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Special Issue: Irrigated Agriculture

Research Paper

# Mapping soil hydraulic conductivity and matric potential for water management of cranberry: Characterisation and spatial interpolation methods

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ARTICLE INFO

*Article history:*
Published online 24 September 2014

*Keywords:*
Spatial interpolation methods
Spatial variability
Soil hydraulic properties
Irrigation and drainage

Spatial interpolation methods are required for analysing the effects of soil hydraulic properties on irrigation management. This study was conducted to determine which interpolation methods are best suited to map these properties. During the summer of 2012 we mapped the spatial variability of soil physical properties, soil matric potential, water table depth and yield of two cranberry fields located near Quebec City, Canada. Three spatial interpolation methods, inverse distance weighting (IDW), thin plate splines (TPS) and kriging with external drift (KED), were compared by means of cross-validation. The best interpolation method for a given property was used to produce maps and perform HYDRUS 1D simulations for the purpose of irrigation management. Results show that even in highly constructed fields, such as for cranberries, spatial patterns of soil hydraulic properties exist. The TPS method was the best interpolation method based on the cross-validation analyses and generated maps. Spatial variability of crop yield showed a strong relationship with soil hydraulic properties and simulations suggest that irrigation can be reduced by 75% when accounting for the spatial variability of soil hydraulic properties.



## 1. Introduction

The cranberry production industry has experienced a rapid expansion in Canada, especially in the last two decades. In 1992 three growers in Québec owned around 105 ha of cranberry, while in 2011 about 92 growers cultivated 2872 ha (MAPAQ and ISQ, 2012, p. 110). This rapid expansion weighs heavily on the environment and therefore the responsible management of water resources has become a priority. Understanding soil hydrodynamic properties in relation to spatial variability of cranberry yield is a critical factor to developing responsible and sustainable water management practices. As precision irrigation management is a logical approach to this issue, linking the spatial variability of soil

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http://dx.doi.org/10.1016/j.biosystemseng.2014.09.002

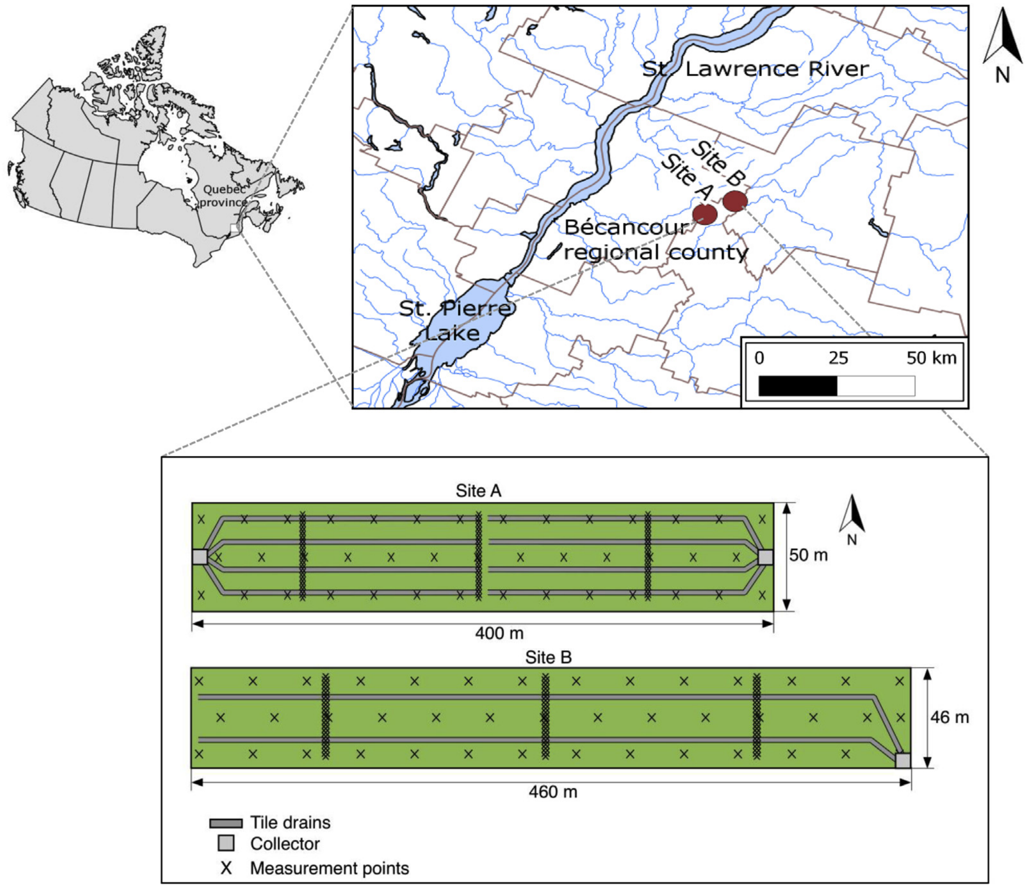


**Fig. 1 – Location of the two study sites within Canada, field dimensions, soil core sampling grid and tensiometer locations at site A and site B.**

hydrodynamic properties with hydrological conditions and developing local management zones is of great interest for growers.

Cranberry (*Vaccinium macrocarpon* Ait.) is a high-value perennial crop which has historically been grown on wetlands (peat soils), but is also commonly cultivated on sandy anthropogenic soils. Contrary to the popular belief that cranberry grows in standing water, it actually requires only about 60 mm of water per month during the growing season in Québec (Bonin, 2009). The water table must be controlled during the growing season because too high or too low a level can affect cranberry growth and root development (Hall, 1971). For capillary rise, Handyside (2003) showed that a water table depth between 0.3 and 0.5 m for sandy soils and around 0.6 m for peat soils can meet cranberry water requirements. A soil with high hydraulic conductivity is preferable to water table control and irrigation (Handyside, 2003) to maintain an optimal water status for cranberry growth. An optimal soil water matric potentials of −6.5 to −4.0 kPa at 7–10 cm depth has been determined for cranberry production in Québec (Bonin, 2009; Pelletier, Gallichand, Caron, 2013). Therefore, soil matric potential, together with soil hydraulic conductivity, are important properties that have a considerable impact on cranberry yield. Homogeneity of these soil hydrodynamic properties over cranberry fields is often assumed on these highly constructed fields. Detailed investigations are needed to verify this assumption.

Various methods can be used to interpolate between spatial data and three are of specific interest in this study: inverse distance weighting (IDW), thin plate splines (TPS) and kriging (KRG). These three methods are commonly used for interpolation of hydrological and soil properties (Ahmed and De Marsily, 1987; Cook, Mostaghimi, & Campbell, 1993). The IDW method is based on an inverse function of distance between data points in which the weights depend on an exponent that has to take values greater than zero (Webster & Oliver, 2007, p. 315). For instance, a value of 2 would mean that the data are inversely weighted as the square of the distance. The IDW method is deterministic and shows no discontinuities when the weighting exponent is greater than zero (Webster & Oliver, 2007, p. 315). However, the choice of the weighting exponent is somewhat arbitrary and the IDW method does not take into account the configuration of the sampling scheme (Webster & Oliver, 2007, p. 315). The TPS method is deterministic with a local stochastic component; it is also a continuous method, but offers the choice for the interpolated surface to pass exactly through the data points or to estimate points that produce a smoother surface (Webster & Oliver, 2007, p. 315). Kriging is a method that uses a fitted variogram to determine the weights needed for interpolation.