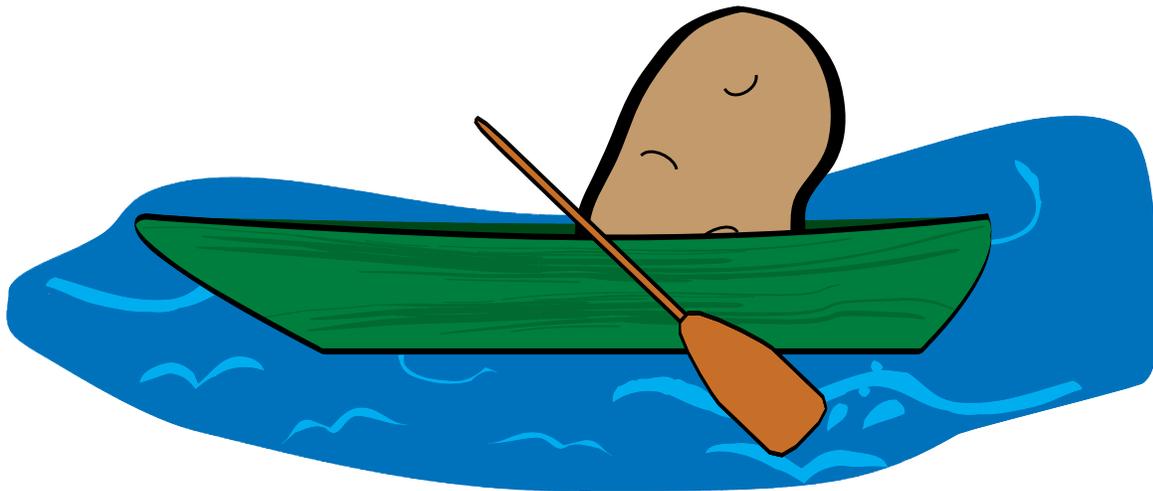


Storage Management of **Clearwater Russet** Potatoes



Introduction

Clearwater Russet is a dual-purpose potato variety released in 2008 by the USDA Agricultural Research Service and the agricultural experiment stations of Idaho, Oregon, and Washington. Clearwater Russet has good cold-induced sweetening resistance and exhibits excellent fry color out of long-term storage. Clearwater Russet tubers have a very attractive, medium-russet skin, making this variety suitable for both processing and fresh market usage. It is also notable for its high tuber protein content—35% greater than that of Russet Burbank.

Clearwater Russet tubers have specific gravities comparable to those of Ranger Russet and have resistance to sugar ends. This variety is less susceptible to growth cracks and secondary cracks than Ranger Russet and Russet Burbank. It is also less susceptible to blackspot bruise than Ranger Russet, and its susceptibility to hollow heart is similar to that of Russet Burbank.

Clearwater Russet tubers are resistant to tuber late blight and PVX and moderately resistant to verticillium wilt, common scab, and PVY^o.

About the study

Clearwater Russet potatoes were field grown at the University of Idaho Kimberly Research and Extension Center in 2006, 2007, and 2008. After harvest, potatoes were placed in storage and allowed to cure at 55°F and 95% relative humidity for 14 days. The temperature was then decreased at a rate of 0.5°F per day to holding temperatures of 42°F, 45°F, and 48°F. The potatoes were subsequently stored for 9 months at these temperatures.

Potatoes used in analyses of sugar content, fry color, mottling, disease susceptibility, and weight loss were treated with a thermal aerosol application of chlorpropham (CIPC) at 22 ppm approximately 60 days after harvest. Potatoes used in assessing dormancy length were not treated with a sprout inhibitor.

Glucose, sucrose, and fry color data were collected each month in storage from three replications of 10 tubers per variety and storage temperature. Glucose and sucrose concentrations were determined using a YSI model 2700 Analyzer (Yellow Springs Instrument Co., Inc., Yellow Springs, OH) and

expressed on a percentage fresh weight basis.

Fry color analysis was performed concurrent with sugar extraction and using the same tubers. Fry color was determined on 10 planks (1.2 inch × 0.3 inch) per sample after cooking the planks in canola oil at 375°F for 3.5 minutes. Percentage reflectance was read with a Photovolt Reflection Meter Model 577 (Photovolt Inc., Indianapolis, IN) on the stem ends of each plank. The planks were also scored subjectively for mottling.

In studies to evaluate *Fusarium* dry rot infection, potatoes were first bruised and then inoculated with *Fusarium sambucinum*. Following inoculation, potatoes were cured at 55°F and 95% relative humidity for 2 weeks and then stored at 45°F. After approximately 3 months in storage, tubers were evaluated for the percentage of dry rot decay and the incidence of the disease, expressed as the percentage of tubers evaluated having more than 5% decay.

