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Physiological Maturity of Ranger Russet Tubers Affects Storability & Processing Quality

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Recent problems in maintaining the processing quality of Ranger Russet tubers in storage may be related to the tendency of this cultivar to become over-mature at the end of the growing season. Ranger vines are persistent and can easily remain green for 150 days or more, resulting in high yields of large tubers. However, high yields do not necessarily translate into increased returns when quality is considered. **Extending the growing season by planting early (e.g. early March) and harvesting late August to early October, thereby allowing tubers an extended maturation period under green or dead vines, may not be the best strategy to maximize returns from Ranger Russet.**

Our data indicate that out-of-field processing quality and storability can indeed be compromised by the tendency of this cultivar to become over-mature after about 150 days. **In short, a crop that has been grown for a prolonged period could very well be worth less than a crop harvested at optimum physiological maturity because of market-imposed penalties for reduced quality from an over mature crop (bruise-free, sugar ends, oversize, etc.).**

Tubers harvested at physiological maturity retain processing quality the longest when stored under ideal conditions. For processing purposes, tuber physiological maturity coincides with maximum dry matter content (specific gravity) and minimum concentrations of sucrose and reducing sugars. We have completed three years of research to define the attainment of physiological maturity for Ranger Russet under Columbia Basin growing conditions and to understand the effects of maturity on the storability of tubers. Physiological maturity was calculated as the average days after planting (DAP) to reach maximum tuber fresh weight, maximum specific gravity, minimum sucrose concentration, and the beginning of end-of-season increase in reducing sugars (glucose + fructose) in the stem ends of tubers.

Figure 1 shows changes in sucrose, reducing sugars, tuber fresh weight, and specific gravity of tubers over time during the 2003 and 2004 growing seasons. Bulking was faster in 2003 than in 2004, resulting in tubers achieving maximum size (fresh wt) later in 2004 than in 2003. Tuber specific gravity also increased faster in 2003 than in 2004, reaching 1.088 at 161 DAP in 2003 and 178 DAP in 2004. Sucrose concentrations fell rapidly through 116 DAP, reaching minimum concentrations at 157 and 122 DAP in 2003 and 2004, respectively. Trends in tuber reducing sugar concentrations were similar to those for sucrose; however, in both years the bud ends of tubers had much higher concentrations than the stem

ends during early tuber growth. Reducing sugars were 0.15% (dry wt basis) or less by 110 DAP in both years and then began to increase in the stem ends of tubers starting 157 DAP in 2003 and 142 DAP in 2004. The end-of-season increases in reducing sugars were substantial, averaging 390% in 2003 and 600% in 2004.

Figure 2 shows similar data for the 2005 growing season, with added information on foliar growth (vines) and tuber yield. Note that a maximum in vine fresh weight occurred approximately 88 DAP, followed by a slow but steady decline through 170 days. The end-of-season increase in reducing sugar concentration of tubers began at 116 days and progressed through 170 DAP, much earlier than that evident during the 2003 and 2004 seasons. This likely reflects heat stress experienced by the 2005 crop during the last third of the growing season. While the end-of-season increases in reducing sugars were insufficient to affect at-harvest fry color, they indicate over-maturation and, potentially, an increased tendency for tubers to develop sugars and lose processing quality prematurely in storage. Moreover, reducing sugars will likely continue to increase as harvest date is shifted later, eventually affecting at-harvest processing quality. Tuber physiological maturity varied from 145- to 159-DAP (averaging 154 DAP over the 3-year period) and coincided with maximum yield (Figs. 1 & 2).

Ranger Russet tubers should be harvested slightly immature or at physiological maturity for optimum processing quality and longest storage life. A prolonged maturation period between vine kill and harvest will contribute to over-maturation of tubers. Delaying harvest beyond approximately 155-160 days may (depending on the year) increases the percentage of sugar ends and bruise (Fig. 3). Over-mature tubers generally enter storage with higher levels of reducing sugars than physiologically mature tubers (Figs 1 & 2), and continued increase in reducing sugars during storage can result in premature loss of processing quality in the former (Fig. 4). This was shown in studies where end-of-season tuber maturity was altered by planting in mid April and mid May and then harvesting on the same date (Sept. 25) to produce crops grown for 133- and 163-days, respectively. Eight-ounce tubers from the early- and late-planted crops were then stored under nine temperature regimes (combinations of conditioning and holding temperatures) to characterize the effects of tuber maturity on changes in reducing sugar levels (and processing quality) over a 230-day storage period (Fig. 4). Averaged over storage time, tubers from the early-planted crop (grown for 163 days) had significantly higher concentrations of reducing sugars at all storage temperatures than those from the late-planted crop (grown for 133 days). Furthermore, reducing sugar concentration increased more in tubers from the early-planted crop than in those from the late-planted crop as storage temperature decreased from 48 to 40^{o}F (Fig. 4).

