Influence of water stress on root/cladode ratio and water-use efficiency of *Opuntia ficus-indica* and *O. robusta*

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Introduction Due to the regular occurrence of drought in southern Africa, there is a need for more research on drought tolerant fodder plants such as *Opuntia* (cactus pear) species. In contrast with the cladode system, the roots of cactus pear have received little attention, however, they certainly differ from other plants, as they develop xeromorphic characteristics, enabling the plant to survive prolonged periods of drought (Nobel, 1988). The influence of different water applications was evaluated in terms of root and cladode mass, water-use efficiency (WUE) and root length for one-year-old plants of *Opuntia ficus-indica* (cultivar Morado) and *O. robusta* (cultivar Monterey).

Materials and methods The cladodes were planted in pots (210 mm diameter and 550 mm deep soil) and grown in the greenhouse at day/night temperatures of 25-30/15-18 ^{0}C. The water treatments applied were 0-25%, 25-50%, 50-75% and 75-100% depletion of total plant available water. After four weeks of keeping the soil at field water capacity, the water stress treatments started. The planted pots were washed out when reaching the different water levels, after which root lengths, root and cladode mass and WUE (dry matter production per mm water used) were determined. The length of the washed roots was measured by using a modified infrared root length counter (Rowse & Phillips, 1974). The thickness at the end of the root where die-back took place was measured by a vanier calliper. The number of side roots per tap root was also determined by measuring twenty roots, randomly selected, in each pot. A 2x4 (*Opuntia* species and water treatment) factorial experiment with two replications for each water treatment was conducted.

Results and discussion The root mass for *O. ficus-indica* and *O. robusta* decreased ($P<0.01$) from 27.5 to 10.6 g/plant and 18.6 to 9.9 g/plant respectively with increased water stress. Due to the finer root system of *O. robusta* the root mass was lower ($P<0.01$) than that of *O. ficus-indica*. In contrast, the root length increased ($P<0.01$) with water stress for *O. ficus-indica* and *O. robusta* from 55.3 to 68.2 m/plant and 51.3 to 59.7 m/plant respectively. The root/cladode ratios for *O. ficus-indica* and *O. robusta* decreased ($P<0.01$) with water stress from 0.136 to 0.092 and 0.144 to 0.075, respectively. On average for all water treatments the roots of *O. ficus-indica* and *O. robusta* composed only 12% and 10% respectively of the total plant biomass. These low root/cladode ratios are supported by the 0.14 found by Nobel (1988) for *Opuntia* species. Water-use efficiency decreased (0.091 to 0.072 g/mm) ($P<0.01$) with an increase in water stress for *O ficus-indica*, while in contrast increased (0.029 to 0.081 g/mm) ($P<0.01$) for *O. robusta*. The side roots per tap root increased ($P<0.01$) with water stress with as much as 35 and 70 for *O. ficus-indica* and *O. robusta* respectively. The influence of water stress on root die back was clearly observed in *O. ficus-indica* but less noticeable in *O. robusta*. The average thickness at the end of the roots for *O. ficus-indica* and *O. robusta* where die back took place was 0.9 and 0.3 mm respectively for the highest water stress treatment. The water percentage in the cladodes decreased with water stress from 90.3 to 86.9% and 91.3 to 86.4% for *O. ficus-indica* and *O .robusta* respectively.

Conclusions The unique and efficient root system of the cactus pear can not be over emphasized if taking into account the small amount of roots in the total plant biomass. It was clear that *O. ficus-indica* is more sensitive to water stress than *O. robusta*. *Opuntia* species is a multifunctional crop (fodder and fruit) which can be of great value in both developed and undeveloped countries, because of its ability to utilise arid areas to its full potential.

References

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