TUBER BULKING RATE AND PROCESSING QUALITY OF EARLY POTATO SELECTIONS

Clinton C. Shock, Eric P. Eldredge, and Monty D. Saunders
Malheur Experiment Station
Oregon State University
Ontario, OR, 2004

Introduction

Five potato cultivars ‘Ranger Russet’, ‘Russet Burbank’, ‘Shepody’, ‘Umatilla Russet’, and ‘Wallowa Russet’, and two early selections, ‘A92294-6’, and ‘A93157-6LS’ were compared at six harvest dates in this trial. Ranger Russet, Russet Burbank, and Shepody are currently grown in the Treasure Valley for processing and served as the check varieties. Umatilla Russet and Wallowa Russet are new releases from Oregon State University (OSU) that have yield, grade, and processing quality generally superior to Ranger Russet, Russet Burbank, and Shepody. The numbered clones have performed well in several previous variety trials at this location, including the Western Regional Early Harvest Trial. The first objective of this study was to quantify the tuber bulking rate of potato cultivars that are currently grown, and some numbered clones that may soon be released, and to compare their suitability for production of early harvest potatoes for processing directly from the field. The second objective was to determine which, if any, of these clones could continue to bulk tubers late in the season.

Materials and Methods

The soil was Owyhee silt loam where the previous crop was winter wheat. The wheat stubble was flailed and the field was irrigated and disked. A soil test taken on September 16, 2003 showed 37 lb nitrogen (N)/acre in the top 2 ft of soil, and 102 lb available phosphate (P2O5), 851 lb soluble potash (K2O), 29 lb sulfate (SO4), 1966 ppm calcium (Ca), 463 ppm magnesium (Mg), 87 ppm sodium (Na), 1.6 ppm zinc (Zn), 18 ppm iron (Fe), 4 ppm manganese (Mn), 0.7 ppm copper (Cu), 0.5 ppm boron (B), organic matter 3.5 percent, and pH 7.4 in the top foot of soil. Fall fertilizer was spread to apply 60 lb N/acre, 50 lb P2O5/acre, 80 lb K2O/acre, 57 lb sulfur (S)/acre, 8 lb Zn/acre, 5 lb Cu/acre, and 1 lb B/acre. The field was ripped, Telone II® soil fumigant was injected at 25 gal/acre, and the field was bedded on 36-inch row spacing.

Potato seed was obtained from the OSU Potato Variety Development program at Powell Butte, and the USDA/Agricultural Research Service (ARS) potato program at Aberdeen, Idaho. Seed of Ranger Russet was commercial certified seed from eastern Oregon, and seed of Umatilla Russet was commercial certified seed from central Oregon. Seed was cut by hand into approximately 2-oz pieces, treated with Tops-MZ® plus Gaucho® seed treating dust, and counted into bags of 15 seed for each row of the 2-row plots.

The potato clones were planted on April 13, with rows spaced 36 inches apart and 9-inch spacing between seed pieces in the row. The soil condition was excellent, with good tilth and good soil moisture. The soil temperature at the seed piece depth, 10-inches, was 56°F. The experiment was laid out in a split-plot design, with the harvest dates replicated four times as main plots within blocks and the varieties randomized in each subplot. This was accomplished by planting the rows so that the six harvest date passes through the four replicates would include all of the varieties.

A two-row per bed configuration was started at planting by leaving off the center furrowing shovel of the two-row planter. On May 6, the two-row beds were formed with a spike harrow pulling wide shovels to clean the furrows and form the shoulders of the beds, and dragging a heavy chain to smooth and flatten the top of the bed. The tool bar on back of the bed harrow also carried shanks and spools of drip tape to install a drip tape at 2- to 3-inches depth directly above each potato row. The drip tape was 5/8-inch diameter, with 5-mil wall thickness, 6-inch emitter spacing, 0.22 gal/min/100-ft flow rate (T-tape, T-Systems International, San Diego, CA).

