ศึกษาอิทธิพลของปุ๋ยฟอสเฟทที่ค้างในดิน :

๑. ศึกษาในเรือนกระจก[1]

Residual Availability of Phosphate Fertilizers :

I. Greenhouse Study[1]

Treepanga Komolyabutra, Sorasith Vacharotayan and Tawin Krutkul
Faculty of Agriculture, Kasetsart University

Soils of Thailand are generally low in ailable phosphorus, as indicated by the sponse of crops to the application of phos- hate fertizers. The low phosphorus status the soils may be due to generally mature ils containing large amounts of iron and uminum oxides. It is well known that luble phosphate in soils is readily tied up these oxides and become dificultly available the plant. Therefore the soluble or available osphate in the soil, at any one time, is nerally low. Soluble phospate fertilizers, plied to the soil, are not completely avai- ble to the plant. Large portions of them ay be fixed and become unavailable to the mediate crop. The fixed phosphate ferti- zers, however, may not be lost forever, but ill accumulate in soils and can be utilized the following crops to certain degree. The ailability of residual phosphate fertilizer in ils depends largely on the kind of soil and P and also upon the amounts of phosphate rtilizer applied previously. The objective this study was to determine to what extent the previously applied phosphate fertilizer become available to the following crop.

Work supported by the KU/UH research project No. 12, Soils Section, Agronomy Dept.

MATERIALS AND METHODS

Soil samples were taken from 72 subplots, after harvest, from the Agronomy Farm, at Pakchong. These plots had been previously treated with different levels of nitrogen, phosphate and potash fertilizers (Table 1). The samples were brought to the greenhouse, dried and pulverized. The experiment was conducted in duplicate. Two-5 kg. of each of the soil sample were placed in one-gallon plastic pails. One gram of ammonium sulfate and of potassium chloride was added to the soil in each pot and thoroughly mixed. This was done in order to maintain the nitrogen and potassium status of the soil at the optimum level, so that only the phosphorus status of the soil was carried directly into the pot. When the plants were about two inches high, they were thinned to one plant per pot. Soil moisture was maintained at field capacity level as much as possible. The crop was harvested at the flowering stage by cutting at the base and the stumps

were allowed to ratoon. The ratoon crop was then harvested again at the same stage of maturity. The harvested plants were placed in hot air oven at 60°C., to drive off moisture, for 24 hours. The oven dried top growth obtained from each treatment was weighed and recorded. The plant parts were then ground in a Wiley Mill and collected in a plastic cup for determination of phosphorus content of the crop.

Phosphorus determinations in the plant tissue

The plant samples were wet digested and analyzed for phosphorus as follows: the samples were first predigested with concentrated nitric acid until the brown nitric oxide fume disappeared. This mixture was then further digested with perchloric acid on the hot plate until the solution was clear, and fumes of perchoric acid persisted. About 20 ml. of distilled water was then added and the mixture heated to boiling for a few minutes. The solution was cooled, filtered and diluted with water to 90 ml. Phosphorus in the solution was determined by ammonium molybdate – 1,2,4 aminonapthol sulfonic acid. Perchloric acid was employed to acidize the system. The transmittancy of the developed blue colored solution was measured on a Cenco Photelometer using a red filter (645 micron).

Table 1

Previous treatment of the soil samples used in the greenhouse study

Number of soil samples in each level of P	Level ef P (kg/rai)**			
	P_0	P_1	P_2	P_3
3	0–0–0*	0–8–0	0–16–0	0–24–0
3	0–0–8	0–8–8	0–16–8	0–24–8
3	0–0–16	0–8–16	0–16–16	0–24–16
3	24–0–0	24–8–0	24–16–0	24–24–0
3	24–0–8	24–8–8	24–16–8	24–24–8
3	24–0–16	24–8–16	24–16–16	24–24–16
Total number of soil samples in each level of P	18	18	18	18

* The first, second and third digit represent the levels of N, P_2O_5 and K_2O previousely applied to the soil respectively.

** 2.5 rai = 1 acre

ESULTS AND DISCUSSION

Yield dry weight of the first and second ttings and the amounts of phosphorus taken by the plant at each cutting were recorded. ata are shown in Tables 2 and 3 respectively. nalysis of variance of yield was performed d found to be non-significant, Table 4. e data indicate that the residual phosphate the soil has no significant influence upon amount of yield of *Sorghum almum*. nother words the availability of the residual osphate in the soil is insufficient to promote nificant differences in growth of the in- ator crop.

