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Date of Renovation Affects Fall and Summer Fruiting of June-bearing Strawberry

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Abstract. Two experiments were conducted to study the effect of date of renovation of strawberry (*Fragaria* x *ananassa* Duch.) on yield and yield components. In the first experiment, early-renovated (1 to 3 weeks after harvest—WAH) 'Benton' plants produced more trusses and flowers in fall 1988. However, in summer 1989, late-renovated plants (4 to 8 WAH) had more trusses and flowers, and higher yield. In a second experiment, 'Benton' plants that were renovated from 4 to 6 WAH produced the most trusses and flowers in fall 1989. 'Redcrest' responded similarly to 'Benton' in Experiment 1. 'Totem' produced no fall fruit in 1989. With regards to summer fruiting, these cultivars did not respond differently to date of renovation; renovation at 2 to 5 weeks after harvest had a positive effect on yield the following season in all three cultivars. However, renovation increased berry size in 'Totem' and delayed the date of harvest for 'Totem' and 'Redcrest' compared to non-renovated plants.

Introduction

Most growers in the Pacific Northwest keep strawberry plantings for at least three, and often four, fruiting seasons. Renovation is thus common both to prepare a planting for the next fruiting season, and to invigorate it with thoughts of increasing next season's yield. Renovation involves mowing off the foliage just above the crown, narrowing the rows in a matted row planting, controlling weeds, fertilizing, and irrigating. It is common for Oregon growers to renovate any time from right after harvest, about July 1, to early August. Certainly the value of this practice has been recognized, although the results have not been uniform.

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Previous research has shown that many factors can influence the effects of renovation (foliage removal), such as date of renovation (2,6,7), cultivar (2,7), location (1), and plant age and health before renovation (8).

The June-bearers, 'Benton' and Totem', are the predominant commercial cultivars grown in Oregon. 'Redcrest', recently released by the U. S. Department of Agriculture and Oregon State University breeding program, is also being planted.

The objectives of this research were to determine the effect of date of renovation on yield and yield components of 'Benton', 'Totem', and 'Redcrest' strawberry.

Materials and Methods

Two experiments were conducted at the North Willamette Research and Extension Center, Aurora, OR on a Latourell loam soil type. Plants were grown in a hill system at a spacing of 15 inches (38 cm) with 3 feet (0.9 m) between rows.

Experiment 1. Plots within a planting of 'Benton' (planted 1987) were renovated weekly from July 6, 1988 (one week after harvest—WAH) through August 24, 1988 (8 WAH). Renovation involved mowing off foliage above the crown, removing runners, and fertilizing and irrigating the plots. The experimental design was complete randomization with eight renovation treatments and five replicates with 12 plants in each replicate (plot). Since there was considerable fall fruiting in 1988, flower, truss, and runner number per plant were recorded non-destructively for each treatment. Runners were then removed to maintain plants in a hill system. The following summer, total fruit yield and average berry weight (average of 25 fruit at each harvest date) were collected from each plot. After harvest, flower number (counted pedicels), truss number, and crown number per plant were determined by destructively sampling three plants in each plot.

Experiment 2. Plants of 'Benton', 'Totem', and 'Redcrest' (planted in 1988) were renovated weekly from July 12, 1989

