Agronomy of New Potato Lines

(Supported by the Agricultural Development Fund of Saskatchewan Agriculture and Food)

The objective of these trials conducted from 2005-2008 is to evaluate the performance of a range of newly released potato cultivars under Saskatchewan growing conditions. Changes in yield and quality as a function of N-fertility, crop maturity, irrigation, and in-row spacing were evaluated in trials 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. This site has only a limited history being cropped to potatoes - until 5 years ago it was in dryland alfalfa.

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 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 15ºC, then cooled to 4ºC 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.

The results from the 2005 - 2007 trials are available at :

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

2008 Growing Season

Temperatures in 2008 were well below normal in May and June, about normal in July and slightly above normal in August and through the harvest period in September. The frost free period (May 26 to Sept 24) was near the 30 year average. About 17 cm of rainfall was received from June 1 - Sept 1 (normal = 17 cm). Very limited precipitation throughout August resulted in exerted substantial moisture stress on the dryland crop during the crucial period of tuber set and bulking. A total of 15 cm of supplemental irrigation was applied during the 2008 growing season (Fig. 08-1).

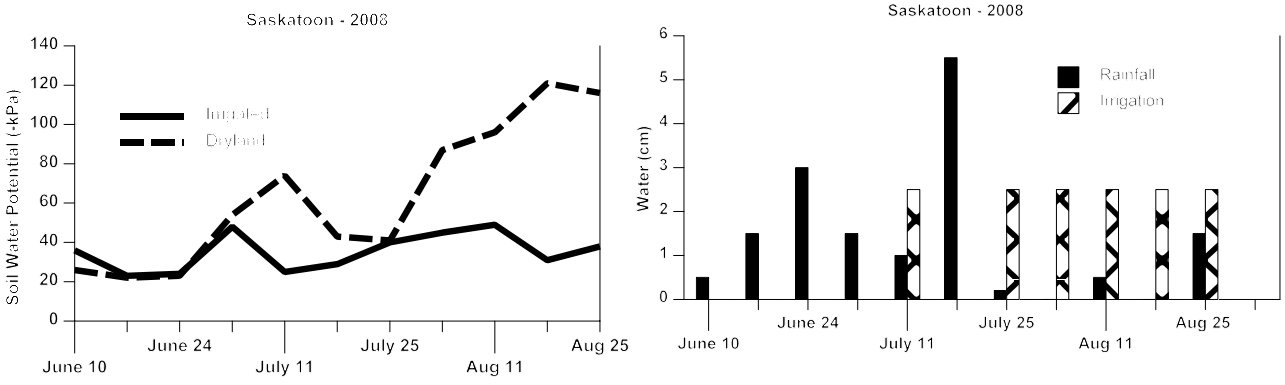


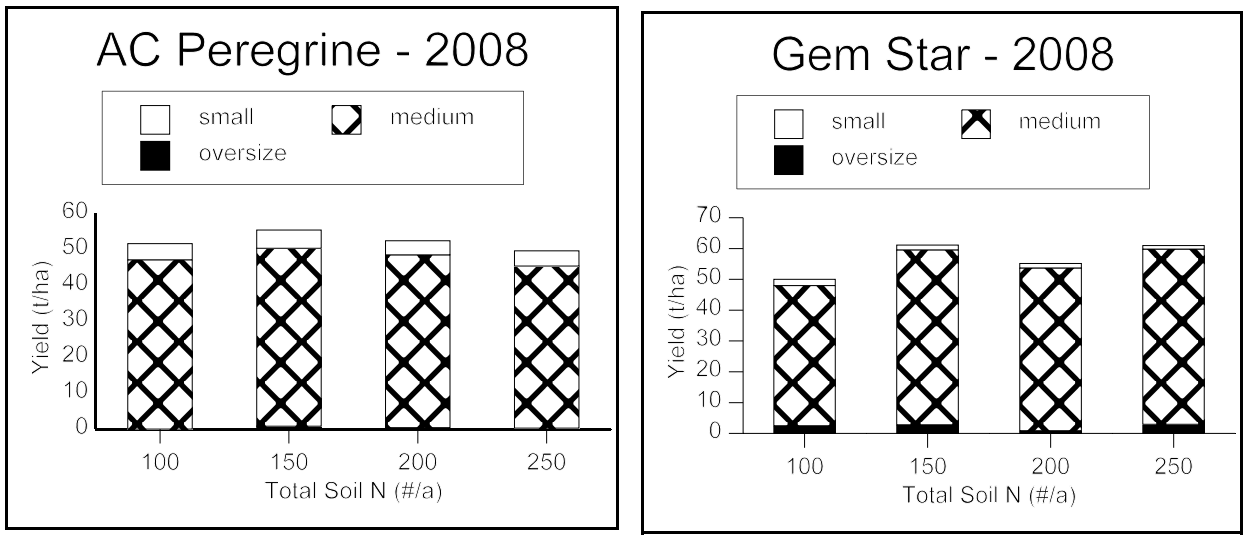
Fig. 08-1. Soil water potentials, rainfall and irrigation events for the 2008 potato trials in Saskatoon.

