Reducing Thorn Contamination in Machine Harvested 'Marion' Blackberry

B. Strik
Department of Horticulture
Oregon State University
4017 ALS, Corvallis
OR 97331-7304, USA
e-mail: strikb@bcc.orst.edu / fax: 541-737-3479

G. Buller
Research Assistant
NWREC
Oregon State University

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Abstract

Thorn contamination, particularly of old leaf petioles, can be a problem in machine harvested 'Marion' blackberry. The objectives of this study were to determine whether various pre-harvest treatments could reduce thorn contamination of machine harvested 'Marion' fruit. We evaluated eight treatments: 0.6% copper chelate (Cu EDTA) applied on Nov. 2, 1999 or Dec. 3, 1999; ethephon (Nov. 2, 1999); 1.2% copper chelate (Jan. 26, 2000); a Littau mechanical harvester with standard rotary heads followed by a Littau harvester equipped with brushing heads (Feb. 4, 2000); a harvester with brushing heads (Feb. 4, 2000); 0.6% copper chelate (Nov. 2, 1999) + a harvester with brushing heads (Feb. 4, 2000); and an untreated control. The study was done in an every year (EY) and an alternate year (AY, in the fruiting year) mature 'Marion' field. The rotary harvester followed by brushing removed 2.8 and 0.8 kg debris per plot in the AY and EY systems, respectively. Brushing alone removed 0.7 kg/plot in both the EY and AY systems. The winter treatments had no significant effect on yield per plot, percent bud break or fruit/lateral the following season. There was no treatment effect on the thorn contamination in harvested fruit. This was likely a reflection of the number and quality of the sorters this grower had on the machine. When we evaluated treatments for reduction of total contaminants (harvested fruit + sorted out or cull fruit), the machine harvester followed by brushing treatment reduced petioles/plot by 66% compared to the untreated control in the AY field. The amount of petiole contaminants was lower in the EY field, but there was no treatment effect. Winter removal of debris using a rotary harvester followed by brushing shows promise for subsequent reduction of petiole thorn contaminants in 'Marion', particularly in AY fields.

INTRODUCTION

Oregon is the world's leading blackberry production region with 3,130 hectares and 23,572 tonnes harvested in 2000. In 1992, 85% of the trailing blackberry production was estimated as being harvested by machine (Strik, 1992). Although no survey has since been done, the amount of production harvested by machine has decreased. Although high labor costs and relative poor availability of labor does not make hand harvest as economical as machine harvest (Eleveld et al., 2001), machine harvesting has become less common due to concern with harvest contaminants, particularly in thorny cultivars. 'Marion' trailing blackberry accounted for 57% of the hectarage planted in 2000. Over 99% of the total production was processed. 'Marion' is highly valued by the processing industry for its high-flavored, aromatic fruit with small seed size. However, 'Marion' is thorny (Finn et al., 1997). Machine harvest is preferred due to economic considerations (Eleveld et al., 2001) and because machine-harvested fruit have higher flavor, soluble solids and anthocyanin content than hand-harvested fruit (Booster and Bullock, 1965; Martin and Lawrence, 1983; Morris et al., 1978).

In a thorn survey done in 1998 (Strik, unpublished), thorn content in machine-harvested fruit was high relative to hand-harvested fruit. "Thorn" contaminants ranged from large, woody thorns originating from floricanes, small thorns, likely originating from fruiting laterals, pedicels, sometimes with berries attached, and petioles. Although 'Marion' is deciduous, leaves often do not senesce in our mild winters or the leaflets abscise and the petiole is persistent. Thus, these old (last year's) petioles can be dislodged and fall into the fruit during machine harvest. The processing industry considers thorns one of the most serious biological contaminants of 'Marion' (Oregon Raspberry and Blackberry Commission, personal communication). Fall applications of ethephon were found to hasten leaf abscission in eastern thornless blackberry (Kraut et al., 1986). Also, copper chelate has been successfully used as a defoliant in the ornamentals nursery industry in Oregon (Fuchigami, personal communication). The objectives of this study were to determine if various pre-harvest treatments could reduce thorn contamination of machine-harvested 'Marion' fruit.

