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Storage Management of Dakota Russet Potatoes

R. Rhett Spear

Potato Variety Development Specialist,
Department of Plant Sciences,
University of Idaho Extension, Aberdeen

Nora Olsen

Potato Storage Specialist, Department
of Plant Sciences, University of Idaho
Extension, Kimberly

Gustavo Teixeira

Potato Storage Physiologist,
Department of Plant Sciences,
University of Idaho Extension, Kimberly

Melissa Bertram

Potato Research Scientist, Department
of Plant Sciences, University of Idaho
Extension, Aberdeen

Rabecka Hendricks

Potato Research Associate,
Department of Plant Sciences,
University of Idaho Extension, Kimberly

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Introduction

DAKOTA RUSSET IS A MULTIPURPOSE, medium-maturity potato variety released in 2012 by North Dakota State University. It produces attractive long and blocky tubers with a light skin and creamy white flesh. The tuber has low-temperature sweetening resistance, resulting in excellent french fry color out of storage. In 2022 Dakota Russet was approved for use by the McDonald's Corporation, one of eight different potato varieties accepted by the fast-food chain in North America.

Dakota Russet tubers have specific gravities that are ideal for processing, which fall between Ranger Russet and Russet Burbank. Dakota Russet has shown less susceptibility to sugar ends, environmental stresses, and several problematic potato diseases, including *Verticillium* wilt, pink rot, powdery scab, and *pythium* leak. It also exhibits high yield-potential and nitrogen requirements that are approximately 20% less than Russet Burbank; however, it shows greater susceptibility to blackspot bruising (Hendricks et al. 2022 and *Potato Grower Magazine* 2017).

Methods

Dakota Russet and Russet Burbank potatoes were field grown at the University of Idaho Kimberly Research and Extension Center in 2020–22. Following harvest, potatoes were placed in storage and allowed to cure at 55°F and 95% relative humidity for approximately two weeks. 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 nine months at these temperatures.

Sugar and Reflectance

Potatoes used in analyses of fry color, mottling, sugar content, disease susceptibility, and weight loss were treated with a thermal aerosol application of chlorpropham at 22 parts

per million approximately sixty 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 ten tubers per variety and storage temperature. Glucose and sucrose concentrations were determined using a YSI model 2900 Biochemistry Analyzer and expressed on a percentage fresh-weight basis. Fry color analysis was performed concurrently with sugar extraction using the same tubers. Fry color was determined on ten fry planks (1.2 inches × 0.3 inches) per sample after cooking the planks in canola oil at 375°F for 3.5 minutes. Percentage reflectance was read using a Photovolt Reflectance Meter Model 577 on the stem and bud ends of each plank. The planks were also scored subjectively for mottling and incidence of sugar ends. Thin, thread-like areas of dark coloration found in the cortex of the fried potato tissue, known as **mottling**, occur in some varieties. Each fry plank was subjectively evaluated for mottling on a scale of 1–4, where 1 = no mottling, 2 = mild mottling, 3 = moderate mottling, and 4 = severe mottling.

Reflectance readings are presented together with corresponding United States Department of Agriculture (USDA) fry color data. USDA colors correspond to the reflectance ranges:

- USDA 1 >44% reflectance
- USDA 2 35%–44% reflectance
- USDA 3 26.0%–34.9% reflectance
- USDA 4 <25.9% reflectance

Higher reflectance readings indicate a lighter fry color. Fry colors below the USDA range are typically unacceptable by the frozen-food processing industry.

Fusarium Dry Rot

In studies to evaluate *Fusarium* dry rot infection, potatoes were first bruised and then inoculated with *Fusarium sambucinum* (50/50 mixture of thiabendazole sensitive to resistant). Following inoculation, potatoes were cured at 55°F and 95% relative humidity for two weeks and then stored at 45°F. After approximately three 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.

Weight Loss

Samples of Dakota Russet and Russet Burbank, averaging 10 lb per sample (replicated three times), were weighed monthly and the results averaged over three storage seasons (2020–22).

