SUBTERRANEAN CLOVER RESPONSE TO RECOMBINED AG GRADE AND SUPERFINE LIMESTONE

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SUMMARY

Subterranean clover yield response to limestone rates, methods of application, and combinations of ag grade and superfine limestones was evaluated in the glasshouse. Increasing the fineness of limestone up to 25/75 ag grade to superfine effectively increased dry matter production when the limestone was incorporated. However, with surface application, dry matter production was reduced when the combination percentage of superfine was raised above 50. Surface application of limestone was less effective than incorporated treatments. A 50/50 combination of the present ag grade to superfine limestone appeared to allow optimum production when surface-applied. This combination may also be adequate for incorporated limestone. This research verified that increased fineness could be partially substituted for higher rates. However, the long-term effectiveness of the finer limestone was not evaluated.

INTRODUCTION

Limestone producers have been conscious of the need to provide a more reactive limestone product. This concern led the Texas Aglime and Fertilizer Association to provide specially sized limestone products for an evaluation of limestone reactivity in the mid-1960's (Haby, 1969). The results of this research encouraged the Association to increase the fineness of agricultural grade limestone. Present ag grade limestone is finer than previous ACP specifications which allowed application of limestone in which 10% of the crushed rock was larger than 8-mesh.

Field observations have indicated that surface application of ag grade limestone does not efficiently increase soil pH. Recent research has found varying amounts of unreacted particles of limestone in the surface of several fields where limestone was surface-applied (Allen, 1986). Nitrification of ammonium forms of nitrogen releases acidity into the soil. Clover establishment failures have been thought to be related to concentrated acidity in the surface inch of soil due to the acidifying effect of fertilizer nitrogen applied to hay meadows and pastures.

Renewed interest in surface-applied limestone reactivity, and the availability of large quantities of limestone dust washed from concrete aggregate led to the initiation of this research to evaluate response of subclover to combinations of ag grade and superfine limestone.

PROCEDURES

Representative samples of the ag grade and superfine limestones were evaluated individually and in weight/weight combinations of 75/25, 50/50, and 25/75 percent, respectively. Evaluations included particle size, efficiency rating, calcium carbonate equivalence (CCE), and effective calcium carbonate equivalence (ECCE). Particle size was evaluated by wet sieving a 50 gm limestone sample through 8-, 20-, and 60-mesh screens. Material remaining on each screen was oven-dried and weighed. Reaction efficiency factors of 0, 0.2, 0.6, and 1.0 were assigned to stone larger than 8-mesh, 8 to 20, 20 to 60, and <60-mesh, respectively. Limestone efficiency rating was calculated by multiplying the particle size fraction (in percent) times the efficiency rating factor. Calcium carbonate efficiency was determined by dissolving 1.0 gm of limestone in 50 ml of 0.5 N hydrochloric acid. The excess acid was titrated with 0.25 N sodium hydroxide and percent CCE was calculated from this result. Effective CCE was calculated by multiplying the sum of the fractional efficiency ratings times the CCE.

A representative sample of Lilbert loamy fine sand with an initial 2:1 water:soil pH of 5.3 was collected for use as the potting medium for this glasshouse study. This soil was initially treated with the pounds per acre equivalent of 0-75-150, as N-P_2O_5-K_2O along with 30 lb MgO and 37 lb S/ac equivalent. Appropriate limestone treatments were applied to one set of pots and mixed into the soil with the fertilizer treatments. The fertilizer treatments were mixed into the soil in the second set of pots, after which the limestone treatments were applied and left on the surface. Limestone treatments, in addition to method of application, included rates equivalent to 0.25, 0.5, and 0.75 tons per acre applied as 100/0, 75/25, 50/50, 25/75, and 0/100 percentages of ag grade/superfine limestone. Four additional pots of soil were fertilized but not limed. Twelve pre-germinated and inoculated Mt. Barker subterranean clover seeds were planted into each pot. Each treatment was replicated four times in a randomized complete block design. Four harvests were made.

