Management of Primocane-Fruiting Blackberry to Maximize Yield and Extend the Fruiting Season

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Abstract

'Prime-Jan' and 'Prime-Jim' were studied in a field planting established in June 2003 in Aurora, Ore., USA. Primocane management treatments studied were: 1) primocane-only cropping with no manipulation [un-tipped]; 2) double cropping with no primocane manipulation [primocane + floricane crop]; 3) primocanes "soft-tipped" at 1 m to encourage branching; and 4) rowcovers used in late-winter to early-spring to advance primocane growth; treatments 1, 3, and 4 were a primocane crop only. 'Prime-Jan' had a higher floricane yield than 'Prime-Jim' (6.1 vs. 4.0 t/ha), but a smaller berry size (4.0 vs. 4.6 g; $P \leq 0.01$). Primocanes that grew in the presence of floricanes were significantly longer (2.5 m) than un-tipped canes (2.1 m) in both cultivars. On average, the un-tipped primocanes of 'Prime-Jan' were shorter than those of 'Prime-Jim'. On 14 July 2004, primocanes in most treatments were just starting to flower and fruit harvest began on 16 Aug. Use of rowcovers in 2005, advanced bloom 14 d (24 June) compared to un-tipped canes. The 50% yield date was 7–14 Sept. for 'Prime-Jim', depending on treatment and 14 Sept. for 'Prime-Jan'. Rowcovers increased yield, compared to un-tipped, non-covered plots. Soft-tipped primocanes had up to three fold the yield of un-tipped canes (5.2 vs. 1.8 t/ha). We stopped picking in mid-Oct. due to poor weather, but at that time there were still flower buds, flowers, and un-ripe fruit present on most treatments.

INTRODUCTION

The new primocane-fruiting blackberries, 'Prime-Jan' and 'Prime-Jim', released by the University of Arkansas in 2004, show promise for high-value fresh markets worldwide. Primocane-fruiting blackberries, like primocane-fruiting raspberries, should be adapted to a diverse range of climates, particularly as cold hardiness is not an issue when plants are grown for a primocane crop only. Primocane-fruiting blackberries can produce two crops per season, one on the floricane and the other on the primocane. Drake and Clark (2003) showed that double cropping (floricane + primocane crop) did not reduce the yield of the primocane crop in Arkansas. They suggested that these blackberries would be ideal to extend the season, but protected culture may be necessary in some regions and production systems needed to be developed (Drake and Clark, 2003).

Trailing, erect, and semi-erect blackberries induce flower buds under the short days of autumn, winter, or spring depending on cultivar and location (Takeda et al., 2002, 2003). Primocane-fruiting blackberries initiated flower buds after a short period of growth (Lopez-Medina et al., 1999) and growth and flowering were enhanced when root cuttings were chilled (Lopez-Medina and Moore, 1999). Primocane-fruiting blackberries might induce flower buds independently of photoperiod and temperature (Lopez-Medina et al.,

1999), as has been shown in primocane-fruiting raspberries (Takeda, 1993). In primocane-fruiting raspberry, fruiting season can be modified by advancing or delaying primocane growth using rowcovers. Primocane-fruiting raspberries can also be manipulated to produce fruit at most times of the year in tunnels to target high-priced niche markets (Pritts et al., 1992).

Research in primocane-fruiting raspberry showed that primocane tipping affected fruiting season and yield. "Hard tipping" (removal of 30 cm) 'Heritage' primocanes to 1 m delayed fruiting (Jordan and Ince, 1986; Richter et al., 1989). The effects of "soft-tipping" (removal of 2 to 5 cm) primocane-fruiting blackberry primocanes on yield and berry size depended on when the tipping was done (Drake and Clark, 2003). "Soft tipping" when inflorescences appeared or later reduced primocane yield and berry weight compared to un-tipped canes (Drake and Clark, 2003). Tipping of individual plants and canes may not be representative of results found when manipulating whole plots and the resulting changes in canopy and light interception. Also, Drake and Clark (2003) suggested that other tipping treatments and studies in a milder climate than that of Arkansas would allow for more rapid development of a production system for this new crop.

The objectives of this study were to determine the impact of primocane tipping, rowcovers, and double-cropping on the fruiting season, yield, and quality of primocane-fruiting blackberry.

