UNIVERSITY OF SASKATCHEWAN

VEGETABLE CULTIVAR AND CULTURAL TRIALS 2010

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FUNDED BY:
AGRICULTURE DEVELOPMENT FUND

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Saskatchewan Agriculture and Food

Agronomy of New Potato Lines

The objective of this on-going project is to evaluate the performance of a promising new potato cultivars under Saskatchewan growing conditions. Yields and quality as a function of N-fertility, crop maturity, irrigation, and in-row spacing have been evaluated in trials (2005-2010) conducted on the Plant Sciences Department Potato Research plots in Saskatoon. The site features a sandy loam, pH 7.8, EC < l dS, with 4% O.M. In all trials, each treatment plot consisted of a single, 8-m long section of row. Unless otherwise specified, the row spacing was 1 m between rows, with 25 cm between plants within a row. Weed control was achieved by applying eptam + metribuzin prior to planting, followed by linuron applied at ground crack. The crop was hilled twice prior to ground crack. In the irrigated treatments, an overhead system was used whenever soil water potentials averaged over the effective root zone (0-30 cm) fell below -50 kPa. Unless otherwise specified, the trials were top-killed using diquat in mid-September (ca. 120 DAP) and machine harvested by early October using a Grimme harvester. Tubers were cured for 10 days at 15^{o}C, then cooled to 4^{o}C for longterm storage. The tubers were mechanically graded into size categories; small = < 44 mm diam., medium = 44 - 88 mm and oversize = > 88 mm diam. The boiling, baking, chipping and frying quality of the various lines were evaluated using standard methodologies.

Detailed results from trials conducted from 2005-2009 are available at :

www.usask.ca/agriculture/plantsci/vegetable/potato/pagronomy.htm

New cultivars tested in 2010

Milva (exclusive to a SSPGA member) - a yellow fleshed oval table potato
Pacific Russet - (SSPGA/EPG exclusive) - red skinned, white fleshed table potato
Gem Star (SSPGA members as local agents) - a russet processing potato
O'Pearle (exclusive to a SSPGA member) - a yellow fleshed "Baby" type potato
Alpine Russet – SSPGA member as local production/marketing agent
Blazer - SSPGA members as local production/marketing agents
Modoc – SSPGA member as exclusive agent

The trials evaluated the new lines against established industry standard lines (Russet Norkotah, Russet Burbank, Shepody and Norland).

2010 Growing Season

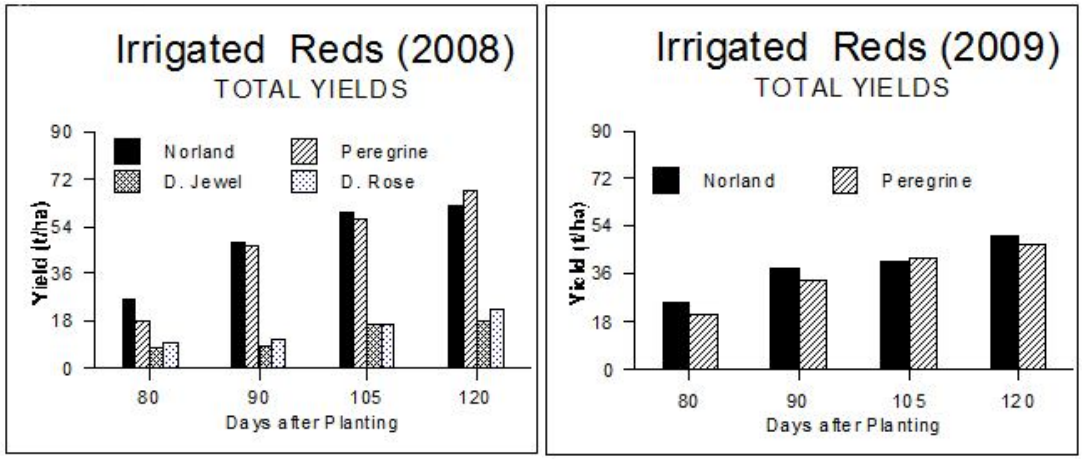
Temperatures were below normal throughout the 2010 growing season. About 34 cm of rainfall was received from June 1 - Aug 31 of 2010 (normal = 17 cm). Due to the steady rain, the 2010 crop only needed to be irrigated twice in late July/early August (5 cm total). Cool, wet conditions through most of 2010 were near-ideal for the development and spread of Late Blight. Despite repeated applications of protectant fungicides, blight was observed in the plot area in early August. Repeated rain events over the next 2 weeks allowed rapid development and spread of the disease, despite an intensified spray program. The resulting early loss of the crop canopy would have reduced the yield potential of the more blight sensitive cultivars.

