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Effect of drip irrigation management on yield and quality of field grown green beans

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Abstract

This study examines the effects of different irrigation regimes on yield and water use of green beans irrigated with a trickle system under field conditions in 2003 in the Mediterranean region of Turkey. Irrigation regimes consisted of four irrigation intervals (I_1: 13–17 mm, I_2: 28–32 mm, I_3: 43–47 mm and I_4: 58–62 mm of cumulative pan evaporation) and three plant-pan coefficients ($K_{cp_1} = 0.50$, $K_{cp_2} = 0.75$ and $K_{cp_3} = 1.00$) were evaluated. Both K_{cp} and irrigation intervals influenced significantly green bean yields. Irrigation intervals varied from 2 to 3 days in I_1, 5 to 7 days in I_2, 8 to 9 days in I_3 and 10 to 12 days in I_4 treatments. Maximum and minimum yields were obtained from the $I_1K_{cp_3}$ and $I_4K_{cp_1}$ treatments as 20,558 and 12,243 kg ha^{-1}, respectively. As the K_{cp} value decreased the total yields in each irrigation interval also decreased. However, with the lower irrigation frequency (I_4), lower yields were obtained with all K_{cp} coefficients. Seasonal water use values in the treatments varied from 253 mm in $I_4K_{cp_1}$ to 338 mm in $I_1K_{cp_3}$. Significant linear relations were found for green bean yield and total water use for each irrigation interval. Irrigation intervals resulted in similar water use in the treatments with the same K_{cp} value. Water use efficiency (WUE) and irrigation water use efficiency (IWUE) values were significantly influenced by the irrigation intervals and plant-pan coefficients. WUE ranged from 4.14 kg m^{-3} in $I_4K_{cp_3}$ to 6.16 kg m^{-3} in the $I_1K_{cp_2}$. The maximum IWUE observed in $I_1K_{cp_1}$, minimum IWUE were in $I_4K_{cp_3}$ treatment. The yield response factor (k_y) was found to be 1.23 for whole growing season. Both

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K_{cp} coefficients and irrigation frequencies had significantly different effects on quality parameters such as fresh bean length, width, number of seed per pod and 100 fresh bean weights. In conclusion, $I_1K_{cp_3}$ irrigation regime is recommended for field grown green bean in order to attain higher yields with improved quality.

Keywords: Deficit irrigation; Green bean; Water use efficiency; Drip irrigation; Irrigation frequency

1. Introduction

Water supply is a major constraint to crop production in the Mediterranean region of Turkey. The economy of the region relies heavily on irrigated crop production. However, surface irrigation is commonly used in the area resulting in low irrigation efficiencies as well as salinity and drainage problems. Efficient use of water by irrigation is becoming increasingly important, and alternative water application methods such as drip and sprinkler, may contribute substantially toward making the best use of water for agriculture and improving irrigation efficiency.

The trend in recent years has been towards conversion of surface to drip irrigation which is considered to be a more efficient delivery system. Scheduling water application is very critical to make the most efficient use of drip irrigation system, as excessive irrigation reduces yield, while inadequate irrigation causes water stress and reduces production. On the other hand, the intensity of the operation requires that the soil water supply be kept at the optimal level to maximize returns to the farmer. High-frequency water management by drip irrigation minimizes soil as a storage reservoir for water, provides at least daily requirements of water to a portion of the root zone of each plant, and maintains a high soil matric potential in the rhizosphere to reduce plant water stress (Phene and Sanders, 1976; Nakayama and Bucks, 1986).

Annual green bean production of Turkey is about 514,000 Mg of which 22.6% is produced in the Mediterranean region (DIE, 2000). Water management in green beans is extremely important at all stages of plant development due to its influence on stand establishment, fungal problems and pod set and quality. For this reason, the crop must be supplied with adequate water to ensure vigorous growth. Irrigation is important for its plant and pod growth (Smesrud et al., 1997).

Common irrigation methods practiced for green bean production in this region are wild flooding, furrow and basin. In general, the farmers over irrigate, resulting in high water losses and low irrigation efficiencies, and thus creating drainage and salinity problems (Tekinel et al., 1989). With drip irrigation systems, water and nutrients can be applied directly to the crop at the root level, having positive effects on yield and water savings and increasing the irrigation performance (Phene and Howell, 1984). For these reasons, drip irrigation systems have seen widespread use in the world in recent years.

Irrigation scheduling methods based on pan evaporation are widely used because of their easy applications (Elliades, 1988). With available pan coefficient in hand, pan evaporation (Class A Pan) can be used in the arrangement of irrigation programs. Bharat (1989) compared different pan coefficients and suggested a pan coefficient of 0.80 for optimal yield in Fort Valley, USA.