Potato Progress

Research and Extension for Washington's Potato Industry
Published by Washington State Potato Commission **www.potatoes.com**
Andrew Jensen, Editor. Submit articles and comments to: ajensen@potatoes.com
108 Interlake Rd., Moses Lake, WA 98837; Fax: 509-765-4853; Phone: 509-765-8845.

Volume II, Number 11 *September 26, 2002*

Responses of Umatilla Russet Potatoes to Storage and Reconditioning Temperatures

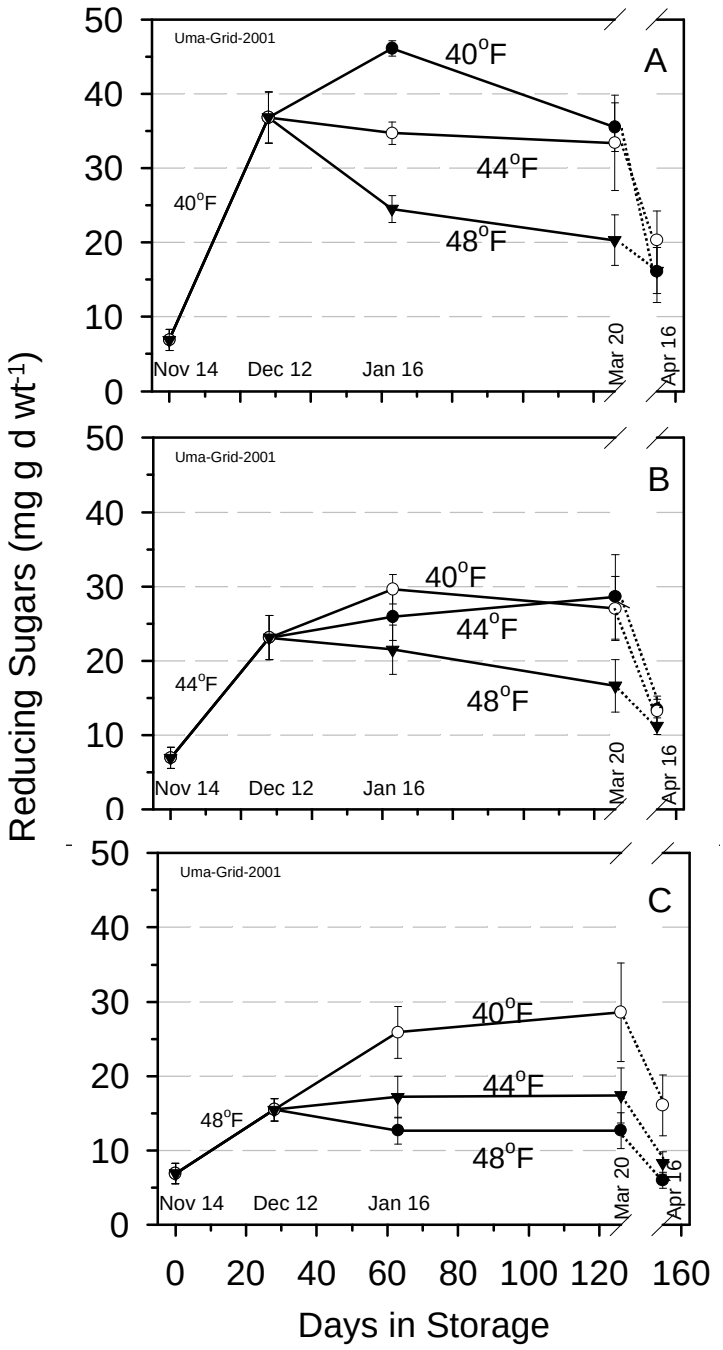
N. Richard Knowles[1], L.O. Knowles[1] and Bob Goeden[2]
[1]Department of Horticulture & Landscape Architecture, Washington State University
Pullman, WA 99164-6414. [2]Lamb-Weston, Inc., Quincy, WA 98848.

By design, new cultivars developed through the Tri-State program are tested using production and postharvest handling practices that are considered ideal for Russet Burbank, the standard cultivar. It is well recognized, however, that newer cultivars such as Umatilla are, in many respects, physiologically different than Russet Burbank. For example, dormancy of Ranger is less than Umatilla, which, in turn, is less than Russet Burbank, and this affects the efficacy of sprout inhibitors and storage longevity in relation to processing quality. Ideal temperature regimes for short- and medium-term storage of Umatilla, Ranger and Russet Burbank may be different than those required for longer-term storage. Reconditioning abilities of these cultivars are also thought to differ, although comparative data upon which cultivar-specific postharvest management decisions should be based has yet to be published. Specific questions that we are addressing with funding from the Washington State Potato Commission include: What are the ideal temperature regimes for short-, medium- and long-term storage for each cultivar? Can these cultivars be held at lower than normal temperatures for a period after wound-healing without effecting loss of processing quality? What are the reconditioning potentials of these cultivars?

With the availability of precision temperature and humidity controls in modern potato storages, it should be possible to fine-tune storage temperature regimes to control reducing sugar levels and thus processing quality, relative to tuber maturity coming into storage and anticipated processing dates. Storage managers will then have more management options for maintaining potato quality than simply achieving a single temperature target.