Time of Planting and Harvest Trials

This trial examined the impact on time of planting and harvest on yields and quality. The trials were planted in mid-May or early June and harvested in late August or mid-September. This combination of planting and harvest dates resulted in plots harvested at 80, 90, 105 and 120 days after planting. Each treatment was replicated four times.

Results

Red skinned cultivars - In trials conducted in 2008-2010 Norland appeared to have a slight yield advantage at the early harvests (80 and 90 DAP) while Peregrine produced higher yields at the later harvests (Fig. 1). Neither of the Dakota series reds tested in 2008 had yields that warranted further testing. In a single year of testing (2010) Modoc showed some promise with yields that were comparable to the industry standard reds. The yield potential of Modoc may have been compromised in 2010 as it appeared sensitive to defoliation by late blight.



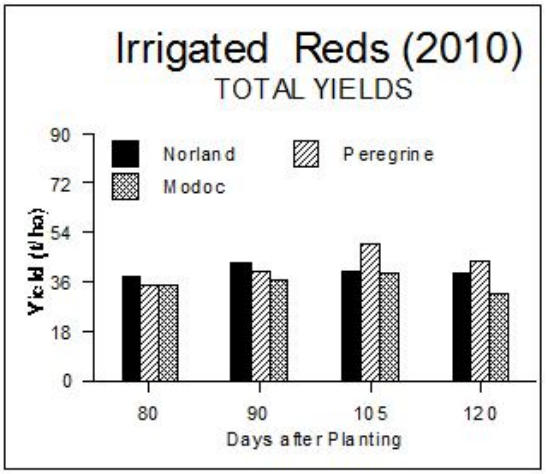


Fig. 1. Yields for various red-skinned potatoes under irrigation in 2008, 2009 and 2010.

Russets - Yields of the russet type lines tested in 2008 were comparable at all four sampling dates, while in 2009 and 2010 yields of Russet Burbank and GemStar tended to lag behind the other russet cultivars (Fig. 2). In warmer years, yields of these slow developing cultivars tend to catch up late in the season, but this did not occur in 2009 and 2010 - a reflection of the cool 2009 growing season and problems with blight limiting crop vigour late in the season in 2010. The SSPGA line Pacific Russet showed excellent early and total yields in 2010 – it out-yielded the industry standard table russet (Norkotah) at all harvest dates. The two new processing russet lines introduced for testing in 2010 – Alpine and Blazer both out-yielded the industry standard for processing russets (Burbank). Yields of Shepody actually decreased with increasing time in the field in 2010 – this reflects increasing

cullage to late blight. Shepody is extremely sensitive to blight.

