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Teton Russet: An Early-Maturing, Dual-Purpose Potato Cultivar Having Higher Protein and Vitamin C Content, Low Asparagine, and Resistances to Common Scab and *Fusarium* Dry Rot

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Abstract Teton Russet is an early-maturing, medium-russeted, potato cultivar with high merit for both fresh-pack and processing. In early harvest trials in the Pacific Northwest, Teton Russet had total yields similar to Russet Norkotah, and higher than Ranger Russet and Russet Burbank. Marketable yield of Teton Russet in the early harvest trials was also comparable to or higher than Russet Norkotah in Washington and Oregon, and higher than Ranger Russet and Russet Burbank at these sites, as well as in Idaho. In full-season trials, while total yield of the earlier-maturing Teton Russet tended to be lower than Ranger Russet and Russet Burbank, marketable yield was generally higher than Russet Burbank across the majority of sites due to its higher percentage of U.S. No. 1 tubers. Teton Russet is suitable for processing, with acceptable fry color following up to 8 months of storage at 8.9 °C. Uniformity of fry color was also very consistent. Teton Russet has shown lower levels of the amino acid asparagine relative to Ranger Russet and Russet Burbank which may contribute to lower acrylamide levels in French fries and other processed potato products. Teton Russet is notable for having resistance to common scab (*Streptomyces* spp.) and *Fusarium* dry rot, and is moderately resistant to tuber net necrosis. Analyses have also shown Teton Russet to have significantly higher protein levels than Russet Norkotah, Ranger Russet, and Russet Burbank, as well as higher vitamin C content than Russet Norkotah and Russet Burbank. Teton Russet was released in 2011 by the USDA-ARS and the Agricultural Experiment Stations of Idaho, Oregon, and Washington, and is a product of the Pacific Northwest Potato Variety (Tri-State) Development Program.

Resumen Teton Russet es una variedad temprana de papa, de piel medianamente rugosa, con amplios méritos tanto para mercado fresco como para proceso. En ensayos de cosecha temprana en el noroeste del pacífico Teton Russet tuvo rendimientos similares a Russet Norkotah, y mayores que Ranger Russet y Russet Burbank. El rendimiento comercial de Teton Russet en estos ensayos de cosecha temprana también fueron comparables o mayores a Russet Norkotah en Washington y Oregon, y mayores que Ranger Russet y Russet Burbank en estos sitios, así como en Idaho. En los

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ensayos de ciclo completo, mientras que el rendimiento total de la variedad temprana Teton Russet tendió a ser más bajo que Ranger Russet y Russet Burbank, el rendimiento comercial fue generalmente mayor al de Russet Burbank en la mayoría de los sitios, debido a su porcentaje más alto de tubérculos US1. Teton Russet es deseable para proceso, con color de freído aceptable después de ocho meses de almacenamiento a 8.9º C. La uniformidad en el color del freído también fue muy consistente. Teton Russet ha mostrado niveles más bajos del aminoácido asparagina en relación a Ranger Russet y Russet Burbank, lo que pudiera contribuir a niveles inferiores de acrilamida en papas a la francesa y otros productos procesados de la papa. Teton Russet es notable por su resistencia a la roña común (*Streptomyces* spp.) y a la pudrición seca por *Fusarium*, y es moderadamente resistente a la necrosis del tubérculo. Los análisis también han demostrado que Teton Russet tiene significativamente mayores niveles de proteína que Russet Norkotah, Ranger Russet y Russet Burbank, así como contenido más alto de vitamina C que Russet Norkotah y Russet Burbank. Teton Russet se liberó en 2011 por USDA-ARS y por las estaciones agrícolas experimentales de Idaho, Oregon y Washington, y es un producto del Programa de Desarrollo de Variedades de Papa Triestatal del Pacífico Noroeste.

Keywords *Solanum tuberosum* · Breeding · Variety · Processing · Fresh pack · Common scab resistance · Fusarium dry rot resistance · Asparagine · Acrylamide

Introduction

Teton Russet is a product of the cooperative Pacific Northwest Potato Variety Development Program, comprised of the USDA Agricultural Research Service and the Agricultural Experiment Stations of Idaho, Oregon and Washington. Teton Russet originated from a hybridization conducted in 2000 by personnel of the USDA-Agricultural Research Service at Aberdeen, Idaho between Blazer Russet (Stark et al. 2007) and Classic Russet (Stark et al. 2010) (Fig. 1). Blazer Russet is the parent of Classic Russet, yet inbreeding depression, which can occur in the intercrossing of closely related parents, was not manifested in Teton Russet with its good early harvest yields and attractive tuber type. The cross was made to explore whether the desirable tuber types of the two related parents could be expressed in earlier maturing progeny without the concomitant inbreeding depression that might normally be expected. Additional potato cultivars in the pedigree of Teton Russet include Butte (Pavek et al. 1978), Kennebec (Akeley et al. 1948), Nooksack (Hoyman and Holland 1974), Summit Russet (Love et al. 2005), and Norking Russet (Johansen et al. 1986) (Fig. 1).

Teton Russet was subsequently selected as a single-hill breeding clone (A0008-1TE) in the field at Tetonia, Idaho in 2002 based on its early maturity and acceptable tuber type under the short growing season at that site (vine kill occurring approximately 80-85 days after planting). Teton Russet was then grown in six-hill and 12-hill plots at Aberdeen and Tetonia, Idaho, respectively in 2003, and from 2004 to 2005 in replicated yield trials at Aberdeen, Idaho. Teton Russet was entered in the Tri-State Variety Trials in Idaho, Oregon, and Washington in 2006 and 2007, and subsequently advanced to the Western Regional Potato Variety Trials where it was evaluated in California, Colorado, Idaho, Oregon, and Washington in 2008 through 2010.

In early-season irrigated trials in the Pacific Northwest (PNW), total and U.S. No. 1 yields of Teton Russet were comparable to or exceeded those of the early-maturing cultivar Russet Norkotah, and exceeded those of the later maturing cultivars Russet Burbank and Ranger Russet. In full-season trials, Teton Russet generally displayed lower total yields than Russet Burbank and Ranger Russet, but had a higher U.S. No. 1 yield than Russet Burbank due to its lower percentage of external tuber defects, such as second growth and growth cracks. Favorable agronomic performance, resistances to common scab and dry rot, and higher protein and Vitamin C content, reinforced the release of Teton Russet as a cultivar.

The name, Teton Russet, was chosen to denote its initial selection in the field at the Tetonia Research and Extension Center near the scenic Teton Mountains. Release documents for Teton Russet were completed in 2011, with approval of plant variety protection rights by the USDA Plant Variety Protection Office in 2013.

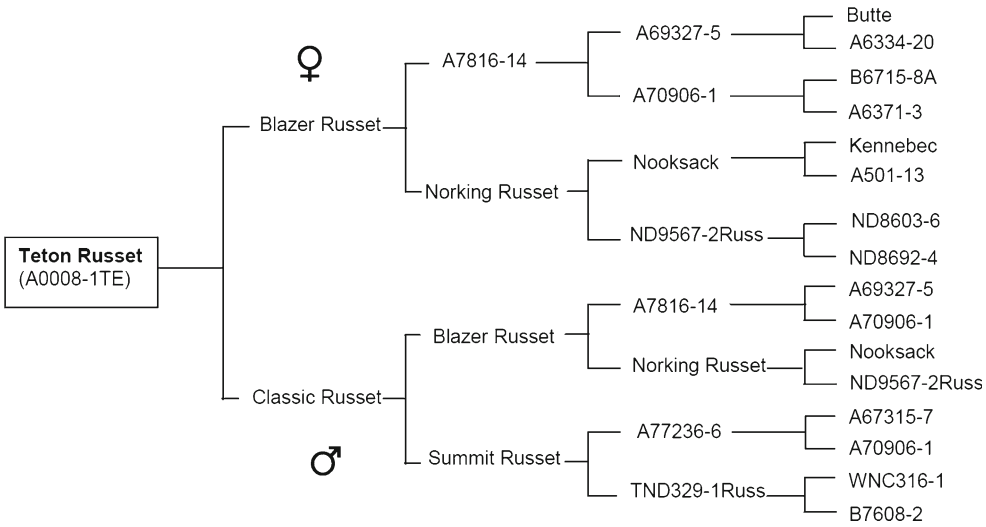
Varietal Description

Plant and tuber descriptions of Teton Russet were obtained from field evaluations conducted at Aberdeen, ID.

Plants (Fig. 2a and b)

Growth habit: Small-medium, semi-erect vine expressing early maturity. Vine architecture is partially closed with some stems partially visible through foliage canopy. *Stems*: Anthocyanin pigmentation is present and strong with weakly prominent stem wings. *Leaves*: Larger-sized, darker-green (Royal Horticulture Society Color Chart [RHSCC], 137A) with a partially closed silhouette, moderate pubescence, and weak anthocyanin pigmentation on the petioles. *Terminal leaflets*: Broadly ovate shape with an acuminate tip and obtuse base; weakly wavy margins present. *Primary leaflets*: Range of two to five pairs with an average of 3.4 pairs; medium ovate with an acuminate tip and cordate base. *Secondary and tertiary*

Fig. 1 Pedigree of Teton Russet



leaflets: Three to ten pairs, average of 6.7 pairs. *Stipular leaves*: Small.