Umatilla Russet is a relatively new cultivar that was released from the Pacific Northwest Tri-State Potato Variety Development Program in 1998. It has high gravity and good processing quality, making it ideal for the frozen French fry industry for which it was developed. The acreage devoted to Umatilla in Washington increased from 7% in 1999 to 12% in 2001. Umatilla tubers can maintain quality in storage for about 8 months, longer than Ranger, but not as long as Russet Burbank. The increased adoption of Umatilla has revealed some degree of variation in storability and processing quality, underscoring a need for additional characterization of the postharvest biology of this cultivar. The following storage management questions were addressed during the 2000/01-storage season:

- What are the effects of storage at 40, 44, or 48^{o}F on processing quality of 'Umatilla Russet'?
- Are there combinations or sequences of storage temperatures that interact to affect longevity and tuber quality?
- Can tubers that have undergone low-temperature sweetening be reconditioned at a higher temperature to improve their processing quality at the end of a storage cycle?



A 'temperature grid' protocol was used to assess the response of tubers to different storage temperature regimes. Umatilla Russet tubers were harvested from a commercial field in the Columbia Basin on September 19, 2000 and placed in a commercial storage at 53°F to wound heal. Samples were collected from the commercial storage on November 14 and placed in 40, 44 or 48°F storages at the potato postharvest research facility at Washington State University. The tubers remained at these initial 'conditioning temperatures' for 28 days. On Dec 12, tubers from each of the conditioning temperature storages were transferred to 40, 44, or 48°F holding temperatures, where they remained for an additional 98 days. The study thus consisted of 3 conditioning temperatures factorially arranged with 3 holding temperatures for a total of 9 treatments (conditioning temperature x holding temperature combinations). Note that inherent in the grid are three treatments corresponding to constant 40, 44 or 48°F storage for the duration of the experiment. To assess reconditioning potential, all tubers were placed at 60°F on March 20, where they remained until April 16, 2001. Hence, in addition to the initial 56 days in commercial storage, the experimental storage duration of 153 days (126 days plus 27 days of reconditioning) resulted

in a total storage period of 209 days (7 months). Reducing sugars were measured and fry colors were assessed with a Photovolt reflectance meter at key times during the experiment.

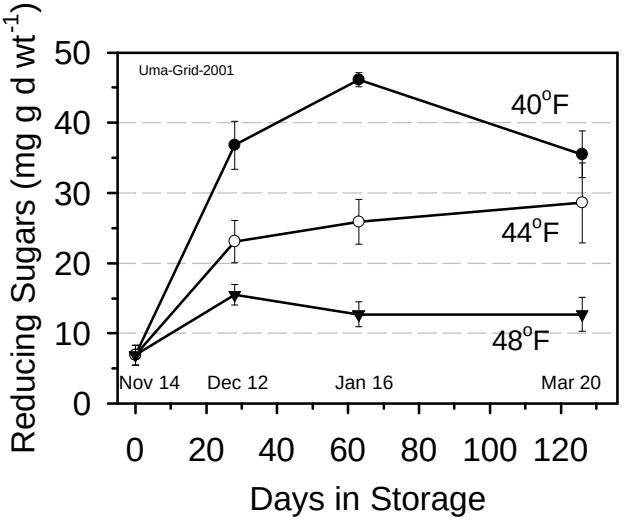


Fig. 1. Effects of storage temperature on the buildup in reducing sugars in Umatilla Russet tubers during the 2000/01 storage season. Tubers were harvested on Sept. 19 and held at 50-53°F until Nov. 14 (56 days), whereupon the storage temperature was lowered to 40, 44 or 48°F (zero-time on graph). CIPC was applied on Nov. 12.

Response to Storage at Constant Temperature. Reducing sugar concentrations increased 2-fold at 48°F, 4.7-fold at 44°F and 6-fold at 40°F through the 126-day study interval (Fig 1). USDA color classes derived from associated photovolt values of French fries showed that tubers maintained excellent processing quality when stored at 48°F. In contrast, the processing quality of tubers stored for 126 days at 44 and 40°F had deteriorated to the point of being marginal and unacceptable, respectively.

Effects of Sequential Conditioning and Holding Temperatures. Conditioning temperature had a significant affect on reducing sugar concentrations early in the storage season. The rate of sweetening over the 28-day conditioning period (Nov 14 to Dec 12) increased with decreasing temperature (Fig. 2ABC). Processing quality of French fries immediately following the conditioning period (Dec. 12) was unacceptable at 40°F, marginally acceptable at 44°F, and acceptable at 48°F.

Sugar levels in 40°F-conditioned tubers (Fig. 2A) declined significantly when stored subsequently at 48°F, reflecting partial reconditioning. Transfer to 44°F or continued storage at 40°F ultimately resulted in unacceptable sugar levels at the end of storage on March 20, comparable with those at the end of the conditioning period (Dec 12).

Sugar levels in 44°F-conditioned tubers remained high when stored subsequently at 40 or 44°F for the remaining 98 days, but transfer to 48°F resulted in improved processing quality (Fig. 2B).