RESULTS

Results of limestone quality analyses are presented in Table 1 for all combinations of limestone evaluated. The calculated efficiency rating increased linearly as the percentage ag grade was decreased and superfine limestone increased. The regression equation was efficiency rating = 60.95 + 0.3868(x), where (x) is the percent by weight of superfine limestone in the combination. The CCE was unaffected by alterations in the fineness of the limestone combination fineness because excess hydrochloric acid used to evaluate CCE dissolved all the limestone. The ECCE increased linearly and in a similar manner to the efficiency rating, as the percent superfine limestone in the combination was increased (Fig. 1). The equation was ECCE = 59.62 + 0.3977(x), where (x) is the percent by weight of superfine limestone in the combination.

Clover yields accumulated over the four harvests indicated that dry matter continued to increase as percent superfine limestone in the combination was increased at both the low and medium rates of application (Fig. 2). However, dry matter yield declined when the percentage of superfine limestone was increased beyond 50% at the 0.75 ton/ac lime rate. When incorporated, greater than 50% superfine was not necessary except at the lowest rate of application (Fig. 3). At the medium and highest rate, clover growth was similar at the 50/50 and 0/100 ag grade/superfine combinations. Data in Fig. 3 indicated that increasing limestone fineness compensated for higher rates. Clover yield at the 50/50 combination and the medium rate of application was equal to yield at the 100/0 combination applied at the highest rate.

Clover yield response to surface application was generally lower than from incorporated limestone treatments (Fig. 4). Dry matter production was increased due to increasing fineness at the lower rates, but at the highest application rate increasing the superfine above 50% significantly reduced dry matter production. Clover seeded into the unlimed pots of soil germinated and grew to about one inch height, then turned chlorotic and died.

Yields represented by averages for all limestone rates indicated surface applications of the coarser combinations were less effective than incorporated treatments (Fig. 5). When the limestone combinations exceeded 50% superfine, clover yield response to surface application was severely reduced relative to incorporated treatments. Dry matter production was increased by incorporated and surface applications as the percentage superfine was increased up to the 50/50 combination. When incorporated, the greatest percent increase in clover production occurred with the first 25% addition of superfine limestone. Surface application required 50/50 combinations to equal the effectiveness of the incorporated 75/25 combinations.

Data in Fig. 6 represent subclover response to limestone rates and application methods averaged over all particle sizes. Results indicate that surface application is less effective than limestone properly incorporated into the soil.

REFERENCES

Allen, E. 1986. Accumulation of surface-applied agricultural limestone in acid soils of East Texas. M.S. Thesis. Texas A&M University library. 155 pg.

Haby, V. A. 1969. The effects of calcitic and dolomitic limestone rates and particle sizes on soil chemical changes, plant nutrient concentration, and yields of corn and Coastal bermudagrass on two acid Texas soils. M.S. Thesis. Texas A&M University library. 94 pg.

TABLE 1. LIMESTONE PARTICLE SIZE, EFFICIENCY RATING, CALCIUM CARBONATE EFFICIENCY, AND EFFECTIVE CALCIUM CARBONATE EFFICIENCY

Ag Grade/ Superfine	Mesh Size	Limestone Fraction	Efficiency Factor	Efficiency Rating	CCE	ECCE
%		%		%	%	%
100/0	>8	1.80	0.00	0.00		
	8-20	30.80	.20	6.16		
	20-60	31.22	.60	18.73		
	<60	36.18	1.00	36.18		
				61.07	98.30	60.03
75/25	<8	1.84	0.00	0.00		
	8-20	22.70	.20	4.54		
	20-60	23.56	.60	14.14		
	<60	51.90	1.00	51.90		
				70.58	98.88	69.79
50/50	>8	1.02	0.00	0.00		
	8-20	15.64	.20	3.13		
	20-60	15.72	.60	9.43		
	<60	67.62	1.00	67.62		
				80.18	97.65	78.30
25/75	>8	0.52	0.00	0.00		
	8-20	8.20	.20	1.64		
	20-60	7.68	.60	4.61		
	<60	83.60	1.00	83.60		
				89.85	99.61	89.50
0/100	>8	0.00	0.00	0.00		
	8-20	0.16	.20	0.032		
	20-60	0.24	.60	0.144		
	<60	99.60	1.00	99.60		
				99.78	100.11	99.89

