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The Use of Limestone in Mixed Fertilizers

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FERTILIZERS have been sold on the basis of their content of nitrogen, phosphoric acid, and potash. Studies have shown, however, that the value of a fertilizer may be influenced by its residual effects on the soil. This is of particular importance when the residual effects over a period of years are considered.

The mixed fertilizers used in the United States are, with few exceptions, acid forming in their influence on soils and their continued use without limestone makes the soil more acid and lowers its productivity. Acid-forming fertilizers are most harmful in those regions where the soils are naturally acid and sandy. This is the case in the region where fertilization is most extensively practiced, namely, the southeastern states. In this section, liming is not generally practiced and consequently the continued use of acid-forming fertilizers causes an increase in soil acidity, a depletion of soil bases, and a reduction in the productivity of the soil. Therefore, it is absolutely essential from an economic standpoint to supply the necessary limestone to prevent a decline in yields.

During recent years many changes have occurred in the composition of fertilizers. The plant food content of most of the fertilizer materials used in mixed fertilizers has been increased and many new ones, with very high concentrations of plant foods, have appeared on the market. The sources of nitrogen for mixed fertilizers have also changed with time. For instance, in 1900 approximately 71 per cent of the nitrogen in mixed fertilizers was derived from organic ammoniates and only about 6 per cent from ammonia and its salts, whereas in 1932 only 18.3 per cent of the nitrogen in mixed fertilizers was derived from organic ammoniates and 56.4 per cent from ammonia and its salts (3)[2]. It has been necessary, therefore, to raise materially the grade of fertilizer mixtures or to dilute them with sand or other fillers.

In the United States, the average fertilizer grade was raised from 14.8 to 18.5 per cent plant food between 1910 and 1932; during this period in Alabama the average grade of fertilizer was raised from 15.6 to 17.4 per cent plant food (3). Since the grade of fertilizer has not been materially raised but the plant food content of most of the fertilizer materials has been increased it is evident that more filler is required in mixed fertilizers than formerly. For example, the mixed fertilizers of the United States contained about 6.75 per cent filler in

[1]The figures regarding costs, profits, and amounts of filler given in this circular are only estimates, but they serve to illustrate the points just as well as if they were exact.

[2]Reference by number is to "Literature Cited."

1900, whereas they contained 15.17 per cent in 1931. The fertilizers are also more acid forming than formerly. The amount of ammonium sulfate used in mixed fertilizers of the United States increased from 4,120 tons in 1900 to 322,878 tons in 1931 (3). During this time many other acid-forming nitrogenous fertilizers have been used in mixed fertilizers. It is reasonable to expect that the relative amount of nitrogen in mixed fertilizers from acid-forming nitrogenous fertilizers will increase because they are cheaper. Based on prices during 1933, if a given amount of nitrogen from ammonium sulfate costs $1.00, that amount of nitrogen from organic ammoniates costs approximately $3.30. The cheaper source of nitrogen is just as efficient as the other for most crops if the acid residue which it leaves in the soil is neutralized.

Where acid-forming nitrogenous fertilizers were used over a period of years, the results of many experiments (5, 6, 7) show clearly that limestone applied on acid soils or mixed with the fertilizer increased cotton yields. These increases were from 30 to 318 pounds of seed cotton per acre, depending on the kind of soil, climatic conditions, and the period of years over which the acid-forming fertilizer had been used on a given soil. In 259 tests, Williamson (7) found that limestone mixed with a complete fertilizer increased the yield of seed cotton by an average of 49 pounds per acre. It is reasonable to expect that in future years the increases in crop yields due to limestone will be greater than those reported if the residual acidity developed by the acid-forming fertilizers is not corrected.

It is the purpose of this circular to present the results of a study which show the amount of limestone required to neutralize the acidity developed by the mixed fertilizers used in Alabama in 1933 and the desirability of neutralizing this acidity.