Dormancy

Dormancy length is defined as the number of days from harvest until sprout elongation (at least 0.2 inches) occurs in 80% of tubers in the sample. This definition is used because the length of time between initial sprout development (peeping) and sprout elongation varies greatly among potato varieties.

In the absence of sprout inhibitors, dormancy length for Clearwater Russet is 55 to 65 days shorter than for Russet Burbank (table 1) and similar to the natural dormancy length of Ranger Russet. Since dormancy length of Clearwater Russet is relatively short, it is important to apply proper sprout inhibitors early if the intended storage duration is longer than the indicated dormancy length.

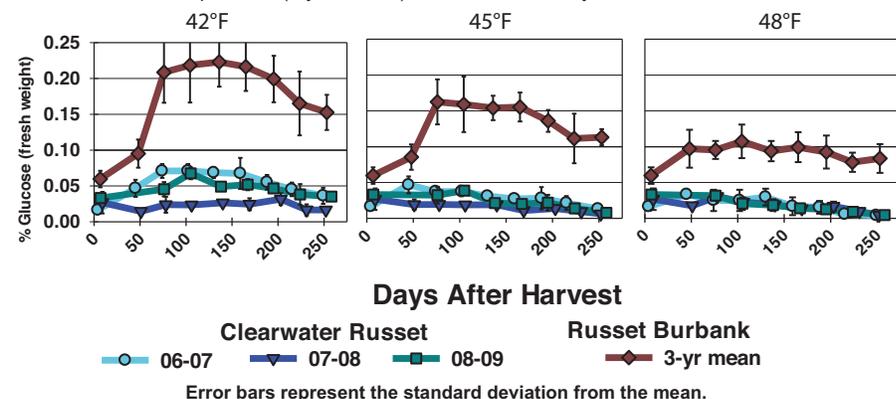
Glucose and sucrose concentrations

Potatoes used for frozen or dehydration processing must meet

Table 1. Mean dormancy length (days after harvest) of Russet Burbank and Clearwater Russet potatoes at three storage temperatures. Values are means of three years (2006-09).

Variety	42°F	45°F	48°F
Russet Burbank	175 days	155 days	130 days
Clearwater Russet	110 days	90 days	85 days

Figure 1. Mean glucose concentrations (% fresh weight) in Clearwater Russet potatoes at harvest and in storage at three temperatures during three storage seasons (2006 through 2009) compared with Russet Burbank potatoes (3-year mean) stored those same years.



reducing sugar criteria specific to the end use. High concentrations of glucose (a reducing sugar) in potato tubers produce a dark coloration in potatoes exposed to high processing temperatures. Glucose concentrations above 0.10% fresh weight (FW) are often considered too high for frozen processing. Sucrose serves as a potential pool for glucose formation in stored tubers and therefore is monitored throughout storage.

Glucose concentrations at harvest. Glucose concentrations at harvest (7 days after harvest) in Clearwater Russet were low across the three study years, ranging from 0.016% FW in 2006 to 0.033% FW in 2008 (figure 1). The 3-year average glucose concentration in Russet Burbank at harvest was 0.059% FW, which was two times higher than the 3-year average of 0.025% FW in Clearwater Russet.

Glucose concentrations during storage. Glucose concentrations in Clearwater Russet tubers were significantly lower than those in Russet Burbank at all three storage temperatures (figure 1). These glucose concentrations are notably low for a french fry processing potato variety and make this cultivar suitable for use in the processing market as a long-term storage variety:

- At 48°F, glucose concentrations of Clearwater Russet remained at or below 0.04% FW throughout the 9-month storage season during 3 years of testing. The 3-year average glucose concentrations for Russet Burbank were approximately 0.10% FW throughout most of the storage period.
- At 45°F, glucose concentrations of Clearwater Russet remained at

or below 0.05% FW throughout the 9-month storage season during 3 years of testing. Glucose concentrations of Russet Burbank were much higher and peaked at 0.16% FW at the 45°F storage temperature.

- At 42°F, glucose concentrations in Clearwater Russet remained below 0.10% FW throughout the storage season in all of the 3 years tested. These low glucose concentrations indicate that Clearwater Russet has cold-induced sweetening resistance and can be stored at cooler temperatures and still be used to make premium processed products.

Sucrose concentrations. Sucrose concentrations in Clearwater Russet at harvest varied across the 3 years, ranging from 0.12% FW in 2007 to 0.17% FW in 2008. These

concentrations are similar to those observed in Russet Burbank—0.12% FW averaged over the 3-year study (figure 2).

In general, the seasonal pattern of sucrose concentrations in Clearwater Russet was similar to that in Russet Burbank. Peak sucrose concentrations occurred at harvest and decreased over time in storage.

Fry color

Glucose concentrations in potato tubers are a good indicator of fry color. The higher the glucose concentration, the darker the fry color. However, the processing industry generally makes fry color determinations using samples of fried potato strips, discs, or planks to assess product quality.