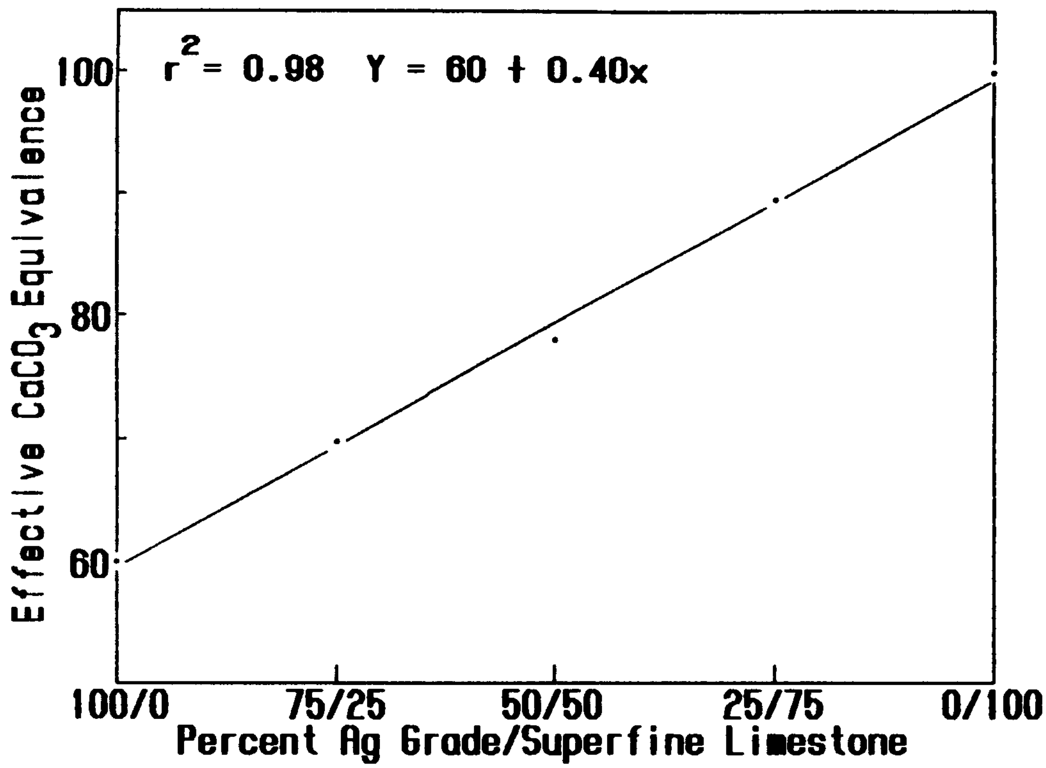

Fig. 1 Effective Calcium Carbonate Equivalence of Ag Grade/Superfine Lime Combinations

