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Timing and Severity of Pruning Effects on Cranberry Yield Components and Fruit Anthocyanin

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Abstract. **Timing and severity of pruning in a 30-year-old commercial 'McFarlin' cranberry *(Vaccinium macrocarpon* Ait.) bed were studied. Treatments in 1989 and 1990 consisted of early or late pruning and heavy, moderate, light, or no pruning. Yield component data were collected in Fall 1989 and 1990, just before harvest. Time of pruning did not affect yield components. In 1989, the unpruned and lightly pruned vines had a higher total plant fresh weight, fewer berries, higher berry yield, longer and more fruiting uprights, and fewer nonfruiting uprights (U,) compared with moderately or heavily pruned vines. Average length of U_N and anthocyanin content of berries in 1989 were not influenced by pruning. In 1990, the effects of pruning severity were similar to 1989. In 1990, unpruned vines had a lower percent fruit set and berries contained less anthocyanin than pruned vines. Annual pruning with conventional systems in use decreases yield.**

Mature cranberry beds tend to produce excessive vegetative growth, characterized by long runners and old, long, upright shoots. Reductions in yield may result, probably by limited light interception and decreased flower bud formation (Chambers, 1918; Eck, 1990). Excessive vine growth also creates a microclimate conducive to fruit rot development (Eck, 1990) and may limit fruit set. To maintain high yields, cranberries are periodically pruned to control excessive vegetative and runner growth. Pruning also enhances harvest efficiency by reducing interference of runners with harvest equipment. Chambers (1918) documented a 45% increase in yield the 2nd year after a planting of vigorously growing 'Early Black' was pruned. Pruning severity is critical, however, as some fruiting uprights are also removed when runners are pruned (Chambers, 1918; Doehlert, 1955). Eck (1990) suggested a light annual pruning of vines would be the best approach to controlling excessive vegetative growth. However, little is understood about the immediate and long-term effects of pruning on components of yield.

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Most cranberry beds in Oregon are flooded for fruit harvest (late September-October). Except for the few dry-harvested beds that also are pruned during harvest, pruning in Oregon is usually done from December-January. Late pruning may have an advantage over early pruning in years with injurious winter temperatures, as damaged wood would be removed during pruning.

Our objectives were to assess the effects of date of pruning and pruning severity on yield components and fruit anthocyanin content of cranberry.

A commercial 30-year-old 'McFarlin' cranberry bed was used. The experiment was set up as a split-plot design with three replicates. Time of pruning (early or late) was the main effect and pruning severity (heavy, moderate, light, or no pruning; Table 1) was the subplot effect. Plot size was 1.8 x 6 m. Treatments were repeated on each plot for two consecutive years. Pruning dates were 5 Dec. (1988 and 1989) and 9 Mar. (1989 and 1990) for the early and late treatments, respectively. A commercial pruner was used.

In Oct. 1989 and 1990, just before commercial harvest, yield component data were collected from three 3-dm^2 samples, pooled, from each plot. Total sample plant fresh weight, total number of uprights (U_T), number of nonfruiting uprights (U,), number of fruiting uprights (U,), average length of current season's growth of U_N and U_F (mean of 25 uprights randomly selected from sample), number of runners, number of U_F with one through six fruit or flower pedicels per upright, number of nonmarketable berries, and number and weight of marketable berries were noted. Total anthocyanin content of fruit was determined by extracting a 100-g sample of fruit with 95% ethanol (Sapers and Hargrave, 1987). Average berry size, percent fruit set, and percent U_F were calculated.

Timing of pruning did not influence yield components, suggesting that early pruning did not stimulate additional vegetative growth. Thus, data from the two pruning dates were pooled and analyzed as a randomized complete-block design. Analysis of variance and mean separations by a Waller test were done using the SAS statistical package (SAS Institute, Inc., 1987).

