Photosynthetic water-use efficiency of irrigated winter and summer crops in a typical mountain oasis of northern Oman

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Dedicated to Prof. Dr. Burkhard Sattelmacher, who passed away on November 21, 2005

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Summary

The millenia-old existence of traditional, surface-irrigated Omani mountain oases implies a remarkable sustainability of such systems in a hyperarid environment. This study was conducted in the mountain oasis of Balad Seet, situated in the Al-Jabal-al-Akhdar mountains of northern Oman, to investigate the water-use efficiency (WUE) of these oases and how farmers regulate it. In 2005, gas exchange of single leaves of 9–16 plants was measured for the most important perennial field crop alfalfa in both February and August, for the typical winter crop oat in February, and the dominating summer crop sorghum in August. The measurements were conducted five times a day in subplots irrigated the evening before and in the surrounding control plots, where plants had been withheld from irrigation for 14–16 d.

Water deficit at the end of the irrigation interval reduced the stomatal conductance (g_s) strongly in summer alfalfa, oat, and sorghum, but only slightly in winter alfalfa. In oat, the reduction of net photosynthetic rate (P_N) at the end of the irrigation cycle was caused mainly by stomatal closure, in sorghum by nonstomatal factors and in summer alfalfa by both, whereas P_N in winter alfalfa remained unaffected. The ratio of net photosynthetic rate to stomatal conductance (P_N/g_s), the "intrinsic water-use efficiency", increased in all investigated crops in response to drought because of a stronger reduction of g_s than of P_N. This increase was small in winter alfalfa, but much stronger in oat, sorghum, and summer alfalfa.

The data indicate that alfalfa maintains a relatively high CO_2 assimilation rate year-round, contributing to a relatively high annual dry-matter production. The decrease of the light intensity in the late afternoon caused by the shading effect of the surrounding mountains diminishes the crop evapotranspiration in the oasis.

Key words: Aflaj / alfalfa / irrigation agriculture / oat / sorghum / photosynthesis

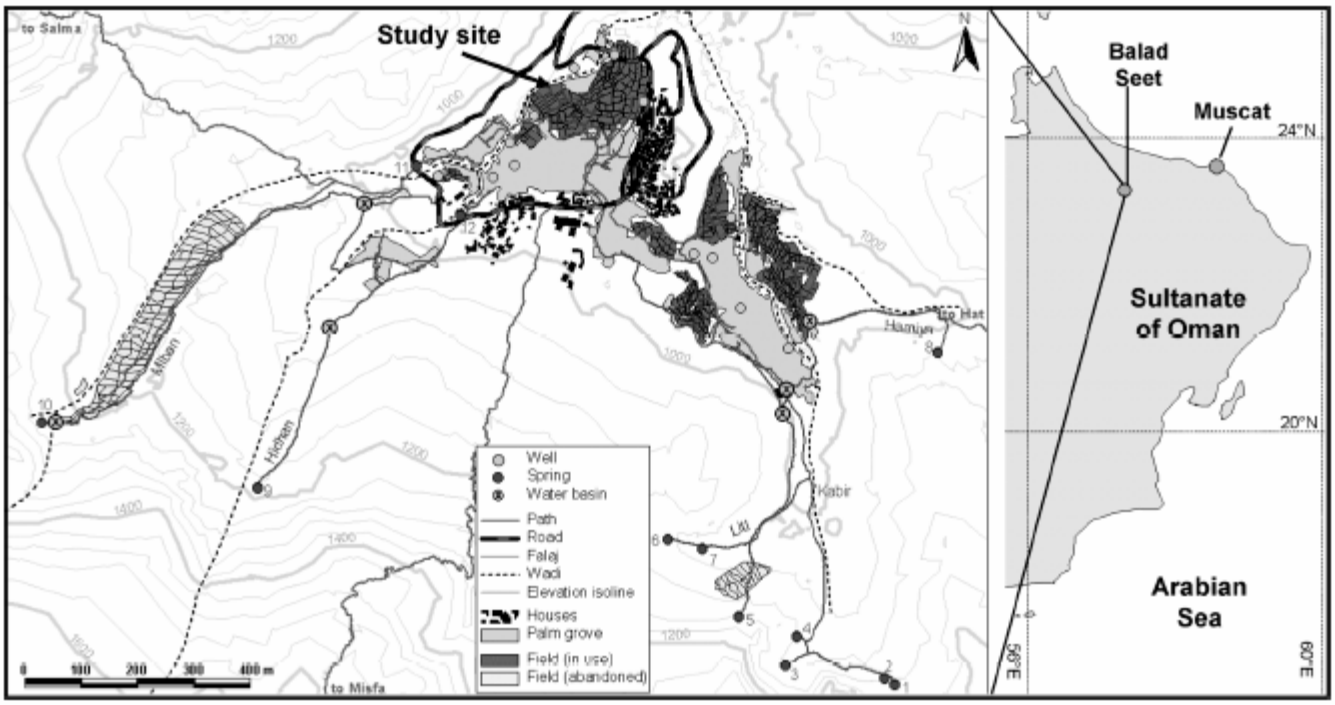

Figure 1: Map of the Sultanate of Oman with the mountain oasis of Balad Seet inserted. The black arrow indicates the terraced field of alfalfa (*Medicago sativa* L.) where the study was conducted (*Luedeling* et al., 2005).