The decreased storability of Ranger tubers from the early-planted (over-mature) crops is readily apparent by the limited choice of storage temperature regimes resulting in acceptable quality of processed French fries. Tubers from the late-planted crop produced lighter colored fries under a broader range of temperature regimes (5 in total) than the chronologically older tubers from the early-planted crops (3 in total) (Table 1). Ranger Russet tubers showed a tendency to over mature if produced over a relatively long season (>160 days), particularly if the tubers were left under dead vines for more than 10 days prior to harvest. Vines from the late-planted crop of RR were greener than those from the early-planted crop at vine kill. Tubers thus matured under dead vines longer for the early-planted crop and this decreased the ability to maintain processing quality, as evidenced by darker fries under many of the temperature regimes, resulting in fewer conditioning/holding temperature options for storing tubers with acceptable quality (Table 1).

While tuber maturity was manipulated indirectly by varying the planting dates in this study, the results agree with previous studies in WA and ID where tubers harvested without vine kill (i.e. from partially green vines) maintained lower sugar levels and better processing quality than those left to mature for 2 to 4 weeks under dead vines (Knowles et al., 2001; Woodell et al., 2004). **Therefore, for Ranger Russet produced in the Columbia Basin of WA, planting dates, vine kill dates, and harvest dates should be adjusted and crops managed to limit the propensity of this cultivar to over-mature if tubers are destined for storage. One way to accomplish this is by planting no earlier than 15 April, vine killing approximately 145- to 155-days after planting, and harvesting within a week of vine kill to minimize tuber maturation under dead vines.** Growers can even harvest from partially green vines

with diligence to minimize bruising and skinning during harvest and desiccation during wound healing in storage, through control of humidity and temperature.

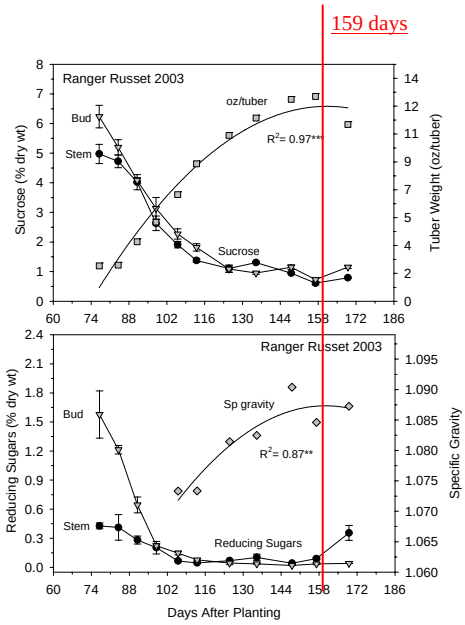
Knowles, L.O., N.R. Knowles and M. Martin. 2001. Postharvest behavior of vine-desiccated versus green-harvested Ranger Russet tubers. Potato Progress 1(7): 1-3.

Woodell, L., Olson, N., Brant, T.L., and G.E. Kleinkopf. 2004. Vine kill and long-term storage of Ranger Russet potatoes. University of Idaho Extension Bulletin, CIS 1119.

Table 1. Combinations of storage conditioning (CT) and holding (HT) temperatures that resulted in acceptable processing quality of French fries from Ranger Russet tubers of different maturity stored for 111- 169-, 230- and 251-d. The 251-d storage period included 21 days of reconditioning (R) at 60°F (from 230- to 251-d). Tuber maturity was manipulated by planting date. The early- and late-planted crops were harvested on 25 Sept, 163- and 133-d after planting, respectively. Tubers were then wound-healed at 54°F for 17 d following harvest, conditioned at 40, 44 and 48°F for a month, and then stored at 40, 44 and 48°F (holding) for an additional 182 d (until 13 May), resulting in nine CT/HT combinations. The tubers were then reconditioned for 21 d at 60°F (13 May to 3 June). Fries were processed after the indicated storage days and fry color and uniformity were evaluated for acceptability. For a storage CT/HT regime to be deemed acceptable, less than 20% of the tubers produced French fries exceeding a USDA 2 rating and the difference in color (lightness) from stem to bud end was less than 9 photovolt reflectance units. These data represent the storability of tubers over three storage seasons (2002-04).

