

## CRANBERRY FRUIT SET: PROBLEMS AND POTENTIALS

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Fruit set is a term used to describe the persistence and development of an ovary or associated tissues following blossoming. It is calculated as a percent of the number of flowers successfully developing into fruit. Failure of fruit to set and develop is a common occurrence in fruit crops. The cranberry is no exception. Normal cranberry fruit set in Wisconsin ranges between 25% to 40%, occasionally up to 50% on newer cultivars in test plots. Over the past 5 decades, similar low levels of fruit set in other cranberry producing areas have stimulated studies on pollination and bee behavior, plant nutrient relationships, plant growth regulators, bee attractants, flower anatomy, contributions of various components of flower initiation and flowering behavior to yield in an attempt to understand and increase fruit set, with the prospect for enhancing yield.

Since 1982, our research program has examined a host of factors as possibilities to alter or increase fruit set in cranberry. In early field trials I tested a series of plant nutrients including zinc, foliar phosphorus, slow release nitrogen, boron and calcium-boron combinations as potential limiting factors to fruit set. No significant effect on altering flowering or fruit set was observed or measured. Concurrently, a series of tests with new plant growth regulators demonstrated the potential to increase fruit set. Fruit however were seedless (parthenocarpic) and typically did not develop to normal size. Undesirable side effects, usually excessive upright growth, further limited the potential for positive results. Despite this, our plant growth regulator research continues in the attempt to influence fruit set. A mechanical pruning trial in conjunction with plant growth regulator suppression of regrowth resulted in increased flowering in 'Searles' with little or no subsequent effect on increased fruit set or yield.

The failure of these and other field tests to increase fruit set stressed the great need for more basic studies on factors controlling flowering and fruit set in cranberry. To that end and with financial support from the Wisconsin Cranberry Board, Inc. in 1987 we initiated a project to evaluate factors affecting fruit set in cranberry. Objectives were to evaluate pollination, pollen tube growth, competition within the plant for carbohydrates and effects of night temperature on cranberry fruit set.

In a detailed examination of pollination, supplementing natural insect pollination with hand pollination increased fruit set in 'Searles' from 30% to 38% in two successive years. Inadequate pollination thus partially limits fruit set in the field. The earliest opening flowers had a greater probability of fruit development compared to flowers opening later. With one or both of the two earliest flowers developing into fruit, 18% of the flowers opening later matured into fruit. Removal of the earliest two flowers at early blossom allowed 45% to 58% fruit set for the remaining flowers, strong evidence that within plant competition for resources, possibly carbohydrates, may determine fruit set.

Examination under fluorescence microscopy verified that cranberry fruit which fail to set contain pollen tubes which may grow only partially into the style. Pollen tubes in this case are thicker, contain numerous callose plugs and fail to complete growth to the ovary and ovules (seed).

Analysis of cranberry upright tissue at various stages of flower development showed dramatic changes in carbohydrate content through the season. Sucrose,

glucose, fructose, raffinose and stachyose were predominant carbohydrates in cranberry vegetative tissue.

Except during dormancy, cranberry uprights had the highest concentration of carbohydrates at early blossom, when the lower flowers were at full bloom. As early flowers developed into fruit and later opening flowers were at or just beyond full bloom, uprights had lower carbohydrate concentrations. Starch was primarily stored and later depleted in the previous season's growth and trailing, woody stems. Fruit developed from 53% of the flowers under greenhouse conditions, compared to 38% in the field. Tissue from the greenhouse was generally higher in carbohydrates than was field grown tissue and may explain increased fruit set under controlled environments. Insufficient carbohydrate levels at the time of late blossoming, after first fruits have set, may be responsible for the low fruit set observed in the field.

In controlled temperature tests where warm night temperatures (60°F) were compared to cool nights (45 °F), increased fruit set in controlled conditions could not be attributed to night temperature differences.

Inadequate pollination and failure of pollen tube growth only partially accounts for reduced fruit set in cranberry in the field. Competition within the plant during blossoming for available carbohydrates appears to be an important factor in controlling fruit set and development.

Whether carbohydrate levels influence fruit set directly through controlling seed set, alternatively through effects on pollen tube growth or both is unknown. Possible influences of natural hormones or plant nutrient deficiencies in stylar tissue on pollen tube growth cannot be discounted. These factors remain to be investigated.

Carbohydrate levels in the plant in the prebloom and early bloom stages appear to be critical to fruit set. Possibilities for altering carbohydrate levels under conventional cranberry management practices may be limited.

An unrelated test in 1989 on the use of spunbonded fabric covers to alter the early season plant environment in cranberry suggests a prospective method for altering early season plant development. Under fabric covers earlier leaf greening, if it results in earlier photosynthetic activity and higher carbohydrate levels, may influence fruit set. Initial observations of a trend to increased fruit set with fabric covers offers exciting potential to positively alter fruit set in the field. More detailed field tests in 1990 are planned to verify this intriguing possibility.

The potential for enhancing fruit set in cranberry exists. Crucial to these attempts is a better understanding of the ultimate cause(s) for flower abortion and failure to develop. This remains our objective in further research on fruit set in cranberry.

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