UNIVERSITY OF SASKATCHEWAN

VEGETABLE CULTIVAR AND CULTURAL TRIALS

2007

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Saskatchwan Agriculture and Food

Agronomy of New Potato Lines

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

The objective of this series of trials conducted from 2005-2007, was 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 its was in dryland alfalfa.

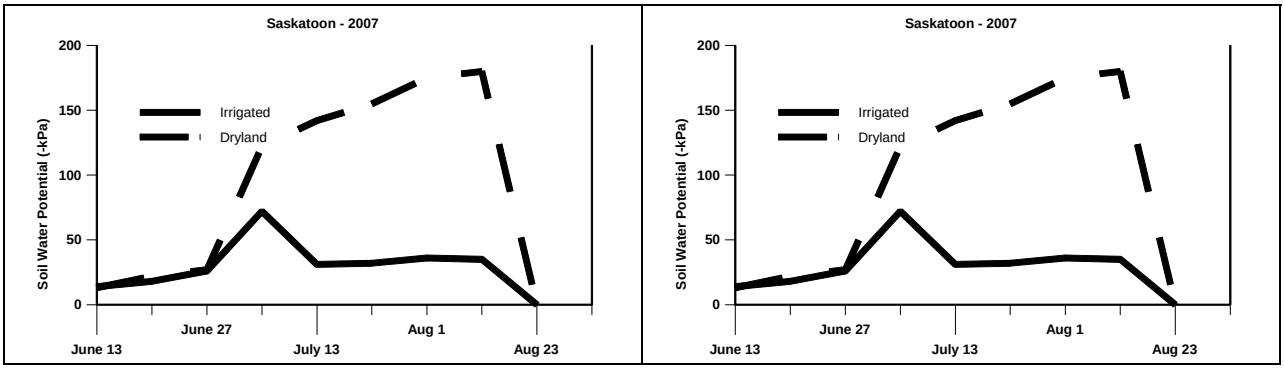
In all trials, each treatment plot consisted of a single, 8-m long section of row. Unless otherwise specified, the row spacing was 1 m between rows with 25 cm between plants within a row. Weed control was achieved by applying metribuzin prior to planting, followed by linuron applied at ground crack. 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 in 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 2005 and 2006 are available online at:
www.usask.ca/agriculture/plantsci/vegetable/potato/pagronomy.htm

2007 Growing Season

Temperatures and rainfall in 2007 were about normal through May and June, exceptionally hot in July and then August was cooler than normal. A total of 25cm of rainfall was received over the growing period of June 1 - Sept. 1 (normal = 17 cm), but most of this precipitation came in the form of two very heavy storm events in mid-June and mid-August. A total of 15cm of supplemental irrigation was applied during the 2007 growing season (Fig. 07-1).

Fig. 07-1. Soil water potentials, rainfall and irrigation events for the 2007 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. Each cultivar was planted in mid-May in two 8-m long rows within each N-level. The in-row spacing was 25 cm, with 1 m between rows. Each treatment was replicated twice.

Results

The yield responses of the AC Peregrine, Gem Star, Dakota Jewel and AC Pacific Russet to total soil-N levels ranging from 100-250 # N/a are presented in Fig 07-2.

