Stushnoff - Kulen

RESEARCH PROGRESS REPORT for 2002

To SLV Research Center Committee and the Colorado Potato Administrative Committee (Area II)

Part A **Potato tuber dormancy**

Project justification: This project is based upon the continuing need to develop storage profiles of new introductions, to determine mechanisms that impart postharvest dormancy in potato minitubers, and to develop well defined protocols to overcome dormancy.

Project status: (a) Field tuber storage profiles. We have essentially completed the objectives we established for 2002. Carbohydrate analyses using gas chromatography was carried out on seven cultivars stored at 5 temperatures for each of seven monthly intervals. These results, combined with bud dormancy data also taken monthly have been incorporated into two manuscripts (attached) for submission to Acta Horticultura and the American Journal of Potato Research. This work was also reported at International Society for Horticultural Science Congress, August, 2002, Toronto, Canada.

For 2002/2003, eight entries were included in the storage study presently underway (AC89536-5, BC-08942W, Cherry Red, Chipeta, Fremont R., CO89097-2R, Silverton R., and Yukon Gold. All but Cherry Red and Chipeta are new entries. Insufficient Russet Burbank was available for inclusion in this trial. In the future, storage studies will be conducted by Samuel Essah who has a strong interest in this type of research and we will concentrate more on antioxidant properties, vitamin content, and acrylamide formation. We will be pleased to assist Samuel any way we can during the transition.

(b) Minituber dormancy. Oktay Kulen, a PhD student funded by the Turkish government, repeated several minituber dormancy breaking experiments and added a field plot yield trial at SLV to assess the effects of dormancy breaking treatments on emergence and yield. The field trial will be repeated in 2003, the final year of his studies.

Significant accomplishments and potential impacts:

(a) Potato tuber dormancy.

The attached manuscripts provide details of a three-year storage study. In summary:

- The most effective storage temperatures for maintaining dormancy are 1.1 and 2.2 °C (34 and 36 °F), but these temperatures (especially 1.1°C are also most prone to producing the highest levels of reducing sugars thus requiring post-storage warm temperature treatment to reduce glucose and fructose prior to processing. The sugar promotion effect is less at 2.2 °C than at 1.1°C, while the storage response at 2.2 °C is much better than at 3.3 °C (38 °F) or warmer. Thus, producers of organic potatoes may wish to

choose 2.2 °C to prolong storage without the use of sprout inhibitors and to reduce soluble sugar content.

- Based on three years storage data, RNK3, Russet Nugget, RNK8, Cherry Red, Durango Red, and Chipeta stored the longest without sprout formation. While differences were minimal among the top six cultivars, Keystone Russet did not store well at any temperature (Fig. 1). Durango Red tubers grown in 2000 did not store well, but those grown in 1999 and 2001 did store well (Fig. 2).

- The tendency to produce glucose at 1.1 and 2.2 °C at the highest levels was more pronounced in RNK8, Russet Nugget, Keystone Russet, Durango Red, and RNK3, and least in Chipeta, and Cherry Red (Fig. 3).

- No symptoms of chilling injury were detected in any of the entries even after 160 days storage at 34 F followed by warming at 75 F for 3 weeks.

- High glucose content is also most likely to result in higher acrylamide content as a consequence of combination with asparagine during heating. Thus, high and low sugar producing cultivars should also be examined for asparagine and acrylamide content.

