Return per rupee invested on water and N was high during summer than in SWM. Thus during summer, for profitable use of water, higher dose of N should be applied compared to SWM season. From the data, it could to suggested that a higher application of N need be done for profitable use of water when the availability of water is not so abundant.

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CALCIUM CONCENTRATION IN DIFFERENT PARTS OF GROUNDNUT *Arachis hypogaea L.* AS INFLUENCED BY LEVELS AND METHODS OF APPLICATION OF GYPSUM

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ABSTRACT

Field experiment conducted at Hebbal, Bangalore, on TMV - 2 groundnut during 1977 and 1978 *kharif* seasons, to study the calcium concentration in different plant parts of groundnut as influenced by levels and methods of gypsum application indicated that the addition of increasing levels of gypsum proportionately increased the concentration of calcium in leaf, stem tissue and in groundnut pods. Application to the sides at flowering resulted in highest concentration of calcium.

In Karnataka, groundnut is usually grown on well drained, light to medium textured soils. These soils are generally low in soil fertility and have low calcium saturation. The importance of calcium in the nutrition of groundnut has long been recognised. The presence of adequate amount of

Table 1. Calcium concentration (per cent) in groundnut leaf tissue on 60th day as influenced by levels and methods of gypsum application during 1977 and 1978.

Levels (tonnes / ha)	1977 Methods					1978 Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	0.60	0.61	0.64	0.93	0.70	0.63	0.65	0.69	1.01	0.75	0.73
1.0	0.61	0.82	0.88	1.01	0.83	0.68	0.72	0.91	1.15	0.87	0.85
1.5	0.88	0.88	0.90	1.25	0.98	0.92	0.94	1.10	1.31	1.07	1.03
Mean	0.70	0.77	0.81	1.06		0.74	0.77	0.90	1.16		
Mean over two years						0.72	0.77	0.86	1.11		
Dusting					0.80					1.05	0.93
Control					0.51					0.55	0.53

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	0.017	0.05	0.033	0.09
Methods	0.019	0.05	0.038	0.10
General and Interaction	0.034	0.10	0.065	0.19

Table 2. Calcium concentration (per cent) in leaf tissue at harvest of groundnut as influenced by levels and methods of gypsum application during 1977 and 1978.

Levels (tonnes / ha)	1977					1978					
	Methods					Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	0.57	0.59	0.66	0.87	0.57	0.44	0.45	0.51	0.67	0.52	0.60
1.0	0.70	0.72	0.76	0.91	0.77	0.48	0.49	0.52	0.72	0.55	0.66
1.5	0.79	0.79	0.86	0.96	0.85	0.56	0.64	0.67	0.99	0.72	0.79
Mean	0.69	0.70	0.76	0.91		0.49	0.53	0.57	0.79		
Mean over two years						0.59	0.62	0.67	0.85		
Dusting					0.82					0.53	0.68
Control					0.46					0.40	0.43

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	0.020	0.058	0.012	0.03
Methods	0.023	0.06	0.014	0.04
General and Interaction	0.040	0.117	0.025	0.071

calcium in the fruitification zone of the soil is essential. The gynophores and pods absorb the nutrient from the soil at the time of fruit development (Bunting and Anderson, 1960) However, very little information is available on relative concentration of calcium in various parts of groundnut in red soil regions of Karnataka. To find out the optium quantity and method of application on concentration of calcium in groundnut, the present investigation was taken up.

A field experiment was conducted during 1977 and 1978 *kharif* season, at Agronomy field Unit, University of Agricultural Sciences, Bangalore, on

Table 3. Calcium concentration (per cent) in groundnut stem tissue on 60th day as influenced by levels and methods of application of gypsum during 1977 and 1978.

Levels (tonnes / ha)	1977					1978					
	Methods					Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	0.74	0.75	0.78	080	0.77	0.67	0.72	0.81	0.88	0.77	0.77
1.0	0.75	0.79	0.83	0.85	0.81	0.83	0.87	0.89	0.91	0.88	0.85
1.5	0.84	0.86	0.88	0.90	0.87	0.88	0.90	0.94	0.98	0.93	0.90
Mean	0.78	0.80	0.83	0.85		0.79	0.83	0.88	0.92		
Mean over two years						0.79	0.82	0.86	0.89		
Dusting					0.85					0.91	0.88
Control					0.66					0.60	0.63

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	0.005	0.017	0.006	0.018
Methods	0.006	0.019	0.007	0.021
General and Inter action	0.012	0.033	0.012	0.036

Table 4. Calcium concentration (per cent) in stem tissue of groundnut at harvest as influenced by levels and methods of application of gypsum during 1977 and 1978.

Levels (tonnes / ha)	1977					1978					
	Methods					Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	0.79	0.83	0.83	0.90	0.84	0.68	0.71	0.81	0.91	0.78	0.81
1.0	0.84	0.85	0.86	0.92	0.87	0.83	0.87	0.90	0.98	0.90	0.89
1.5	0.88	0.89	0.90	1.04	0.93	0.89	0.95	1.00	1.20	1.01	0.97
Mean	0.84	0.86	0.86	0.95		0.80	0.84	0.90	1.03		
Mean over two years						0.82	0.85	0.88	0.99		
Dusting					0.89					0.99	0.94
Control					0.64					0.59	0.62

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	0.017	0.051	0.027	0.07
Methods	0.020	0.059	0.031	0.09
General and Interaction	0.035	0.10	0.054	0.16

red sandy loam soil. The average annual rainfall is 830 mm and is fairly well distributed from May to November. Bunch type (CV.TMV-2) groundnut was grown under rainfed condition to study the calcium nutrition. Gypsum at the rate of 0.5, 1.0 and 1.5 tonnes per ha (levels) was applied to the crop as broadcasting, application in the seed row at sowing, application to the both sides of the row at sowing and application to both sides of row at 35 to 40 days respectively at all the three levels, besides dusting at 0.5 tonnes at 35 to 40 days after sowing (methods) and control (NPK only) was followed.

Table 5. Calcium concentration (per cent) of groundnut pods at harvest as influenced by levels and methods of application of gypsum during 1977 and 1978.

Levels (tonnes / ha)	1977					1978					
	Methods					Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	0.31	0.36	0.38	0.39	0.36	0.33	0.35	0.36	0.38	0.35	0.36
1.0	0.40	0.44	0.45	0.47	0.44	0.42	0.45	0.47	0.49	0.45	0.45
1.5	0.49	0.53	0.55	0.56	0.53	0.51	0.53	0.56	0.58	0.54	0.54
Mean	0.40	0.44	0.46	0.47		0.42	0.44	0.46	0.48		
Mean over two years						0.41	0.44	0.46	0.48		
Dusting					0.43					0.48	0.45
Control					0.28					0.30	0.29

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	0.006	0.019	0.0066	0.018
Methods	0.007	0.022	0.0076	0.021
General and Interaction	0.0132	0.038	0.0132	0.038

Table 6. Pod yield (kg/ha) of groundnut as influenced by levels and methods of gypsum application during 1977 and 1978.

Levels (tonnes / ha)	1977					1978					
	Methods					Methods					
	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Broad casting	In seed row	Sides of the row	Sides at flowering	Mean	Mean over two years
0.5	1410	1400	1422	1480	1428	1230	1254	1290	1340	1278	1353
1.0	1428	1454	1526	1562	1492	1320	1390	1430	1470	1402	1447
1.5	1444	1582	1654	1690	1592	1450	1505	1664	1886	1626	1609
Mean	1427	1479	1534	1577		1333	1383	1461	1565		
Mean over two years						1380	1431	1498	1571		
Dusting					1426					1465	1445
Control					1126					1158	1144

	1977		1978	
	$SE_m \pm$	CD at 5%	$SE_m \pm$	CD at 5%
Levels	8.0	26.6	6.0	19.6
Methods	10.0	30.6	8.0	22.8
General and Interaction	18.3	53.2	29.7	84.8

The 14 treatments were replicated three times in a randomised complete block design. The crop was sown during August in both the seasons with 25 cm X 15 cm spacing. The crop was fertilised with 25 kg N, 50 kg P_2O_5 and 25 kg K_2O per ha. Urea, diammonium phosphate and muriate of potash were used to supply nitrogen, phosphorus and potassium to the crop respectively and other recommended cultivation practices were followed. The gypsum (60 mesh) obtained from the market was analysed for chemical purity before application to field. The required quantity of gypsum for each treatment was incorporated in soil at sowing and at flowering as per the treatment. Finer grade (200 mesh) was used for dusting the foliage. The collection and preparation of plant samples for chemical analysis was done as per the recommended procedure (Richards, 1954) and the calcium was determined on 5ml aliquot by titrating against standard Versenate solution (ethylene diamine tetra acetic acid) using Mureoxide indicator (Jackson, 1958).

RESULTS AND DISCUSSION

The data on calcium concentration in groundnut leaf and stem tissue on 60th day and at harvest (Tables 1 to 4) indicate that the calcium content both in leaf and stem tissues increased appreciably with the application of gypsum. Increasing the level of gypsum applied to the soil significantly increased the calcium content in the leaf as well as in stem. Maximum concentration of calcium was 1.25 and 0.85 per cent in leaf and 0.90 and 1.04 per cent in stem in 60th day and at harvest respectively with the application of 1.5 tonnes gypsum per ha to the soil.

The above results corroborate with those obtained by Bunting and Anderson (1960). They pointed out that 90 per cent of the total calcium present in the whole plant was absorbed through the roots and most of it was retained in the vegetative organs. According to Beringer and Toha (1976) some calcium absorbed by pods and gynophores also migrated to the vegetative parts.

The per cent calcium in leaf and stem tissues at harvest in general was lower than that observed at 60th day after sowing, but the trend of treatment effect remained the same as on 60th day. The low calcium concentration in tissues might be due to low nutrient absorbing capacity of the roots after attaining the maximum vegetative growth. As a result, the plant roots might not be in a position to absorb calcium after 60th day despite the presence of calcium in readily available form in the soil. Further, t crease in the dry matter production at

harvest (Table 6) might have caused dilution effect on the calcium content in the vegetative parts which resulted in lower calcium concentration at harvest than at 60th day.

Methods of gypsum application had significant influence on the leaf and stem tissue concentration of calcium both on 60th day and at harvest. Higher calcium content was noticed when gypsum was applied to the sides either at sowing or at flowering irrespective of the level of gypsum applied to the soil. This suggest the additive effect of absorption both by the roots in the early stages of plant growth and in the later stages by gynophores. Since gynophores have root hair like structures, they actively participate in calcium absorption. (Waldron 1919). Further, the calcium absorbed by the gynophores from the fruiting zone was subsequently translocated and accumulated in the above ground portions (Bunting and Anderson, 1960). They suggested that the peak period of calcium uptake by groundnut ranged from 49 to 63 days when 37 mg calcium per week were taken up per plant.

Data on the calcium content of groundnut pods as influenced by levels and methods of gypsum application (Table 5) indicate that the level of calcium in pods increased appreciably with each increment in the quantity of gypsum applied. Higher calcium content in pods was recorded when gypsum was applied to the sides either at sowing or at flowering. The results are in confirmity with results of Harris *et al* (1956). Based on their results, they suggested that there was a critical period of nutrient up take at the fruitification stage, when the presence of sufficient quantity of calcium was necessary in that region. This phenomenon was further confirmed by Subbiah and Nanak Singh (1970), using radio active calcium and separating rooting and fruiting zone of groundnut. The pod yield also followed similar trend (Table 6).

The data on the effect of dusting on the concentration of calcium by groundnut plant has revealed that dusting 0.5 t of gypsum at flowering has significantly increased the tissue concentration of calcium as compared to that of control and the application of same quantity of gypsum to the soil by different methods except application to the sides at flowering. In general, the effect of dusting was on par with that of application of 1.0 t gypsum to the soil. However, higher levels of gypsum (1.0 to 1.5 t/ha) applied to the sides at flowereing increased the calcium content significantly over that due to dusting. The increase in calcium content in the various plant parts might be attributed to its uniform distribution on the soil surface near the locus where it is most needed and at the peak period of absorption by the plant. Since the groundnut plants cannot absorb calcium through leaves and its translocation within the plant parts is restricted, the direct effect of dusting gypsum on calcium uptake and distribution does not arise.

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