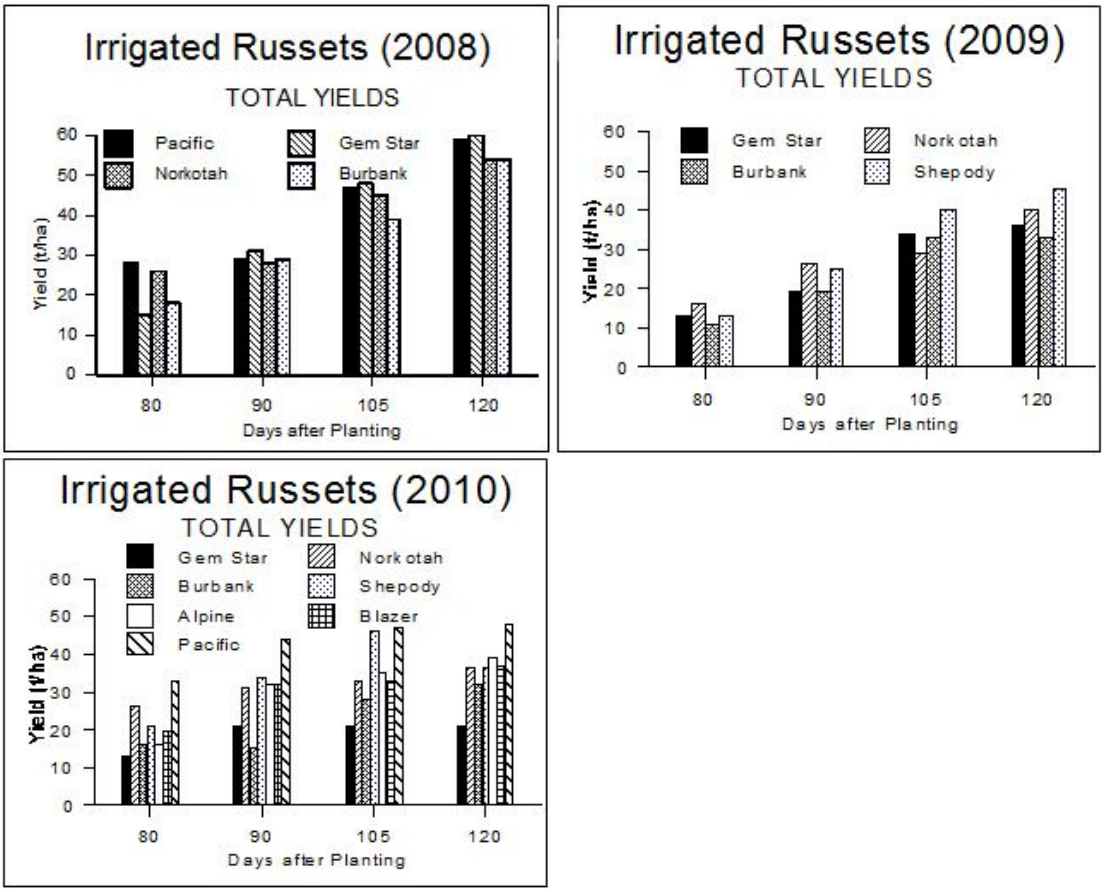


Fig. 2. Yields of russet-type potato cultivars under irrigation in 2008, 2009 and 2010.

In all three years of testing there was a progressive increase in specific gravities of the Russet cultivars with increasing time in the field – this was expected as gravities increase with crop maturity (Fig. 3). Specific gravities for all of the russet cultivars tested in 2010 were lower than in previous years – this again reflects the poor growing season and early termination of crop development in 2010 by late blight. The industry standard R. Burbank had some of the lowest gravities in all three trials which confirms the difficulty of getting this long season cultivar to mature within the limited growing season available in SK. The only russet cultivar in the 2010 trial that had what could be considered "acceptable" gravities for a processing potato was the new cultivar Alpine.