Cultivar	Storage days	Planting Date	
		Early (15 Apr)	Late (15 May)
		conditioning/holding temperature (°F) producing acceptable French fries	
Ranger Russet	111	44/48, 48/44, 48/48	40/48, 44/44, 44/48, 48/44, 48/48
	169	Same as above	Same as above
	230	48/48	Same as above
	251-R*	44/40, 44/44, 48/44 48/48	40/40, 40/44, 40/48, 44/40, 44/44, 44/48, 48/40, 48/44, 48/48

*230 days of storage plus 21 days of reconditioning at 60°F.



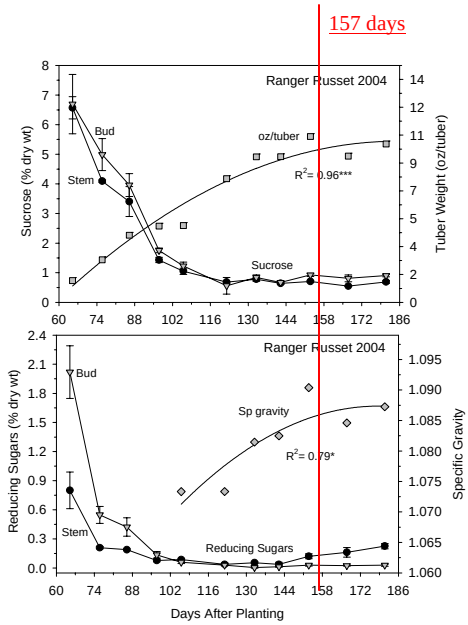


Fig. 1. Changes in sucrose, reducing sugars (glucose and fructose), specific gravity, and average tuber fresh weight with time during growth of Ranger Russet during the 2003 and 2004 growing seasons (Othello, WA). Tuber physiological maturity was estimated at 159 DAP in 2003 and 168 DAP in 2004 (vertical lines). Plots were planted April 13 and 15 in 2004 and 2003, respectively. Vine kill was at 150 DAP in 2003 and 153 DAP in 2004. Final yields were 35.8 T/A in 2003 and 37.4 T/A in 2004. *,**,***P<0.05, 0.01, and 0.001, respectively.

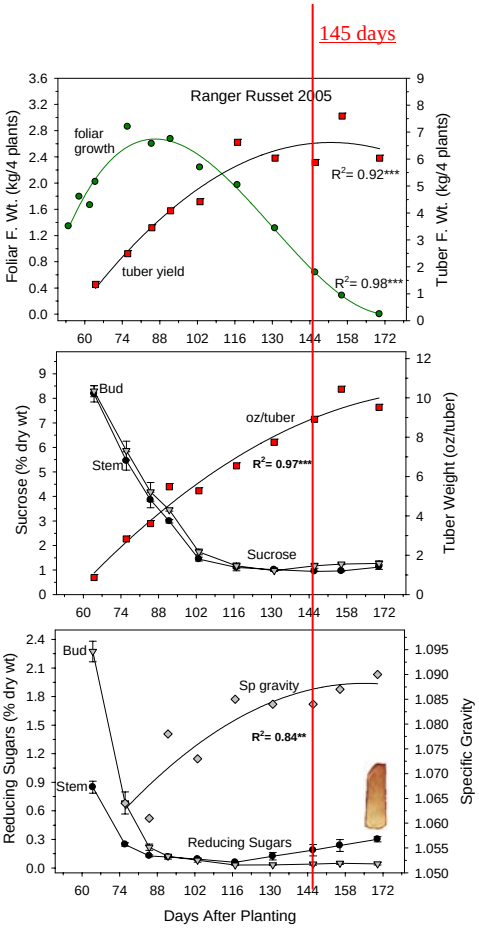


Fig. 2. Changes in foliar growth, tuber yield, sucrose, reducing sugars (glucose and fructose), specific gravity, and average tuber fresh weight with time during growth of Ranger Russet during 2005 (Othello, WA). Tuber physiological maturity was estimated at 145 DAP (vertical line). Plots were planted April 13 and harvested Sept. 30 (170 DAP). Final yield was 34.7 T/A. The end-of-season increase in reducing sugars likely indicates the onset of sugar-end development (fry inset). *,**,***P<0.05, 0.01, and 0.001, respectively.