EXPERIMENTAL STUDY AND DISCUSSION

A number of samples of the various grades of fertilizers sold in Alabama, during the 1933 fertilizer season, was secured from the Control Laboratory and the acidities or basicities of the samples were determined by the method described by Pierre (4). The number of tons of each grade of fertilizer sold in the State was obtained from the report of Gist (1).

Acidity of Mixed Fertilizers

The results of the study are presented in Table 1. It may be seen that the mixed fertilizers sold in Alabama during 1933 would have required 25,546 tons of limestone to neutralize the acidity developed by them. To move this quantity of limestone would have required approximately 21 trains, with 40 cars per train and 30 tons per car. The limestone requirement was

TABLE 1.—Limestone required to neutralize the residual acidity of mixed fertilizers in Alabama during 1933.

Formulae N-P_2O_5-K_2O	Number samples[1]	Pounds limestone required per ton fertilizer[3]		Number tons fertilizer used	Total limestone required for mixed fertilizers
		Range	Average		
Per cent					Tons
0 -12-4	3	50B- 40A	28A	1,349	19
2.06-11-3	20	33A-180A	158A	25,084	1,981
2.5 -10-4	9[2]	147B-232A	40A	7,282	145
3 - 8-5	32	240B-377A	131A	99,528	6,469
3 -10-3	27	150B-242A	215A	36,143	3,885
4 - 8-4	19	200B-393A	230A	60,148	6,917
4 -10-4	21	27B-323A	279A	20,499	2,859
4 -10-7	10	128A-350A	291A	3,776	549
4 -12-4	9	226A-405A	335A	1,888	316
5 -15-5	4	438A-499A	472A	539	127
Miscellaneous	25	180B-937A	338A	13,486	2,279
Total	179	—— ——	189[4]	269,722	25,546

[1]Where less than 10 samples were used—no more were available.
[2]1932 samples—none available for 1933.
[3]"B" following figure refers to equivalent basicity and "A" to equivalent acidity.
[4]Average amount of limestone per ton of fertilizer.

probably less than that required by the mixed fertilizers used in any year since 1924. It may be seen that the limestone requirements of the various grades of fertilizers increased when the nitrogen content of the fertilizers increased. Based on the amount of ammonium sulfate which probably went into mixed fertilizers in 1933, the actual limestone requirement would have been approximately 35,578 tons if no limestone or other basic materials had been added to the fertilizers. Thus it will be seen that approximately 10,000 tons of limestone or its equivalent were probably used with the fertilizers during the 1933 fertilizer season.

Fillers in Mixed Fertilizers

It is estimated that in 1933 approximately 40,000 tons of filler were used in Alabama if the mixed fertilizers were made from the materials indicated in Table 2. This means that approximately 30,000 tons of sand as a filler must have been placed in the fertilizers of the State, since about 10,000 tons of limestone or its equivalent were used. This amount of sand represents about 11.3 per cent of the weight of the mixed fertilizers or 226 pounds per ton. No one would argue that this sand was beneficial to crops, yet delivered to the mixing plants it cost the fertilizer dealers more than $30,000. After the sand was mixed with the fertilizers, it acquired the fertilizer freight rate. At $3.00 per ton, the freight alone on the sand after it was mixed with the fertilizer amounted to $90,000. Furthermore, this sand required about 304,510 shipping bags

TABLE 2.—Estimated amounts of various fertilizer carriers required for the mixed fertilizers used in Alabama during 1933.

Ingredients	Tons
Superphosphate[1]	134,562
Ammonium sulfate[2]	29,649
Calcium cyanamid[3]	5,920
Organic ammoniates[3]	13,024
Muriate of potash[4]	6,748
Manure salts[5]	39,368
Total fertilizer ingredients	229,271
Filler	40,451
Total mixed fertilizers	269,722

[1]It is calculated that all of the phosphate in mixed goods was derived from superphosphate or ammoniated superphosphate.
[2]This material probably supplied 70 per cent of the nitrogen in mixed fertilizers.
[3]Supplies probably 15 per cent of the nitrogen in mixed fertilizers.
[4]Supplies probably 30 per cent of the potash in mixed fertilizers.
[5]Supplies probably 70 per cent of the potash in mixed fertilizers.

which, at 12 cents each, cost $36,000. Together these items total $156,000, all of which is added to the cost of fertilizers to the farmer. In addition to this expense, the filler had to be handled and hauled by the fertilizer companies and by the farmers—a heavy expense for an article as useless as sand.