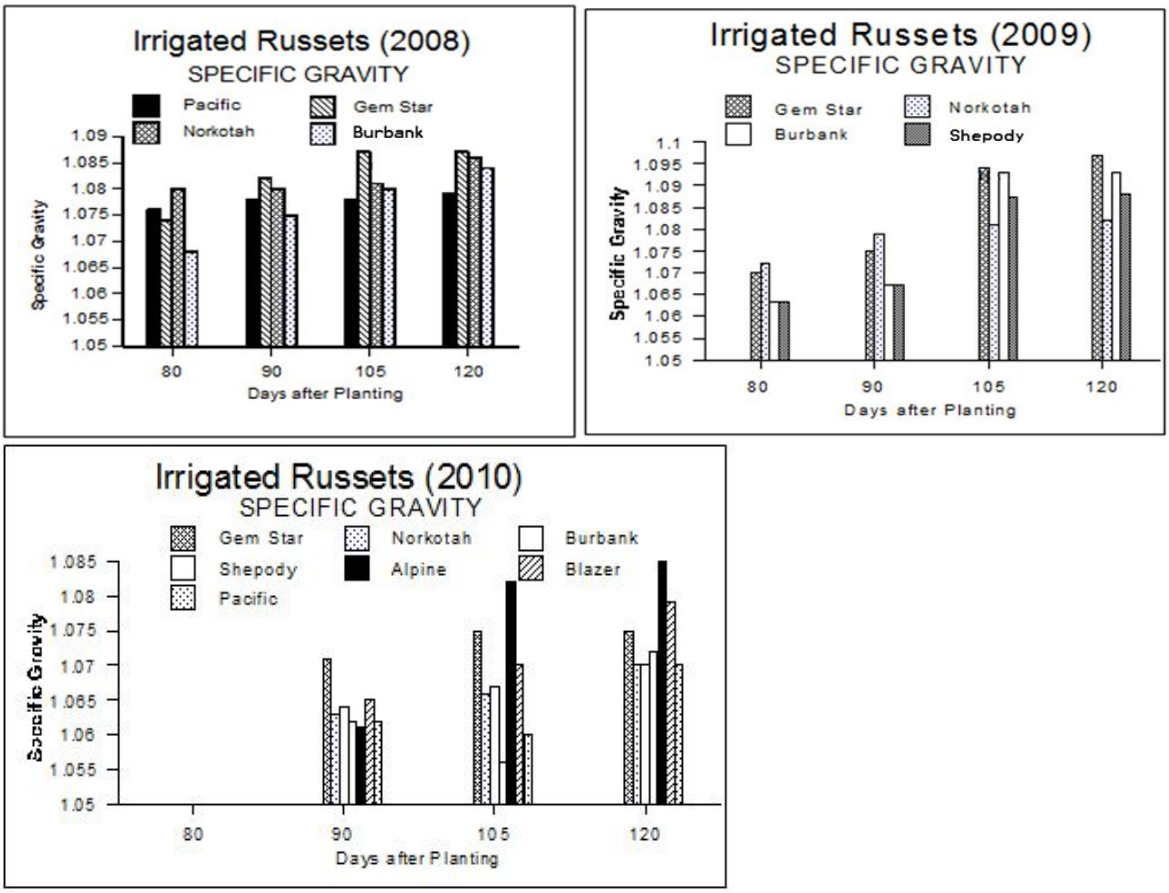


Fig 3. Specific gravities of irrigated russet-type potatoes in 2008-2010.

Yellow fleshed cultivars – The yield profiles of Milva and O'Pearle were comparable in 2009 (Fig. 4). However in 2010 yields of Milva were superior to O'Pearle and all the other yellow fleshed lines tested at all harvest dates. Milva appears to be highly tolerant of late blight – which may explain why it's performance was superior to the other less blight tolerant yellow lines tested in 2010. The new cultivar Yukon Gem had quite high gravities by the final harvest in 2010 (data not shown) – this contributed to its excellent performance in processing trials.

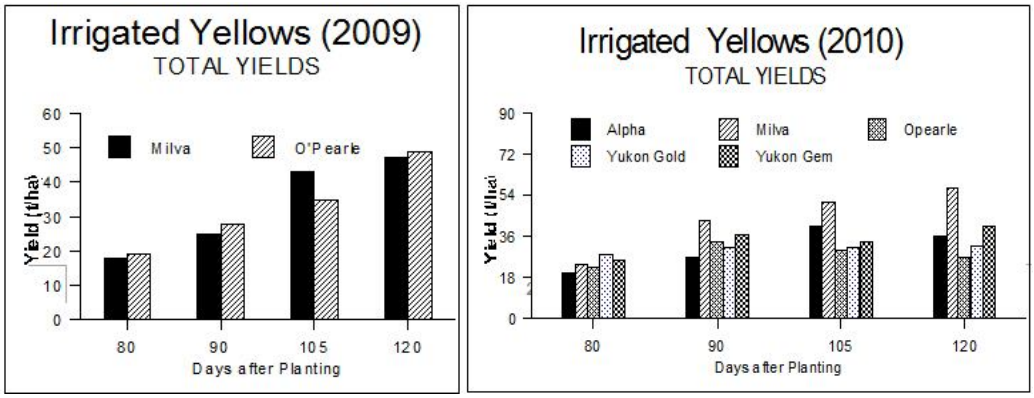


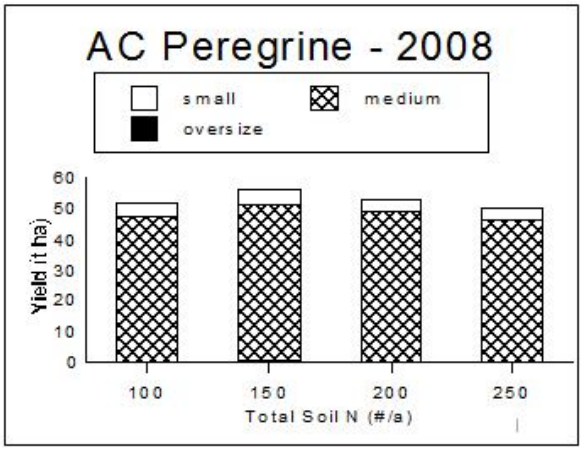
Fig. 4. Yields for irrigated yellow-fleshed potatoes in 2009 and 2010.

