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Leaf Area and Fruiting Efficiency of Large and Small Fruited Cranberry Cultivars

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Abstract

Fruit size in cranberry is highly variable between cultivars. Small fruited cultivars produce more berries per hectare than large fruited cultivars but yield per hectare is ofter similar. The relationship between fruit size, yield and leaf area per fruiting upright was examined. Large fruited cultivars produced more fruit per leaf area on fruiting uprights than small fruited cultivars. This suggests that large fruited cultivars are more efficient at producing dry weight than small fruited cultivars. Fruit number per fruiting upright was similar regardless of fruit size but small fruited cultivars had more fruiting uprights per unit area than did large fruited cultivars. In this study, fruit size was important in determining the number of flowering uprights, which is an important yield component.

Introduction

The cranberry (*Vaccinium macrocarpon* Ait.) has been domesticated relatively recently. Many commercially grown cranberry cultivars were selected from the wild. Fruit size and shape vary widely among cranberry cultivars; size by weight ranges from 0.8 to 1.75 g per berry. Small fruited cultivars produce more berries per hectare than large fruited cultivars so that yields per hectare are similar. This suggests that two strategies i.e. fewer, larger berries or more, smaller berries may occur for fruit production in cranberry.

Growth and development of fruit crops is dependent on the amount of leaf area available to supply photosynthates to developing fruit (5, 8). In apple, a positive correlation ($r = 0.65$) was found between leaf area per spur and 17 year accumulated yield for 9 cultivars (6). Small apple fruit may be caused by insufficient leaf area during the season (4, 7).

The ability to produce high yields with minimal leaf area would be desirable for fruit crops since this indicates high photosynthetic efficiency. In cranberries, fruit are produced on vertical shoots, called uprights. Production is in beds of uprights developed from random horizontal runners. This re-

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search was undertaken to examine the relationship between leaf area per fruiting upright and fruit size in cranberry.

Yield component analysis of cranberry has shown that fruit yield increases as the number of flowering uprights per area increases (2, 3). These authors mainly studied 'McFarlin' and 'Bergman' cultivars which produce fruit of similar size. Perhaps as a result, fruit size was not identified as a major component of yield (3). This research examines some yield components for large and small fruited cranberry cultivars.

Materials and Methods

Samples of large and small fruited cranberry (*Vaccinium macrocarpon* Ait.) were obtained at the University of Wisconsin cultivar trial planting located at DuBay Cranberries, Inc. near Stevens Point, Wisconsin. Samples were taken from 6 small fruited and 6 large fruited cultivars (Table 1). Cultivar selection was based on fruit size and yield data from previous years. Four replicate samples were taken from each nonreplicated plot. In 1988 four aluminum rings of 14 cm diameter (154 cm^2) were placed randomly in the plot and all of the uprights within the rings were cut, placed in polyethylene bags and brought to the lab for analysis. In 1989, four PVC plastic rings of 10.2 cm diameter (89 cm^2) were used. Samples were collected on Sept. 12, 1988 and Sept. 11, 1989, which is just before commercial harvest begins.

Fruiting and nonfruiting uprights were separated and counted. Fruit counts and the fresh weight of the berries were determined. The berries were dried in a forced air oven at 50°C and then weighed. All leaves were removed from fruiting uprights and leaf area for each sample was measured with a Li-Cor LI-3000 (Lincoln, NE) area meter. Production efficiency was defined as the grams dry fruit weight produced per cm^2 leaf area. Analyses of variance were performed and means were separated by Tukey's LSD following a significant F test.

Results and Discussion

The large fruited cultivars selected for this study produced fruit nearly 40% larger than the small fruited cultivars (Table 1). However, small fruited cultivars produced 70-80% more fruit per unit area (Table 2). Thus, yield (measured as grams fresh fruit per ring) was comparable for both large and small fruited cultivars for both 1988 and 1989 (Table 2). These results are similar to yield data that have been taken on these plots for several prior years (D. Boone, unpublished data).

Large fruited cultivars had a significantly greater yield efficiency (g dry weight of fruit produced per cm^2 of leaf area on fruiting uprights) than small fruited cultivars (Table 2). Thus,

Table 1. Mean berry weight of cranberry cultivars evaluated in Wisconsin for this study. Each number is the mean of 4 samples.