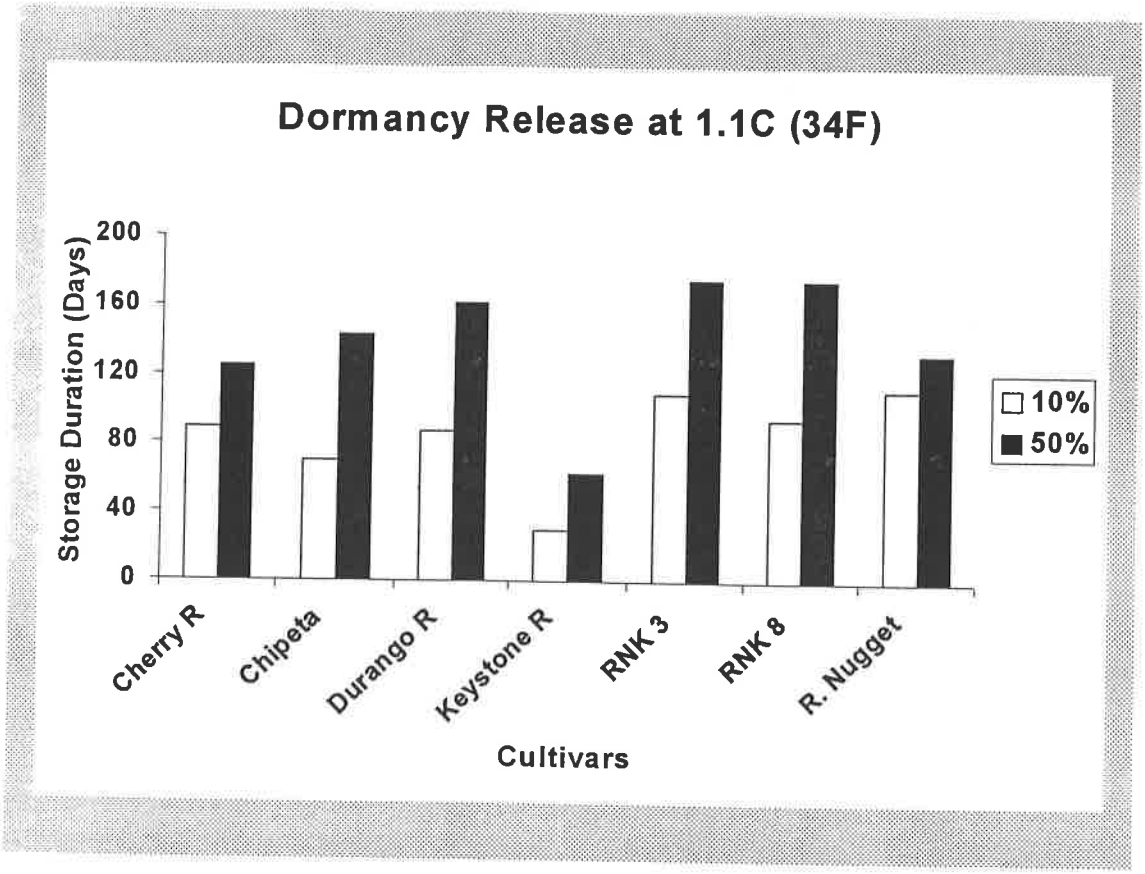


Figure 1. Dormancy response of seven cultivars stored at 1.1 °C (34°F) averaged over three years (1999/00 to 2001/02).

