<Original article>

The Amounts of the Available Phosphorus in Soils of Kwang-nung Forest

CHANG, Nam Kee

(Dept. of Biology, College of Education, Seoul National University)

光陵森林土壤의 有効燐酸量에 關하여

張　　楠　　基

(서울大學校 師範大學 生物科)

ABSTRACT

Determination of the pH value and analyses of the available phosphorus of some soils under the forest and grassland Kwang-nung have been examined to study the relationship between the soil pH and available phosphorus. The results might be summarized as follows:

1) The available phosphorus decrease steadily as the pH goes up to 5.2. However, at the pH 5.2~6.3, it shows an increase and decreases again as the rise above pH 6.3.

2) There is a significant difference in the amounts of the soil phosphate among the areas sampled.

3) The statistical analysis of the data obtained shows that soil phosphate is limiting factor governing the distribution of natural vegetal pattern.

INTRODUCTION

On the various forms, abundance and movement of phosphorus in the natural soils in relation to vegetal pattern in areas, several informations have been given by many investigators.

Karim and Khan (1955) refered the probable relationship beween pH and the organic, absorbed and sesquioxide-bound forms of phosphorus in some soils of East Pakistan.

Allard (1942) found that the real limiting factor is the lack of phosphorus in normal plant succession on small areas on Bull Run Mountain, Virginia. It has been brought to light by Bard (1954) that variation between identical species on the different soil types indicated a correlation between the soil type and the phosphorus content. Billings (1952) proved that Tobacco and Tomato plants did not grow in the soil in which only distilled water is given or in the nutrient solution lacking in phosphorus or nitrogen but they matured and flowered when these elements were added. However, this hypothesis that soil phosphate is the initial limiting factor in the distribution of vegetation has been disputed among the ecologists. Coaldrade and Haydock (1958) stated recently that the soil phosphate does not determine vegetal pattern in South-Eastern Queensland, Australia irrespective of the level of classification of the vegetation. The major interest lies in the investigation of the relationship between the soil pH and the available phosphorus. It seems to be desirable to determine the pH value and available phosphorus in some soils neath the forest and grass lands of Kwang-nung.

MATERIAL AND METHODS

TYPE OF PLANT COMMUNITIES.

The plant communities studied are as follows:

1) Pinetum densiflorae 2) Pinetum koraiensisae 3) Abietum holophyllae
4) Laretum kempferiae 5) Robinetum pseudacaciae 6) Carpinetum laxiflorae
7) Quercetum serratae 8) Quercetum deutatae 9) Caretum conicae
10) Zoysetum japonicae 11) Agrostetum perennans 12) Trifoletum repensae
13) moss community

The soil samples were collected from three horizons of soils under all communities; A, B and C respectively.

The surface soil (A) contained more humus than other two layers. The root systems in the upper 4 inches (B) were extensive with normally branching, slender, thread like roots. In the subsoil (C) no small roots were observed except the massive roots. Since the depth of root of herbs and mosses differs from that of tree root, the soil layers are divided into three; surface layer, root zone and lower part without roots. In the case of mosses, the soils were taken from beneath the mosses grown on rock, wood and soil.

The soil samples were also taken from the surface soil, subsoil and parent material of the naked soil. The bed rock of Kwang-nung chiefly consist of granitic rock.

CHEMICAL ANALYSIS

The pH was determined with a glass electrode (Portable Beckman Model N Potentiometer) in a thick paste of soil about 25cc with distilled water(Wilde 1955)

The available phosophorus were determined by the Truog's method using a colorimeter (Clinical electrophotometer). The soils were extracted with 0.002 N sulphuric acid (H_2SO_4) solution which was buffered by adding 3 gm of ammonum sulphate ($(NH_4)_2\ SO_4$) per liter. The pH of extractive solution was about 3, and a ratio of soil to solvent is 1 : 200 (Wilde 1955).

RESULTS AND DISCUSSIONS

The results of the chemical analysis are shown in Table 1, and Figure 1. Figure 1 indicates the relationship between pH and available phosphorus in some soils of Kwang-nung.

As the soil pH goes up to 5.2, the available phosphorus decreases steadily and shows a minimum value at pH 5.2, but as the pH rise up to 6.3, then the available phosphorus increases gradually, whence at the pH above 6.3 the available phosphorus decreases again.