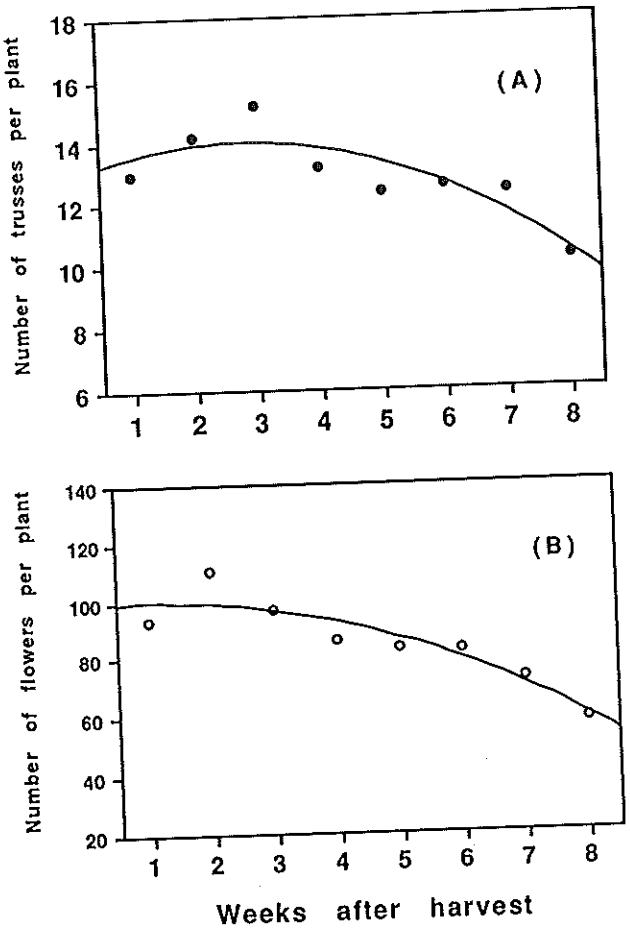

Figure 1. Relationship between date of renovation (weeks after harvest) of 'Benton' in 1988 and the number of trusses (A) and flowers (B) per plant in the fall of 1988. Equations for the lines: (A) $Y = 12.9 + 0.76X - 0.13X^2$, $R^2 = 0.75$; (B) $Y = 98.4 + 1.9X - 0.85X^2$, $R^2 = 0.87$.

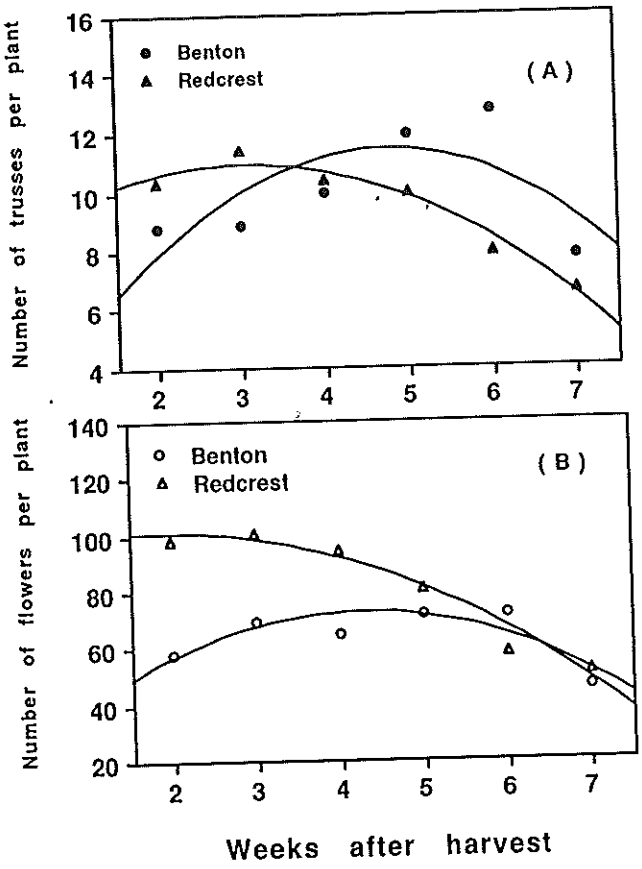

Figure 2. Relationship between date of renovation (weeks after harvest) of 'Benton' and 'Redcrest' in 1989 and the number of trusses (A) and flowers (B) per plant in the fall of 1989. Non-renovated plants produced 44 flowers and 7 trusses per plant for 'Benton' and 77 flowers and 10 trusses per plant for 'Redcrest', on average. Equations for the lines: (A) 'Benton', $Y = 4.8 + 3.5X - 0.47X^2$, $R^2 = 0.51$; 'Redcrest', $Y = 9.6 + 1.2X - 0.29X^2$, $R^2 = 0.96$; (B) 'Benton', $Y = 39.8 + 19.9X - 3.04X^2$, $R^2 = 0.71$; 'Redcrest', $Y = 99.3 + 3.5X - 2.1X^2$, $R^2 = 0.96$.

Table 1. Correlation coefficients between yield per plant in the summer of 1989 and yield components in the fall of 1988 for 'Benton'.

		Fall 1988		
		Trusses/ plant	Flowers/ plant	Runners/ plant
Summer 1989	Crowns/plant	-0.15	-0.02	-0.35
	Trusses/plant	-0.65	-0.81*	-0.68
	Flowers/plant	-0.66	-0.70	-0.88*
	Yield/plant	-0.85**	-0.85**	-0.86**

*, **: Significant at $P < 0.05$ and $P < 0.01$, respectively.

(2 WAH) through August 16, 1989 (7 WAH). Renovation procedures were the same as for Experiment 1. The six renovation treatments, plus a control or non-renovated treatment, were arranged in a completely random design with four replicates, 12 plants in each replicate.

