Fall 1980

Primary production in wild and cultivated cranberries

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PRIMARY PRODUCTION IN WILD AND CULTIVATED CRANBERRIES

Cranberries grow in many Wisconsin sphagnum bogs. One of the two species, the large cranberry, *Vaccinium macrocarpon* Ait., is among the few American fruit crops in cultivation. Most of the cultivated cranberries have been derived by selection from wild, and more recently from cultivated clones.

Like the large cranberry, the small cranberry, *Vaccinium oxycoccos* L., is native to Wisconsin bogs and it, too, provides wildlife food, though it has not been selected for cultivation.

The producer of any agricultural crop is interested primarily in yield. For cranberries this means the barrels of fruit produced per acre. However, as with any crop, the yield depends upon the ability of the plant to photosynthesize and utilize the photosynthate efficiently for vegetative as well as reproductive growth. Thus, yield is related to total net productivity and the accumulation of organic matter in a plant. This study examined the primary productivity of wild and cultivated cranberries (Wahlstrom 1979).

METHODS

Photosynthetic efficiency of plants can be measured by the amount of carbon dioxide absorbed by the leaves. The rate reported for cranberries is considerably higher than that for many crop plants (40 mg CO_2/ dm^2/hour) (Bonn, *et al.* 1969). While less efficient than sweet corn, cranberries are more efficient than most vegetables or fruit trees.

The second approach to primary production is by harvesting samples, which is the method used in this study. In September, 1978, three central Wisconsin cranberry areas were sampled to determine peak biomass. Twelve individual bogs were chosen, and six samples were obtained in each of these bogs. The sample bogs included young, medium and old stands (approximately 10, 20 and 40 years or older). Several different cultivars were sampled, but one, "Searles," was sampled in each of the age groups.

Plots were sampled with a sharpened circular sampler 5 inches in diameter (area .0127 m^2). The sampler was driven through the vegetation into the sandy substrate by hand, and the sample was removed, placed in plastic bags, and later separated into various components. The separated material (new leaves, old leaves, new stems, old stems, fruit, etc.) was weighed, individually dried and weighed again to obtain dry weight. Standing crop was determined to be the sum of all plant parts, while net primary production was defined as new leaves and twigs and fruit plus the new wood of older stems.

In the wild bogs, cranberries grow less densely than in cultivation Larger quadrats of 0.1 meter square were harvested in each of 2 bogs. Monthly samples were obtained to follow production as the season progressed.

Dry weight of plant material has served as a useful value in comparative productivity studies. However, the amount of stored energy represented by a gram of weight may vary depending upon the material stored (i.e. carbohydrate vs. fat, etc.). A Parr bomb calorimeter was used to obtain caloric values for the various plant parts of wild and cultivated cranberries.

RESULTS

The stands of cultivated cranberries showed reasonably high net primary production, an average value of 723g/m^2/year. This compares reasonably with values for agricultural crops which range between 100 and 3500 g/m^2/year as indicated by Whittaker (1975) (average 650 g/m^2/year).

Cranberry stands of different ages have different total productivity levels; younger and medium age stands are somewhat more productive than older ones (mean production 754, 751 and 658 g/m^2/year respectively). The apportionment of photosynthate to different plant parts appears to shift with age of plant. Older cranberries apportion less to leaves than do medium-age plants, and older plants allocate more photosynthate to fruit than do the younger plants. Thus, although total net primary production of a cranberry bog declines with age, biomass allocation to the fruit increases, and the bog maintains a relatively constant fruit yield. As the plants age, the unit dry weight (g/m^2) of fruit remains approximately the same, but the number of fruits increases suggesting that older plants tend to bear more but smaller fruits (Table 1). New shoot production appears to remain constant throughout the life of the plant, although the shoot length may vary with age. The water content of cranberry plant parts varies considerably. Young cranberry leaves contain 35% water while the older leaves have 25%, considerably less than the water content of most leaves. In contrast, fruits are 90% water, and the whole plant average is about 59% water for the cultivated *V. macrocarpon* and 51% for the wild *V. oxycoccos*.