Bruise

To assess for bruise susceptibility, tubers were impacted soon after harvest using a device that dropped a 100 g steel weight from a 7-inch (2020–22) or 12-inch height (2021 and 2022) to deliver a uniform impact on both the bud and stem ends of a stationary tuber. Pulp temperatures of tubers were 55°F at the time of impact and maintained for twenty-four hours at 70°F until impacted areas were peeled and evaluated for blackspot bruise severity, bruise depth, incidence of blackspot bruise, and incidence of shatter bruise. Blackspot bruise severity was rated on the darkest color and observed on a scale from 1 to 4: 1 = no color; 2 = light gray color, not severe but discoloration occurred; 3 = dark gray color, severity moderate, dark, but not extreme; and 4 = dark gray/black color, severity extreme. Blackspot bruise depth was evaluated by recording the number of slices (1.27 mm per slice) removed by the peeler until no bruise was present.

Dormancy

Dormancy length was defined as the number of days after harvest until sprout elongation (at least 0.2 inches) occurred in 80% of tubers in the sample. This definition was used because the length of time between initial sprout development (peeping) and sprout elongation varies greatly among potato varieties. Using this definition of dormancy, ten nontreated potatoes (replicated three times) were assessed each month at two storage temperatures (45°F and 48°F) for sprout growth.

Results

Glucose

Potatoes used for frozen or dehydration processing must meet specific color criteria, often set by the customer. Elevated concentrations of the reducing sugar glucose can produce an unacceptably dark fried product when exposed to the high temperatures required for making french fries or potato flakes. Potato varieties that maintain glucose concentrations below 0.1% fresh weight (FW) throughout storage

and processing are often considered to be cold-sweetening resistant and usually produce a light-colored final product acceptable to consumers. Sucrose, which is converted into reducing sugars through physiological processes, is monitored throughout the storage season to aid in predicting increases in glucose and subsequent color shifts.

Mean glucose concentrations at harvest (ten days after harvest) for Dakota Russet were 0.011% FW, 0.016% FW, and 0.008% FW in 2020, 2021, and 2022, respectively (Figure 1). The three-year average glucose concentration for Russet Burbank was 0.049%, four times greater than the mean concentration of 0.012% FW for Dakota Russet.

Glucose concentrations in Dakota Russet during storage were significantly lower than those of Russet Burbank at all three storage temperatures (Figure 1). Low-glucose concentrations in processing potatoes are desirable for producing light-colored french fries throughout long-term storage.

- At 48°F storage temperature, glucose concentrations remained below 0.035% FW over the course of two hundred seventy days in storage and across three years of trials. Russet Burbank had an average glucose concentration of 0.06% FW across three years of trials.

- At 45°F, glucose concentrations remained below 0.05% FW during the nine-month storage season across the three years of testing. This concentration was low compared to Russet Burbank, which had an average of 0.08 % FW and a peak of 0.1% FW after approximately one hundred days in storage.
- At 42°F, glucose concentrations for Dakota Russet remained below 0.1% FW during 2021 and 2022 and for 75% of the storage season in 2020. Potato varieties that maintain glucose concentrations below 0.1% FW at colder storage temperatures are considered cold-sweetening resistant and can be stored at this cooler temperature without the heightened risk of darkening of the finished product that can occur with varieties that are noncold-sweetening resistant.

Sucrose

Sucrose concentrations in Dakota Russet showed little variability and ranged from 0.03% FW in 2022 to 0.10% FW in 2020 (Figure 2). Mean sucrose concentrations for Dakota Russet were similar to Russet Burbank, which averaged 0.06% FW over the three-year period in 2020 and 2021; however, sucrose concentrations for Dakota Russet decreased in 2022.