Summary of Time of Planting and Harvest Trials

The results of the time of planting * harvest date studies indicate the importance of maximizing the duration of the effective growing season for growers in Saskatchewan wishing to maximize their yields. Yields of both the new and industry standard cultivars tested increased progressively with duration in the field through to 120 days. A 120 day season represents the effective maximum available to potato growers in Saskatchewan - as earlier plantings or later harvests run into excessive risk of frost damage. By contrast, some growers opt for a very short duration growing season - in the seed industry this is used to minimize the risk of virus infection, whereas in the table sector, growers may opt for an early harvest to catch a high value market opportunity or to keep the size of their tubers within the optimum range desired in the marketplace. The results clearly illustrate the magnitude of yield sacrifice associated with an early harvest. The relative amount of yield loss associated with an early harvest was greater for late maturing cultivars like Gem Star and Russet Burbank than for earlier cultivars like Shepody or Norland. This suggests that growers should use caution when growing slow maturing cultivars like Gem Star or Russet Burbank as a slow start to the season, an unusually cool summer or an early fall could severely depress yields. In all cases the increase in yields with time in the field was strictly a function on an increase in average tuber size, rather than any increase in tubers produced. As expected, the dry matter content (specific gravities) increased with duration in the field - reflecting increased physiological maturity. The increase in specific gravity with maturity is of only limited importance to the seed and table growers of Saskatchewan - but this information will be of use to growers in other areas wishing to use these newly developed cultivars for processing.

N-Fertility Trials

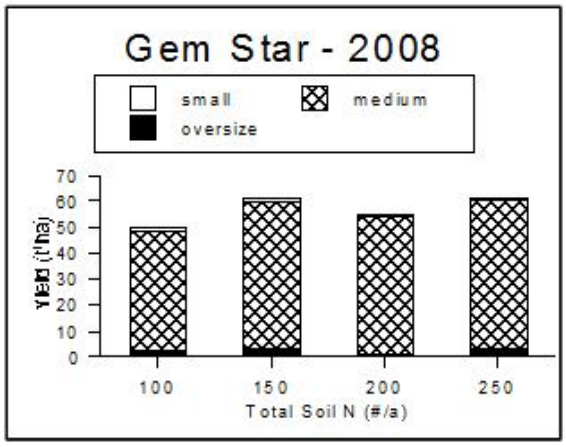
At present N fertility recommendations for potatoes in Saskatchewan range from 150 #/a (dryland) to 190 #/a (irrigated). The objective of this trial was to determine optimum N-fertility rates under irrigation for a range of new cultivars. The soil-N treatments (total of 50, 100, 150, 200 or 250 #N/a) were achieved by pre-plant broadcasting sufficient 46-0-0 to supplement the residual soil N (ca. 50-100 # N/a). The N-treatments were laid out in an incremental design with two replicates.

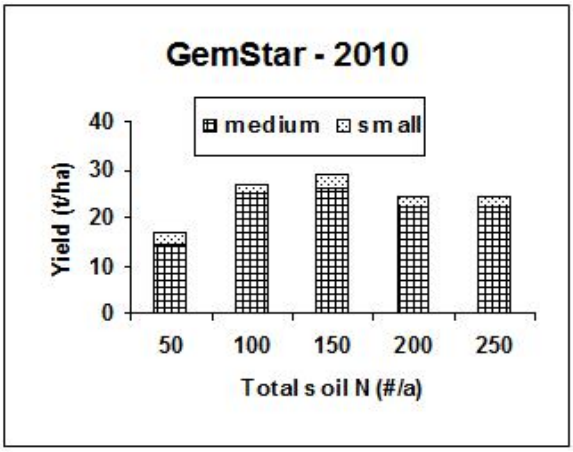


Results - The N-response of AC Peregrine (2008) was quite flat, which corresponds to the results seen in trials conducted in 2005, 2006 and 2007. The lowest level of soil-N tested in 2008 (100 # N/a) resulted in total yields for AC Peregrine within 6% of the highest yield observed (150 # N/a).

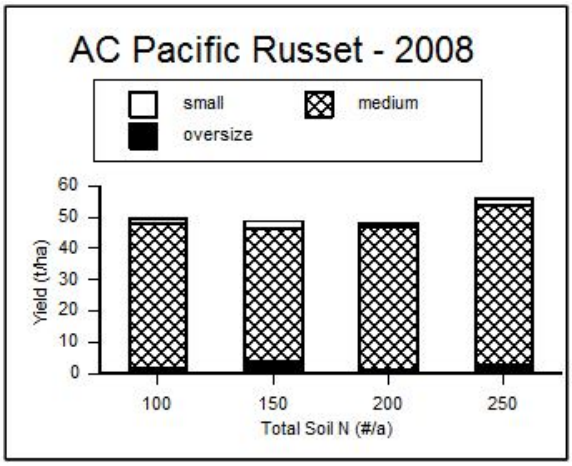
In 2005, yields of GemStar increased through to the highest soil-N level tested (250# N/a). In 2006 and 2007, the N response by GemStar was more limited, with the lowest rate of N applied (100 #/a) producing yields that were within 10% of the highest yields produced (200 #/a). In the 2008 and 2010 trials, the N response of GemStar was again relatively flat, although it appeared that at least 150#/a N was required for optimum yields. It is noteworthy that yields of GemStar in 2010 were

very low – reflecting the combined effects of poor seed quality and early loss of the tops due to Late blight. The limited yield potential of the 2010 crop may have restricted the N fertility response. A very high rate of hollow was noted in the Gem Stars in previous trials but there was no apparent relationship between the N rate applied and the incidence of hollow heart. In the 2008 and 2010 trials there was little hollow heart in the GemStars, irrespective of the N-fertility levels.



