Getting a Handle at Harvest Time

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Pumpkin breeding at UNH

My introduction into breeding pumpkins began in 1979, but not in the traditional sense. For some years I had been interested in improving the productivity of hull-less (edible) seeded pumpkins as a food crop. Lack of being able to acquire research support for such a project had precluded my development of a pumpkin breeding program. However, in 1979 I was fortunate enough to get funding for a graduate student, Susan Stuart, through the Genetics Program at UNH. Susan was interested in basic research on the biochemical genetics of the hull-less trait, but nonetheless, provided me with summer research assistance to begin a pumpkin breeding program that has been very fruitful (no pun intended). I was eventually able to get some industry support that kept the project viable during the mid-1980s. Along the way, I recognized that in addition to breeding hull-less seeded pumpkins which might have limited use in the Northeast, there was need for improved varieties of jack-o'-lantern pumpkins. The focus of this paper will be on jack-o'-lantern pumpkins, and in particular, how to achieve better handle strength both through breeding and management.

My entry into variety development in pumpkins has been successful largely because of my recognition that hybrid varieties, because of their greater uniformity and adaptability, would likely begin to occupy a larger share of the commercial pumpkin market. F_1 hybrids result from the crossing of two parental, inbred lines. Production of hybrid pumpkin seed is most easily accomplished by using a bush strain as the female parent. The bush line can be converted to all female flowering by spraying plants with an ethylene-releasing compound (ethephon). Hybrid seed can then be produced by inter-planting rows of the female and male parents and letting the bees do the cross-pollination. By the early 1990s I was fortunate enough to have developed some bush lines with good handle strength, good resistance to fruit rots, and good seed yields. In cooperation with several seed companies, I have been able to combine some of my lines with their proprietary lines to create some new hybrids with desirable traits. I some instances, both parents of a hybrid have come from my breeding program, and all but one (Gold Medal) of the hybrids produced to date are the result of a bush x vine or bush x bush cross. The F_1 hybrids from such crosses have more restricted vine growth and can be planted with closer row spacing (6-7 ft.).

Table 1 lists all of the commercially available pumpkin varieties emanating from the UNH pumpkin breeding program during the past 12 years.

Table 1. Pumpkin varieties released through the NH Agricultural Experiment Station during the past 12 years. The source of male and female parents is also given, along with known vendors of the varieties and the producers of the seed.

Variety	Size (lbs.)	Female parent	Male parent	Known vendors	Seed prod.
Big Rock	15-25	UNH	Johnnys	JS	JN
Gold Fever	13-18	UNH	Rupp	RU	RU
Gold Standard	12-16	UNH	Rupp	JO, RU, SW	RU
Gold Medal	20-35	UNH	Rupp	RU	RU
Howdy Doody	12-16	UNH	Rupp	RU, SW	RU
Hybrid Pam	4-7	UNH	Seminis	SW, HA, JO, RU	SM
Neon	8-14	UNH	UNH	JO, RU, ST, SW,	HO
Orange Smoothie	4-8	UNH	UNH	JS, RU, ST,	SM
Pik-a-Pie	3-6	UNH	UNH	JO, RU, SW	RU
Racer	12-16	UNH	Johnnys	JS	JN
Schooltime	8-12	UNH	Seminis	new release	SM
Snackjack	1-3	UNH	UNH	HA, JO, RU, ST, SW	SM
Trickster	2-4	UNH	Seminis	JO, RU, ST, SW	SM
NH1041	2-3	UNH	UNH	new release	SM
NH1747	2-5	UNH	UNH	new PMT release	RU

HA = Harris Seeds; HO = Hollar Seeds; JS = Johnnys Selected Seeds; JO = Jordan Seeds; RU = Rupp Seeds; ST = Stokes Seeds; SW = SeedWay