Table 1. Distribution of the available phosphorus and the soil pH for some soils under neath the forest of Kwang-nung.

Soil Samples	hor.	pH	available phosphorus (ppm)	Soil Samples	hor.	pH	available phosphorus (ppm)
naked-soil	A	6.9	9.3	Pinus bensiflora	A	4.9	19.7
	B	7.1	8.8		B	4.7	18.5
	C	7.3	8.6		C	5.1	17.8
Average			8.90	Average			18.67

moss	Rock	5.3	10.2	Abies holophylla	A	4.9	21.3
	Soil	5.2	8.9		B	5.0	19.7
	Wood	5.2	10.4		C	4.9	19.1
Average			9.83	Average			20.03
Carex conica	A	5.5	13.4	Larix kaempferi	A	4.9	20.6
	B	5.3	12.5		B	5.5	20.0
	C	5.4	14.4		C	5.6	19.7
Average			13.43	Average			20.10
Zoysia japonica	A	5.4	15.9	Robinia pseudacacia	A	6.2	22.6
	B	5.1	15.1		B	5.7	21.8
	C	5.4	14.8		C	5.0	20.0
Average			15.27	Average			21.47
Agrostis perannans	A	5.8	16.1	Carpinus laxiflora	A	6.1	24.0
	B	5.7	15.5		B	5.0	23.0
	C	5.5	15.3		C	4.8	22.4
Average			15.63	Average			23.13
Trifolium repens	A	5.7	18.1	Quercus serrata	A	6.1	25.0
	B	6.7	16.9		B	5.9	24.1
	C	5.8	16.0		C	6.6	24.8
Average			17.00	Average			24.63
Pinus koraiensis	A	5.9	19.2	Quercus dentate	A	6.3	27.0
	B	5.4	17.8		B	6.5	25.9
	C	5.6	18.0		C	6.2	26.1
Average			18.33	Average			26.33

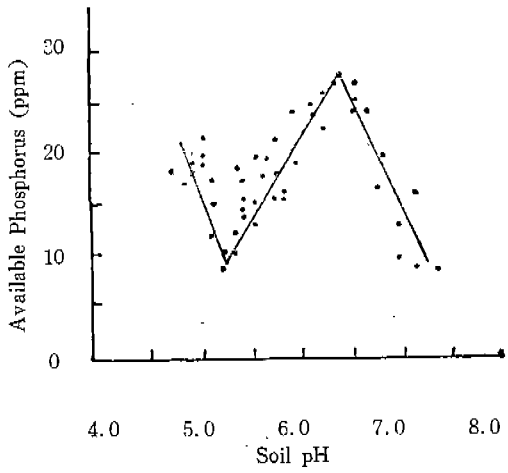

Figure 1. Relationship between pH of soils and the amounts of the available phosphorus in the soil of Kwang-nung.

Accoding to Karim and Khan(1955) the available phosphorus is more higher at pH 4.7~5.1, by the major influence of organic phosphorus. The low to and at pH 7.0 seems to be the influence of sesquioxide-bound phosphorus and adsorbed phosphorus. The variability of the available phosphorus within vegetational types seems obvious from the Table 1. The statistical treatment for the data in Table 1 indicates that the variance has a significant value.

The significance among the individual species of the forest type, herbs, moss and naked-soil is tested by the analysis of variance (Table 3 and 4). The "t" test (Table 2) is attempted to get a information whether there are the differences between three horizons of conifers, hardwoods, herbs, and naked-soil. The results of the statistical analyses are shown in Table. 2, 3 and 4.

According to the results of "t" test (table. 2), the available phosphorus has significant difference between horizon A and B or horizon C, and between horizon B and C.

From this fact, such disparities of phosphorus among the horizons probably come from the different

amounts of humus originated from the litters. Robert and Chandler (1944) states that the amounts of all other elements besides calcium and nitrogen are considerably smaller in the case of conifers as compared with the hardwoods. He suggests that there is a difference in the amounts of soil phosphate between the two types of trees.

Table. 2. The "t" test of available phosphorus given in Table 1 for comparison of the significant difference.

