EFFECT OF VARYING LEVELS OF ROCK PHOSPHATE ON THE GROWTH AND YIELD OF STYLO (*Stylosanthes guyanensis* Aubl.) UNDER ACIDIC SOILS

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ABSTRACT

Height of stylo plants at first and second cuttings significantly increased upon application of 300 kg/ha rock phoshate (103.71 kg P_2O_5). Fresh herbage yield also increased when 100 to 400 kg/ha of rock phosphate was applied. Total fresh herbage and dry matter yields of Stylo applied with 100 kg/ha rock phosphate and supplemented with 30 kg N/ha and 60 kg K/ha were comparable to the yield of plants applied with 60 kg P_2O_5/ha from solophos. Plant tissue analysis from second to fourth cuttings revealed a general increase in P content, but not in N and K with increasing rates of rock phosphate application.

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KEY WORDS: *Stylosanthes guyanensis* Aubl. Apatite. Rock phosphate. Acidic soils. Pasture legume.

INTRODUCTION

Acidic soils in Leyte which are generally associated with phosphorus deficiency are widespread in upland areas particularly in deforested areas with heavy rainfall. This large area can be utilized for pasture production if the soil P deficiency problem is corrected by the application of phosphorus fertilizers (PCARR, 1976). Phosphorus to be applied to this soil can either be derived from fertilizers with readily soluble P (e.g. solophos) or from fertilizer materials with relatively low P solubility (e.g. rock phosphate). Due to the high cost of commercial P sources, attempts should be made to seek for cheaper alternative sources of P such as rock phosphate.

The insufficient and poor quality of forage fed to ruminants contributes to the low productivity of the country's livestock at present (PCARR, 1976). The introduction of improved forage legumes such as stylo (*Stylosanthes guyanensis* Aubl.)

can provide good quality pasture for animals. This crop fixes nitrogen from the air and contains adequate quantities of bone-building minerals such as P, K, Ca and various vitamins desirable for livestock nutrition (Heath et al., 1973).

This study was conducted to determine the growth and yield of stylo at varying levels of rock phosphate application and to determine the phosphorus level required for optimum herbage yield under acidic soils.

MATERIALS AND METHODS

An area with soil pH of 5.15 was used in the study. The experiment was laid out using the randomized complete block design with three replications. Each treatment plot had an area of 3 x 3.75 m with 5 rows each spaced at 0.75 m apart. The seven treatments used were designated as follows:

T_0 = 0-0-0 (control)

T_1 = 30-0-60 kg N and K_2O/ha (no phosphorus)

T_2 = 30-60-60 kg N, P_2O_5, K_2O/ha (300 kg solophos)

T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)*

T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)

T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)

T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)

*Analysis of rock phosphate material (34.57% P_2O_5)

Before planting, soil samples were collected from the experimental area and sent to the Department of Agronomy and Soil Science Soil Research, Testing and Plant Analysis Laboratory, ViSCA, Baybay, Leyte for nutrient and pH analysis.

Seeds of stylo (*Stylosanthes guyanensis*) were drilled in furrows immediately after thorough land preparation. One week after emergence, the plants were thinned to 18 plants/linear meter to meet the desired population of 300,000 plants per hectare.

Urea (45% N), solophos (0-20-0) and muriate of potash (0-0-60) were applied in the furrows at planting. Ground rock phosphate material at different levels was broadcast and mixed with the soil 2 weeks before planting. Thiodan and Benlate were sprayed at 30 ml/20 L H_2O whenever necessary to protect the plants against insect pests and fungal damage. The experimental area was kept weed-free from planting until canopy closure. Harvesting was started when 75% of the plants attained a height of 40 cm. The plants in the three inner rows per treatment/plot were clipped 30 cm from the ground. The first clipping was done at 3 months after seeding and the succeeding three cuttings at 30 days interval.

RESULTS AND DISCUSSION

Soil Analysis

Initial soil analysis revealed the following results: soil pH = 5.15, organic matter = 3.68%, Bray #2 phosphorus = 8.79 ppm, and extractable potassium = 187 ppm. Results imply that the soil has high K and moderate N and P contents.

Plant Height

Plant height was significantly affected by the treatments during the first and second cuttings only (Table 1). Regardless of the rates and sources of P fertilizer, stylo plants did not significantly differ from each other in height. Moreover, plants applied with 300 kg rock phosphate (T_4) were statistically similar in height to the plants with no P application (T_0 and T_1) during the first cutting. This could be attributed to the low inherent P level in T_1 and T_0 and to possible initial fixation of phosphorus by the soil in T_4 which made P less available to the plants during the first cutting. Plants that received 300 to 400 kg/ha of rock phosphate were significantly taller than the rest of the treatments during the second cutting. In the succeeding cuttings, no significant differences in plant height were observed. This could be attributed to the successive defoliation during each cutting such that although phosphorus was available to the plants, limited substrates could be synthesized and translocated to the aerial parts of the plant to replenish its top regrowth (PCARR, 1983). Moreover, Epstein (1972) and Tisdale and Nelson (1975) reported that phosphorus plays a key role in vital energy metabolism and energy transfer processes. It is required for the synthesis of adenosine triphosphate and other phosphorylated compounds necessary in energy metabolism and cell development.

