SUBTERRANEAN CLOVER RESPONSE TO PHOSPHORUS AND BORON FERTILIZATION

V. A. Haby, G. R. Smith, A. T. Leonard, C. L. Gilbert, and J. V. Davis

SUMMARY

Clover production was increased by boron (B) treatment of the soil in previous glasshouse and preliminary field studies. This study was designed to evaluate the response of subterranean clover to B fertilization in a replicated field trial. Four rates of B and 5 rates of phosphorus (P) were applied in all combinations to plots on a Keithville-Sawtown soil complex. Subterranean clover was planted in a prepared seedbed. Yield response was evaluated over a three-year period. Results indicated that subterranean clover responded to 1.5 lb B/ac the first year of the study but yields were not increased for any B rates thereafter. Subterranean clover continued to respond to increasing P application rates throughout the study period. The plant P content and amount of uptake were also increased by increasing rates of fertilizer P. The optimum P rate for subterranean clover production was 22 lb/ac (50 lb P_2O_5/ac) in this study.

INTRODUCTION

Clover stands are often difficult to obtain in the East Texas Timberland soils. A clover response x nutrient screening study indicated that P and B greatly improved clover yield in a glasshouse study. Preliminary field tests indicated that B greatly increased vegetative growth and reseeding of rose clover. This test was established to evaluate the response of subterranean clover to P and B in a replicated and randomized field study. Objectives of this study were: 1) To determine the optimum rates of P and B fertilization for annual clover production, 2) To evaluate the B fertilizer requirement of subclovers under varying production intensities, and 3) to calibrate the soil test for subclover response to B and P.

PROCEDURES

The field research site was located on a Keithville-Sawtown soil complex (fine-loamy, siliceous, thermic Aquic Paleudult) which was limed to approximately pH 6.5. Boron rates of 0, 1.5, 3.0, and 4.5 lb/ac and P rates 0, 22, 44, 88, and 176 lb/ac (0 to 400 lb P_2O_5) were applied in all combinations in a randomized complete block design study with 4 replications. Plots were 9 ft wide by 10 ft long. A 3 ft

alley-way was located between the ends of the plots. Potassium (K), magnesium (Mg), and sulfur (S) were uniformly applied and incorporated at rates of 156 lb K_2O, 68 lb S, and 34 lb Mg/ac prior to seeding 'Mt. Barker' subterranean clover. Treatments were incorporated into a prepared seed bed on the same site in 1986-1987 and 1987-1988. The experiment was moved to an alternate site on the same soil complex for 1988-1989.

RESULTS

Main reactions to B were averaged over all P rates and reactions to P were averaged over all B rates except where interactions are presented. Subterranean clover yield was significantly increased (15%) by B at the 1.5 lb/ac rate only in the first cutting in 1986-1987 (Table 1). This response remained visible in the total yield that first year. The same rate tended to increase clover yield the following two years but the increases in production were not statistically significant. Only one cutting was produced on the second site in year three. Boron treatment did not increase subclover yield. Limestone treatment to eliminate strongly acid conditions followed by tillage of the research site prior to establishing clover interact to favor mineralization of organic matter. It is likely that sufficient B was made available through mineralization to negate a clover response after the first cutting on site one and no response on site two where only one harvest was produced.

Phosphorus fertilization increased clover growth each year. The optimum P rate appeared to be 22 lb P (50 lb P_2O_5/ac). There was no significant interactive effect of B and P on clover yield.

Increased rates of B application increased plant uptake of B each of the three years (Table 2). Clover produced by the zero B treatment in 1986-1987 contained 19.3 ppm B, the lowest clover B level in the study. The statistically significant yield increase occurred when the B content of the clover was increased above this level by the 1.5 lb B/ac rate. Boron uptake was not as great at the second site as it was the first two years at the first site. The recovery of applied B (B uptake) was 5.3 % or less at the 1.5 lb B/ac rate and decreased as the B rate was increased.

When the B treatment was increased to 1.5 lb/ac or above, plant B content was increased by increased P rates up to the 88 lb/ac rate (Table 2a). Plant B content remained relatively stable at the 22 and 44 lb P/ac rates as the B rate was increased from 1.5 to 4.5 lb/ac. At the 88 lb P/ac treatment, increasing rates of B increased plant B content. With no added B, applied P did not increase plant B

content.

Each increase in P rate increased the P content of the clover all three years (Table 3). Phosphorus uptake by the clover increased but the percent uptake of applied P decreased as the P rate was increased. Percent uptake of applied P was low and ranged from 11 to 1.9%.

Soil test P levels were increased by increasing application of fertilizer P (Table 4). The amount of P_2O_5 required to raise the soil test 1 ppm decreased as the rate of applied P was increased. The amount of fertilizer phosphorus required to raise the soil test 1 ppm agrees with results obtained on a Lilbert soil limed to pH 6.2 in a previous study.

