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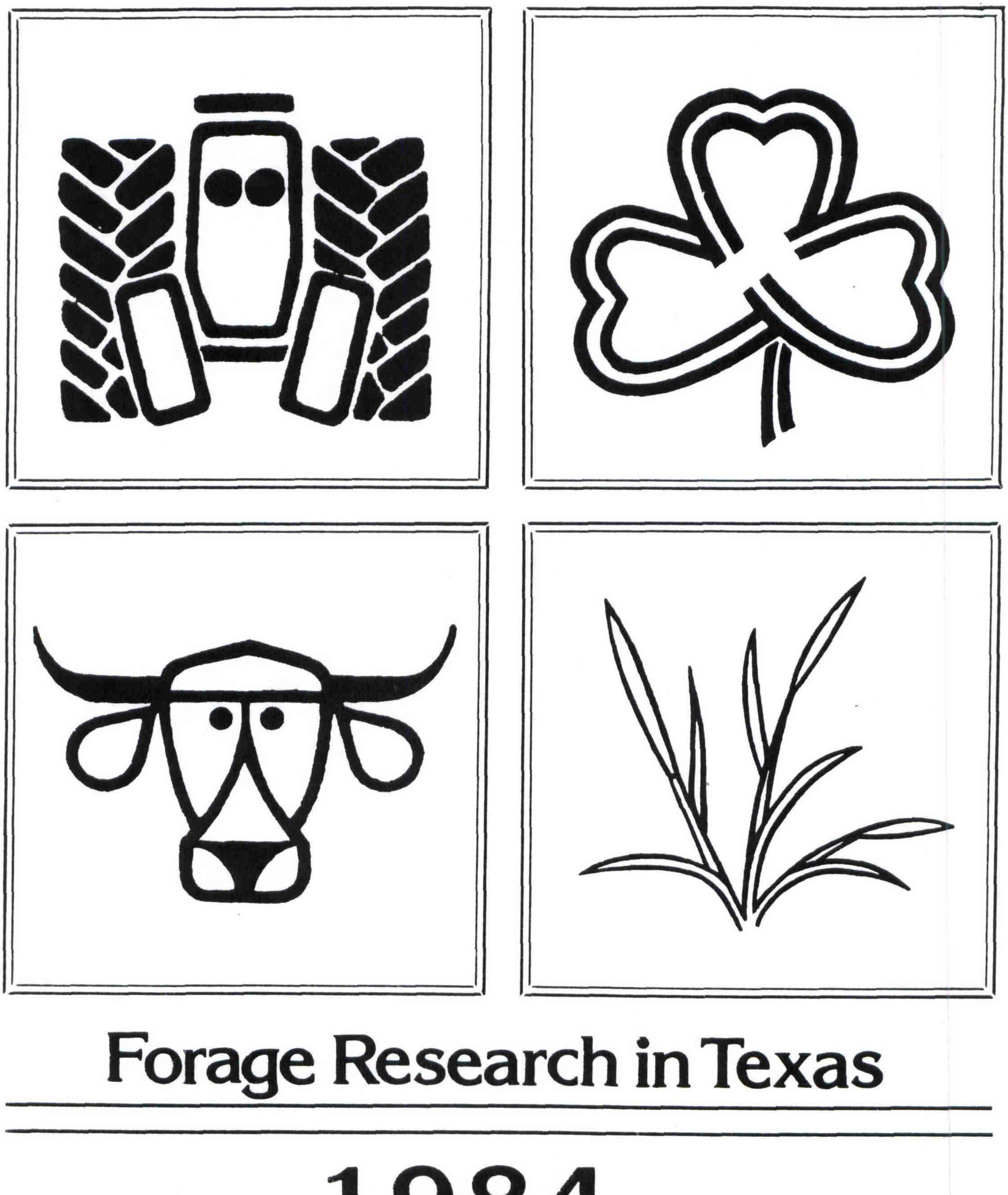

