THE EFFECT OF TOPDRESSED SUPERPHOSPHATE ON THE YIELD AND BOTANICAL COMPOSITION OF A *STYLOSANTHES GUYANENSIS* PASTURE

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ABSTRACT

A Stylosanthes guyanensis *pasture in North Queensland was topdressed with five rates of superphosphate and dry matter yields measured over a period of three successive growing seasons. Total dry matter yields were increased by superphosphate at each harvest. The initial response was by the legume but at later harvests the grasses also responded, leading to a grass dominant mixture or to approximately equal proportions of grass and legume. Guinea grass* (Panicum maximum) *was more responsive than molasses grass* (Melinis minutiflora). *There was also a seasonal variation in legume : grass ratio.*

Soil nitrogen analyses failed to detect any increase in total soil nitrogen as a result of fertilizer treatment but available phosphorus analyses showed a decline in phosphorus status with time.

INTRODUCTION

The legume stylo (*Stylosanthes guyanensis* cv. Schofield) is a valuable pasture legume in parts of Queensland north of the Tropic of Capricorn where the rainfall exceeds 1524 mm (60 in.) per year (Grof, Harding and Woolcock 1970). Many thousands of acres of it have been planted over the last 10 years in the high rainfall tropics where it is a suitable legume for medium and coarse textured soils of lower fertility (Gilchrist 1967). Phosphorus deficiency is the principal limitation to plant growth in the area (Teitzel and Bruce 1970 a) and superphosphate is necessary for rapid establishment of tropical pasture species (Jamieson 1969; Teitzel and Bruce 1971 b). However the rates and frequencies of application of fertilizer necessary to maintain a productive grass/legume mixture are incompletely known.

The aim of the experiment reported here was to investigate the response of an established stylo/grass pasture to topdressed superphosphate and to measure any associated changes in botanical composition of the pasture.

METHODS

Site

The experiment was located on the property of the Warringha Pastoral Co. at Bilyana, some 18 miles south of Tully in north Queensland. The soil, which is derived from granitic parent material, has a range in texture down the profile from sandy clay loam to sandy light clay and fits the Gn 2.21 Principal Profile Form of Northcote (1971). In the soil-vegetation classification of Teitzel and Bruce (1971 a) the site was a grassy sclerophyll woodland on a granitic soil.

Pasture

Stylo, molasses grass (*Melinis minutiflora*), and guinea grass (*Panicum maximum* cv. Coloniao) had been planted in January 1966 with a dressing of 250 kg per ha of superphosphate (9.6% P, 10% S). The pasture had been heavily grazed during 1966. In February 1968, stylo was the dominant species and appeared to be effectively nodulated. There were some molasses grass and guinea grass plants. Some wattle (*Acacia flavescens*) regrowth was also present.

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Treatments

The design used was a 6 × 6 Latin square with duplicate controls. Plot size was 10 m × 8 m and treatments were the equivalents of topdressing at rates of 0, 250, 375, 500, 625 kg superphosphate per ha.

After four harvests each plot was split into two sub-plots, one receiving 250 kg per ha superphosphate and the other not fertilized.

Procedure

The experimental area was slashed to a height of about 30 cm in February 1968. A basal dressing of copper and zinc sulphates, each at the rate of 13.4 kg per ha was applied before superphosphate treatments were superimposed.

Yields were measured on five occasions, in June, 1968, February, 1969, June, 1969, March, 1970, and July, 1970.

At the first harvest a strip 4.4 m in length was cut with an autoscyth to a height of 10 cm. The material was weighed and subsampled for botanical separation. At the other harvests two quadrats of 1 m × 1 m were cut per plot with shears and the material was botanically separated. At the last harvest the two quadrats were cut per sub-plot.

After each harvest cattle were allowed to graze the experimental area. A slasher was used to even up the area after grazing before allowing regrowth for the next harvest. After the February-March harvests grazing and slashing were done as quickly as practicable (3 to 4 weeks) but after the June-July harvests cattle remained longer on the area.

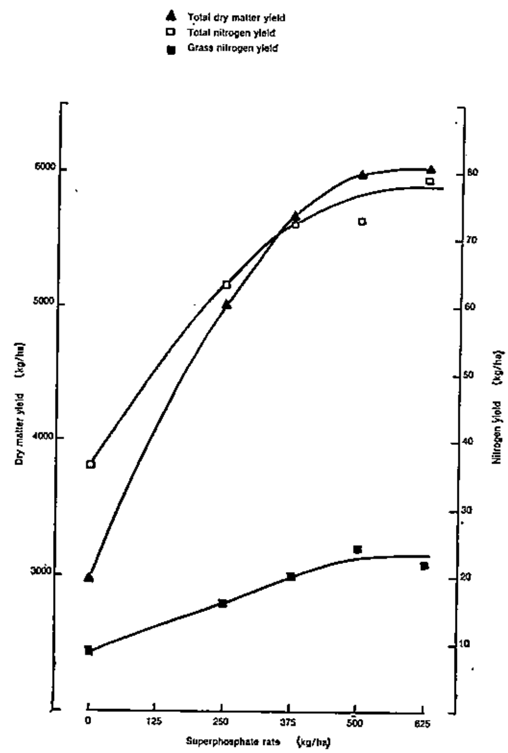

FIGURE 1
Dry matter and nitrogen yields pooled over five harvests and expressed as per mean yields harvest.

