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Effect of Parent Material and Land Use on Phosphorus Accumulation in Soils
(토양이용 및 모재에 따른 토양의 인 집적)

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1. Introduction

Phosphorus (P) is an essential nutrient for plant growth and is often the limiting nutrient for the primary production of lakes and streams (Correll, 1998). Phosphorus occurs naturally in soils at 100 to 3000 mg kg-1(Frossard et al., 2000). The native P content in soils depends on the parent material and the degree of weathering. In the most soils, 50 to 70% of the P is inorganic and the inorganic P forms are dominated by hydrous sesquioxides, amorphous and crystalline aluminum (Al) and iron (Fe) compounds in acidic, noncalcareous soils and by calcium (Ca) compounds in alkaline, calcareous soils (Dobermann et al., 2002; Fang et al., 2002; Sharpley, 1995).

The amount of plant available P in the soil is often inadequate to meet agricultural production. Phosphorus is therefore applied to agricultural fields and the amount of applied P often exceeds the uptake by plants. The continued application of fertilizers and manures to agricultural land results in the high concentration of P and in increase for the potential of P loss to surface water. The transportation of the accumulated P from arable land to surface water can cause an accelerated eutrophication. The eutrophicationcan impair water use for drinking, recreation, aquaculture and industry due to the increased growth of undesirable algae and aquatic weeds.

The main processes for P losses from agricultural land to surface water are erosion, runoff and subsurface drainage (Borling, 2003). The loss of P from soil by erosion and runoff is controlled by topography, physical and chemical properties of soil, soil hydrology, surface coverage and soil P concentration. We studied the effect of land use and parent material on P accumulation in soils.

2. Material and Method

Surface soil (0-25 cm in depth) samples were collected from forest, dry farmland, orchard and paddy field of which soils were developed from biotite granite, micrographic granite or acidic volcanic rock in a watershed in Busan, Korea. The collected samples were air-dried and gently ground to a 2 mm sieve for further analysis. Organic matter content, pH, EC, water extractable cations and water extractable anions of the soil samples were determined using ignition and 1soil-5water method. Reactive Al and Fe contents were determined with an oxalate extraction method. Inorganic P in the soil samples was fractionated into adsorbed, carbonate, oxide and residual forms using a sequential extraction method. Water extractable and organic P were also determined using ignition method and 1soil-5water method, respectively.

3. Results and Discussion

Chemical characteristics of the soils are shown in Table 1. All soils were acidic. Uncultivated forest soils had higher pH, EC and NO3-1 content and lower organic matter content than the cultivated soils such as paddy, orchard and dry farmland soils. It is probably due to the input of fertilizer and tillage.

Table 1. pH, EC and contents of NO3-1 and organic matter of soils.

Parent rock	Land use	pH	EC	NO_3^{-1}	Organic Matter
			(cS/m)	(mg/kg)	(%)
Biotite granite	Forest	4.6	85.1	106.9	1.7
	Paddy	5.5	83.2	88.3	1.3
	Orchard	5.8	112.5	171.5	1.3
	Dry farmland	6.3	177.7	407.2	1.5
Micrographic granite	Forest	4.5	98.9	95.9	1.6
	Paddy	5.2	99.6	146.7	1.4
	Orchard	6.0	96.3	187.2	1.1
	Dry farmland	6.3	232.8	606.1	1.4
Acidic volcanic rock	Forest	4.7	170.0	354.1	3.1
	Paddy	5.5	125.8	212.9	2.2
	Orchard	5.2	127.6	313.0	2.2
	Dry farmland	5.3	336.6	973.7	2.4

Table 2 shows the concentrations of various forms of P and oxalate extractable Al and Fe in the soils. The cultivated soils had higher both inorganic and organic P than uncultivated soils. It might be the result of fertilizer application for agricultural production. The soils from orchard and dry farmland had greater P content than the soils from paddy field. Even though the cultivated soils had greater amount of organic P comparing with uncultivated forest soil in the same parent rock, proportion of organic P in the cultivated soils was smaller than the uncultivated soil. It indicates that most applied P as fertilizer remained as inorganic form in soils. The soils developed from acidic volcanic rock had the highest P concent and had the highest content of oxalate extractable Al and Fe.

Table 2. Concentrations of various forms of P and oxalate extractable Al and Fe.

Parent rock	Land use	Inorg. P	Org. P(%)	Water Ex. P	Oxal. Al	Oxal. Fe
		----------mg/kg----------				
Biotite granite	Forest	32.9	29.5(47.3)	0.05	37.4	17.6
	Paddy	280.7	42.0(13.0)	0.25	20.4	29.8
	Orchard	424.0	72.0(14.5)	1.85	21.9	32.9
	Dry farmland	465.2	106.0(18.6)	2.01	23.5	22.9
Migrographic granite	Forest	23.2	17.5(43.0)	0.05	30.9	10.3
	Paddy	203.7	42.0(17.1)	0.29	16.7	39.5
	Orchard	175.1	23.5(11.8)	0.91	15.4	19.3
	Dry farmland	332.1	63.0(15.9)	2.53	15.5	23.5
Acidic volcanic rock	Forest	70.6	35.2(33.3)	0.09	36.9	24.6
	Paddy	364.9	43.5(10.7)	0.50	22.9	82.5
	Orchard	423.4	64.4(13.2)	1.39	24.4	37.2
	Dry farmland	498.3	112.3(18.4)	2.35	26.2	29.1

4. Conclusion

Application of fertilizer and tillage on farmland increased pH and EC and the contents of NO_3^{-1} and P in soils but decreased organic matter content in soils. Most applied P remained as inorganic form in soils. The soil with the higher content of oxalate extractable Al and Fe had the greater P fixation capacity.

5. References

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