Pak. J. Bot., 40(4): 1481-1486, 2008.

ECO-PHYSIOLOGY OF *CAPPARIS SPINOSA* L. : A PLANT SUITABLE FOR COMBATING DESERTIFICATION

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Abstract

Capparis spinosa from the family Capparidaceae is widely distributed on varying habitats in Turkey. Recently, it has been recommended for the evaluation of degraded arid lands in the country. This study was thus undertaken to investigate the diurnal time course of water relations of *C. spinosa* L. growing on healthy and degraded sites. Water stress was analysed on the basis of stomatal conductance (g_s), leaf water potential (ψ_w) and transpiration rate. The species appeared to be a drought resistant with lower WSIS (16 MPa h), showing a negligible difference between the two sites. A high g_s, with lowest WSIS value shows that despite being a water spender, *C. spinosa* dynamically recovers even in the warmest hours of the day and under drought conditions. The long roots and wide ecological amplitude allow it to withstand harsh environments. The species thus appears to be a suitable candidate for the protection of degraded areas.

Introduction

Most of the Mediterranean countries are facing a progressive degradation of their vegetation cover due to increasing anthropic pressures. Overgrazing, repeated fire events and indiscriminate urbanisation are common factors (Ozurk1, 995,1999; Türkmen *et al*.,1996; Maragaris *et al*., 1996) contributing to impoverishment of Mediterranean dry lands and hence, to increasing environmental aridity (Hussain & Durrani, 2007; Ture & Bocuk, 2007). One of the species that is coming to the forefront to overcome this impoverishment of land cover is *Capparis spinosa* (Caper). It is a common shrub of Mediterranean countries and is cultivated on a large scale in Spain, Italy, France, Greece, and North Africa (Zohary, 1960; Ozdemir & Ozturk, 1996; Rhizopoulou *et al*., 2006).The species has been reported to be fire resistant and good for erosion control (Ozkahraman, 1997).

C. spinosa is an important species for our natural surroundings and economy (Baytop, 1984). This is an evergreen shrub, covering soil surface widely, and produces one of the deepest root systems (Ozkahraman, 1997). Being a rich source of minerals and vitamins caper buds are essential component of several Mediterranean cuisines (Aktan *et al*., 1981; Baytop, 1984; Rodrigo *et al*., 1992). More than 300 tons of the buds per year are consumed locally in Turkey or exported to other countries. The root bark of *C. spinosa* acts as a detergent and astringent, expelling cold humors, and is also a remedy for spleen, renal and hepatic complaints. Fruits are atterative, astringent, diuretic, expectorant and carminative. Fruits are regarded as diuretic, kidney disinfectants, vermifuges and tonics and are used for treating arteriosclerosis and tuberculosis (Walter

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& Lewis, 1976; Baytop, 1984; Hussain *et al.*, 2007). The plant is a good accumulator of selenium (Herrero-Latome *et al*., 1987).

This paper investigates ecological characteristics in particular adaptation to water stress of *C. spinosa* growing in the degraded and healthy sites in the Turkish Mediterranean region.

Materials and Methods

Study sites: Samples of *Capparis spinosa* L. plants were collected from a degraded site situated in Dilek Peninsula, near the village of Karine (37°38' N, 27°07' E, altitude 20 m), and from a healthy site lying within the borders of Güzelçamlık National Park (37°41 ′N, 27°08 ′N, altitude 30 m) (Fig. 1).

Water relations: The diurnal time course of leaf conductance to water vapour (g_s) and water potential (Ψ_w) was measured every 90 min between 06.00 h and 19.00 h. for 5 individual caper shrubs. The measurements were repeated every 60 min between 10.00 h and 14.00 h to get better information on changes in minimum diurnal Ψ_w (Ψmin) and maximum g_s. The measurements were obtained for 5 one-year-old leaves in three different plants in April 2007 and September 2008.

