

## MATURITY AND SPECIFIC GRAVITY OF RUSSET BURBANK TUBERS AS INFLUENCED BY FERTILIZATION RATE \*

by  
Loretta Mikitzel  
Washington State University, Pullman, Washington

The storage and processing quality of Russet Burbank potatoes is influenced by specific gravity and relative maturity of the tubers at time of harvest. Tubers with a high specific gravity do not accumulate appreciable amounts of reducing sugars in storage and when processed, produce light-colored French fries with minimal oil uptake. Compared with immature tubers, tubers of the "proper" maturity are not as susceptible to bacterial soft rot, water loss or starch to sugar conversions. Excessive and/or late applications of nitrogen fertilizer may delay vine senescence and result in immature tubers at harvest.

Specific gravity and tuber size (weight) are important to growers (through incentives) and processors (for a quality product); however, how tuber weight and specific gravity are related remains unclear. This study was initiated to better understand the effects of nitrogen fertilization on tuber weight, specific gravity and maturity. Accordingly, the objectives of this research were three-fold:

1. to establish the relationship between tuber weight and specific gravity.
2. to determine the influence of nitrogen fertilization rate and tuber weight on specific gravity and time of vine senescence.
3. to study the effect of harvest date and tuber weight on the degree of skin set (tuber maturity).

### Tuber Weight and Specific Gravity

The relationship between tuber weight and specific gravity of Russet Burbank potatoes was studied over a four year period, from 1982 to 1985. The tubers were grown at the Othello Research Station under rill irrigation, with 320 pounds of nitrogen (N) /acre applied prior to planting. The average planting and harvest dates over the four years of the study were April 21 and September 25, respectively. After harvest, the tubers were divided into three weight groups: 3-5, 6-8 and >10 ounces. Specific gravity of 330 tubers from each weight group was determined by the brine method after 3-4 months of storage at 45°F (7°C). Four specific gravity ranges were identified:  $\leq 1.075$ , 1.080, 1.085 and  $\geq 1.090$ .

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\* This research was conducted by Dr. Willy Iritani at Washington State University, with the assistance of Mr. Lawrence Weller.

This Presentation is part of the Proceedings of the 1990 Washington State Potato Conference & Trade Fair.

On average, the tubers >10 ounces had the highest specific gravity (Fig. 1). The distribution of specific gravities within each weight group is shown in Figure 2. A small percentage of 3-5 ounce tubers had specific gravities  $\geq 1.090$ ; however, 34% had specific gravities  $\leq 1.075$ . In contrast, 36% of the tubers greater than 10 ounces had a specific gravity  $> 1.090$ , and less than 15% of the tubers were found to have a specific gravity  $\leq 1.075$ .

The relationship between tuber weight and specific gravity becomes evident when the percentage of tubers (within each weight class) with specific gravities below 1.0825 and over 1.0825 are combined (Fig. 3). As tuber weight increased, the percentage of tubers with specific gravity over 1.0825 also increased, and the percentage of tubers with a specific gravity below 1.0825 decreased. Forty-three percent of the 3-5 ounce tubers had specific gravities over 1.0825, compared with 65%, or approximately two-thirds of the tubers >10 ounces. The trend is reversed for tubers with specific gravities below 1.0825. Only 35% of the tubers >10 ounces were in the below 1.0825 specific gravity range and the majority (57%) of the 3-5 ounce tubers were below 1.0825.

Specific gravity was highly dependent on tuber weight ( $P < 0.01$ ). These results suggest that higher specific gravity tubers may be obtained by growing larger average sized (heavier) tubers.

#### Fertilizer Rate and Tuber Growth

To determine the effect of nitrogen fertilization rate and tuber weight on specific gravity, Russet Burbank tubers were grown with 160 or 320 pounds N/acre (N:P:K, 16:16:16; applied preplant) at the Othello Research Station under rill irrigation, from 1986 to 1989. The tubers were planted in mid-April and harvested at 10 day intervals from July 15 through September 30. For clarity, the data have been combined to four harvest dates; late-July, mid-August, early- and late-September. At each harvest, the tubers were sorted into four weight groups: <4, 4-6.9, 7-10 and >10 ounces, and specific gravity determined by the weight in air: weight in water method.

