Russet Burbank: No Ordinary Potato

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Abstract. The ‘Russet Burbank’ potato cultivar currently occupies first place in acreage planted in North America and is worth in the United States $1.4 billion annually. It is a sport of ‘Burbank’s Seedling’, which was selected by Luther Burbank in 1873. The ancestry of Burbank stems from a plant introduction brought to the United States by the Rev. Chauncey Goodrich of New York State in 1853. The priorities of potato breeding had been transformed by repetitive crop failures caused by the emergence of the plant pathogen Phytophthora infestans. Modern testing suggests that derivatives of Goodrich’s potatoes were slightly more resistant to Phytophthora. Burbank discovered a single fruit on one of these derivatives, ‘Early Rose’, in his mother’s garden. Taking the 23 true seeds, he nursed them to full-sized plants and selected ultimately No. 15. It produced an unusually high yield of large, very oblong tubers, stored well, and was a good eating potato. Burbank’s life was destined for a long career in California and he attempted to sell the clone to J.J.L. Gregory of Gregory’s Honest Seeds, a successful businessman. Ultimately Gregory agreed to buy it for $150, far less than Burbank wanted, but enough to propel him to California. Gregory named the potato ‘Burbank’s Seedling’, which no doubt engendered fame for the entrepreneur. Luther Burbank had been allowed by Gregory to keep 10 tubers, which became the seed source for the ‘Burbank’s Seedling’ to spread north and south along the West Coast of North America with a crop value, stated by Burbank, of $14 million in 1914. It is not clear that Luther Burbank prospered from ‘Burbank’s Seedling’ in the West. A skin sport with a russet skin was found in Colorado in 1902 and was advertised by a seed company under the name ‘Netted Gem’. ‘Burbank’s Seedling’ per se disappeared from commerce and ‘Netted Gem’ slowly increased, finding a special niche in production of French fry potatoes. It is clear that Luther Burbank gained tremendous insight into the dynamics of hybridization in revealing genetic variation from clonally propagated species. During the rest of his career he would use this technique to produce new and amazing forms of numerous food and ornamental species. ‘Burbank’s Seedling’ was his entrez into the world of plant breeding.

There are many different plant species where Luther Burbank was responsible for innovative creations. Potato is one of these. Luther Burbank’s potato breeding must be seen from an historical perspective. Potatoes were found in South America by Spanish Explorers in the Central Andes. Introduced more as a botanical curiosity than for its food value, potatoes were later considered a nutritious food as judged by a letter written by Saint Teresa of Avila, founder of the Barefoot Carmelites, who wrote of their restorative traits when she ate them while in ill health.

In 1843, starting in North America, a mysterious disease began afflicting potato in the northeast of the United States. Two years later, starting on the continent, in Belgium, the same type of fast-moving epidemic started early and then appeared throughout a large area in Ireland (Bourke, 1993). This led to an almost total potato crop failure in 1845 and by the fall of 1846, after another crop failure, an all-encompassing food scarcity. Food stores disappeared in pockets, especially in western Ireland, subsequently vanishing throughout many parts of Ireland. In the previous 55 years, Ireland’s population had risen from 2 to 8 million at least partly the result of the success and succor of potato as a crop. Infrastructure was ill-prepared to address famine, and as many thousands of people died, others, with their last remaining energy, took to the road seeking food. Human diseases appeared, foremost among these cholera. Science understood neither the fast-moving, moisture-loving, air-dispersed late blight nor the drinking waterborne cholera, which vanquished the hunger-debilitated population with spectacular rapidity.

Wherever rumors of food stores emerged, hordes of desperate people would arrive and break into supposed food warehouses. Violence and death ensued, while food became unavailable, at any price in ever widening regions. Meanwhile in England, a debate raged on the appropriate response to the famine. It was one of the first philosophical clashes on the value of welfare to help the poor. There was a prevailing socioreligious standpoint that the massive death occurring in Ireland was an act of God. Above all, harmony had been lost in Ireland and its return was best left to natural processes. When Parliament finally attempted to purchase shiploads of grain for Ireland, the process was much delayed and resulted in a worldwide increase in grain commodity prices (Kelly, 2012).

In the end it is estimated that 1 million Irish perished and 1.5 million emigrated mostly to the United States. Emigration took place during and after the famine. Ireland has yet to recover previous population levels. Perhaps the greatest tragedy of the 19th century, the Irish potato famine was caused by the oomycete Phytophthora infestans. The potato varieties of the time in Ireland were completely susceptible (Salaman, 1949). It still is the most serious disease of potato worldwide.