METHODS AND MATERIALS

Tissue-cultured plugs of 'Prime-Jan' and 'Prime-Jim' were planted on June 3, 2003 at Oregon State University's North Willamette Research and Extension Center, Aurora, Ore., USA [lat. 45°17 ´N, long. 122°45 ´ W; U.S. Dept. of Agriculture (USDA) hardiness zone 8; elev. 46 m above sea level; average last freeze date 17 April; average first freeze date 25 Oct.; the weather records for this site can be viewed at Anonymous (2005)]. The soil type was Quatama loam (fine-loamy, mixed, mesic Aqualtic Haploxeralfs). Plants were spaced 0.6 m in the row with 3 m between rows. Five-plant plots were 3m long with 3 m separating plots. There were four replicates of the following treatments arranged as a randomized complete block design: 1) primocane-only cropping with no manipulation [un-tipped]; 2) double cropping with no primocane manipulation [primocane + floricane crop]; 3) primocanes "soft-tipped" [2 to 5 cm of the tip removed] at 1 m to encourage branching; and 4) rowcovers used in late-winter to early-spring to advance primocane growth. In treatments 1, 3, and 4 only the primocane crop was harvested.

In the planting year, plants grew, un-trained and un-manipulated. In spring 2004, the short floricanes were removed from all plants and the primocane treatments (1–3) were initiated. All treatments were repeated in 2005.

The field was drip irrigated (3.8 L/hr emitters at 0.6 m spacing) as required; typically 30 min/d (7.6 L/d) from June through Sept. Plots were fertilized with 55 $kg \cdot ha^{-1}$ of N, 35 $kg \cdot ha^{-1}$ of P, and 66 $kg \cdot ha^{-1}$ of K each spring and an additional 28 $kg \cdot ha^{-1}$ of N at primocane bloom. Weeds were controlled by use of preemergence herbicides and mechanical methods. Blackberry row width was maintained at 45 cm using cultivation. Canes were trained between double sets of trellis wires located at 30 cm and 1.7 m high, but were not tied to the wires. In late October 2004 and 2005, all primocanes were removed from treatments 1–3 for data collection. In treatment 2, where floricanes were retained, no pruning of floricanes was done, as it was not clear which parts of the canes were going to fruit the following season or were dead.

In treatment 3, primocanes were soft-tipped to 1 m several times during the growing season, from 1–14 June 2004 and 15–29 June 2005 to catch the various flushes of cane growth. In treatment 4, rowcovers (5 mm, white spun bound polyester 85% transparent, 1.1 to 2.2°C; Reemay, Inc., Old Hickory, Tenn.) were placed over the plots before primocane emergence and removed when primocanes got too tall for un-impaired growth under the cover (~ 30 to 45 cm tall); dates for rowcover treatments were 31 Mar.

to 3 May 2004 and 22 Feb. to 20 Apr. 2005.

Data collected per plot included date of first bloom on primocanes, marketable yield, weight of non-marketable fruit, average berry eight (25 berries per harvest date), date of first and last harvest, and primocane growth (measured every 2 weeks on 3 canes/plot). Analysis of variance was performed for treatment effects using the GLM procedure in SAS (SAS Institute Inc., 1999).

RESULTS AND DISCUSSION

Primocane Growth

Primocane growth was affected by cultivar and primocane management treatment in 2004 and 2005. On average, the un-tipped primocanes of 'Prime-Jan' (Fig. 1) were shorter than those of 'Prime-Jim' (data not shown). In 2005, by the end of the season, soft-tipped canes (treatment 3) had less total growth on average (1.5 m) than un-tipped canes (2.1 m), although branches were included in the measurements (Fig. 1). Un-tipped primocanes that grew in the presence of floricanes (treatment 2) were significantly longer (2.5 m) than un-tipped canes without floricanes retained (2.1 m) in both cultivars. Rowcovers had no significant effect on average primocane length (2.3 m) by the end of the season. Results for 2004 were similar (data not shown).

Bloom and Harvest Season

Date of first bloom on the primocanes (four open flowers) and cane height at bloom were not affected by cultivar in either year and were only affected by primocane management treatment in 2005. Primocanes averaged 1.5 m in height at bloom on 14 July 2004. In 2005, primocanes that grew in the presence of floricanes (treatment 2) averaged 2.2 m in height at bloom, significantly taller than the other treatments (averaged 1.3 m). Un-tipped primocanes in the double-cropping plots (treatment 2) bloomed on 22 July 2005, 8 d later than un-tipped canes in treatment 1. Use of rowcovers in 2005 advanced bloom 14 d (24 June) compared to un-covered canes. Rowcovers did not have an effect on bloom date in 2004, likely because the rowcovers were not applied early enough to significantly advance growth. Date from first bloom to first black fruit was not affected by cultivar or treatment and averaged 36 and 43 d in 2004 and 2005, respectively.