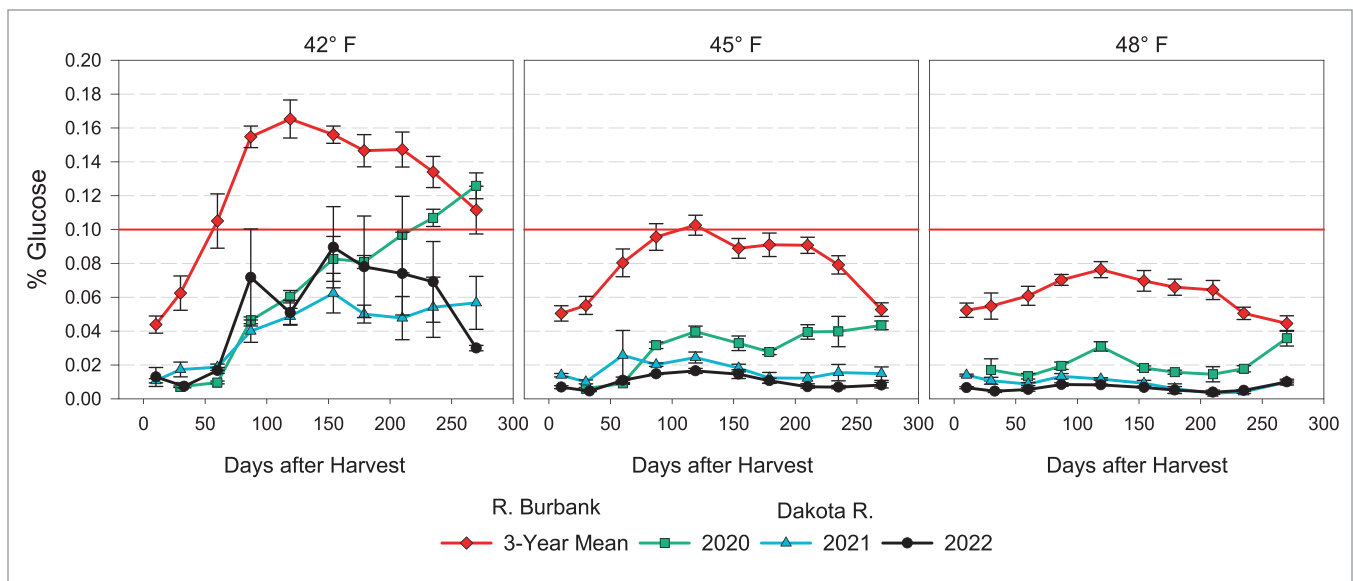


Figure 1. Mean tuber glucose concentrations (% FW) averaged across 2020, 2021, and 2022 for Dakota Russet and Russet Burbank at three temperatures over two hundred seventy days in storage. The red reference line indicates 0.1% glucose. Varieties that maintain glucose concentrations below this level are generally considered to be cold-sweetening resistant. Error bars represent standard error.

Fry Color

Glucose concentrations are typically a good indicator of fry color. Higher glucose concentration often results in darker fry color. The processing industry generally uses samples of fried product in the form of planks, strips, or discs instead of measuring tuber glucose concentrations. Variations in fry color in a potato are generally most noticeable between the stem and bud ends of the tuber. The stem end (end closest to the plant where the stolon attaches) often has the highest levels of sugars and potentially the darkest color.

Stem-end reflectance values for Dakota Russet were higher than Russet Burbank, indicating a lighter fry color at 42°F, 45°F, and 48°F in all three years of the study (Figure 3). Fry colors for Dakota Russet were consistently light compared to Russet Burbank and showed little deviation across storage temperatures and between years with the exception of 2020, when Dakota Russet dropped to a USDA 2 midway through the storage season at 42°F. In comparison, Russet Burbank dropped to a USDA 3 by fifty days after harvest at 42°F and maintained a USDA 2 for the majority of the storage season at 48°F.

