

## **Nitrogen Fertility Requirements for Commonly Grown Potato Varieties in Saskatchewan**

Effective fertility management is critical to profitable production of potatoes. Potatoes are highly responsive to N fertilizer, but N fertilizer use efficiency is low (Rourke 1985; Porter and Sisson 1991). Consequently, growers striving to meet the crop's N requirements frequently over-fertilize. Excessive application of nitrogen is uneconomical, environmentally unsound and potentially detrimental to the crop (Gardner and Jones 1975; Westermann and Kleinkopf 1985).

The objective of this project was to determine optimum N-fertility recommendations under irrigation for a range of potato cultivars of interest to growers in Saskatchewan. The trials were conducted from 1994 – 2011 on the University of Saskatchewan Plant Sciences Department Potato Research plots located in Saskatoon. The site features a sandy loam, pH 7.8, EC < 1 dS, with 4% O.M. Wherever possible, standard commercial production practices were utilized. The trials were established in mid-May using certified, cut seed. Each treatment plot consisted of a single, 8-m long section of row, with 1 m between rows and 23 cm between plants within a row. Weed control was achieved by applying EPTC + metribuzin prior to planting, followed by linuron applied at ground crack. The crop was hilled twice prior to ground crack. This combination of herbicides and tillage provided good weed control. The crop was overhead irrigated whenever soil water potentials averaged over the root zone (0-30 cm) fell below -50 kPa. Insects and disease problems were managed as required. The trials were top-killed using diquat in early September (ca. 100 DAP) and machine harvested in late September (120 day growing season). Tubers were cured for 10 days at 15°C and then graded for size and freedom from defect. Specific gravity of the tubers was determined using the (weight in air)/(weight in water) method.

The soil-N levels tested (total of 50, 100, 150, 200 or 250 kg/ha) were achieved by pre-plant broadcasting sufficient 46-0-0 to supplement the residual soil N (ca. 50-75 kg/ha). The N-treatments were laid out in an incremental design. Each treatment was replicated twice.

The N fertility responses of Alpha, AC Peregrine, Norland, Ranger, Russet Norkotah, Pacific Russet, Russet Burbank and Shepody were tested over a minimum of 5 growing seasons. To allow for comparisons across years with varying growing conditions, the yields for each soil N level were expressed as a % of the highest yielding N fertility treatment in each year.

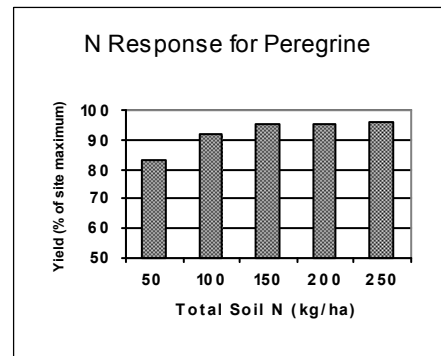
### **Results**

For most cultivars, the relationship between yield and N applied was quadratic, with yields increasing with initial increments of N applied and then declining once N levels increased beyond an optimal level. Similar N response patterns for potatoes have been reported previously (Waterer 1997), although in some cases or cultivars, yields plateaued rather than declining with increasingly high levels of N (Westermann and Kleinkopf 1985; Porter and Sisson 1991; Lewis and Love 1994). In many cases, the yields obtained with just the residual soil N (50-75 kg/ha) were within 15% of the maximum obtained with supplemental N. Fertilizer use efficiency of potatoes is known to be low and limited yield responses to N fertilizer are common in both research trials and commercial situations (Johnson et al. 1995). Zebarth et al (2004) showed that a combination of relatively modest residual soil NO<sub>3</sub>, plus the N made available through the growing season via mineralization of soil organic matter could provide sufficient N fertility to produce Russet Burbank yields within 15% of the maximum achieved by using 175 #/a of applied N.