Important attributes of a good pumpkin

Pumpkins come in all sorts of shapes, sizes and variations in orange hues. Each grower and each customer has his or her own preference for what constitutes the best pumpkin. There are now over 50 commercial pumpkin varieties, so growers have a large choice from which to select varieties that are best adapted to local growing conditions and meet the marketing needs and the demands of the customers that purchase pumpkins at roadside retail outlets. There is one common attribute, however, that all growers and customers like in a jack-o'-lantern pumpkin, and that is "good handle appearance and integrity." The handle or stem of a pumpkin, technically called the peduncle, must not only look attractive, but also should not shrivel excessively or deteriorate following harvest, and should generally be strong enough so that the fruit can be picked up by the handle and transported short distances without breaking. To understand how to best manage a pumpkin crop or select varieties with good handles, it is useful to understand how the fruit and stem of a pumpkin develop. Melanie Berg, a graduate student in Plant Biology at UNH, has been conducting research during the past three years on the developmental physiology of pumpkin peduncles. Her research is helping to provide answers to

questions on what constitutes a strong handle, when do handles reach maturity, and when should pumpkins be harvested to maintain the strongest handles.

Fruit development in pumpkins

Pumpkins produce both male and female flowers; the male flowers are produced near the crown of the plant and female flowers are produced further out on the vines. Fruit growth actually begins when the ovary of female flowers starts enlarging. Flowers open in the morning and are only receptive for pollination for a few hours. And by the time the female flowers open, most of the cells that will comprise the pumpkin fruit have already been produced. Therefore, most pumpkin growth after flowering is due to cell enlargement. The time-course for fruit development is given in days after flower opening (anthesis). Pumpkin fruits expand quite rapidly and reach near maximum size by 20 to 25 days after anthesis (DAA). The most rapid period of expansion is between 10 to 20 DAA. Warm temperatures and ample moisture during this period of rapid growth are thus conducive to attainment of maximum fruit size. The solids or dry matter content of the flesh (mostly starch) also begins to increase during this period, and peak dry matter contents are attained by 30 to 35 DAA. High dry matter contents of the fleshy part of the fruit (the mesocarp) are associated with good eating quality in squash, but in ornamental pumpkins the flesh in usually not used. Nonetheless, the dry matter in fruit stems shows a similar pattern of increase as the flesh, and the dry matter accumulated in the stem of the fruit contributes to development of secondary wall molecules that provide stem strength and integrity. With higher stem dry matter, there is potentially greater accumulation of molecules such as lignin, cellulose and hemicelluloses that give stems the hard, woody structure.

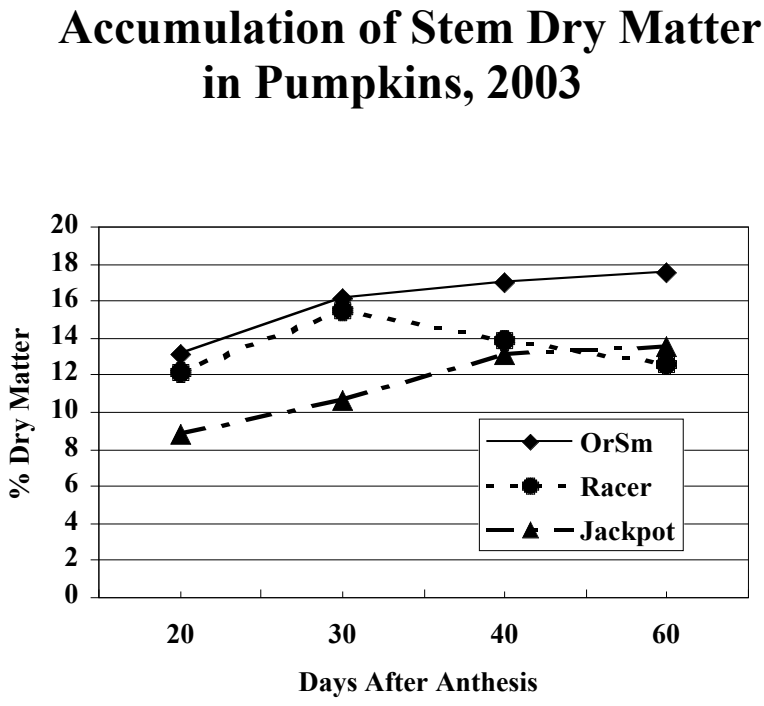

Figure 1. Acumulation of stem (peduncle) dry matter in pumpkin fruits of three varieties at different times after pollination. OrSm = Orange Smoothie

