Effects of Soil Salinity on Potatoes

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In five years, between 1997 and 2002, the Alberta potato industry expanded from 12300 to 22600 ha (30,500 to 55,800 acres). Much of this expansion took place in the irrigated region of southern Alberta, due to the opening of new processing facilities.

However, Alberta is also home to approximately 647000 ha (1,600,000 ac) of dryland salt-affected soils, with estimates that the salt affected area of soils in Alberta grows by 10% per year. Potatoes are a high input, high value crop that is known to be sensitive to soil salinity.

Because soil salinity is a possible limitation to continued growth of the potato industry in the province, it is important to quantify the potential negative impacts of salinity on yield and quality of potatoes and this was the objective of the study.

Method

Two field-scale crops of Russet Burbank potatoes were tested for the impacts of salinity on yield and specific gravity. During the 1999 growing season, a small amount of elevated salinity was noticed on a producer's field, due to leaky irrigation equipment and canal seepage. In April salinity was mapped and, at harvest, tuber samples (2.23 m^2 each) were collected at 61 sites, representing the range of soil salinity found in the field (Fig. 2a). At each tuber sample site, salinity was measured using a Geonics^{TM} EM38 in combination with a Global Positioning Satellite (GPS) system (Fig. 1). The tubers were graded for size and specific gravity was determined for each sample.

During the 2003 growing season, a crop of potatoes was grown at the CACDI site, on soil with variable salinity. Salinity variability, at the site, was due to topography related recharge-discharge areas. In April of 2003, salinity and topography maps were made in order to determine the best locations for tuber sampling. At harvest, 20 tuber samples (0.302 m^2 each) were collected across the full range of salinity present (Fig. 2b) and salinity was also measured with an EM38. The samples were graded and analyzed for specific gravity. In addition, load cells (scales) were attached to the rollers near the end of the belt on the potato harvester and linked to GPS equipment, in order to monitor and map potato yield across the field.

Results

At the 1999 Vauxhall site, salinity was generally low, with small areas of high salinity along the southwest and southeast edges (Fig. 2a). When hand samples of tubers were collected, the area of greatest salinity (east edge) was avoided due to standing water.

Tuber samples were graded for size and deformities. The yield of medium sized tubers, as determined by the processing industry standards of 4.4-8.9 cm (1.75-3.5") in diameter, was calculated and compared to soil salinity (Fig. 3a top). As expected with field data, there is considerable scatter (r^2=0.373), however, there was a significant decline in potato yield with increasing salinity. When surface (0-0.75 m) salinity increased from 1 to 3 dS/m, yield declined by over 25%. The scatter in the data may be attributed to uncontrollable factors in the field, such as variability in soil moisture and fertility, crop disease, weeds and insects. A slight increase in tuber specific gravity was observed with increasing soil salinity (Fig. 3a bottom). Again, a low coefficient of correlation (r^2=0.142) was observed. The mean tuber weight was also determined at each sample site and there was an observed decrease with increasing soil salinity.

At the 2003 Lethbridge site, salinity exhibited a greater degree of variability, due to topography, with low salinity on the knolls and higher salinity at the lower slope discharge areas (Fig. 2b). A map of the wider area also showed slough-ring effects, with highest salinity concentrations around the edges of potholes.

No relationship between yield and salinity (Fig. 3b top) and specific gravity and salinity (Fig. 3b bottom) was observed at this site. The disappointing results from this experiment are likely a combination of factors, including an extremely early harvest date, which resulted in immature tubers. One occurrence of insufficient irrigation, which occurred in early July, would have caused areas of high topography and low salinity to be water deficient, while areas of low topography and high salinity would have maintained sufficient moisture. This situation would have temporarily counteracted the negative effects of soil salinity. In addition, only 20 hand samples were taken at this location. More samples may have served to better characterize the results.