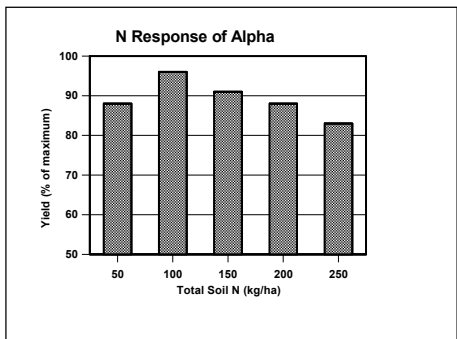
Kelling and Wolkowski (1991) found the N requirements of fast maturing determinant cultivars such as Russet Norkotah were substantially higher than slower growing indeterminant types like Russet Burbank and Alpha. They suggested that in early maturing cultivars, tuber set and development occurs at the expense of root development, resulting in a small root system with low nutrient recovery potential and correspondingly high N fertilizer requirements. In our trials we found that the optimum level of N for relatively fast maturing cultivars such as Russet Norkotah and Pacific Russet were substantially higher than for longer season cultivars like Ranger or Alpha. However, the fast maturing cultivar Norland was also found to have a relatively low fertility requirement.

### Specific Cultivar N Responses

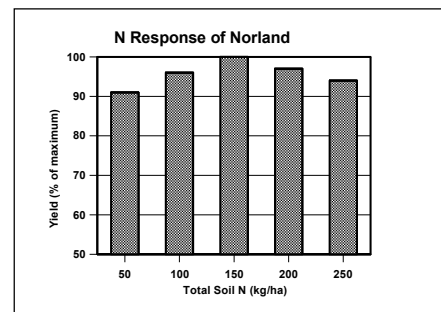
**AC Peregrine Red** - the yield response of AC Peregrine Red to pre-plant N was fairly strong. Insufficient N resulted in a substantial yield loss, with yields reaching a plateau at about 150 kg N/ha.



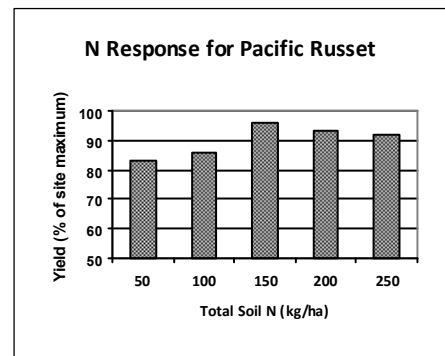
**Alpha** – yields for Alpha peaked at only 100 kg N/ha and declined with excessive N fertility. High rates of N fertilizer resulted in Alpha producing an excessively large plant canopy which reduced harvest efficiency.



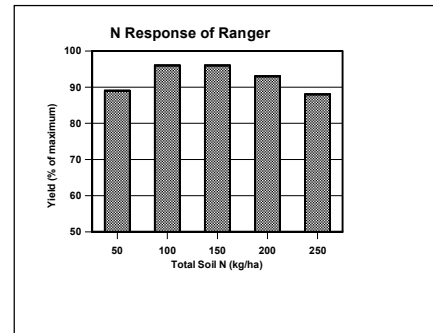
**Norland** – the yield response of Norland to pre-plant applied N was relatively flat. Yields exceeding 90% of site maxima were achieved with as little as 50 kg N/ha. Over-application of N had little impact on Norland yields, however the tubers took on a “rough” appearance.



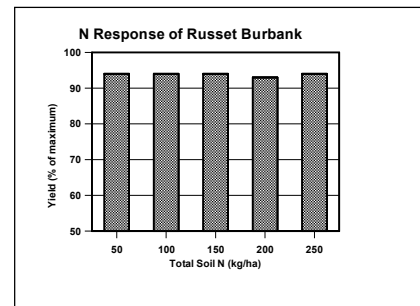
**Pacific Russet** - trials conducted in Alberta indicated very limited N fertilizer responses for this fast maturing russet, with maximum yields achieved at 100 kg N/ha. Trials in Saskatchewan showed a yield benefit of applying substantially higher rates of pre-plant N to Pacific Russet.