Cultivar	Mean fruit weight (g)	
	1988	*1989*
Small fruited		
AW2	1.0	0.72
Round Howes	0.96	0.76
Wilcox	0.94	0.83
Howes	0.93	0.74
Rezin	1.0	1.0
Early Black	0.81	0.55
Large fruited		
Stevens	1.6	1.3
Stankovich	1.5	1.3
Bain Favorite #1	1.8	1.5
Bain 10	1.7	1.3
Habelman 2	1.6	1.3
Pilgrim	1.6	1.2
LSD (P = 0.05)	0.19	0.18

Table 2. Plant and fruit characteristics of selected large and small fruited cranberry cultivars.

Fruit size	yield/ ring[z] (g/)	leaf area/ upright (cm^2)	fruit dry wt/ area (g/cm^2)	fruit/ ring[z] (#)	fruiting uprights/ ring[z] (#)	nonfruiting uprights/ ring[z] (#)
			1988			
small[y]	53.2	5.3	0.034	56.3	37.2	81.3
large[x]	52.7	5.4	0.051	32.5	23.1	83.8
	ns[w]	ns	**	**	**	ns
			1989			
small	22.0	5.5	0.023	30.9	21.2	47.8
large	22.3	6.1	0.034	17.0	11.6	46.4
	ns	ns	**	**	**	ns

z. Rings were 154 cm^2 and 89 cm^2 in 1988 and 1989, respectively.
y. Small fruited cultivars were: AW2, Round Howes, Wilcox, Howes, Rezin, and Early Black.
x. Large fruited cultivars were: Stevens, Stankovich, Bain Favorite #1, Bain 10, Habelman 2, and Pilgrim.
w. ns = nonsignificant; ** = significant at the 0.01 level. Mean separation within years by Tukey's LSD following a significant F test.

large fruited cultivars produced more grams of dry weight per fruiting upright leaf area than small fruited cultivars.

Leaf area was measured only on fruiting uprights. It was assumed that carbohydrates for fruit growth came primarily from leaves on the fruiting uprights. However, additional carbohydrates could also come from non-fruiting uprights along the same stem. Thus, measuring the leaf area of the non-fruiting uprights in these samples may have been misleading because fruiting and non-fruiting uprights within each sample might have come from different stems. Thus, the non-fruiting uprights measured would not necessarily have contributed directly to the growth of the measured fruit.

The mean leaf area per fruiting upright was similar for large and small fruited cultivars (Table 2). Nevertheless, total leaf area of the fruiting uprights per sample was greater for small fruited cultivars because there were more fruiting uprights per sample in small fruited cultivars. Although the leaf area of non-fruiting uprights was not measured, the fact that average leaf area of fruiting uprights and number of non-fruiting uprights is similar, regardless of fruit size, suggests that total leaf area would have been similar had it been measured. If cranberries are able to obtain photosynthate from adjacent non-fruiting uprights then both large and small fruited cultivars may have had access to similar amounts of leaf area. At present, however, there are no data giving the source of carbohydrates for fruit growth in cranberries.

An individual cranberry upright produces 1 to 7 blossoms and typically will bear 1 to 5 fruit. Average fruit number per upright was about 1.5, regardless of fruit size (data not shown). This is consistent with other studies of cranberry (1). Individual cranberry uprights had about the same amount of leaf area and there was no apparent correlation between leaf area per upright and fruit size or set.

The number of non-fruiting uprights within samples was the same for large and small fruited cultivars for both 1988 and 1989 (Table 2). Almost twice as many fruiting uprights were found for small fruited cultivars compared to large fruited cultivars. Eaton and Kyte (3) report that the number of flowering uprights as a portion of total upright numbers was an important component of yield. In this study,

fruit size was correlated with the number of fruiting uprights per area, and thus may have an effect on yield components.

Fruit size was not related to yield in this study. However, if carbohydrates for fruit growth came primarily from fruiting uprights, increasing the proportion of flowering and fruiting uprights in large fruited cranberry cultivars should increase yields. On the other hand, if nonfruiting uprights are important sources of carbohydrate for fruit growth, increasing the proportion of fruiting uprights alone may have a deleterious effect.

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