Specific gravity of the tubers (all weight groups) from both fertilizer treatments increased to a maximum then decreased prior to the final harvest (Fig. 4). Maximum specific gravity of the tubers grown with 160 pounds N/acre occurred in mid-August, approximately 3 weeks earlier than that of the tubers grown with 320 pounds N/acre (Fig. 4). There was no significant difference in the average specific gravity of the tubers at the peak values (compare mid-August for 160 pounds N/acre with early-September for 320 pounds N/acre). In support of the previous study, smaller tubers had the lowest specific gravities. In early September, tubers <4 oz. were lower in gravity than all larger tubers from the low fertilizer treatment. Of the tubers grown with 320 pounds N/acre, specific gravity of tubers <6.9 ounces was significantly lower than that of larger tubers.

At each harvest, the vines were visually assessed for senescence. The vines of plants grown with 160 pounds N/A had completely senesced three weeks earlier than those grown under the high fertilizer regime (Fig. 5).

Independent of fertilizer rate, maximum specific gravity of the tubers was reached when approximately 50% of the vines were dead.

The tubers were harvested in mid-August when specific gravity of the tubers from the low fertilizer treatment was at its maximum. Total yield, an average of 503 cwt/acre, was not significantly different for the two fertilizer rates (results not shown). However, plants grown with 160 pounds N/acre produced 13% more small (<4 ounces) tubers and 34% fewer (>10 ounces) large tubers compared with the plants from the 320 N/A treatment.

Potatoes produced with 160 pounds N/acre had acceptable specific gravities, which reached a maximum sooner than those from plants grown with 320 pounds N/acre. However, quality of the crop with respect to tuber weight percentages, was reduced.

### Maturity Study

Tubers grown with 320 pounds N/acre were used to study the effect of harvest date and tuber weight on maturity (degree of skin set). The percent of the tuber which had skinned (amount of periderm lost) was rated at 10 day intervals beginning September 1. All tubers were handled in a similar fashion: machine washed, sorted and transported to Pullman in burlap sacks.

Specific gravity (Fig. 6) and percent of tuber skinned (Fig. 7), were significantly higher on the September 1 harvest date than on September 30. On September 1, an average of 42% of each tuber >10 ounces had skinned. This was twice as much periderm lost as for tubers <4 ounces (22% of tuber skinned on September 1). Tuber skin set increased over the month of September and skinning decreased to less than 2% for all tuber weight groups by September 30. Larger tubers skinned significantly more than smaller tubers on all harvest dates except September 30.

The decrease in tuber skinning with advancing harvest date for each weight group, indicates skinning is a function of tuber maturity.

There was a strong negative correlation between tuber skinning and vine senescence (Fig. 8). Also, there was a significant difference ( $P < 0.05$ ) between the various tuber weight groups and the rate that skinning decreased with advancing vine death. As the vines senesced, skinning of the large >10 ounce tubers ( $Y = 44.5 - 0.45x$ ) decreased 80% faster than that of <4 ounce tubers ( $Y = 23.2 - 0.25x$ ). In other words, the skin set occurred faster in larger tubers than on all smaller tubers.

Weight loss was also highly correlated with vine senescence and tuber skin set. Tubers harvested on September 20 and 30, when the majority of the vines were dead and tuber skinning was greatly reduced, lost significantly less weight in storage than tubers harvested before September 20. No difference was found in sugar level of French fry color due to maturity.

### Summary

The relationships between tuber weight, specific gravity, fertilization rate and tuber maturity were studied using Russet Burbank tubers grown at the Othello Research Station between 1982 and 1989. Tuber weight and specific gravity were positively correlated. Generally, the larger the tuber, the higher the specific gravity. Fertilization rate affected the time of vine senescence and time of peak specific gravity of the tubers, but had no effect on the average specific gravity of the tubers. Plants grown with 160 pounds N/acre produced fewer large tubers and more small tubers than did plants from the higher fertilizer rate. Tuber skin set was correlated with vine death and tuber weight. Larger tubers skinned more but set skin faster than smaller tubers. Peak specific gravity was reached when half the vines are dead independent of fertilizer rate then decreased toward the end of the season.

Figure 1. Average specific gravity of Russet Burbank potato tubers. Each value represents the average of 330 tubers. The data was collected from tubers grown with 320 pounds N/acre at the Othello Research Station from 1982 to 1985.