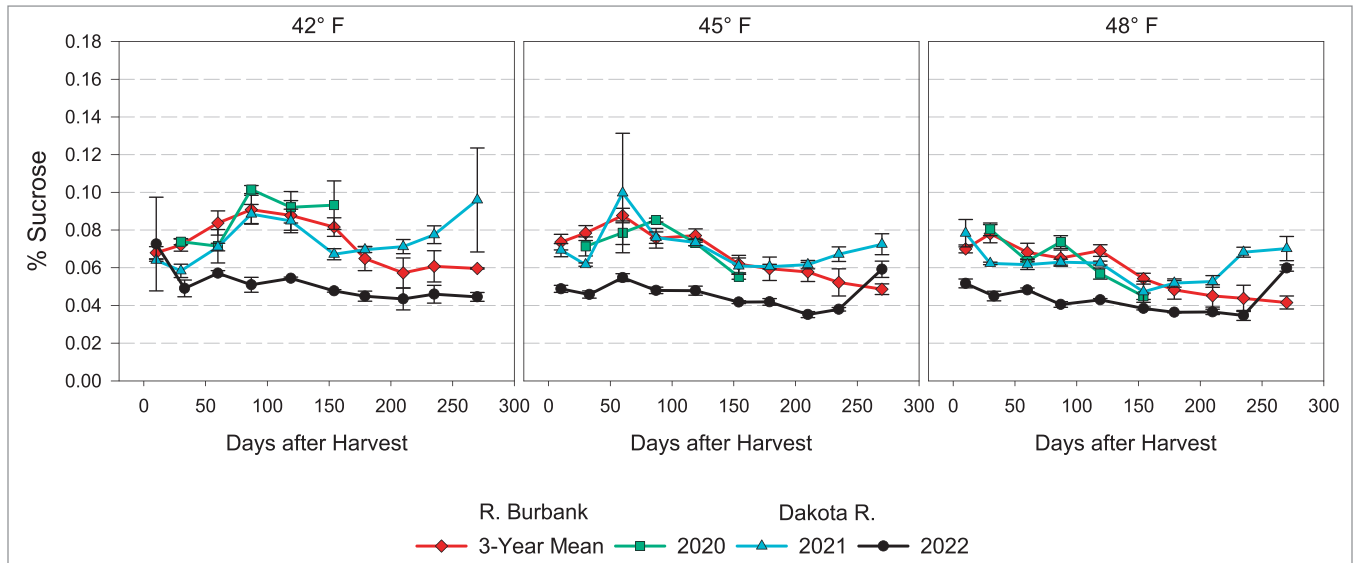


Figure 2. Sucrose concentrations (% FW) for Dakota Russet and Russet Burbank tubers during two hundred seventy days in storage over three years (2020–22). Error bars represent standard error.

