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Effects of dynamic and static deficit and partial root zone drying irrigation strategies on yield, tuber sizes distribution, and water productivity of two field grown potato cultivars

Seyed Hamid Ahmadi [a,b,*], Mohammad Agharezaee [b], Ali Akbar Kamgar-Haghighi [b], Ali Reza Sepaskhah [b]

[a] Irrigation Department, Faculty of Agriculture, Fasa University, Fasa, Iran
[b] Irrigation Department, Faculty of Agriculture, Shiraz University, Shiraz, Iran

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ABSTRACT

New strategies of partial root-zone drying (PRD) and deficit irrigations (DI) were studied on potatoes in a semi-arid area of Iran. A factorial experiment was conducted as a complete randomized design in three replications. The potato cultivar treatments were Agria and Ramos. The whole growth period of both cultivars was divided into three stages based on the BBCH scale. There were five furrow irrigation treatments. The full irrigation treatment (FI) received 100% of potential evapotranspiration (ET); static deficit irrigation (SDI) received 75% of ET during the growth period; dynamic deficit irrigation (DDI) received 90% of ET in the first one-third of growth period, 75% of ET in the second one-third of growth period, and 50% of ET in the last one-third of growth period; static partial root zone drying irrigation (SPRD) received 75% of ET during the growth period; dynamic partial root zone drying irrigation (DPRD) received 90% of ET in the first one-third of growth period, 75% of ET in the second one-third of growth period, and 50% of ET in the last one-third of growth period. Analysis showed that there were significant differences between irrigation strategies as DI did outperform PRD in tuber production. The SDI, DDI, SPRD, and DPRD irrigation treatments decreased the potato tuber yield by 4%, 7%, 56%, and 52% compared to FI, respectively. SPRD and DPRD decreased potato tuber yield by 54% and 48% compared to SDI and DDI, respectively. Results also showed that there were no significant differences between cultivars. Interaction between irrigation strategies and cultivars was not significant. Furthermore, water productivities (WP) were significant among irrigation strategies. Compared to FI, the SDI and DDI increased WP by 28% and 34%, respectively, but SPRD and DPRD decreased WP by 40% and 31%, respectively. In general, the DI strategy (SDI, DDI) is recommended in the study area due to the slight fresh tuber yield reduction (4%, 7%) and considerable increase (28%, 34%) in WP relative to FI. Furthermore, the dynamic irrigation strategies led to higher WP than the static ones. It was also found that Agria outperformed the Ramos because of higher fresh tuber yield under water-saving irrigation strategies. Under non-limiting water conditions, Ramos produced higher fresh tuber yield. Furthermore, it is required to decrease the duration of wet/dry cycle under PRD strategy to guarantee efficient PRD and cope with extra water stress and hot weather in the region.

1. Introduction

Potato is a tuber crop that plays an important role in feeding people of the world. Potato production ranks fourth in the world after wheat, maize and rice with the production of 368 million tons from 19.3 million hectares (FAO, 2012). It is well known that potatoes are very sensitive to soil moisture stress (Lynch et al., 1995; Porter et al., 1999; Onder et al., 2005) due to their sparse and shallow root system (Opena and Porter, 1999). Therefore, they need frequent irrigations for good growth and tuber yield production (Ahmadi et al., 2010b). However, due to global restriction in fresh water resources, irrigation strategies that have higher water productivity should be adopted in order to save the water resources and improve crop production.

Partial root zone drying (PRD) is a modified form of deficit irrigation (DI) that half of the root system is subject to drying soil and the other half is growing in irrigated soil in each irrigation event. The root parts that grow in drying soil produce Abscisic acid (ABA) and that is carried by water flow in xylem to the shoot for regularizing the shoot physiology (Ahmadi et al., 2010a). The PRD irrigation is an improvement of deficit irrigation that its principal

* Corresponding author at: Irrigation department, Faculty of Agriculture, Fasa University, Fasa, Iran.
E-mail address: seyedhamid.ahmadi@gmail.com (S.H. Ahmadi).

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