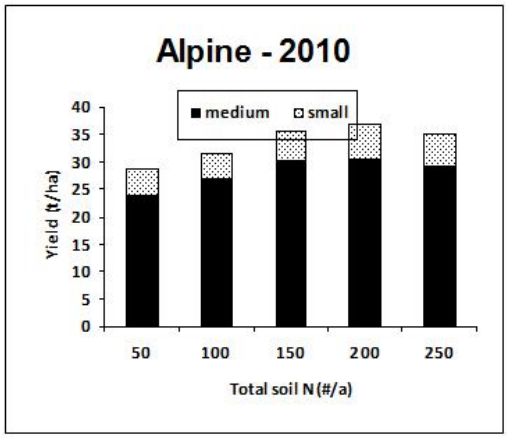


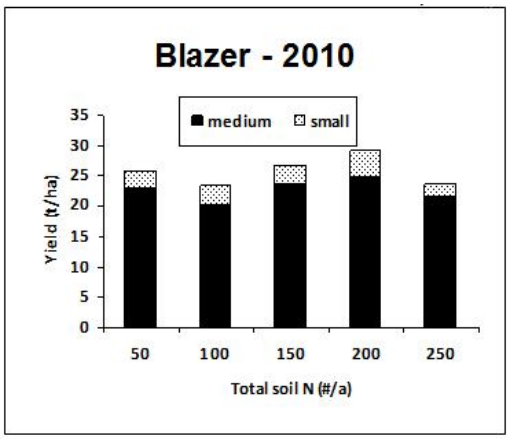
In 2006 and 2007 yields of AC Pacific Russet had peaked when 150 # N/a was used. In the 2008 trial, the highest yields were seen with the highest rate of N applied (250 #/a), however the actual yield difference between the highest and lowest rates of N applied were relatively small.

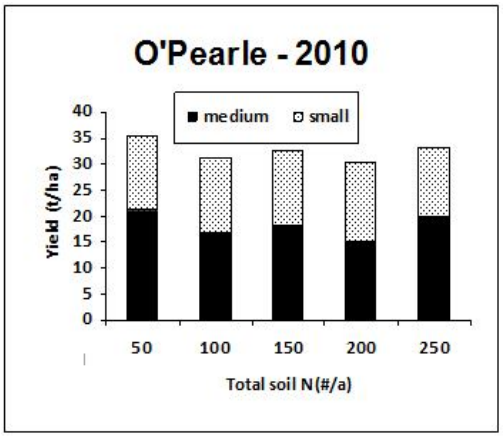


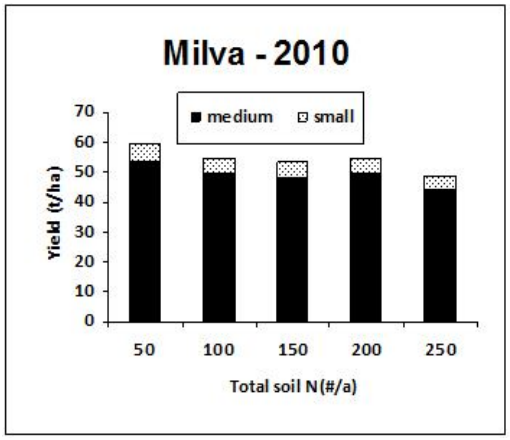
Yields of the new russet cultivar Blazer were low in the 2010 trial and were not influenced by the N fertility treatment. Another new russet cultivar Alpine showed much higher yields that peaked at around 150 #/a of total N.

O'Pearle which is grown for the small potato market showed no N fertility response. It is noteworthy that the N fertility variable also had no impact on the tuber size distribution of O'Pearle. The yellow fleshed table cultivar Milva showed a slightly negative yield response to increasing soil N availability. Even at the lowest level of available soil N, Milva produced yields that were far higher than the other cultivars tested in 2010. Milva appeared to be highly resistant to late blight – which suggests that late blight sensitivity, rather than soil N availability, may have been the major determinant of yields of the cultivars involved in the 2010 fertility trials.