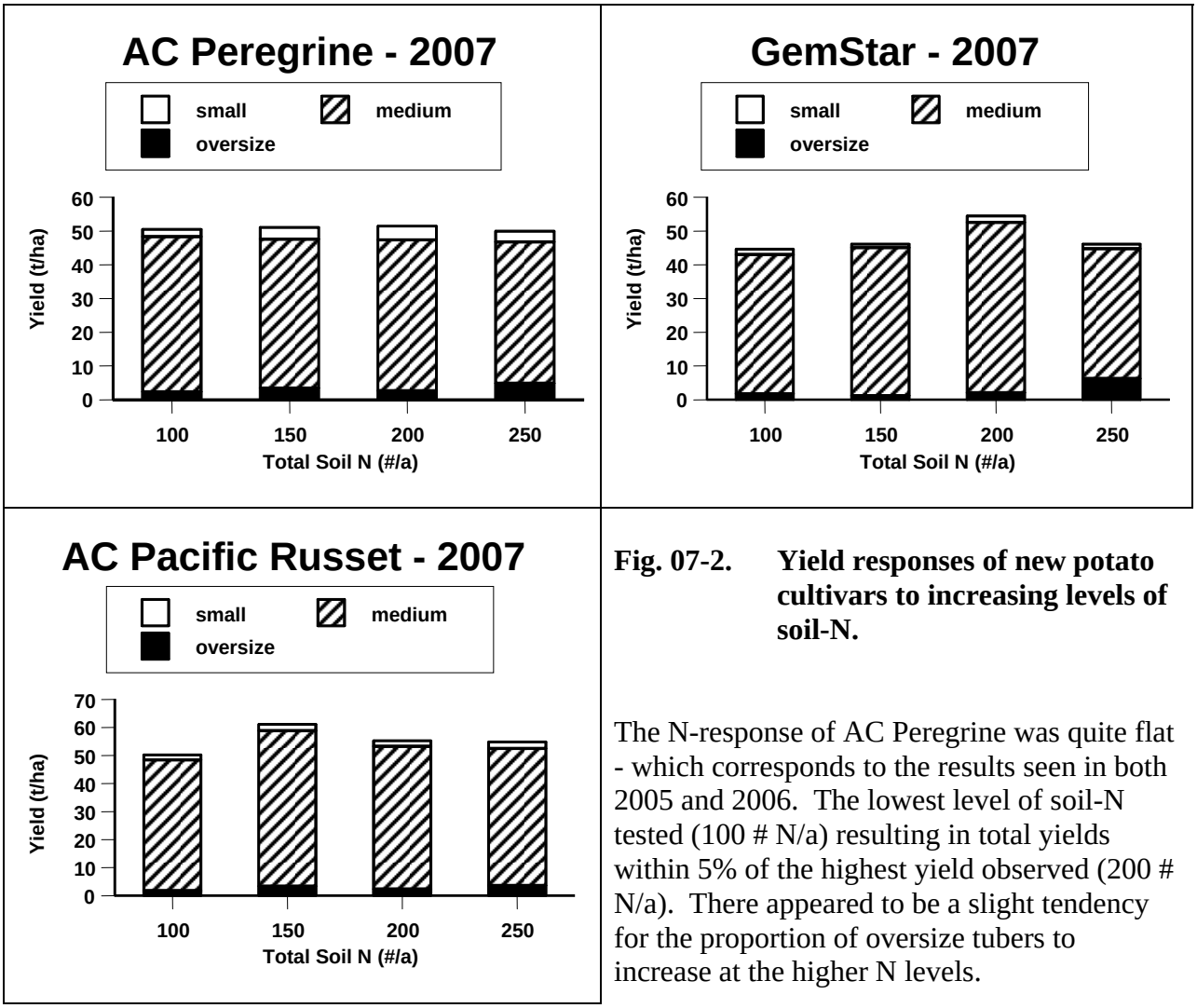


Fig. 07-2. Yield responses of new potato cultivars to increasing levels of soil-N.

The N-response of AC Peregrine was quite flat - which corresponds to the results seen in both 2005 and 2006. The lowest level of soil-N tested (100 # N/a) resulting in total yields within 5% of the highest yield observed (200 # N/a). There appeared to be a slight tendency for the proportion of oversize tubers to increase at the higher N levels.

In 2005 yields of Gem Star 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). Very

high levels of N again appeared to promote the development of oversize tubers. A very high rate of hollow was noted in the Gem Stars (ca 45%) but there was no apparent relationship between the N rate applied and the incidence of hollow heart.

Yields of AC Pacific Russet were low in 2005 due to problems with seed quality and herbicide damage. In 2006 and 2007 neither of these problems occurred and Pacific Russet produced excellent yields which peaked when 150 # N/a was used

Specific gravities of the four cultivars were consistent with previous trials. As was seen in the 2005 trial, specific gravities declined as the N application rate increased in 2007 (Fig. 07-3). This is a fairly common finding, especially if the higher raters of applied N delay crop maturity.

