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Effect of soil water potential on radish (*Raphanus sativus* L.) growth and water use under drip irrigation

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Abstract

Radish (*Raphanus sativus* L.) is a moisture loving vegetable and is widely planted in China. Soil water is one of most important factors affecting the yield and quality of radishes. Field experiments for the effect of soil water potential on radish growth and water use were carried out in 2001 and 2002. The experiment included five treatments, which controlled soil water potential (SWP) at 20 cm depth immediately under emitter higher than −15, −25, −35, −45 and −55 kPa. The results show that different SWP treatments affected temporal and spatial distribution of soil water. As the target SWP value decreased, the average SWPs between 0 and 90 cm depth decreased, and the dry domain in the root zone became larger. The variability of SWPs values at 0–90 cm depths before and after irrigation increased as the target values decreased. Irrigations scheduled between −15 and −55 kPa had no significant effects on radish growth and yield, but affected radish root distribution and market quality. The lower the target SWP value was, the more radish roots developed. The lowest radish cracking rate and the most radishes of Grade 1 occurred at a SWP of −35 kPa in 2002. Different SWP treatments affected radish evapotranspiration (ET) and WUE. The total radish ET decreased as SWPs decreased in both years. The highest radish WUE values were achieved with SWPs of −55 and −35 kPa in 2001 and 2002, respectively, and the lowest WUE values were recorded at a SWP of −15 kPa in both years. The SWP of −35 kPa at

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20 cm depth immediately under drip emitter can be used as an indicator for radish drip irrigation scheduling in the North China Plain.
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Keywords: Radish; Drip irrigation; Soil water potential

1. Introduction

Soil water potential (SWP), a measure of the holding strength of the soil matrix for water, is a critical variable in crop yield, runoff, erosion, evapotranspiration and irrigation scheduling (Phene et al., 1989). In general, optimum SWP can meet the physiological needs of plant growth and be favorable for water and nutrition uptake. Low SWP will result in adverse impacts on crop growth, for example, increased soil strength impedes root penetration; stoma resistance increases, decreasing photosynthesis. Too high SWP causes drainage and loss of nutrients, and also has negative effects on crop growth. At high SWP root growth and functions will be affected by inadequate oxygen diffusion into the soil (Hodnett et al., 1990).

Rhoads and Stanley (1973, 1974) reported that the highest yields of corn (*Zea mays* L.) could be obtained when SWP in the upper 30 cm maintained above −10 kPa (for sands) to −40 kPa (for clays). Long-day onion (*Allium cepa* L.) was subjected to five SWP treatments (−10, −20, −30, −50, and −70 kPa) to evaluate the effects of several SWP on onion yield and quality by Shock et al. (2000) and the results showed that depending on the year, the optimum SWP for maximum profits of drip-irrigated onion was in the range of −10 to −17 kPa, and a SWP closer to −17 kPa was the best. Hegde and Srinivas (1989) investigated different SWP (−25, −45, −65 and −85 kPa at 15 cm depth) on growth, yield and water use of banana (*Musa sapientum* L.). A SWP from −25 to −45 kPa resulted in better growth, dry matter and yield, and the SWP from −65 to −85 kPa adversely affected growth and productivity of banana. Hegde (1987) indicated the treatment with the soil matric potential at 18 cm depth about −20 kPa obtained the maximum radish (cv. Japanese White) root yield, highest ET and moderately high WUE, but the different in root yield between irrigations scheduled at −20 and −40 kPa was not significant.

In northern China, radish is widely cultivated and generally planted in raised beds in spring and autumn. Radish yields and quality dramatically fluctuate due to frequent droughts and poor irrigation management.

Drip irrigation lends itself readily to establish a nearly constant water regime in the root zone and the fluctuation of the SWP can be held to a minimum without difficulties (Horton et al., 1982), which ensure plants growing under proper soil water for the optimum yield and size.

The objectives of this study are: (1) to measure the effects of different SWPs on radish growth, yield, water use and water use efficiency; and (2) to define the basis for irrigation scheduling of drip-irrigated radish and water resource planning in the North China Plain.

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