When variation in fry color occurs within a potato, it is generally the

Figure 2. Mean sucrose concentrations (% fresh weight) in Clearwater Russet potatoes at harvest and in storage at three temperatures during three storage seasons (2006 through 2009) compared with the 3-year mean of Russet Burbank potatoes similarly stored the same years.

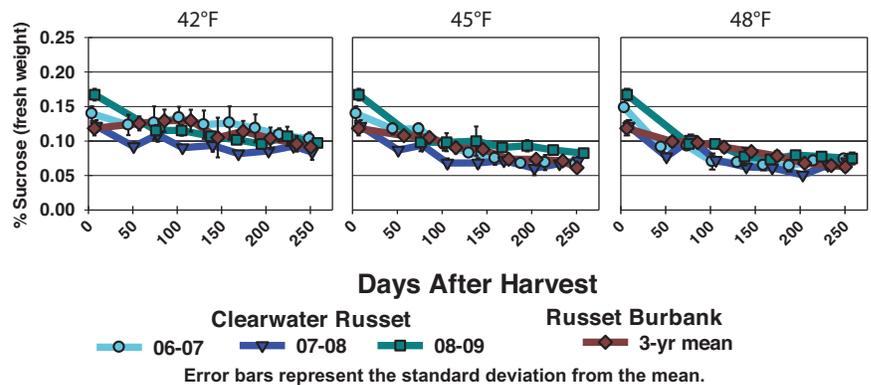
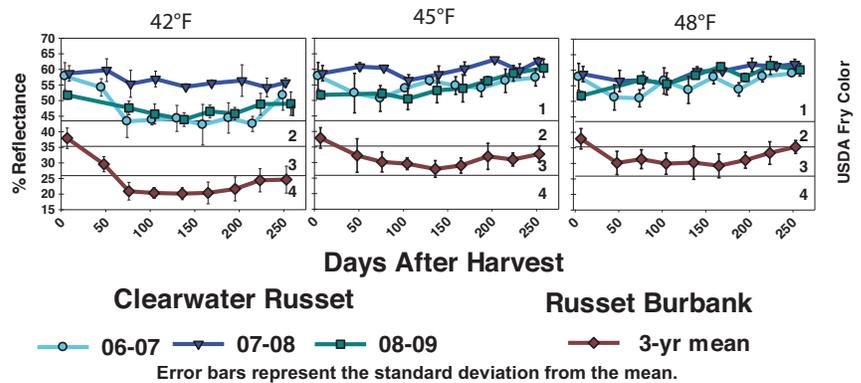


Figure 3. Mean reflectance (%) and USDA fry color of stem-end fries from Clearwater Russet potatoes at harvest and in storage at three temperatures during three storage seasons (2006 to 2009) compared with the 3-year mean of Russet Burbank potatoes similarly stored the same years.



stem end (tuber end closest to the plant and where the stolon attaches) that has the highest levels of sugar and the darkest color. Representing the most stringent test of fry color, the stem-end fry color data are presented in figure 3. Reflectance readings are presented together with the corresponding USDA fry color data. The USDA colors correspond to the following reflectance ranges:

- USDA 1 > 44% reflectance
- USDA 2 = 35 to 44% reflectance
- USDA 3 = 26 to 34.9% reflectance
- USDA 4 < 25.9% reflectance

The higher the reflectance reading, the lighter the fry color. Fry color of USDA 2 or lower ($\geq 35\%$ reflectance) is generally considered acceptable by the frozen potato industry.

Stem-end fry color of Clearwater Russet was lighter than that of Russet Burbank (higher reflectance than Russet Burbank) at 42°F, 45°F, and 48°F in the 3 years tested. Fry color was the lightest at the higher storage temperature, darker at the lower storage temperature. When averaged across 3 years of evaluations, the USDA fry color for each storage temperature over time did not exceed a USDA 1 in Clearwater Russet.

- Storage at 48°F—Fry color in Clearwater Russet was lightest when stored at this temperature. The average fry color was less than a USDA 1 and lighter than the 3-year mean of Russet Burbank, which was a USDA 3 except on the first and last sampling dates.
- Storage at 45°F—USDA fry color of Clearwater Russet samples was less than or equal to a USDA 1 in 3 years, while the average fry color in Russet

Burbank was a USDA 3 (except at harvest).

- Storage at 42°F—Fry color of Clearwater Russet was lighter than the fry color of Russet Burbank and less than or equal to a USDA 1.

Mottling

Thin, thread-like areas of dark coloration found in the cortex of the fried potato tissue, known as mottling, can occur in some varieties. Each fry was subjectively evaluated for mottling on a scale of 1 to 4, where 1 = no mottling, 2 = mild, 3 = moderate, and 4 = severe mottling (figure 4). Mottling in Clearwater Russet was lower than in Russet Burbank at the three storage temperatures during 3 years of testing and ranged from none to mild.