In fall 1989, the number of flowers and trusses per plant (four plants/replicate) and the number of runners/plant (12 plants/replicate) were recorded non-destructively for each treatment. Prior to harvest the following summer, flower and truss number per plant were recorded for the same four plants as measured the previous fall. Total fruit yield, berry weight, and the number of crowns, trusses, and flowers per plant were recorded as for Experiment 1.

Data were analyzed by one-way analysis of variance (ANOVA), multiple factors (sub-sampling) ANOVA, and simple and multiple regression analysis (9).

Results and Discussion

Fall fruiting. There was fall fruiting on 'Benton' in 1988 (Experiment 1) and 1989 (Experiment 2) and on 'Redcrest' in 1989 (Experiment 2); 'Totem' had essentially no fall fruit in 1989 (Experiment 2). Although the fall crop is of no commercial significance because yields are typically low, we felt it was important to study the effects of date of renovation on fall fruiting.

Early renovation (1 to 3 WAH) of 'Benton' led to a greater number of flowers produced in the fall of 1988 (Fig. 1). This increase in flower number was the result of an increase in the number of trusses per plant (Fig. 1). Thus, early renovation and the subsequent early stimulation of growth and flower bud initiation led to greater fall fruiting. The greater flower number on early-renovated plants may have been the result of earlier flower initiation (4,11) and/or larger plants and thus more sites for flower bud induction (10).

In fall 1989, although there was also considerable fall fruiting, 'Benton' responded differently to date of renovation than in fall 1988 (Fig. 2). In fall 1989, the peak shifted with renovation from July 26 to Aug. 9 (4 to 6 WAH), leading to the greatest amount of truss and flower production. The control, or non-renovated, plants had similar fall fruiting to those renovated 2, 3, or 7 WAH. In 'Benton', the difference in response of fall fruiting to renovation in 1988 and 1989 may have been due to temperature differences between the two preceding summers. Mean summer temperature in 1988 was 5°F (3°C) warmer on average than in 1989 for the period of Aug. 7-Sept. 7. 'Redcrest' responded similarly to date of renovation as 'Benton' did in fall 1988 with early (1 to 3 WAH) renovation leading to greater fall fruit production (Figs. 1 and 2). 'Totem' had no fall fruiting in 1989 for any of the treatments.

Summer fruiting. Experiment 1. In 'Benton' there was a significant negative correlation between yield in the summer of 1989 and truss, flower, and runner number per plant the previous fall across all treatments (Table 1). Thus, early renovation in 1988 (1 to 3 WAH) led to greater fall yield, expressed in terms of truss and flower production (Fig. 1), but resulted in lower yield the following summer (Fig. 3A). These results contradict those of Guttridge and Wood (3) and Guttridge and Mason (2) who found that delaying defoliation reduced yield in 'Talisman', 'Redgauntlet', and 'Cambridge Favourite'. Mason (5) found that early renovation had little effect whereas late renovation increased yield.

Experiment 2. In the summer of 1990, 'Totem' had a significantly lower yield per plant on average than 'Benton' (Table 2). However, despite differences in fall fruiting, all cultivars responded similarly to date of renovation with regards to yield the following summer (Table 2); thus the data for all cultivars were pooled to determine the treatment effect on yield (Fig. 3B). The early-renovated plants (5 WAH or earlier) had higher average yields than late-renovated (6 and 7 WAH) or non-renovated plants in all 3 cultivars (Fig. 3B). These findings agree with those of Guttridge and Wood (3) and Guttridge and Mason (2). However, Moore (6) found that defoliation reduced yield compared to non-defoliated plants. In our study, unlike Nestby's (7), cultivars did not differ in the effect of date of defoliation on summer fruiting.