Nodulation

The application of varying levels of phosphorus had no significant effect on the number and dry weight of stylo nodules (Table 2). Results imply that phosphorus application did not affect the nodulation capacity of the plants regardless of amount applied.

Herbage Yield

Only the fresh herbage yield in the first cutting and the total fresh herbage yield were significantly affected by the treatments (Table 2). No significant differences were noted for the rest of the cutting periods.

In the first cutting, herbage yield of plants applied with phosphorus regardless of source at various rates are not significantly different. Herbage yield in the second cutting was higher than in the first cutting due to the formation of more branches and shoots in the former. In the succeeding cuttings, lower herbage yields were obtained due to less production of new shoots caused by the decrease in the carbohydrates supply in the plants following frequent cutting. This in turn could have limited the assimilates translocated to other plant parts constituting the herbage yield.

Table 1. Plant height of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Plant Height (cm)[1]			
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
T_0 = Control	558.00b	637.00d	705.00	696.67
T_1 = 30-0-60 kg N and K_2O/ha (no P)	556.20b	645.80d	808.70	690.33
T_2 = 30-60-60 kg N, P_2O_5, K_2O/ha (300 kg solophos)	701.30a	717.70b	779.30	677.83
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)	701.80a	680.70c	727.00	668.17
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	661.30ab	680.20c	790.80	739.33
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	754.20a	817.20a	816.20	727.67
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	759.50a	825.80a	801.20	701.83
C.V. (%)	10.94	5.96	5.46	6.55

[1]Computed based on RCBD with subsampling. Treatment means within a column followed by a common letter and those without letters are not significantly different at 5% level, DMRT.

Within 6 months, the total fresh herbage yields of fertilized plants were significantly higher than the control (T_0). This agrees with the findings of PCARR (1983) that stylogenerally establishes better and grows more profuse with phosphate fertilizer application.

The dry matter production from the first to the fourth cutting was not significantly affected by the treatments (Table 3). The trend for the total dry matter yields of stylo in 6 months is almost similar to that of the total fresh herbage yield. The dry matter yield is related to pasture

Table 2. Nodulation and fresh herbage yield of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Nodulation		Fresh Herbage Yield (t/ha)[1]				Total Herbage
	Ave. No. of Nodules	Dry Wt. of Nodules/ Plant (g)	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	Yield (tons)[1]
T_0 = control	93.33	0.10	2.00c	8.07	7.04	5.33	22.44b
T_1 = 30-0-60 kg N and K_2O/ha (no P)	72.33	0.09	2.85bc	12.96	7.93	7.48	31.22a
T_2 = 30-60-60 kg N, P_2O_5, K_2O/ha (300 kg solophos)	110.33	0.17	6.74ab	14.07	9.55	6.96	37.32a
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)	104.33	0.12	7.22a	13.63	8.30	6.74	35.89a
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	113.33	0.10	4.30abc	14.44	8.62	7.26	34.62a
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	119.67	0.20	7.15a	12.82	8.89	6.07	34.93a
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	87.67	0.09	7.26a	12.37	8.44	7.48	35.55a
C.V. (%)	29.63	63.00	41.29	23.26	14.11	17.48	13.73

[1]Treatment means within a column followed by a common letter and those without letters are not significantly different at 5% level, DMRT.

Table 3. Dry matter yield of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Dry Matter Yield (t/ha)				Dry Matter Yield 6 months[1] (tons)
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	
T_0 = control	0.38	1.44	1.85	1.15	4.82b
T_1 = 30-0-60 kg N and K_2O/ha (no P)	0.66	2.44	2.11	1.67	6.88a
T_2 = 30-60-60 kg N, P_2O_5, K_2O /ha (300 kg solophos)	1.31	2.48	2.55	1.48	7.82a
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha(100 kg rock phosphate)	1.05	2.41	2.22	1.41	7.09a
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	0.97	2.59	2.29	1.59	7.44a
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	1.23	2.26	2.41	1.33	7.23a
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	1.40	2.22	2.26	1.59	7.47a
C.V. (%)	40.84	19.50	13.90	19.30	12.65

[1]Treatment means within a column followed by a common letter are not significantly different at 5% level, DMRT.

productivity, hence, it is used (not fresh herbage yield) to evaluate how productive a pasture because the latter is highly dependent on environmental factors, e.g. soil moisture.