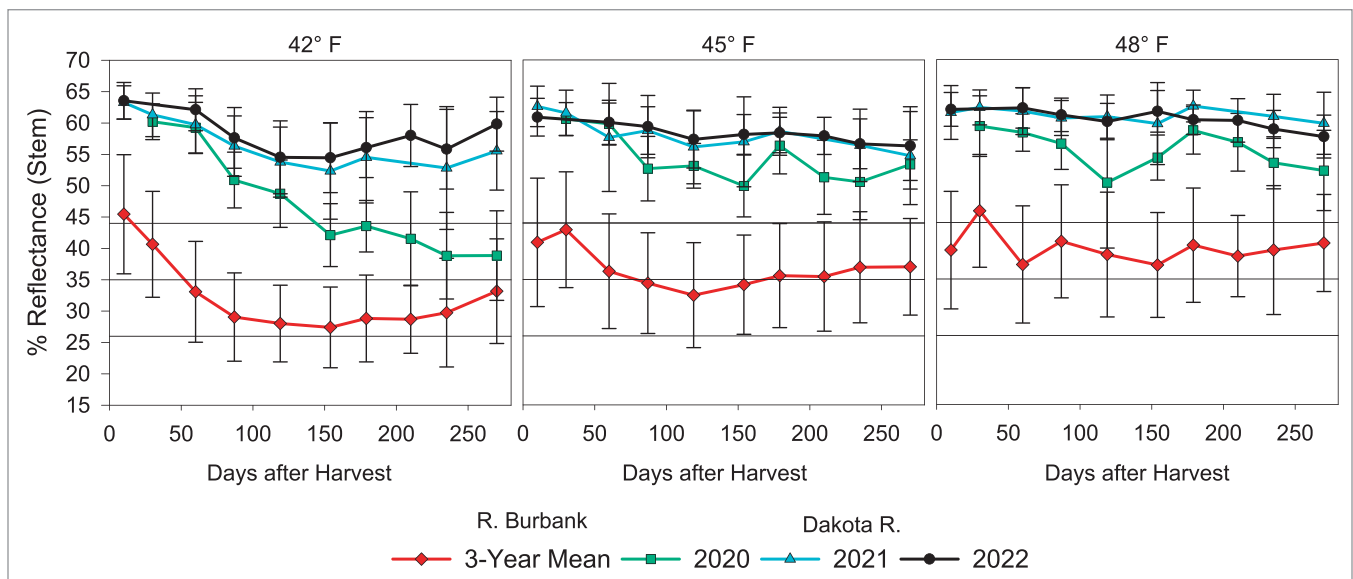


Figure 3. Percent stem-end reflectance and associated USDA reflectance values (right axis) of Dakota Russet and Russet Burbank tubers over two hundred seventy days in storage at three temperatures. Values were averaged across three years (2020–22). Error bars represent standard error.

- At 48°F storage temperature, fry color for Dakota Russet maintained the lightest color throughout the storage season at this temperature. The mean fry color was well above the USDA 1 cutoff and much lighter than the three-year mean of Russet Burbank, which maintained a USDA 2 except for the second sampling date.
- At 45°F, fry color for Dakota Russet was well above the USDA 1 cutoff for the duration of the storage season compared to the three-year mean of Russet Burbank, which showed fry colors of USDA 2 and USDA 3 for the entire storage season.
- At 42°F, Dakota Russet primarily maintained light fry colors (USDA 1 and 2) compared to the three-year average for Russet Burbank (USDA 3).

Mottling

Mottling in Dakota Russet was lower than Russet Burbank at all three temperatures, with a greater difference between the varieties seen at the colder temperatures (Figure 4). Mottling scores for Dakota Russet ranged from none to mild, while Russet Burbank mottling ranged from mild to moderate.

Fusarium Dry Rot

Because *Fusarium* dry rot is an important storage disease in potatoes, new varieties are screened for susceptibility to it. To provide an entry point for the pathogen, potatoes were first bruised and then inoculated with *Fusarium sambucinum* to evaluate dry rot susceptibility. Results averaged over

three years indicate that Dakota Russet was less susceptible than Russet Burbank to *Fusarium* dry rot (Table 1). The percentage of tuber decay due to dry rot in Dakota Russet was 17% with a 56% incidence (potatoes with >5% decay), compared to 36% decay and 71% incidence for Russet Burbank.

Weight Loss

Dakota Russet had significantly greater weight loss compared to Russet Burbank at 42°F and 48°F; however, there was no significant difference between the varieties at 45°F (Table 2).

Table 1. Percent decay (severity) and incidence of potatoes with greater than 5% decay of *Fusarium* dry rot in bruised and inoculated Dakota Russet and Russet Burbank potatoes. Values are means of three storage seasons (2020–22). Values followed by the same letter were not significantly different ($\alpha < 0.05$) within a column.

Cultivar	% Decay	% Incidence (Potatoes with >5% Decay)
Dakota Russet	17 a	56 a
Russet Burbank	36 b	71 b

Table 2. Percent weight loss of Dakota Russet and Russet Burbank tubers after two hundred seventy days in storage averaged across three years (2020–22). Values followed by the same letter were not significantly different ($\alpha < 0.05$) within a column.

