

## Summary

The responses of potato (*Solanum tuberosum* L. cv. Folva) to partial root-zone drying (PRD) and deficit irrigation (DI) were investigated in sandy soil in potted plants grown in a greenhouse in 2005 and under semi-field conditions protected by an automatic rain-out-shelter in 2005 and 2006. In the greenhouse, at the tuber bulking stage irrigation was applied daily to the whole root system to restore pot holding capacity, viz. a volumetric soil water content ( $\theta$ ) of 17.5% the fully irrigated treatment (FI), or one-half of the root system was irrigated and daily restored to a  $\theta$  value of 17.5%, while the other half was allowed to dry until  $\theta$  decreased to 7%, the partial root drying treatment (PRD). In the semi-field experiment the whole root-zone was drip irrigated daily to keep  $\theta$  until 5-10 mm below field capacity (16.1%) in the fully irrigated treatment (FI). In the PRD treatment the plants were irrigated to one side of the roots system using 70% of the irrigation amount of the FI treatment, and shifted to the other side every 5-10 days. In the DI treatment the plants were irrigated equally to both sides of the roots system daily using 70% the irrigation amount of the FI treatment. The PRD and DI irrigation modes were applied either during the whole growing season (PRD<sub>1</sub> and DI) or applied just after tuber initiation (PRD<sub>2</sub>) until maturity.

Stomatal conductance ( $g_s$ ) was more sensitive to PRD irrigation than photosynthesis (A) particularly in the semi-field experiments leading to an increase in intrinsic water use efficiency. In the 2005 greenhouse and semi-field experiments the xylem sap ABA concentration ( $[ABA]_{\text{xylem}}$ ) of PRD plants was significantly greater than the FI plants. Compared with FI plants, lowered stomatal conductance and decreased leaf

area index in the PRD plants might be attributed to the greater xylem sap ABA concentration in these plants.

In the semi-field experiment in 2005, the soil residual nitrogen content at harvest was significantly ( $P<0.05$ ) 29% lower in the PRD<sub>2</sub> as compared with the FI treatment for the whole root-zone; and the leaf nitrogen concentration for the PRD<sub>2</sub> treatment was significantly ( $P<0.05$ ) higher as compared with the FI treatment. In 2006, the soil residual nitrogen content at final harvest was non-significantly 33% lower in the PRD<sub>2</sub> treatment than in the FI treatment. For both years the PRD<sub>2</sub> treatment had the lowest residual nitrogen content in the root-zone of all the treatments. The improved nitrogen uptake under the PRD<sub>2</sub> treatment was reflected in the fact, that during the late season in both years under semi-field conditions, the reflectance vegetation index (RVI) and the leaf area index for the PRD<sub>2</sub> treatments were higher than for the FI treatments.

For both years of semi-field experiments, the PRD<sub>2</sub> treatment resulted in 30% water saving during the treatment period and maintained yield as compared with the FI treatment, while DI and PRD<sub>1</sub> treatments resulted in significant ( $P<0.05$ ) yield reductions. In 2005, the important portion of the marketable class (tuber diameter of 40-50mm) was significantly ( $P<0.05$ ) 20% higher in the PRD<sub>2</sub> treatment than in the FI treatment. When the data were aggregated over the two years, the marketable 40-60 mm fraction was significantly greater ( $P<0.001$ ) in PRD<sub>2</sub> as compared with the FI treatment.

Based on the greenhouse experiment and the two years of semi-field experiments under temperate conditions with potatoes grown in sandy soil we conclude that:

1. The time interval of shifting irrigation side in the PRD treatment can be based on actual evapotranspiration amount of the FI treatment. This method for shifting should be defined for different soil types and climate conditions.
2. The PRD treatment should be applied after tuber initiation until maturity (PRD<sub>2</sub>) only. During the early growth stages including the tuber initiation growth stage the PRD and DI treatments decrease the growth and tuber yield of the plants.
3. Of the investigated water-saving irrigation strategies (PRD<sub>1</sub>, PRD<sub>2</sub>, and DI), the PRD<sub>2</sub> treatment from end of tuber initiation until maturity was the only water-saving irrigation strategy able to maintain yield and significantly increase IWUE.
4. The PRD<sub>2</sub> treatment increased significantly ( $P < 0.001$ ) the amount of marketable tubers with a diameter of 40-60 mm as compared with the FI treatment.
5. The PRD<sub>2</sub> treatment improved soil nitrogen availability late in the growing season maintaining top greenness to a greater extent, as compared with PRD<sub>1</sub>, DI and FI treatments. This effect might have contributed significantly to the continued tuber filling late in the growing season resulting in yield maintenance and improved tuber size distribution.