Long-Term Effect of Intensive Irrigated Agriculture on Dryland Soil Quality Within the Vicinity of *Thymelea Hirsuta* Shrubs in the Negev Highlands

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Abstract

The increased demand for agricultural land has led to dryland areas being converted into irrigated farmlands. This has resulted in land degradation and hence poor soil quality. Within the Negev Highlands, loessal soil organic carbon, salinity and microbial respiration were compared above and below an eroded patch created by erosion resulting from intensive irrigation, as well as beneath the canopy of Thymelea hirsuta shrubs and in adjacent open areas. The objective the study was to determine effects of erosion on some biochemical characteristics of loess soil, i.e. organic carbon, soil salinity and soil respiration in areas located above versus those below waterfalls. Sixty soil samples were taken from the topsoil (30 above and 30 below waterfall). The bulk soil samples were air-dried, mixed in a mortar and pestle and sieved through a 2- mm sieve to remove coarse fragments then used for laboratory analysis. These were used to determine organic carbon, electrical conductivity and soil respiration. Organic carbon showed significant differences between areas above waterfalls and those below waterfalls. Soil salinity had significant differences below waterfalls beneath the Thymelea shrubs and the open area. Thymelea, being a halophyte was the source of salts, drawn up from deeper soils within the rhizosphere. Soil respiration, which proved to be significantly correlated ($r^2=0.90$) with organic carbon, also showed a significant difference above and below the waterfall in the samples taken beneath the canopy of Thymelea. Generally, mean values of all measured soil parameters were found to be lowest in the open areas below the waterfall and highest above the waterfall. The values were also high beneath the *canopy of Thymelea. This suggests that soils are inherently variable, becoming impoverished and homogenized as a consequence of erosion and loss of vegetation cover.*

Keywords: Irrigation, Thymelea hirsuta, organic carbon, soil respiration, soil salinity

Introduction

Effects of climate change, through its influence on wind fetch and direction, as well as vegetative structure, is believed to be responsible for a reduction in eolian soil deposition in areas of loessal soils in the Negev desert (Ward *et al.*, 2001). Soil erosion, a natural process in these desert areas which is possibly exacerbated by human activities (Akuja, 2001), presently occurs at a faster rate than deposition and represents a threat to these locally important centres of agricultural activity. The effects of soil erosion are most dramatic within the wadis (ephemeral rivers) where runoff from episodic winter rainfall events is concentrated. Gully erosion within the wadi bed creates a vertical erosion front or waterfall which may reach bedrock and migrates upstream with each rainfall event (Gerrard, 1981). Above and below the waterfall representing current and post-erosion states respectively, within an area in which it can be assumed that environmental conditions are comparable. However, an important limitation with this space for time comparison is that it assumes that all conditions, apart from the erosion process, will remain static over the longer time frame required for the same degree of soil loss through extensive sheet erosion. Consequently, these results can be interpreted with caution.

Changes in soil quality may be indexed by organic carbon content. This important soil characteristic relates to soil chemistry, structure, fertility, origin and classification (Chapman & Pratt, 1961). Contained in the soil organic fraction, organic carbon consists of microbial biomass, plant and animal residues at various stages of decomposition, stable humus synthesized from residues and highly carbonized compounds such as graphite and coal (Nelson and Sommers, 1996). The microbial biomass is largely responsible for

nutrient cycling within the soil (Anderson, 1982), provides an index of the soil microbial activity.

Soil salinity is high throughout the Negev desert and it is one of the most important factors limiting plant growth (Shalhevet & Bernstein, 1968; Williams & Colwell, 1977; Szabolcs, 1979; Dan & Koyumdjisky, 1987). It is typically a consequence of flooding or irrigation, which causes a rise in soluble salts back into lower horizons (Middleton & Thomas, 1997). Thus, in the absence of artificial irrigation, salinization tends to occur in vicinity of springs or seepage points on hillsides. In areas of uneven topography, soil salinization may result from deposition of soil leachates from areas of higher elevation on those of lower elevation (Rendig & Taylor, 1989). Within the Negev desert, vegetation tends to be concentrated within the wadis (Ward & Olsvig-Whittaker, 1993) which are low-lying saline depressions in the Negev (Zohary, 1966) and which is relatively abundant within the wadis. Its leaves have a high salt content, which increases aridity (Zohary, 1966).

The Negev desert being a fragile ecosystem and with increased demand for agricultural land, has led to dryland areas being converted to irrigated farmlands. This has resulted in land degradation due to soil erosion and the end result is poor soil quality. In this study, therefore, the objective was to determine effects of erosion on some biochemical characteristics of loess soil on soil salinity, organic carbon and soil respiration in areas located above versus those below waterfalls.

Materials and Methods

The study was conducted at Nahal Revivim located within an intensively eroded area of the Central Negev Highlands of Israel (30°50'N, 34°45'E). Average rainfall here is 90 mm per annum. During the period of study (1998-2001) below average rainfall were received, resulting in droughts. Minimum and maximum temperatures are {1& 20°C} in winter and {20& 40°C} in summer. The soils are brown lithosols and loessal serozems, upon limestone and dolomite (Stern *et al.*, 1986). The vegetation is steppe semi-arid shrub (Zohary 1966). The wadi floor is subject to gully erosion.

Sixty sampling sites were located within the wadi, 30 below the waterfall and 30 above. Of each of these 30 sampling sites, 15 were