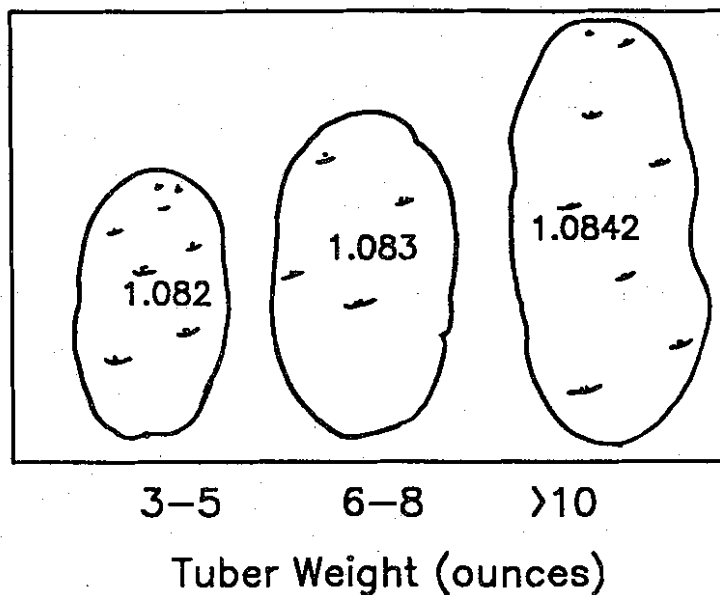


Figure 2. The percentage of tubers within each weight group with specific gravity of  $\leq 1.075$ , 1.080, 1.085 and  $> 1.090$ . Average specific gravity of each tuber weight is shown in Figure 1.

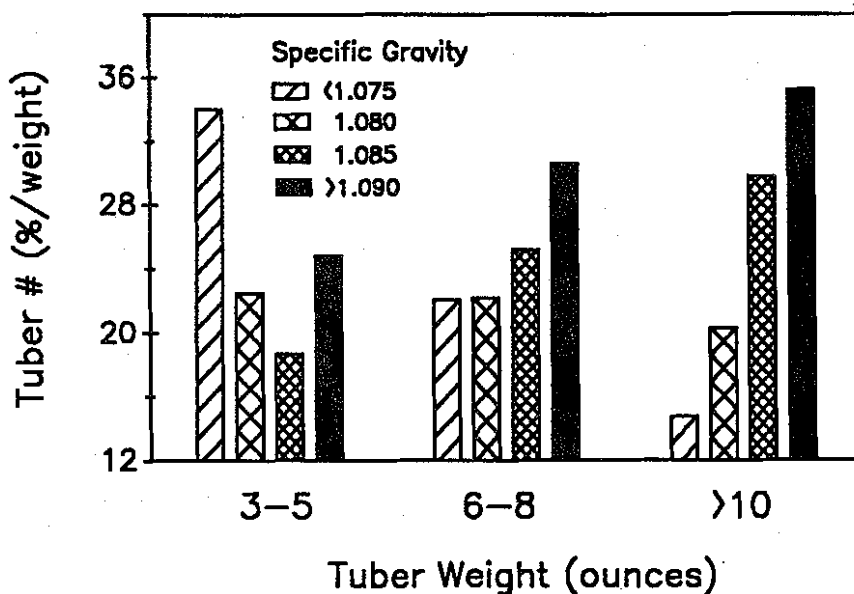


Figure 3. The percentage of tubers, per tuber weight, with specific gravity less than 1.0825 and greater than 1.0825.