There are varietal differences in stem dry matter and differences in the rate at which stems accumulate dry matter. For example, Melanie Berg found in her pumpkin stem research that the variety "Orange Smoothie" has high stem dry matter (Figure 1), and in some years accumulates moderately high levels of stem dry matter as early as 20 DAA. As a result Orange Smoothie stems show much less shrinkage or shriveling than some larger fruited varieties at different harvest times (Figure 2). In other varieties such as "Jackpot", most stems never accumulate high levels of dry matter and the stems tend to deteriorate badly even if the pumpkins are harvested when fully colored. In general, if stems show 50% or less shrinkage, stem integrity is adequate, especially in the smaller-fruited varieties where stem strength is less important.

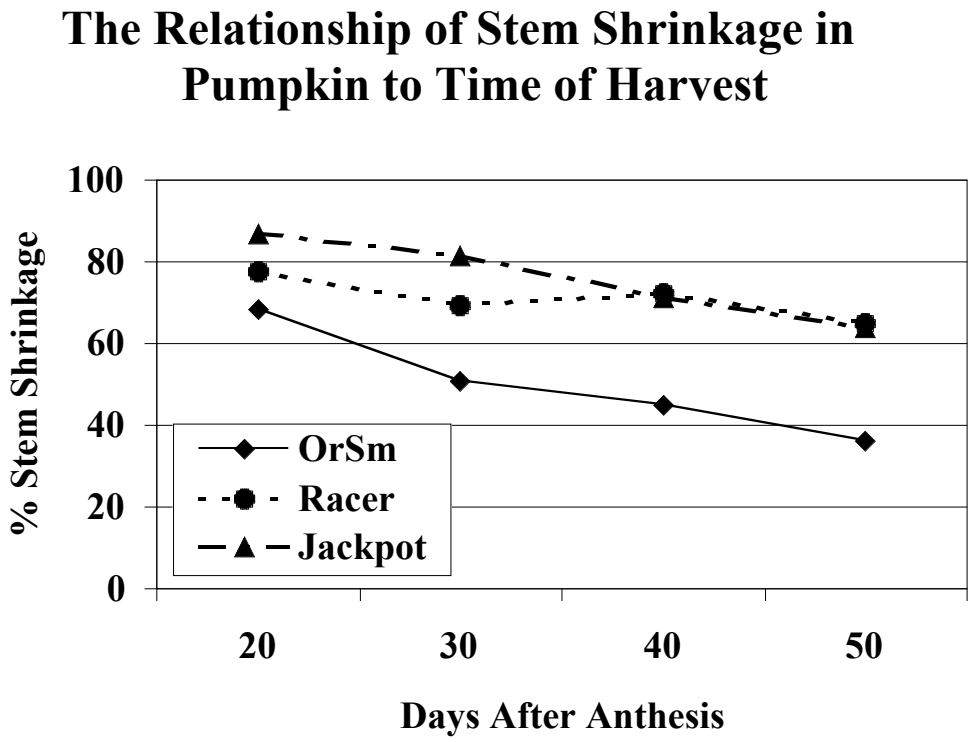

Figure 2. Stem shrinkage in 3 varieties of jack-o'-lantern pumpkin in relation to time of harvest. OrSm = Orange Smoothie.