It was in this context, and considering that potato breeding was in private hands in 1850, that the Reverend Chauncey Goodrich undertook his calling to fight hunger on receiving potatoes from the Panamanian Consulate, which came with the name “Chili,” perhaps denoting the country of origin as Chile. Out of this exotic germplasm Goodrich selected, from openpollinated fruits, first, ‘Rough Purple Chili’, then ‘Garnet Chili’, and subsequently another breeder, Albert Bresee, released a seedling derived from ‘Garnet Chili’, which he named ‘Early Rose’ (Goodrich, 1863a, 1863b; Plaisted and Hoopes, 1989; Smith, 2009). At this time the greatest goal of plant breeders was to breed varieties more resistant to disease, probably referring to late blight.

The origin of ‘Burbank’s Seedling’, a story filled with unbelievably good fortune, evokes the incredulity of any plant breeder. Luther Burbank as a young man in Massachusetts took on potato as one of his first plant business projects and discovered a fruit in his mother’s ‘Early Rose’ garden patch. This in itself was almost unheard of in the non-fruiting Early Rose cultivar. Carefully marking the fruit, he waited for it to mature. The fruit initially was lost, but was found after 3 full days of searching. Yielding a scant 23 seeds, each of them was carefully germinated and transplanted to his garden. After nurturing each plant to full maturity, he harvested them and made his assessment. Of the 23 seedlings, two were unusual and outstanding. After a second year of propagation, No. 15 was the sole selection, offering an astounding yield of large tubers, good storability, and very good eating quality (Dreyer, 1993). By today’s standards the derivatives of Goodrich’s potatoes were not particularly resistant as tested in modern resistance trials, but the fact that ‘Russet Burbank’, a later sport of ‘Burbank’s Seedling’, was not particularly susceptible to late blight might have been an achievement at its highest level (Inglis et al., 1996) (Table 1). Although it is often said that no resistance to
late blight was present in varieties of the day in 1845 nor in varieties released for more than three-fourths of a century afterward (Spooner et al., 2005), modern studies place ‘Russet Burbank’ in an intermediate susceptible status of resistance, relative to many other potato varieties. Not a matter for superlatives, neither resistant nor very susceptible, it and its relatives may have been notable for a greater, albeit slight, abatement of disease than that offered by any other cultivar of the time. Therefore, the overwhelming use of ‘Early Rose’, ‘Burbank’s Seedling’s immediate maternal ancestor, as a parent in breeding programs in Europe and North America may have had a basis in a conspicuous ability to transmit some resistance to late blight to the progenies (Reader, 2008).

This could explain the longevity and international dissemination of ‘Early Rose’, which was used extensively in breeding in Europe. In fact, it is difficult to find a pedigree that does not include ‘Early Rose’ as an ancestor in the early 20th century (Plaisted and Hoopes, 1989).

At the time, breeding of new potato varieties was of intense commercial interest to a few private breeders. It was customary to harvest open-pollinated berries from field-grown plants; hence, the pedigrees often only indicated the plant from which the berries were taken. Formal trials really did not exist and much of the description of a cultivar was hearsay, rarely with actual yields included. Keeping quality and culinary traits on boiling were foremost in the minds of the potato cultivar merchants. A bushel of seed of a new cultivar could sell for $50, $900 in today’s currency (Best, 1870). Burbank decided to relocate to the West and needed traveling funds. He offered his clone to J.H.J. Gregory, a successful seedsman, for $500 in 1873. Gregory countered with $150, which Burbank accepted disappointedly. Gregory generously named the clone ‘Burbank’s Seedling’. It appeared in the Gregory Seed Catalog in 1880 (Fig. 1). However, by 1920, it was no longer part of the Gregory Seeds offerings. Now in California, Burbank became remorseful of his sale to Gregory and sent a letter asking for greater remuneration. Gregory was quite direct in his response:

“My Dear Sir,

I have given you great fame by attaching your name to the potato and spread-

ing it through the length and breadth (sic) of the land. I purchased the Early Ohio at just about the same price I gave you for your seedling, did not give the originator’s name to it, and have made greater sale of this than the Burbank.

As to the profit of selling potatoes in my business, with the cost of advertising and handling and loss by freezing and the filling out of orders comes with the opening of spring, test when we are heel over head with filling seed orders, causing us such a week behind hand I have half resolved more than once (forsake) the whole potato business as unprofitable and a great nuisance. You mistake in inferring that all this notoriety upon Burbank means money for me. It rather means fame for you. The more generally it is advertised, the more completely it is taken out of my hands.