N-Fertility Trials

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

Results

The yield responses of the AC Peregrine, Gem Star and AC Pacific Russet to total soil-N levels ranging from 100-250 # N/a are presented in Fig 08-2.



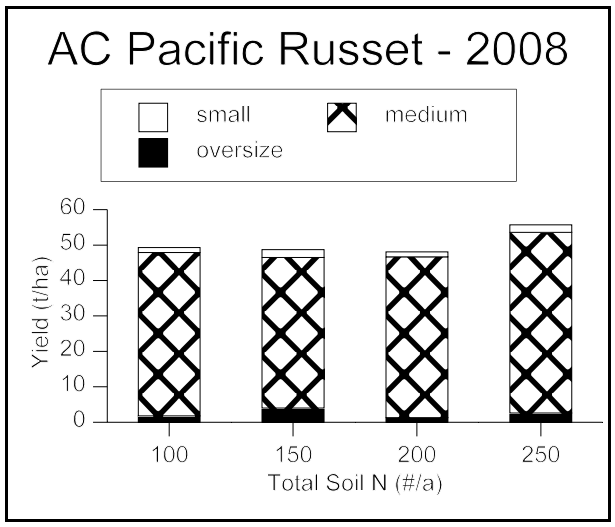


Fig. 08-2. Yield responses of new potato cultivars to increasing levels of soil-N.

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

In 2005, yields of Gem Star increased through to the highest soil-N level tested (250# N/a). In 2006, 2007 and again in 2008, 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 obtained in the trial. A very high rate of hollow heart 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 trial there was little hollow heart in the GemStars, irrespective of the N-fertility levels.

In 2006 and 2007 yields of AC Pacific Russet 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.

Specific gravities of all four cultivars in 2008 were lower than in previous trials. In the trials conducted from 2005-2007, specific gravities had declined as the fertility level increased. However, in the 2008 trial there was no consistent relationship between specific gravities and N fertility levels (Fig 08-3).

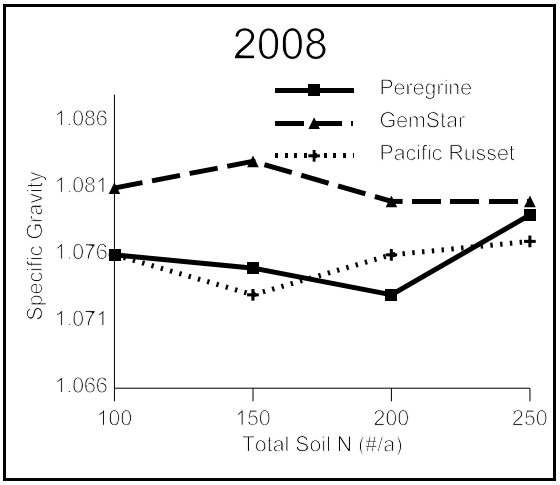


Fig. 08-3. Influence of N fertility levels on specific gravities of new potato lines.

Conclusion

The N fertility responses of the three new cultivars were;

a) quite similar to one another,
b) less consistent from year to year
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.

