 = 100, 200 or 400 # N/A pre-plant broadcast
N 200 + 200 = 200# N/A pre-plant broadcast + 200# N/A sideband.
N 400 + 200 = 400# N/A pre-plant broadcast + 200# N/A sideband.

All fertilizer N was supplied as 34-O-O (ammonium nitrate). Other nutrient levels were at recommended levels. Norland and Russet Burbank were tested in 1993, while in 1994, Shepody was also used. The crop was planted in mid-May (30 cm in-row, 1 m between rows). Overhead irrigation was used in both years. The split N was broadcast in late June, just prior to canopy closure and incorporated by shallow tillage followed by a heavy irrigation. Petiole samples were taken from late June through to harvest, between 10 a.m. and 12 noon. The most recently fully expanded leaf was used sampled (4th from top). A minimum of 20 petioles were collected from each test plot. The leaves were removed and the petioles were kept in plastic bags, under refrigeration until sampled. The petioles were cut into short sections and the sap was extracted using a garlic press. The sap NO3 and K levels were determined using appropriate Cardy Meters. The plots were harvested in late September, and the crop was weighed and graded according to industry standards.

## Results

**SAP NO3** levels and the changes in levels over the season were relatively similar for the cultivars tested; only the data for Norland is presented. In both 1993 and 1994, sap NO3 levels in the 0, 100 and 200 #/A pre-plant treatments declined over the growing season, while the 400 #/A treatment showed less change over the season (Figure 1 and 2). Mid-season application of N prevented the late season decline in SAP NO3 levels (Figure 3 and 4). For Norland in 1993, yields increased with pre-plant N to a peak at 200 #/A and declined when 400#/A was added (Figure 5). The split application produced little yield advantage over an initial pre-plant treatment. In 1994, the low N Norland plots were raided prior to harvest (Figure 6). There was no advantage to applying more than 200 # N/a in 1994.

[ --- Figures at end of paper --- ]

**Figure 1.** Sap **NO3** levels with varying pre-plant nitrogen levels -1993.

**Figure 2.** Sap **NO3** levels with varying nitrogen levels - 1994.

**Figure 3.** Sap **NO3** levels with split nitrogen applications - 1993.

**Figure 4.** Sap **NO3** levels with split nitrogen applications - 1994.

**Figure 5.** Yields versus nitrogen levels 1993.

**Figure 6.** Yields versus nitrogen levels 1994.

### Yield Prediction

To more thoroughly examine the relationship between sap NO3 levels and yields, the data for the 1993 trial was subjected to stepwise regression analysis. This process starts by determining which sap sampling data gave sap NO3 levels which were most highly correlated with final yields. At each subsequent step, additional sampling data were added to improve the yield prediction model. The yield prediction models for Norland and Russet Burbank potatoes are presented in Table 1. Although data was available from six sampling dates, the models based on only four sampling dates were very accurate. The equations for both cultivars indicate that high sap NO3 levels in late July had a negative effect on yields, while on all other sampling dates, yields were positively correlated with sap NO3 levels. Late July corresponds with the end of tuber set and the beginning of rapid tuber fill. Why high NO3 levels at this time would have a negative effect on yields is unknown.

**Table 1. Yield Prediction Model for Norland and Russet Burbank Potatoes based on Sap NO3 levels during the Growing Season.**

| **N orland** | | | |
|---|---|---|---|
| | Sampling Date | Coefficient | $R^2$ |
| **Step 1** | July 6 | 0.01556 | 0.24 |
| **Step** 2 | July 27 | -0.00484 | 0.90 |
| **Step** 3 | June 28 | 0.00209 | 0.99 |
| **Step** 4 | July 16 | 0.00755 | 0.99 |
| **Russet Burbank** | | | |
| **Step 1** | August 13 | 0.001823 | 0.46 |
| **Step** 2 | July 6 | 0.012114 | 0.66 |
| **Step** 3 | August 24 | 0.006693 | 0.69 |
| **Step** 4 | July 27 | -0.006503 | 0.98 |

## Sampling of Commercial Fields

Petiole samples were obtained on several occasions in 1993 from a commercial field of Norland. The field was a sandy loam, under irrigation. In 1993, 100#/A N was applied preplant and the crop showed significant signs of nitrogen deficiency by mid-season. As is shown in Figure 7, the Cardy meter reading indicated that the crop was N deficient by early July. The data from the commercial field was tested in the yield prediction equation developed for the Saskatoon trial. The predicted yield based on the sap NO3 data was 18.7 t/ha while the actual yield was 17.9 t/ha. This clearly illustrates the potential for utilizing sap NO3 levels as a crop monitoring/yield prediction tool.