Table 1. Percentage biomass allocation to cultivated cranberry plant parts[a]

Stand age	Fruit	New Leaves	New stems	Roots	Pedicels	Wood
Young	17.3	30.9	17.5	2.1	1.9	30.3
Medium	15.0	30.4	16.9	2.5	1.9	33.4
Old	20.2	27.5	17.2	1.6	2.0	31.5

a Percentages are means of 24 individual samples (4 sites, 6 samples per site).

In the wild bog, productivity of the small cranberry varied, but in the better locations, it produced 68 g/m^2. In another adjacent bog, production was 136.7 g/m^2. These values appear reasonable considering the dispersed nature of the wild cranberry population contrasted to the dense monotypic population in a cultivated bog.

Caloric values were obtained from oven-dried samples of wild and cultivated cranberries using standard calometric techniques. Caloric values appeared relatively high in comparison to those of other plants, and the energy content of the cultivated and wild plants of *V. macrocarpon* was similar (Table 2). Cranberry leaves were higher in energy content than other plant leaves which may be related to the resinous storage products and the photosynthetic efficiency reported previously. The relatively high levels of stored energy indicated by the caloric values decrease slightly as the structures (leaves, stems, etc.) age (e.g. new leaves contain 5114 cal/g dry weight, old leaves 4925 cal/g). Caloric values did not differ greatly between cultivated and wild forms of the large cranberry, *V. macrocarpon*, and were slightly higher in the small wild cranberry, *V. oxycoccus.*

Table 2. Caloric content of cranberry plant structures

Species	Plant part	Caloric value[1] (Cal/g)
Vaccinium macrocarpon Ait.	Old wood	4867
Cultivated cranberry	New wood	4906
	Old leaves	4925
	New leaves	5114
	Fruit	4471
	Roots	4505
	Pedicels	5050
Vaccinium macrocarpon Ait.	New and old wood	4814
Wild, large cranberry	New and old leaves	5019
	Fruit	4568
Vaccinium oxycoccos L.	Old wood	4890
Wild, small cranberry	New wood	4939
	Old leaves	5082
	New leaves	5125
	Fruit	4911

1/ Each value represents the mean of two determinations

DISCUSSION AND CONCLUSION

Since knowledge of plant productivity serves to characterize growth efficiency, and information on allocation of photosynthate is useful in understanding differences in yield, the relationships between productivity and fruit production should be helpful in selecting cultivars. Root productivity is always difficult to estimate, and with cranberries this was so; hence, the root weights reported here are probably low (a ratio for below to above ground production of 0.02 compared to 0.18 for several woody plants, Bray, 1963). Work in progress on natural bogs indicates that average net primary production for all species varied between 600 and 868 g/m^2, whereas that for the cultivated cranberry bogs was 723 g/m^2. The similar levels are notable since the cultivated bogs are fertilized and water is maintained at appropriate levels, while the natural bog depends on nutrients received from the atmosphere or through recycling. Light, nutrients and competition are all involved. While production in the cultivated bog takes place in one stratum, production in the natural bog occurs in several layers.

Changes in biomass allocation during the existence of the cultivated cranberry suggest that once established a cranberry bog will be productive for many years. This indeed appears to be the case; one bog sampled was 75 years old and still yielded fruit at acceptable levels. It is possible that with lower total net production in the older bogs, less fertilizer would be needed to maintain growth than in the younger bogs. This question needs further exploration.

The physiologic mechanisms of the cranberry are the result of long-term natural selection in a complex bog community where competition for light and nutrients is often severe. This study suggests that this evolved adaptation to bog conditions and efficiency of photosynthate production has not been greatly altered by the hundred or more years of agricultural selection. Understanding of plant productivity and photosynthate allocation gained in this study suggests the potential of more extensive work for increasing yields and evaluating cultural practices.

LITERATURE CITED

Bonn, B. R. Forsyth and I. V. Hall. 1969. A comparison of the rates of apparent photosynthesis of the cranberry and the common lowbush blueberry. Le Naturaliste Canadien 96: 799-804.

Bray, J. R. 1963. Root production and the estimation of net productivity. Can. J. Bot. 41: 65-72.

Walstrom, Mark L. 1979. Primary production of wild and cultivated cranberries. M.S. thesis, Botany. University of Wisconsin–Milwaukee. 68 p.

Whittaker, R. H. 1975. Communities and Ecosystems. 2nd. Ed. MacMillan. N.Y.

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