Soil samples (depth 0-7.5 cm, diameter 2.5 cm) were taken in September, 1969 (20 cores per plot) and in October, 1970 (10 cores per sub-plot).

Chemical Analyses

Soil samples were analysed for nitrogen by the Kjeldahl method while soil available phosphorus was determined by the dilute acid extraction of Kerr and von Stieglitz (1938).

RESULTS

Rainfall

Rainfall totals were 2334, 2060 and 2156 mm (91.88, 81.10 and 84.88 in.) for the years 1968, 1969 and 1970 respectively. Mean annual rainfall nearby at Murray Upper is 2393 mm (94.23 in.). Between 73 and 86% of the annual totals was received in the January to May period indicating its distinct seasonal distribution. Prior to each sampling soil moisture for growth was considered adequate.

Dry Matter Yields and Botanical Composition

As the pattern of total dry matter yield response to superphosphate showed no trends with time, yields pooled over the five harvests are given in Fig. 1. Yield response decreased with increasing amounts of superphosphate.

There was a seasonal variation in botanical composition. Stylo was dominant in June-July harvests (60% for aggregate of three harvests) but in February-March harvests grasses were dominant (35% stylo for two harvests).

Yields of each species at each harvest are given in Table 1. Species response to superphosphate varied with time. Superphosphate increased yields of stylo at harvests 1, 2, and 3 and of molasses grass at harvests 3 and 4. Guinea grass, which was not present at harvest 1 and contributed only slightly to yield at harvest 2, responded to superphosphate and became a substantial yield component at harvests 4 and 5.

Stylo yield as a percentage of total yield decreased at harvests 3 and 4 in comparison to harvests 1 and 2 respectively. This was the result of increased grass growth as there was little change in the absolute level of legume yield.

In general, the effect of fertilizer was an early stylo response which increased legume dominance in the pasture and a subsequent grass response which led to a grass dominant mixture or to approximately equal proportions of grass and legume.

Weeds (native grasses and wattle) formed only a minor component except on plots without superphosphate.

The yields of the sub-plots which received 250 kg superphosphate per ha are not shown. They did not differ significantly and ranged from 5600 to 6100 kg per ha. The only outstanding features of these plots were the relatively high weed content on the original 0 plot (7%) and the higher guinea grass content (25%) of plots originally receiving 500 and 625 kg.

Nitrogen Yields

Nitrogen yields generally showed the same trends as dry matter yields. Superphosphate increased the nitrogen yield of both legume and grass. Nitrogen yields pooled over five harvests are given in Fig. 1 for grass and for legume plus grass. Nitrogen yields at June-July harvests were higher than those at February-March harvests, reflecting the higher legume content of plots at that time.

TABLE 1
Dry matter yields of each species at each harvest

Harvest date	Superphosphate rate (kg/ha)	Dry matter yields (kg/ha) Stylo	Molasses	Guinea	Total sown species	Weed	Total
3.vi.68	0	2027	1085	0	3113	34	3147
	250	2890	1155	0	4045	45	4089
	375	3285	854	0	4139	0	4139
	500	3587	858	0	4445	11	4456
	625	4224	1071	0	5294	0	5294
L.S.D. P = 0.05	A*	791	527		970		
	B†	915	608		1120		
6.ii.69	0	821	1208	39	2069	106	2176
	250	2232	1516	240	3987	86	4074
	375	1908	2029	237	4173	93	4267
	500	1890	2483	268	4641	50	4691
	625	2157	2040	119	4316	48	4364
L.S.D. P = 0.05	A*	686	962	152	754		
	B†	791	1111	176	871		
9.vi.69	0	1823	1056	159	3037	467	3504
	250	3415	2882	563	6859	38	6898
	375	4793	3180	328	8302	0	8302
	500	3647	3283	1481	8411	0	8411
	625	4112	3105	609	7825	141	7966
L.S.D. P = 0.05	A*	869	733	639	958		
	B†	1003	847	739	1106		
5.iii.70	0	1177	1605	106	2889	770	3660
	250	1795	3498	214	5506	323	5829
	375	1773	3843	910	6526	160	6687
	500	1391	4055	1263	6709	41	6750
	625	2010	3305	2721	8040	124	8165
L.S.D. P = 0.05	A*	743	1100	736	939		
	B†	858	1270	851	1087		
14.vii.70	0	2862	786	67	3715	315	4030
	250	3172	1197	396	4765	108	4873
	375	3176	1479	655	5310	27	5337
	500	2683	1841	1127	5650	40	5689
	625	2245	1358	1130	4733	71	4805
L.S.D. P = 0.05	A*	998	703	670	788		
	B†	1165	812	775	910		

A* for comparison of 0 kg/ha with other rates
B† for comparison between 250, 375, 500, 625 kg/ha rates

Soil Analyses

There were no consistent effects of treatment on total soil nitrogen at either sampling date (data not presented). The overall means were 0.216 and 0.225% nitrogen for the 1969 and 1970 samplings respectively.

