SEASONAL VARIATIONS OF LABILE SOIL ORGANIC CARBON AND NITROGEN FERTILITY IN GRASSLAND SOIL IN TOKYO, JAPAN

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ABSTRACT

We investigated seasonal variations of soil enzyme activities, soil inorganic N, soil microbial biomass N (BN) and soil total sugar C (TSC) during March to December in cattle-grazed pasture in Japan (Andisols). Dehydrogenase activity had three peaks in a year, on the other hand, phosphomonoesterase activity increased from spring (April) up to summer (August) but then gradually decreased toward winter. BN also showed a seasonal variation, which gradually increased from April to August, but in the end of August once decreased rapidly because of soil becoming dry. Soil inorganic N had three peaks which appeared after the appearance of dehydrogenase activityí-s peaks and which resulted from N-fertilization or cattle pasturage. TSC showed a seasonal variation which didní-t show any change from April to early in August (about 3000mg/kg) but then sharply decreased down to about 1500mg/kg in the end of August. In this study, these labile soil organic matter fractions and the amount of soil inorganic N in cattle-grazed pasture showed seasonal variations.

KEYWORDS

Seasonal variation, labile soil organic matter, soil enzyme activity, soil inorganic N, soil microbial biomass N, soil total sugar C

INTRODUCTION

The accumulated soil organic matter (SOM) becomes a major source of nutrient for agricultural production in well-developed pastures. In particular, the quality and quantity of labile SOM fractions (e.g. soil enzyme, microbial biomass, soil carbohydrates) showing seasonal variations, their status can be taken as an indicator of seasonal variation in soil fertility.

Soil enzymes dividing into intracellular and extracellular type, dehydrogenase is intracellular type and its activity is often used to assess microbial activity. Phosphomonoesterase is extracellular type and mineralizes organic P into mineral P. Thus soil enzyme activities are useful to assess active fractions of SOM.

The soil microbial biomass, the living fraction of SOM that plays a major role in the cycling and transformation of C, N and other nutrients has been suggested as a sensitive indicator in SOM status.

Soil carbohydrates are primarily derived from plant debris but they can be immediately decomposed by microorganisms in soil. The amount of soil carbohydrates in grazed pastures is strongly influenced by soil management systems and may show the seasonal variations because a large quantity of organic matter from pastoral plants returns to the soil and is decomposed.

The main objective of the present study was to determine the seasonal variations in labile SOM status and the amount of soil inorganic N in cattle-grazed pasture.

MATERIALS AND METHODS

Study area and soil sampling. Soil samples (0-75mm) were collected from cattle-grazed pasture, which had been sown with toll fescue (*Festuca arundinaces* SCHREB) and white clover (*Trifolium repens* L.). Soil samples were taken during March to December and passed through a 2-mm sieve for analyses of soil enzyme activities and microbial biomass N. Subsamples of sieved moist soils were air-dried and ground (< 0.25mm) for analyses of soil inorganic N and carbohydrate. The soil, stony clay loam (*mesic Typic Hapludands*) is located in Kanagawa prefecture near Tokyo.

Analytical methods. TC and TN were determined with a NC analyzer with dry combustion. Two soil enzyme activities were chosen, dehydrogenase activity as intracellular enzyme activity and phosphomonoesterase activity as abiontic enzyme activity. BN was determined by chloroform fumigation-extraction method of Brookes *et al*. (1985). Soil inorganic N was extracted for 2hr with 2M KCl (1:10 soil : extractant ratio) and inorganic N in the extractants was determined. Soil total sugar C (TSC) were determined by HPLC after acid hydrolysis with sulfuric acid using the method of Tanaka *et al*.(1990).

RESULTS AND DISCUSSION

All the labile SOM fractions and the amount of soil inorganic N in this study had seasonal variations during March to December.

Soil enzyme activities of both dehydrogenase and phosphomonoesterase showed seasonal variations (Fig.1). Dehydrogenase activity had three peaks in a year: first and third peaks appeared just after cattle pasturage and the second one appeared in mid-summer. Taking this activity relating to soil microbial activity into account, this seasonal variation can be considered to indicate the status of soil microbial activity in grazed pasture. On the other hand, phosphomonoesterase activity increased from spring (April) up to summer (August) but then gradually decreased toward winter.

BN also showed a seasonal variation which increased from April (69 $\mu g\, g^{-1}$) up to early in August (81 $\mu g\, g^{-1}$), but in the end of August showed a temporary decrease (47 $\mu g\, g^{-1}$) due to soil becoming dry (Fig.2). But BN was not correlated with dehydrogenase activity, which was similar to report by Sparling (1981).

Soil inorganic N had three peaks (Fig.2). First one early in May resulted from probably N-fertilization (26th April) and N mineralization promoting according to temperature increase. Second one early in September resulted from the return of a lot of labile SOM by cattle pasturage which is easily decomposed and mineralized. Although N-fertilization was applied on 15th July, it didn't reflect on the amount of soil inorganic N on 15th August probably because of pasture plants absorbing and leaching. Third peak probably resulted from N-fertilization after the last cattle pasturage in this year. But we could not find which N-fertilization or a lot of labile SOM return by cattle pasturage is more effective on increase of soil inorganic N. In addition, interestingly, every soil inorganic N peak had appeared after the appearance of dehydrogenase activity's peak.

TSC showed a seasonal variation, which didn't show any change from April to early in August (about 3000mg/kg) but in the end of August, sharply decreased down to about 1500mg/kg. This TSC rapid decrease was similar to the pattern of BN's seasonal variation.

Biological properties of the soil generally seem to be influenced under grazed pasture. Bolton *et al*.(1985) reported leguminous green manure increased soil enzyme activities, microbial biomass C and N flush. A large mass of pasture root causes a large microbial biomass in the pasture rhizosphere, and large amount of SOM and high microbial activity under pasture results in a high level of activity of soil enzymes (Ross *et al.*, 1984). Also, in our study, soil enzyme activities, soil inorganic N, BN and TSC had seasonal variations which seems to be influenced by vegetation growth, temperature, fertilization and cattle pasturage.

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