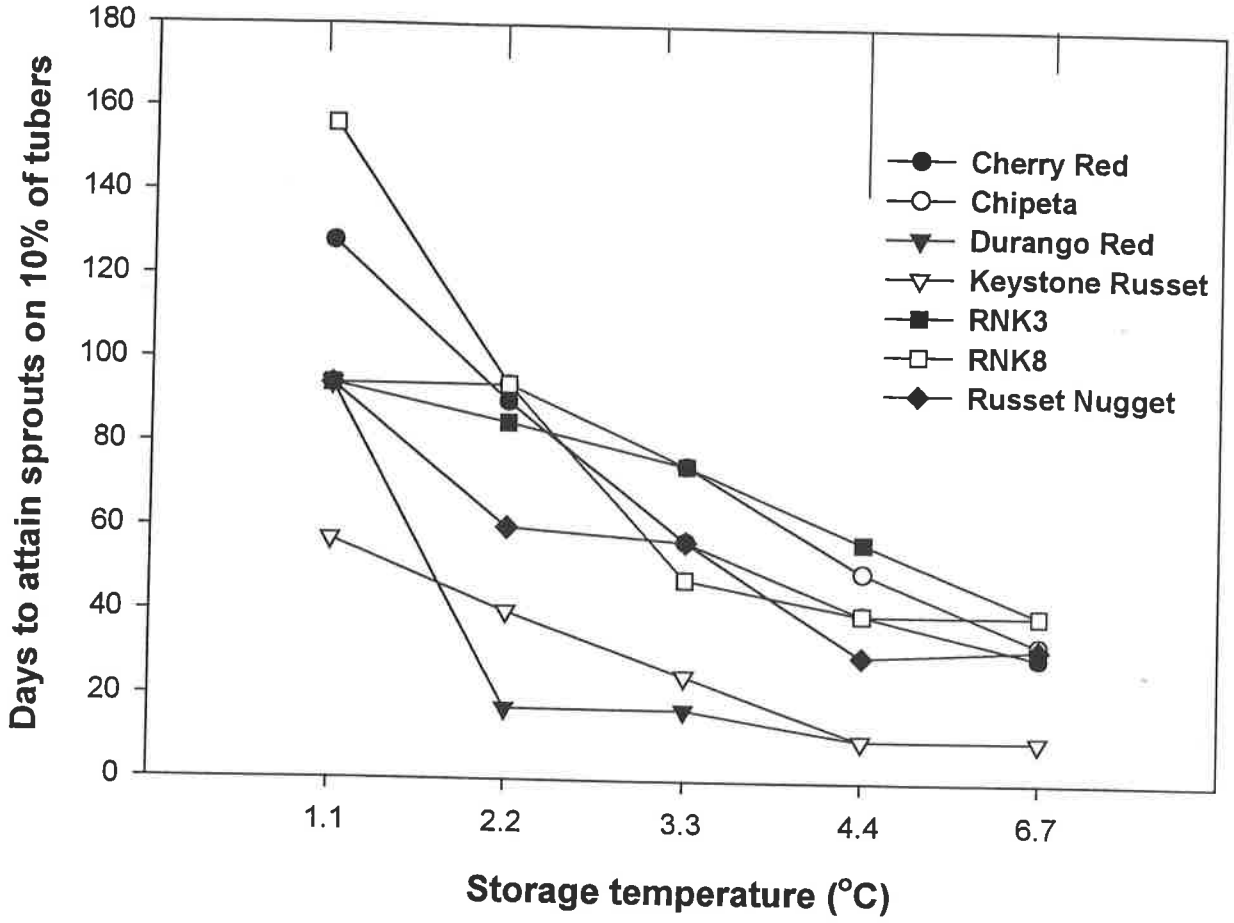


Figure 2. Dormancy response (10% of tubers with sprouts) for five cultivars grown in 2000 and stored at five temperatures through March 2001.