Forage Research in Texas

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Forage Legume Production as Influenced by Nitrogen and Phosphorus Fertilization

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SUMMARY

The influence of nitrogen and phosphorus fertilization on the forage production of six legume species was investigated. These legumes were grown on an alluvial calcareous silty clay soil with fairly good inherent soil fertility. The location was at the Texas A&M University Plantation River Bottom Farm. Inoculated seed of the six legume species was planted in early October and good stand establishment obtained before cessation of growth with the occurrence of winter weather. Spring regrowth was harvested April 2 and a second harvest of May 28. Although there was a slight tendency for phosphorus application to increase legume production, it was not statistically significant. The fact that legumes are quite self sufficient in N fixation coupled with the commonly inherent P and K fertility of alluvial soils eliminates much prospect for response to fertilization of alluvial soils. However, there were considerable yield differences between legume species. The total forage production in order of legume species was: Red Clover > Alfalfa = Yuchi arrowleaf = Hubam sweetclover > Mt. Barker subterranean > Madrid sweetclover.

INTRODUCTION

There is a lack of information concerning what response to fertilization various cool season legumes would have when grown on a rather fertile alluvial soil. Information was also sought on the comparative production of several legume species under the specific local climatic conditions.

PROCEDURE

Fertilizer sources were ammonium nitrate (34% N) and triple superphosphate (46% P_2O_5). Fertilizer treatments expressed in kg per hectare of elemental N-P-K were: (0-0-0), (0-50-0), (0-100-0), and (25-100-0). Fertilizer treatments were broadcast by hand and lightly incorporated with a rotera machine.

Seed was obtained from a commercial source for the following legume species: Yuchi arrowleaf clover (*T. vesiculosum*), Mt. Barker subterranean clover (*T. subterraneum*), 'Nolin' red clover (*T. pratense*), 'Florida 77' alfalfa (*Medicago sativa*), 'Madrid' sweetclover (*Melilotus officinalis*), and 'Hubam' sweetclover (*Melilatus alba*). Seed of each species was inoculated with the appropriate commercial strain of rhizobium before drill planting into a calcareous silty clay alluvial soil. Plot size was 5 rows wide (1 foot spacing) by 20 ft long.

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RESULTS AND DISCUSSION

Legume plant regrowth after the first harvest, on this calcareous silty clay soil site location, was sufficient to allow for a second harvest.

First harvest

Forage dry matter yield. Yield data for the different legume cultivars studied are shown in Table 1. Madrid sweetclover lacked sufficient growth at the time of the first harvest (April 2, 1983, approximately 6 months after planting) thus no yield data was collected. Plants were close to maturity when harvested due to continued wet weather that delayed harvest. Statistical analysis of the yield data showed no significant differences among fertilizer treatments at the 0.05 level. However, among species and cultivars there were significant differences, which suggest that the yield capacity of each cultivar, due to its genetic potential to produce, was not altered by fertilizer applications. Nolin red clover yield was significantly greater than the other legumes.

Tissue N, P, and K concentrations. Fertilizer applications tended to decrease the tissue N of legumes (Table 2). Averaged across cultivars, the mean N content (3.08%) of the unfertilized treatment was significantly greater (P = 0.05) than the P-100 treatments. This likely occurred from the increased growth by the P-100 treatments resulting in dilution of the N content. A similar situation occurred when comparing the legume cultivars, where the greater dry matter produced by the Nolin red clover may have resulted in a dilution effect, since percent N in tops was less as compared with those that produced lower dry matter yield (Hubam, Florida 77, and Yuchi) and which had higher N concentration in tops.

The tissue P concentrations are listed in Table 3. The high rate of P significantly increased P in the tops. In regard to the cultivars, Yuchi arrowleaf and Hubam sweetclover had the highest P concentrations. Again Nolin red clover was the lowest.