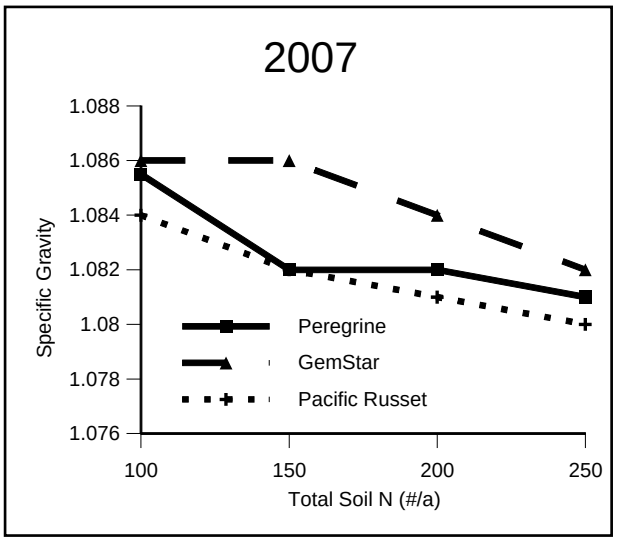


Fig. 07-3. Influence of soil-N levels on specific gravities of new potato cultivars

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 impact on time of planting and harvest on yields and quality. Irrigated trials were planted on May 16 and June 7 and harvested August 21 or October 5. This resulted in plots harvested at 80, 90, 105 and 120 days after planting. Separate plots were grown for each planting and harvest date. In a dryland trial only a single combination of planting and harvest dates was used - the crop was planted in mid-May and harvested at 120 days after planting. In both the dryland and irrigated trials, each treatment plot consisted of a single, 8-m long section of

row. Each treatment was replicated three times in a split plot design (main plot = planting date and sub-plot = planting date). The rows were spaced 1 m apart with 25 cm between plants within a row. The irrigated trials were watered whenever soil moisture potentials in the hills dropped below -50 kPa. Weed control was achieved through application of herbicides and cultivation as previously described.

The early harvested plots had the tops removed by hand a week prior to the harvest. For the 120 day harvest, the plots were sprayed twice with Reglone 10 days prior to the harvest. The crop was machine harvested and then sized and graded as previously described.

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. 07-4a). Dakota Jewel consistently had the lowest yields of the red lines tested. Tuber size was much larger for Norland than the other red lines tested (Fig. 07-4b), while Peregrine had the smallest tuber size profile. As seen in previous trials, Peregrine had higher tuber specific gravities than the other red varieties in this trial (Fig. 07-4d). Yields in the dryland trial were about 70% of the irrigated trial for most cultivars - except in Dakota Rose where dryland yields were almost 90% of irrigated. This suggests that either Dakota Rose has exceptional drought stress tolerance or that its yield potential under non-stressed conditions is limited. Relative yields of the four red-skinned varieties in the dryland trial were very comparable to their relative yields under irrigation. Specific gravities and average tuber sizes in the dryland trial were quite comparable to the irrigated crop.

Russets - The new SSPGA line Pacific Russet was consistently the highest yielding in the russet trial, followed by Russet Norkotah. Yields of the processing type lines (Russet Burbank and Gem Star) lagged well behind the lines most commonly used in the table market. Yields and specific gravities of Gem Star were again inferior to the standard Russet Burbank. (Fig. 07-5 a and d). Pacific Russet and Gem Star had a larger tuber size profile than the other lines (Fig 07-5c). Specific gravities were low and or inconsistently in this trial. Processing quality at 80 and 90 days was uniformly poor. At the later dates, Gem Star had excellent fry and chip colors, while the poorest colors were seen in Burbank which is considered the standard in the processing sector. Yields from the dryland russet trial ranged from as low as 56% of irrigated for Burbanks, through to 92% of irrigated for Gem Star (Table 07-1). Relative yields of the russet varieties in the dryland trial were again comparable to the corresponding trial under irrigation - except that Gem Star outyielded Burbank in the dryland trial. Specific gravities in the dryland and irrigated trials were comparable, as was the processing quality of the crop.

Table 07-1. Yield and quality components for Red and Russet potatoes under dryland conditions in 2007.

Line	Yield (t/ha)	Specific Gravity	Avg Tuber Wt. (g)
Reds			
Norland	50.3 a	1.070 b	192 a
AC Peregrine	55.6 a	1.080 a	151 ab
Dakota Rose	42.6 a	1.069 b	150 ab
Dakota Jewel	21.2 b	1.070 b	131 b
Russets			
R. Norkotah	46.0 ab	1.078	184 b
R. Burbank	36.5 b	1.082	155 b
Pacific Russet	55.8 a	1.079	179 b
Gem Star	41.8 b	1.084	303 a

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 3 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 planting or later harvest run into excessive risk of frost damage. By contract, 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 after 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 on an increase in average tuber size, rather than any increase in tubers produced. Even at the latest harvest date (120 days) only small proportion of the tubers had exceeded optimum size for marketability. It should however be noted that these trials were based on a 25 cm (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 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.