Flowers (Fig. 2c)

The number of inflorescences ranges from one to five per plant (average of 3.3), with an average of 3.1 florets per inflorescence. *Calyx:* Anthocyanin pigmentation is moderate. *Corolla*: White (RHSCC 155A) with semi-stellate shape. *Anthers*: Yellowish-orange (RHSCC 15A) with a loose shape. *Stigma*: Capitate. *Pollen*: Fertile, although limited shed. *Female fertility*: Observed to be good in crosses with male fertile breeding clones/cultivars; however, abortion of buds frequently occurs in the greenhouse, limiting its use as a parent in hybridizations.

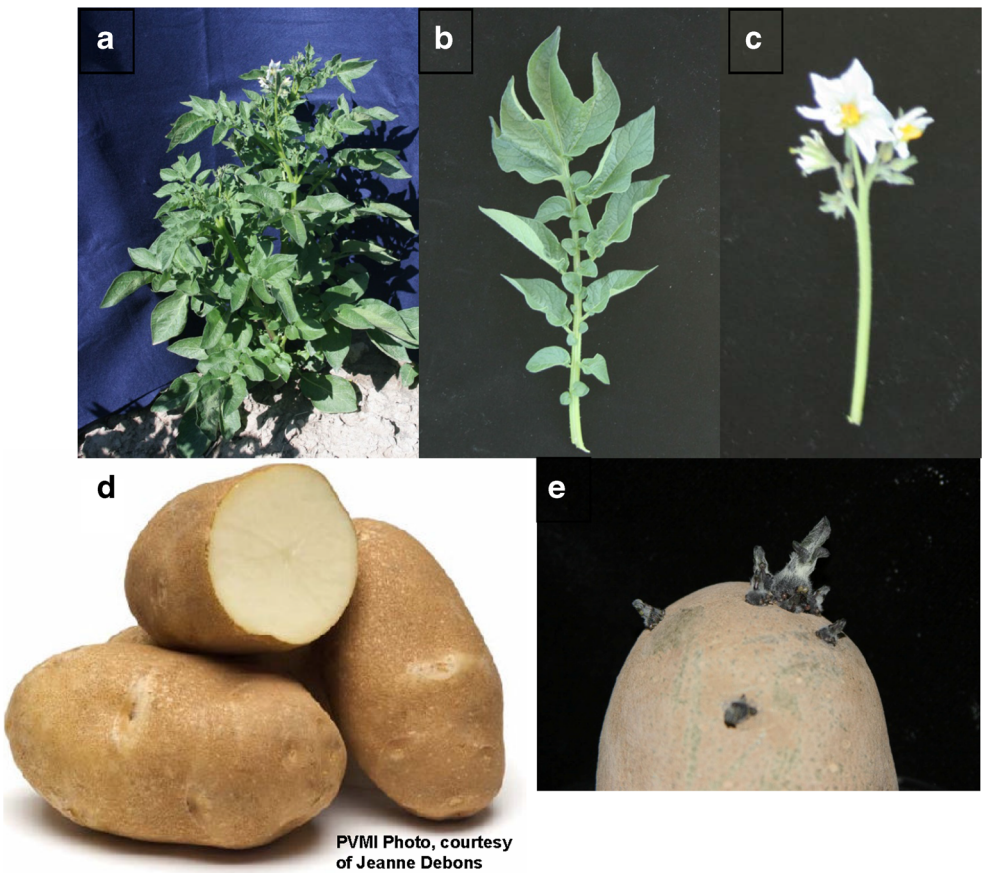


Fig. 2 Teton Russet: (**a**) plant, (**b**) leaf, (**c**) inflorescence, (**d**) external and internal tuber appearance, and (**e**) light sprouts on tuber

Tubers (Fig. 2d)

Oblong to long, medium russeted, with shallow eye depth and white flesh; mean length of 106 mm, range 80-137 mm; mean width of 61 mm, range 50–75 mm; mean thickness of 56 mm, range 45 to 69 mm; mean tuber weight, 213 g(average of 80 tubers). *Eyes:* Shallow, with eyebrows having medium prominence and evenly distributed; mean number of eyes per tubers, 14, range 10 to 19. Average tuber numbers per plant at Aberdeen, ID during 4 years of evaluation was 5.6, with Ranger Russet and Russet Burbank having 5.1 and 5.5 tubers respectively in the same field evaluations. Russet Norkotah, in three of the 4 years of evaluation had 6.6 tubers per plant.

Light Sprouts (Fig. 2e)

Spherical shape; base and tip are blue-violet with a strong expression of both pigmentation and pubescence, and a moderate number of root initials at the base.

Agronomic Performance

Total yields of Teton Russet in early-season irrigated trials in the PNW were similar to those of Russet Norkotah in Idaho and Washington, but were higher in Oregon. Teton Russet also out-yielded Ranger Russet and Russet Burbank in all three states (Table 1). Early U.S. No. 1 yields (United States Standards for Grades of Potatoes 1997) of Teton Russet also were comparable or higher in Washington and Oregon respectively, relative to Russet Norkotah, with U.S. No. 1 yields being lower in Idaho due to a high incidence of growth cracks in tubers in 2009 that was attributed to the application of the herbicide Rimsulfuron (Trade name: Matrix®). U.S. No. 1 early yields of Teton Russet were also greater than Ranger Russet and Russet Burbank at all sites (Table 1). The percentage of total yield that could be categorized as U.S. No. 1 yield was similar for Teton Russet, Russet Norkotah, and Ranger Russet averaged across all sites, with Russet Burbank having a substantially lower percentage of U.S. No. 1 tubers (Table 1). Specific gravities of tubers of Teton Russet, Ranger Russet, and Russet Burbank were similar when averaged across location, with Russet Norkotah displaying the lowest value (Table 1). Merit scores for both fresh and processing use of Teton Russet averaged across all sites exceeded those of the check cultivars (Table 1), indicative of the dual-purpose, early harvest merit of Teton Russet, with a perfect score of 5.0 (excellent merit) assigned for processing merit in Oregon over a 2 year period. Field fry color was similar among all entries, with Teton Russet displaying a larger average tuber size (Table 1).

Teton Russet also was evaluated over a 5 year period in full-season trials conducted in Idaho, Oregon, and Washington (Table 2). Total yields of Teton Russet were lower than those

Table 1 Total yield, U.S. No. 1 yield, percent U.S. No. 1 tubers, tuber specific gravity, fry color, and percentage of sugar ends of Teton Russet, Russet Norkotah, Ranger Russet, and Russet Burbank in early- season irrigated trials grown in Idaho, Oregon, and Washington

	ID	OR	WA	Mean
Total yield (t/ha)				
Teton Russet	60.3	72.4	55.2	**62.6**
Russet Norkotah	60.0	62.6	57.2	**59.9**
Ranger Russet	52.9	62.6	51.0	**55.5**
Russet Burbank	50.8	69.8	53.8	**58.1**
U.S. No. 1 yield (t/ha)				
Teton Russet	48.4	65.1	48.8	**54.1**
Russet Norkotah	55.2	53.6	49.8	**52.9**
Ranger Russet	44.8	53.3	46.0	**48.0**
Russet Burbank	35.1	41.1	42.3	**39.5**
% U.S. No. 1				
Teton Russet	81	90	88	**86**
Russet Norkotah	92	86	87	**88**
Ranger Russet	85	86	90	**87**
Russet Burbank	68	60	79	**69**
Specific gravity[a]				
Teton Russet	1.079	1.077	1.077	**1.078**
Russet Norkotah	1.081	1.071	1.074	**1.075**
Ranger Russet	1.084	1.072	1.080	**1.079**
Russet Burbank	1.084	1.073	1.080	**1.079**
Merit score[b] *(fresh/processing)*				
Teton Russet	3.4/3.8	4.8/5.0	4.1/3.4	**4.1/4.1**
Russet Norkotah	3.3/3.8	4.8/2.8	3.6/3.3	**3.9/3.3**
Ranger Russet	2.9/3.9	2.8/4.0	3.0/3.3	**2.9/3.7**
Russet Burbank	2.4/3.7	1.5/1.8	2.2/2.9	**2.0/2.8**
Field fry color[c]				
Teton Russet	0.2	0.1	n.a	**0.2**
Russet Norkotah	0.1	0.4	n.a.	**0.3**
Ranger Russet	0.1	0.1	n.a.	**0.1**
Russet Burbank	0.1	0.5	n.a.	**0.3**
Average tuber size (grams)				
Teton Russet	213	224	221	**219**
Russet Norkotah	216	173	201	**197**
Ranger Russet	238	181	221	**213**
Russet Burbank	156	147	184	**162**

Trial locations were Parma (ID), Hermiston (OR), and Othello/Pasco (WA) with average early harvest growing seasons of 112, 117, and 116 days, respectively. WA means represent 5 years of combined data from the early-harvest trials of the 2006 to 2007 Tri-State Potato Variety Trials and the 2008 to 2010 Western Regional Potato Variety Trials (WRPVT). ID is represented by 3 years of data from the 2008 to 2010 WRPVT, with OR represented by 2 years of data from the 2008 to 2009 WRPVT