Variety	42°F	45°F	48°F
Dakota Russet	8 a	9 a	10 a
Russet Burbank	6 b	8 a	7 b

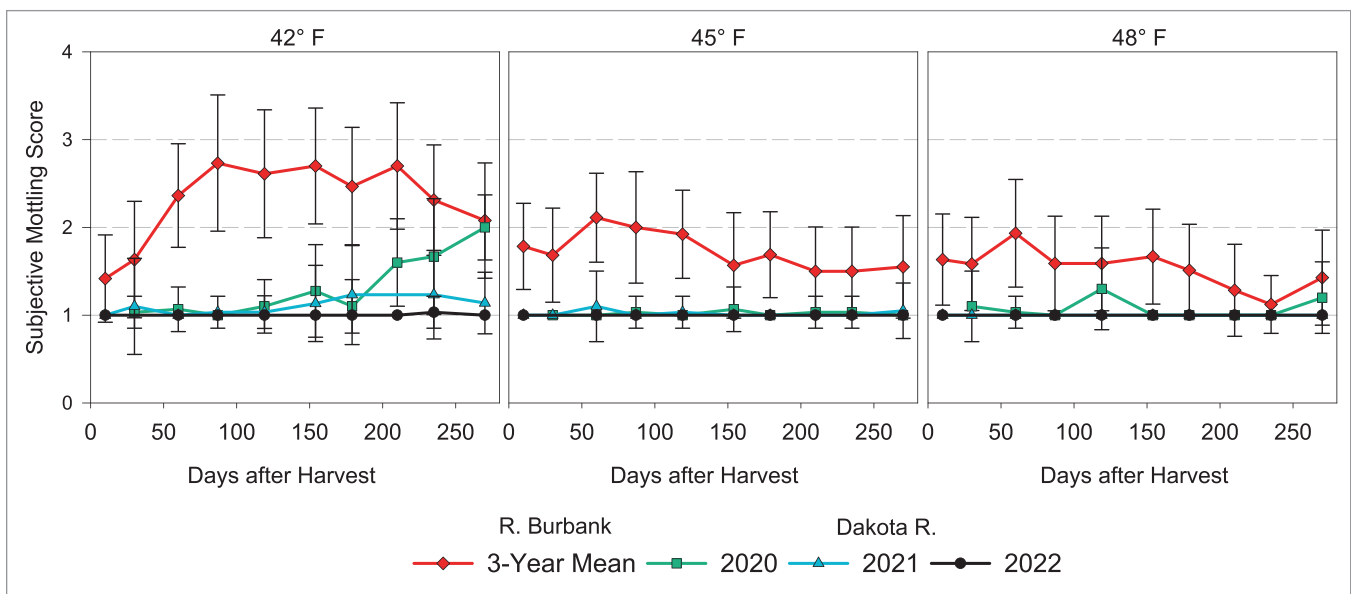


Figure 4. Subjective mottling scores of Dakota Russet and Russet Burbank tubers over two hundred seventy days in storage for three years (2020–22). Error bars represent standard error.

Bruise Susceptibility

During harvest and handling, potatoes encounter physical impacts that can result in a blackspot or shatter bruise. Variety susceptibility to two levels of impact (7- and 12-inch drop height of a known weight) was assessed and regardless of drop height, Dakota Russet showed a high incidence of blackspot bruise and a low susceptibility to shatter bruise (Table 3). The severity and depth of the blackspot bruise was higher in Dakota Russet compared to Russet Burbank.

Dakota Russet showed a high incidence of blackspot bruise on both the bud and the stem end, whereas

Russet Burbank had a higher incidence on the stem end compared to the bud end at the lower drop impact force (Figure 5).

Dormancy

Without sprout inhibitors, dormancy length for Dakota Russet is 60–65 days shorter than Russet Burbank (Table 4). The relative shorter dormancy length of Dakota Russet may indicate the need to apply sprout inhibitors earlier in the storage season and to routinely scout the stored crop for sprout development.

Table 3. Effects of drop height on blackspot bruise incidence, severity, depth, and shatter bruise incidence for tubers impacted at 7-inch drop height (2020–22) and 12-inch drop height (2021 and 2022) of Dakota Russet and Russet Burbank. Values followed by the same letter were not significantly different ($\alpha < 0.05$) for each drop height within a column.

Cultivar	Blackspot Bruise Incidence (%)	Blackspot Bruise Severity Rating (1–4) ¹	Blackspot Bruise Depth (mm)	Shatter Bruise Incidence (%)
7-Inch Drop Height				
Dakota Russet	94 b	2.7 b	4.8 b	1.0 a
Russet Burbank	46 a	1.7 a	2.2 a	5.0 b
12-Inch Drop Height				
Dakota Russet	97 b	3.2 b	5.7 b	1.0 a
Russet Burbank	67 a	1.9 a	3.2 a	25 b

¹Blackspot bruise severity was rated on the darkest color observed on a scale from 1 to 4: 1 = no color; 2 = light gray color, not severe but discoloration occurred; 3 = dark gray color, severity is moderate, dark but not extreme; 4 = dark gray/black color, severity is extreme.

