Waste lime supplies phosphorus to sugarbeet

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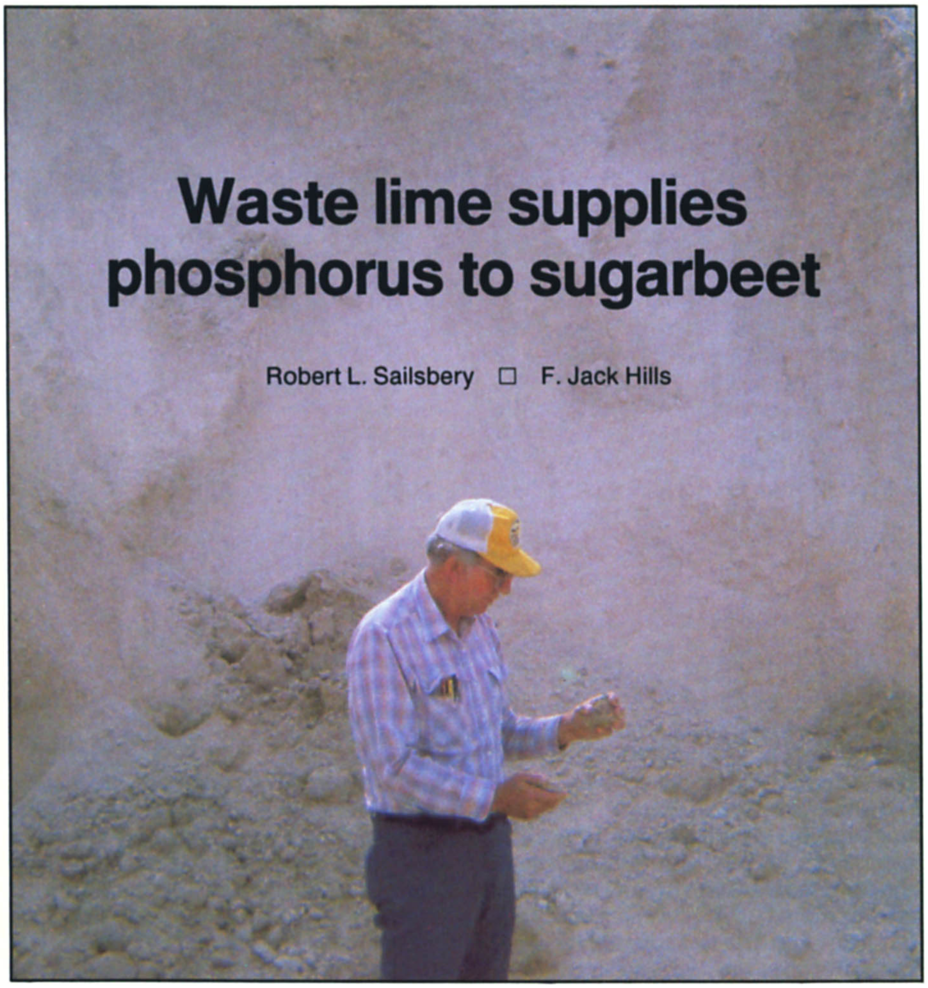

Farm Advisor Bob Sailsbery with waste lime produced as by-product of sugarbeet processing.

Sugarbeet responded as well to waste lime as to phosphorus fertilizer. The lime aided seedling emergence and yields.

Lime (calcium carbonate) is used in sugarbeet processing to aid in the removal of impurities from sugar juice. The reprecipitated lime, a waste product, is largely calcium carbonate but also contains plant nutrients extracted from beet roots. Lime is often applied to soils to decrease acidity, but most California soils are neutral to slightly alkaline and would not be expected to benefit from lime additions. Sugarbeet waste lime, however, has been applied to California soil with reported good results.

In laboratory and greenhouse experiments (*California Agriculture,* August 1959), sugarbeets responded to lime additions on soils low in phosphorus. The addition of waste lime at 10 tons per acre to clay soils also increased water infiltration and decreased the modulus of rupture, a test indicating that lime may reduce the crusting tendency of these soils.