Fusarium dry rot

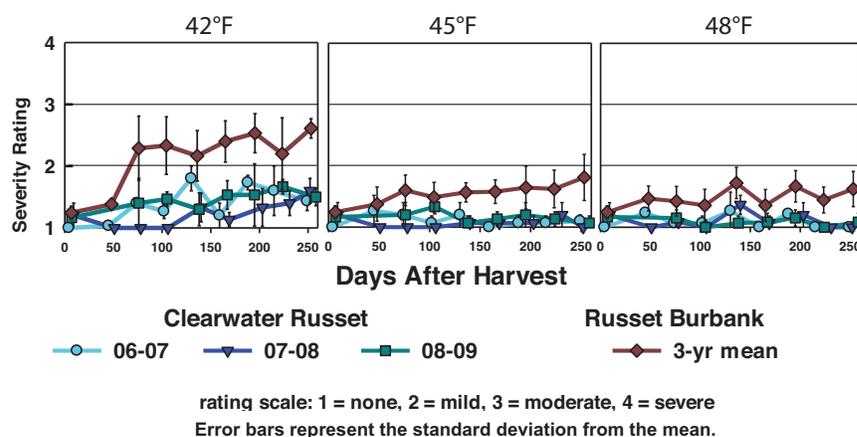
Because Fusarium dry rot is an important storage disease in potatoes, new varieties are screened for susceptibility to this disease in an inoculation study as previously described. The disease organism infects tubers through cuts or openings in the skin.

Results averaged over 3 years indicate that the percentage of decay due to dry rot in Clearwater Russet (31%) was significantly higher than in Russet Burbank (12%) (table 2). The incidence of potatoes with at least 5% decay was also significantly higher in Clearwater Russet (63%) compared to Russet Burbank (39%). These results indicate that Clearwater Russet has increased susceptibility to Fusarium dry rot relative to Russet Burbank. Bruising should be minimized during harvest and handling in order to minimize this disease in storage.

Table 2. Mean decay (%) and incidence of potatoes with greater than 5% decay of Fusarium dry rot in bruised and inoculated lots of Russet Burbank and Clearwater Russet potatoes. Values are means of three years (2006-09).

Variety	Decay (%)	Incidence (% potatoes with > 5% decay)
Russet Burbank	12	39
Clearwater Russet	31	63
LSD ($P < 0.05$)	7	12

Figure 4. Mean severity of mottling in fried planks of Clearwater Russet potatoes at harvest and in storage at three temperatures during three storage seasons (2006 to 2009) compared to the 3-year mean of Russet Burbank potatoes similarly stored during the same time periods.



Weight loss

Percentage weight loss was tracked in three replications of 10-pound samples of Clearwater Russet and Russet Burbank potatoes throughout three storage seasons (table 3). There was no significant difference in

weight loss between Clearwater Russet and Russet Burbank at 45°F and 48°F, although at 42°F Clearwater Russet had significantly higher weight loss than Russet Burbank.

Table 3. Mean total percentage weight loss (for 9 months in storage) in samples of Russet Burbank and Clearwater Russet potatoes at three temperatures. Values are means of three years (2006-09).

Variety	42°F	45°F	48°F
Russet Burbank	5	5	5
Clearwater Russet	8	5	6
LSD ($P < 0.05$)	2	ns	ns

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Storage recommendations for Clearwater Russet

Harvest conditions: Clearwater Russet is more susceptible to *Fusarium* dry rot than Russet Burbank and should be managed accordingly. Bruising should be minimized during harvest and handling in order to minimize this disease in storage.

Curing. Cure at 55°F and 95% relative humidity for 14 days.

Storage. Maintain 95% relative humidity throughout storage.

- **Frozen processing.** While Clearwater displayed acceptable processing from 42°F, holding tubers at 45°F or above will minimize fry mottling.

- **Fresh market.** Hold at 42°F.

- **Dehydration processing.** Hold at 42°F.

Sprout inhibition. Apply CIPC before dormancy break but after curing.

- **42°F.** Apply CIPC between 2 and 15 weeks after harvest
- **45°F.** Apply CIPC between 2 and 13 weeks after harvest
- **48°F.** Apply CIPC between 2 and 12 weeks after harvest

Storage duration. High processing quality persists throughout 36 weeks after harvest at 42°F, 45°F, and 48°F.

Fry mottling. Only slight mottling has been observed in Clearwater Russet and only at 42°F storage; at 45°F and 48°F mottling was seldom observed.

Fusarium dry rot. Clearwater Russet has a higher susceptibility to *Fusarium* dry rot than Russet Burbank in our evaluations. Bruising and wounding should be minimized during harvest and handling in order to lessen this disease in storage.

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