Leaf Water Potential (Ψ_w): Five one-year-old leaves per individual plant were tested for leaf water potential, Ψ_w, during daytime, using a portable pressure chamber (PMS 1000, PMS instrument Company, Corvallis, OR, USA). Leaf petiole was long cutted carefully by razor blade and the leaf immediately covered by stretch film. Then petiole tip was recut firmly and placed in pressure chamber. The pressure in chamber was increased gradually. Each time, pressure was increased 5 psi until the sap came out of the petiole tip. The point at which, the water wets the surface of petiole slightly, is the equilibrium point, when the pressure written on chamber is equal to the water potential of those leaves.

Stomatal Conductance (g_s): g_s was measured using a steady-state porometer (LI-1600, LI-COR Inc., Lincoln, NE, USA). Each time 5 leaves were used and measurements were completed within about 30 s, while maintaining the air relative humidity inside the porometer cuvette near the ambient value. Air temperature and relative humidity were also measured using porometer cuvette held at about 1 m from the plant crown.

Estimating the Impact of Water Deficit Stress on Single Species (WSIS): The impact of water deficit stress on plants provided by the entire diurnal time course of Ψ_w, could be expressed in the integrated form as suggested by Mishio & Yokoi (1991) or by the equation:

$$\text{WSIS}=\int \psi_L \, dt \quad (1)$$

Where WSIS is the impact of water stress on individuals of a given species and dt is the time interval when Ψ_w measurements are performed (usually between pre-dawn, t_o, and sunset, t_x). In this form, diurnal changes of leaf water potential can be used to estimate the amount of the "environmental pressure" exerted on plants by water deficit.

Results and Discussion

Diurnal time course of leaf conductance to water vapour (stomatal conductance g_s) and leaf water potential (Ψ_w) were measured in May, 2001 in the field (Fig. 2). $\underline{g_s}$ of *C. spinosa* showed relatively constant trend from predawn (6.00 hours) till early morning (10.00 hours), increasing abruptly till midday (13.00-14.00 hours), then decreasing gradually till evening (18.00 hours). Leaf water potential and transpiration behaviour also followed the same variation trend. The plant flourishes during dry hot summers in the Mediterranean even under severe water scarcity, possibly due to root hydraulic conductance. Similar findings have been reported by several workers (Vardar and Ahmed,1972; Sheikh,1976; Ozturk *et al*.,1983; Rhizopoulou & Psaras, 2003).

The integral of the curves describing the diurnal pattern of Ψ_w changes (WSIS) calculated at the two sites shows that WSIS was around 16 MPah, being much lower than those of Carob tree (*C. siliqua* L.) and olive tree (*O. oleaster* Hoffmgg. et Link) (Vertovech *et al*., 2001; Sakcali and Ozturk, 2004). Although the WSIS difference between healthy and degraded sites for olive tree is high, the difference is negligible in the case of carob and especially caper (47.7 - 70.8; 16.7 - 29.5; 14.4 - 16.1 repectively) (Fig. 3).

Water relation measurements and WSIS changes enlighten the fact that *C. spinosa* is a species well adapted to aridity and environmental degradation and may, therefore, be considered as a suitable candidate, together with *Ceratonia siliqua* as reported by Vertovec *et al*., (2001) and Sakcali & Ozturk (2004) for natural reforestation of degraded and eroded areas of the Mediterranean basin.