[ --- Figure at end of paper --- ]

**Figure 7.** Sap NO3 and K levels in a commercial field of Norland in 1993.

## Summary

Analysis of sap NO3 content using ion specific electrodes such as the Cardy meter appears to have merit as a simple, inexpensive means for monitoring crop nutrient status and fine tuning mid-season fertilizer applications. Utilizing regression models it was possible to predict yields based on sap NO3 levels. Samples taken from commercial growers fields demonstrated the utility of the sap testing system as a means for early diagnosis of nutrient deficiencies and for monitoring crop responses to fertilizer inputs.

**RESEARCH SUPPORTED BY THE AGRICULTURE DEVELOPMENT FUND**

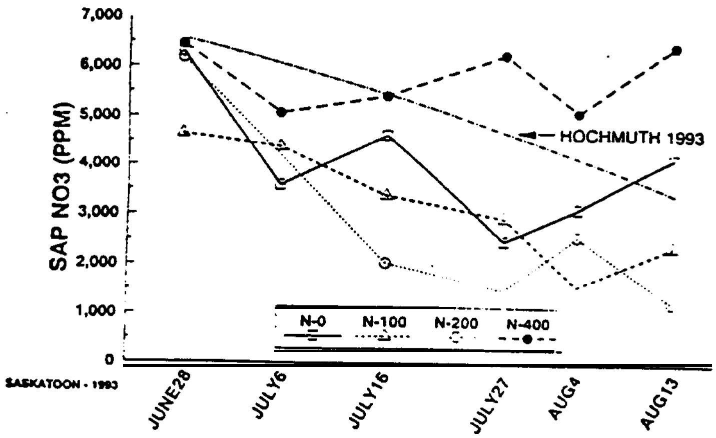


Figure 1. Sap NO3 levels with varying pre-plant nitrogen levels - 1993.

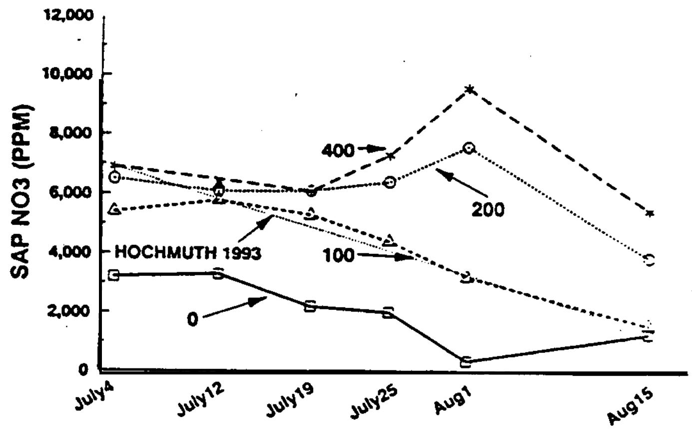


Figure 2. Sap NO3 levels with varying pre-plant nitrogen levels - 1994.

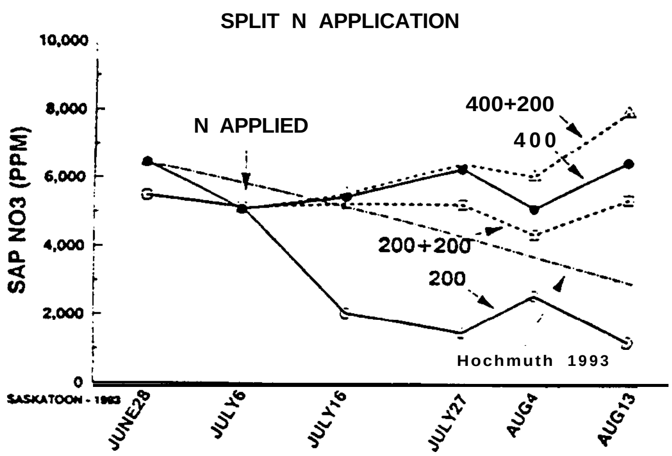


Figure 3. Sap NO3 levels with split nitrogen applications - 1993.

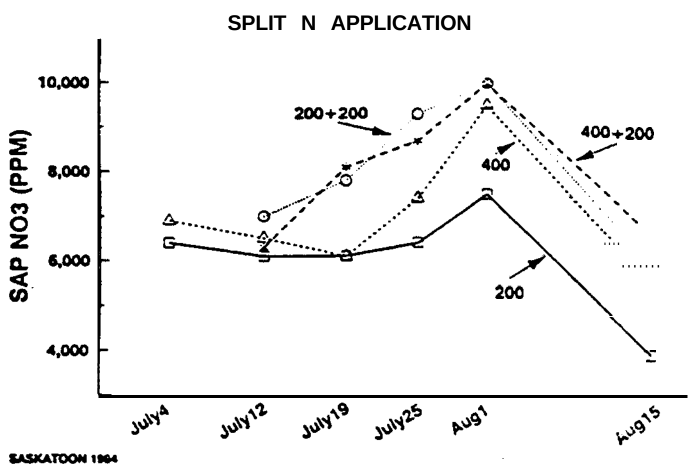


Figure 4. Sap NO3 levels with split nitrogen applications - 1994.

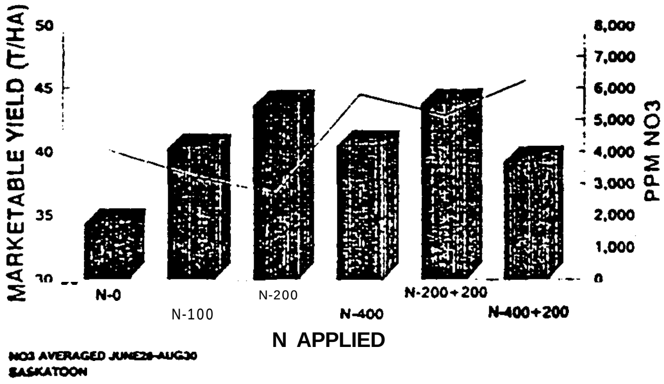


Figure 5. Yields versus nitrogen levels 1993.

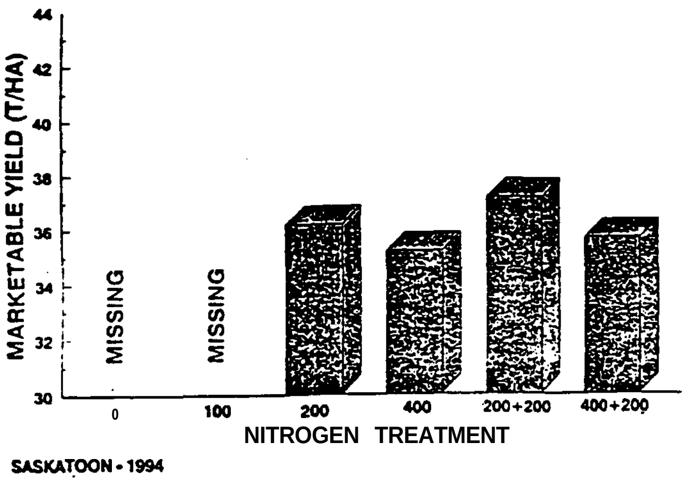


Figure 6. Yields versus nitrogen levels 1994.

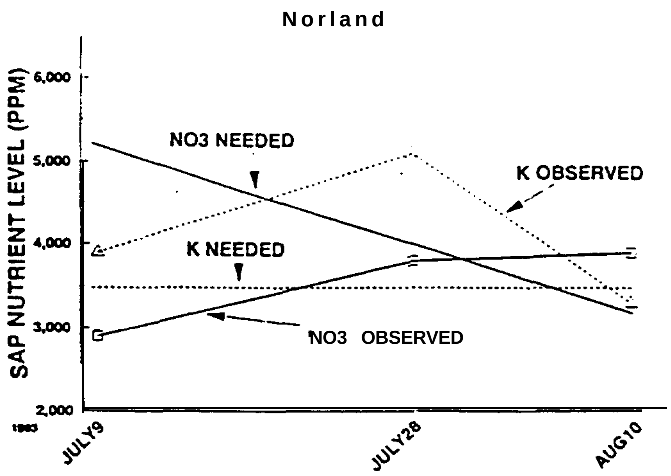


Figure 7. Sap NO3 and K levels in a commercial field of Norland in 1993.