The data further indicate that total phos- orus content of plants increases with the reasing levels of residual phosphate in the il. Analysis of variance of the phosphorus ken up by *Sorghum almum*. is shown in ble 5. Data indicate the F ratios of the st cutting and of the total of two cuttings be significant at 5 percent probability level, hereas that of the second cutting is non- nificant. This indicates that the amount residual phosphate fertilizer in the soil n be partially utilized by the following crop. However, when the ratoon was allowed to grow, the growth of the ratoon crop was rather poor and the amount of P taken up was approximately half of that of the first cutting. Apparently the residual phosphate fertilizer in the soil became available with difficulty to the ratoon crop while indicated no significant difference in the P content regardless of the differences in the residual phosphate level. It can be concluded that phosphate fertilizer applied previously to a crop of corn at the rate of 8, 16 and 24 kg./of P_2O_5 per rai, the remaining fertilizer in the soils can be pertially utilized by the next crop. However, the availability of the residual phosphate is not sufficient to cause significant increase in the yield of the second crop, especially when the native P in soil is medium to moderately high. The merit of this study indicates that the application of phosphate fertilizer to the crop immediately following the preceeding corn crop, can be made at a lower rate since part of the phosphate fertilizer applied earlier is still available to the following crop.

Table 2

Total yield dried weight of *Sorghum almum* growth in Pakchong soil containing different levels of residual phosphate (data expressed in gram)*

Sample number	Levels of Residual Phosphate											
	P_0			P_1			P_2			P_3		
	Cutting			Cutting			Cutting			Cutting		
	I	II	total	I	II	total	I	II	total	I	II	total
1	38.67	26.38	65.05	55.54	37.16	92.70	24.30	25.34	49.64	46.13	28.52	74.65
2	35.11	35.94	71.05	38.00	28.49	66.49	30.62	14.95	45.57	52.59	21.83	74.42
3	23.64	12.32	35.96	40.26	22.79	63.05	57.76	25.09	85.85	42.90	20,62	63.52
4	20.83	20.67	41.50	23.05	24.13	47.18	37.02	16.92	53.94	35.25	17.72	52.97
5	40.57	21.40	61.97	40.95	39.59	80.54	52.91	38.30	91.21	25.60	35.88	61.48
6	31.15	24.01	55.16	26.48	25.25	51.73	59.27	27.99	87.26	38.26	28.53	66.79
7	37.28	29.06	66.34	49.38	18.01	67.39	34.20	25.92	60.12	52.18	26.28	78.46
8	35.29	10.19	45.48	41.20	34.46	75.66	35.30	33.32	68.62	52.76	24.94	77.70
9	44.31	43.33	87.64	48.61	17.44	66.05	24.38	24.46	48.84	34.65	25.70	60.35
10	49.68	15.91	65.59	57.66	14.69	72.35	57.06	25.74	82.80	69.68	34.28	103.96
11	39.75	32.71	72.46	48.80	26.81	75.61	30.28	25.47	55.75	63.22	23.28	86.50
12	24.90	20.55	45.45	48.74	28.67	77.41	28.22	25.51	53.43	45.58	37.52	83.10
13	44.59	36.11	80.70	63.67	25.54	89.21	41.45	29.61	71.06	49.03	42.77	91.80
14	27.48	26.93	54.41	37,60	28.08	65.68	42.46	40.52	82.98	62.95	42.80	105.75
15	37.54	26.41	63.95	76.19	32.36	108.55	39.48	29.59	69.07	33.10	34.41	67.51
16	35.35	31.65	67.00	41.90	35.11	77.01	64.52	44.19	107.71	32.55	31.97	64.52
17	41.54	28.52	70.06	34.14	45.92	80.06	41.04	23.66	64.70	33.35	39.91	63.26
18	53.94	24.39	78.33	40.50	31.15	71.65	50.63	16.46	67.09	35.64	27.87	63.51
Mean Cut. I	36.76			45.15			41.72			44.75		
Mean Cut. I		25.92			28.65			27.37			29.71	
Mean two cuttings			62.67			73.80			69.10			83.77

Phosphorus taken up by *Sorghum almum* grown in Pakchong soil of different residual phosphate levels (data is expressed mg. of P)*