Unpruned and lightly pruned vines tended to produce more vegetative growth in 1989 than moderately or heavily pruned vines as expressed by a higher total sample plant fresh weight and U_F length (Table 2). More differences in vegetative growth were apparent after two consecutive years of pruning treatments. In 1990, the unpruned and lightly pruned vines had a higher total sample plant fresh weight and U_N length than moderately or heavily pruned vines. Also, unpruned vines had longer U_F than pruned vines. Unpruned vines tended to have more runners than those pruned, but none of the differences were significant (range 100-157 runner pieces).

Pruning severity treatment effects on reproductive growth were evident the first growing season after pruning, but differences among treatments were more pronounced after two consecutive seasons of pruning (Table 3). In 1989 and 1990, a negative relationship between yield and pruning severity was evident. Severely pruned vines yielded less than unpruned and lightly pruned vines (Table 3). Reduced yield resulted from fewer U_F, specifically U_1, U_2, and U_3. and fewer marketable berries (Tables 2 and 3). Moderate and heavy pruning tended to remove U_F along with runners, adversely affecting yield. Doehlert (1955) found even with careful removal of runner growth with hand shears that 7% of the uprights were removed. Chambers (1918) found a 10% reduction in yield the year after pruning, possibly also due to U_F removal by pruning.

Pruning severity did not affect percent nonmarketable fruit (2% to 8%) or berry weight (0.7 to 1.3 g) in either year, or fruit set in 1989 (Table 3). Thus, canopy density did not influence fruit rot, as suggested by Eck (1990). Contrary to our results, Eaton and Kyte (1978) observed a negative relationship between berry weight and U_T in

Table 1. Pruning severity treatments on 'McFarlin' cranberry in 1989 and 1990.

Pruning	Canopy depth (cm)	Estimated wt of prunings (t·ha⁻¹)
None	22	0
Light	20	1.8
Moderate	18	2.6
Heavy	16	4.3

Table 2. Effect of pruning severity on vegetative yield components of 'McFarlin' cranberry in 1989 and 1990.

Pruning	Total plant wt[z] (g/dm²)	Upright length[y] (mm) U_N	Upright length[y] (mm) U_F	No. uprights[z,x] U_T	U_N	U_F	U_1	U_2	U_3	U_{4-6}	U_F/U_T (%)
1989											
None	69.9 a[w]	53	60 a	603	404 a	199 a	58 a	70 a	48	25	35 a
Light	65.6 a	51	54 ab	633	460 ab	173 ab	53 ab	63 ab	42	15	27 ab
Moderate	44.1 b	45	50 ab	687	556 bc	131 b	41 b	48 b	30	13	19 bc
Heavy	51.6 ab	46	47 b	718	593 c	125 b	36 b	47 b	31	11	18 c
Significance	*	NS	*	NS	**	*	*	*	NS	NS	**
1990											
None	71.0 a	51 a	67 a	650	497	153 a	29 a	63 a	44 a	18	23 a
Light	59.1 b	49 a	53 b	680	580	100 b	20 ab	35 b	32 ab	12	15 b
Moderate	51.6 c	42 b	47 b	647	575	72 bc	18 b	25 b	20 bc	10	11 c
Heavy	50.5 c	42 b	45 b	694	635	59 c	15 b	21 b	17 c	6	9 c
Significance[v]	***	**	**	NS	NS	***	**	***	**	NS	**

[z]Sample area of 930 cm².
[y]Average of 25 randomly selected uprights.
[x]U_T = total no. uprights; U_N = No. nonfruiting uprights; U_1–U_6 = No. uprights with one to six pedicels, respectively; U_F = no. fruiting uprights = $\Sigma (U_1 + U_2 + U_3 + U_4 + U_5 + U_6)$.
[w]Mean separation within seasons by the Waller test, $P < 0.05$.
[NS,*,**,***]Nonsignificant or significant at $P < 0.05$, 0.01, or 0.001, respectively.

Table 3. Effect of pruning severity on fruiting characteristics of 'McFarlin' cranberry in 1989 and 1990.