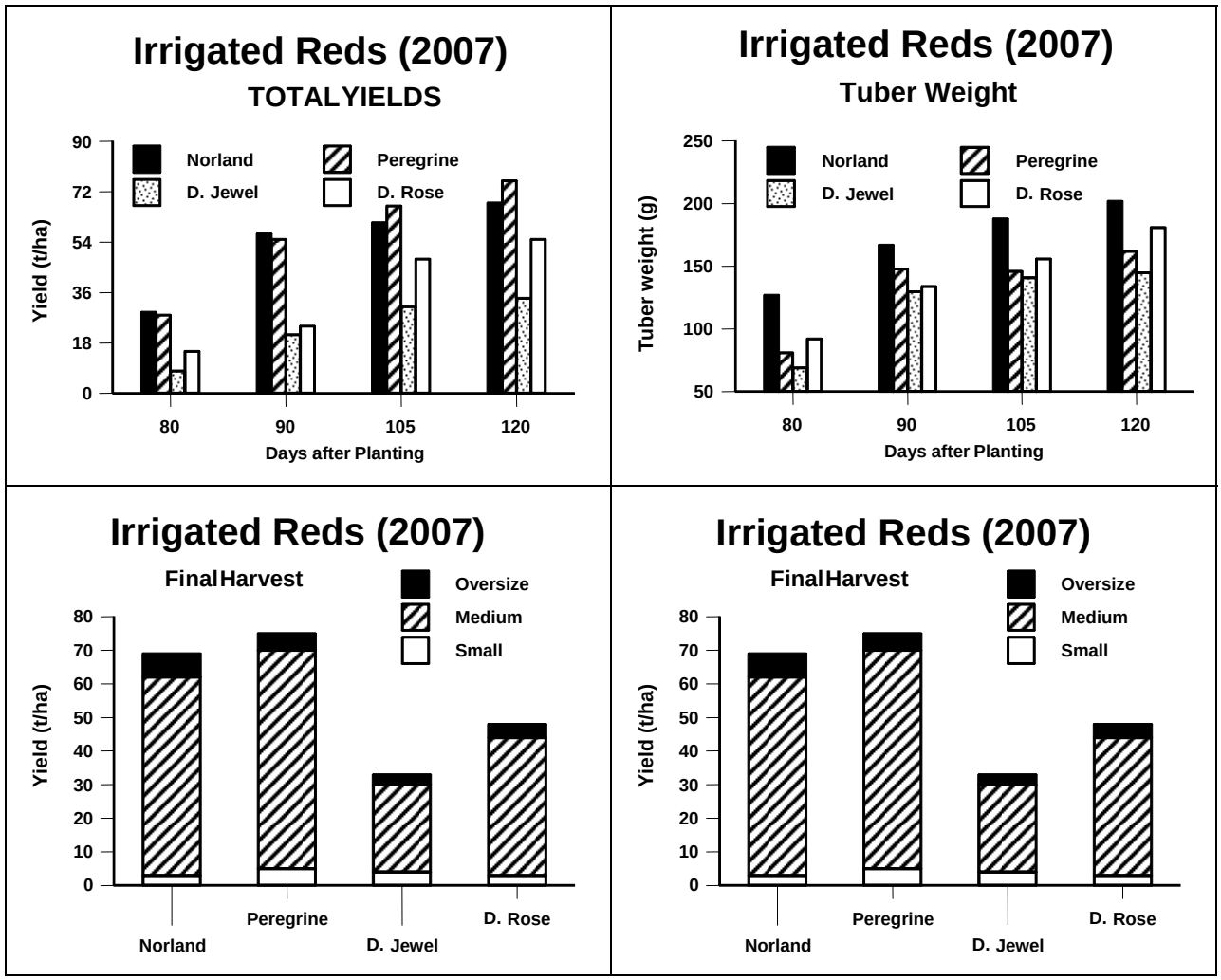


Figure 07-4. a-d. Yields (a), average tuber weights (b), tuber size profile at the final harvest (c) and specific gravities (d) for various red-skinned potatoes under irrigation in 2007.