Soil water potential was measured with six Watermark sensors Model 200SS (Irrometer Co. Inc., Riverside, CA) installed in the potato row at the seed piece depth and connected to an AM400 data logger (M.K. Hansen, East Wenatchee, WA) that recorded soil water potential every 8 hours. Water potential readings were also recorded manually from the data logger. Irrigations were scheduled to avoid soil water potential at the root zone dropping below -30 kPa. Crop evapotranspiration (ETc) was estimated by an automated AgriMet (U.S. Bureau of Reclamation, Boise, ID) station located about 0.5 mile away on the Malheur Experiment Station.

Prowl® at 1 lb/acre plus Dual® at 2 lb/acre was applied on May 7, before any potato plants had emerged, and was incorporated with the bed harrow. Matrix® herbicide was applied at 1.25 oz/acre on May 17, and was incorporated by 0.41 inch of rain on the next day, followed by 0.89 inch additional rain through the end of May. Fungicide applications to control early blight and prevent late blight infection started with an aerial application of Ridomil Gold® and Bravo® at 1.5 pint/acre on June 12. On June 25, Headline® fungicide was applied; on July 17, Topsin-M® fungicide plus liquid S with 1.5 lb P2O5/acre and 0.2 lb Zn/acre was applied by aerial applicator. On August 8, Headline plus 6 lb S/acre was applied to prevent two-spotted spider mite infestation and powdery mildew infection. No fertilizer was applied to the field in the spring. Petiole tests were taken every 2 weeks from June 11, and fertilizer was injected into the drip system during irrigation to supply the crop nutrient needs (Table 1).

Approximately 40 percent emergence was noted in the trial on May 12. On June 22, the first tubers were dug from one plot in each replicate. Tubers were sorted by weight and tubers in each weight category were counted and weighed. On July 13, tubers were harvested from each replicate, and graded by the U.S. No. 1 and No. 2 for processing standards, sorted by weight, and counted and weighed in each weight category. Specific gravity and length-to-width ratio were measured using a sample of 10 tubers, and fry color was measured on a sample of 20 tubers from each plot. The subsequent harvests, on August 3, August 24, September 14, and October 5, followed the same procedure as the second harvest.

Yield and quality results data were compared using analysis of variance (Number Cruncher Statistical Systems, Kaysville, UT). The tuber bulking rate over time was evaluated using the equation: $y = A+B / (1+C\text{-}Dt)$, where y is the tuber yield in cwt/acre, A, B, C, and D are the potato tuber bulking growth parameters, and t is the time in days after planting (DAP). A suitable value for the exponential variable D was found by preliminary regressions on all the varieties. An average tuber initiation date for all clones was found by dividing the yield of the first harvest by the cwt/acre/day bulking rate between the first and second harvests. The resulting tuber initiation (zero yield) date was 59.9 DAP.

Results and Discussion

The 2004 growing season was cool and rainy in April and May and lacked the usual prolonged heat in the summer months. The total amount of irrigation water applied through the drip tape fell behind potato crop evapotranspiration (ETc) through the growing season, with a total of 15.22 inches of applied irrigation plus rain, and a total accumulated ETc of 27.60 inches (Fig. 1). The soil moisture sensors showed an early season moisture deficit (Fig. 2). This was due to the early season water being only small rainfall events and irrigation beginning June 4. Through the period from 56 to 113 DAP, the sensors indicated wetter soil in the crop root zone than the optimum soil water potential for drip-irrigated potato of -30 kPa, despite the irrigations being less than the amount required to match ETc. The soil was intentionally allowed to become drier after August 31, 140 DAP, to avoid rotting the tubers after vine senescence.

Because the crop root zone remained moist through the growing season, the plants were not stressed and the fry color light reflectance was uniformly 40 percent or higher, except for the stem-end light reflectance of Russet Burbank from the final harvest (Table 2). Very few sugar ends were encountered in frying the samples. In the fourth harvest, 132 DAP, one sugar end was found in A93157-6LS out of 80 tubers fried, or 1.25 percent. In the fifth harvest, 153 DAP, one sugar end was found in Russet Burbank. In the sixth harvest, 174 DAP, one sugar end was found in Russet Burbank, and one in Shepody.

Potato clones varied in yield and the size distribution of the tubers at the three latest harvest dates (Tables 2 and 3). Among the potatoes tested, A92294-6 was the heaviest bulking clone when harvested 132 DAP, with 466 cwt/acre total yield, and 90 percent U.S. No. 1 tubers. At 153 DAP, A93157-6LS with 512 cwt/acre and A92294-6 with 494 cwt/acre were the highest in total yield.

