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Role of deforestation and hillslope position on soil quality attributes of loess-derived soils in Golestan province, Iran

F. Khormali [a,*], M. Ajami [a], S. Ayoubi [b], Ch. Srinivasarao [c], S.P. Wani [c]

[a] Dept. of Soil Science, College of Agriculture, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran
[b] Dept. of Soil Science, College of Agriculture, Isfahan University of Technology, 84156-83111 Isfahan, Iran
[c] International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

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ABSTRACT

Conversion of natural land resources into croplands, which is triggered by the rapid population growth, causes serious soil degradation. A loess hillslope located in eastern Golestan province of Iran was selected to study the role of deforestation and slope position on soil quality attributes. Surface (0–30 cm) and subsurface (30–60 cm) soil samples were taken from five slope positions (summit, SU, shoulder, SH, backslope, BS, footslope, FS and toeslope, TS) of forest (FO) and adjacent deforested cultivated land (DEF) in a factorial trial with completely randomized design. Ten pedons were also investigated and undisturbed soil samples were taken from different horizons for micromorphological studies. The texture of the original loess is silt loam. The soil textural class varies from silty clay loam in FO to silt loam in DEF, mainly due to the loss of finer particles as a result of soil erosion followed by deforestation and long-term cultivation. Mean weight diameter (MWD) of aggregates decreased following deforestation (0.88 mm compared to 1.49 mm in FO), as a result of considerable losses of organic carbon (OC) and breakdown of aggregates. Bulk density (BD) increased and soil infiltration rate decreased by about 50% in DEF. Reduction of annual organic matter input to soil as a result of deforestation and also rapid oxidation of organic matter in DEF were responsible for a significant decrease (>70%) in OC and total nitrogen (TN). Soil microbial respiration (SMR) also decreased significantly, following deforestation. Carbon, and N contents and population of fungi were significantly higher in all hillslope positions of the FO than the DEF. Changes in soil quality attributes were not significant in different slope positions of FO, which might be related to the stability of forest landscape. Effect of different slope positions on soil quality attributes was more pronounced in the DEF. The SH and BS were found as the most susceptible positions to erosion in DEF. Soils of the FO were mainly classified as Alfisols and Mollisols with evidences for clay illuviation compared to the weakly developed Inceptisols formed in the DEF. Micromorphological investigations revealed that the FO soils had strong granular and crumb microstructure with a high porosity indicating the presence of high amount of organic matter. The high microbial and faunal activity was confirmed through the presence of excremental pedofeatures in the topsoil of the FO. Lower organic matter and consequently microbial activity in the topsoil of the DEF have resulted in the massive microstructure with little porosity.

1. Introduction

Soil quality is a concept that integrates soil biological, chemical, and physical factors into a framework for soil resource evaluation (Karlen et al., 1997). Larson and Pierce (1991) define soil quality as the capacity of a soil to function within the ecosystem boundaries and to interact positively with surrounding ecosystems. Conversion of forest and grasslands into agricultural land is one of the main concerns worldwide in the context of environmental degradation and global climate change (Wali et al., 1999). Conversion of natural land resources to crop production as the largest source of anthropogenic carbon emissions after fossil fuel burning, has resulted in the release of about 200 Pg C over the past 250 years, globally (Scholes and Noble, 2001; Fitzsimmons et al., 2004).

It is also very well known that cultivation of the natural land resources brings about the loss of OM and this directly affects the soil chemical, physical, and biological properties resulting in loss of

Abbreviations: FO, forest; DEF, deforested land; SU, summit; SH, shoulder; BS, backslope; FS, footslope; TS, toeslope; MWD, mean weight diameter; BD, bulk density; *F*, soil porosity; OM, soil organic matter; OC, soil organic carbon; TN, total nitrogen; CEC, cation exchange capacity; CCE, calcium carbonate equivalent; EC, electrical conductivity; K_{ava}, available potassium; SMR, soil microbial respiration; BioC, biomass carbon; BioN, biomass nitrogen; *K*-factor, erodibility factor; WSA, water stable aggregates.

* Corresponding author. Tel.: +98 171 4426523; fax: +98 171 4420981.
E-mail address: khormali@yahoo.com (F. Khormali).

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