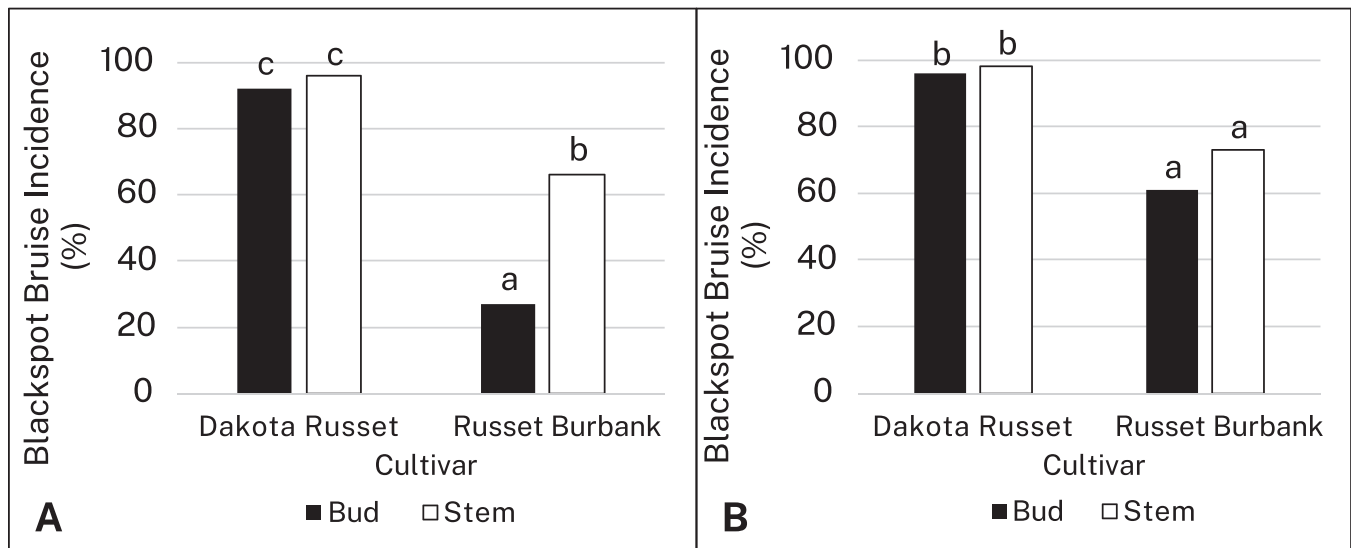


Figure 5. Effect of variety and tuber end on blackspot bruise incidence for **A**, 7-inch drop height and **B**, 12-inch drop height. Means are averaged between years: **A**, 2020–22 and **B**, 2021 and 2022. Values followed by the same letter for each graph were not significantly different ($\alpha < 0.05$).

Table 4. Mean dormancy length in days after harvest (DAH) across three years (2020–22) of Dakota Russet and Russet Burbank tubers at two storage temperatures.

Variety	45°F	48°F
Russet Burbank	190 DAH	178 DAH
Dakota Russet	127 DAH	119 DAH

Further Reading

American Journal of Potato Research (over one hundred issues, 1923–)

Hendricks, Rabecka L., Nora Olsen, Michael K. Thornton, and Patrick Hatzenbuehler. 2022. “Susceptibility of Potato Cultivars to Blackspot and Shatter Bruise at Three Impact Heights.” *American Journal of Potato Research* 99: 358–68. <https://doi.org/10.1007/s12230-022-09887-y>.

Potato Grower Magazine. 2017. “The Smorgasbord: Dakota Russet.” <https://www.potatogrower.com/2017/04/the-smorgasborddakota-russet>, accessed 14 August 2023.