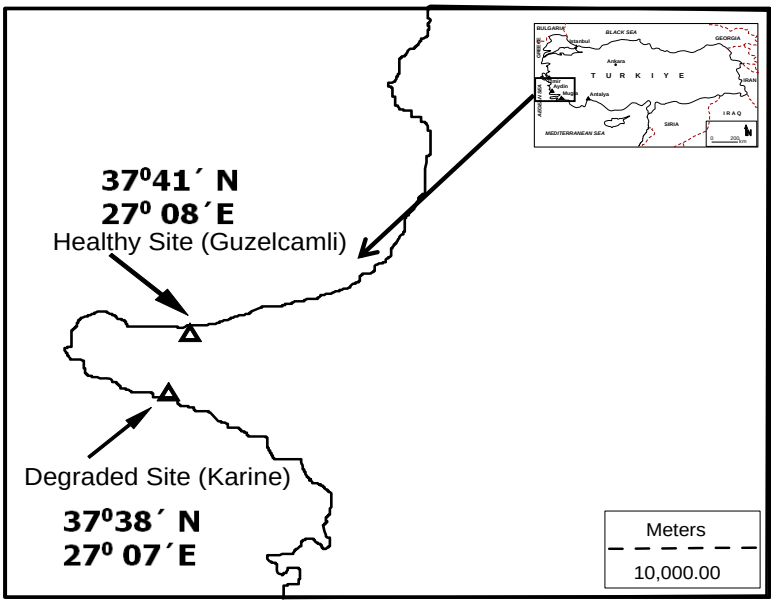

Figure 1. Water relations study sites for *C. spinosa* on the Mediterranean coast of Turkey.

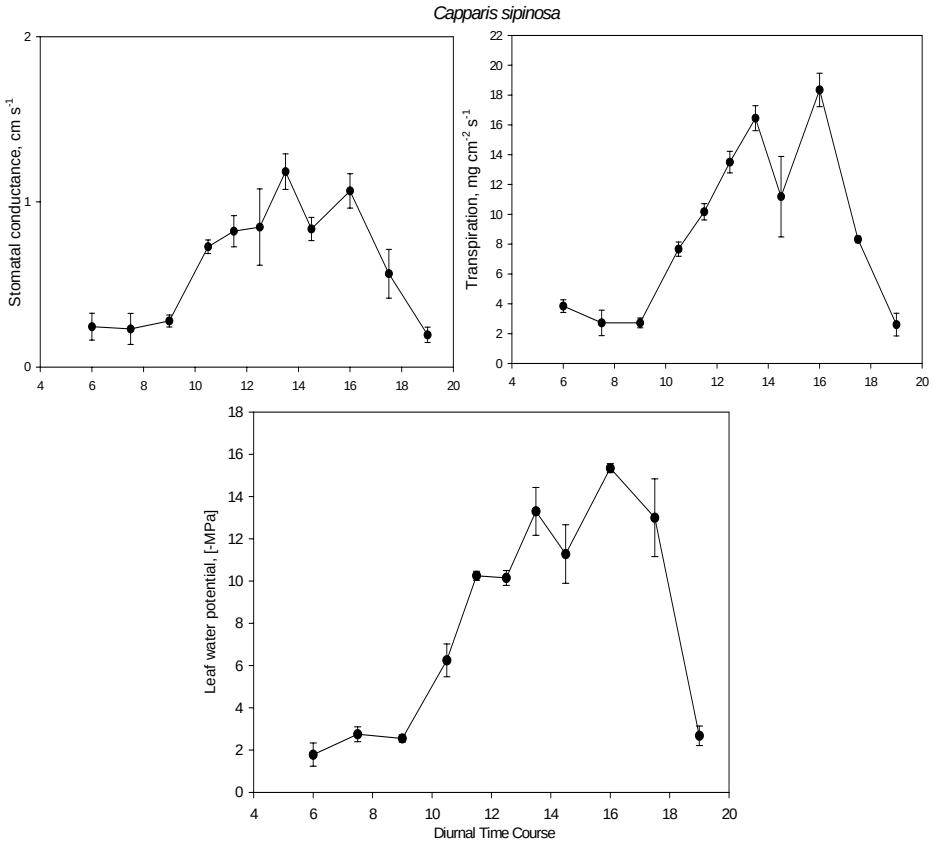

Figure 2. Diurnal physiological behaviour of *Capparis spinosa*.