[a] Specific gravities were determined using the weight-in-air, weight-in-water method

[b] Merit ratings: 1=Very Poor, 2=Poor, 3=Average, 4=Good, 5=Excellent

[c] French fry scores rated using USDA standards, with 0=light and 4=dark. A rating≤2.0 is an acceptable score. Tubers harvested from the field with no storage were used for the production of fries

Table 2 Total yield, U.S. No. 1 yield, percent U.S. No. 1 tubers, tuber specific gravity, fry color, and percentage of sugar ends of Teton Russet, Ranger Russet, and Russet Burbank in full-season irrigated trials grown in Idaho, Oregon, and Washington

	ID	OR	WA	Mean
Total yield (t/ha)				
Teton Russet	43.7	76.4	67.9	**62.7**
Ranger Russet	50.5	98.2	75.6	**74.8**
Russet Burbank	53.2	99.1	70.0	**74.1**
U.S. No. 1 yield (t/ha)				
Teton Russet	37.4	65.6	58.8	**53.9**
Ranger Russet	38.0	81.9	66.0	**62.0**
Russet Burbank	31.1	59.9	55.4	**48.8**
% U.S. No. 1				
Teton Russet	86	86	86	**86**
Ranger Russet	75	84	87	**82**
Russet Burbank	60	61	77	**66**
Specific gravity[a]				
Teton Russet	1.081	1.072	1.079	**1.077**
Ranger Russet	1.087	1.080	1.087	**1.085**
Russet Burbank	1.079	1.078	1.078	**1.078**
Merit score[b] *(fresh/processing)*				
Teton Russet	3.6/3.1	3.0/2.7	2.9/3.1	**3.2/3.0**
Ranger Russet	2.9/3.1	1.7/3.4	2.7/3.4	**2.4/3.3**
Russet Burbank	2.2/2.6	1.8/2.2	1.9/1.9	**2.0/2.2**
Fry color from 4.4 C/7.2 C[c]				
Teton Russet	3.9/0.7	n.a./1.5	2.8/0.6	**3.4/0.9**
Ranger Russet	3.3/0.8	n.a./1.1	2.4/0.6	**2.9/0.8**
Russet Burbank	3.8/0.7	n.a./1.8	2.8/1.2	**3.3/1.2**
% sugar ends: 7.2 C				
Teton Russet	25	11	n.a.	**18**
Ranger Russet	24	12	n.a.	**18**
Russet Burbank	39	47	n.a.	**43**
Average tuber size (grams)				
Teton Russet	199	230	216	**215**
Ranger Russet	250	286	250	**262**
Russet Burbank	221	224	201	**215**

Trial locations were Aberdeen (ID), Hermiston (OR), and Othello (WA). Means represent 5 years of combined full-season data from the 2006 to 2007 Tri-State Potato Variety Trials and the 2008 to 2010 Western Regional Potato Variety Trials (WRPVT). Average growing season across sites over years was 123, 150, and 152 days for Aberdeen, Hermiston, and Othello, respectively

[a] Specific gravities were determined using the weight-in-air, weight-in-water method

[b] Merit ratings: 1=Very Poor, 2=Poor, 3=Average, 4=Good, 5=Excellent

[c] French fry scores rated using USDA standards, with 0=light and 4=dark. A rating≤2.0 is an acceptable score. Storage at given temperatures prior to frying was 6, 7, and 8 weeks for OR, ID, and WA, respectively. Storage temperatures in WA were 4.4 and 6.7 C

of the later-maturing check cultivars, Ranger Russet and Russet Burbank, in all three states. However, U.S. No. 1 yield of Teton Russet consistently exceeded that of Russet Burbank at all locations, averaging 5.1 t/ha higher yields across all sites, due to a 20 % higher percentage of U.S. No. 1 tubers relative to Russet Burbank (Table 2). Specific gravities and average tuber size for Teton Russet were similar to those of Russet Burbank and lower than those of Ranger Russet. Fry colors were comparable for all three entries, with the percentage of sugar ends being identical (18 %) for Ranger Russet and Teton Russet, with values substantially reduced when compared to Russet Burbank at 43 % (Table 2). Fresh use merit scores for Teton Russet exceeded those of Ranger Russet and Russet Burbank, with processing merit of Teton Russet comparable to Ranger Russet and greater than Russet Burbank (Table 2).

In 3 years of full-season evaluations in the Western Regional Potato Variety Trials, Teton Russet had lower total yield, but a higher percent of U.S. No. 1 yield relative to Ranger Russet and Russet Burbank, when averaged across all eight locations (Table 3). The higher percentage of U.S. No.1 tubers contributed to higher U.S. No. 1 yield for Teton Russet relative to Russet Burbank at all trial sites, with the exception of the Colorado and Washington sites where the yield advantage of Russet Burbank was 1.3 and 1.0 t/ha, respectively (Table 3). The specific gravities of tubers of Teton Russet were similar to those of Russet Burbank and lower than Ranger Russet (Table 3). Fresh merit scores for Teton Russet were higher than those of the check cultivars, with processing merit of Teton Russet being lower than Ranger Russet, and similar to Russet Burbank (Table 3). Fry colors among all three entries were similar when averaged across all sites (Table 3).

Tuber Quality Characteristics and Usage

Processing Characteristics

Percent sucrose in tubers of Teton Russet showed a very similar pattern to that of Russet Burbank (3 year. mean) following up to 250 days storage at 7.2 and 8.9 °C (Fig. 3a). At 5.6 °C, sucrose was higher in Teton Russet in two of the 3 years tested compared to the mean of Russet Burbank. Percent glucose in stored tubers of Teton Russet was nearly identical to that of Russet Burbank at 7.2 and 8.9 °C (Fig. 3b). At 5.6 °C storage, tuber glucose concentrations of Teton Russet at most sampling dates in two of 3 years were higher than those of Russet Burbank (Fig. 3b). Teton Russet fry colors were lightest (USDA 2 or lighter) at 8.9 °C and generally were lighter than Russet Burbank fries across storage dates (Fig. 3c.). Similar to observations for Russet Burbank, fry color in Teton Russet was USDA 3.0 or darker, and considered unacceptable, throughout much of the storage season when stored at 5.6 and 7.2 °C. Mottling, a dark, uneven coloration which can occur in fried products, was observed in a moderate amount in Teton Russet tubers held at 5.6 °C, a

Table 3 Total and U.S. No. 1 yield, percent U.S. No. 1 tubers, specific gravity, and fry color of Teton Russet, Ranger Russet and Russet Burbank in full-season trials in the 2008 to 2010 Western Regional Potato Variety Trials

	CA	CO	ID			OR		WA	Mean
			1	2	3	1	2		
Total yield (t/ha)									
Teton Russet	51.2	45.1	43.7	49.3	68.4	79.2	52.2	72.6	**57.7**
Ranger Russet	54.4	55.6	49.3	48.6	67.4	94.6	62.3	81.9	**64.3**
Russet Burbank	49.8	59.5	49.7	55.7	67.8	101.7	64.6	79.4	**66.0**
U.S. No. 1 yield (t/ha)									
Teton Russet	44.4	36.6	37.7	41.3	60.1	68.4	39.6	65.0	**49.1**
Ranger Russet	43.6	44.8	37.9	39.1	59.2	80.0	41.0	72.0	**52.2**
Russet Burbank	36.9	37.9	33.6	44.7	49.3	64.0	37.4	66.0	**46.2**
% U.S. No. 1									
Teton Russet	87	81	87	84	88	86	76	89	**85**
Ranger Russet	80	81	76	81	88	85	68	88	**81**
Russet Burbank	74	64	68	64	79	63	58	82	**69**
Specific gravity[a]									
Teton Russet	1.085	1.086	1.082	1.082	1.083	1.073	1.083	1.078	**1.082**
Ranger Russet	1.094	1.089	1.086	1.089	1.089	1.080	1.092	1.086	**1.088**
Russet Burbank	1.088	1.091	1.080	1.079	1.084	1.079	1.088	1.079	**1.084**
Merit score[b] *(fresh/processing)*									
Teton Russet	n.a.	2.3/2.0	3.9/3.2	3.3/3.3	3.3/4.0	3.2/3.0	n.a.	3.4/3.2	**3.2/3.1**
Ranger Russet	n.a.	4.0/3.0	2.7/3.2	3.0/3.3	3.3/4.3	1.5/3.5	n.a.	2.7/3.6	**2.9/3.5**
Russet Burbank	n.a.	2.7/3.0	2.4/3.0	2.0/3.0	2.7/3.9	2.0/2.5	n.a.	2.1/2.3	**2.3/3.0**
Fry color[c]									
Teton Russet	n.a.	2.7	0.7	0.8	n.a.	1.4	n.a.	0.7	**1.3**
Ranger Russet	n.a.	2.3	0.9	0.6	n.a.	1.0	n.a.	0.3	**1.0**
Russet Burbank	n.a.	1.7	0.6	0.5	n.a.	1.8	n.a.	1.0	**1.1**

Trial locations were Tulelake (CA), San Luis Valley (CO), Aberdeen (ID-1), Kimberly (ID-2), Parma (ID-3), Hermiston (OR-1), Klamath Falls (OR-2), and Othello (WA); All sites represent 3 years of data with the exception of the Kimberly, ID (08 and 10 only) with the number of days in the growing season for each site given in the 2008–2010 Russets/Processing WRPVT reports at : http://www.ars.usda.gov/Main/docs.htm?docid=21888

[a] Specific gravities were determined using the weight-in-air, weight-in-water method

[b] Merit ratings: 1=Very Poor, 2=Poor, 3=Average, 4=Good, 5=Excellent

[c] French fry scores rated using USDA standards, with 0=light and 4=dark. A rating≤2.0 is an acceptable score. Tubers were evaluated following 6 to 11 weeks storage at 7.2 ° C, with the exception being WA with storage at 6.7 ° C

mild amount at 7.2 and none to mild amount at 8.9 °C storage temperatures.