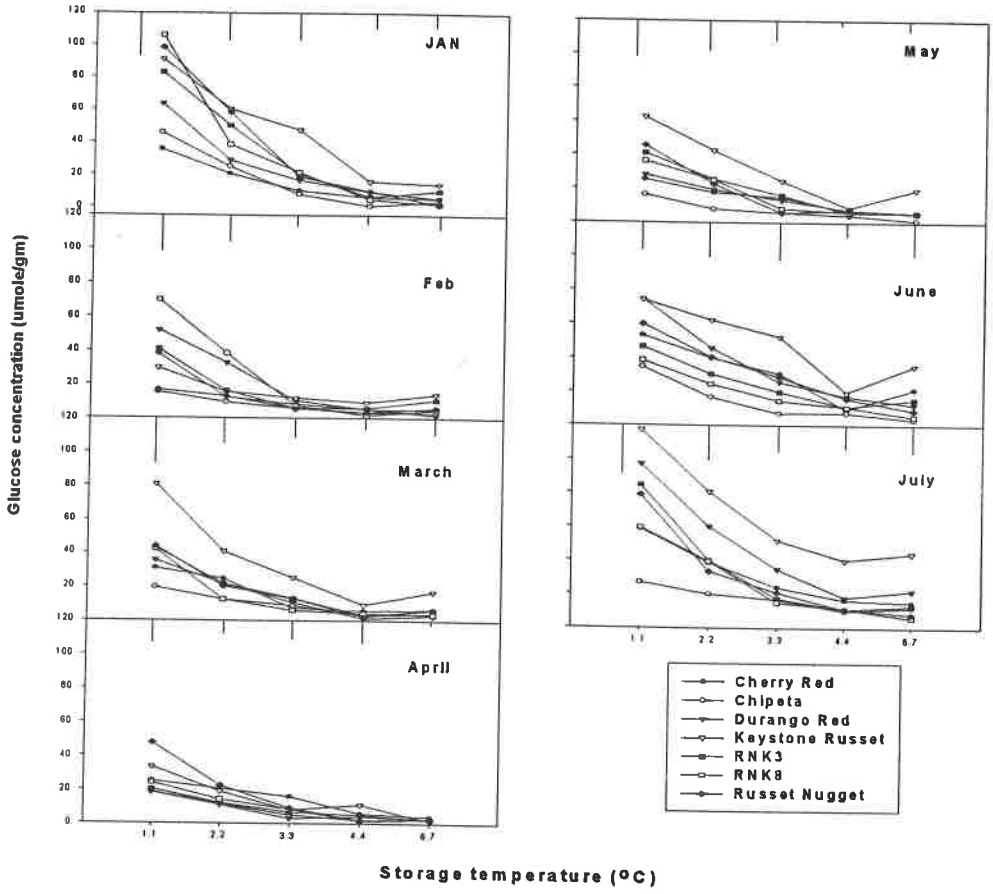
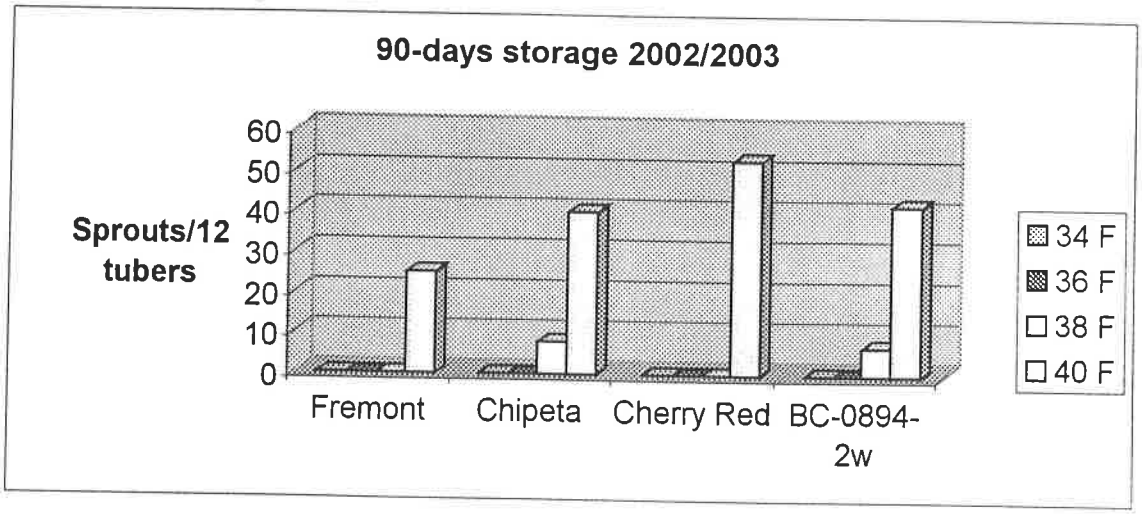
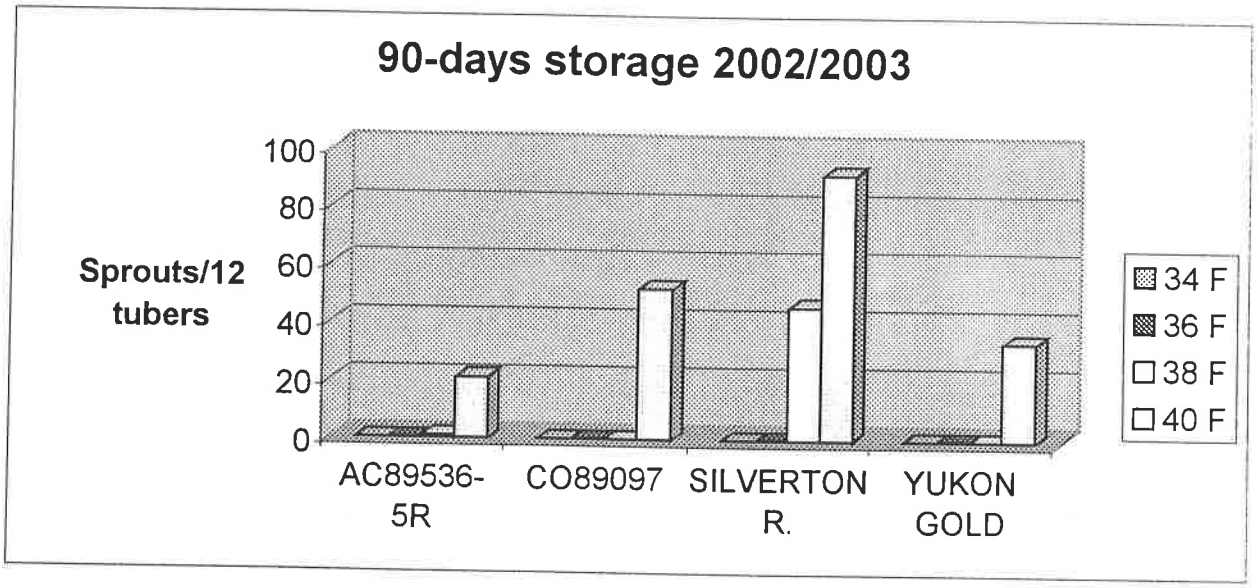


