Effects of Fused and Rock-P Application on the Available Phosphorus and P Uptake by Plants Grown in Volcanic Ash Soils

M. C. Kim, D. A. Kim*, C. C. Choung and S. J. Song**
College of Agriculture, Cheju National University

火山灰土壤의 草地에서 熔成燐肥와 燐鑛石施用이 土壤의 有効燐酸과 牧草內 P含量에 미치는 効果

金文哲 · 金東岩* · 鄭昌朝 · 宋成俊**
濟州大學校 農科大學

摘 要

濟州火山灰土壤의 混播牧草地(orchardgrass+ladino clover)에서 熔鑛燐肥와 燐鑛石施用 効果를 究明하기 위해 試驗이 遂行되었다.

黑色土壤이 濃暗褐土壤보다 有効燐酸 含量이 낮았으며 역시 乾物收量도 낮았다. Carrier(KH_2PO_4)가 없는 경우에 燐酸施用은 燐酸無施用에서 보다 乾物收量을 增進시켰고 한편 Carrier처리(0.5mole KH_2PO_4)된 경우에는 燐酸無施用과 施用處理間에 乾物收量이나 有燐酸含量에 차이를 발견하지 못하였다. 草地에 燐酸施用時 熔成燐肥가 燐鑛石에 비해 乾物收量 및 牧草의 P攝取量도 增進되었다.
(Key words : Fused phosphorus, rock-phosphorus, P uptake)

I. INTRODUCTION

Cheju volcanic ash soils consists mainly of very dark brown(41.4%) and black soil(21.6 %). These soils have originated from the combination of grass and clay high phosphate fixing capacity(Yoo et al., 1985). Yoo. et al(1985) recommended that fused phosphorus be applied to these solis, because this fertilizer can decrease the activity of Al and Fe by its high Ca/Mg ratio. However, rock phosphorus, in addition to weakening the activity of Al and Fe, can help plant uptake by the action of microbes in acid soils(Kittam at el., 1955). Therefore an experiment was carried out to find the effect of application of fused-P and rock-P on mixed pasture species grown in volcanic ash soils.

* College of Agriculture, Seoul National University(서울대학교 농과대학)
** The Applied Radio Radio Isotope Institude, Cheju National University(제주대학교 방사능이용연구소)
韓畜誌 : 28(7)512-514(1986)에 게재 되었음.

Ⅱ. MATERIALS AND METHODS

This experiment was carried from September to December, 1983, in mixed pasture of orchardgrass(*Dactylis glomerata*) and ladino clover(*Trifolium repens*). The split-split plot design was as follows ; main plot(2 kinds of volcanic ash soil; black and very dark brown soil), sub-plot(3 phosphorus treatments ; non-P, fused-P, rock-P) and sub-sub plot(2 carrier levels ; carrier free, 0.5 mole KH_2PO_4). The chemical properties of soil tested is shown in Table 1. Pasture species cut 6 weeks after sowing were weighed, and dried in an oven at 80℃. These samples were reduced to ash by boiling in 20ml acid mixture(HNO_3 : H_2PO_4 : $HClO_4$, 5 : 1 : 2) in order to measure the P content of pasture species(Ammonium molybvanadate method). After harvesting pasture species, soil samples were taken and analyzed for available phosphorus, using the bray No. 2 method.

Table 1. Chemical properties of soil tested

Soil type	ph (1 : 5)	Organic matter(%)	Available P_2O_5(ppm)	Exch. cation(me/100g) Ca	Mg	K	C. E. C. (me/100g)
Non	6.9	1.4	25.4	13.0	6.8	1.26	28.1
Black	6.8	9.6	66.1	1.4	1.2	2.06	11.3
Very dark brown	5.7	3.2	30.5	1.3	2.3	0.56	11.0

Ⅲ. RESULTS AND DISCUSSION

Cheju volcanic ash soil has the character of being readily short of available phosphorus, becaused of its high phosphorus fixing capapcity. So Yoo et al. (1985) recommended fused-P as the most effective phosphorus in Cheju volcanic ash solis, as this fertilizer is high by efficient for pasture species grown in these soils with a high content of Ca and Mg.

Table 2 shows that when the carrier was not treated, very dark brown soil increased the available phosphorus more by fused-P application than by rock-P. These results support the findings of Yoo et al. (1985). When carrier(0.5mole KH_2PO_4) was treated, in any soil type, the available phosphorus content was increased by rock-P application. However. the reasons for these results were not apparent.

Table 3 shows the dry matter yield of pasture species obtained in this experiment. Whichever the carrier treatments, the dry matter yields of pasture species grown in black soil were lower than those grown in very dark brown soil, as reported by Choung et al.(1983).