Generally, the fresh herbage and dry matter yields of stylo particularly from the second up to the fourth cuttings were not significantly affected despite the increase in phosphorus content in the tissue (Table 4). This could be attributed to the limited synthesis and translocation of substrates as a result of frequent defoliation.

Nutrient Analysis

Phosphorus contents were significantly different among treatments from the second to the fourth cutting (Table 4) whereas no significant differences were noted on the nitrogen and potassium contents from the first until the fourth cutting (Tables 5 and 6). In the second cutting, application of rock phosphate at 100, 300 and 400 kg/ha significantly increased the phosphorus content in plant tissues.

Table 4. Phosphorus content of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Phosphorus Content (%)[1]			
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
T_0 = control	0.15	0.19c	0.19bc	0.22bc
T_1 = 30-0-60 kg N and K_2O/ha (no P)	0.15	0.19c	0.17c	0.20c
T_2 = 30-60-60 kg N, P_2O_5, K_2O/ha (300 kg solophos)	0.17	0.19c	0.19bc	0.23b
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)	0.17	0.21bc	0.20ab	0.25ab
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	0.17	0.20c	0.19bc	0.23b
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	0.19	0.24ab	0.20ab	0.27ab
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	0.19	0.25a	0.23a	0.29a
C.V. (%)	12.99	8.51	8.71	10.09

[1]Treatment means within a column followed by a common letter and those without letters are not significantly different at 5% level, DMRT.

Plants applied with phosphorus contained more phosphorus in their tissues than those which were not applied with P (T_0 and T_1) (Table 4). On the other hand, phosphorus uptake of plants applied with N and K but without phosphorus (T_1) was lower than that of the control (T_0). This suggests that adequate amounts of N and K in P-deficient soils (particularly in acidic soils) lower the plant's uptake of available soil P. It is also possible that the amount of P in P-deficient soil is low, hence, the low uptake. Antagonistic effect of either N or K on P uptake had been reported. Fudge (1928 as cited by Grunes, 1959) mentioned that nitrogenous fertilizers decreased the soluble soil phosphorus hence, less P uptake by plants. Grunes (1959) also reported that in acidic soils , the negative charge on the soil surface and application of nitrogen fertilizers to this soil decrease the soil phosphate solubility. Similarly, Volk (1959 as cited by Grunes, 1959) claimed that when ammonium sulfate was banded

Table 5. Nitrogen content of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Nitrogen Content (%)[1]			
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
T_0 = control	2.71	2.41	2.09	2.68
T_1 = 30-0-60 kg N and K_2O/ha (no P)	2.89	2.40	2.19	2.46
T_2 = 30-60-60 kg N, P_2O_5, K_2O/ha (300 kg solophos)	2.52	2.47	2.32	2.66
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)	2.49	2.42	2.57	2.85
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	2.44	2.34	3.00	2.68
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	2.28	2.57	2.44	2.72
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	2.46	2.57	2.59	2.98
C.V. (%)	10.09	9.47	14.32	7.03

[1]Treatment means within a column are not significantly different at 5% level, DMRT.

Table 6. Potassium content of *Stylosanthes guyanensis* at four cutting periods as affected by varying levels of phosphorus application.

Treatment	Potassium Content (%)[1]			
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
T_0 = control	1.11	1.37	1.31	1.03
T_1 = 30-0-60 kg N and K_2O/ha (no P)	1.17	1.46	1.34	1.08
T_2 = 30-60-60 kg/ha N, P_2O_5, K_2O/ha (300 kg solophos)	1.15	1.43	1.37	1.09
T_3 = 30-34.57-60 kg N, P_2O_5, K_2O/ha (100 kg rock phosphate)	1.13	1.37	1.33	0.91
T_4 = 30-69.14-60 kg N, P_2O_5, K_2O/ha (200 kg rock phosphate)	1.14	1.41	1.34	0.95
T_5 = 30-103.71-60 kg N, P_2O_5, K_2O/ha (300 kg rock phosphate)	1.04	1.39	1.09	0.87
T_6 = 30-138.28-60 kg N, P_2O_5, K_2O/ha (400 kg rock phosphate)	0.9	1.28	1.11	0.84
C.V. (%)	9.04	8.80	11.95	16.06

[1]Treatment means within a column are not significantly different at 5% level, DMRT.

at the rate of 162 kg N/ha, the soluble soil phosphorus decreased more than the non-nitrogen fertilized soil.

Antagonism between P and applied KCl was also noted in the leaves of corn. Application of potassium at higher rates decreased P uptake in the plants. Application of K markedly increased the K concentration in the leaves of snap beans but decreased the uptake of P and Mg (Terman et al., 1975).

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