I have stated the facts in the case and now enclose 25 dollars; for whatever I may write I know you will feel that some recompense is owed you.” (Smith, 2009; Worrell, 2013)

Gregory had allowed Burbank to keep 10 tubers, which he used to start the cultivar in California. It went on to the west coast of North America where in 1914 it was stated to be worth $17 million (Burbank, 1914). There is no evidence that ‘Burbank’s Seedling’ was remunerative to Burbank despite the potential. It was a casualty to its ready vegetative propagation without legal means to recover royalties. Luther Burbank himself attributed the discovery of a russet skin mutant to Lou Sweet, a Colorado farmer, in 1914 (Burbank, 1914). However, it appears to be clear now that the russet sport was discovered earlier and called ‘Netted Gem’ (Bethke and Donnelly, 1960). Newspaper articles and seed catalogs place this in the year 1895. It was officially introduced in 1902 in the L.L. Mays seed catalog. Today the name ‘Netted Gem’ is introduced in 1902 in the L.L. Mays seed catalog. Today the name ‘Netted Gem’ is used in Canada and ‘Russet Burbank’ in the United States and elsewhere. Eventually ‘Burbank’s Seedling’ disappeared and ‘Russet Burbank’ increased in acreage, especially in the Intermountain West.

‘Russet Burbank’ found market acceptance heretofore unknown in potato cultivars. In the Pacific Northwest, ‘Russet Burbank’ comprised 85% of the crop in Washington State, destined largely for processing.

Ray Croc, who undertook the expansion of McDonald’s restaurants on a franchise model, started with one restaurant in San Bernardino, CA. He made an interesting discovery early in the process that proved essential to McDonald’s French fries’ reputation for excellence. First he determined that ‘Russet Burbank’ potatoes needed to sit and slightly dehydrate after delivery. Second, he found that fries were most appealing if they went through a two-step cooking process. The fries were half-cooked in hot oil and allowed to sit. The second step could be a short oil fry that imparted appropriate texture, taste, and unique mouth feel. All of this was done with ‘Russet Burbank’ as the model raw product. Continuous use of ‘Russet Burbank’ ensured exclusive preference for it as the raw product that most frequently performed the best. Processing innovations were always accomplished on ‘Russet Burbank’. At first Ray Croc manufactured his once-cooked product, shipped in his raw potatoes, and stored on site (Croc, 1985). He found a willing industrial partner, J.R. Simplot Company, which pre-cooked the fries and sent them frozen in easily storable boxes to the restaurants. So successful was this that the brand McDonald’s became synonymous with the most delicious French fries in the business. Ray Croc eventually bought out the McDonald Brothers and presided over the expansion of the McDonald’s brand with construction of tens of thousands of new restaurants on a franchise model (CNBC, 2007; Croc, 1985). Today almost all quick service restaurants receive parfried frozen fries from potato processors, which the restaurants finish off with a second fry. Today 33% of McDonald’s sales are French fries, estimated at 7 billion pounds per year. A highly trained tasting team tries out new varieties every year, and the lack of new recommendations characterizes a static situation, which protects ‘Russet Burbank’s’ retention of such a large portion of the market (Love, 1995). A cultivar acceptable as a McFry® must perform in a narrow range in the following list of characters:

1. Crispness;
2. Color;
3. Texture external crusty surface, internal soft but not mushy;
4. Optimum absorption of oil. McDonald’s has switched to a healthier Canola® vegetable oil for frying, the result of close collaboration with Cargill researchers (Cargill, La Crosse, WI);
5. Percent limp units (or fries that have lost their stiffness and become soft) at a specified time after frying;
6. Retention of freshly fried taste and texture after a specified number of minutes postfry;
7. A mix of strip lengths that occupy a certain volume and stay below a specified weight. Strips that are similar in

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Table 1. Area under the disease progress curve (AUDPC) on exposure to a field source of late blight (Phytophthora infestans) pathotypes identified after 1990 in Mount Vernon, WA.  