Date of first fully black fruit was not affected by cultivar in either year and only by primocane management treatment in 2005. In 2004, black fruit were observed on 20 Aug., on average. In 2005, rowcover treatment plots had black fruit on 14 Aug., un-tipped and soft-tipped treatments on 25 Aug. (on average, not significantly different) and primocanes in double-cropped plots on 5 Sept., significantly later than all other treatments. However, only 1% to 7% of total yield was harvested on 16 Aug. for 'Prime-Jim' and 0.5 to 1.5% for 'Prime-Jan' in 2004 (data not shown).

The 50% yield date (half crop harvested) in 2004 was 7–14 Sept. for 'Prime-Jim', depending on treatment and 14 Sept. for 'Prime-Jan'. In 2005, the fruiting season was later with only 0 to 1.5% of total yield harvested on 15 Aug. for both cultivars (Fig. 2). Cumulative yield for 'Prime-Jan' in 2005 is shown in Figure 2; 'Prime-Jim' responded similarly. Plots in which rowcovers were used in late winter to advance primocane growth produced fruit earlier than other treatments (Fig. 2). We stopped picking in mid-October in both years due to rain, but at that time there were still flower buds, flowers, and unripe fruit present on most treatments. A high tunnel would have allowed for much later harvest and would have protected fruit from sunburn which was a problem in late August due to high temperatures and/or light intensity. The floricane crop (treatment 2) had a fruiting season from 30 June to 22 Aug. 2005.

Yield and Fruit Quality

Cultivar and primocane management treatment had a significant effect on yield and berry weight with no significant interactions (Table 1). Soft-tipped canes had up to three fold the yield of un-tipped canes. The "double-cropped" plots in 2004 had just

primocanes and were thus similar to the un-tipped treatments. Thompson et al. (2005) studying 'Prime-Jan' and 'Prime-Jim' in the same field found that tipped primocanes developed twice the amount of flowers than did un-tipped canes. Rowcovers increased yield compared to un-tipped non-covered plots (Fig. 2). Primocanes that grew in the presence of floricanes ("double-cropping") did not have a reduced yield even though these fruited later, as described previously. In 2005, 'Prime-Jan' had a significantly higher ($P \leq 0.05$) floricane yield than 'Prime-Jim' (6.1 vs. 4.0 t/ha), but a smaller berry size (4.0 vs. 4.6 g; $P \leq 0.01$).

Berry size was affected by primocane management only in 2004 where soft-tipped canes produced larger fruit (Table 1). Percent fruit rot was significantly affected by year and was only reduced by soft-tipping in 2004.

CONCLUSIONS

'Prime-Jan' and 'Prime-Jim' primocane fruiting blackberry responded similarly to primocane management treatments. In Oregon, the fruiting season for the floricane crop was from 30 June to 22 Aug. and the primocane crop was harvested from early August through mid-October when harvest was curtailed due to poor weather. Soft-tipping increased yield and rowcovers, when placed on plots in late winter, could advance the fruiting season. This type of blackberry shows great promise for season extension. However, it is apparent that primocane-fruiting blackberries benefit greatly from tipping, a key production difference from primocane-fruiting raspberry.

ACKNOWLEDGEMENTS

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Tables

Table 1. The effect of cultivar and primocane management system on yield, fruit size, and percent fruit rot in 2004 and 2005.

Primocane management	'Prime-Jan'			'Prime-Jim'		
	Yield (kg/plot)	Berry size (g)	Fruit rot (%)	Yield (kg/plot)	Berry size (g)	Fruit rot (%)
2004						
Un-tipped	2.9	6.8	12.9	1.6 a[x]	5.9 a	12.7 a
Double-cropping[z]	3.2	7.0	9.5	1.6 a	5.2 a	11.6 a
Soft-tipped	4.9	7.2	8.6	4.8 b	7.0 b	6.8 b
Rowcovers	3.8	7.4	12.0	1.9 a	5.8 a	12.1 a
Significance[y]	NS	NS	NS	***	*	**
2005						
Un-tipped	1.9 a	6.2	4.2	2.2 a	5.8	3.9
Double-cropping[z]	1.6 a	5.7	2.7	2.2 a	6.6	5.3
Soft-tipped	5.5 b	5.5	4.5	5.0 b	6.3	3.6
Rowcovers	4.0 c	5.8	1.9	2.9 ab	6.3	2.6
Significance[y]	***	NS	NS	*	NS	NS

[z] Double-cropping yields in this table were for the primocanes only in both years. In 2004, floricanes were absent. However, results for 2005 show the effect of floricanes on yield of primocanes.
[y] NS, *, **, ***= Non-significant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively, within year.
[x] Means followed by the same letter within years are not significantly different, $P > 0.05$.