Supra-optimal rates of applied N seldom had any significant negative impact on yields but did tend to delay crop maturity as reflected by the lower specific gravities. Delayed crop maturity would also tend to make it more difficult to achieve vine desiccation prior to harvest.

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, it is clear that growers can cut their N applications substantially without a significant yield penalty.

Time of Planting and Harvest Trials

This trial examined the yields and quality of new potato cultivars harvested 80, 90, 105 and 120 days after planting. Separate plots were grown for each planting and harvest date. In a dryland trial only a 120 day harvest was used.

Results

Reds - In the irrigated trial, total yields for Norland and Peregrine were comparable at all four growth intervals and were consistently higher than the yields for either of the Dakota lines. (Fig. 08-4a). In previous trials, Peregrine had higher tuber specific gravities than the other red varieties tested - in the 2008 trial this difference was less pronounced (Fig. 08-4c). Norland had the largest average tuber size, while Peregrine had the greatest proportion of the total yield falling into the small size category. Yields in the dryland trial for reds averaged less than 40% of the irrigated trials (Table 08-1). Norland appeared to be the most drought tolerant of the red lines tested. Specific gravities in the dryland trial were comparable to the irrigated crop.

Russets - Yields of the four russet type lines were comparable at all four sampling dates (Fig 8-4a). This is in contrast to previous years where the table russets (Pacific Russet and Russet Norkotah) were consistently higher yielding early in the season than the processing types (GemStar and Burbank). As in previous years, Pacific Russet and Gem Star had a larger tuber size profile than the other lines (Fig 08-4b). Specific gravities at the early harvest dates were higher than in previous years, while at the later harvests the specific gravities were similar to previous trials (Fig 08-4c). Yields from the dryland russet trial ranged from 28-40% of irrigated - with the processing types (GemStar and Burbank) appearing to be more sensitive to drought stress than the table types (Pacific and Norkotah) (Table 08-1).

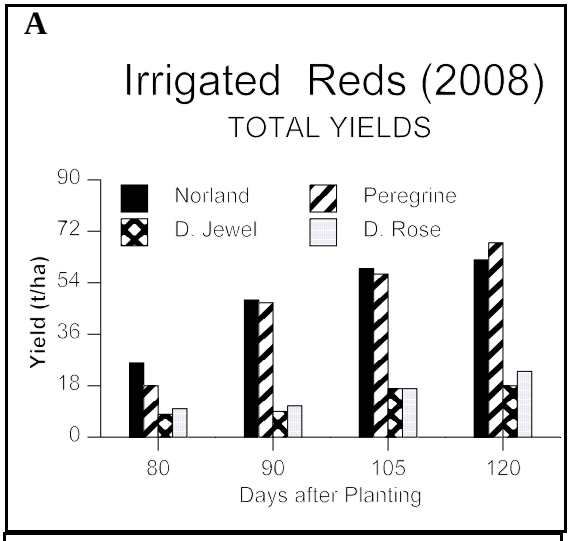
Table 08-1. Yield and quality components for Red and Russet potatoes under dryland conditions in 2008.

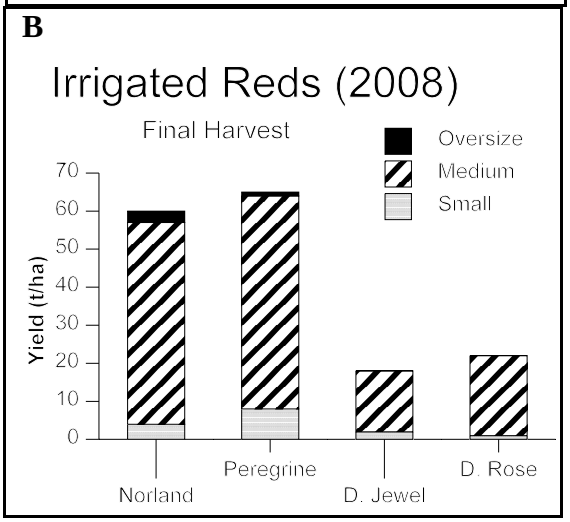
Line	Yield (t/ha)	Yield - % of irrigated	Specific gravity
Reds			
Norland	26.0 a	42 a	1.078
AC Peregrine	24.9 a	37 b	1.077
Dakota Rose	8.1 b	34 b	1.078
Dakota Jewel	5.5 b	26 c	1.074
Russets			
R. Norkotah	22.8 a	41 a	1.083
R. Burbank	16.1 b	30 c	1.075
Pacific Russet	20.9 a	36 b	1.079
Gem Star	16.6 b	28 c	1.08