MATERIALS AND METHODS

This experiment was conducted in a commercial field of mature 'Marion' blackberry in Keizer, Oregon. The fields used were maintained in either the alternate year (AY) production system or in the every year (EY) production system (Strik, 1992). In this study, two separate fields were used in 1999/2000: 1) in the "on year" of AY production established in 1978 at a plant spacing of 1.8 m in the row and 3m between rows with primocanes trained as they grew in 1999; and 2) an EY field established in 1997 at a spacing of 1.5 m by 3m with primocanes trained in August, 1999. The grower applied the anti-desiccant VaporGard (Miller Chemical and Fertilizer Corp., Hanover, PA; a.i. 96% di-1-p-Menthene) at a rate of 7.6 liters product in 935 l water per hectare on December 1, 1999.

We evaluated the following treatments: I. 0.6% Copper Chelate, applied Nov. 2, 1999; II. 0.6% Copper Chelate (Dec., 1999); III. Ethephon at 1086 ppm (Nov. 2, 1999); IV. 1.2% Copper Chelate (Jan. 26, 2000); V. one pass of a mechanical harvester with standard rotary heads followed by a harvester equipped with brushing heads (Feb. 4, 2000); VI. one pass of a harvester equipped with brushing heads (Feb. 4, 2000); VII. Treatment I + treatment VI; and VIII. an untreated control.

Copper chelate (Hampshire Chelates, HAMP-ENE 10.5% Cu EDTA) was applied as 86 g product in 8.34 l water per plot for treatments I, II, and VII and 172 g product in 8.34 l water per plot for treatment IV. Sprayer output was 934 l per hectare. Ethephon (Micro Flo Co., Ethephon 2, 21.7% [2-chloroethyl) phosphoric acid] was applied with X-77 spreader-sticker at a rate of 234 ml product + 117 ml X-77 per ha in 18.9 l per plot. There were 5 replicates arranged in a completely randomized design. Each plot was 30.5m of row length.

The mechanical harvester used was a Littau (Littau Harvesters Inc., Stayton, Ore.) with two free-wheeling rotary picking heads equipped with fiberglass rods that moved in a horizontal motion. In treatments V, VI and VII we used a similar machine harvester modified with brushing heads instead of picking heads.

Pre-counts of leaf petiole number were done before treatment application and before bud break in spring, 2000 on a 1 m^2 section of row. Debris was collected and weighed after the machine harvest/brushing treatments (V, VI and VII).

Treatments were machine harvested by the grower in July, 2000 using the same rotary picking machine we used for treatment V. We estimated yield by counting the number of crates (~ 5.5 kg each) harvested per plot. A 400 to 800 gram sub-sample of machine-harvested fruit was collected and frozen for later evaluation of thorn content; this was done on each of the five harvest dates for each plot. The culls/sort outs collected by the four people sorting on the machine were collected for each plot on each harvest date and weighed. For all but the first harvest date, the number of petioles and pedicels with and without fruit attached in each sample were counted.

After fruit harvest, the number of fruiting sites on a sub-sample of 20 laterals/plot was counted. Data were analyzed using PROC GLM analysis of variance and a protected LSD for mean comparisons (SAS Institute, Cary, NC, USA).

RESULTS

Debris Removal

In the AY field, the machine harvester followed by brushing (treatment V) removed an average of 2.1 kg debris (leaves and petioles) per plot, whereas brushing alone (treatment VI) removed 0.7 kg. In the EY field, treatments V and VI removed 0.4 kg and 0.7 kg of debris, respectively. Leaf and petiole counts in spring, 2000 indicated that only the rotary harvester + brushing (V) removed a significant number of petioles ($65/m^2$) compared to the untreated control ($82/m^2$) in the AY field. In the EY field, treatments V ($29/m^2$), VI ($26/m^2$), and VII ($31/m^2$) reduced leaf and petiole counts compared to the untreated control ($51/m^2$).

Yield

The winter treatments had no significant effect on yield per plot, percent bud break or fruit/lateral the following season (data not shown). Percent bud break and the number of fruit/lateral were higher in the EY field, but yield was about 40% higher in the AY field.

Cull Counts

The treatments had little effect on the amount of debris or cull weight in the EY field; this represents the weight of the "junk" removed from the sorting belt on the machine harvester, after the fan, including leaves, fruit with stems attached and petioles and pedicels (data not shown). However, in the AY field the 1.2% copper chelate (IV) and the machine harvester followed by brushing (V) reduced cull weight (4.6 and 4.6 kg/plot for the season, respectively) compared to the untreated control (5.2 kg/plot).