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>AUDPC 1993</th>
<th>Significance</th>
<th>AUDPC 1994</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elba</td>
<td>529</td>
<td>a</td>
<td>135</td>
<td>a</td>
</tr>
<tr>
<td>Kennebec</td>
<td>476</td>
<td>b</td>
<td>247</td>
<td>ab</td>
</tr>
<tr>
<td>Ranger Russet</td>
<td>1,101</td>
<td>bc</td>
<td>389</td>
<td>bc</td>
</tr>
<tr>
<td>Russet Burbank</td>
<td>1,035</td>
<td>b</td>
<td>650</td>
<td>d</td>
</tr>
<tr>
<td>White Rose</td>
<td>1,060</td>
<td>bc</td>
<td>834</td>
<td>de</td>
</tr>
<tr>
<td>Shepody</td>
<td>1,169</td>
<td>cd</td>
<td>807</td>
<td>cd</td>
</tr>
<tr>
<td>Superior</td>
<td>1,516</td>
<td>f</td>
<td>1,079</td>
<td>ef</td>
</tr>
<tr>
<td>Russet Norkotah</td>
<td>1,214</td>
<td>de</td>
<td>1,424</td>
<td>g</td>
</tr>
<tr>
<td>Hi Lite Russet</td>
<td>1,388</td>
<td>ef</td>
<td>1,456</td>
<td>g</td>
</tr>
</tbody>
</table>

a Clones are ranked from most to least resistant. Russet Burbank is less resistant than Elba but more resistant than Superior, Russet Norkotah, and Hi Lite Russet. Table extracted from Inglis et al. (1996).

b AUDPC values not sharing a letter are significantly different at P < 0.05 according to analysis of ranked AUDPC values and a least significant difference test.
length tend to fill the serving container with too high a weight; and
8. Retention of good fry quality after 8 months of storage.

At this writing only four varieties are acceptable for the McFry brand: ‘Russet Burbank’, ‘Shepody’, ‘Ranger Russet’, and ‘Umatilla Russet’ (CNBC, 2007).

CONCLUSIONS

Luther Burbank’s early success with ‘Burbank’s Seedling’ certainly fed his confidence that he was following the right route to fame. The domination of ‘Russet Burbank’ of the North American market makes Luther Burbank the most successful breeder of potatoes in history. In present-day terms, ‘Russet Burbank’ is worth $1.5 billion annually. This is true despite decades of decline in acreage. In Washington State for instance, ‘Russet Burbank’ has declined from 82% to 45% of the acreage from 1990 to 2011 (Pavek and Knowles, 2013; USDA/NASS, 2012) (Fig. 2).

In addition, the pattern of variation in the progenies coming from the fruit of an ‘Early Rose’ plant reinforced his philosophy about revealing genetic variation. The variation accumulated over many generations of sexual reproduction was hidden only to be unfettered by hybridization. “We have observed that the latent qualities of diverse strains of ancestors are permitted to come to the surface and make themselves manifest once the tendency to relative fixity has been broken by hybridization” (Burbank, 1914). Certainly this contention has proven useful in vegetatively propagated crops, which when perpetuated vegetatively only change slightly over time as a result of somatic “sports.” Sexual reproduction reveals the highly heterozygous composition underlying the otherwise unvarying line of clonal reproduction. After looking at another half million seedlings, Burbank could state another

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Fig. 1. Gregory’s announcement of the Burbank Seedling in his seed catalog in 1880. Kindly provided by Shari Kelley Worrell, J.H.J. Gregory’s great great granddaughter and author of “Remembering James J.H. Gregory: The Seed King, Philanthropist, Man,” 2013.
breeding truism from experience; sexual reproduction rarely produces a progeny as good as a highly successful clonally propagated parent (Burbank, 1914). ‘Russet Burbank’ always has been very hard to beat. Donnelly et al. (2014) have concluded using the most sensitive test available (Li et al., 2008) that ‘Early Rose’ and ‘Burbank’s Seedling’ were derived from outcrosses to other unidentified pollen parents.

Luther Burbank’s lifelong belief that ‘Burbank’s Seedling’ was a self of ‘Early Rose’ was not correct. He made crosses of ‘Burbank’s Seedling’ with a red-skinned potato brought in from Chile, reportedly, but ‘Burbank’s Seedling’ with a red-skinned potato brought in from Chile, reportedly, but ‘Burbank’s Seedling’ was a self of ‘Early Rose’ and ‘Burbank’s Seedling’ were derived from outcrosses to other unidentified pollen parents.


CNBC. 2007. Big Mac: Inside the McDonald’s empire. Television documentary on DVD.


Fig. 2. Decline in percentage of total potato acreage planted to ‘Russet Burbank’ compared with new varieties from 1990 to 2011.