Fry color uniformity, a measure of the homogeneity of reducing sugar concentrations along the length of a tuber, is calculated as the difference in Photovolt light reflectance readings from the stem to bud end of tubers following frying (Table 4). Little variability in reducing sugar concentrations from tuber stem to bud end is reflected in uniform Photovolt readings between fry ends—important to the processing industry. With the exception of Oregon, Teton Russet consistently displayed uniformity of fry color (≤9.0 reflectance unit difference) after 7 months of storage (Table 4). In contrast, Russet Burbank and Ranger Russet displayed non-uniform fry colors, with values exceeding the 9.0 photovolt reflectance unit difference between bud and stem ends at all sites (Table 4).

Over a 5 year period, the post-harvest process rating of Teton Russet (rating based upon fry color, reducing sugar concentrations, tuber specific gravity, and sensory evaluations following harvest from the field without storage, and following 60 days of storage at 8.9 and 6.7 °C) was superior to the rating for Russet Burbank and similar to the rating for Ranger Russet (Table 5). Out of a possible 38 points, Teton Russet averaged 65 % of this maximum value, whereas Ranger Russet and Russet Burbank were 69 % and 49 % respectively, indicative of the processing merit of Teton Russet.

Teton Russet also is notable for having a significantly lower concentration of the amino acid asparagine relative to

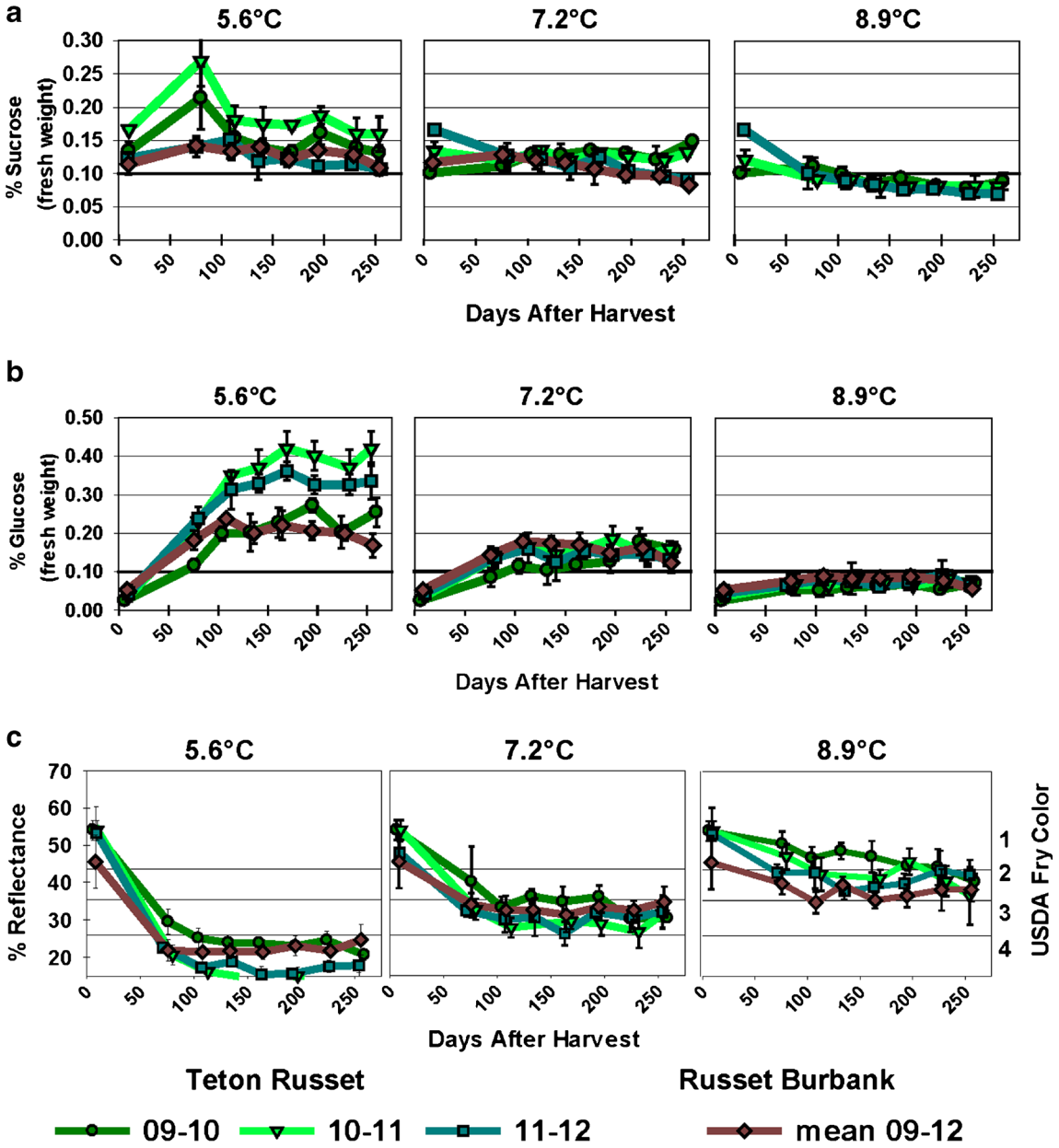


Fig. 3 **a** and **b** Tuber sucrose and glucose concentrations, and **c**. fry colors (% reflectance) of Teton Russet over a 3-year period (2009-10, 2010-11, 2011-2012) relative to Russet Burbank, following 0 to 250 days of storage at 5.6, 7.2, and 8.9 °C; tubers were from research plots at Kimberly, ID. These three storage temperatures reflect an initial storage of harvested tubers for 14 days at 12.8 °C followed by an incremental lowering of the temperature by 0.28 °C per day until the three storage temperatures were reached. Sugar concentrations and fry colors of Russet Burbank represent a 3 year average. Fry colors with Photovolt light reflectance readings of ≥35 and USDA ratings of≤2.0 are considered acceptable

Ranger Russet (with the exception of Late-2011) and Russet Burbank in 2 years of evaluations in the National Fry Processing Trial (NFPT) (Table 6). Asparagine and reducing sugars are important precursors in acrylamide formation, with significant correlations identified for both free asparagine and reducing sugars in acrylamide formation in potato varieties used for French fry production (Halford et al. 2012). The lower concentration of asparagine observed in Teton Russet may contribute to reduced acrylamide formation in its processed products relative to potato cultivars currently being utilized by the processing industry.

Economic returns for Teton Russet for process markets based on 5 years of data obtained from Washington trial sites were calculated as described by Knowles and Pavek (2013). For early harvest trials, Teton Russet compared favorably to Ranger Russet, with a higher gross economic return of $340 per hectare (Table 7). In late harvest trials, the early maturity of Teton Russet was reflected in a significantly reduced

Table 4 Post-harvest ratings of Teton Russet, Ranger Russet, and Russet Burbank following 7 months of storage (3 months at 8.9 °C and 4 months at 6.7 °C)

Location/cultivar	Photovolt reading[a]			Difference[b]:	USDA color	% Reducing sugars[d]			Tuber sprouting[e]	
	Stem	Bud	Avg.	Stem –vs- Bud	Rating[c]	Stem	Bud	Avg.	% of tubers	Sprout length (mm)
Washington										
Teton Russet	30.3	33.8	32.1a	6.3a	0.8	1.45	1.16	1.31	77b	9.5
Ranger Russet	30.1	41.5	35.8ab	11.7b	0.8	1.49	0.72	1.10	81b	12.1
Russet Burbank	32.8	41.8	37.3b	9.6ab	0.3	1.21	0.68	0.95	0a	0.0
Idaho										
Teton Russet	30.7	31.8	31.2a	7.6a	0.5	1.34	1.28	1.31	48.2b	5.7
Ranger Russet	35.8	42.9	39.3c	9.3ab	0.0	0.96	0.63	0.79	73c	5.1
Russet Burbank	30.6	40.3	35.5b	11.3b	0.5	1.37	0.72	1.05	0a	0.0
Oregon										
Teton Russet	23.6	33.1	28.4a	10.3a	1.5	2.14	1.15	1.64	88b	8.9
Ranger Russet	25.3	39.3	32.3b	14.0ab	1.3	1.97	0.77	1.37	92b	15.2
Russet Burbank	22.3	40.7	31.5ab	18.4b	1.8	2.33	0.70	1.52	3a	0.6

All post-harvest evaluations and ratings were conducted at Pullman, WA using tubers harvested from 2006 to 2010 trials at Aberdeen, ID, Hermiston, OR, and Othello, WA. Means in a column followed by different letters differed significantly from one another