A field trial on an acid, organic, Ryde clay loam soil in the Sacramento Delta obtained a response of 2.6 tons of beets per acre to 8.5 tons of waste lime per acre (*California Agriculture,* February 1968). A followup greenhouse experiment indicated that this response was most likely due to phosphorus supplied by the waste lime plus an increase in available nitrogen. The nitrogen increase resulted from microbial release from organic matter whose decomposition was stimulated by a decrease in soil acidity.

We report here on two trials conducted to evaluate the availability of phosphorus in sugarbeet waste lime applied to a nonacid soil low in organic matter. They were in Glenn County on a Tehama silt loam soil but in different fields. Sugarbeet planted in this soil early in the spring usually responds to phosphorus fertilization, and the soil tends to crust when it dries after being wetted for seed germination. The first trial (1975) included two high rates of waste lime and four levels of fertilization with single superphosphate. In the second trial (1976), a followup on the first, we hoped to improve our estimate of the phosphorus-supplying power of the waste lime; we used a single lower rate of lime and six levels of fertilization with treble superphosphate.

Procedures

Analyses of the waste lime used indicated that it contained 25 pounds of phosphorus pentoxide (P_2O_5) per ton in 1975 and 22 pounds in 1976. Both experiments had a split plot design, with the main plots being rates of waste lime in four randomized complete blocks. Subplots (six 26-inch rows wide by 50 feet long) received different rates of phosphorus fertilizer. All materials were broadcast by hand and mechanically incorporated into the surface soil before the fields were listed into beds for planting.

A locally adapted sugarbeet variety was planted by a precision planter that sowed the seeds approximately 6 inches apart. Seedlings emerged in mid-April in both years. The resulting stands were not thinned and, when the plants were well established (about six true leaves), they were counted to determine possible effects of the treatments on stand establishment. At that time, 10 plant tops were removed from border rows of each plot for assessment of treatment effects on early plant growth.

The 1975 trial was harvested on August 26 and the 1976 trial on November 1 (about 4.5 and 6.5 months of growth, respectively). At harvest, we took data on the plants in the center two rows of each plot.

Results

In 1975, phosphorus fertilization increased both seedling stand and vigor in the absence of lime, but did neither when lime was applied at 10 tons per acre (table 1). Lime increased seedling stand in general, but most markedly in the absence of phosphorus fertilizer. The increase in the number of seedlings when lime was applied along with the high rate of phosphorus fertilization suggests that the lime may have reduced soil crusting and thus improved emergence. Ten tons of lime per acre appeared to furnish sufficient phosphorus to maximize seedling growth.

At harvest, the effect of lime on stand was still evident. Averaged over all rates of phosphorus fertilizer, there were 123, 132, and 139 roots per 100 feet of row for 0, 5, and 10 tons of lime per acre, respectively (LSD .05 = 7). These differences in

TABLE 1. Effect of waste lime and phosphorus fertilizer on sugarbeet stand, seedling growth, and root yield

1975 trial

Fertilizer phosphorus (P_2O_5)	Waste lime, tons per acre			Waste lime, tons per acre		
	0	5	10	0	5	10
lb/acre	*Seedling stand, plants/100 ft.*			*Seedling fresh wt., g/10 plant tops*		
0	137	145	156	38	74	91
40	128	150	147	74	87	89
80	144	141	146	86	87	101
120	141	151	152	99	88	92
LSD†, 5%:	8,10			16,19		
	Marketable roots‡ 100 ft. at harvest			*Harvest root yield, tons/acre*		
0	122	129	140	31.1	34.2	33.9
40	116	133	140	32.3	33.5	34.4
80	128	132	136	34.5	34.6	35.5
120	128	135	139	33.8	34.0	34.2
LSD†, 5%:	7,10			2.0, 2.8		

1976 trial

Fertilizer phosphorus (P_2O_5)	Waste lime, tons per acre		Waste lime, tons per acre	
	0	2	0	2
lbs/acre	*Seedling stand, plants/100 ft.*		*Seedling fresh wt., g/10 plant tops*	
0	122	133	184	187
30	116	126	—§	—
60	122	137	200	207
90	120	134	—	—
120	118	137	192	208
150	126	134	—	—
Lime means:	120	133*	192	201
	Marketable roots‡ 100 ft. at harvest		*Harvest root yield, tons/acre*	
0	112	140	35.6	39.2
30	118	125	38.2	37.9
60	121	133	38.4	39.5
90	119	135	38.9	39.3
120	112	139	37.8	39.7
150	128	135	38.7	40.5
Lime means:	118	134**		
LSD†, 5%:			2.1,3.7	

*,** Difference statistically significant at the 5% and 1% levels, respectively.
† Least significant difference for P_2O_5 rates for the same and different lime rates, respectively.
‡ Roots greater than 2 inches in diameter.
§ Plots not sampled.

stand, however, probably had little effect on root yields, since it is well established that stands between 100 and 150 beets per 100 feet of row produce about equal root yields.