Soil available phosphorus analyses for each sampling are plotted in Fig. 2. Means for the 1970 sub-plots are shown separately. There is a low residual value of the original treatments and a decline in phosphorus status with time. The 1970 application of superphosphate offset the decline with time.

DISCUSSION

A large and sustained yield response to superphosphate was measured during the period of the experiment. This response occurred two years after the establishment dressing of 250 kg superphosphate per ha (2 cwt per acre) and probably reflects a decline in availability of applied superphosphate as well as an inadequate rate of

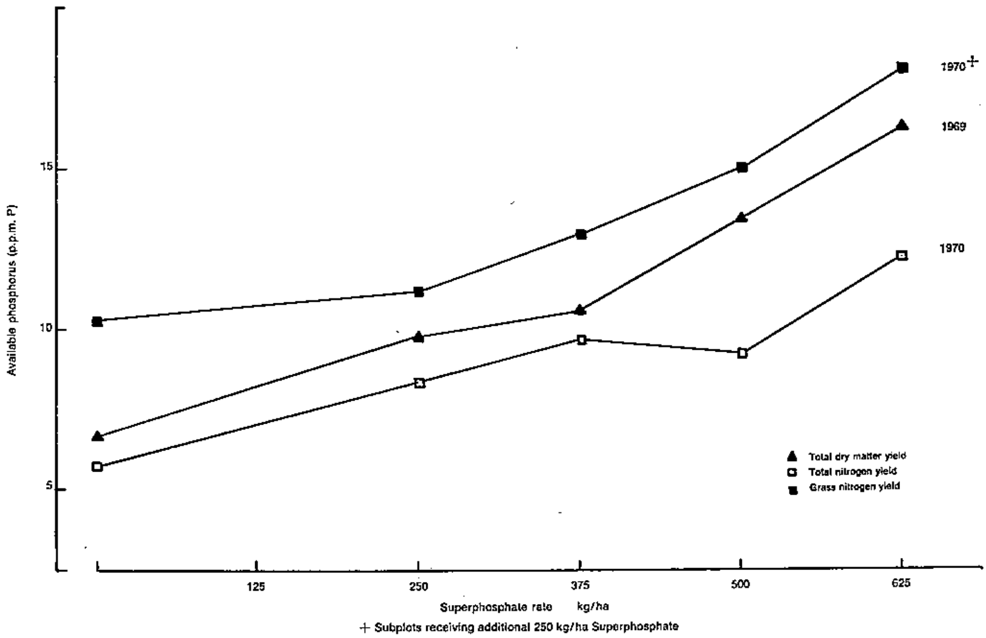

FIGURE 2
Soil available phosphorus analyses at two sampling dates.

fertilization at establishment. Teitzel and Bruce (1970 b) recommended 500 kg superphosphate per ha for this particular location. The build up of native grasses and wattle regrowth in the control plots and their absence from fertilized plots emphasizes the decline in vigour of the sown species and highlights the necessity for maintenance fertilizer. The value of a vigorous pasture in controlling weeds, particularly *Acacia flavescens* has been discussed by Bailey (1969). The higher rates of maintenance fertilizer produced higher total dry matter yields and higher proportions of guinea grass relative to molasses grass. On a field scale this should lead to a more productive pasture.

Judging from the soil phosphorus analyses (Fig. 2) the residual value of superphosphate in this soil is low. This is shown by the small residual value of 625 kg superphosphate after just less than three years (5.8 ppm phosphorus in unfertilized and 12.3 ppm phosphorus in 625 kg treatment) and by the relatively small effect of 250 kg superphosphate on soil phosphorus in 1970. The soil analyses together with the consistently higher yields and more desirable species composition of the 500 and 625 kg plots suggest that 15 ppm phosphorus could be adequate for the growth of guinea/stylo pastures on this soil. From an animal nutrition viewpoint higher nitrogen and phosphorus yields consequent upon a higher phosphorus status may be important and 20 ppm phosphorus may be a better level to maintain.

The pattern of species response described in this experiment has been one of initial legume response followed by grass response, with guinea grass becoming ascendant over molasses grass at higher fertility levels. A similar pattern has been reported from Puerto Rico (Caro-Costas and Vincente-Chandler 1963; Vincente-Chandler *et al.* 1964) where the tropical legume puero (*Pueraria phaseoloides*) has been studied in association with the grasses molasses, guinea, para (*Brachiaria mutica*), and elephant (*Pennisetum purpureum*).

The mechanisms operative in these responses appear to be similar to those suggested by Rossiter (1964) in his attempt to rationalize the effects of phosphorus supply on botanical composition of annual pastures in a Mediterranean type climate.

Differential plant characteristics, concerned with differences between species in demand for, or ability to absorb phosphorus, are allowed to become operative according to nitrogen supply. The nitrogen may come from symbiotic fixation, which is also confounded with time, or from fertilizer nitrogen.

Although no soil nitrogen changes were detected, plant nitrogen data show that increased nitrogen fixation must have occurred after the initial legume response. This caused the grasses to respond to phosphorus treatment.

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