Pak. J. Bot., 35 (5): 902-906, 2003.

PROLINE AND WATER STATUS OF SOME DESERT SHRUBS BEFORE AND AFTER RAINS

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Abstract

Four desert shrubs (*Abutilon indicum*, *Aerva javanica*, *Calotropis procera* and *Senna holosericea*) commonly found in Karachi and its vicinity were studied for the plant water status and proline contents during rainy and dry periods. Succulence in all plants increased after the rainfall and this increase was substantial in *Calotropis procera*. *Senna holosericea* maintained more negative water potential while it was less negative in *Calotropis procera*. Proline content substantially decreased in all species after rainfall and in the case of *Senna holosericea* it decreased from about 330 to less than 140 m mol L^{-1} plant water. Our data clearly indicates that increase in proline is related to increase in drought stress.

Introduction

Most plants are exposed to water stress due to extreme soil water deficits in arid and semi arid environment (Morgan, 1984). Large areas of the earth's surface where temperature would permit plant growth are arid or semi arid deserts. The survival of land plants in such areas relies on the availability of water and their adaptation under stress (Kramer, 1984). Adaptation to water stress in plants involve the reduction of cell dehydration by avoidance (leaf shedding, leaf rolling and low stomatal conductance) or tolerance through osmotic adjustment (Turner, 1979). Osmotic adjustment refers to the lowering of osmotic potential due to the net accumulation of solutes in response to water deficits or salinity (Munns, 1988). It is an important mechanism in drought tolerance as it enables a continuation of cell expansion (Wyn Jones & Gorham, 1983), stomatal and photosynthetic adjustments (Ludlow, 1980) and better plant growth by lowering their water potential in response to decreasing soil water (Wyn Jones & Gorham, 1983).

Plants under stress undergo osmotic adjustment by accumulating one or more low molecular weight organic solutes known as compatible osmolytes (Naidu *et al*., 1992). They are potent osmoprotectants that play a role in counteracting the effect of osmotic stress (Yoshiba *et al*., 1997). Proline is one of the most common compatible osmolytes in water stressed plants that does not interfere with normal biochemical reactions and make their survival possible under stress (Stewart, 1981). It is accumulated in various plants that are subjected to water stress or salinity (Lee, 1974; Storey *et al*., 1977; Aziz and Khan, 2000, 2001).

The present study was designed to understand the changes in plant water status and proline contents in four desert shrubs of Karachi before and after rainfall.

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Table 1. Results of two- way ANOVA of characteristics in leaves by plant species (P) and seasons (S).

Independent variable	P	S	P x S
Water potential	42.7*	68.1**	23.1*
Proline	32.7*	67.5***	61.3**
Leaf succulence	133.9***	84.1**	27.2*

Note: Numbers represent F-values. * = P < 0.05; ** = P < 0.01; *** = P < 0.001.

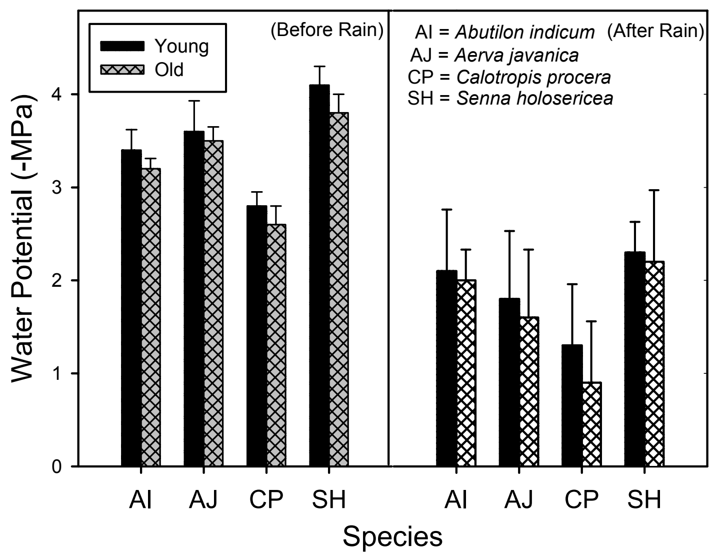

Fig. 1. ____.

