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Number of drip laterals and irrigation frequency on yield and exportable fruit size of highbush blueberry grown in a sandy soil

E. Holzapfel[a,*], J. Jara[b], A.M. Coronata[c]

[a] Universidad de Concepción, Facultad de Ingeniería Agrícola, Departamento de Recursos Hídricos, Centro de Recursos Hídricos para la Agricultura y la Minería, Chillán, Chile
[b] Universidad de Concepción, Facultad de Ingeniería Agrícola, Departamento de Recursos Hídricos, Centro de Recursos Hídricos para la Agricultura y la Minería, Chillán, Chile
[c] Graduate Student, Instituto Profesional Santo Tomás, Área de Recursos Naturales, Los Ángeles, Chile

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ABSTRACT

Wetted area is an important factor in the production of blueberries. The effects of the number of drip laterals (wetted area) and irrigation frequency on fruit production were evaluated in two seasons in a mature field of northern highbush blueberry (*Vaccinium corymbosum* L. '*Brigitta*'). The field was located on a sandy soil in south-central Chile. Seven-year-old plants were irrigated from Sept. to April with two, four or six drip laterals per row, either four or six days per week. All treatments received the same amount of water per week for a total of 532 mm per season, according to the irrigation schedule established by the grower. During the 2008–2009 season the volume of water applied through irrigation plus precipitation corresponded to 90% of the theoretical crop evapotranspiration (*ETc*), and in the 2009–2010 season (until harvest) it was 122% of the *ETc*. Blueberry production on sandy soil was affected by the number of drip laterals per row, and total berry yield was the greatest when plants were irrigated with four drip laterals per row. The two irrigation frequencies evaluated did not affect the blueberry production under drip irrigation, although a barely noticeable trend of greater yield was observed under the irrigation treatments of six days per week, compared with those that were irrigated only four days per week. An interaction effect was observed between irrigation frequency and number of laterals on the percentage of exportable fruit (caliber ≥10 mm). Plants irrigated four days per week produced a significantly larger percentage of exportable fruit, compared with those irrigated six days per week. Nevertheless, when plants were irrigated six days per week the increase in number of drip laterals per row increased the percentage of exportable fruit. Therefore, it is recommended to use four drip laterals per row for commercial production of highbush blueberry in sandy soils.

1. Introduction

Irrigation is critical to highbush blueberry because plants are shallow-rooted and fruit production is reduced by even moderate levels of water stress (Bryla and Strik, 2007; Mingeau et al., 2001). Most blueberry orchards in Chile, which currently comprise over 8000 ha, are irrigated by microjet or drip. Sprinklers are also used but are not advisable unless sprinkler frost protection is needed. Sprinklers increase incidence of fungal disease in the fruit and canopy, and increase water cost and requirements (Bryla, 2008).

Most drip systems used in blueberry production are configured with one or two laterals per row, and laterals are usually placed 0.10 to 0.15 m from the base of the plant. Bryla et al. (2011) found that plant growth in 'Elliot' blueberry was generally better with drip than with sprinkler or microjet irrigation during the first two years after planting, while Pannunzio et al. (2011) found that 'O'Neal' blueberry yield was higher with two drip laterals per row than with one lateral per row. Also, Holzapfel et al. (2004) reported, in a 7-year study on 'Brigitta' blueberry, that microjet irrigation produced greater yield and larger fruit weight than drip irrigation, but there were no clear differences between the numbers of berries per bush obtained with either drip or microjet irrigation. Bryla et al. (2009) reported that fruit size is affected by irrigation method and level of water application, indicating that the drip system produced higher yields and larger fruit with less water than with a microjet system. With respect to irrigation frequency, Lyrene and Crocker (1991)

* Corresponding author. Tel.: +5642208804; fax: +5642275303.
E-mail addresses: eholzap@udec.cl (E. Holzapfel), jcjara@udec.cl (J. Jara), acoronata@santotomas.cl (A.M. Coronata).

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pointed out that 'Rabbiteye' blueberry has to be irrigated daily in sandy soils. Clearly, the response of blueberry to irrigation is related to plant age and root development and the ability of an irrigation system to adequately meet plant water demands, and irrigation water must be placed in the root extraction zone.

The objective of the present study was to evaluate the effects of irrigating with two, four or six drip laterals per row at either four or six days per week on fruit production of mature highbush blueberry plants grown on a sandy soil.