[a] Fries (0.95 cm×2.87 cm) were fried at 191 °C for 3.5 min and color was measured with a Photovolt reflectance meter (model 577, Photovolt Instruments Inc., Minneapolis, MN) within 3 min of removal from oil. A Photovolt light reflectance reading of ≤19 is considered unacceptably dark (see note 3 below). Within a state, means in a column followed by different letters differed significantly (LSD, $P<0.05$)

[b] A difference ≥9 Photovolt light reflectance units between bud and stem end constitutes non-uniform fry color. Values represent an average of actual Photovolt differences in each of 4 years and therefore do not relate directly to averaged stem and bud values listed in the table

[c] USDA color (0=light and 4=dark) ratings were assigned based upon Photovolt light reflectance readings of the darkest ends of fries (typically stem ends); Photovolt readings ≥31=USDA 0, 25-30=USDA 1, 20-24=USDA 2, 15-19=USDA 3, ≤14=USDA 4. Data are averaged over years

[d] Glucose+Fructose (dry matter basis) were estimated from an algorithm relating fry color to percent reducing sugars assayed by the dinitrophenol method of Ross (1959). Acceptable values for processing are≤2.6 %

[e] Sprouting was measured following 56 days of storage at 8.9 °C using tubers not treated with sprout inhibitor

Table 5 Mean post-harvest ratings[a] of Teton Russet, Ranger Russet, and Russet Burbank in full-season trials in the 2006-2010 Tri-State and Western Regional Potato Variety Trials

	Washington	Idaho	Oregon	Mean
Teton Russet	27.6	25.6	21.0	**24.7**
Ranger Russet	27.1	31.0	20.8	**26.3**
Russet Burbank	22.3	19.8	13.6	**18.5**

Post-harvest evaluations and ratings were conducted at Pullman, WA using tubers produced in trials at Aberdeen, ID, Hermiston, OR, and Othello, WA

[a] Values were assigned based on the sum of individual ratings for fry color from the field, after storage at 8.9 and 6.7 °C (56 days) (0–5 scale, 1= dark, 5=light), reducing sugar concentrations following 56 days storage at 8.9 and 6.7 °C (1–5 scale, 1=high, 5=low), specific gravity (0–5 scale, 1=low, 5=high), and average sensory evaluations by taste panels (1–5 scale, 5=best). With three fry color ratings(field, 8.9° and 6.7 °C), two reducing sugar concentration ratings (8.9 and 6.7 °C), and 1 rating each for specific gravity and sensory evaluation, a maximum rating of 35 could be obtained if the most favorable score (5) is given in each of the seven total ratings. An additional 3 points could be added for high fry color uniformity, resulting in a maximum possible value of 38. Higher values are indicative of superior post-harvest attributes

Table 6 Means for asparagine concentrations in tubers of Teton Russet, Ranger Russet, and Russet Burbank across 3 locations (Idaho, Washington, and North Dakota) of the National Fry Processing Trial (2011–2012)

	Asparagine (mg/g)[a]			
	2011		2012	
	E[b]	L[c]	E	L
Teton R.	4.84b	5.49b	1.92b	2.56b
Ranger R.	9.14a	6.61ab	3.62a	3.63a
Russet B.	8.66a	7.62a	3.55a	3.78a
Mean	7.55	6.57	3.03	3.32
LSD=0.05	2.99	1.37	0.64	0.82

[a] Values from lab analyses are based on dry weight in 2011 and fresh weight in 2012 due to a change to a new laboratory for assessment of asparagine content in 2012

[b] Early (E)=within 1 month of harvest; means in a column followed by different letters differed significantly

[c] Late (L)=7 and 8 months storage at 8.9 °C in 2011 and 2012, respectively; means in a column followed by different letters differed significantly from one another

Table 7 Gross economic return ($/ha) for Ranger Russet, Russet Norkotah, and Teton Russet in the Columbia Basin of WA for fresh and process markets for an early and late harvest (Early harvest=106 days after planting (DAP); late harvest 153 DAP; DAP values represent an average across 5 years of trials) averaged across trials from 2006 to 2010

	Fresh[a] market		Process[a] market	
	Early harvest $/ha	Late harvest $/ha	Early harvest $/ha	Late harvest $/ha
Teton Russet	10,300	14,210	7,510	8,700
Ranger Russet	na[b]	na	7,170	10,160
Russet Norkotah	8,180	10,550	na	na
p-value[c]	0.0272	0.0375	ns	0.0121

[a] Fresh market and process market (french fry) gross return per acre was calculated using methods by Knowles and Pavek (2013). Production costs per hectare were not applied

[b] Not applicable to the particular market

[c] Significance determined using Fisher's Protected LSD Test

economic return relative to the later-maturing Ranger Russet (Table 7).

Fresh-Pack Usage

Sensory evaluations conducted over a 3 year period from early and late storage of tubers showed no significant differences for aroma, flavor, texture, aftertaste, and overall acceptance between Teton Russet and the check varieties Russet Norkotah, and Russet Burbank (Table 8). Russet Norkotah and Russet Burbank are the two most widely-grown russet-skinned varieties for fresh-pack usage, indicating that the sensory qualities of Teton Russet would be favorable for its acceptance by consumers.

Economic returns for Teton Russet for fresh markets based on 5 years of data obtained from Washington trial sites were calculated as described by Knowles and Pavek (2013). Teton Russet had significantly greater economic returns that were $2,120 and $3,660 per hectare higher in early and late harvest comparisons with Russet Norkotah, indicative of its merit for fresh-pack usage (Table 7).

Tuber Defects

Using a five point rating scale with a value of 5.0 indicative of no defects, Teton Russet had a greater tendency for growth cracks than Russet Norkotah, was comparable to Ranger Russet, and had a much reduced incidence relative to Russet Burbank. Teton Russet, Russet Norkotah, and Ranger Russet were similar with respect to ratings for second growth, with all three cultivars displaying a reduced incidence relative to Russet Burbank in 5 years of trial evaluations (Table 9). The low incidence of growth cracks and second growth in Teton Russet has contributed to its greater U.S. No. 1 yield relative to Russet Burbank in both early and full-season trials (Tables 1, 2,and 3). Ratings for shatter bruise indicated a greater susceptibility of Teton Russet relative to check cultivars, especially in the full-season trials. Percentages of hollow heart in Teton Russet tubers were lower than that of Russet Burbank, comparable to Russet Norkotah, and higher than Ranger Russet (Table 9). No significant differences in percentage of internal brown spot was observed among cultivars, whereas Teton Russet had a lower incidence of black spot bruise relative to Ranger Russet and Russet Burbank in full-season trials. Percent of tubers displaying symptoms of net necrosis/vascular discoloration was lowest for Teton Russet in both early and full-season trials (Table 9). Weight loss (shrinkage) of Teton Russet tubers over 9 months of storage at 5.6°, 7.2°, and 8.9 °C was not significantly different from that of Russet

Table 8 Sensory evaluations of baked tubers of Teton Russet, Russet Norkotah, and Russet Burbank, 2011-13

Cultivar	Early-storage[a]					Late storage[b]				
	Aroma	Flavor	Texture	Aftertaste	Acceptance	Aroma	Flavor	Texture[c]	Aftertaste	Acceptance
Russet Burbank	6.1	6.0	6.4	5.8	6.0	6.4	6.1	5.9b	5.7	5.9
Russet Norkotah	5.8	5.9	6.7	5.7	6.1	5.7	6.0	6.5a	5.6	6.1
Teton Russet	6.1	6.1	6.4	5.9	6.3	5.6	5.9	6.3ab	5.7	5.9
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	0.5	ns	ns

Blind sensory evaluations were conducted in Pullman, Washington during the 3 year period of 2011-13 (2 session/year) using 100 untrained panelists under the supervision of the WSU Food Sensory Laboratory. Panelists were asked to evaluate each sensory attribute for each cultivar on a 1–9 scale with 1 being 'extremely dislike' and 9 being 'extremely like'. Tubers were baked at 204 ° C for 1 h, and allowed to cool to room temperature prior to evaluation

[a] Early storage evaluations were conducted approximately 2 months after harvest. The early-harvest tubers were held at a temperature of 9 ° C from harvest until evaluation

[b] Late storage evaluations were conducted following approximately 6 months of storage at 6.6 ° C

[c] Means in a column followed by different letters differed significantly from one another

Table 9 Evaluation of internal and external defects of Teton Russet, Russet Norkotah, Ranger Russet, and Russet Burbank in Early Harvest (EH) and Full-Season (FS) Tri-State and Western Regional Trials (2006-2010)

Cultivar	Growth cracks[a,c]		Second growth[a,d]		Shatter bruise[a,e]		% hollow heart & brown center[b,f]		% internal brown spot[g]		Black spot bruise[a,h]			% net necrosis/ vasc. disc.[i]	
	EH	FS	EH	FS	EH	FS	EH	FS	EH	FS	EH	FS	Peel	EH	FS
Teton R.	4.2	4.2	4.9	4.9	4.2	3.5	1.0	5.1	0.5	0.6	4.7	4.3	2.8	2.0	1.2
R. Norkotah	4.9	4.9	5.0	4.9	5.0	4.9	3.1	3.3	0.0	0.3	4.5	4.7	2.2	3.7	4.7
Ranger R.	4.7	4.4	4.8	4.6	4.9	4.7	0.0	0.2	0.5	0.5	4.2	3.3	2.1	4.7	5.7
R. Burbank	3.4	3.5	3.7	3.6	5.0	4.7	15.8	9.6	0.7	2.5	3.9	3.6	2.7	3.0	2.2