Tubers conditioned at 48°F continued to sweeten if transferred to 40°F (Fig. 2C). Holding temperatures of 44 or 48°F allowed sugar levels to remain constant during the 98-day holding period. These data indicate that there may be potential in using lower temperatures later in the storage season, provided the conditioning temperature is at least 48°F.

The overall affects of conditioning and holding temperatures on French fry color at the end of the 126-day storage period were assessed. On average, USDA fry color ratings rose from 0 to 3 as storage temperature decreased from 48 to 40°F, indicating a significant deterioration in processing quality. However, it is significant to note that although constant 48°F was the optimum storage temperature of the three, lowering the temperature to 44°F after conditioning for 28 days at 48°F resulted in only a loss of quality equivalent to 1 USDA unit (from USDA 0 to USDA 1) by March 20. In addition, tubers initially stored at 44°F achieved this same fry color rating if subsequently held at 48°F until March 20. Even 40°F for 28 days initially in the storage season resulted in marginally acceptable fry color (USDA 2) if the tubers were stored subsequently at 48°F until March 20.**Fig. 2.** Effects of 40°F (A), 44°F (B) and 48°F (C) conditioning temperatures (Nov. 14 to Dec 12) on the sweetening response of Umatilla Russet tubers stored subsequently at 40, 44 and 48°F for 98 days (Dec. 12 to March 20). Note that the tubers had been

stored at 53°F for the first 56 days after harvest, prior to placing in the conditioning temperatures (at zero-time on the graph). Tubers were reconditioned at 60°F for 27 days (March 20 to April 16) at the end of the study.

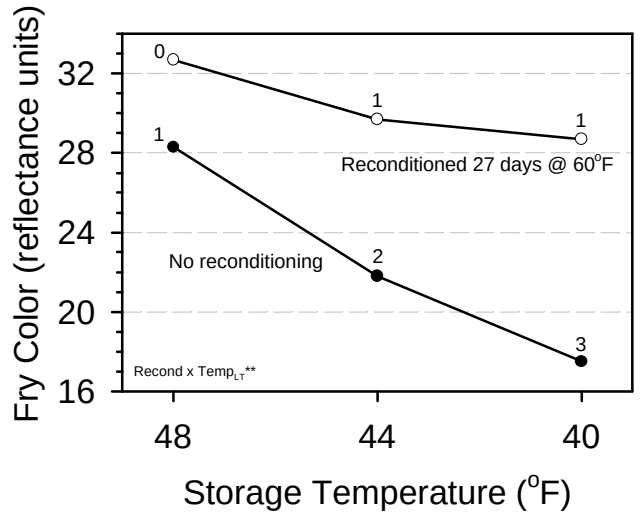


Fig. 3. Effects of storage temperature and reconditioning on French fry colors of Umatilla Russet tubers. Tubers were harvested on Sept. 19, 2000 and stored until March 20, 2001, as described in Fig. 1 (data is averaged over the initial conditioning temperatures). French fry colors were assessed at the end of storage on March 20, 2001 and after reconditioning at 60°F for 27 days (March 20 to April 16). Numbers on each point in the graph indicate the USDA fry color ratings.

Reconditioning Ability. The extent to which reducing sugar concentrations can be lowered to restore processing quality through reconditioning at 60°F was determined at the end of the 98-day holding period. (from March 20 to April 16, Fig. 2). Reconditioning resulted in a significant decrease in reducing sugar concentrations in tubers stored at all nine conditioning/holding temperature combinations (Fig. 2ABC). The greatest decreases were observed in tubers that had accumulated the highest levels of sugars in response to lower holding temperatures. For example, when averaged over initial conditioning temperatures, tubers stored at 48°F produced USDA 1 fries that improved to USDA 0 in response to reconditioning (Fig. 3). Tubers stored at 44°F produced USDA 2 fries that improved to USDA 1 in response to reconditioning. The greatest reconditioning response was observed in tubers stored at 40°F, where fry color changed from an unacceptable USDA 3 to an acceptable USDA 1 rating (Fig. 3).

While the results presented in this report represent only one year of data spanning the 2000/01-storage season, they clearly show that cold-sweetened Umatilla Russet tubers can be successfully reconditioned to improve French fry processing quality. Additional studies are currently in progress.

Summary and Conclusions (2000/01 storage season)

- Umatilla Russet tubers were the most sensitive to low temperature-induced sweetening (reducing sugar buildup) during the first three months following harvest.
- Temperatures of 44°F or 40°F early in the storage season (e.g. within the first 85 days after harvest) stimulated reducing sugar buildup that reduced the processing quality later in the season.
- Storage at higher temperatures early in the season (e.g. 53°F after harvest gradually lowering to no less than 48°F over a 3-month period) limited the ultimate reducing sugar accumulation at any subsequent holding temperature (e.g. 40 and 44°F) later in the storage season. The use of lower temperatures (e.g. 44°F) later in the storage season would likely be advantageous to the postharvest life and quality of this cultivar.
- Cold-sweetened Umatilla Russet tubers successfully reconditioned at 60°F at the end of storage, resulting in lower reducing sugar content and improved processing quality.