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A COMPARISON OF CHEMICAL PROPERTIES OF SOME FOREST SOILS*

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車鍾煥：各種林土에 對한 化學成分의 比較

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ABSTRACT

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Determination of the chemical properties in some forest soils and the naked soil developed on granite in the mountains of the vicinity of Seoul, Korea are presented in this study.

The soil under the broad leaved forests has a higher nutrient indicated by available nitrogen, nitrate nitrogen, and phosphorus contents, compared with that under the needle leaved forests.

On the contrary the content of organic matter and base exchange capacity in the needle forest soils is higher than in the broad leaved forest soils.

The significant difference between two horizons of each soil appeared only to be in the content of the available phosphorus, and that of the needle and the broad leaved forest soils, and the naked soils was the nitrate nitrogen and organic matter content among the several chemical properties.

INTRODUCTION

On the various physical and chemical properties under the natural soils in relation to vegetal pattern in areas, several informations have been observed, from the earliest records of agriculture to the present day, as various biological and chemical methods.

Whiteside et al. (12) dealt with some differences between cultivated and uncultivated areas of a dark-colored prairie soil in the humid areas of the United States. In the humid regions studied, they found that the tilled area had less organic carbon, base exchange capacity, and exchangeable bases in upper 12 inches of the profile. No difference in mechanical composition of virgin and cultivated profiles was observed, although considerable variation within the areas was noted. Paulson (7) studied that a comparison of surface soil properties under perennial grassland areas and interspersed areas recently invaded by mesquite was analyzed for physical and chemical properties. Karim and Khan (4) have presented data to show the probable relationship betweem pH and different forms of phosphorus in some soils of East Pakistan. By the analysis of soil phosphate and records of native vegetation of three analogous areas in Southeast Queenland, Australia. Coaldrade and Haydock (3) have examined and statist-

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ically tested the hypothesis that soil phoshorus is the primary factor governing the distribution of native vegetation in these areas. Kim (5) has studied the variation in the properties of the base exchange capacity, of the total exchangeable bases and of the pH which might vary due to the added salts in the soils. Snaydon (10) has studied the variations in edaphic factors associated with the pattern of micro-distribution of white clover.

However, in respect to most of these studies there is not any record as yet in Korea. The investigation reported here was designed to observe some differences among some forest soils and the naked soils developed on granite in Mt. Sam-Gak, Mt. Bai-Bong, Mt. Soli-Bong, and the mountain of the Forestry Experiment Station in the vicinity of Seoul. The chemical properties of two profiles in soils reported in this paper are those of available nitrogen, nitrate nitrogen, available phosphorus, organic matter, total exchangeable base, exchangeable hydrogen, and H ion concentration.

MATERIALS AND METHODS

The forests studied are as follows: (1). Needle leaved forest communities: *Pinus densiflors* Siebold and Zuccarini, *Pinus rigida* Mill, *Pinus koraiensis* Siebold and Zuccarini, *Abies holophylla* Maximowicz, and *Larix kaempferi* Sargent. (2). Broad leaved forest communities: *Alnus japonica* Steudel, *Castanea crenata* Siebold and Zuccarini, *Quercus acutissima* Carruthers, *Robinia pseudacacia* Linne, *Quercus mongolica* Fisher, and *Lespedeza bicolor* Turczaninow.

The soil samples were collected from A and B horizons of the soil under the above mentioned forest types and of naked soils. These were obtained from 2 plots in each forest type of 4 mountains during the drought in April 1962. These sample plots were in the crown perimeter of the trees.

The annual precipitation for the site is approximately 1260.8mm, of which 39% occurs during the drought season sparsely, but the remainder falls in summer violently.

Chemical analyses of these samples were conducted according to standard laboratory techniques. The soils were analyzed for potentially available nitrogen by the procedure proposed by Purvis et al. (8), and for available phosphorus by the modified Truog's (11) stannous chloride method with a electrophotometer. Nitrate nitrogen contents of soils were determined by the phenoldisulfonic method. The extraction of nitrates was performed by the reagent of extracting solution. After the phenolsulfonic acid is dropped into the residue, ammonium hydroxide is added until it becomes yellow. The content of nitrate nitrogen of this solutoin was determined by the electrophotometer. Organic matter of the soil samples was ashed in a muffle furnace at 525—550°C, and its results expressed as percentage dry weight of soil. The soil pH was measured by the glass electrode, and the exchangeable hydrogen and total exchangeable basic cation were measured according to the procedure proposed by Brown (1).

RESULTS

The data of chemical analysis of the soil samples obtained from the various forest types and the naked soils are shown in Table 1.

The result of the data cannot be fully evaluated by statistical treatment, because the number of sample was, of necessity, limited. Nevertheless, statistically significant differences were found among three groups of samples in respect to some important chemical properties. In other cases, the differences, while not significant at the 5% levels, were at least consistent among the three groups of samples. The results of the statistical analysis are shown in Table 2.