[a] Rated using a 1-5 scale with 1=severe and 5=none observed

[b] Rated as the percentage of tubers >341 g with hollow heart and brown center

[c] Average of 13 and 27 ratings for EH and FS respectively

[d] Average of 11 and 23 ratings for EH and FS respectively

[e] Average of 13 and 14 ratings for EH and FS respectively

[f] Average of 13 and 32 ratings for EH and FS respectively

[g] Average of 12 and 25 ratings for EH and FS respectively

[h] Average of 10, 16, and 8 ratings for EH, FS, and Peel respectively; 'Peel' represents an abrasive peel test conducted in Aberdeen, ID using a Hobart © commercial abrasive potato peeler with blackspot ratings (as in footnote a) then taken 18 h following removal of skin

[i] Average of 9 and 22 ratings for EH and FS respectively

Burbank, with the 3 year mean shrinkage from the three storage temperature ranging from 4 to 5 % for both cultivars. Stored tubers of both cultivars had been treated with chlorpropham spout inhibitor (22 mg/kg) and maintained as sprout free during the 9 months storage. Tuber weight loss was therefore not confounded by differences in cultivar tuber dormancy and associated sprouting.

Disease and Pest Responses

Methodology Evaluations of disease responses for Teton Russet were based on data collected from replicated field trials conducted for a minimum of 2 years. Verticillium wilt (*Verticillium dahliae)* evaluations were conducted at Aberdeen, Idaho using naturally occurring inoculum and protocols described by Corsini et al. (1988). Common scab (*Streptomyces* spp.) was evaluated on tubers collected from three replicates from field trials arranged in a randomized complete block (RCB) using naturally occurring inocula at Aberdeen, Idaho. Teton Russet also was evaluated in the national common scab trial in 2009 and 2010 for common scab response at Aberdeen, Idaho, Becker, Minnesota and Rock Springs, Pennsylvania as described by Haynes et al. (2010). Early blight *(Alternaria solani)* foliar evaluations were conducted at Aberdeen, Idaho and were based on visual estimates of the amount of leaf area infected in three replicate plots of a RCB design. Tuber evaluations for early blight were conducted using tubers harvested from plants used in assessing foliar resistance; following 3.5 months of storage at 10 °C, tubers were evaluated for early blight tuber lesions.

Late blight *(Phytophthora infestans*) field evaluations were conducted at Corvallis, Oregon as described by Mosley et al. (2003) and in the National Late Blight Germplasm Evaluation Trials as described by Haynes et al. (2002).

The severity of black dot (*Colletotrichum coccodes)* colonization of aboveground stems was assessed as described by Nitzan et al. (2009) based on field testing at Moses Lake, Washington in 2007-12. Evaluations of potato leafroll virus (PLRV), potato virus Y (PVY), and potato virus X (PVX) resistances were conducted at Kimberly, Idaho using virus-infected spreader rows as described by Corsini et al. (1994). Corky ringspot (tobacco rattle virus) evaluations were conducted in the Columbia Basin of Washington using protocols described by Brown et al. (2000). Storage disease evaluations were performed as described by Corsini and Pavek (1986) with evaluations for dry rot resistance also being conducted at the University of Idaho, Kimberly Research and Extension Center as described in Novy et al. (2012). Columbia root-knot nematode *(Meloidogyne chitwoodi)* evaluations were conducted in the Columbia Basin using methods described in Brown et al. (2006).

Disease and Pest Response Teton Russet is notable for its resistances to common scab and *Fusarium* dry rot (Tables 10 and 11). In 2 years of evaluations in the National Common Scab Trial (NCST) at sites in Idaho, Minnesota, and Pennsylvania, Teton Russet had a significantly reduced number of tubers with scab symptoms relative to Ranger Russet in both years of evaluations in Idaho and Pennsylvania, and in 2010 in Minnesota (Table 11). In Pennsylvania, Teton Russet also

Table 10 Disease and pest response of Teton Russet relative to Russet Norkotah, Ranger Russet, and Russet Burbank

Cultivar	Vert. wilt	Black Dot[a]	Root knot nem.	Early blight		Late blight		Symptoms of virus infection		Viruses			Storage diseases	
				Com. scab	Foliar	Foliar	Tuber	Net necrosis	Corky ringspot	PVX	PVY	PLRV	Soft rot	Dry rot[b]
Teton R.	S	S	S	R	S	S	S	MR	MS	MS	S	S	S	R
R. Norkotah	S	S	S	MR	S	S	VS	MS	MS	VS	VS	S	MR	MR
Ranger R.	MR	MS	S	S	MS	S	VS	MS	S	MR	S	S	MR	MS
R. Burbank	S	S	S	R	MS	S	S	S	S	VS	S	VS	MS	S

Responses of Teton Russet to diseases were based on a minimum of 2 years of field evaluations, with the exception of only 1 year of data for Root Knot Nematode response. Responses were defined as very resistant (VR), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S), and very susceptible (VS). Disease evaluations were conducted at the following locations: Verticillium wilt - Aberdeen, ID; Root Knot Nematode–Prosser, WA; Corky ringspot – Prosser, WA and Klamath Falls, OR; Common scab - Aberdeen, ID, Becker, MN, and Rock Springs, Pennsylvania; Early blight- Aberdeen, ID; *Pectobacterium* (*Erwinia*) soft rot, Fusarium dry rot - Aberdeen, ID; Viruses and net necrosis - Kimberly, ID; Late blight – Corvallis, OR

[a] The disease severity index (DSI) for black dot (in parentheses) was calculated following the formula: DSI= {Σ (segment height in centimeters)*(0 or 1)}/(Max DSI value). The values 0 and 1 represented the colonization outcome, where 0=not colonized at all and 1=maximum colonization. The determination of black dot disease ratings was based on field testing at Moses Lake, WA in 2007-12 with Teton Russet, Russet Norkotah, Ranger Russet, and Russet Burbank having DSI values of 0.35, 0.52, 0.38, and 0.44 respectively

[b] Results for *Fusarium sambucinum* and results for *F. solani* var. *coeruleum,* while differing in magnitude on a 5 point Likert scale had the same rank order for the listed cultivars with Teton Russet being assigned a resistant rating to both *Fusarium* species

displayed a significant reduction in tubers having scab relative to Russet Burbank in both years. The tuber surface area covered with scab (Area Index) was also significantly reduced for Teton Russet relative to Ranger Russet in Idaho (2010) and Pennsylvania in both years. Lesion severity (Lesion Index) also was significantly reduced in Teton Russet relative to Ranger Russet in the 2 years of trials in Minnesota and Pennsylvania, with lesion severity also being reduced relative to Russet Burbank in Pennsylvania in 2009.

Data from the NCST over years and locations supports the classification of Teton Russet as being resistant to common scab, the exception being Minnesota in 2009, with Teton Russet displaying a percentage of tubers with common scab symptoms intermediate to that of susceptible Ranger Russet and resistant Russet Burbank—however, a review of the management of common scab by Dees and Wanner (2012) describes the complexity of both environmental factors and pathogen genetic variation that can contribute to variability in common scab response of breeding clones/varieties in the field in different years, as well as under controlled environmental conditions in the greenhouse or growth chamber. The consistency of the resistance response of Teton Russet to common scab across trial years in Idaho and Pennsylvania is therefore notable.

Over a 3 year period, tubers of Teton Russet and Russet Burbank were evaluated for response to *Fusarium* dry rot decay using a 50/50 mix of Thiabendazole resistant: susceptible strains of *F. sambucinum* as described by Novy et al. (2012). The mean percentage of tissue decay for Teton Russet was 10 % which was significantly lower relative to Russet Burbank with 26 % tissue decay ($P<0.01$ – data not shown). The percent incidence of potatoes with ≥5 % decay was also significantly lower in Teton Russet (36 %) compared to Russet Burbank (58 %) ($P<0.05$).

Teton Russet is moderately resistant to net necrosis, and is considered susceptible to Verticillium wilt, black dot, Columbia root- knot nematode, foliar early blight, foliar and tuber late blight, corky ringspot, PVX, PVY, PLRV, and soft rot; levels of susceptibility to these pests and diseases are given in Table 10.