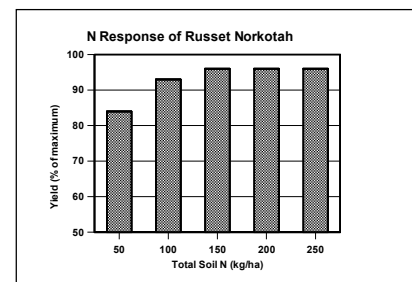
**Ranger** – pre-plant application of 100 - 150 kg N/ha resulted in consistent high yields. N applications above 150 kg/ha negatively affected yields - Ranger is notoriously vigorous and excessive N may delay maturity and exacerbate problems with top-killing.



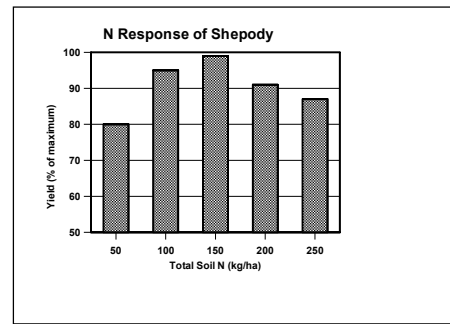
**Russet Burbank** – this long-season indeterminate cultivar is difficult to grow within the relatively short growing season available in Saskatchewan. Russet Burbank is sensitive to unfavourable temperature or moisture conditions, leading to substantial year to year variation in yields and quality. This year to year variability in yield potential was reflected in the Russet Burbank crop’s response to N fertility – with differing yield responses in each year of testing. In years with favourable production conditions, yields increased with N fertility to reach a peak at about 150 kg N/ha. If however, conditions were not favourable, yields were suppressed with each increment of applied N above the baseline of 50 kg/ha. The N fertilizer appeared to encourage the Burbank crop to stay vegetative which was highly detrimental to yields in cool wet years.



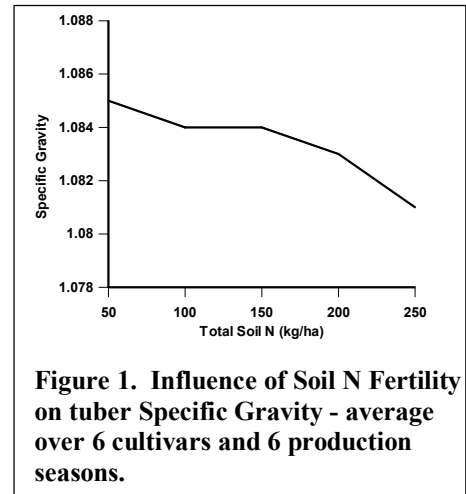
**Russet Norkotah** – yields of Norkotah increased substantially to plateau at 150 kg N/ha. Application of “excess” N did not appear to have any negative impact of yields, harvest management or appearance of the Norkotah crop.



**Shepody** – showed a strong response to pre-plant applied N, with both insufficient and excess N resulting in substantial yield losses. Yields of Shepody peaked at around 150 kg N/ha.



Although there was substantial variability in the specific gravities amongst the cultivars and across the years of testing there was a fairly consistent trend for the specific gravities to decline as the amount of N fertilizer applied was increased. This would be expected if the N fertilizer was encouraging the crop to stay in a vegetative state. The relatively limited impact of N fertility on specific gravities would be of limited importance in table potatoes but may be of relevance to processors.



**Figure 1. Influence of Soil N Fertility on tuber Specific Gravity - average over 6 cultivars and 6 production seasons.**

At present, the economics of potato production dictate that growers should strive to maximize yields, even if it involves the application of very high rates of N fertilizer. However, increasing costs of N fertilizers, along with growing concerns regarding the environmental impact of heavy applications of N fertilizers, may cause growers to re-examine their N-fertility program. The data generated in this long term study suggests that growers of potatoes in Saskatchewan may be able to reduce the N fertility rates applied to a range of commonly grown cultivars without an excessive yield penalty. The resulting gain in fertilizer use efficiency, along with improved crop quality and/or enhanced ease of harvest management associated with reduced N application, should be factored into this decision.

**This research was made possible with funding support from:  
Agriculture Development Fund of Saskatchewan Agriculture and Food**

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