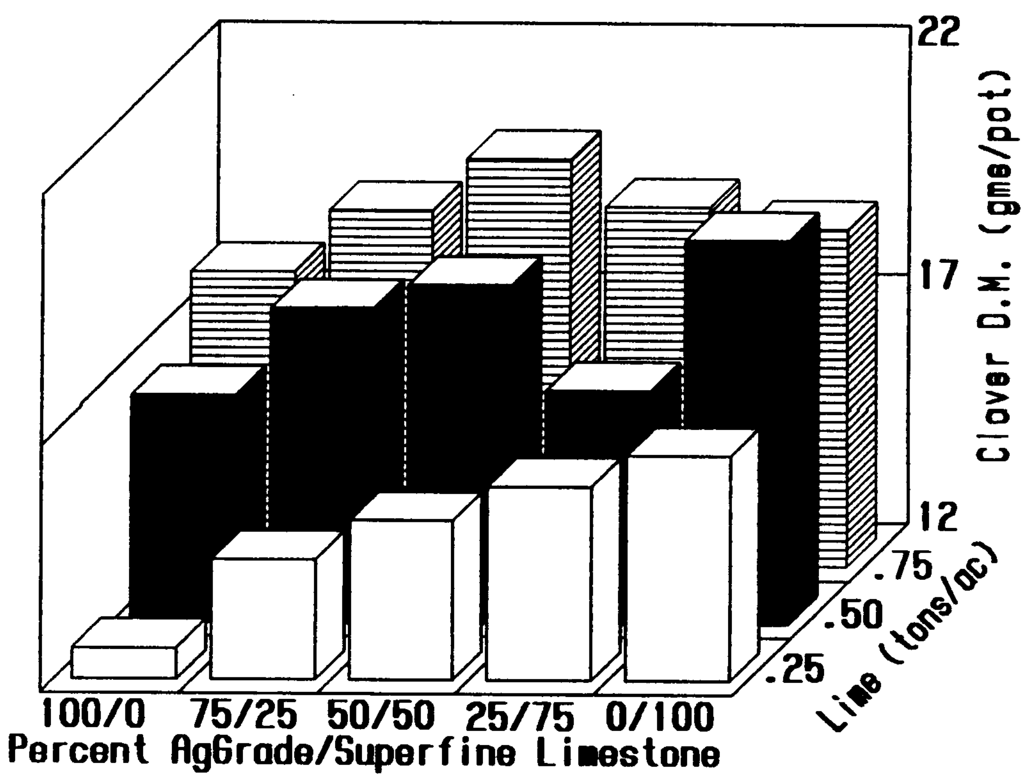

Fig. 2. Subclover response to limestone particle size recombination and rate, all methods

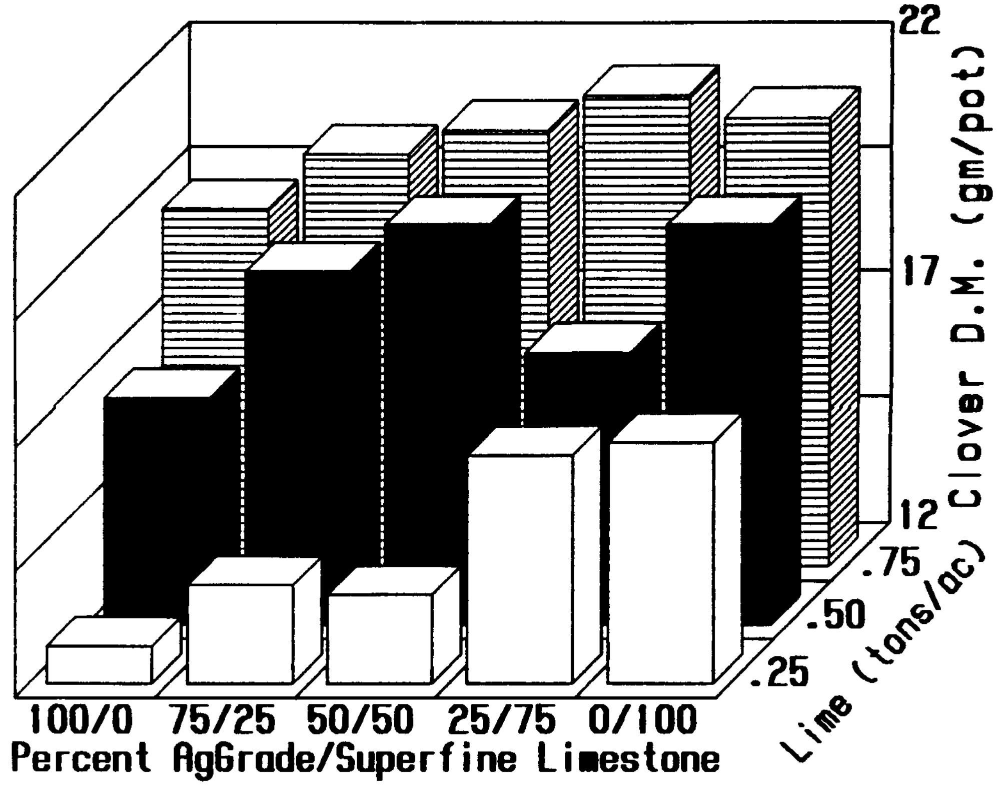

Fig. 3. Subclover response to limestone particle size recombination and rate (Incorp'ed)

