By Paul Bethke & Shelley Jansky

The Birds and the Bees … and the Potato

How improving fertility through careful breeding can help the potato industry

From left: potato flowers, berries and berries cut in half to reveal the small white or brown seeds within

Potato lovers love to tell potato stories. Most of these stories focus on extraordinary varieties, tenacious growers or charismatic entrepreneurs.

This is a story about potato flowers. It is an old story that we are now revisiting because of interest in propagating new potato varieties from true seed; that is, seed produced by pollinated flowers.

Potato was brought to Europe in the 1500s as a botanical novelty. It did not become an important food crop in Europe and North America until the 18th century. At that time, bees were responsible for producing new varieties. As bees collected pollen from potato flowers, they inadvertently pollinated those flowers. Berries developed, containing seeds that germinated and gave rise to unique plants, different from each other and different from their parents. Some of those plants caught the eye of farmers or hobby gardeners who clonally multiplied them by planting the tubers they produced. In this way, new potato varieties were generated, much as they had been created in their South American homeland for thousands of years.

In the mid-19th century, however, the situation had changed dramatically. Potato faced numerous disease challenges, but by far the most severe were the late blight epidemics that ravaged the crop in the 1840s. Most varieties had no resistance to late blight. They succumbed to the disease and were lost forever. A few varieties, along with some wild relatives of potato, had partial resistance to late blight and were used widely to generate new varieties through manual cross-pollination. Unfortunately, this restoration of the potato came with a cost. There was a sharp decline in fertility of potato flowers. Although the vines continued to make beautiful flowers, the flowers themselves produced little pollen, and in many cases the pollen that was produced was deformed and non-functional. To a large degree, the new varieties were male sterile.

By the early 20th century, most potato breeders in the U.S. had given up on creating new varieties via cross-pollination. Successful pollinations happened infrequently, and when they did, the berries often contained few seeds that gave rise to weak offspring. Instead, most new varieties were tuber selections from existing varieties. Viruses were endemic in potato at that time, and it is likely that most "new" varieties from that period were multiplied from individuals of old varieties that, by chance, had less virus than most.

Why, after thousands of years of cultivation, had potato suddenly become so infertile? Three causes contributed to this change. First, potato varieties created by breeders after the late blight epidemics were highly inbred, as the limited number of lines with resistance to late blight were used repeatedly as parents to produce new varieties. Secondly, although potato is a cool-weather crop, it was being grown increasingly in warm climates. High temperatures cause flower buds to drop prematurely and reduce pollen vitality. Lastly, utilization of wild species relatives of potato to improve disease resistance and introduce other beneficial traits had inadvertently introduced

fertility barriers that preclude successful pollinations between some individuals.

Future potato breeding efforts, especially hybrid breeding, will benefit from recovering fertility in potato. Crosses that produce a larger number of vigorous offspring will increase breeding efficiency and will allow breeders to effectively use computer-based tools for variety improvement. A greater number of seeds per pollination, in this case carried out by hand rather than by bees, will also decrease the labor involved in producing hybrid true potato seed from selected parents.

A field of potatoes in full flower is a beautiful sight. Our perception of those flowers might change before long as we better appreciate how flowers give rise to seeds, and how hybrid seeds can be grown to produce new varieties.

This story is based on an open-access research article titled "Genetic and Environmental Factors Contributing to Reproductive Success and Failure in Potato" that was published in the American Journal of Potato Research *in January 2021.*

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The Burbank Potato

Luther Burbank related the story of how his Burbank potato came about. He spotted a berry on a potato plant in his mother's garden, watched it develop, almost lost it when it fell from the vines, found it after much searching, and ultimately planted the 23 seeds that were inside.

One of those seeds grew to become the "The Burbank Seedling," as it was called when it was first marketed in 1876. What we often fail to note is that seeing a potato berry at that time was a rarity. Twenty-three is a very small number of seeds compared to the several hundred seeds that result from a cross between fertile parents. Marketing the new variety as a seedling emphasized how uncommon it had become to develop varieties this way.

The Burbank Seedling, and the chance mutation of it that we grow today as Russet Burbank, has been an extraordinary variety. Unfortunately, it has been almost useless as a parent in breeding programs because it carries with it the limitations of its time. It is nearly sterile as a male and has poor fertility as a female.