Do Primocanes and Floricanes Compete for Soil Water in Blackberry?

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Introduction

Though blackberry is a perennial crop, its shoots are biennial, simultaneously producing 1-year-old canes known as primocanes and 2-year-old canes known as floricanes. Primocanes arise from root buds or old stem bases each spring and remain vegetative until floral initiation in late summer. The following spring, primocanes become floricanes, which flower and fruit and senescence after harvest. During production, primocanes shade floricane leaves and laterals and potentially compete with them for water and nutrients.

The objectives of the present study were to determine the hydraulic relationship between primocanes and floricanes in blackberry and to identify any water limitations to plant and fruit development attributable to within-plant competition among cane types. The study was done on plants grown in an alternate-year (AY) production system. In an AY system, both floricanes and primocanes are cut and removed after harvest so that only primocanes are produced the following year, followed by fruit harvest again the year after.

Materials and Methods

The study was conducted in 2004 and 2005 on a 0.09-ha field of 'Marion' trailing blackberry (*Rubus* spp. hyb) established in April 2000 (Fig. 1). Plants were spaced 0.6 or 1.5 m apart within rows and 3.0 m apart between rows, trained on a standard upright two-wire trellis system, and maintained in alternate-year (AY; both spacings) production systems. Plants spaced 0.6-m apart were either topped (i.e., pruned) at 1.8 m once primocanes reached the top trellis wire or not topped during 'off-years'; plants spaced at 1.5-m were not topped only. Each treatment plot consisted of a 6.1-m row of plants that was replicated five times and arranged in a randomized complete-block design. Plots were separated within rows by 3.0 m of unplanted space to allow for separation by treatment during harvest. The field was irrigated by drip tubing with 3.8 L·h-1 emitters spaced 0.76-m apart, located on the trellis ≈0.45 m above the soil surface. Water was applied weekly as needed (between May and September) at a rate of 25-50 mm·week-1. Enough water was applied to meet or exceed 100% of the estimated crop evapotranspiration (ET) requirement. Fruit were harvested by machine on 28 June-19 July in 2004 and hand-picked on 30 June-25 July in 2005.

Fig. 1. Field site at the North Willamette Research and Extension Center in Aurora, Oregon, USA. Plants were maintained in an alternate-year (AY) production system. Each half of the treatment plots was alternated so that each year half the plot was in production ('on-year') while the other half was not ('off-year').

Daily weather conditions were obtained from a nearby weather station and used to calculate reference ET. Plant water potential (both primocanes and floricanes) was measured periodically in each treatment using a pressure chamber; measurements were made at midday between 1330-1530 hours PST on single fully-expanded leaves enclosed for at least 1 h in foil-laminated plastic bags. Water potentials were measured on only 'on-year' plants in 2004, but on both 'on-' and 'off-year' plants in 2005. Changes in soil water content were measured periodically using a time-domain reflectometry (TDR) system and 0.30-m TDR probes installed vertically near the center of each plot.

Results and Discussion

Floricane and primocane water potentials were nearly identical among topping and spacing treatments on each date measured in 2004 and 2005 and were therefore pooled within cane types.

Within a single plant, water potential was consistently lower in floricanes than in primocanes throughout fruit development in June and July 2004, but was quite similar between cane types after harvest until floricanes began senescing in early September (Fig. 2A). Floricane water potential declined gradually during fruiting to about -1.2 MPa by late harvest and then increased rapidly to -0.8 to -0.9 MPa after harvest. Primocane water potential, by comparison, declined throughout the summer, but never dropped below -0.8 MPa all season. Lower water potentials in floricanes may be attributed to greater resistance to water transport and/or to accumulation of solutes during fruiting. Brierley (1929) reported relatively poor xylem development in red raspberry fruiting laterals, which structurally are quite similar to fruiting laterals on blackberry floricanes. Fewer xylem vessels may restrict water movement through floricanes, potentially leading to lower water status when water demands are high (i.e., during fruit ripening in mid summer). To our knowledge, no work has been published on osmotic potentials in blackberry.

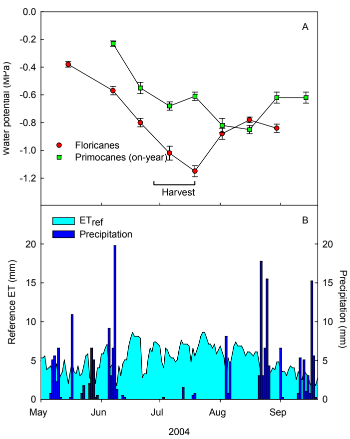

Fig. 2. A) Floricane and primocane water potentials in 'Marion' blackberry grown in an alternate-year production system. B) Reference evapotranspiration (ET) and precipitation measured at the site in 2004. Floricane and primocane measurements were made on the same fruiting plants.