Table 1. Chemical properties in some forest soils developed on granite.

Trees	Horizons	Available nitrogen ppm	Nitrate nitrogen ppm	Available phosphorus ppm	Organic matter %	Base exchange capacity m.e.	Total exchangeable base m.e.	Exchangeable hydrogen m.e.	Base saturation %	pH
Pinus densiflora	A	3.15	1.85	0.48	0.88	36.1	22.0	14.1	60.9	4.68
	B	2.75	1.25	0.62	0.62	29.0	18.9	10.1	65.2	4.65
Pinus rigida	A	2.60	1.60	1.30	0.72	42.4	16.3	26.1	38.4	5.66
	B	3.27	1.75	0.91	0.52	33.5	9.7	23.8	28.7	5.71
Pinus koraiensis	A	3.16	2.00	1.84	0.82	27.7	18.5	9.2	66.8	5.21
	B	2.59	1.60	1.46	0.62	25.9	14.9	11.0	57.5	5.66
Abies holophylla	A	2.72	1.75	1.26	0.99	24.3	12.5	11.8	51.4	4.56
	B	2.50	1.50	1.14	0.82	18.1	7.2	10.9	39.7	4.60
Larix kaempferi	A	2.32	1.65	1.81	0.62	20.7	11.0	9.7	53.1	4.60
	B	2.41	1.60	1.42	0.91	20.3	10.6	9.7	52.2	5.03
Average of	A	2.79	1.77	1.34	0.81	30.2	16.1	14.2	53.3	4.94
Average of	B	2.71	1.54	1.11	0.70	25.7	12.3	13.1	47.8	5.13
Average of	A&B	2.75	1.66	1.23	0.76	28.0	14.2	13.7	50.0	5.04
Alnus japonica	A	3.35	3.05	1.60	0.73	28.6	8.4	20.2	29.4	5.15
	B	3.04	2.15	0.34	0.69	27.7	5.3	22.4	19.1	4.89
Castanea crenata	A	3.39	1.55	1.16	0.62	30.8	17.6	13.2	57.1	5.30
	B	2.83	1.65	0.82	0.49	29.9	17.6	12.3	58.8	5.33
Quercus acutissima	A	4.21	1.75	3.44	0.68	29.0	17.6	11.4	60.7	5.42
	B	2.69	1.65	1.74	0.50	22.0	12.3	9.7	55.9	5.82
Robinia pseudacacia	A	5.51	1.95	3.02	0.63	23.7	11.4	12.3	48.1	5.26
	B	3.75	2.15	2.52	0.67	16.2	10.1	6.2	62.3	5.14
Quercus mongolica	A	2.57	1.85	2.76	0.88	24.3	15.8	8.5	65.1	5.21
	B	1.20	1.80	1.06	0.90	18.8	13.8	5.0	73.4	4.95
Lespedeza bicolar	A	3.14	2.50	1.43	0.67	26.0	12.8	13.2	49.2	5.41
	B	3.12	2.55	0.56	0.57	22.2	8.8	13.4	39.6	5.47
Average of	A	3.70	2.11	2.24	0.70	27.1	13.9	13.1	51.3	5.29
Average of	B	2.77	1.99	1.17	0.64	22.8	11.3	11.5	49.5	5.24
Average of	A&B	3.24	2.05	1.72	0.67	25.0	12.6	12.3	50.4	5.27
Naked soils	A	2.32	1.20	0.62	0.27	23.8	9.7	14.1	40.7	4.64
	B	2.35	1.50	0.41	0.29	21.6	8.8	12.8	40.7	4.70
Average of	A&B	2.34	1.35	0.52	0.28	22.7	9.3	13.5	40.7	4.67

Table 2. Statistical analysis of the chemical properties given in Table 1.

	Available nitrogen	Nitrate nitrogen	Available phosphorus	Organic matter	Total exchangeable base
"t"—test	1.10	0.11	5.63*	1.32	2.85
"F"—test	2.68	9.61*	3.47	47.55**	3.47
L. D. S.	—	0.51	—	0.52	—

**: Significant at the 1% level. *: Significant at the 5% level.

"t"—test: under A and B horizons of each soil.

"F"—test: among the forest and the naked soils.

L. D. S.: least significant differences of star marks at the "F" test.

The chemical properties of the soil under forests indicate greater content of nitrogen, phosphorus, organic matter, and base exchange capacity than those of the naked soils. Chemical analysis shows higher available nitrogen, nitrate nitrogen, and available phosphorus contents of the soil under the broad leaved forest in comparison with that under the needle leaved forest. That is, the broad leaved forest soil has a higher nutrient capital as indicated by the available nitrogen, nitrate nitrogen, and available phosphorus determinations. But the needle leaved forest soil has a higher nutrient capital as indicated by the content of organic matter and base exchange capacity compared with components under the broad leaved forest soils.