Root yield responded to fertilizer phosphorus when lime was not applied, but the response did not increase after the application of 80 pounds of fertilizer phosphorus per acre. When fertilizer phosphorus was not used, both 5 and 10 tons of lime increased root yield, but when fertilizer phosphorus was applied, neither lime rate produced significant root yield increases. The lack of response to fertilizer phosphorus when 5 tons of waste lime was applied is illustrated in figure 1, in which the horizontal line shows the average sugarbeet response to the 5-ton lime rate. The response curve for the effect of fertilizer phosphorus without waste lime intersects the horizontal line at about 100 pounds of fertilizer phosphorus per acre. Waste lime thus supplied about 20 pounds of fertilizer phosphorus per ton, nearly equivalent to the 25 pounds of fertilizer phosphorus it contained.

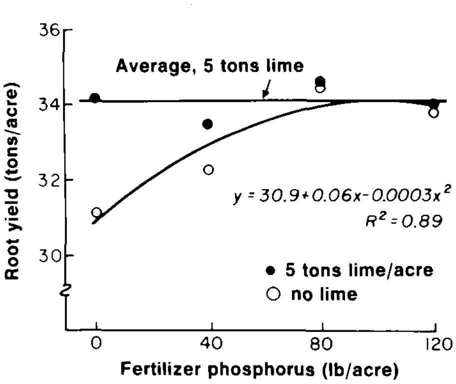

Fig. 1. Five tons of waste lime per acre increased sugarbeet root yield equivalent to 100 pounds of fertilizer phosphorus per acre.

None of the treatments had any significant effects on the sucrose content of the beet roots, which averaged 13.1 percent.

In the 1976 trial neither stand nor seedling weight showed any significant response to phosphorus fertilizer, with or without 2 tons of waste lime per acre. There was, however, a significant increase in stand from use of lime at all levels of phosphorus fertilization. This effect is best estimated by the lime means in the table. The 10 percent increase in seedling establishment due to the use of lime quite possibly could have been the result of improved soil structure making it easier for seedlings to emerge. Improved seedling survival also may have resulted from an effect of the waste lime on soil fungi or insects that frequently attack seedlings. In this trial, as well as in the 1975 trial, there were no obvious signs of such attacks.

It is doubtful that the increase in stand at harvest due to lime contributed to increased yield because, as in the 1975 trial, all stands were in a range where differential effects on root yield would not be expected. Phosphorus fertilization increased root yield when lime was not used, but the response did not increase beyond that caused by 30 pounds of phosphorus fertilizer per acre. The 2 tons of lime per acre contributed about as much to root yield as did 30 pounds of fertilizer phosphorus. The lime used in this trial contained 22 pounds of fertilizer phosphorus per ton, so the 44 pounds added in the lime performed similarly to a like amount of fertilizer phosphorus added as superphosphate.

The sugar content of the beets in this trial was considerably higher than in the previous year, averaging 17.7 percent, but again, none of the treatments had any significant effect.

Conclusions

For soils where sugarbeet is likely to respond to phosphorus fertilization, the crop should respond to broadcast applications of waste lime much as it would respond to broadcast applications of a phosphorus fertilizer containing an equivalent amount of phosphorus. When waste lime is applied as a phosphorus fertilizer, we recommend that it be analyzed for its content of acid-soluble phosphorus, since this can vary appreciably from lot to lot.

Waste lime broadcast at 2 tons or more per acre and incorporated into the surface soil may improve seedling emergence, probably because of an effect on soil tilth that allows more seedlings to break through the soil surface. Lower rates and other methods for applying lime should be investigated for improvement of seedling emergence, as should the mode of action of lime in producing this effect.

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