The soil conditions, at this research site, were atypical for potato production. Clay content was higher and sand content lower than soil normally used in potato production. A combination of soil texture and moisture conditions, at harvest, led to the formation of many potato-sized clods of soil during the machine harvest. These clods constituted 0-75% of the material passing over the load cells and, as a result, the yield monitoring was unsuccessful.

Further research is necessary to determine the effects of soil salinity on yield and specific gravity of potatoes, in southern Alberta. It is recommended that a minimum of 40-50 hand-dug tuber samples be taken per field. Also, study at a more sandy-textured site will serve to increase the chances of successful yield monitoring.

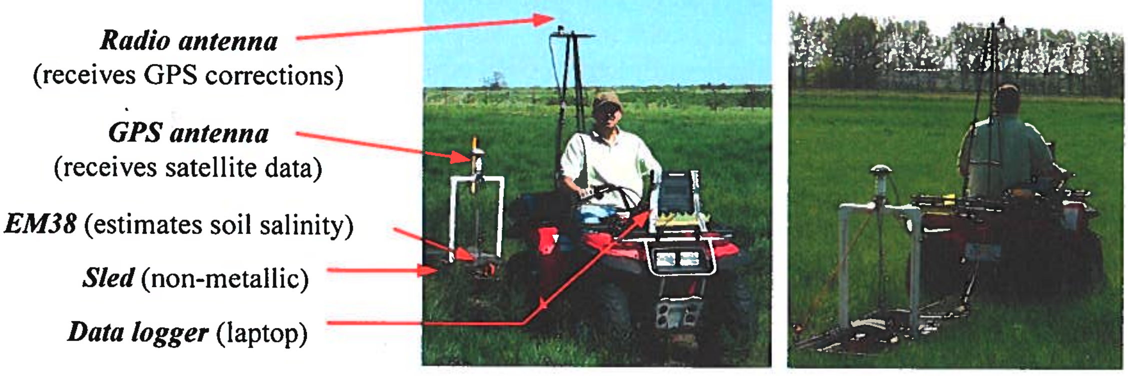

Figure 1.Salinity mapping equipment set-up.

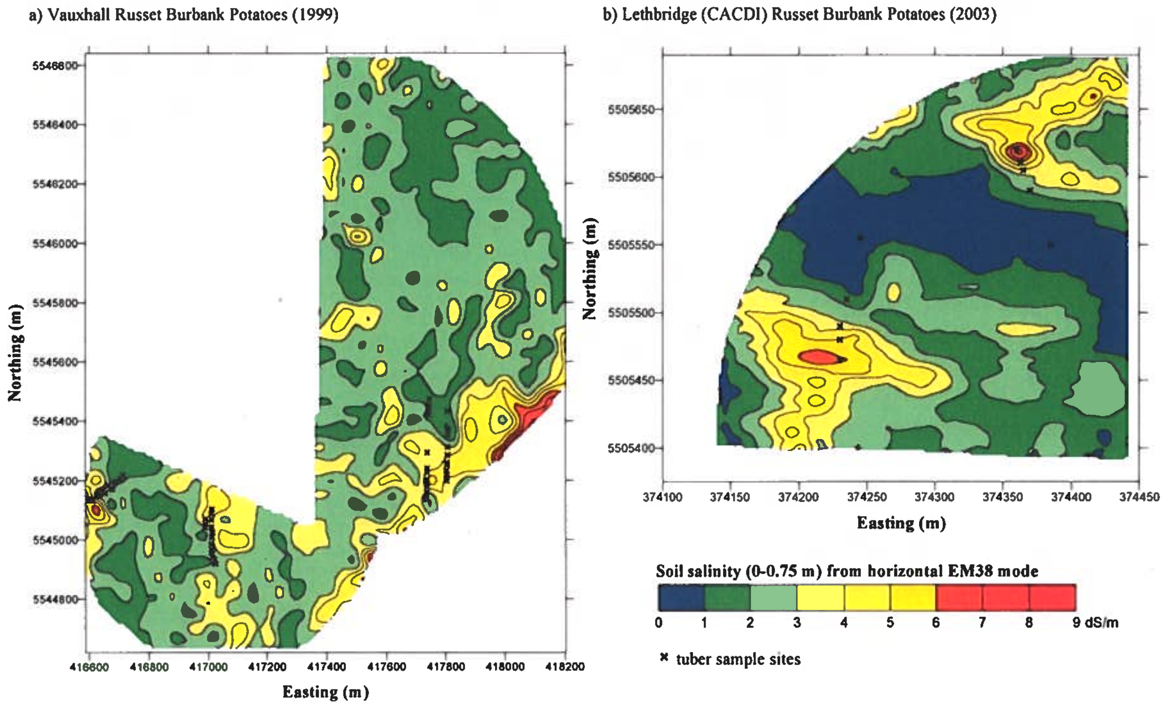

Figure 2. Soil salinity maps indicating tuber sample locations.

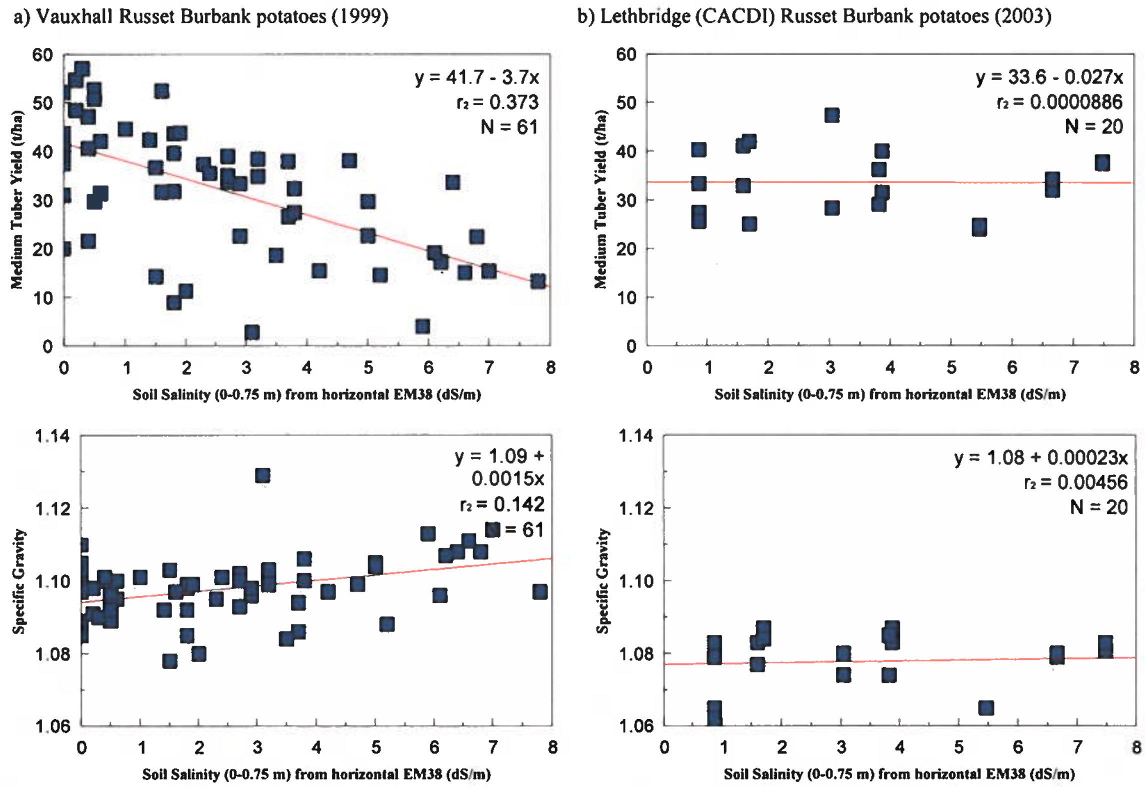

Figure 3. The response of medium tuber yield and specific gravity to increasing soil salinity.