It was found that organic matter could hold, by absorption, considerable quantities of nutrients in ionic form. In Table I it can be seen that the base exchange capacity is closely related to the organic content.

The fertility of soil decreased with increasing depth.

DISCUSSION

The data obtained in these experiments were treated statistically by analysis of variance and the "t" test to draw the general conclusion. The "t" test has attempted to get information on the significant differences between two horizons of the needle and the broad leaved forest soils, and the naked soils. According to the results of the "t" test, the available phosphorus was only significant at the 5% levels of probability (Table 2). From this fact, the disparities of phosphorus between the two horizons are probably due mainly to the different amount of humus.

The significances among the groups of the needle and the broad leaved forest soils, and the naked soils, were tested by the analysis of variance (Table 2). According to the results of analysis of variance of two groups of forest soils and the naked soil, organic matter and nitrate nitrogen contents were only significant as the 1% and 5% levels of probability.

The contents of the available nitrogen, nitrate nitrogen, and available phosphorus recorded in these samples are almost all within the deficient categories by agricultural standards.

The soil under the broad leaved forest (generally deciduous angiosperm trees) has a higher nutrient capital as indicated by available nitrogen, nitrate nitrogen, and available phosphorus contents compared with that under the needle leaved forest (generally conifer needle trees). On the contrary the content of organic matter in the needle leaved forest soils is higher than that in the broad leaved forest soils. It is found that the differences in the content of inorganic and organic matters in soils may be influenced by the chemical composition of the litter from which it is derived. Conifer needles contain acid-forming compound and resins which are very resistant to decay: therefore they can be low in available nitrogen, nitrate nitrogen, and available phosphorus contents. In contrast, the leaves of most deciduous angiosperm trees are nonacid-forming and contain little or no resin but considerable quantities of the minerals listed above. The contents of organic matter in the needle forest soils were more than that in broad forest soils because the contents of organic matter are increased by the organic residues of litter of the needle trees added to the forest soils. It can be seen that the exchange capacity is closely related to the organic content. This is in agreement with the results of the study of Chandler (2).

Although the soils were developed from the same parent rock, percentage base saturation of soils under each forest was different from the other because soluble nutrients of each soil may be adsorbed differently and held temporarily among the solutions on the surfaces of the colloidal micelles.

An increase of the exchangeable hydrogen is shown to decrease the percentage base saturation. It was suggested that the degree of saturation of basic ions can always be reduced by cation exchange whereever there are enough H ions to bring about this displacement.

According to McGeorge(6), base exchange capacity was changed by an invariable relationship with the pH-values in semi-arid soils. In this study, however, the result shows no similar relationship in soils developed out of granite.

In the pH-values of the soils, the naked soils indicated more increasing acidity than that of forest soils. The needle leaved forest soils showed more acidity than the broad leaved forest soils, because certain types of the litter yield considerable quantities of acid-forming compound when they decompose.

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摘 要

서울 附近에 있는 花崗巖에서 由來된 11 個의 森林群落(針葉樹와 闊葉樹로 大別)및 林土와 裸地의 化學的 性分을 調査하여 群落과의 關係를 比較했다.

闊葉樹 群落의 林土는 針葉樹 群落의 林土보다 有效 窒素, 硝酸態 窒素, 有效 燐酸의 含量이 많이 包含되어 있고 有機物 含量과 염기치환능은 위와 反對이었다.

土層에 따른 土壤 成分의 有意性은 有效 燐酸만이 5%에서 나타났고 針葉樹와 闊葉樹의 林土 및 裸地등 分散分析의 結果에 依한 有意性은 硝酸態 窒素가 5%에서 有機物 含量은 1%에서 나타 났다.

LITERATURE CITED

1. Brown, I.C. 1943, Soil Sci., 56 : 353—357.
2. Chandler, R.F., Jr. 1939, Jour. Agr. Res. 59 : 491—506.
3. Coaldrade, J.E. and K.P. Haydock 1958, Ecology 39 : 1—5.
4. Karim, A. and D.H. Khan 1955, Soil Sci. 80 : 229—233.
5. Kim, C.M. 1960, Seoul Univ. J. (D) 9 : 44—47.
6. Mc George 1952, Soil Sci. 73 : 271—275.
7. Paulsen, H. A. 1953, Ecology 34 : 727—732.
8. Purvis, E.R. and Micah W.M. Leo 1961, J. of Agr. and Food Chem. 9 (1) : 15—17.
9. Smith, H. W., and C. D. Moodie 1955, Dept. Agron., State Coll. Wash., Pullman.
10. Snaydon, R.W. 1962, J. Ecol. 50 : 133—143.
11. Truog, E. 1947, Soil Sci. Soc. Amer. Proc. 11 : 305—308.
12. Whiteside, E.P. and R.S. Smith 1941, Amer. Soc. of Agronomy 33 : 765—775.