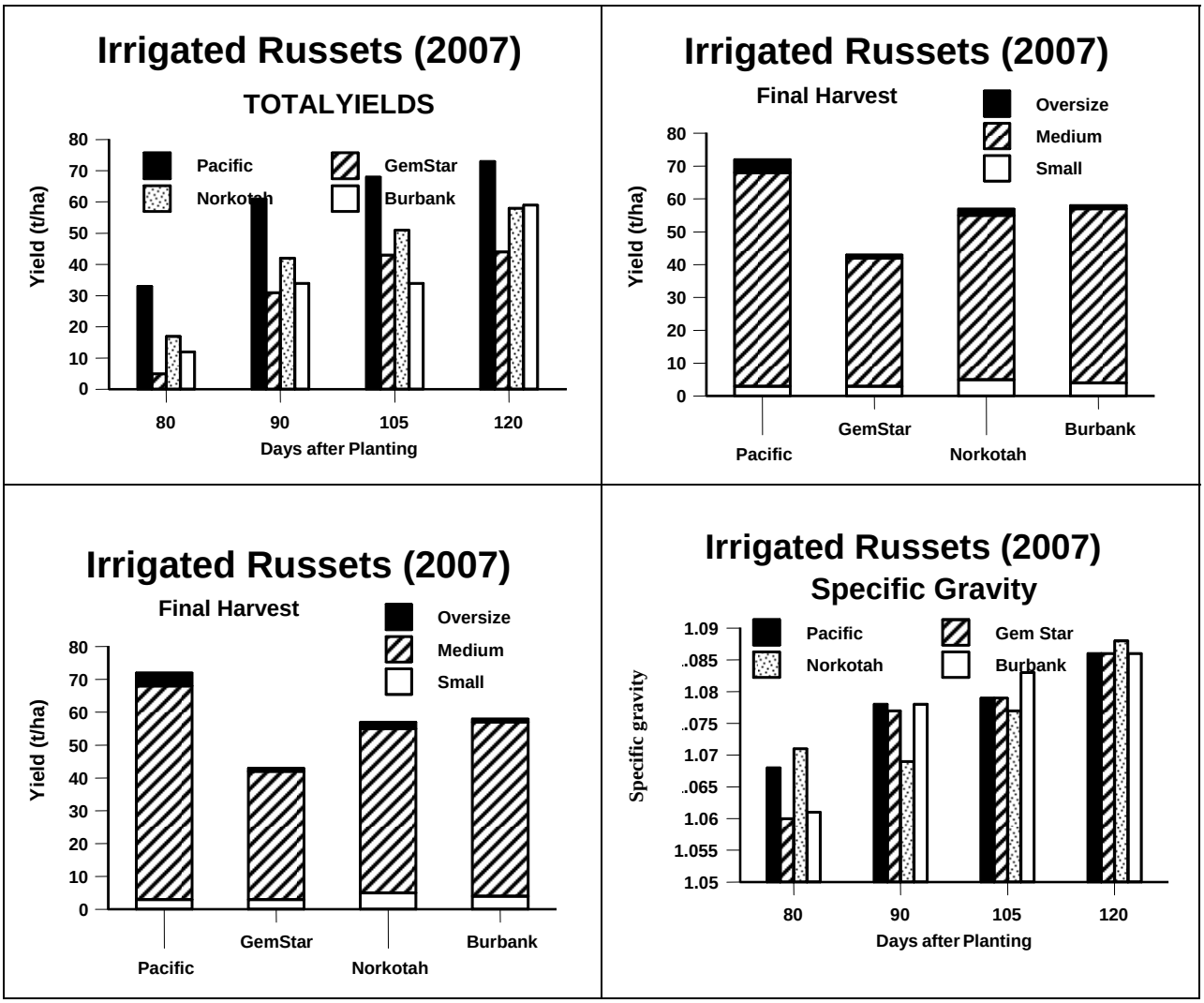


Figure 07-5. a-d. Yields (a), average tuber weights (b), tuber size profile at the final harvest (c) and specific gravities (d) for various russet-skinned potatoes under irrigation in 2007.

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 2005-2007 cropping seasons. The trial was planted in mid-May using 6, 10 or 14" (15, 25 or 35 cm) in-row spacings. Each treatment row was 8 m long with 1 m between rows. Each treatment was replicated four times in a randomized complete block design. The trial was irrigated and weeds were managed as previously described. The crop was top killed in the 2nd week of September and harvested in early October (120 days after planting). The crop was 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 three year (Fig. 07-6a). 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. 07-6b). 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.