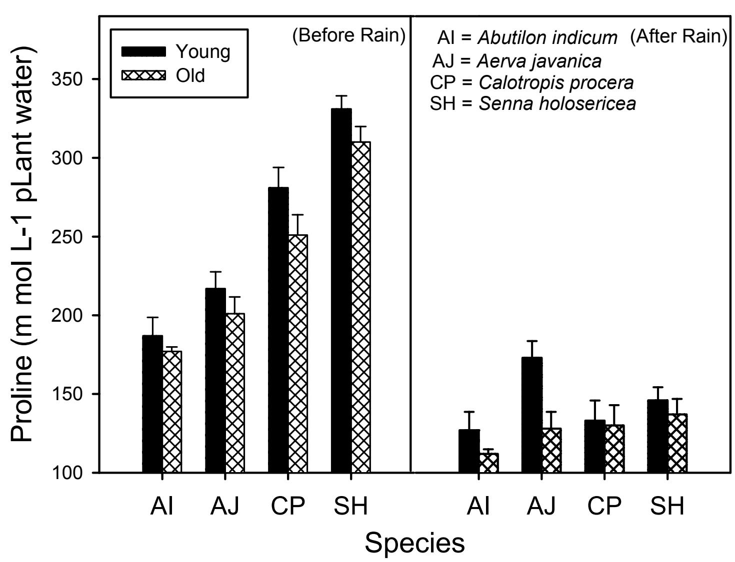

Fig. 2. ____.

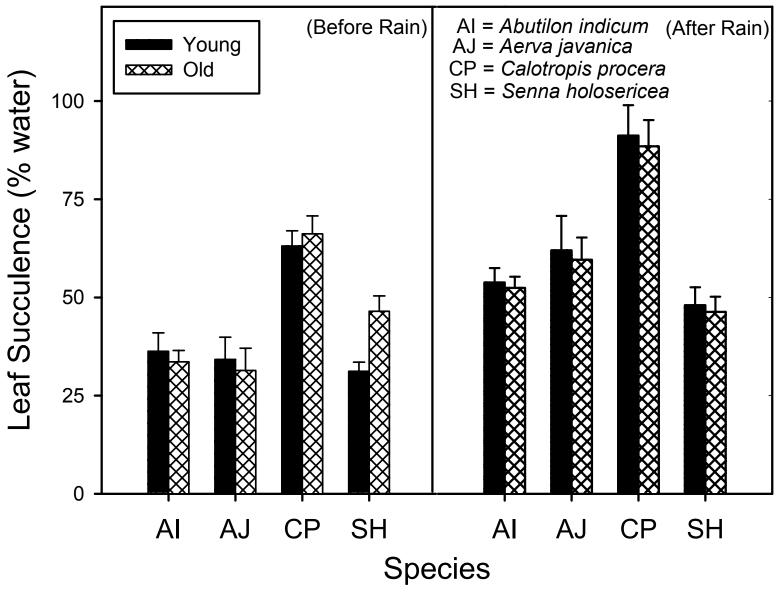

Fig. 3. ____.

Plants follow an osmoconformor strategy by lowering their tissue water and osmotic potential due to the net accumulation of solutes (osmotic adjustment) in response to water deficit (Munns, 1988) or salinity (Khan *et al*., 1999, 2000). An increase in solute including the osmolytes occurs with the reduction in water potential (Turner & Jones, 1980). Accumulation of proline as an osmolyte in our studies occurred to varying extents in all species. Proline levels in both young and old leaves substantially increased during the dry period (Fig. 3). There was a significant ($P<0.05$) variation in proline content among all plant species (Table 1) and between seasons ($P<0.001$) with maximum accumulation in *S. holosericea* and minimum in *A. indicum* (Fig. 3). Two-way interactions of species x seasons on proline was also significant ($P<0.01$) (Table 1). In general higher proline content was observed in young leaves than the old ones (Fig. 3). *Senna holosericea* accumulated higher proline content during the dry period, followed by *C. procera* and *A. javanica* and it was minimum in *A. indicum*. However, as the rain approached, levels of proline dropped dramatically in all species. The accumulation of proline in plants subjected to water stress or salinity has been observed widely (Stewart & Lee, 1974; Storey *et al*., 1977; Cavalieri, 1983; Aziz & Khan, 2000, 2001). Higher levels of proline during the dry period in *S. holosericea*, was a feature of decreased water potential as indicated in other drought stressed studies (Turner and Jones, 1993, Naidu *et al*., 1992; Storey *et al*., 1977; Singh *et al*., 1973). *Calotropis procera* also had a higher proline content during the dry period though it is the most succulent species. On the contrary, *A. indicum* and *A. javanica* (being less succulent) showed a more negative water potential than *C. procera* but still had lower proline content. These results indicate that the survival of *C. procera* in arid regions depends upon increased succulence and osmotic adjustment both, whereas, the survival of other species depends upon the availability of moisture during rainy season and they follow osmoconformor strategy during the dry period through osmotic adjustments.

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