Conclusion - The N fertility responses of the new cultivars were;

a) quite similar to one another, b) inconsistent from year to year and c) quite limited - in that the lowest rate of N applied (100 #/a) typically produced yields that were within 10% of the highest yielding treatments.

The inconsistency of the N fertility responses from year to year is likely driven by differences in the relative suitability of the growing season for potato growth. In poor growing seasons (such as 2010) yield responses to fertility treatments may be small as the availability of N is not limiting growth. While supra-optimal rates of applied N seldom had any significant negative impact on yields they may have had a negative impact on crop quality. Heavy applications of N tended to delay crop maturity making harvest difficult and leading to a reduction in specific gravities.

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. As the cost of N increases and/or concerns increase regarding the environmental impact of over-application of fertilizers, the data generated in this study suggest growers of potatoes in SK can cut their N applications substantially without a significant yield penalty - and this management decision may actually increase crop quality.

Spacing trial

The effect of in-row spacing was fairly consistent across the cultivars tested in 2010. As seen in previous years, the closest in-row spacing (15 cm) consistently resulted in the highest yields – with less obvious differences between yields at 23 and 30 cm in-row spacings (Fig. 5). There was a tendency for the average tuber size to decrease along with the in-row spacing – but the effect was not significant in most cases (Fig. 6). Loss of crop vigor due to late blight may have limited yield responses to the spacing variable in 2010.

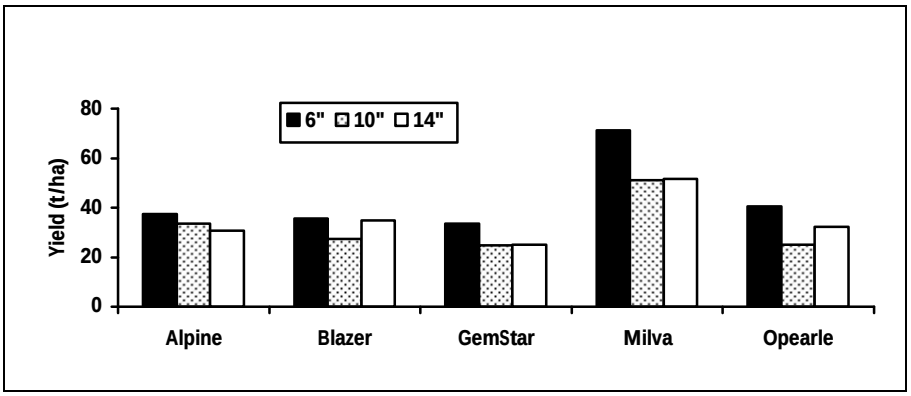


Fig. 5. Impact of in-row spacing on tuber yields in 2010.

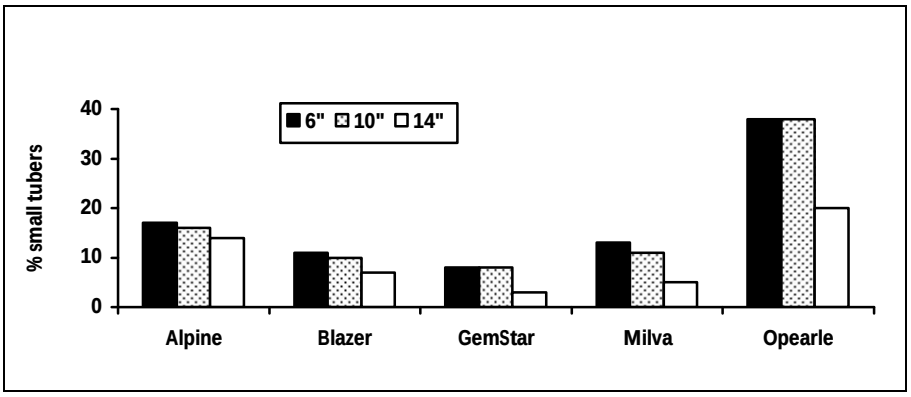


Fig. 6. Influence of in-row spacing on % small tubers (< 44 mm diam) – 2010 trial

Conclusion - The results clearly illustrate the responsiveness of potato to manipulation of plant populations. If the objective is to maximize yields, a close in row spacing is clearly desirable as long as reaching a certain minimum tuber size is not a significant issue. In seed production a close in-row spacing would produce high yields and a highly desirable small average tuber size distribution. The table and processing sectors are looking for a larger size profile - and therefore a slightly wider in-row spacing might be desirable - as long as it does not represent an excessive compromise in yield potential or processing quality. It is noteworthy that yields were increasing with plant population through to the closest spacing used ie; 6". This raises two questions;

a) Would the trend continue for an even closer spacing ?