There were differences among 3 types of phosphorus applications according to carrier levels. In the case of carrier free, the dry matter yields between no phosphorus and phosphorus application showed a statistical significances($p<0.01$), while there was no significance in carrier treatment(KH_2PO_4 0.05mole). With the exception of carrier free in black soil, when 2 kinds of phosphorus applications were compared, rock-P increased dry matter yield more than fused-P. It is assumed that greater efficiency of rock-P for pasture species was due to the better effect on tolerant-acid crops(Ensminger, 1967) or the

lower fixing with Al in acid soil(Ashby et al., 1966). The phosphorus content of pasture species was lower in black soil than in very dark brown soil(Table 3), and there was no difference in P utilization of pasture species between no phosphorus and phosphorus application in black soil, not treated carrier. These results support the finding of Yoo et al.(1985) who found that high clay content in black soil promotes the activity of Al, and lowers its uptake to plants because applied phosphorus was fixed with Al. Through advanced studies in the future, it should be possible to discover an effective method that can raise the phosphorus utilization of pature species in black soil. And when based on the fact that rock-P gave higher yields than fused-P by carrier treatment, rock-P is expected to be accepted as one of the economic P fertilizers, if rock-P can be effectively utilized.

Table 2. Changes of availiable phosphorus as affected by fused-P and rock-P application in volcanic ash soils(ppm).

Carrier level	Black soil			Very dark brown soil		
	Control	Fused-P	Rock-P	Control	Fused-P	Rock-P
Corrier free	0.21	0.03	0.94	0.15	12.50	2.50
Low carrier	0.92	1.65	3.02	23.51	3.96	15.31

Table 3. Changes of dry matter yields and P uptake of plants as affected by the fused-P and rock-P appliction in volcanic ash soils.

Treatment			Dry matter yield(mg)		Total	P uptake(ppm)	
			Orchard-grass	Ladino colver		Orchard-grass	Ladino clover
No carrier	Black soil	Control	75.7	41.0	117.6	75.7	5.6
		Fused-P	226.5	50.6	277.1	76.3	6.2
		Rock-P	138.4	45.6	184.0	79.8	5.3
	Very dark	Control	96.6	58.6	128.2	43.5	7.0
		Fused-P	312.8	–	312.8	247.1	–
	Brown soil	Rock-P	255.6	89.1	344.7	149.1	15.2
Low carrier	Black soil	Control	313.7	87.0	400.7	122.3	27.5
		Fused-P	243.8	93.1	236.9	404.7	63.9
		Rock-P	403.8	62.9	466.7	173.6	81.4
	Very dark	Control	311.3	93.8	405.1	427.5	18.4
		Fused-P	432.8	118.8	551.6	558.3	41.2
	Brown soil	Rock-P	456.7	168.2	624.9	637.8	53.8

Ⅳ. SUMMARY

An experiment was carried out to find out the effect of fused-P and rock-P applications to mixed pasture species (orchardgrass ; *Dactylis glomerata*, and ladino clover ; *Trifolium repens*) grown in Cheju volcanic ash soils. Back soil when compared with very dark brown soil, is generally lower in available phosphorous. Phosphorus uptake in pasture species lowers its dry matter yield. In the case of carrier free, phosphorus application increased dry matter yield more than no phosphorus, while carrier was treated(0.5 mole KH_2PO^4) there was no difference in the dry matter yield and available phosphorus between no P and P applications. When applied to pastures, fused-P compared with rock-P gave higher dry matter yields and increased P-uptake.

Ⅴ. REFERENCES

1. Ashby, D. L., W. E. Fenster, and o. J. Attoe. 1966. Effect of partial acidulation and elemental sulfur on availability of phosphorus in rock phosphate. Agron. J. 58 : 621－25.
2. Choung, C. C., M. C. Kim and S. J. Song. 1983. The determination of fused-P and rock-P uptake by two pasture species in volcanic ash soils using 32P tracer. The Office of Rural Dev. Report.
3. Ensminger, L. E., R. E. Person, and W. H. Arminger. 1967. Effectiveness of rock phosphate as a source of phosphate requirements of soil. Soil Sci. Am. Proc. 34 : 903－907.
4. Kittams. H. A. and O. J. Attoe. 1965. Availability of phosphorus in rock phosphate sulfur fusions. Agron. J. 57 : 331－34.
5. Yoo, S. H. and K. C. Song. 1984. Characteristics of soils in Cheju Island. Res. Ins. Subtro. Agr. Cheju Nat'l Univ. 73－104.