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The effect of Liming Acid soils on the yield and composition of Groundnut crop *

by

G. V. KOTHANDARAMAN[1] and A. MARIAKULANDAI[2]

Synopsis: A pot culture experiment was laid out with the acid soil of Nanjanad, Nilgiris district to determine the effect of lime on the yield and composition of groundnut. The growth and yield of groundnut haulms, pods and kernels were found to be increased by the application of lime alone at 7000 lb. per acre and in combination with superphosphate at 60 lb. P_2O_5 per acre. Both the calcium and phosphorus content of the crop were also increased by the application of lime and superphosphate. The CaO/P_2O_5 ratio in the crop increases as the crop approaches maturity and the ratio in the groundnut kernel is very low as compared to groundnut haulms and shells.

Introduction: Earlier work has clearly brought out that liming not only changes the pH of the soil but also adds to the nutrient in supplying calcium and magnesium to the soil. Liming may also reduce the plant uptake of other basic ions by competing with them for absorption. Since calcium as a nutrient is found in abundance in normal soils, it is usually considered adequate for normal requirements of most of the crops. Consequently, liming is done only when the soil becomes too acid to grow crops. However calcium has become important as one of the essential nutrients because of its influence over other nutrient elements indirectly apart from its direct effect. The very common association of phosphorous with calcium in nature and greater effectiveness of the former as fertilizer in conjunction with liming suggests possible effects of calcium on the mobilisation of phosphorus in the crops. Numerous investigators have reported that lime influences the mineral and protein content of the crops. But further information is needed to know whether it acts as direct nutrient or as an indirect influence in the uptake of other nutrients and in mineral and protein content of the crop.

Groundnut being a legume has high feeding power for assimilating calcium and therefore this crop was used in this study to find out the liming in chemical composition of groundnut when grown in acid soil.

Review of Literature: Liming materials are used for the correction of soil acidity and they also affect the solubility and availability of nutrient ions. Albrecht (1932) stated that the principal benefit from liming acid soil comes from calcium as nutrient for the plants. Albrecht and Smith (1939) considered the condition of soil acidity to be due to nutrient deficiency and that calcium is a

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1. Assistant Lecturer in Chemistry and 2. Professor of Agronomy, Agricultural College & Research Institute, Coimbatore-3.

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prominent one of these deficiencies. Chambers and Garden (1951) suggested that the effect of liming on yield can be attributed not only to the reduction of soil acidity but also the increased supply of calcium. Colwell and Brady (1945) showed that calcium is an important factor in the nutrition of groundnut. They also reported that the soil must be well supplied with calcium for the production of yield of groundnut. Brady (1947) increased the yield of groundnut, by applying calcium to the fruiting medium after gynophores reached the soils.

According to Strabss and Gizzard (1948) the percentage of calcium saturation of exchangeable complex was correlated with the average weight of nut produced by the plant. Calcium - Magnesium ratio of the soil content was also correlated with the number of nuts found per plant. According to Colwell and others (1945) calcium content of groundnut shell reflects the calcium applied to the groundnut fruit. Bledsoe and others (1949) by studying the calcium nutrition reported that radio-active calcium Ca^{45} administered to the roots was detected after three hours in all vegetative portions of the groundnut plant and most prominently in the stem. It was also found that it does not move freely in the gynophore from the remainder of plant, and that gynophores have their own absorption from the soil.

As stated earlier, since phosphorus nutrition is related to calcium in the soil availability, phosphorus in the soil is influenced by the liming of acid soils. Hilgard (1907) stressed the highly favourable influence of lime on the availability of soil phosphorus. Naftel (1937) reported that the readily soluble phosphorus was more than doubled by adding lime. Birch (1951) reported that phosphate response was found to be very significant and inversely related to the exchange calcium.