Tissue K concentration is shown in Table 4. Potassium was not applied as a fertilizer treatment because this soil had a high K level. Fertilization treatments did not significantly affect the K absorption from the soil. Among cultivars, Yuchi had the significantly highest K concentration. It has been characteristic of Yuchi to have higher N, P, and K percentage than other cultivars.

Second harvest

Forage dry matter yield. The second cutting occurred on May 28, 1983, approximately two months after the first cutting. A general increase in yield was obtained at the second harvest over the first harvest on all the cultivars, except Mt. Barker which showed a decrease in yield (Table 5). This exception was probably due to the earlier maturity of Mt. Barker than the other cultivars followed by growth cessation in later spring. As in the first harvest, there was no significant differences in yield among the fertilizer treatments. Even though there was a considerable increase in yield of Florida 77 alfalfa when fertilized with P alone (100 kg ha^{-1}) and especially with P plus N, it was not statistically significant. Previous work has shown that alfalfa requires high fertility for top production and sometimes needs N to increase yield.

Once again, legume cultivars showed significant differences in forage production. Florida 77, Yuchi, Hubam, and Nolin yielded significantly better than Mt. Barker and Madrid.

Tissue N, P, and K concentrations. Generally, the N, P, and K concentration in the tops decreased as compared with those values at the first harvest. This is attributed to the warmer temperatures and higher light intensities where the growth dilution resulted in a decrease in N, P, and K percentages (Tables 6, 7, and 8). As in the first harvest, the N, P, and K concentrations were not significantly influenced by the fertilizer treatments, but were by legume cultivars. Madrid sweetclover had the highest N percentage (Table 6), which was significantly different from the other legumes. Since Madrid had not been harvested previously as were the other legumes, it likely did not encounter the shock or reduction in root-nodule N fixation activity. Harvesting of legumes can result in sloughing off of root and nodule tissue, inhibiting the legume N_2-fixation until new leaf area is actively formed to supply carbohydrates to roots. Moreover, the little top growth made by Madrid may lead to N accumulation in plant tops.

The P concentration of Madrid also was the highest which may be attributed to the latter reason as for N concentration (Table 7). However Madrid was statistically similar to Yuchi arrowleaf in P content and different from the other legumes.

The K concentration of Madrid and Yuchi were significantly greater than the rest of legumes (Table 8). As in the first harvest, Yuchi arrowleaf tended to accumulate the highest N, P and K concentration during this experiment, which makes it a high quality forage.

Accumulative harvest

The total accumulative forage yield showed significant differences among cultivars but not among fertilizer treatments (Fig. 1). Nolin red clover produced significanlty more forage than other cultivars. Madrid sweetclover was the least productive cultivar, attributed to slow growth and establishment which resulted in only one harvest occurring at the time of the second harvest of the other cultivars. Madrid sweetclover tends to have less top growth than other sweetclovers, but a more extensive root system, suggesting that in the present study, this cultivar was still in the vegetative stage, and maximum yield response was not obtained. Previous field observations have shown that this cultivar makes little growth during the first year of establishment, but higher yields are expected the following growing season, probably due to its extensive root system. Hubam sweetclover, on the other hand, is a fast growing legume, which explains its high productivity.

Lack of legume response to P fertilizer in previous work on this clay type of soil indicates that it has a fairly adequate amount of P for establishment and production of legumes during the first one or two years, but after that, P fertilization was necessary for sustained production of high yields. The ability of legumes to deplete soil P and K levels must be recognized in order to maintain adequate production of the growing legume. Continued cropping without applying P could eventually deplete fertility of the soil and reduce crop production.

TABLE 1. Forage dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer		Legume cultivars					
N	P	Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
		kg ha^{-1}					
0	0	3800	3564	3360	2922	4582	3647a*
0	50	3930	3084	3507	2823	4841	3637a
0	100	3678	3840	3873	3035	4882	3861a
25	100	3580	3254	3442	3938	4947	3832a
	Mean	3743b*	3433b	3539b	3181b	4809a	

C.V.=17.04

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 2. The N (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest).