The cost items mentioned above are not the only factors affecting the ultimate loss in money to the farmer. The use of sand rather than limestone as a filler has probably meant the annual loss of approximately 50 pounds of seed cotton per acre on the 3,000,000 acres of acid soils in Alabama, which would have a total value of $4,500,000, assuming that the increase from limestone in the fertilizer would be as great when a small amount of fertilizer is used per acre as when a large amount is used. A continued decrease in the yield of cotton will undoubtedly result if the use of sand is continued as the principal filler. On the other hand, if sufficient limestone is added to produce non-acid-forming fertilizers then the farmer will be assured that these fertilizers will not further reduce the productivity of the soil.

If limestone is used in the fertilizer mixture to the extent of neutralizing the residual effect of the fertilizer, the organic ammoniates which are used in fertilizers can be replaced by ammonium sulfate or some other cheap acid-forming nitrogenous fertilizer without decreasing the efficiency of the fertilizer mixture. It is estimated that about 15 per cent of the nitrogen used in mixed fertilizers of Alabama during 1933 was derived from organic ammoniates at a cost of about $461,250; this amount of nitrogen could have been derived from ammonium sulfate at a cost of approximately $139,773. To correct the acidity developed from this quantity of ammonium sulfate about $22,881 worth of limestone would be required.

The difference in the cost of these materials if passed on to the farmer would represent an annual saving of about $298,596. It is recognized that the substitution of ammonium sulfate for all of the nitrogen from organic ammoniates might introduce certain problems concerning the physical properties of the mixture but these could probably be overcome.

Most of the sand which is used as a filler for fertilizers should be replaced by limestone. The form of limestone should be dolomite if the use of the present official method for available phosphoric acid is to be continued in the Control Laboratory. MacIntire and Shuey (2) have shown that in the course of testing a fertilizer for available phosphoric acid the high calcic limestones revert phosphate. Since the cost of handling, mixing, bags, and transportation after mixing with the fertilizer is the same, the only additional cost involved in the use of dolomite instead of sand would be the difference between the cost of this limestone and the sand to the fertilizer mixer. This difference at present prices should not be over $2.00 per ton, which would amount approximately to 20 cents worth of limestone per ton of fertilizer in addition to the usual charges.

If 300 pounds of this fertilizer are used per acre, limestone as a filler sufficient to neutralize the acidity of the fertilizer would cost only about 6 cents per acre more than the same quantity of sand which is now used. Then this fertilizer mixture could be used on an acid soil for an indefinite period without further injurious effects on the soil and at the same time it would produce more cotton than the same fertilizer without the limestone.

SUMMARY

The present tendency in the manufacture of fertilizers is in the direction of the substitution of lower priced materials largely consisting of salts of ammonia for the more costly organic ammoniates. The materials replacing the organic ammoniates contain a higher percentage of plant food and when used for a period of years on the acid soils of the southeastern states develop a residual acidity in the soil and result in lower yields of crops.

In the manufacture of mixed fertilizers, increased amounts of sand as a filler have followed the increased use of high-analysis materials. The cost of the sand in fertilizers to the farmers of Alabama, in 1933, amounted to $156,000.

Experiments are cited which show that the incorporation of limestone with the fertilizer (to the extent of neutralizing the acids developed) resulted in an increase of approximately 50 pounds of seed cotton per acre.

Results are given showing that most of the mixed fertilizers sold in Alabama during 1933 were acid forming. For these

fertilizers, the limestone requirement was 25,546 tons. The limestone requirement of the high-grade fertilizers was greater than that of low-grade fertilizers.

Figures are given which show that for about $80,000, limestone might replace sand as a filler in mixed fertilizers which would result in an increase in the value of the cotton crop produced in Alabama by approximately $4,500,000 per year.

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