Biochemical and Nutritional Characteristics

Teton Russet, Russet Norkotah, Ranger Russet, and Russet Burbank tubers, grown at Aberdeen, ID, were analyzed 6 weeks after harvest over a 3-year period to assess biochemical and nutritional components (Table 12). Dry matter content of Teton Russet was comparable to Russet Burbank and Ranger Russet, and significantly greater than that of Russet Norkotah. Sucrose content was similar to that of Ranger Russet and higher than concentrations observed in Russet Norkotah and Russet Burbank. Glucose concentration of Teton Russet was comparable to values for Ranger Russet and Russet Burbank, and significantly lower than Russet Norkotah. Protein content of Teton Russet was significantly greater than values observed for the check varieties (Table 12). Teton Russet also had significantly greater Vitamin C content than Russet Norkotah or Russet Burbank, with lower values than those of Ranger Russet—a cultivar noted as having higher levels of Vitamin C in its tubers (Love et al. 2004). Total glycoalkaloids were lower for Teton Russet and Russet Norkotah relative to Range Russet and Russet Burbank—all, however, having acceptably low values below 20 mg/100 g

Table 11 Responses of Teton Russet, Ranger Russet, and Russet Burbank to infection by common scab in the Idaho, Minnesota, and Pennsylvania sites (Trial sites were Aberdeen, Idaho, Becker, Minnesota, and Rock Springs, Pennsylvania) of the National Common Scab Trial 2009-2010

Cultivar	Idaho		Minnesota		Pennsylvania	
	2009	2010	2009	2010	2009	2010
a. Percentage of tubers with scab symptoms[a]						
Teton Russet	12b	10b	71ab	22b	5b	42b
Ranger Russet[b]	33a	57a	90a	100a	94a	98a
Russet Burbank[b]	13ab	26ab	50b	35b	65a	77a
Mean	**19**	**31**	**70**	**53**	**55**	**72**
LSD=0.5	**21**	**39**	**34**	**47**	**40**	**35**
b. Area Index[a,c]						
Teton Russet	0.02a	0.02b	0.39ab	0.05a	0.01b	0.07b
Ranger Russet	0.06a	0.09a	0.68a	0.50a	0.33a	0.49a
Russet Burbank	0.02a	0.05ab	0.17b	0.10a	0.16ab	0.16b
Mean	**0.03**	**0.05**	**0.41**	**0.22**	**0.17**	**0.24**
LSD=0.5	**ns**	**0.07**	**0.48**	**ns**	**0.27**	**0.15**
c. Lesion Index[a,c]						
Teton Russet	0.02a	0.03a	0.12b	0.12b	0.04c	0.07b
Ranger Russet	0.13a	0.17a	0.41a	0.68a	0.37a	0.30a
Russet Burbank	0.05a	0.08a	0.20b	0.30b	0.15b	0.13b
Mean	**0.07**	**0.09**	**0.24**	**0.37**	**0.19**	**0.16**
LSD=0.5	**ns**	**ns**	**0.12**	**0.33**	**0.06**	**0.08**

[a] Means in a column followed by different letters differed significantly from one another

[b] Ranger Russet and Russet Burbank are classified as common scab susceptible and resistant, respectively

[c] The scoring of tubers and the calculation of area and lesion indices were conducted as detailed in Haynes et al. (2010), with area index reflecting the percentage of the tuber surface area covered with scab, and lesion index being a rating of the most severe lesion observed; higher values represent greater surface area with scab and increased lesion severity

FWB, which is recognized as the concentration at which tuber glycoalkaloid content becomes unacceptable.

Management

A limited number of studies for developing management practices optimal for the production and storage of Teton Russet were conducted in southern Idaho and in the northern Columbia Basin of Washington. Results of these studies may provide growers in these and other production regions with a basis for developing appropriate management guidelines for their locale.

Southern Idaho

Optimal seed size for Teton Russet is approximately 57 to 85 g. Seed should be treated and planted in soil of optimal temperature (7.2 to 12.8 °C) to minimize the potential for soft rot decay. Dry rot potential of seed lots should also be determined and seed should be treated with an effective fungicide when needed, with the dry rot resistance of Teton Russet also aiding in the control of this disease. Planting depth should be 15 to 20 cm from the top of the seed piece to the top of the hill. For early harvest, seed piece spacing for 91 cm wide rows should be 23 to 25 cm for fresh market use, with seed spacing increased to 25 to 28 cm for processing. Seed spacing of 23 to 28 cm is recommended for full season harvest of Teton Russet for either fresh market or processing.

Teton Russet has exhibited good resistance to metribuzin when applied at labeled rates. However, it is not recommended that the herbicide Rimsulfuron (Trade name: Matrix®) be applied, due to observations of increased growth cracks on tubers of Teton Russet following its use. However, no replicated trial data is available to confirm the susceptibility of Teton Russet to Matrix.

Soils infested with root-knot nematodes or a history of severe early die problems should be fumigated. Routine fungicide applications should also be made to prevent serious early blight infections. Early blight control for tubers in fields scheduled for storage can be facilitated by minimizing tuber skinning and bruising during harvest and subsequent handling and by avoiding harvesting in wet weather conditions.

Nutrient Management Total seasonal nitrogen requirements for Teton Russet are approximately 20–30 % less than Russet Burbank for the same yield objectives. For southern Idaho, total soil plus fertilizer nitrogen (N) recommendations range from 179 to 202 kg N/ha in areas with a 45 t/ha yield potential, 224 to 246 kg N/ha in areas with a 56 t/ha yield potential, and 269 to 291 kg N/ha in areas with a 67 t/ha yield potential. It is important to note that these amounts include the amount of residual nitrogen in the soil prior to planting. About 65 % of the fertilizer nitrogen should be applied by tuber initiation, with the remaining nitrogen applied via sprinkler irrigation prior to the last week of July. To promote skin set, nitrogen applications should be completed at least 30 days prior to harvest.

Nitrogen response studies conducted for 2 years at Aberdeen, Idaho indicate that optimal petiole nitrate concentrations for Teton Russet should be about 18,000 to 20,000 ppm at tuber initiation and 14,000 to 16,000 ppm at midseason. During late bulking, petiole nitrate concentrations should be allowed to decrease to 8,000 to 10,000 ppm.

Phosphorus, potassium and micronutrient requirements have not been established for Teton Russet. Therefore, it is recommended that growers follow local nutrient management recommendations for Russet Burbank until new guidelines for Teton Russet become available. However, since phosphorus is important for enhancing crop maturity, growers should make sure that adequate amounts of this nutrient are available for their crop.

Table 12 Biochemical analyses of Teton Russet, Russet Norkotah, Ranger Russet, and Russet Burbank tubers from Western Regional Trials (2008-2010) conducted at Aberdeen, ID

Cultivar	Dry matter (%)	Sucrose[b] (% FWB[a])	Glucose[b] (% FWB[a])	Protein[c] (% DWB[a])	Vitamin C[d] (mg/100 g FWB[a])	Total Glycoalkaloids[e] (mg/100 g FWB[a])
Teton Russet	21.0 ab[f]	0.159 a	0.047 b	6.4 a	27.5 b	1.5 b
Russet Norkotah	19.7 c	0.128 b	0.076 a	4.9 c	21.3 c	2.0 b
Ranger Russet	21.5 a	0.163 a	0.067 ab	5.5 b	29.3 a	3.3 a
Russet Burbank	20.4 bc	0.133 b	0.061 ab	4.8 c	20.7 c	3.6 a

Analyses were conducted on freeze-dried tuber tissue at Aberdeen, ID; tissue was taken from 4 replicates of 5 tubers (20 tubers total) stored at 7.2 °C for 6 weeks following their harvest

[a] *FWB* Fresh Weight Basis; *DWB* Dry Weight Basis; Sucrose and glucose values of 0.15 % and 0.10 % respectively are maximum values for acceptable fry color in this evaluation, with glucose being the greater contributor to fry color

[b] Sugar concentrations were calculated according to: Glucose and sucrose measurements in potatoes, Application Note No. 102, Scientific Division, Yellow Springs Instrument Co., Yellow Springs, Ohio 45387

[c] Protein content was determined using a Coomassie blue protein assay developed from the protocol of Bradford (1976)

[d] Vitamin C (ascorbic acid) content in tubers was determined using a microfluorometric method detailed in the Official Methods of Analysis Handbook, 14th edition, sections 43.069-43.075

[e] Total glycoalkaloids was determined using the protocol of Bergers (1980)

[f] Mean values within a column followed by different letters are significantly different ($P<0.05$) from one another based on Student's t- test

Irrigation Management Available soil moisture (ASM) should be maintained within the range of 70 to 85 % for optimal yield and quality. Plant water uptake decreases appreciably in early August, so irrigation application rates need to be adjusted according to soil moisture measurements to avoid developing excessively wet soil conditions that promote disease and enlarged lenticels. Low soil moisture (<60%ASM) conditions should be avoided during tuber maturation and harvest to minimize tuber dehydration and blackspot bruise. However, since shatter bruise has been observed in commercial operations when Teton Russet is well hydrated, it should be harvested with a moderate tuber hydration level.

Storage Management Three years of storage trials with no application of sprout inhibitors were conducted at Kimberly, Idaho. The tuber dormancy of Teton Russet averaged 35 days less than Russet Burbank when stored at temperatures of 5.6 to 8.9 °C. Duration of dormancy was defined as the number of days from harvest until 80 % of potatoes had at least one sprout ≥5 mm in length.

Following 56 days of storage at 8.9 °C, the percentage of sprouted tubers and length of sprouts for Teton Russet was similar to Ranger Russet in Washington and Oregon, with Teton Russet displaying significantly less sprouting in Idaho. Russet Burbank had significantly fewer sprouted tubers at all sites relative to Teton Russet (Table 4). Therefore, the tuber dormancy of Teton Russet is comparable to that of Ranger Russet and shorter relative to Russet Burbank, confirming dormancy observations for Teton Russet and Russet Burbank at Kimberly, ID.