We suspect that the yield profile would tend to plateau - with the cost benefit ratio depending

on the relative cost of seed versus the harvested crop. For cultivars like O'Pearle and Peregrine, the yield profile at 6" was already quite small. There is a substantial price penalty in table markets if the tuber size falls below "A" size (1 3/4" or 55 mm diam). If however, the tuber size falls all the way to a "Creamer" size (1" or 25 mm) these tubers command a price premium as "Baby" potatoes. O'Pearle is specifically targeted at this Creamer market. The fact that yields of Creamer sized potatoes for O'Pearle was still increasing as in-row spacing narrowed to 6" suggests that there may be advantages of even closer in-row spacing.

b) Would a commercial grower expect to see the same responses?

The yields obtained in this trial were well in excess of those obtained in typical commercial fields in SK. This may reflect efforts to manage all inputs so as to minimize crop stress or competition for resources. These management practices would have allowed the crop to express its full yield potential - even when there were very large numbers of plant competing for resources. However, the cost and cost efficiency of this type of management regime was not considered. If a grower cannot or does not provide the same stress-free production environment, this will lead to competition between plants within the row - with a corresponding drop in yield potential. This loss of yields will be greatest in situations where a high plant population tends to exacerbate competition effects. Growers will need to tailor their plant populations to match their ability to manage the crop while also factoring in costs of production and anticipated yields and economic returns.

Review of the agronomic responses of the new cultivars tested in 2008-2010;

O'Pearle

The small but uniform tuber size profile of O'Pearle makes it well suited to the baby potato market. It appears to be earlier maturing with a smaller more manageable vine than the present industry standard (Alpha). O'Pearle produces a higher proportion of tubers meeting the size standard for "baby" potatoes (<35 mm diam). O'Pearle responded very favourably to close in-row spacings.

Some concerns regarding O'Pearle are;

a) the results from 2009 suggest that O'Pearle is sensitive to drought stress. By comparison, the standard cultivar Alpha is quite drought tolerant.

b) O'Pearle appeared to be more sensitive to defoliation by late blight than the present standard Alpha.

c) O'Pearle showed a high percentage of tubers with common scab in the 2010 trial.

Milva

Milva is hoped to represent an alternative to Yukon Gold as a smooth skinned yellow fleshed table potato. Milva appeared to have exceptional yield potential, even in early harvests. Its tuber size distribution was more uniform than Yukon Gold and it also shows less tendency to oversize. Milva is exceptionally tolerant of Late Blight and also has fewer problems with scab than Yukon Gold. The only significant limitation of Milva may be that its tubers are tear-drop shaped - and this shape is not familiar in the North American marketplace.

Pacific Russet

is an early maturing dark russet line designed for use in the table market. Once issues with limited supplies of quality seed were rectified, this SSPGA line performed very well. Pacific

Russet is clearly superior to all other russet lines for yield potential, especially early in the season. While the average tuber size of Pacific Russet is quite large, tuber size can be manipulated by altering in-row spacings. Pacific Russet appears to be quite sensitive to both defoliation and tuber decay caused by late blight. Pacific Russet has limited processing potential.

GemStar

This recently released processing russet had performed well in trials conducted from 2005-2007, but it did not yield well in the trials conducted from 2008-2010. It appears that there may be issues with quality of the seed presently available for GemStar. Until these quality issues are rectified we cannot recommend the adoption of this cultivar.

Blazer and Alpine

are newly released processing type russet potatoes. Both lines showed promise in the 2010 trials – consistently out-yielding the industry standard (Burbank). They also had superior processing quality than Burbank, especially during early harvests. Both of these lines also showed high levels of tolerance of late blight. More testing of these lines is warranted.

Modoc

This newly released red-skinned table cultivar showed some promise in the single season of testing in 2010. It produced yields that were comparable to the industry standard reds – despite early loss of the foliage to late blight. Modoc appears to have superior colour and appearance than Norland and is more scab tolerant than Peregrine.

Yukon Gem

This yellow flesh cultivar is envisioned as a replacement for Yukon Gold in the table market. Yukon Gem appears equivalent or superior to Yukon Gold in terms of yield potential, especially in years with significant late blight pressure. The processing quality of Yukon Gem was surprisingly good – it produced the highest quality fries of any line tested in 2010. Taste panels also indicated that the flavour of Yukon Gem was superior to Yukon Gold. Yukon Gem does not appear to be as sensitive to common scab as Yukon Gold. The only limitation to Yukon Gem may be its appearance – it does not have as uniform shape as Yukon Gold and it has pink eyes.