Values within columns followed by the same letter are not significantly different (p=0.05)

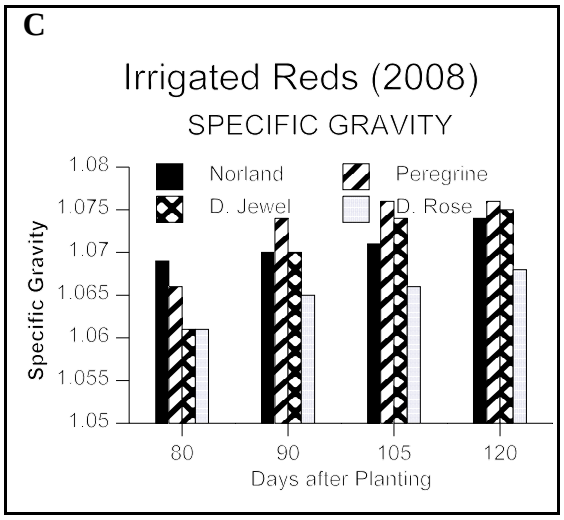
Summary of Time of Planting and Harvest Trial

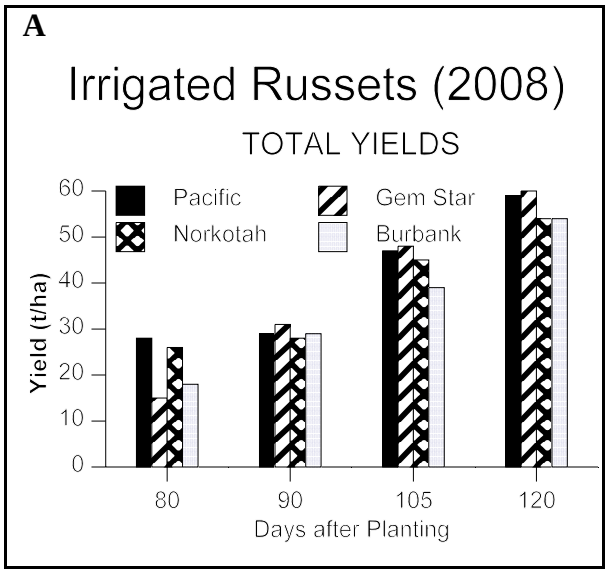
The results of this 4 year study clearly indicate the importance of maximizing the duration of the effective growing season if growers in Saskatchewan wish to maximize yields. Yields of all of the new cultivars tested increased progressively with duration in the field through to 120 days. A 120 days 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 rate of yield gain was greatest for the earlier harvests but was still significant up to 120 days in the field. 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 cultivars like Pacific Russet or Norland. This suggests that growers should use caution when growing 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 of an increase in





average tuber size, rather than any increase in tubers produced. Even at the latest harvest date (120 days) only a small proportion of the tubers had exceeded optimum size for the table market. It should however be noted that these trials were based on a relatively close (25 cm or 10") in-row spacing. Growers opting for wider in-row spacings may find a relatively large proportion of the crop grading out as oversize after 120 days - especially for cultivars like Norland, Gem Star and Pacific Russet which have a larger than average tuber size profile. 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.