Treatment for sprout inhibition should be made after wound healing, but within the first 2 months of storage to reduce sprouting throughout long term storage. Storage temperature recommendations for fresh market or dehydration processing use of Teton Russet are 7.2 °C or higher. For the frozen processing market, it is recommended that Teton Russet be stored at 8.9 °C to retain the lightest fry color and to minimize mottling over long term storage.

Columbia Basin of Washington

Cultural management recommendations for the Columbia Basin of Washington are similar to those for southern Idaho with the following exceptions:

For harvest dates between mid-July and early-August seed piece spacing should be approximately 30 cm for rows 86 cm wide. Petiole NO_3 level should be at above 22,000 ppm and total soil N above 55 kg N/ha at 60 days after planting (DAP) (mid-June, end of tuber initiation). At approximately 90-100 DAP (mid-July, early bulking), petiole NO_3 should be at or below 20,000 ppm and soil N below 55 kg N/ha. Petioles should be allowed to decline at least 30 days prior to harvest with values below 12,000 ppm at late bulking (approx. 125 DAP, end of July).

For harvest dates later than mid-August, plant seed pieces 20 to 25 cm apart. Ideal N petiole levels for mid-June are 26,000 ppm, mid-July 21,000 ppm and early-August 18,000 ppm. Adjust N timing and rate to deplete soil N and allow plant to mature naturally prior to harvest. To reduce shatter bruise and improve skin set, do not over-fertilize or over-irrigate late in the season and allow plants to mature and skins to set by killing vines at least 10 days prior to harvest.

Seed Availability

In 2013, a total of 306 acres of certified seed of Teton Russet was grown in Colorado, Idaho, Minnesota, Montana, North Dakota, Oregon, Washington, and Wisconsin. Contact information for seed growers having Teton Russet is listed at the Potato Variety Management Institute (PVMI) website (http://www.pvmi.org). Smaller amounts of seed, for research purposes, also can be obtained by contacting Richard Novy or Jonathan Whitworth, USDA-ARS, Aberdeen, Idaho. Pathogen-free tissue culture plantlets of Teton Russet are also maintained by Lorie Ewing, Manager of the Potato Tissue Culture Lab, University of Idaho, Moscow, Idaho.

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References

Akeley, R.V., F.J. Stevenson, and E.S. Schultz. 1948. Kennebec: A new potato variety resistant to late blight, mild mosaic, and net necrosis. *American Potato Journal* 25: 351–361.

Bergers, W.W. 1980. A rapid quantitative assay for solanidine glycoalkaloids in potatoes and industrial potato protein. *Potato Research* 23: 105–110.

Bradford, N.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein using the principle of protein dye binding. *Analytical Biochemistry* 72: 248–254.

Brown, C.R., H. Mojtahedi, G.S. Santo, P. Hamm, J.J. Pavek, D. Corsini, S. Love, J.M. Crosslin, and P.E. Thomas. 2000. Potato germplasm resistant to corky ringspot disease. *American Journal of Potato Research* 77: 23–27.

Brown, C.R., H. Mojtahedi, S. James, R.G. Novy, and S. Love. 2006. Development and evaluation of potato breeding lines with introgressed resistance to Columbia root-knot nematode (*Meloidogyne chitwoodi*). *American Journal of Potato Research* 83: 1–8.

Corsini, D., and J.J. Pavek. 1986. Fusarium dry–rot resistant potato germplasm. *American Potato Journal* 63: 629–638.

Corsini, D.L., J.J. Pavek, and J.R. Davis. 1988. Verticillium wilt resistance in non-cultivated tuber-bearing *Solanum* species. *Plant Disease* 75: 148–151.

Corsini, D.L., J.J. Pavek, M.W. Martin, and C.R. Brown. 1994. Potato germplasm with combined resistance to leafroll virus and viruses X and Y. *American Potato Journal* 71: 377–385.

Dees, M.W., and L.A. Wanner. 2012. In search of better management of potato common scab. *Potato Research* 55: 249–268.

Halford, N.G., N. Muttucumaru, S.J. Powers, P.N. Gillatt, L. Hartley, J.S. Elmore, and D.S. Mottram. 2012. Concentration of free amino acids and sugars in nine potato varieties: Effect of storage and releationship with acrylamide formation. *Journal of Agricultural and Food Chemistry* 60: 12044–12055.

Haynes, K.G., B.J. Christ, D.P. Weingartner, D.S. Douches, C.A. Thill, G. Secor, W.E. Fry, and D.H. Lambert. 2002. Foliar resistance to late blight in potato clones evaluated in national trials in 1997. *American Journal of Potato Research* 79: 451–457.

Haynes, K.G., L.A. Wanner, C.A. Thill, J.M. Bradeen, J. Miller, R.G. Novy, J.L. Whitworth, D.L. Corsini, and B.T. Vinyard. 2010. Common scab trials of potato varieties and advanced selections at three U.S. locations. *American Journal of Potato Research* 87: 261–276.

Hoyman, W.G., and R.C. Holland. 1974. Nooksack: A russet potato adapted to northwestern Washington. *American Potato Journal* 51: 99–102.

Johansen, R.H., B. Farnsworth, D.C. Nelson, G.A. Secor, N. Gudmestad, P.H. Orr, and A.A. Boe. 1986. NorKing Russet: A new russet-skinned potato cultivar. *American Potato Journal* 63: 701–707.

Knowles, N.R. and M.J. Pavek. 2013. WSU potato cultivar yield and postharvest quality evaluations for 2012. Washington State University Special Report. pp. 18-19. Accessed August 13, 2013 at http://potatoes.wsu.edu/trials/

Love, S.L., T. Salaiz, B. Shafii, W.J. Price, A.R. Mosley, and R.E. Thornton. 2004. *Stability of expression and concentration of ascorbic acid in North American potato germplasm HortScience* 39: 156–160.

Love, S.L., R. Novy, J. Whitworth, D.L. Corsini, J.J. Pavek, A.R. Mosley, R.E. Thornton, N.R. Knowles, S.R. James, and D.C. Hane. 2005. Summit Russet: A new russet potato variety with good fresh market and frozen processing qualities. *American Journal of Potato Research* 82: 425–432.

Mosley A, S. Yilma, D. Hane, S. James, K. Rykbost, C. Shock, B. Charlton, E. Eldredge, and L. Leroux. 2003. Oregon. In: K.G. Haynes (ed), *National Potato Germplasm Evaluation and Enhancement Report*, 2001. pp. 369-388.

Nitzan, N., M.A. Evans, T.F. Cummings, D.A. Johnson, D.L. Batchelor, C. Olsen, K.G. Haynes, and C.R. Brown. 2009. Field resistance to potato stem colonization by the black dot pathogen *Colletotrichum coccodes*. *Plant Disease* 93: 1116–1122.

Novy, R.G., J.L. Whitworth, J.C. Stark, B.A. Charlton, S. Yilma, N.R. Knowles, M.J. Pavek, T.L. Brandt, S. Gupta, N. Olsen, M. Thornton, C.R. Brown, D.L. Corsini, J.J. Pavek, S.R. James, D.C. Hane, H. Lozoya-Saldana, and M.I. Vales. 2012. Palisade Russet: A Late Blight Resistant Potato Cultivar Having a Low Incidence of Sugar Ends and High Specific Gravity. *American Journal of Potato Research* 89: 89–101.

Pavek, J.J., D.L. Corsini, D.R. Douglas, R.E. Ohms, J.G. Garner, H.C. McKay, C. Stanger, G.E. Vogt, W.C. Sparks, R. Kunkel, J.R. Davis, A.J. Walz, C.E. Dallimore, and J. Augustin. 1978. Butte: A long russet potato variety with excellent dehydrating quality. *American Potato Journal* 55: 685–690.

Ross F.A. 1959. Dinitrophenol method for reducing sugars. In: W.F. Talburt and O. Smith, (eds.), *Potato Processing*, AVI Publ., Westport, Connecticut pp. 469-470.

Stark, J.C., R.G. Novy, S.L. Love, J.L. Whitworth, D.L. Corsini, J.J. Pavek, A.R. Mosley, M.J. Pavek, N.R. Knowles, R.E. Thornton, S.R. James, D.C. Hane, N. Olsen, and M.I. Vales. 2007. Blazer Russet: An early to mid-season potato cultivar with high U.S. No. 1 yields and good processing and culinary qualities. *American Journal of Potato Research* 84: 467–477.

Stark, J.C., R.G. Novy, J.L. Whitworth, N.R. Knowles, M.J. Pavek, S.L. Love, M.I. Vales, S.R. James, D.C. Hane, C.R. Brown, B.A. Charlton, D.L. Corsini, J.J. Pavek, N. Olsen, and T. Brandt. 2010. Classic Russet: A potato cultivar with excellent fresh market characteristics and high yields of U.S. No. 1 tubers suitable for early harvest or full-season production. *American Journal of Potato Research* 87: 360–373.

United States Standards for Grades of Potatoes. 1997. United States Department of Agriculture, Agricultural Marketing Service. p 2.