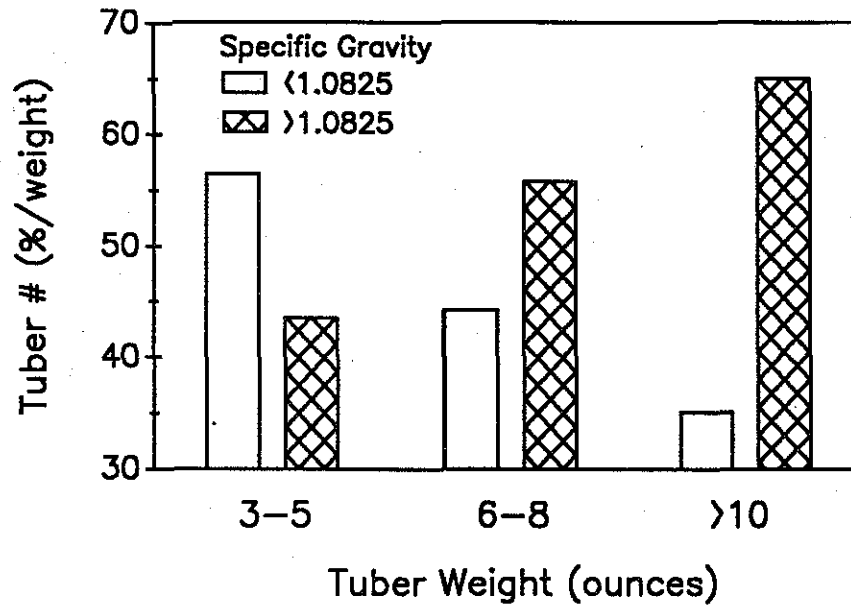


Figure 4. The effect of harvest date and nitrogen fertilization rate on specific gravity of Russet Burbank tubers weighing <4, 4-6.9, 7-10 or >10 ounces. Each point represents a minimum of 28 tubers. The closed symbols ( $\blacktriangle$ ,  $\blacklozenge$ ,  $\bullet$ ,  $\blacksquare$ ) represent tubers grown with 320 pounds N/acre. The open symbols ( $\triangle$ ,  $\diamond$ ,  $\circ$ ,  $\square$ ) are for tubers grown with 160 pounds N/acre.

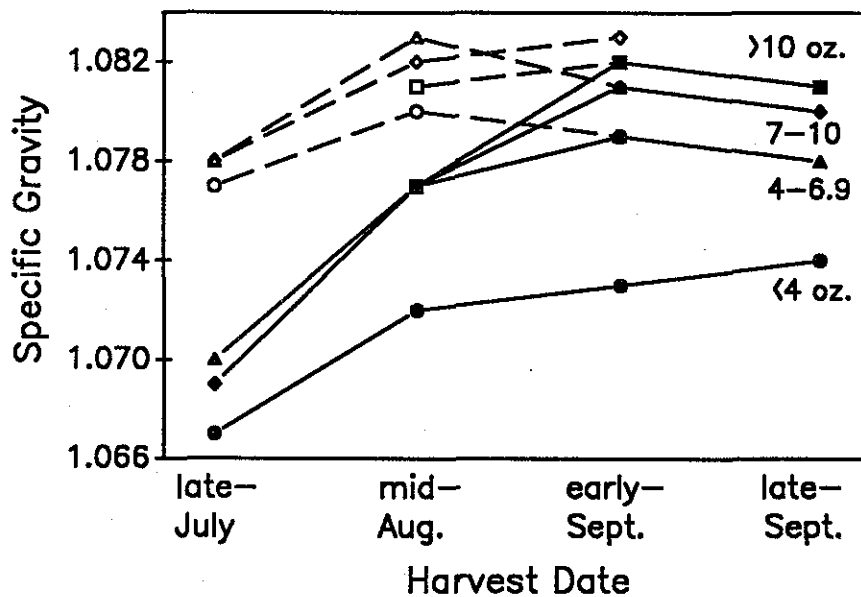


Figure 5. The relationship between specific gravity and vine senescence. Growing conditions are described in Figure 4. The reported specific gravity is the average for all weight groups. ●, ▲; 320 pounds N/acre. ○, △; 160 pounds N/acre.