Thus a few data that are available on the effect of liming on the absorption of fertilizer phosphorus by crops are inconclusive and very little work has been done on growing groundnut in acid soils and the effect of liming on the composition of the groundnut crop. Hence the present problem was taken up for study with the object of finding out the effect of liming alone and in combination with superphosphate on (1) growth and yield of groundnut crop; and (2) on the availability of calcium and phosphorus and their utilisation by groundnut crop grown on acid soil.

Materials and Methods: The soil taken up for the study was acid soil collected from the Agricultural Research Station, Nanjanad with a pH of 4·5. Groundnut TMV 2, which is a bunch variety with a short duration of three to four months, was grown for the study in pots. A basal dressing of FYM 5 tons per acre with fertilizers at 15 lb. N per acre in the form of ammonium sulphate, 50 lb. potash in the the form of potassium sulphate were applied to the soil. Lime in the form of well powdered limestone sieved through a fine mesh (containing 56% CaO) was applied a fortnight before the date of sowing. The phosphorus was applied in the form of superphosphate at the time of sowing the crop. The following were the treatments.

(1) No lime (Control)
(2) Lime 3500 lb. per acre
(3) Lime 7000 lb. per acre
(4) P_2O_5 30 lb. per acre (superphosphate)
(5) P_2O_5 60 lb. per acre (superphosphate)
(6) Lime 3500 lb. and P_2O_5 30 lb. per acre
(7) Lime 3500 lb. and P_2O_5 60 lb. per acre
(8) Lime 7000 lb. and P_2O_5 30 lb. per acre
(9) Lime 7000 lb. and P_2O_5 60 lb. per acre

The treatments were replicated four times and the crop was sown on 3—9—1959. The growth measurements were recorded and periodical plant samples were collected and anlysed for CaO and P_2O_5. The crop was harvested during the first week of January 1960 and the pods were separated from the plants. The weights of dried groundnut haulms and pods were recorded separately. The pods were also shelled and weighed. The weight of groundnut kernels were also recorded. The dried plant samples were analysed for CaO and P_2O_5.

Results: *Yield:* The average yield data of the dry groundnut haulms, pods and kernels are presented in Table No. I. From this, it is evident that the yield of groundnut is increased by the application of lime at 7000 lb. alone or in combination with super phosphate. The yield of groundnut haulms is increased by 11% over the unlimed pots. By application of lime at 7000 lb. per acre, the yield of pods and the kernels has also increased in appreciable amounts over the control, that is, by nearly 43%. The phosphatic treatments by themselves do not show any appreciable increase in the yield of groundnut pods or kernels.

TABLE I.

Average dry weight of groundnut haulms, pods and kernels (on 3 plant basis per pot)

S. No.	Treatment	Weight of groundnut haulms in gms.	Weight of groundnut pods in gms.	Weight of groundnut kernels in gms.
1.	No lime (Control)	10·25	2·00	1·49
2.	Lime 3500 lb./acre	10·50	2·13	1·53
3.	Lime 7000 lb./acre	11·50	3·50	2·63
4.	P_2O_5 30 lb./acre	10·50	2·38	1·77
5.	P_2O_5 60 lb./acre	11·00	1·75	1·23
6.	Lime 3500 lb. + P_2O_5 30 lb.	0·75	2·38	1·70
7.	Lime 3500 lb. + P_2O_5 60 lb.	10·90	2·00	1·55
8.	Lime 7000 lb. + P_2O_5 30 lb.	11·30	2·43	1·75
9.	Lime 7000 lb. + P_2O_5 60 lb.	11·50	3·40	2·58

Calcium uptake: The calcium content of groundnut haulms, shells and kernels is given in Table No. II. It can be seen from the table that the calcium content is increased by the application of lime at different doses alone and in combination with phosphate. During the vegetative period of growth, calcium content of the plant is increased from 2·23 to 2·53 per cent by the application of lime of 7000 lb. with phosphate and 2·23 to 2·78 per cent by the application of lime alone. Calcium content is increased more from 2·58 to 40·4 per cent during the flowering period and from 3·44 to 4·34 per cent during the harvest period by the application of lime with phosphate. But in all the three periods, no marked increase of calcium content is obtained in the phosphate alone treatments. It can be seen from the table that the calcium content of the plants increases gradually in all the treatments as the plant approaches maturity. Calcium content of groundnut shells is also increased from 1·92 to 2·37 per cent by the application of lime alone at 7000 lb. and in combination with phosphate. There is not much of difference in the calcium content of the groundnut kernel due to treatments. The calcium content of the kernel is very low in comparison to the shells and haulms. The total uptake of calcium by the groundnut haulms is also increased due to liming.