2. Materials and methods

The study was conducted in a commercial 7-year-old field of 'Brigitta' blueberry during two consecutive growing seasons (2008/2009 and 2009/2010). The field was located in the Santa Aida Farm in the Central Valley in the Bío-Bío Province, Chile (37°19′28″S and 72°21′38″W, 151 m.a.s.l.). Soil in the field had a sandy texture (Dystric Xeropsamments, Entisol), field capacity varied from 0.32 at the surface to 0.23 $m^3 m^{-3}$ at a depth of 0.6 m and permanent wilting point varied from 0.19 to 0.12 $m^3 m^{-3}$, as determined by the pressure plate method (Klute, 1986) at pressures 0.03 and 1.5 MPa, respectively. Soil bulk density ranged from 1.53 $Mg m^{-3}$ at the surface to 1.63 $Mg m^{-3}$ at 0.60 m of depth, and basic infiltration rate of 5 $cm h^{-1}$. At the time of ridge construction and prior to planting, the soil was amended with pine bark (*Pinus radiata* D. Don) in chunks that were distributed in a 1-meter-wide band. In the following year, pine bark was incorporated again on the surface of the ridge. Soil analysis at the time of the experiment indicated that organic matter was 4.3% at the surface, decreasing to 0.7% at a depth of 0.6 m. The plants were spaced 1 m apart in the row with 3 m between rows, on 0.25-m high raised beds mulched with pine bark. Prior to the study, each row of plants was irrigated using two laterals per row of 16-mm diameter drip tubing. The tubing had 2 $L h^{-1}$ non-pressure compensating emitters spaced 0.35 m apart (CV = 0.05), located approximately 0.05 m away from the crown on both sides, and the same tubing was used in the study. Discharge rates of the emitters were evaluated at the beginning of each irrigation season, with values of 2.02 $L h^{-1}$ for the first season, 1.99 $L h^{-1}$ for the second season and Christiansen Uniformity Coefficient (CUC) of 92.3% for both seasons.

The irrigation system was modified in the spring of 2008 to accommodate six irrigation treatments. The experimental design was a randomized complete block design with a 3 × 2 factorial arrangement. The factors were the number of drip laterals per row (two, four or six) and irrigation frequency (four or six irrigation days per week). Blocks were established across rows with irrigation treatments randomly assigned to a specific row within each block. Each block was replicated three times. An individual block consisted of 12 rows: six treatment data rows and six border rows. The border rows were between each treatment row. The experimental unit had six contiguous plants in a row, with a total of 18 experimental units and 108 harvested plants.

According to the standardized irrigation schedule previously established by the technical adviser to the grower in this orchard, each treatment received a total of 532 mm of irrigation (1596 $L plant^{-1}$) between 15 Sept. and 26 April, each season, and received a total of 87 mm of rainfall between Sept. 2008 and Apr. 2009 and 296 mm between Sept. 2009 and Feb. 2010 (Fig. 1). Each treatment was irrigated with the same amount of water during the study by adjusting the length of time in which the water was applied each week. For example, if irrigation was applied 30 min per day in the treatment irrigated six days a week with two laterals per row, then irrigation was applied 15 and 10 min per day in the treatments irrigated six days a week with four or six laterals per row, respectively, and 45, 22.5, and 15 min per day in the treatments irrigated four days a week with two, four, or six laterals per row, respectively. The distance between laterals and the crown was 0.05 m, and the spacing between the other laterals was 0.10 m (Fig. 2).

The theoretical water demand for the plants was calculated based on daily estimates of crop evapotranspiration, following the calculations outlined in Holzapfel et al. (2004) with constant values obtained from Jara (2010):

$$ETc = ETr\,Fc \quad (1)$$

in which

$$Fc = 1.28Pc + 0.11 \quad (2)$$

and

$$Pc = \frac{A_S}{HL} \quad (3)$$

where *ETc* is the theoretical or estimated crop evapotranspiration of fruit trees ($mm\,day^{-1}$); *ETr* is the reference evapotranspiration ($mm\,day^{-1}$), calculated daily using the Penman–Monteith equation (ASCE, 2005) and meteorological data obtained from a weather station (Campbell Scientific Inc., USA, 2002), located 16 km from the experimental site (Table 1); *Fc* is an estimated dimensionless crop factor associated with *Pc*, which corresponds to plant canopy coverage ($0.1 < Pc < 0.7$); A_S is the shaded area at noon (m^2) determined by measuring the shadow diameter projected on the soil by the plant, in several directions; *H* is the distance between rows (m) and *L* is the distance between plants within the row (m). *Pc* of the plants at noon was determined monthly throughout the irrigation season and averaged 0.37 each year during the study.

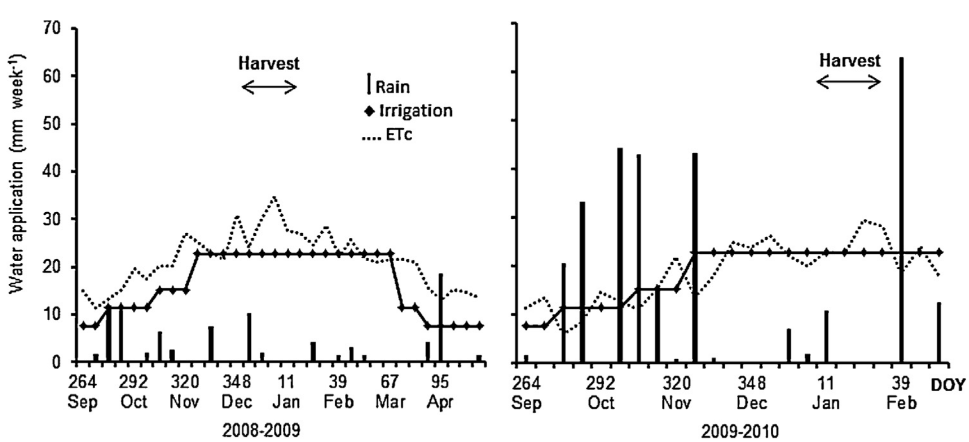

Fig. 1. Estimated crop evapotranspiration (*ETc*), water applied by drip (irrigations) and rainfall through both seasons of the research. DOY is the day of year.