Figures

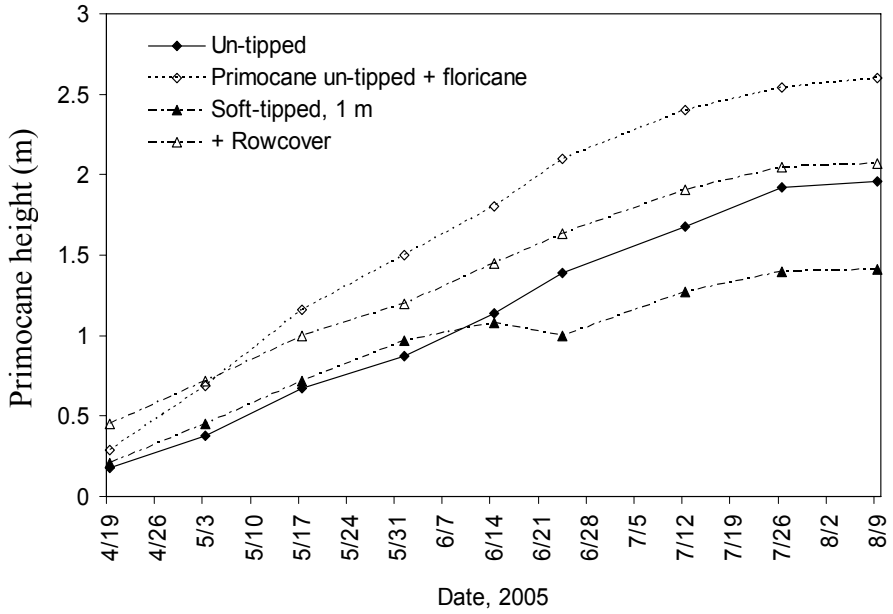

Fig. 1. The effect of primocane management treatment on primocane growth of 'Prime-Jan' in 2005.

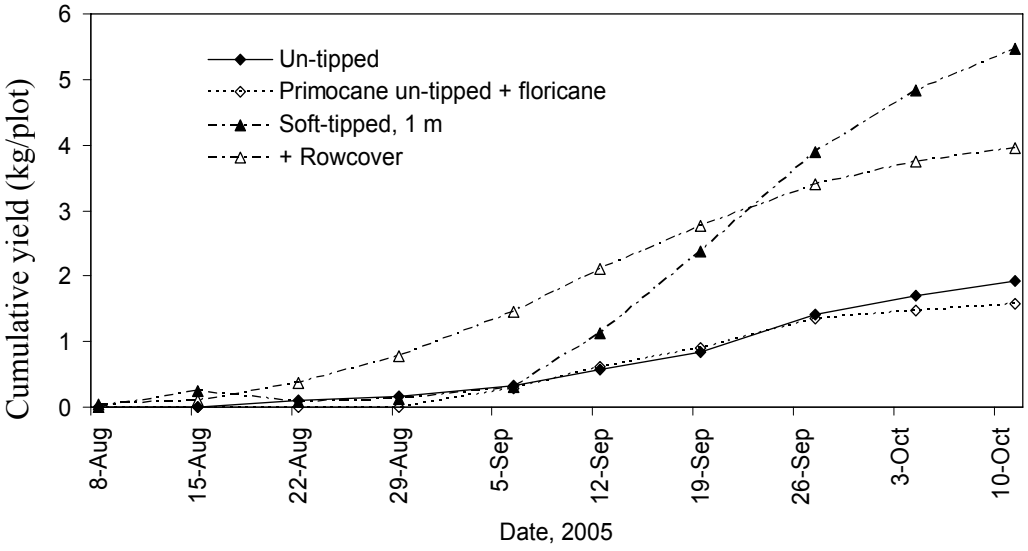

Fig. 2. The effect of primocane management treatment on cumulative yield (kg/plot) of 'Prime-Jan' in 2005.