TABLE II.

Calcium content of the crop in percentage (on oven dry basis)

Sl. No.	Treatments	Groundnut haulms			Groundnut shells	Groundnut kernels
		Vegetative Period	Flowering Period	Harvest Period		
1.	No lime (Control)	2·23	2·58	3·44	1·91	0·72
2.	Lime 3500 lb./acre	2·78	2·79	3·65	2·33	0·76
3.	Lime 7000 lb./acre	2·72	3·17	4·44	2·37	0·74
4.	P_2O_5 30 lb./acre	2·26	2·63	4·10	1·77	0·64
5.	P_2O_5 60 lb./acre	1·97	3·69	3·32	2·06	0·61
6.	Lime 3500 lb. + P_2O_5 30 lb.	2·00	3·32	4·10	19·1	0·60
7.	Lime 3500 lb. + P_2O_5 60 lb.	2·85	2·82	3·96	2·18	0·53
8.	Lime 7000 lb. + P_2O_5 30 lb.	3·45	3·34	3·93	2·28	0·64
9.	Lime 7000 lb. + P_2O_5 60 lb.	3·53	4·04	4·34	2·37	0·67

Phosphorus uptake: The phosphorus content of groundnut haulms, shells and kernels is given in Table No. III. It is clearly seen from the table that the phosphate content of the plants have increased by the application of lime with and without phosphorus during the vegetative period of the growth, maximum uptake of phosphorus (viz. 0.87% P_2O_5) is obtained in the lime at 7000 lb. per acre with phosphate treated plants. In the flowering period and harvest period

also phosphorus content of plants is increased from 0·47 to 0·71 per cent and 0·45 to 0·51 per cent P_2O_5 respectively by the application of lime and phosphates. It is also seen that high phosphorus content is found in plants in the early stages of growth with lower content at later stages of growth. It is indicated that the phosphorus content of plant decreases as the plant develops maturity. There is not much of difference found in the phosphorus in the shells and kernels due to the treatments. The phosphorus content of kernels is very high as compared to the groundnut haulms and shells. The total uptake of phosphorus by the groundnut haulms is also increased due to liming.

TABLE III.

Phosphorus content of crops in percentage (on oven dry basis)

S. No.	Treatments	Groundnut haulms			Ground-nut shells	Ground-nut kernels
		Vegeta-tive period	Flower-ing period	Harvest period		
1.	No lime (control)	0·70	0·47	0·45	0·43	1·20
2.	Lime 3500 lb./acre	0·76	0·48	0·40	0·43	1·17
3.	Lime 7000 lb./acre	0·80	0·57	0·51	0·33	1·22
4.	P_2O_5 30 lb./acre	0·77	0·48	0·39	0·38	1·24
5.	P_2O_5 60 lb./acre	0·79	0·63	0·40	0·60	1·20
6.	Lime 3500 lb. + P_2O_5 30 lb.	0·61	0·67	0·44	0·49	1·19
7.	Lime 3500 lb. + P_2O_5 60 lb.	0·65	0·63	0·46	0·42	1·01
8.	Lime 7000 lb. + P_2O_5 30 lb.	0·87	0·65	0·42	0·45	1·27
9.	Lime 7000 lb. + P_2O_5 60 lb.	0·81	0·71	0·50	0·47	1·29