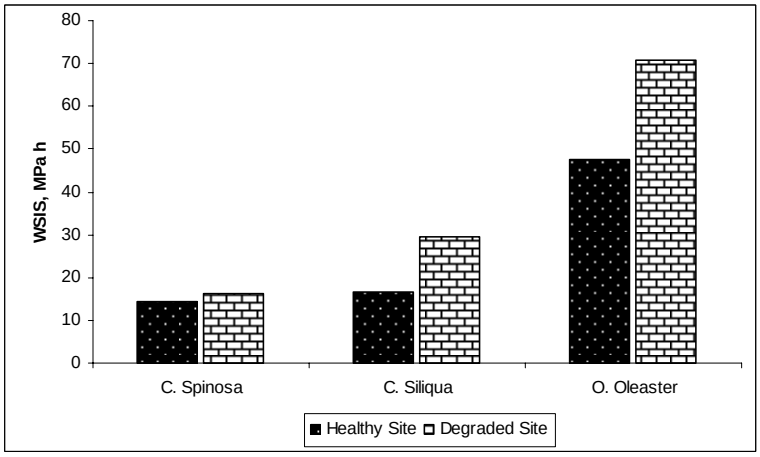

Figure 3. A Comparison of WSIS Values in *C. spinosa* with *Ceratonia siliqua* L. and *Olea oleaster* Hoffmgg.et Link.

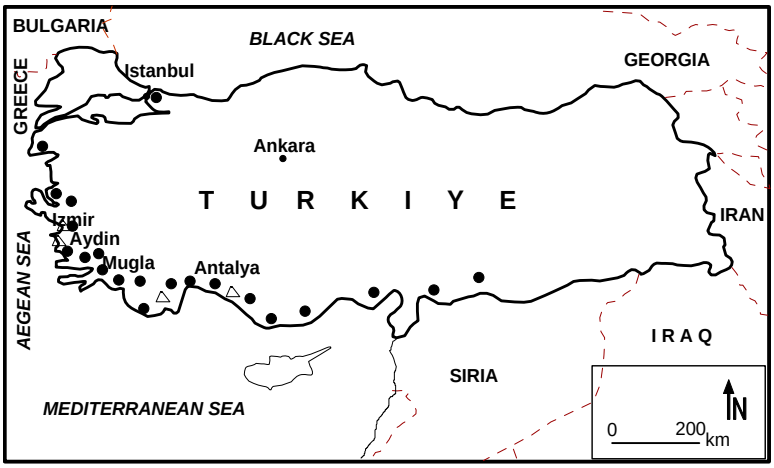

Figure 4. Map showing distribution area of *C. spinosa* in Turkey.

C.spinosa occurs in the Mediterranean and Marmara regions of Turkey (Fig. 4). The plant is light loving and salt tolerant, and flourishes well under intense light and dry hot conditions on nutrient poor, drained, sandy and gravely soils. Soils supporting *C. spinosa* are generally sandy-loam in texture with a low alkalinity, pH being between neutral to slightly basic like many maquis elements (Ozdemir & Ozturk, 1996). *C. spinosa* prefers calcareous soils ($CaCO_3$: 2.5 - 5 %). It is not saline, but very rich in organic matter, nitrogen and phosphorous and poor in potassium in almost every locality. The species are rich in total protein also. The ecological studies carried out on this species by Ozdemir & Ozturk (1996) reveal that these plants contain total nitrogen varying from 3.3-6.5 %, phosphorus 0.16-0.19 %, potassium 1.0-2.2 % and total protein from 20.6-40.5 %. A positive correlation has been observed between soil-plant nitrogen, plant N- soil K, plant P-soil N and plant K-soil P by these authors.

Conclusion: Since *C. spinosa* is a deep rooted, drought tolerant and a fire resistant species, and produces a great vegetative cover which protects soils from water loss, it can prove a real protectant in the erosion control, and can be highly useful as for the prevention of land degradation. It can also be used for the reclamation of saline soils, calcareous soils and fallow lands. All these features stress the fact that this plant can be a promising species that can be used for the re-evaluation of degrading or eroding lands in the Mediterranean countries.

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(Received for publication 21 April, 2008)