TABLE 1. SUBTERRANEAN CLOVER YIELD RESPONSE TO B AND P FERTILIZATION OVER A THREE-YEAR PERIOD

	1986-1987†			1987-1988			1988-1989	3-year
B rate	Cut 1	Cut 2	Total	Cut 1	Cut 2	Total	Total	Total
lb/ac	lb/ac							
0	726 a	1587 a	2314 a	906 a	1688 a	2594 a	2736 a	7643 a
1.5	1059 b	1594 a	2653 b	956 a	1732 a	2688 a	2916 a	8257 a
3.0	739 a	1410 a	2148 a	817 a	1664 a	2481 a	2908 a	7537 a
4.5	800 a	1478 a	2278 a	846 a	1643 a	2489 a	2852 a	7618 a
P rate								
0	194 a	1122 a	1317 a	564 a	1487 a	2051 a	2377 a	5744 a
22	747 b	1534 b	2282 b	992 b	1815 b	2807 b	2746 ab	7834 b
44	932 bc	1589 b	2521 bc	948 b	1756 b	2705 b	2961 b	8187 b
88	1066 cd	1647 b	2713 c	917 b	1675 ab	2592 b	3010 b	8315 b
176	1216 d	1693 b	2909 c	985 b	1675 ab	2660 b	3170 b	8740 b

†For a given column and data set, values followed by the same letter are not different at $P \leq 0.05$ based on Student-Newman-Keuls mean separation test.

TABLE 2. EFFECT OF B FERTILIZATION ON SUBTERRANEAN CLOVER B CONTENT AND UPTAKE

	Average Plant B Content and Uptake†					
	1986 - 1987		1987 - 1988		1988 - 1989	
B rate	Content	Uptake	Content	Uptake	Content	Uptake
lb/ac	ppm	lb/ac	ppm	lb/ac	ppm	lb/ac
0	19.3 a	0.043 a	45.8 a	0.128 a	21.3 a	0.058 a
1.5	39.5 b	0.110 b	68.1 b	0.208 b	24.7 b	0.072 b
3.0	48.2 c	0.112 b	79.6 b	0.244 b	24.8 b	0.072 b
4.5	58.8 d	0.146 c	74.8 b	0.215 b	27.9 c	0.079 b

†For a given column and data set, values followed by the same letter are not different at $P \leq 0.05$ based on Student-Newman-Keuls mean separation test.

TABLE 2a. EFFECT OF B AND P FERTILIZATION ON SUBTERRANEAN CLOVER PLANT B CONTENT

	Boron rate (lb/ac)†			
P rate	0	1.5	3.0	4.5
lb/ac	ppm			
0	25.71	25.25	28.09	40.91
22	19.84	39.49	36.90	40.74
44	17.30	39.96	42.40	42.48
88	16.73	44.22	52.61	59.56
176	19.90	38.38	47.14	49.25

L.S.D. (0.05) = 11.92

†Data from harvest 1 in the 1986-1987 crop year.

TABLE 3. EFFECT OF P FERTILIZATION ON SUBTERRANEAN CLOVER P CONTENT AND UPTAKE

	Average Plant P Content and Uptake†					
	1986 - 1987		1987 - 1988		1988 - 1989	
P rate‡	Content	Uptake	Content	Uptake	Content	Uptake
lb/ac	%	lb/ac	%	lb/ac	%	lb/ac
0	0.19 a	2.49 a	0.24 a	4.71 a	0.21 a	5.02 a
22	0.22 b	4.88 b	0.32 b	8.35 b	0.23 b	6.45 b
44	0.26 c	6.18 c	0.34 c	8.78 b	0.29 c	8.47 c
88	0.30 d	7.87 d	0.39 d	9.58 b	0.34 d	10.15 d
176	0.35 e	10.11 e	0.44 e	11.28 c	0.38 e	12.03 e

†For a given column and data set, values followed by the same letter are not different at $P \leq 0.05$ based on Student-Newman-Keuls mean separation test.

‡Corresponds to 0, 50.4, 100.8, 201.6, and 403.3 lb P_2O_5/ac.

TABLE 4. EFFECT OF APPLIED P ON SOIL TEST LEVELS OF P†

	1987-87		1987-88		1988-89	
Applied P‡	Soil Test P	P_2O_5 Req.§	Soil Test P	P_2O_5 Req.§	Soil Test P	P_2O_5 Req.§
lb/ac	ppm	lb/ac	ppm	lb/ac	ppm	lb/ac
0	9.1 a		5.9 a		1.3 a	
22	11.3 ab	23	9.1 a	32	2.5 a	44
44	15.9 bc	15	13.6 b	26	4.5 a	32
88	20.9 c	17	18.6 c	32	11.9 b	19
176	35.9 d	15	36.4 d	26	18.5 c	23

†For a given column and data set, values followed by the same letter are not different at $P \leq 0.05$ based on Student-Newman-Keuls mean separation test.

‡Corresponds to 0, 50.4, 100.8, 201.6, and 403.3 lb P_2O_5/ac.

§Pounds of fertilizer P_2O_5 required to increase soil test P one ppm.