Fertilizer			Legume cultivars				
N	P		Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}					%			
0	0		3.10	3.06	3.17	3.18	3.18	3.08a*
0	50		3.00	3.06	3.08	3.26	2.67	3.01ab
0	100		3.10	2.95	2.58	3.11	2.69	2.88b
25	100		3.00	2.94	2.84	3.07	2.79	2.92b
		Mean	3.05a*	3.00a	2.91ab	3.15a	2.76b	

C.V.=3.91
* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 3. The P (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer		Legume cultivars					
N	P	Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}		- - - - - - - -	- - - - - - - -	- - - - - - - -	% - - - - - - - -	- - - - - - - -	- - - - - - - -
0	0	0.30	0.30	0.30	0.31	0.24	0.29b*
0	50	o.29	0.33	0.31	0.32	0.24	0.29b
0	100	0.30	0.32	0.31	0.35	0.27	0.31ab
25	100	0.30	0.37	0.34	0.36	0.26	0.32a
	Mean	0.29b*	0.33a	0.31ab	0.33a	0.25c	

C.V.= 5.33

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 4. The K (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer		Legume cultivars					
N	P	Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}		%					
0	0	3.26	4.09	3.58	3.60	3.66	3.63a*
0	50	3.25	4.23	3.61	3.29	3.48	3.75a
0	100	3.28	3.47	3.43	3.23	3.74	3.43a
25	100	3.01	3.72	3.61	3.56	3.86	3.55a
	Mean	3.02b*	3.87a	3.55ab	3.42ab	3.68ab	

C.V.=5.61

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 5 . Forage dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer		Legume cultivars						
N	P	Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
		kg ha^{-1}						
0	0	6560	7551	3075	3043	7554	7803	5962a*
0	50	6542	7470	3458	2961	7761	7632	5970a
0	100	7225	6989	3254	2563	7787	7510	5888a
25	100	8120	6599	3848	2603	7535	7526	6038a
	Mean	7111a*	7152a	3049b	2791b	7706a	7616a	

C.V.=11.98

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 6 . The N (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest).

Fertilizer		Legume cultivars						
N	P	Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}		----------------			%		----------------	
0	0	2.47	2.03	2.51	3.39	2.49	2.38	2.54a*
0	50	2.35	1.99	2.35	3.04	2.82	2.17	2.63a
0	100	2.19	2.22	2.49	2.54	2.31	2.16	2.31a
25	100	2.29	2.28	2.45	3.45	2.11	2.05	2.43a
	Mean	2.32b*	2.40b	2.45b	3.10a	2.43b	2.19b	

C.V.= 8.64
* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 7. The P (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer		Legume cultivars						
N	P	Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}		%						
0	0	0.20	0.22	0.20	0.31	0.19	0.19	0.21a*
0	50	0.21	0.26	0.20	0.28	0.19	0.21	0.22a
0	100	0.21	0.25	0.18	0.26	0.20	0.18	0.21a
25	100	0.20	0.25	0.20	0.31	0.20	0.19	0.22a
	Mean	0.20b*	0.24a	0.19b	0.29a	0.19b	0.19b	

C.V.=7.86
* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 8. The K (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer			Legume cultivars						
N	P		Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}			----------	----------	----------	%	----------	----------	----------
0	0		2.63	2.66	2.26	3.52	2.56	3.04	2.77a*
0	50		2.74	2.42	2.21	3.03	2.63	3.05	2.84a
0	100		2.47	3.09	2.14	2.84	2.66	2.77	2.66a
25	100		2.52	3.14	2.22	3.08	2.35	2.82	2.68a
		Mean	2.59bc*	3.28a	2.20c	3.11a	2.55bc	2.92ab	