Pruning	Fruit set (%)[z]	No. berries[y] Nonmarketable	No. berries[y] Marketable	Estimated yield (t·ha⁻¹)	Anthocyanin (mg/100 g)
1989					
None	50	12	206 a[x]	17.5 a	78.7
Light	57	15	195 a	16.0 ab	86.5
Moderate	48	10	122 b	10.4 bc	87.2
Heavy	54	10	132 b	9.7 c	87.0
Significance	NS	NS	*	*	NS
1990					
None	29 a	11	82 a	11.8 a	52.0 a
Light	41 ab	8	86 a	11.8 a	68.3 b
Moderate	45 b	4	70 ab	9.4 ab	73.0 b
Heavy	45 b	5	48 b	6.5 b	71.0 b
Significance	*	NS	**	**	*

[z]Fruit set = no. berries divided by total no. flowers.
[y]Sample area of 930 cm².
[x]Mean separation within seasons by the Waller test, $P < 0.05$.
[NS,*,**,***]Nonsignificant or significant at $P < 0.05$, 0.01, or 0.001, respectively.

'McFarlin'. Also, the relative importance of fruit set as a yield component varied with year and site (Eaton and Kyte, 1978). In 1990, pruning severity did affect fruit set (Table 3). Although the unpruned vines had a lower fruit set than moderately or heavily pruned vines, this was apparently compensated for by higher numbers of U_F and flowers, as unpruned vines tended to have a higher yield than moderately or heavily pruned vines (Table 3). In a study of seven cultivars, Eaton and MacPherson (1978) found that yield depended on U_F, but, in comparison, set was less important. The lower set in the unpruned plots was perhaps the result of denser canopies causing excessive dampness and shade and decreased accessibility of flowers by bees, preventing adequate pollination (Eck, 1990; Roberts and Struckmeyer, 1942). Eaton and Kyte (1978) found higher fruit set in less dense canopies. Shawa et al. (1981) suggested that in dense canopies of 'McFarlin', competition between vegetative growth (U,) and flower development may cause poor fruit set.

Berries from unpruned vines tended to have less anthocyanin in 1989, and in 1990, berries from unpruned vines had significantly less anthocyanin than those from pruned vines (Table 3). Reduced anthocyanin is certainly a disadvantage in cranberry production as color is a major factor in quality. Thus, heavy shading in the unpruned plots, as indirectly evidenced by a higher sample plant fresh weight, a trend for higher number of runners, U_F length, and U_N length, leads to reduced fruit set and less fruit anthocyanin (Tables 2 and 3).

The total number of upright shoots ranged from 603 to 718 per 930 cm². Thus, the upright density was much higher than the 200 to 300 uprights per equivalent unit area Roberts and Struckmeyer (1942) stated was an indication of optimum growth and maximum production. There was no difference in U_T among pruning treatments in 1989 and 1990. However, the proportion of U_F and U_N was affected by pruning. The number of U_N increased, whereas U_F decreased, with pruning severity (Table 2). Thus, pruning stimulated U_N growth. Percent U_F (U_F/U_T) was highest in the unpruned plots in both years, but in 1989 U_F was similar for unpruned and lightly pruned plots (Table 2). Values ranged from 18% in the heavily pruned plots to 35% in the unpruned plots in 1989. These proportions are similar to the 24% to 44% U_F found by Roberts and Struckmeyer (1942). However, percent U_F dropped much lower the 2nd year in all treatments, indicating a detrimental effect of consecutive-year pruning on fruiting (Table 2).

Date of pruning had no effect on yield components of cranberry. The unpruned and lightly pruned plots had higher yields than the moderately and heavily pruned plots due to a higher number of fruiting uprights and berries. However, lack of pruning after 2 years led to reduced fruit anthocyanin. Chambers (1918) found a 10% reduction in yield the year after pruning but a 45% increase in yield the 2nd year after pruning, indicating that alternate-year pruning may be preferred. Strik et al. (1991) noted percent return bloom in fruiting uprights was as low as 31% in 'McFarlin'. Thus, most of the current season's crop would be from upright shoots that were vegetative (U,) the previous year. Under such conditions, alternate-year pruning may favor higher yield than pruning every year. Our research suggests that pruning lightly (removal of <2 t•ha⁻¹ in a vigorous bed) in alternate years may lead to higher long-term yields without sacrificing fruit color.

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