Changes of Soil Enzyme Activities in the Process of Karst Forest Degradation in Southwest China

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Abstract: Sample plots (15 m × 20 m) were set up in the karst areas in Guizhou Province with an attempt to reveal the changes of soil enzyme activities under karst forest degradation. The results showed that the extent of degradation of plant communities was enhanced leading to the clayification of soil, the drastic decrease in SOM contents, and the reduction of soil nutrients available for plants. The urease activities, peroxidase activities and alkaline phosphatase activities of the soils had also decreased significantly.

Keywords: Karst forest degradation; Soil nutrients; Soil enzyme activities

Introduction

In the karst mountainous areas of Southwest China, which cover about 42.6×10^4 km^2, largely in Guizhou Province (11×10^4 km^2), no sufficient attention has been paid to the problem of karst rocky desertification caused by irrational and intensive land use on a fragile karst geo-ecological environment (Wang *et al.*, 2002). Guizhou, which is located in the center of the karst region of Southwest China, was taken as the study region (Wang *et al.*, 2004b) to explore soil changes in the process of karst forest degradation, so as to establish suitable soil indices to evaluate the impact of karst forest degradation on ecological environment and provide the scientific basis for the restoration of vegetation and rational utilization of soil resources in karst areas.

Materials and Methods

Three regions were investigated, i.e., the Huajiang canyon karst region, the Qingzhen peak forest karst region and the Huaxi peak cluster karst region. Under the condition of relative consistency in landform, geomorphology, slope and lithology, the authors set up sample plots (15 m × 20 m) on the slopes under different vegetation conditions and conduct investigations into the vegetation and soil during February-May 2008. The surface layer of each soil sample (0~15 cm) was obtained by mixing 5~8 sub-samples respectively collected from 5~8 locations in each quadrat.

Results and Discussion

Due to the evolution of plant communities, changes occured in the physicochemical properties of soil. Significant differences appeared in the contents of clay particles in karst soils lying beneath the different plant communities. The contents of <0.01 mm-sized clay particles varied over the range of 43.6%~80.7%, and those of <0.001 mm-sized clay particles, 22.3%~64.2%. It could be seen clearly that soil tended to develop toward clayification following the order of degradation-evolution sequence of plant communities: broad-leaved forest → broad-leaved woodland → shrub forest → open shrub woodland → shrub grassland. The variation of plant communities

had also changed the contents of organic matter, which varied from 18.4~198.8 $g \cdot kg^{-1}$. Changes had also taken place in contents of main nutrients in soils with the variation of plant community. The contents of total nitrogen (TN) and total phosphorus (TP) in soil varied over the ranges of 1.82~10.3 $g \cdot kg^{-1}$ and 0.35~1.71 $g \cdot kg^{-1}$, respectively; acid-soluble potassium in soil, 190~412 $mg \cdot kg^{-1}$; available N, P and K in soil, 64~508 $g \cdot kg^{-1}$, 1.4~12.8 $g \cdot kg^{-1}$ and 60~185 $g \cdot kg^{-1}$, respectively. It was evident that following the order of degradation-evolution sequence of plant communities, the contents of main nutrients in soil decreased.

With the precise degradation-evolution sequence of plant communities as described above, the urease activities, peroxidase activities and also alkalin phosphatase activities of the soils had decreased significantly. Compared with the soil in broad-leaved forest, the urease activities decreased by 60%, the peroxidase activities decreased by 38%, and the alkalin phosphatase activities decreased by 43% for the soil of shrub grassland. During the degradation process of karst forest from broad-leaved forest → broad-leaved woodland → shrub forest → open shrub woodland → shrub grassland, the soil respiration was gradually decreased.

The results of correlation analysis (Table 1) indicated that the contents of organic matter, nitrogen, phosphorus and potassium in soils showed obvious positive correlations with the soil enzyme activities. The contents of organic matter, nitrogen, phosphorus and potassium had obvious positive correlations with the soil respiration. It could be seen that the reduction of vegetation coverage and the variation of plant community were the prerequisites for the changes of soil enzyme activities, and karst forest degradation was necessarily a decisive factor.

Table 1 Correlation coefficients between enzyme activities and soil nutrient contents in the study plots

Enzyme activities	Soil nutrient contents						
	SOM	TN	TP	AK	N	P	K
urease	0.571**	0.546**	0.620**	0.540**	0.613**	0.551**	0.590**
peroxidase	0.560**	0.610**	0.644**	0.680**	0.612**	0.474**	0.542**
phosphatase	0.794**	0.772**	0.745**	0.632**	0.830**	0.720**	0.732**
proteinase	0.370**	0.345**	0.322*	0.205	0.457**	0.365**	0.335*
invertase	0.455**	0.450**	0.505**	0.503**	0.466**	0.308*	0.427**
soil respiration	0.631**	0.674**	0.601**	0.491**	0.620**	0.659**	0.677**

Note: * $P < 0.05$; ** $P < 0.01$; n-1=59. soil organic matter (SOM), total nitrogen (TN), total phosphorus (TP), acid-soluble potassium(AK)

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