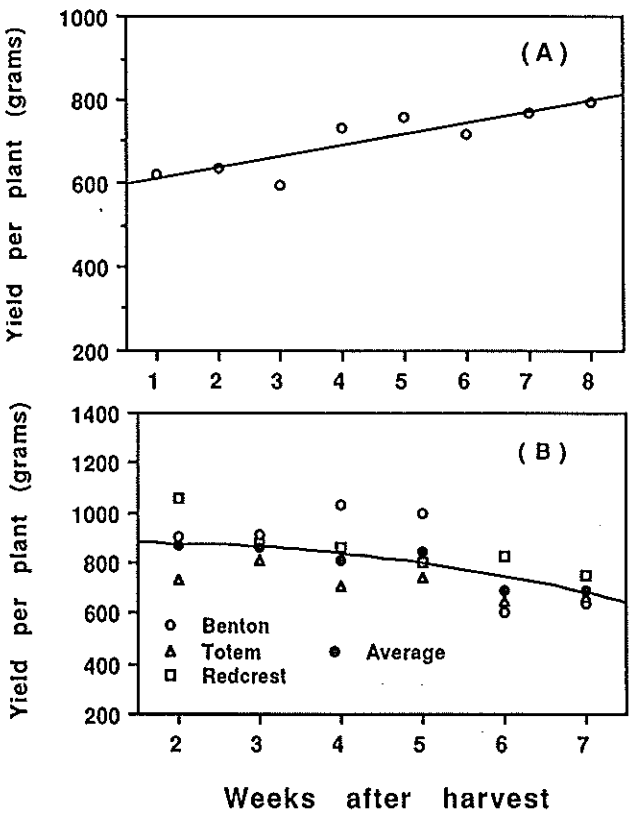

Figure 3. Effect of date of renovation (weeks after harvest) of 'Benton' in 1988 (A) and 'Benton', 'Redcrest', and 'Totem' in 1989 (B) on yield per plant the following summer. Equations for the line: (A) $Y = 580 + 27.3X$, $R^2 = 0.78$; (B) average for all cultivars, $Y = 872 + 7.18X - 6.77X^2$, $R^2 = 0.84$.

Table 2. Effect of date of renovation in 1989 on the yield per plant and fruit size of 'Benton', 'Redcrest', and 'Totem' in summer 1990.

Date of Renovation (1989)	WAH[z]	Benton		Redcrest		Totem	
		Yield/Plant (g)	Berry Size (g)	Yield/Plant (g)	Berry Size (g)	Yield/Plant (g)	Berry Size (g)
7/12	2	901	9.9	1055	6.7	713	10.9
7/19	3	911	10.0	875	6.5	810	11.5
7/26	4	1034	9.7	856	6.6	705	11.5
8/2	5	999	10.3	800	6.6	736	11.6
8/9	6	601	8.6	828	7.7	644	11.8
8/16	7	639	8.6	747	7.2	660	11.3
non-renovated		683	10.0	667	7.1	659	9.0
LSD		328	1.8	372	1.4	202	1.3
significance		NS	NS	NS	NS	NS	0.01

[z] Weeks after harvest.

Comparing the early-renovated treatments (5 WAH or earlier) to the non-renovated controls, the average yield per plant increased 41% for 'Benton', 12% for 'Totem', and 34% for 'Redcrest' with renovation (Table 2). Higher yields were due to greater numbers of crown, trusses, and flowers/plant (data not shown).

Compared to non-renovated plants, renovation increased berry size in 'Totem' (Table 2) and delayed the date of harvest for 'Totem' and 'Redcrest' (20% lower yield on first pick). Moore (6) found a reduction in berry weight with late defoliation.

Date of renovation was observed to affect winter hardiness. Temperatures in Feb. 1989 dropped to as low as 8°F (-13°C) at the North Willamette Research and Extension Center. This led to winter injury of 'Benton' with a significant treatment effect. Plants renovated late the previous summer (from 6 to 7 WAH) were most injured and had smaller plant size and less leaf area than those renovated from 2 to 5 WAH and non-renovated plants in June 1990 (data not shown). Thus, non-renovated and early-renovated plants sustained less winter injury than late-renovated ones. Temperatures in winter 1989/1990 were not cold enough to draw conclusions about cultivar differences in Experiment 2.

Conclusions

In some years, the June-bearing cultivars 'Benton', 'Totem', and 'Redcrest' fruit in the fall. The fall fruit comes on after the commercial summer crop, but yields are too low to make harvesting the fall crop economical. Date of renovation had an effect on fall fruiting of 'Benton' in 1988 and 1989 and on 'Redcrest' in 1989. Fall fruiting was negatively correlated with yield the following summer in 'Benton', indicating that fall fruit production can adversely affect the commercial summer crop the following year.

With regards to summer fruiting, cultivars did not respond differently to date of renovation. However, renovation did have a positive effect on yield the following season in all three cultivars. Early renovation (prior to 5 WAH) led to significantly higher yield in 'Benton', 'Totem', and 'Redcrest' compared to non-renovated plants. Thus, we recommend early renovation rather than late renovation based on these results. However, cultivars may respond differently with year due to environmental conditions, as was the case in 'Benton'.

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