Growers can only plant cultivars that have seed available and that have been accepted by processing companies for contract production. Processors want specific gravity above 1.080 to help assure quality products. Processors prefer tubers with a length/width ratio of about 1.8 to 2.0, so that French fry production is efficient. At present, seed is available for Wallowa Russet, Umatilla Russet, Shepody, and Ranger Russet. When the bulking rate of Wallowa Russet, Umatilla Russet, Shepody, and Ranger Russet are compared at the three latest harvest dates, Wallowa Russet has a yield advantage, producing significantly more than the currently grown cultivars, except for Ranger Russet at 153 DAP. Newer clones, which are not yet released and available to growers, such as A92294-6 and A93157-6LS, had even higher productivity, with 568 and 512 cwt/acre total yield, respectively, at 174 DAP (Table 2).

The tuber bulking rate for total yield, U.S. No. 1, and Marketable categories was plotted over time and evaluated using the equation given above (Figs. 3-9). The U.S. No. 1 category includes all smooth tubers, even undersized tubers less than 4 oz. The Marketable category consists of the U.S. No. 1 and U.S. No. 2 tubers over 4 oz (Figs. 3-9). Early in the growing season, from tuber initiation until tubers exceeded 4 oz, the total yield was the same as the U.S. No. 1 yield, and the bulking rate was generally linear. Where the Marketable yield line crosses the U.S. No. 1 yield line indicates the DAP when U.S. No. 2 tubers outweighed the undersized tubers for each clone (Figs. 3-9).

In previous work (Shock et al. 2002) we showed that early dying of potato vines in mid-August can be a major factor limiting potato productivity in Malheur County, because it limits the ability of tubers to continue to bulk late in the growing season. In the current work, the commercial varieties failed to have substantial marketable yield increases after mid-September, 153 DAP (Figs. 5-7, 9). The lack of increase in marketable yield after 153 DAP was noted for Ranger Russet, Russet Burbank, Shepody, and Umatilla Russet (Figs. 5-7, 9). In contrast, A92294-6, A93157-6LS, and Wallowa Russet continued their upward trends in marketable yield to 174 DAP (Figs. 3, 4, 8) finishing with 568, 512, and 482 cwt/acre, respectively. These clones deserve special attention in future trials and possible tests for resistance to the component pathogens of the early die disease syndrome.

Shepody and Ranger Russet are not especially suitable as early harvest cultivars based on yield. Other clones included in this trial bulked fairly early (Figs. 5-7, 9). From the Western Regional Early Harvest potato variety trials in Ontario over the past few years, several other new clones have also shown promise (data not shown).

References

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 2002. Tuber bulking rate of processing potato clones in relation to planting date. Oregon State University Agricultural Experiment Station, Special Report 1048:152-158.

Table 1. Fertilizer applied through the drip irrigation system in response to petiole tests on potato clones and cultivars grown under drip irrigation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Table 2. Tuber yield, grade, length-to-width ratio, specific gravity, and fry color of five potato clones and six potato varieties that grew until vine removal on August 24, September 13, or October 4, and subsequent harvest on August 24, September 14, or October 5 (Hrv 4, 5, 6), Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Table 3. Tuber grade and size distribution of five potato clones and six potato varieties that grew

until vine removal on August 24, September 13, or October 4, and subsequent harvest on August 24, September 14, or October 5 (Hrv 4, 5, 6), Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Figure 1. Irrigation water applied through the growing season compared to crop evapotranspiration (ETc) estimated by an AgriMet weather station, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 2. Soil water potential (kPa) measured by Watermark sensors during the irrigation period of drip-irrigated potato clones, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 3. Tuber bulking over time for potato clone A92294-6, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 4. Tuber bulking over time for potato clone A93157-6LS, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 5. Tuber bulking over time for Ranger Russet, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 6. Tuber bulking over time for Russet Burbank, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 7. Tuber bulking over time for Shepody, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 8. Tuber bulking over time for Wallowa Russet, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.

Figure 9. Tuber bulking over time for Umatilla Russet, Oregon State University, Malheur Experiment Station, Ontario, OR, 2004.