Sample number	Levels of Residual Phosphate											
	P_0 Cutting			P_1 Cutting			P_2 Cutting			P_3 Cutting		
	I	II	total	I	II	total	I	II	total	I	II	total
1	42.5	26.0	68.5	42.8	18.1	60.9	23.7	14.6	38.3	34.6	13.2	47.8
2	22.9	14.7	37.6	50.2	26.2	76.4	42.3	13.5	55.8	56.5	17.4	73.9
3	14.3	4.4	21.7	57.4	19.6	77.0	41.6	32.7	74.3	26.3	15.7	42.0
4	15.5	10.2	25.7	22.4	10.4	32.8	16.3	8.1	24.4	47.5	17.0	64.5
5	31.4	10.2	41,6	46.3	33.0	79.3	74.8	18.4	93.2	40.2	29.3	69.5
6	3.42	18.2	52.4	26.1	18.6	44.7	48.9	22.3	71.2	40.7	19.1	59.8
7	24.4	15.1	39.5	47.9	17.7	65.6	38.6	18.7	57.3	30.0	12.8	42.8
8	22.1	5.9	28.0	41.2	15.1	56.3	42.2	14.2	56.4	45.3	16.5	61.8
9	34.8	17.8	52.6	41.1	9.7	50.8	19.7	13.7	33.4	39.8	31.4	71.2
10	41.0	14.4	55.4	46.0	6.1	52.1	46.4	11.6	58.0	52.0	20.6	72.6
11	32.2	21.3	53.5	31.1	16.8	49.9	32.9	16.5	49.4	51.9	19.2	71.1
12	19.1	8.6	27.7	28.0	16.9	44.9	26.3	17.0	43.3	44.4	30.7	75.1
13	36.3	30.6	66.9	57.2	14.3	71.5	34.2	20.2	54.4	40.4	26.6	67.0
14	21.7	17.0	38.7	46.4	20.4	66.8	34.2	26.9	61.1	70.8	21.6	92.4
15	37.7	13.2	50.9	66.6	21.3	87.9	37.3	10.7	48.0	22.0	22.0	44.0
16	45.0	21.0	66.0	49.4	33.0	82.4	62.3	31.8	94.1	36.4	22.1	58.8
17	44.7	23.6	68.3	34.5	41.2	75.7	45.1	19.2	64.3	49.1	25.2	74.3
18	53.3	21.0	74.3	53.2	26.6	79.8	38.8	11.0	49.8	26.5	27.7	54.2
Average of cutting I	32.06			43.77			39.20			41.91		
Average of cutting II		26.23			20.37			17.83			21.56	
Average of two cutting			48.29			64.14			57.03			63.47

	Cutting	total two cutting
L.S.D. at 5% level	7.98	10.37
L.S.D. at 1% level	10.58	14.17

*Each figure is an average of a duplicate experiment.

Table 4

Analysis of variance of yield dry weight of *Sorghum almum* in each cutting as affected by soils of different residual phosphate levels

Analysis of Variance

Source of Variation	d.f.	Mean Square			F Ratios		
		cut. I	cut. II	total 2 cutting	cut. I	cut. II	total 2 cutting
Total	71						
Among sample	3	269.934	48.349	532.832	0.134	0.054	0.098
Error	68	2014.086	887.334	5419.091			

Table 5

Analysis of variance of phosphorus taken up by *Sorghum almum* in each cutting as affected by soils of different residual phosphate levels

Analysis of Variance

Source of Variation	d.f.	S.S.			M.S.			F ratios		
		cut. I	cut. II	total	cut. I	cut. II	total	cut. I	cut. II	total
Total	71	11228.31	3875.12	20493.72						
Among sample	3	1439.33	304.03	2929.09	479.78	101.34	976.363	3.332*	1.929	3.779
Error	63	9788.98	3571.09	17564.63	143.955	52.515	258.303			

* significance at 5% probability level

SUMMARY

This experiment was conducted to study the degree of availability of residual phosphate fertilizer in Pakchong clay loam soil, where corn had been grown. Soils previously treated with different levels of phosphate fertilizer for the corn crop were brought to the greenhouse and planted to *Sorghum almum* as indicator crop. The results indicate that phosphate fertilizer remaining in the soil after the corn crop was partially available to the following crop. The amount available may be sufficient to support moderate growth of a short-season crop but may not be sufficient for a long season crop. Additional fertilizer needs to be applied but the quantity may be reduced.

สรุป

การทดลองครั้งนี้เป็นการศึกษาหาอิทธิพลของปุ๋ยฟอสเฟทที่ตกค้างอยู่ในดินปากช่อง ได้ทำการทดลองโดยนำเอาดินตัวอย่างจากแปลงทดลองปุ๋ยข้าวโพดซึ่งเคยได้รับปุ๋ยฟอสเฟทในอัตราต่าง ๆ กัน มาทำการทดลองในกระถางแล้วปลูกหญ้า *Sorghum almum* ลงไปเป็น indicator crop ผลของการทดลองพอสรุปได้คือ ปุ๋ยฟอสเฟทระดับต่าง ๆ ที่ใส่ให้แก่ข้าวโพดในดินปากช่องมาหนึ่งฤดูแล้วนั้น ยังคงเหลือ residual อยู่ในดินเป็นปริมาณเพียงเล็กน้อย พอเพียงสำหรับพืชอายุสั้น ๆ และต้องการฟอสฟอรัสต่ำ แต่จะไม่เพียงพอสำหรับพืชที่มีอายุนาน ๆ เช่น ข้าวโพด ซึ่งมีความต้องการฟอสฟอรัสสูง ต้องให้ปุ๋ยเพิ่มเติม แต่อาจจะลดจำนวนที่ใช้ลงได้บ้างพอสมควร

ACKNOWLEDGMENTS

The authors are very grateful to Dr. W.W. McCall, the Agronomy Soils Advisor, for his assistance in proof reading and constructive criticism during the preparation of this manuscript. They also wish to thank the KU/UII program for providing financial support during the period of this study.