The rind of pumpkins will usually begin to change from green to orange at about 25 to 30 DAA, and will be completely orange by 35 to 45 DAA. The exact point at which a pumpkin changes color will vary from year to year and among varieties. Technically, a pumpkin is not mature when the rind changes to orange, but when the seeds within the fruit mature. Maximum seed fill usually occurs between 50 to 60 DAA. However, because near peak stem dry matter is reached by 30 to 35 DAA, if pumpkins can be harvested at this time stems should become about as strong as if they were left on the vine until the seed matured. That does not mean that stem development is complete by 30 DAA. But if the building blocks are in place in the stem by 30 DAA, then subsequent synthesis of molecules such as lignin that give stems strength and rigidity can continue after the pumpkin is harvested. Currently, we have not identified the precise

period during which the stem strengthening polymers are synthesized. However, stem hardening is apparent by 20 DAA, and based on the stem shrinkage results, may continue until the fruit reaches full maturity as long as the vine bearing the fruit has not died.

Plant growth and aging can affect stem strength

Growth of fruiting vegetable crops can be subdivided into vegetative and reproductive phases. In strictly determinate plants such as maize, the vegetative and reproductive phases are distinctly separated. However, in pumpkins vegetative growth continues after flowering and fruiting commences. In semi-bush or bush strains of pumpkins, especially those that produce large fruits, vegetative growth is markedly decreased or may even halt once the fruit begins to expand rapidly. This phenomenon is caused by the fruit being a more dominant sink for photosynthates produced by the leaves than are the growing points of the plants from which new leaves are initiated. It is important that pumpkin plants develop sufficient vegetative growth prior to fruit development so there are ample sugars produced by photosynthesis to support dry matter accumulation in the fruits and stems. If pumpkin handles do not accumulate sufficient dry matter by 30 days after flowering, then they are destined to shrivel badly or lack adequate strength once the pumpkins mature. Inadequate vegetative growth tends to be more of a problem in semi-bush than in vine varieties, so they have to be managed more carefully to insure good stem development. If photosynthates are inadequate for both vegetative growth and fruit development, premature senescence or death of the plant may occur.

When a plant begins to die or senesce, many of the reserve constituents in the leaves and stems are broken down and transported to the developing fruits and seeds. The control of this remobilization is not fully understood, but involves the production of enzymes that break down the reserve materials into sugars, simple nitrogen compounds, and a few other small molecules that can be transported through the conducting tissues of the stems and into fruits or other sinks (such as tubers in potato). I have observed that when pumpkins are left on the vine as the stems and leaves deteriorate, deterioration of the pumpkin handles occur. This has been viewed by many experts as a problem caused by an infectious disease invading the fruit peduncle. However, this phenomenon seems to occur even in senescing plant vines showing no visible disease symptoms. I believe that if pumpkins are left on a plant when the vine of the plant dies, a "senescent" signal is sent to the pumpkin stem, inducing it to begin the processes that result in degradation of such molecules as cellulose and hemicellulose that contribute to stem strength. Although this hypothesis remains to be proven, pumpkin handles will deteriorate if the vines are dieing, so **my advice** is to harvest pumpkins before the vines die.

Summary

There is a diversity of opinions as to what constitutes the most attractive pumpkin, but most everyone would agree that it is desirable to have an attractive, strong handle. Varieties vary considerably in handle size and strength. Because people tend to carry pumpkins by the handle, it is desirable to have larger and stronger handles for larger-fruited varieties. The dry matter content of the handle contributes to its capacity to synthesize secondary cell wall materials that contribute to stem strength. Because stem dry matter peaks at 30 days after pollination, it is recommended that pumpkins not be harvested until after this time period. Most

pumpkins turn completely orange about 40 to 45 days after pollination, and it is recommended that they be harvested at this time or shortly after before the vines begin to deteriorate. Vine deterioration is associated with deterioration of pumpkin stems. Some of the new semi-bush varieties are adapted to closer row culture and easier weed management than the spreading vine varieties, but they must be managed well so that they produce ample vegetative growth before fruit are produced. A good vegetative, leaf canopy helps insure that a pumpkin plant can provide enough photosynthates for optimum fruit and stem development.