

BREEDING THE AMERICAN CRANBERRY

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Why is a particular cranberry variety grown?

The cranberry varieties that are cultivated, are grown for their particular combinations of characteristics. Obvious desirable traits in cranberry are productivity, color, and fruit quality. As with most crops, productivity is a major criteria for selection a variety to culture. Productivity, however, is a complicated trait with many genetic components, e.g. vine vigor, flowering upright density, adaptation, fruit set, etc. Productivity is also impacted greatly by environment.

In 1958, after over 100 years of commercial cranberry production, 92% of the cranberry acreage was planted with only four varieties: 'Early Black', 'Howes', 'McFarlin' and 'Searles'. These varieties, selected from native bogs, were referred to as the 'Big Four', and were cultivated based regional preferences.

'Searles', the predominant variety grown in Wisconsin, was recognized for its productivity. Dr. H. J. Franklin, was noted as saying that 'Searles' "is perhaps the most productive of all cultivated cranberries". However, 'Searles' was considered to have only poor to fair fruit quality, particularly on the east coast. 'McFarlin', another variety grown in Wisconsin, was also grown widely in the Pacific Northwest. 'McFarlin' was noted for good fruit quality and a berry that was resistant to frost. 'McFarlin' was considered to be as productive as 'Howes', but producing more uniform crops in certain areas. 'Early Black' and 'Howes' were and still are east coast varieties. 'Early Black' was noted for early color and ability to produce on many types of cranberry soil. 'Howes' was noted for very good fruit quality, with a berry very resistant to frost.

Why breed new varieties?

There are two major reasons for breeding new varieties. Through breeding one can enhance levels of certain traits. Obvious traits in cranberry are productivity, disease resistance and TACY. A second reason would be to develop varieties with desirable trait combinations. Desirable trait combinations for most cranberry growing regions are high yield, high TACY and resistance to diseases of a given growing region. For Wisconsin, cotton ball and vicid rot resistance combined with enhanced levels of productivity and TACY would be desirable.

The genetic enhancement of cranberry: the first generation of breeding and selection

In 1929, the USDA embarked on a cranberry breeding program. A major objective of the program was to develop cranberry varieties resistant to false-blossom disease. This is probably why the varieties 'Early Black' and 'McFarlin' were used as parents. From over 30 crosses, over 10,000 seedlings were planted. The majority (8,692) were planted in NJ and 1,993 seedlings were planted in MA. Six varieties, all initially selected from NJ, were released: 'Stevens', 'Pilgrim', 'Franklin', 'Wilcox', 'Bergman', and 'Be&with'. Of these, 'Pilgrim', 'Beckwith' and 'Franklin' were considered to have high resistance to false-blossom.

Besides identifying resistant varieties to false-blossom, selection criteria included: yield, fruit rot resistance, keeping quality, fruit appearance, coloring in storage, date of harvest, and fruit size. The program was terminated after one generation of breeding and selection. A replicated variety trial at the Blueberry and Cranberry Research Center, Chatsworth, NJ has shown that the first generation hybrids, as a group, are more productive than wild selections.

Continued breeding

A strong argument for continued breeding of cranberry is the success of the variety 'Stevens'. The variety 'Stevens' represents a successful outcome of a previous cranberry breeding program. 'Stevens' was derived from a 'McFarlin' X 'Potters' hybridization. 'McFarlin', was noted as having good production, good keeping quality, resistance to false-blossom, but late maturing fruit. Potters' traits were good production and early ripening, but was considered to have "very poor" keeping quality and susceptible to false-blossom. Although both parents had "good production", 'Stevens' is more productive than either parent. 'Stevens' considered of good keeping quality, probably received this trait from 'McFarlin', and is intermediate to both parents for TACY and resistance to false-blossom. Additional genetic gain should be possible with additional breeding and selection cycles in cranberry.

Additional reasons exist for breeding new varieties. The culture of one or few varieties, a mono-culture of sorts, exposes the industry to higher risk of epidemics. Having diverse varieties planted may provide a buffer to disease or insect outbreaks. Varieties with disease resistance would reduce the use of pesticides. The benefits would not only be environmental. Some pesticides, such as chlorothalonil, have been shown to be phytotoxic to the cranberry. Varieties having greater resistance may allow for lower rates of pesticide to be used. As mentioned later, loss can occur even with the use of pesticides. Varieties having some level of resistance could reduce this loss.

The NJAES/Rutgers University Cranberry Breeding Program

A Perspective on Cranberry Breeding in NJ -

The climate and soils of NJ make an excellent site for the breeding of perennials. Varieties of blueberry, peach, apple, and turfgrasses selected in NJ are widely grown in North America. The southern coastal plain of New Jersey offers an ideal site to select broadly adapted cranberry varieties. The six varieties, including 'Stevens', released from the 1929 USDA breeding program were initially set out and selected at Whitesbog, NJ.