Figure 3. Glucose production in tubers stored seven months at five temperatures.

2002/2003 storage results





Rank best to last: AC89536-5R, Fremont, Yukon Gold, CO89097, Cherry Red, Chipeta, Silverton.

(b) Minituber dormancy.

- The most effective dormancy breaking treatments for RNK3 and Silverton minituibers were 1.8 x 10 –3 M Progibb + 250 ppm Etherel, and 250 ppm Etherel. Progibb alone and 10- 3 M Abscisic acid were not significantly different from untreated minitubers. Etherel at 500 and 1000 ppm were effective, but no different than 250 ppm.

- The Progibb + Etherel treatment produced significantly more fructose and glucose one week after treatment indicating the onset of starch hydrolysis, likely associated with dormancy release.
- Yields of seed potatoes produced from treated minitubers were highest from those treated with Progibb + Etherel (Table 1). The most significant response was a 3.5fold increase compared to those treated with Progibb for the long-dormancy cultivars RNK and Nooksak.

Table 1. Yield of seed tubers grown in 2002 from dormancy release treated minitubers at SLV. Yields are Kg/5 minitubers.

	Silverton	RNK3, Sangre, Desiree	RNK, Nooksak
Control	3.68 a	3.06 ab	0.0 b
Progibb (1.8x10-3M)	4.23 a	4.18 a	0.54 b
250ppm Etherel	3.83 a	3.36 ab	0.11 b
1000ppm Etherel	3.73 a	3.28 ab	0.16 b
Progibb+Etherel	5.08 a	4.04 a	1.93 a
Abscisic acid	3.43 a	2.64 b	0.0 b

Numbers followed by the same letter within each column are not significantly different P=0.05.

Part B. Nutritional status and potential health benefits of Colorado potatoes

Project justification: This work is based on the need to investigate the health benefits of potatoes in human diets. The primary goal is to add value to Colorado cultivars by characterizing antioxidant properties, tendencies to produce acrylamide, and water soluble vitamins.