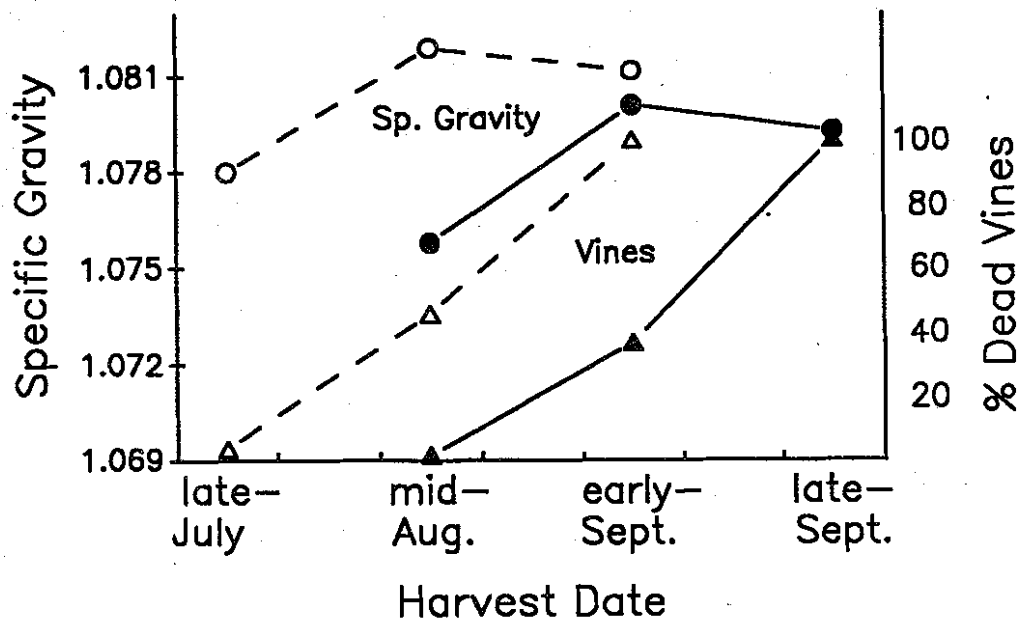


Figure 6. The influence of harvest date and tuber weight on specific gravity. Tubers were grown with 320 pounds N/acre. Each point represents the average of 20 tubers.

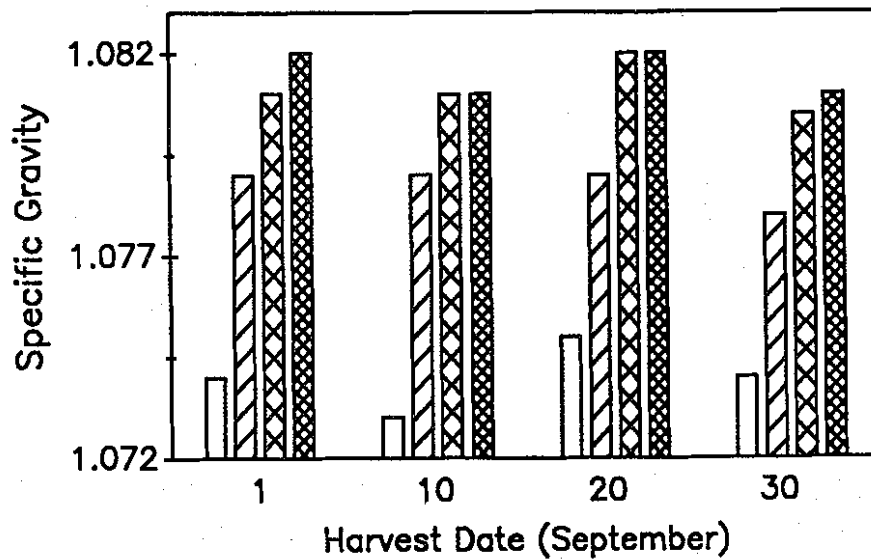


Figure 7. The degree of tuber skin set as affected by tuber weight and harvest date. Tubers were grown with 320 pounds N/acre.

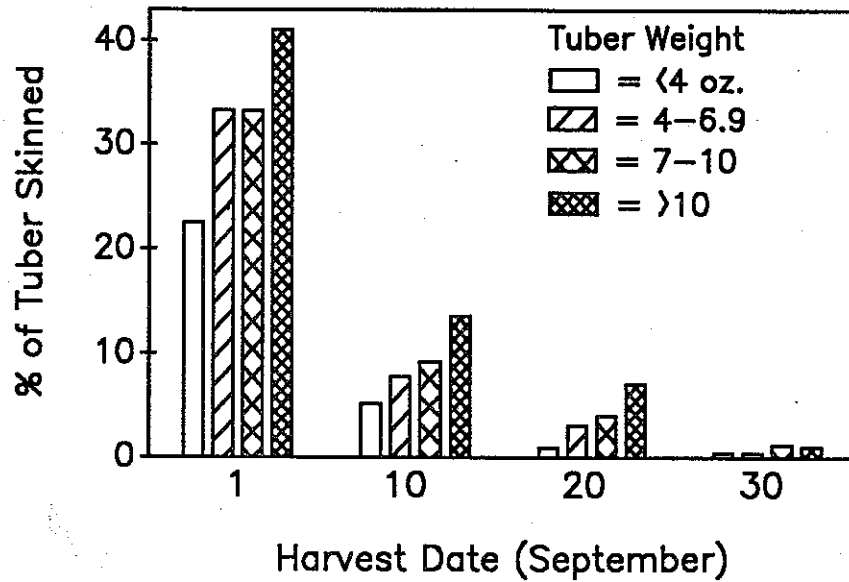


Figure 8. Correlation between tuber skin set and vine senescence of Russet Burbank potatoes grown with 320 pounds N/acre.

