Does a Reduction in Irrigation Equal a Reduction in Marketable Carrot Yield?

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Abstract
Water shortages in California and around the world have created a need for low-water tolerant crop cultivars. California is a major producer of carrots, a crop which requires large amounts of water for growth. Greenhouse studies have shown a decrease in carrot yields under reduced irrigation, but the conditions are different in a field than in a greenhouse. It is possible that reduced irrigation will not significantly reduce marketable carrot yields in an actual production field. Irrigation rates from 151% Ep reduced to 97%, 73%, and 43% significantly reduce the marketable yield of carrots, as shown in this study.

Keywords: carrots, daily pan evaporation (Ep), irrigation, yield

California is a major producer of carrots for much of the country. Carrots are traditionally grown under high water conditions. This can cause some concerns with the public and with growers during times when California experiences severe water shortages. In addition to water budgets, there are concerns over the environmental effects of runoff from carrot production fields. Few studies have been conducted on the effects of reduced irrigation on marketable carrot yield. Those studies that have been conducted have been greenhouse studies that do not replicate the actual field conditions found in California’s carrot production regions. These studies showed yield reductions between 10-50% of the yield under fully irrigated conditions. It is possible that under field conditions, the water relations are different and the reduction in yield with reduced irrigation will not be so great. This study tested the effect of reduced irrigation on marketable yield of carrots.

The carrots were grown under standard production field conditions in California in sandy-loam soil. Full irrigation was applied by overhead sprinklers during the emergence and establishment stages of the plants; the irrigation treatments began 23 days after sowing. Five irrigation treatments were used: 47, 73, 97, 124, and 151% daily pan evaporation (Ep) rate. The 151% Ep treatment represents the industry standard for carrot irrigation. One low range tensiometer was used per plot to monitor water tension. The plants were harvested at 34, 48, 61, 76, 83, 90, 97, and 104 days after sowing to determine marketable yield. Leaf water potential measurements were taken during the last three weeks of the crop cycle.

The 151% treatment resulted in a total yield of 73 tons/hectare (t/ha). This yield is expected in a commercial production field based upon the cultivar and standard irrigation. At 124% Ep there was not a significant reduction in yield. The treatments of 97%, 73% and 47% did result in total yield reductions of 25%, 64%, and 91%, respectively. The percentage of marketable yields from total yields at 151, 124, 97, 73, and 47% Ep were: 73%, 56%, 63%, 27%, and 23%, respectively. Only the 73 and 43% irrigation treatments caused a significant difference in shoot biomass (figure 1). We, also, calculated the differences in water use efficiency (WUE) on the basis of marketable yield. Although total biomass WUE increased as irrigation treatments decreased, when calculated on the basis of marketable yield the WUE decreased. The reduction in water resulted in many short, forked, and irregularly formed roots, thus the increased efficiency of water use did not balance with the decrease in marketable yield at irrigation levels below 151% Ep.
Reduction in irrigation did significantly reduce marketable yield in carrots. This supports previous work that has been done in greenhouses. At this time it is not economically feasible for a grower to reduce irrigation in carrot production fields. Further studies should focus on the effects of irrigation at specific growth stages of the carrot root and the physiology of the development of the root. It is possible that genetic variation in root development among cultivars may lend to the development of a more low-water tolerant variety. In addition, this study only varied the total amount of water applied at frequent irrigation intervals. Reduced irrigation applied at varied amounts and frequency may have a different effect on carrot productivity. It may still be possible to grow carrots under reduced irrigation; however, more research is needed.

**Literature:**