Floricane water potential was also lower than primocane water potential during fruiting in 2005, with differences ranging from 0.4 to 0.6 MPa in June and July. Primocane water potential, however, was nearly identical between 'on-year' plants with floricanes and 'off-year' plants without floricanes (Fig. 3). Between June and August 2005, water potential of floricanes averaged -1.24 ± 0.03 MPa, while water potential of primocanes averaged -0.71 ± 0.02 MPa in both 'on-year' and 'off-year' plants. Soil water content declined steadily between irrigations regardless of plant type, but was consistently 2-4% lower in 'on-year' than in 'off-year' plots. For example, between 12 July (day irrigation was applied) and 18 July (day prior to next irrigation), soil water content decreased from 36 to 24% in plots with 'on-year' plants, and from 38 to 28% in plots with 'off-year' plants (Fig. 4).

Seasonal changes in water potential appeared most affected by fruiting and stage of plant development and only somewhat influenced by weather conditions (Fig. 2B). On a daily basis, however, water potential was highly correlated ($P < 0.001$) to reference ET (which is a function of weather conditions) in both cane types (Fig. 5). Thus, when normalized to reference ET (Fig. 3A), floricane and primocane water potentials remained nearly constant between irrigations (Fig. 3C). Apparently, weekly irrigation by drip was adequate to maintain plant water status between irrigations, even during peak harvest in July. Due to our well-watered conditions, we were unable to find any evidence for direct competition for soil water between primocanes and floricanes, though it does appear that they are hydraulically independent.

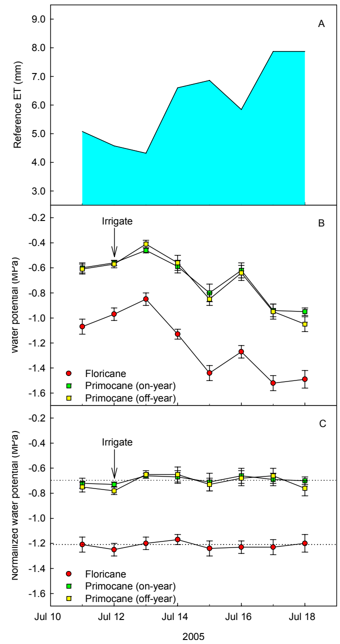

Fig. 3. A) Reference evapotranspiration (ET) and B) water potential of floricanes and primocanes in 'Marion' blackberry grown in an alternate-year production system. Measurements were made in 2005 on fruiting and non-fruiting plants in 'on-year' and 'off-year' cropping cycles, respectively. Plants were irrigated on 12 July. In C), cane water potentials were normalized to changes in references ET .

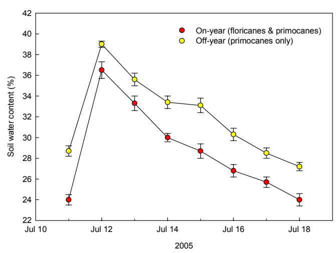

Fig. 4. Daily changes in soil water content in plots containing 'Marion' blackberry grown in an alternate-year production system in 2005. Plants were in either an 'on-year' or 'off-year' cropping cycle and were irrigated on 12 July.

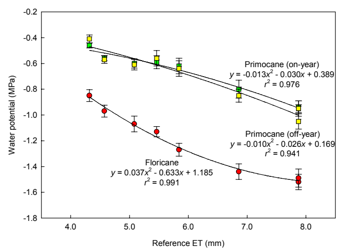

Fig. 5. Relationship between floricane and primocane ('on-year' and 'off-year') water potential and reference evapotranspiration (ET) in 'Marion' blackberry grown in an alternate-year production system. Data were same as those shown in Figs. 2A and 2B, and were fit using second-order polynomial equations.

Conclusions

On any given day, primocane water potential was nearly identical between 'on-year' and 'off-year' plants. Floricane water potential, on the other hand, was consistently lower (by 0.3-0.6 MPa) than primocane water potential throughout the fruiting season, especially during midsummer when crop water demands were high. Water potential was significantly correlated to evaporative water demands (i.e., reference ET) in both cane types, and when normalized to atmospheric conditions, remained nearly constant between irrigations. Such constant water potentials indicate that plant water status was not limited by soil water availability and hence would probably not benefit from extra or more frequent irrigation. However, based on different water potentials between cane types, it appears that primocanes and floricanes are hydraulically independent and therefore may compete for water in dry soil conditions.

Acknowledgements

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