Discussion and Conclusion: Some workers stated that the direct effect of phosphorus availability produced by liming an acid soil is probably less than the indirect effect produced by creating more effective conditions for increased decomposition of plant residues and improved micro-organism activity. The increase in total phosphorus in the crop where lime is used as a supplement to phosphate indicates the beneficial effect of liming in mobilising the phosphorus for absorption by the crop. The liming of acid soils to a pH near the neutral point will promote the availability of both soil phosphorus and fertilizer phosphorus. The results indicated that the groundnut grown on acid soils shows good response to the application of lime with or without phosphates. Several investigators attributed the poor growth of plants in the acid soils to the presence of toxic quantities of aluminium, manganese and iron. According to Schmehl and others (1950), the beneficial effect of liming can be attributed to a decrease in concentration of aluminium, manganese and iron in soil solution. On the other hand the results of Colwell and Brady (1945) showed that the poor growth in acid

soil may be due to deficiency in calcium itself. As already stated, calcium functions in dual manner: (1) it corrects the soil acidity and produces a favourable reaction for the growth of the plant; (2) it supplies calcium which is needed for the nutrition of crops. The results of this experiment confirm the findings of the previous workers that calcium is important for increasing the yield of groundnut pods.

Numerous investigators have also shown that liming acid soil increased the calcium content of the plant. The nutrition of the groundnut plant is peculiar in that its calcium requirements is high at the time of fruit production. Calcium does not seem to move freely to the gynophores from the rest of the plant but has to be observed by the gynophores as it develops. Lime application in this experiment was found to increase calcium content of groundnut shells and this is in line with the findings of Colwell (1945) wherein it has been stated that calcium content of the shell reflects differences in calcium supply to the groundnut. With regard to phosphorus according to Truog (1953) the availability has increased due to the action of lime in breaking up the complexes of iron and aluminium phosphates which are predominant in these acid soils. Liming helps to keep the phosphate largely in the form of calcium phosphate which has more uniform and continued availability. The increase in total phosphorus in the crop where lime is used as a supplement to phosphate indicates the beneficial effect of liming in mobilising the application of phosphorus for absorption by the crop. The liming of soil to a pH near the neutral point will promote availability of both soil phosphorus and fertilizer phosphorus. In the experiment, it is found that the phosphorus content is high in the early stages of crop growth and low in the mature crop. The phosphorus content of the plants gradually decreases as the plant requires more phosphorus for normal growth in early stages and less during the latter stages. The CaO/P_2O_5 ratio in the crop increases as the crop approaches maturity. This is possible due to the increase in calcium content as the crop becomes mature, when the content of phosphorus varies inversely. The CaO/P_2O_5 ratio in the groundnut kernel is very low as compared to groundnut haulms and shells. This indicates that phosphorus is more concentrated in kernel unlike calcium.

Summary: A replicated and randomised pot culture experiment was laid out with acid soil of Nanjanad in Nilgiris district to determine the effect of lime on the yield and composition of groundnut. For the composition only calcium and phosphorus content of the crop were assessed. The growth and yield of groundnut haulms, pods and kernels were found to be increased by the application of lime alone and in combination with superphosphate. But no marked increase was found in the phosphate treated plots. The pH of the soil was raised from 4·5 to 6·1 by the application of lime at 7000 lb. alone and in combination with superphosphate. Liming with soil increased the percentage of calcium content in the crop especially in the groundnut haulms. Calcium content of the plant increased as the crop approached maturity. The total uptake of calcium was also increased by liming. Lime alone and in combination with

superphosphate increased the percentage of phosphorus content in the plant and the total uptake of phosphorus of the plant. The phosphorus content in the kernels was found to be high as compared to the haulms and shells. The phosphorus content of the crop decreased as the plant approached maturity. From the results obtained there were clear indications to show that the direct effect of liming was to correct the pH and indirectly to make the phosphate availability better. The CaO/P_2O_5 ratio was found to increase as the plants neared maturity and the ratio was found to be low in the kernels as compared to that of groundnut haulms and shells.

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