C.V.=6.54

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

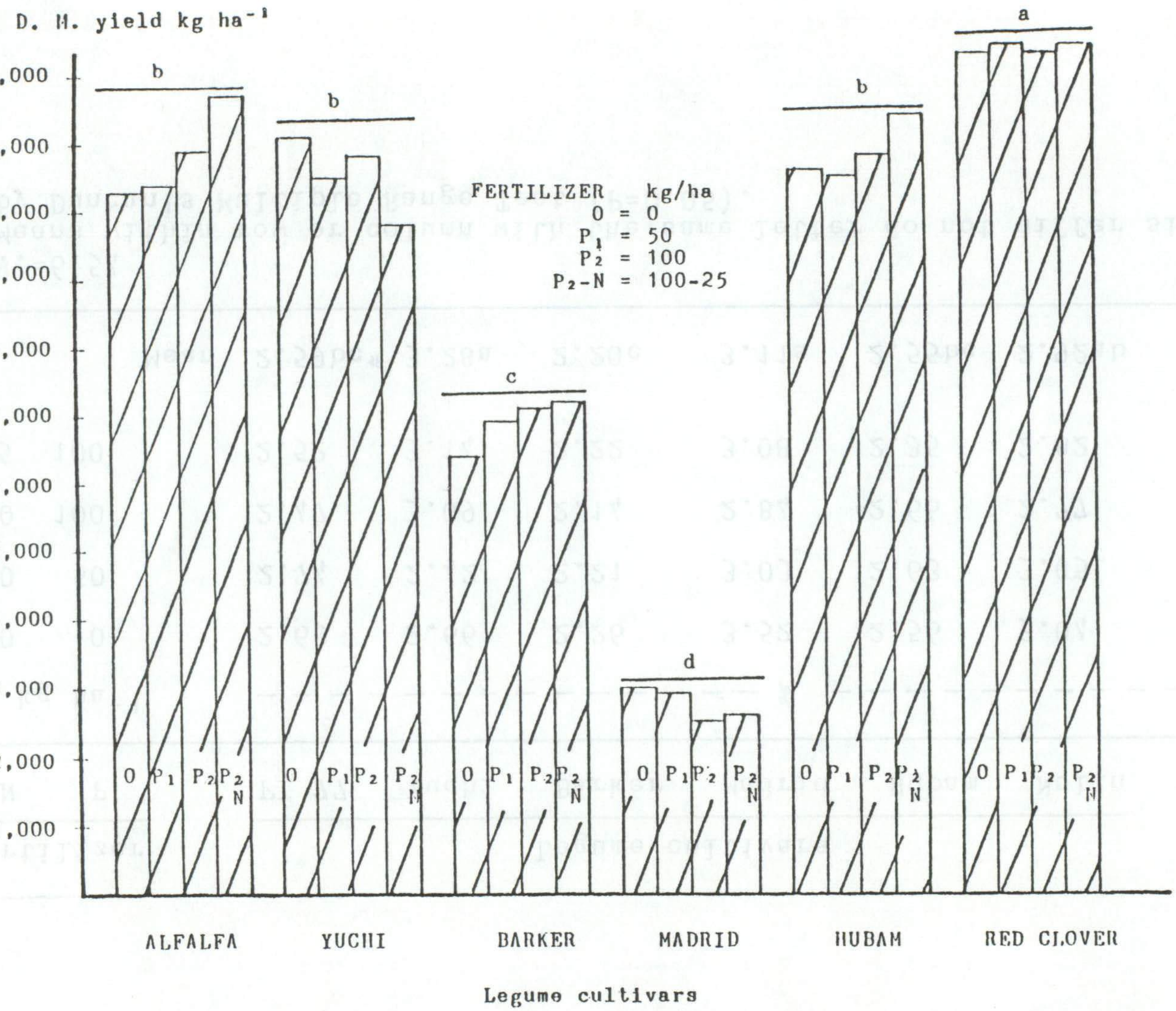

Fig 1. Accumulative dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization.