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Availability of Plant Nutrient Elements in Soils as Influenced by Application of Potassium and Calcium

B. HABEEBULLAH,[1] G. RAMANATHAN,[2] S. LOGANATHAN[3] and K. K. KRISHNAMOORTHY[4]

A pot experiment was conducted to study the influence of calcium and potassium on nutrient availability in soils. Calcium was applied in two forms and at two levels and potassium at four levels in two soils viz., alluvial and red soils with groundnut as test crop. The study revealed that of the two soils, alluvial soil had greater availability of P, K, Ca and Mg than red soil. The interactions were observed to be favourable in certain instances and antagonistic in others between the soil nutrients and applied K and Ca. As for instance, available P in alluvial soil was significantly increased by gypsum treatment. Available Ca registered an increase after flowering stage and a sharp decline at post harvest stage, indicating the utilisation of Ca for fructification and this implied that increased availability of Ca at this juncture would possibly lead to greater utilisation and crop yield.

The oil production in India is far below the requirement and a break-through in oil production has been felt to be a dire need on lines similar to green revolution in cereals and millets. Efficient utilisation of applied fertilisers is one of the means of achieving the goal apart from evolving better varieties with high yield potential and improved cultural practices. Groundnut, an important source of oil production has been described as an unpredictable legume due to its varying responses to applied nutrients in different soils and under different agroclimatic regions. Reports on the crop response in India are varied and sometimes conflicting. The differential behaviour is possibly due to the interaction of the applied nutrients within themselves and with the soils. Work on the combined effect of Ca and K on groundnut is rather limited in Tamil Nadu though such studies are numerous and reported elsewhere in other countries. It is, therefore, pertinent to study the combined effects of Ca and K on nutrient availability which in turn influences the yield, uptake and quality of the produce.

MATERIALS AND METHODS

A pot experiment was conducted with POL 1 variety of groundnut as test crop in two soil types, one representing red soil collected from Pollachi and the other, alluvial soil from Noyyal river basin at Perur. Calcium was applied in two forms as gypsum and as calcium carbonate at two levels, O and 200 kg CaO/ha. Potassium was applied at four levels O (K_0), 50 (K_1), 100 (K_2) and 150 (K_3) kg K_2O/ha as potassium chloride. The rates of FYM, N and P were common for all the

1-4: Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641003

treatments; FYM at 5 tons, N at 35 and P at 70 kg P_2O_5/ha. There were 12 treatments replicated twice for each soil. Each pot contained 50 kg of air-dried soil, mixed with calculated quantities of fertilisers according to the treatments. Irrigation was uniform with constant quantity of water for all treatments. Besides initial soil samples, periodical soil samples collected at four stages *viz.*, presowing, vegetative, flowering and post-harvest stages were analysed for available N, P, K, Ca and Mg. Available N was estimated by alkaline permanganate method, available P by Olsen's method, available K by ammonium acetate extraction followed by determination with flame photometry, available Ca and Mg from ammonium acetate extraction followed by versenate titration method. The data obtained were subjected to statistical scrutiny, carrying out the analysis of variance to determine the effect of treatments on nutrient availability at various stages in the two soils.

RESULTS AND DISCUSSION

The data on soil analysis and the results of statistical analysis are given in Table.

1. **Available nitrogen** (Table): Calcium application to red soil through

TABLE. Available nutrient status at different stages of crop growth (Ranges of values in ppm)

Available Nutrients	Pre-sowing stage		Vegetative stage		Flowering stage		Post-harvest stage	
	Alluvial	Red	Alluvial	Red	Alluvial	Red	Alluvial	Red
Nitrogen	99-10	102-116	480-90	91-96	104-119	122-133	90-96	88-97
Phosphorus	41.0-44.6	31.2-37.0	18.9-210	13.7-15.2	25 4-28.6	15.1-19.4	24.0-31.8	16.8-23.8
K	435-650	167-375	298-422	142-257	285-380	132-190	305-403	138-193
Ca	1100-1580	700-980	1180-1820	820-1260	1660-2440	1140-1380	1420-1720	1140-13020
Mg	300-408	156-216	312-372	192-348	312-564	348-384	432-516	252-288

	C. D. (P=0.05)
1. Available nitrogen in soil	
Comparison of soils	1.50
Comparison of stages	2.36
2. Available phosphorus in soil	
Comparison of soils	0.35
Comparison of stages	0.55
Comparison of calcium forms	0.42
3. Available potassium in soil	
Comparison of soils	6.60
Comparison of stages	10.42
Comparison of potassium	9.31
Comparison of calcium	8.20
4. Available calcium in soil	
Comparison of soils	0.08
Comparison of stages	0.127
Comparison of potassium	0.114
Comparison of calcium	0.097
5. Available magnesium in soil	
Comparison of soils	11.4
Comparison of stages	18.0
Comparison of calcium	13.9

gypsum and calcium carbonate resulted in increased contents of available nitrogen. However, the effect of calcium was not markedly pronounced, since the values on available nitrogen for Ca and no Ca treatments tended to be on par though the absolute values of available N content for calcium-treated pots were slightly greater than the control. Considering the various stages, it was observed that availability of N was maximum at flowering stage and minimum at vegetative stage, probably due to the higher rate of absorption and uptake of N by the young growing plants at vegetative stage. The available N status gradually increased during the flowering stage due to enhanced microbial activity and mineralisation of N. Since there was continued removal by the seed crop, it decreased again at the post harvest stage. Russell (1963) stated that leguminous crops raised the N levels of the soil, but in the seed crops like peas, beans, soybeans and groundnut, the fixed N was, however, utilised by the plant itself, with consequent negligible effect on soil N.

1. Available Phosphorus : Availability of P was decreased by gypsum application. Available P content registered a low value in alluvial soil receiving Ca as $CaSO_4$. Reduced availability of P in gypsum-treated alluvial soil was possibly due to the formation of fairly insoluble phosphate reaction product in soils in the presence of calcium. Calcium carbonate, because of its insoluble nature, did not produce the same effect as gypsum. The data further showed that there was distinct difference due to soils, the alluvial soil recording higher values of available P than red soil at all the four stages. Initial analysis of the two original soils used for the pot experiment also showed that alluvial soil contained a fairly high proportion of available P (7.6 ppm) as compared to red soil (1.6 ppm). This difference noticed in the beginning was maintained throughout at all stages of crop growth. The higher available P content in alluvial soil could be explained partly due to the higher proportion of sodium content in alluvial soil than in red soil. As a result, the interaction between Ca and P might have been restricted to a minimum and hence the greater P availability in alluvial soil. It was also noted that the red soils on the contrary contained higher amounts of hydrated iron and aluminium oxides in various forms tending to lower the P availability.

Comparison of the stages showed that available P was highest at presowing stage possibly due to the receipt of fertiliser P and at vegetative stage, the values were lowest and this represented the utilisation of P by the crop at early stage and perhaps a part of it could have been fixed in unavailable forms. The available P was again on the increase at flowerieg and post-harvest stages. This also conformed to the generally observed trend of utilisation of nearly two thirds of P requirement at the early stage and the resulting increase in available P content in soil at the later stage, when the P uptake by the crop was substantially reduced.

3. **Available Potassium:** Available K content in soil increased significantly with graded doses of K. The increase was 25 ppm for the first dose of K over no K, 19 ppm for the second dose over the first dose and 11 ppm for the third dose over the second dose. This observation was in agreement with the work of Bhide and Motiramani (1964). The effect of Ca on the availability of K was also distinctly manifested. The availability of K was depressed when applied along with Ca. It could be observed that available K content for no Ca treatment was 304 ppm, it was 276 for gypsum application and 289 for application of calcium carbonate. Gypsum, which had relatively higher solubility than calcium carbonate, lowered the availability of K to a greater extent. The antagonistic effect observed between Ca and K was in line with the earlier findings of Misra and Harisankar (1971) and Loganathan (1973).

Available K was much greater in alluvial soil than in red soil at all stages. The available K content decreased from the pre-sowing stage to the vegetative stage in both the soils but the rate of decrease was far greater in alluvial soil. Comparing the flowering and post-harvest stages, the decrease of available K was 195 ppm for alluvial soil and 110 ppm for red soil. The decrease in available K could not be entirely due to the plant uptake, as it was also shown in the studies that K uptake by plants in red soil was even greater than that in alluvial soil. Hence the reduced availability of K in a far greater proportion in the alluvial soil appeared to be due to greater amounts of K fixation in alluvial soil. Further, the alluvial soil contained the 2 : 1 type of clay mineral as reported by several workers, while the red soil was predominant in kaolinite type of clay in most instances. K fixation has been largely attributed to the nature of clay mineral (Grewal and Kanwar, 1967, Misra; Harisankar 1971). It was even probable that besides clay, silt also fixed some amounts of K (Karim and Malek, 1957).

4. **Available calcium:** The available Ca content in soils showed a general trend of higher values of available Ca in calcium treated pots in both the forms of Ca application and in both the soils. However, the difference in available Ca content between Ca treatment and no calcium treatment was not wide. This phenomenon has been due to and was probably associated with the initial available Ca content in both the soils.

There was a marked difference in available Ca content in relation to soil groups, the alluvial soil containing higher available Ca than the red soil at all the four stages of crop growth. Available Ca content of the soils also registered an increase up to the flowering stage in both Ca treatment and no calcium treatment and at post-harvest stage, there was sharp decline. This reduction observed at post-harvest stage was evidently due to the utilisation of Ca by groundnut for fruit development. Calcium was known to be directly absorbed by the developing pods. Mizuno (1961) reported that the best time of application of Ca to groundnut was 10 to 13 days after the gynophores reached the sand. Further, the absorption and translocation of mineral elements from the fruit medium was also reported by Burkhart and Collins (1942) and calcium had a great influence on the fructification of groundnut according to Bolhuis and Stubbs (1955). The above reports brought out the utilisation of Ca by the developing pods and the same was observed in the present study.

5. **Available magnesium**: Available Mg content was also lowered by the graded doses of K in the alluvial soils, but it was not uniform in red soil. The antagonism of K with Mg was manifest. Knoblauch and Odland (1934) explaining the antagonism between the two in acid soils pointed out that the available Mg in soil was displaced by K and washed out; K rendered the uptake of Mg more difficult by the plant. Present findings corroborated the above views. Apart from the effect of K, Ca application in both the forms also appeared to have subdued the availability of Mg. The antagonistic effect between Mg and Ca has also been reported by several workers in other crops. Available Mg was great in alluvial soil than red soil at all stages of crop growth and this trend of variation was very similar to available Ca.

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REFERENCES

BHIDE, V. K. and D. P. MOTIRAMANI. 1964. Effect of fertilisers on available potassium in soils of Madhya Pradesh. *J. Indian Soc. soil Sci.* **12**: 37-41.

BOLHUIS, G. G. and R. W. STUBBS. 1955. The influence of calcium and other elements on the fructification of the peanut in connection with the absorption capacity of its gynophores. *Netherland J. agric. Sci.* **3**: 220-36.

BURKHART, L. and E. R. COLLINS. 1942. Mineral nutrition in peanut plant growth. *Soil Sci. Soc. Amer. Proc.* **6**: 272-80.

GREWAL, J. S. and J. S. KANWAR. 1967. Potassium fixation in some soils of Punjab, Haryana and Himachal. *J. Indian Soc. Soil Sci.* **15**: 237-44.

KARIM, A. Q. M. B. and M. A. MALEK. 1957. Potassium fixation in East Pakistan soils under diffferent conditions. *Soil Sci.* **83**: 229-38.

KNOBLAUCH, H. and T. ODLAND. 1934. *J. Amer. Soc. Agron.* **26**: 609-15.

LOGANATHAN, S. 1973. *Studies on certain aspect of calcium in the soils of South India* Unpub. Ph.D. thesis. Tamil Nadu Agricultural Univ.

MISRA, R. V. and HARISANKAR. 1971. Potassium fixation and the fate of applied potassium in Uttar Pradesh soils. *Indian J. agric. Sci.* **41**: 238-46.

MIZUNO, S. 1961. Physiological studies on the fructification of groundnut. The influence of calcium deficiency in rooting zone on growth, fruiting characteristics and chemical composition of plants. *Soils and Fert.* (Abst.) **25**: 248. 1962.

RUSSELL, E. W. 1963. *Soil conditions and plant growth*. Longmans Green and Co. Ltd., London 688 pp.