Aavailable phosphorus level / Horizon	Mean difference	Standard deviation	Standard error of the mean	"t"	Free degree	Significance level
A horizon & B horizon	12.6	0.33	0.09	140.00	12	0.01>p**
A horizon & B horizon	15.2	0.95	0.26	55.45	12	0.01>p**
B horizon & C horizon	3.3	0.85	0.24	13.75	12	0.01>p**
Herbs & Woody plants	6.27	2.48	0.87	7.21	34	0.01>p**
Herbs & Hard wood	8.57	2.49	0.72	11.90	22	0.01>p**
Conifers & Hard wood	4.59	2.30	0.68	6.72	22	0.01>p**
Herbs & Conifers	3.97	1.83	0.53	7.51	22	0.01>p**

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

Table 3. The "F" test of the avalable phosphorus given in Table 1.

	Sum of square	Degree of Freedom	Variance	"F" value
Total	1054.504	41	—	—
Under each species	1035.907	13	79.6774	119.9**
error	18.597	28	0.6642	

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

Table 4. Analysis of variance of the available phosphorus given in Table 1 for comparison of the difference among the tree, herb, moss and naked-soil.

Sample soils	Total	n	Mean	Mean difference
naked soil	26.7	3	8.90	
under Corex conica	29.5	3	9.83	0.93
under Zoysia japonica	40.3	3	13.43	3.60**
under Agrostis perennans	45.8	3	15.27	1.84**
under Trifolium repens	46.9	3	15.63	0.36
under Pinus koraiensis	51.0	3	17.00	1.37**
under Pinus densiflora	55.0	3	18.33	1.33
under Abies holophylla	56.0	3	18.67	0.30
under Larix kaempferi	60.1	3	20.03	1.36**
under Larix kaempferi	60.3	3	20.10	0.07
under Robinia Psendacacia	64.4	3	21.47	1.37**
under Carpinus laxiflora	69.4	3	23.13	1.66**
under Quercus serrata	73.9	3	24.63	1.50**
under Quercu dentata	79.0	3	26.33	1.70**

** Least significant difference=1.35

Table 2 and 4 show that the soil phosphate has a significant difference between the conifers, hardwoods, herbs, and mosses but not between mosses and naked-soil. From the data it will be able to suggest that the soil phosphate is the factor governing the vegetal pattern subjected.

Allard (1942) and Billings (1950) have states that the soil phosphate is the initial limiting factor in the distribution of vegetation. Beadle (1954) have reported that the soil phosphate is the factor which selects the vegetation with the possible exception of certain of the small patches of rainforest which may be climatically controlled. In the other hand Coaldrade and Hydock (1958) exemplifies that soil phosphate does not determine vegetal pattern in South-Eastern Queensland Australia.

From the statistical analyses, it is said that the available phosphorus determine vegetal pattern in the areas studied.

摘 要

光陵森林土壤의 pH와 有効燐酸을 정량하고 이들 사이의 관계와 이들과 산림군락과의 관계를 알아보았다. 有効燐酸量은 pH 5.2까지는 점차 감소하나 pH 5.2~6.3까지는 增加하여 pH 6.3以上이 되면 다시 減少하였다.

調査된 地域간의 有効燐酸量에는 有意한 差가 있으며 이것의 양과 植生分布 사이에는 서로 關聯性이 있음을 알았다.

Literature Cited

1) Allard A. H. 1942. Lack of available phosphorus preventing normal succession on small areas on Bull Run Mountain in Virginia. Ecology 23: 345-353.
2) Bard, E. G. 1945. The mineral nutrition content of the foliage of forest trees on three soil types of varying lime-stone content. Soil science 10: 419-422.
3) Beadle, W.C. 1954. Soil phosphate and delimitation of plant communities in Eastern Australia. Ecology 35: 370-375.
4) Billings, W.D. 1950. Vegetation and plant growth as affected by chemically altered rocks in th Western Great Basin. Ecology 30: 62-74.
5) Coaldrade, J.E. and K.P. Haydock 1958. Soil phosphate and vegetal pattern in some natural communities of South Eastern Queensland Australia. Ecology 39: 1-5.
6) Karim, A. and D.H. Khan 1955. Relationship between pH and different forms of phosphorus in some soils of East Pakistan. Soil science 80: 229-233.
7) Robert, F. and Jr. Chandler 1944. Amount and freshly fallen needle litter of some northeastern conifers. Soil science 8: 409-411.
8) Wilde, S.A. and G.K. Voigt 1955. Analysis of soils and plants for foresters and horticulturists.