There was no treatment effect on the number of berries with pedicels attached and pedicels per plot in either the AY or EY field (data not shown). However in the AY field, treatment V reduced the number of last year's petioles in machine-harvested cull fruit by 66% compared to the untreated control (16 petioles/plot compared to 48 for the control). Brushing alone (VI) did not significantly reduce the number of petioles/plot in the cull. However, the 0.6% copper chelate followed by brushing (VII) and the 1.2% copper chelate (IV) did reduce petiole counts by 45% compared to the control. There was no treatment effect on the number of petioles per plot in the cull from the EY field (data not shown).

Harvested Fruit Counts

Only the fruit from treatments IV through VIII were fully evaluated for thorn content, as there were no effects of treatments I – III on in-field petiole counts, cull data, or fruit contamination based on a pre-count from a representative number of replicates.

There was no treatment effect on the thorn contamination (petioles, pedicels or large thorns) in harvested fruit in the AY or EY field (data not shown).

Total Level of Contamination in Field

The amount of contaminants that end up in the harvested fruit is very dependent on the number of sorters on the machine harvester. This particular grower had four sorters on the machine (a high number compared to typical commercial practice); these workers were very good at finding petioles as the fruit moved on the sorting belt. Thus, to provide a measure for the total level of contaminants or how "clean" the field was prior to harvest, we added the contaminants in the cull fruit and harvested fruit to arrive at a seasonal total per plot.

In the AY field, there was no treatment effect on the number of pedicels or berries with pedicels attached (Table 1). However, the machine harvester followed by brushing (treatment V) reduced petioles/plot by 66% compared to the untreated control (Table 1). The amount of petiole contaminants was lower in the EY field, but there was no treatment effect.

DISCUSSION

The winter machine harvester treatments or defoliant applications had no negative impact on yield, percent bud break or fruit/lateral indicating plants were not damaged. Kraut et al. (1986) found that fall ethephon application caused leaf abscission in semi-erect blackberry cultivars with no adverse effect on yield. To our knowledge, there has been no previous study of using machine harvesters in winter to clean up the field of debris. The rotary machine harvester followed by brushing was more successful at removing debris in winter than brushing alone; we did not test a rotary harvester alone. EY fields are much less vigorous than AY fields, as was indicated by less debris removal.

Winter debris removal treatments had no effect on the level of contamination of next season's pedicels (alone or with fruit attached), as expected.

No treatment significantly reduced the level of thorn contamination in harvested fruit (after sorting on the machine) in the AY or EY field. This was likely a reflection of the number and quality of the sorters this grower had on the machine. Most growers typically have one person moving full and empty flats and helping with sorting and one full-time sorter on the machine; this grower had four workers sorting and moving flats. Their effectiveness was reflected in having a significant treatment effect on the cull fruit weight and content of petioles in cull fruit in the AY field.

When contamination in cull and harvested fruit were extrapolated to a per plot basis (as cull data were per plot), the machine harvester followed by brushing treatment reduced petiole contamination in the AY field. The copper chelate treatments we evaluated were low rates and it would be worth trying this defoliant at higher rates (3-6%). In general, thorn contamination was lower in the EY field, due mainly to these fields being less vigorous than AY fields. In this study, the EY field was also younger, and thus less vigorous, than the AY field. Treatments had no impact on the level of contamination in the EY field.

Winter removal of debris using a rotary harvester followed by brushing shows promise for subsequent reduction of petiole thorn contaminants in 'Marion', particularly in AY fields. Further work is in progress.

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Tables

Table 1. The effect of winter defoliant and mechanical debris removal treatments on the level of thorn contaminants in the field (cull + harvested fruit) of 'Marion' blackberry grown in alternate year (AY) and every year (EY) production systems in 2000.

Treatment	Berries + pedicels (no./30 m row)	Pedicels (no./30 m row)	Petioles (no./30 m row)
AY			
IV. 1.2% Cu, 1-26-00	301.6	91.7	44.8 ab
V. Rotary harvester + Brushing, 2-4-00	331.4	70.4	24.1 b
VI. Brushing, 2-4-00	350.4	78.7	65.9 a
VII. I + VI	381.8	92.7	57.0 a
VIII. Untreated control	245.8	78.1	71.2 a
Significance[z]	NS	NS	$P<0.05$
EY			
IV. 1.2% Cu, 1-26-00	156.4	59.0	13.7
V. Rotary harvester + Brushing, 2-4-00	150.7	57.0	12.1
VI. Brushing, 2-4-00	138.1	54.0	19.4
VII. I + VI	190.2	65.4	23.2
VIII. Untreated control	165.0	53.6	19.0
Significance[z]	NS	NS	NS

[z]NS=non-significant