The southern coastal plain of NJ is the most southern range of the main distribution of native cranberry. Cranberry is best adapted to cool temperate summer climates. The summer heat and humidity of the southern coastal plain of New Jersey provides a severe test for adaptation to adverse conditions: heat stress and high disease pressure. As a result of the hot humid summer climate, NJ cranberry bogs are likely subjected to the greatest field fruit rot disease pressure of any of the cranberry growing regions.

In NJ, cranberry plantings are regularly sprayed with fungicides with up to four applications; even with four fungicide applications, some plots can suffer 10-15% loss due to fruit rot organisms. Unsprayed 'Benlear' plots at the Center have exhibited 100% rotted fruit in some years. Over 15 different pathogens have been determined to cause fruit rot in NJ. The major organisms, in approximate order of importance, are: Blotch rot (*Phytophthora vaccinii*), Bitter rot

(*Glomerella cingulata*), Ripe rot (*Coleophoma empetri*), Early rot or scald (*Phylosticta vaccinii*), Botryosphaeria (*Botryosphaeria vaccinii*). In some years, End rot (*Godronia cassandrae*) and *Alternaria* are also a problem.

The NJAES Cranberry Breeding Program: Objectives, Approach and Time-frame

Based on the needs of the industry, the major objectives of breeding program are: 1) reliable productivity and 2) resistance to fruit rot organisms. Other characteristics such as TACY, brix, acids are also being evaluated. However, the pressure to reduce use of pesticides makes resistance of highest priority.

The primary effort will involve breeding, controlled crosses, and selection. Since both of the major objectives have a large environmental component, field plots are being established along with replicated field trials to obtain better estimates of the genetic and environmental components. Even in a bog of a relatively homogeneous variety, e.g. 'Stevens', there can be considerable variability for productivity and fruit rot. Thus, when a bog is planted with many plots of different genetic constitutions, the design should be such as to increase the probability of selecting the superior seedling resulting from a superior genetic constitution, and not as a result of a favorable environmental situation.

The evaluation of the germplasm and seedlings will identify useful genotypes (genetic variation) for parental material. Parents will be selected and controlled crosses made to generate progeny with enhanced traits and trait combinations. The most efficient genetic gain is achieved by obtaining an accurate estimate of the genetic component; for traits like yield, this can only be achieved through field testing and good experimental design.

In cranberry breeding, the time interval from cross to release is substantial. In the USDA program crosses were made in 1929 and the first releases were in 1950, 21 years. With replicated field trials, this time interval could be shortened to 12-15 years.

Cranberry Germplasm and Evaluation

Breeding programs require genetic variation. A major effort has been made to assemble cranberry germplasm, both selected and wild at the Center. Over 500 accessions and varieties are being maintained in either greenhouse and/or field plots. Clonal collections from native bogs have also been made. States from which plants of native populations have been obtained include: DE, MA, MI, NC, NJ, NY, PA, and WI. Field plots of all the accessions are planned for evaluation. Field plots will be evaluated for yield, fruit rot, color, vigor, etc.

To obtain a better understanding of the diversity and genetic variation of the cranberry germplasm, biochemical and DNA fingerprinting studies have been and are being conducted. These will be useful in identifying unique plants and understanding the genetic relatedness of plants.

Disease Resistance

The development of productive varieties with resistance to the fruit rot organisms requires the identification of resistant varieties. The identification of resistance will utilize two approaches. One will involve testing for field resistance. Field plots will be set out and fungicide sprays will be reduced or eliminated. The other will involve an artificial screening in laboratory or greenhouse

through controlled inoculation. Artificial screening will be done in cooperation with the plant pathologist, Dr. Peter Oudemans, at the Center.

A number of the varieties considered to have some level of fruit rot resistance have been crossed with productive varieties, and seedlings have been field planted.

Yield and Yield Evaluation

The cranberry varieties being grown today have been selected for cultivation based largely on grower experience. Few replicated trials have been conducted to determine superior varieties for a given region. As a result, the acceptance of new varieties is slowed. For example, 'Stevens' was released in 1950, but only relatively recently is it being widely planted. Although costly of time and space, replicated field trials are the most efficient and quickest method of identifying productive varieties. Due to the phenomenon of 'biennial bearing' in woody perennials, tests running few to many years are required to assess yield potential.

Current Status and Outlook

A replicated cranberry variety trial was established in 1985. The trial has 10 varieties planted in a replicated, 4 replicates, design. Traits being measured include yield, components of yield, and fruit rot. Fairly complete data is available for years 1991, 1992, and 1993. One objective of this trial is to determine the best design for future trials with selections from the breeding program.

Over 150 controlled hybridizations have been made. Over 3,600 seedlings have been field planted either at the Center or cooperating growers locations. An additional 2,000 seedlings will be planted in Spring 1994.

If the success that has been made in other fruit crops through breeding is any indication, future generations of cranberry' should provide the industry with superior varieties to those currently grown.