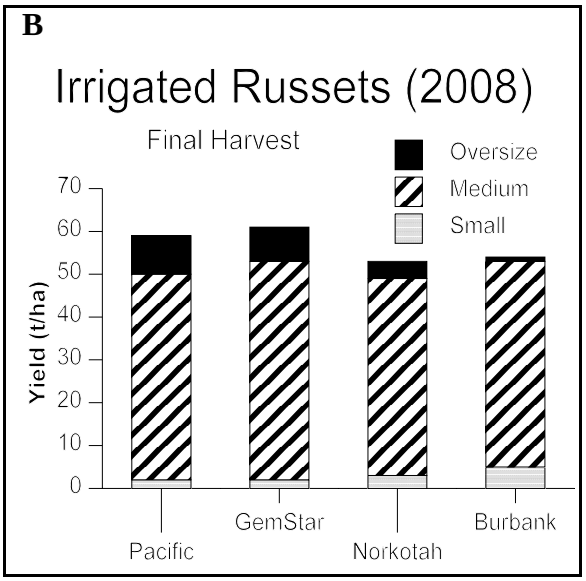
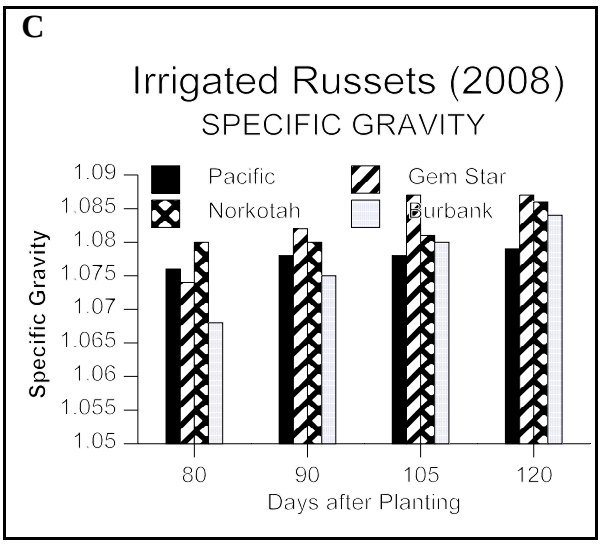
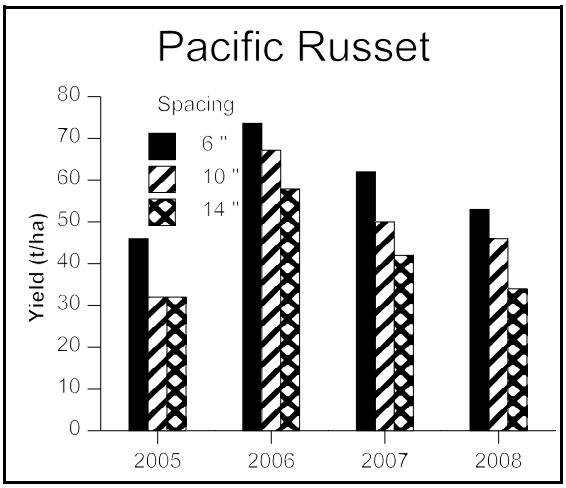


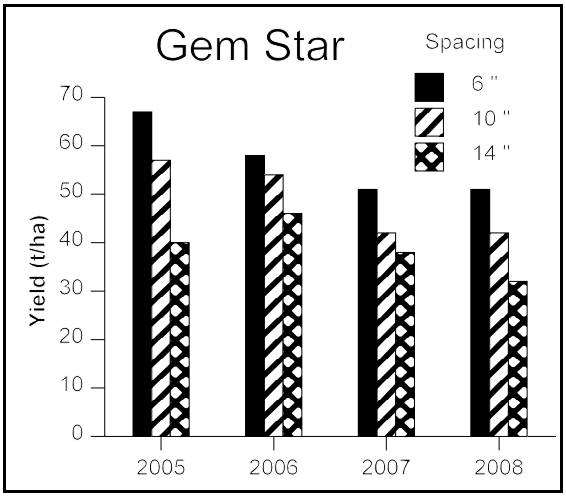
Figure 08-4. a-c. **Yields (a), tuber size profile at the final harvest (b) and specific gravities (c) for various red and russet-skinned potatoes under irrigation in 2008.**