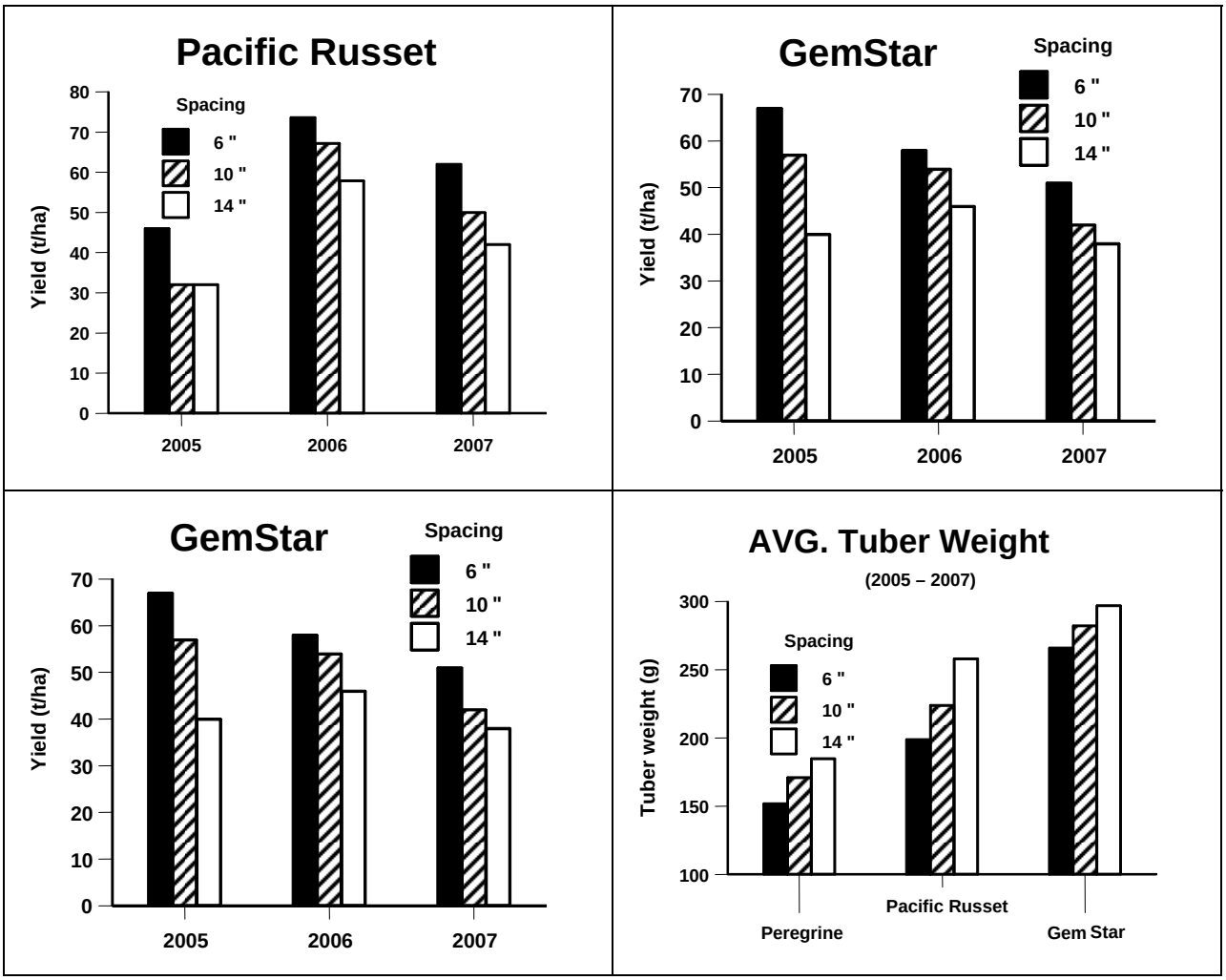


Fig 07-6. Influence of in-row spacing on yields (a) and average tuber weights (b) of Pacific Russet, Gem Star and Peregrine Red.

Conclusion

The results form 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.

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 command a price premium as “Baby” potatoes.

b) would a grower expect to see the same responses ?

Growing conditions in this trial were kept near ideal - with all inputs managed 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. If a grower cannot 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.