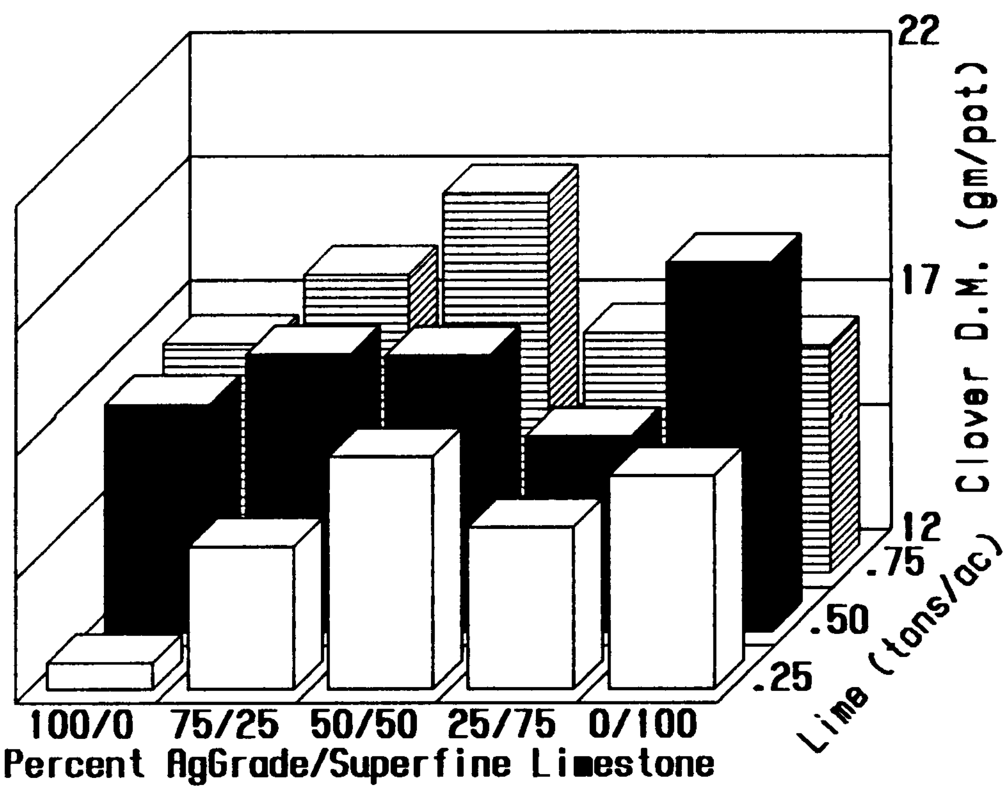

Fig. 4 Subclover response to limestone particle size recombination and rate (Surface)