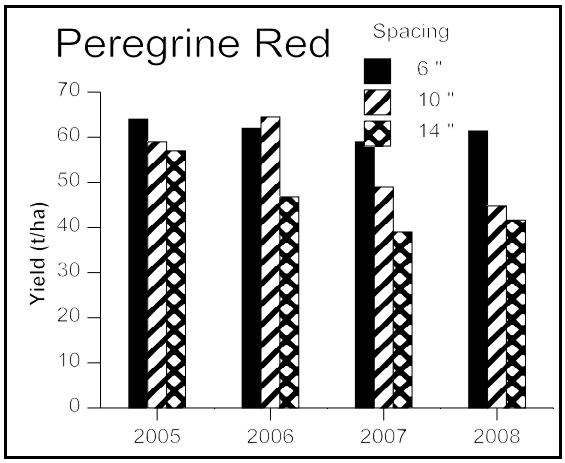


Spacing trial

This trial evaluated the impact of in-row spacing on yields and tuber size distribution of AC Peregrine, Pacific Russet and Gem Star over the 2005-2008 cropping seasons. The trial was planted in mid-May using 6, 10 or 14" (15, 25 or 35 cm) in-row spacings. The crop was grown, harvested and graded as previously described.







Results

Although crops yields varied considerably from year to year, yields of all three cultivars increased as the in-row spacing decreased in all four years of testing (Fig. 08-5). The magnitude of this yield increase was easily sufficient to offset the additional cost of seed required for the closer in-row spacing. As expected, the average tuber size increased as the distance between plants increased (Fig. 08-6). The average tuber size of Peregrine Red was much smaller than the other varieties. The larger average tuber size of Gem Stars is well suited for the production of french fries. Tuber specific gravities showed a small but consistent tendency to increase as the in-row spacing decreased (Fig 08-7).

Fig 08-5. Influence of in-row spacing on yields of Pacific Russet, Gem Star and Peregrine Red.

Conclusion

The results from this trial 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 tuber size is not a significant issue. A close in-row spacing would obviously be desirable in seed production where high yields combined with a small average tuber size distribution would be ideal. 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. The small but consistent decline in tuber specific gravity with increasing in-row spacing may be a concern for the processing sector.

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 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 may command a price premium as “Baby” potatoes.

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.

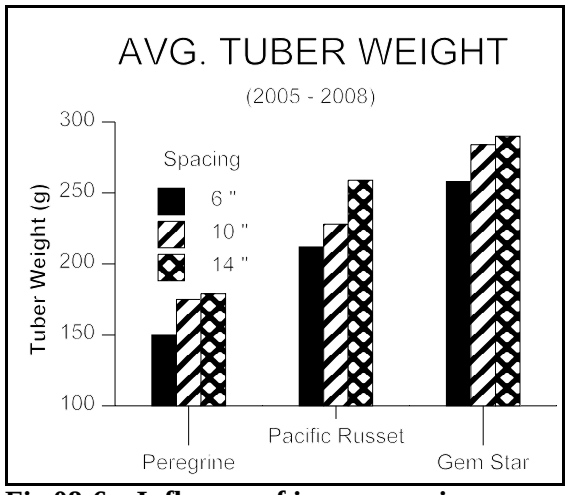


Fig 08-6. Influence of in-row spacing on average tuber weights of Peregrine, Pacific russet and Gem Star.

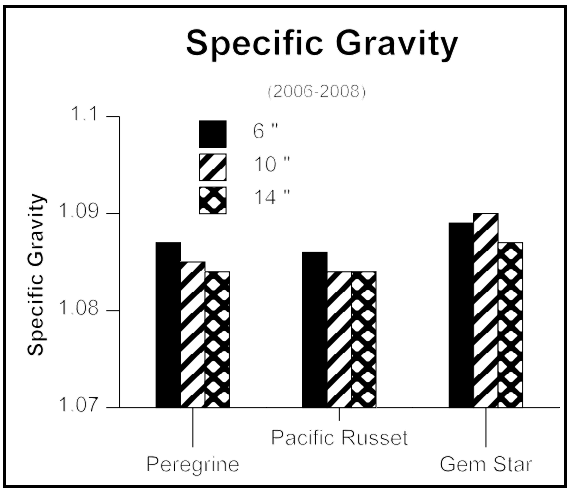


Fig 08-7. Influence of in-row spacing on specific gravities of Peregrine, Pacific Russet and Gem Star.