Project status: Tubers grown from 38 entries in 2001 were analyzed for total phenolic content and ABTS radical scavenging capacity to begin genetic characterization Tables 2,3.

Tubers were collected from 72 entries grown in 2002 for genotype analyses in 2003. Tubers were also collected to evaluate the impact of production environment, storage conditions, antioxidant heat stability, acrylamide production tendencies during processing, and water soluble vitamin content.

Significant accomplishments and potential impacts:

- Seven entries were statistically equal to Russet Burbank, four were more effective and 27 were less effective in ABTS radical scavenging capacity (Table 2).

- Ten entries were statistically equal to Russet Burbank, five were higher, and 23 were lower in total phenolics (Table 3).

- The highest ABTS activity and total phenolics levels were found in the red and purple-pigmented tubers. Even though these tubers lost considerable activity after cooking the end result was still substantially above white and yellow- fleshed tubers.

- Some russet skinned entries may benefit from increased antioxidant activity following cooking.

- Even though yellow-fleshed Yukon Gold is known to contain carotenoid antioxidants similar to tomato, activity and levels were far below the pigmented entries.

- With the current high level of interest among consumers in healthy foods, knowledge about the potential of potato cultivars to contribute to human health should provide opportunities to add value in marketing antioxidant rich potato cultivars.

Table 2. Radical scavenging capacity of Colorado cultivars and breeding lines. Data are expressed as Trolox (water soluble vitamin E) equivalents mM/gdw compared to the control cultivar Russet Burbank = 0.30 mM TEAC/gdw. Column entries are significantly different based on Dunnett's multiple comparison test (P=.05).

Equal to R. Burbank	Greater than R.Burbank	Less than R. Burbank
AC87079	AC91014-2 (0.63mM)	AC93026
CO92027	CO94183 R/R (2.30mM)	AC92009
CO94019	CO94165 P/P (3.42mM)	AC87138-4
NDC5281	RNK#3 (0.76mM)	AC93047
RNK#8		AC87084
TC1675		AC87340
VC0967-5R/Y		AC89536
		BC0894
		CO94065
		CO92077
		CO93037
		CO93016
		CO94222
		CO89097
		NDC5372
		NDC6184
		12V60967
		VC1002-3
		Cherry Red
		Chipeta
		Durango Red
		Freemont R.
		Keystone R.
		R. Nugget
		Sangre
		Silverton R.
		Yukon gold

Table 3. Total phenolic content of Colorado potato cultivars and breeding lines compared to Russet Burbank. Ranks are based on means for four cooking methods, expressed as Gallic acid equivalents mg/gdw. Values for entries are significantly different (p= .05) between the three columns, but not within columns.

Equal to R. Burbank (9.5 mg/gdw)	Greater than R.Burbank (9.5 mg/gdw)	Less than R. Burbank (9.5 mg/gdw)
CO92027 (11.2)	AC89536 (14.5)	AC93026 (6.3)
CO92077 (10.6)	CO94183 R/R (17.4)	AC92009 (4.8)
CO94065 (8.9)	CO94165 P/P (20.1)	AC93026 (6.3)
Cherry Red (8.7)	CO94019 (17.4)	AC93047 (6.1)
Keystone (10.1)	RNK#3 (13.3)	AC9104-2 (8.0)
NDC5372 (10.1)		AC87079 (8.3
R. Nugget (9.4)		AC87084 (6.6)
RNK#8 (11.2)		AC87340 (4.7)
Silverton (9.9)		BC0894 (7.6)
VC0967-5R/Y (9.1)		CO93037 (6.0)
		CO93016 (5.9)
		CO94222 (5.0)
		CO89097 (5.6)
		NDC5281 (8.3)
		NDC6184 (6.0)
		VC09672R/Y (6.8)
		VC1002-3 (7.3)
		Chipeta (5.8)
		Durango Red (7.8)
		Freemont R. (5.2)
		Sangre (6.8)
		Silverton R. (7.5)
		Yukon Gold (4.7)