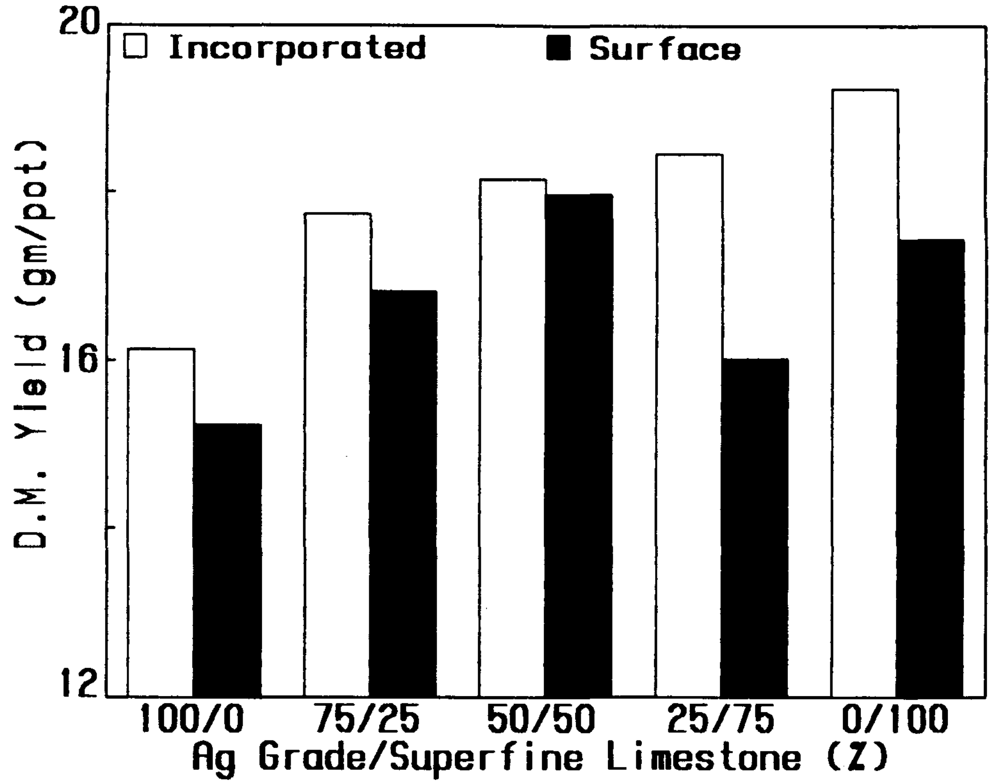

Fig. 5 Subclover response to application method of limestone combinations, Averaged Rate

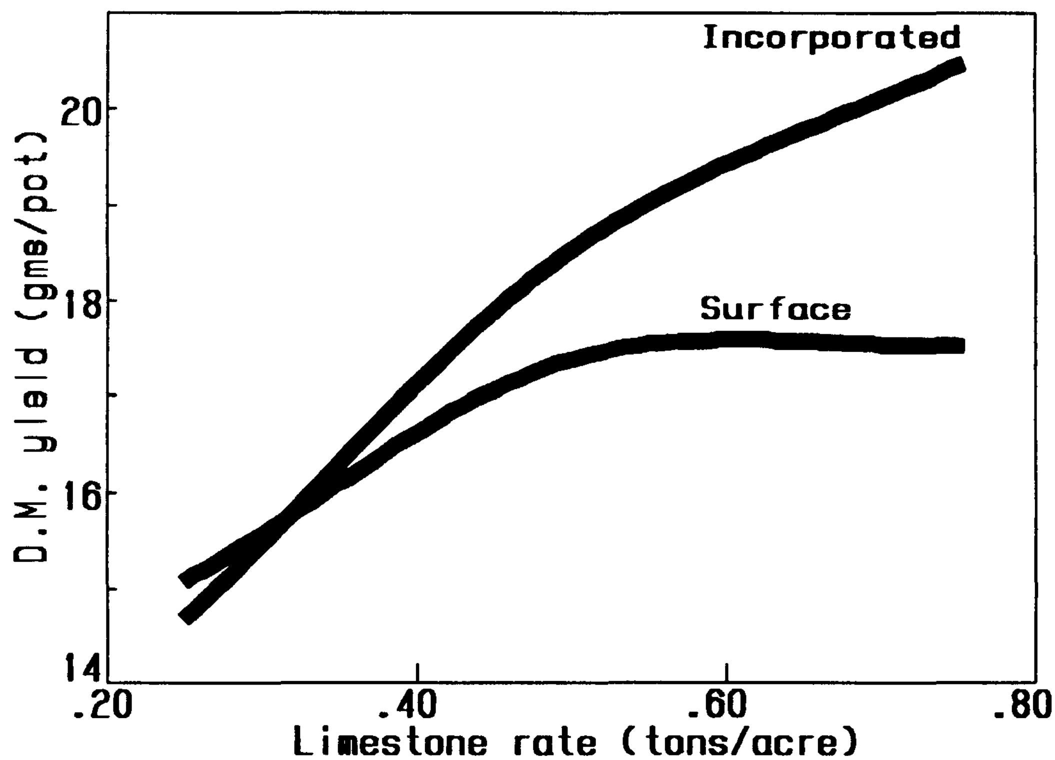

Fig. 6. Subclover response to limestone rate and method of application, combination avg.