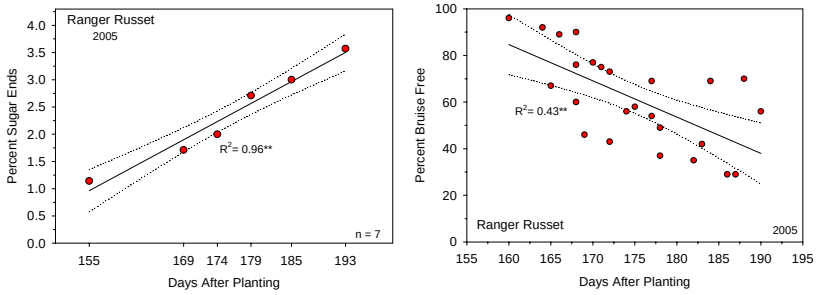


Fig. 3. Trends in the percentage of tubers with sugar ends and percentage bruise free with increasing days after planting for Ranger Russet in the Columbia Basin of WA during the 2005 growing season. Sugar end and bruise free data are the average of 42 and 25 commercial farms, respectively. **,***Correlation coefficients significant at P<0.01 and 0.001, respectively.

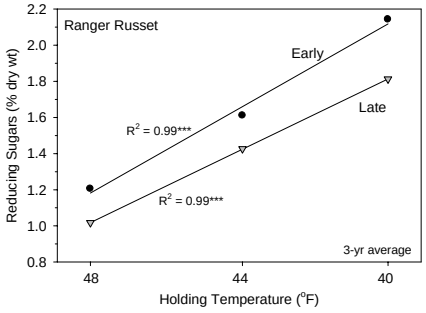


Fig. 4. Effect of storage temperature on reducing sugar levels in Ranger Russet tubers as affected by planting date. The early- and late-planted crops were grown for approximately 163 and 133 days, respectively, and harvested September 25 each year of the 3-year study period. Note the higher sugar levels in tubers from the early-planted crop, regardless of storage temperature. Data have been averaged over 230-days of storage to reveal the significant (P<0.001) effects of tuber maturity (early vs. late) and storage temperature.

Copper Fungicides Under Review by EPA

The U.S. Environmental Protection Agency (EPA), which registers pesticides, is in the process of reviewing the registrations of all copper-containing fungicides. The EPA needs to gather accurate and realistic use pattern information for copper fungicides. **If you value coppers in your farming operation, we suggest you send comments to EPA.** It is a simple web-based process for anyone to provide comments to EPA. To do so, follow the instructions below. Deadline for commenting to EPA is March 27th.

Go to www.regulations.gov.

In the form marked "Search Regulations and Federal Actions Open for Comment" select:

Agency >> Environmental Protection Agency.
Document Type >> All Document Types
Keyword >> copper
then hit **Submit**

Click on Add Comments for Docket ID EPA-HQ-OPP-2005-0558 Coppers Risk Assessments

Example Comment:

My farm raises potatoes and other crops in Washington State. Copper fungicides are valuable disease management tools, providing important economic control of potato diseases. We grow _____ acres of potatoes and use _____ applications of copper fungicide at _____ day intervals at _____ lb/A.

The primary copper fungicide products we use on potatoes are:

_____.

We urge you to continue the registration of copper fungicides for use on both conventionally and organically grown potatoes.

Sincerely,

_____

2006 Commercial Seed Lot Trial Information

Mark J. Pavek
Washington State University

Commercial potato seed samples are requested for the 2006 Washington Seed Lot Trial. Two to three hundred whole (single drop) seed is an acceptable sample size, or 50 lbs of 4 oz single drop seed. This seed should not be treated with insecticide or fungicide. Seed tubers need to be uniformly small (not larger than 4 oz) because no seed cutting is done and a cup-type planter is used. A sample that represents the entire seed lot received is most desirable. Sampling the first (or last) 300 seed from the truck is not likely to provide a representative sample of the lot. Sample tags may be obtained by calling the Potato Commission at 509-765-8845 or stopping by any time during business hours.

Your assistance with collection and drop off of seed samples is needed. Seed samples may be taken to the WSU Othello Research Unit (509-488-3191): south on Booker Road from State Highway 26 about five miles east of Othello. Mark Trent (509-754-2011, ext 413) will be the main contact for North Basin seed pickup (north of Othello). For South Basin sample pickup and any questions regarding the seed lot trials, please call Mark Pavek at 509-335-6861 or Ed Driskill at 509-335-6859.

In the North Basin, one seed "drop-off" has been established. It is located at Qualls Ag Labs (Mick Qualls, 509-787-4210 ext 16) on the corner of Dodson Road and Road 4; come to front office between 8 am and 5 pm. Samples will be picked up at 2:00 pm the day before each planting date (below) to be included. For alternative pickup locations please call Mark Pavek at 509-335-6861 or Mark Trent at 509-754-2011, ext 413.

The planned seed lot planting dates for 2006 are:

1st (Early)	March 21
2nd	April 4
3rd	April 18
4th (Late)	May 2

This year's disease readings of the seed lots will take place on June 6 and 20.

The 2006 Potato Field Day is scheduled for Friday June 23.