Potassium Influences Kernel Filling of Large-Seeded Groundnut in Calcareous Soil

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ABSTRACT

Saurashtra and Kutch regions of Gujarat comprise the main area for production of export-quality groundnut in India. However, under the prevalent practices of fertilizer application, the large-seeded groundnuts show poor filling resulting in low kernel mass. Experiments were conducted in pots (sand culture) and also in field (calcareous soil) to examine the influence of K and Ca nutrition on pod-filling of large-seeded groundnut.

Sand culture, pot experiment revealed that large-seeded groundnut genotypes differed from others and showed shriveled kernels at low levels of both Ca and K. Individual application of increasing levels of Ca or K was not as beneficial as increasing levels of both of these indicating that both K and Ca are to be applied in such proportions which will facilitate optimum uptake of both of these nutrients and in sand culture, the best combination was 100 ppm K + 200 ppm Ca for large-seeded groundnut and 100 ppm K + 50 ppm Ca for other cultivars.

In field, application of K (100 kg/ha K_2O as muriate of potash) alone increased the pod yield by 20.2% and Ca (100 kg/ha Ca as gypsum) alone by 15 %, whereas combined application of these two increased by 29.5%. Further, the increase in pod yield was also accompanied by improvement in shelling out turn, 100-seed mass as well as proportion of sound mature kernels (SMK). The SMK increased from 78 to 89% in large-seeded genotype (TKG 19A) due to combined application of these nutrients.

Thus, it is concluded that K and Ca are important nutrients for proper pod-filling in large-seeded groundnuts. However, in calcareous soils, Ca being present in abundance, K becomes the limiting nutrient and must be applied to produce export quality groundnut.

Key words: Calcareous soil, Ca & K nutrition, large-seeded groundnut, pod filling

INTRODUCTION

The large-seeded groundnut genotypes yields maximum hand picked and selected seeds (HPS) which are exported from India for table consumption. Saurashtra and Kutch are the main area of groundnut production for export purpose in India. However, under the prevalent fertilizer practices either with low dose of K or without K and Ca, in these regions, the large-seeded groundnuts show poor pod filling resulting in low seed mass (Singh, 2000). Though, the fertilizer requirement of the crop has been worked out by several workers (Kanwar et al., 1983; Dwivedi, 1988, Singh, 1999), the nutrition of large seeded groundnut and has not received much attention (Singh, 2000). As the pod nutrition is mainly through soil and there is cations interactions, the nutrition of these large-seeded groundnut need to be look cautiously with higher doses of fertilizers with special reference to Ca and K.

Therefore, experiments were conducted in pots (sand culture) and also in field (calcareous soil) to examine the influence of K and Ca nutrition on pod filling of large-seeded groundnut. Sand culture pot experiments were conducted to see the concentrations of K and Ca, in groundnut plant tissues influenced by various levels of K and Ca, and to find out the suitable concentration of them for the balance nutrition of large-seeded groundnut. And to translate the technology, field experiments were conducted to know how Ca, K and B affect the yield and pod filling of large-seeded groundnuts in calcareous soil.

MATERIALS AND METHODS

Pot experiments

Sand culture pot experiment was conducted under high, and Low levels of Ca and K to find out their role in the nutrition of bold seeded groundnuts and to observe the interaction of Ca and K in nutrition of bold seeded groundnuts at the National Research Centre For Groundnut, Junagadh, India during wet season. Two large-seeded (BAU 13, JSP 19) and a medium-seed size (FeESG 8) groundnut genotypes were used in this study. There were six treatments as mentioned in table 1.

Fifteen kg of sand was filled in a number of pots and seeds of groundnut genotypes were sown at a rate of four seeds per pot in 4 replicates. Steinberg's nutrient solutions, as described by Hewitt (1966) with modification of the Ca and K doses were used in this study. For different doses of Ca and K the minus solution of these nutrients was taken as base solution and as per the treatments, the required quantity of nutrient from the stock solutions (KCl for K, and $CaCl_2.2H_2O$ for Ca) were added. The different doses of macronutrient were given by providing 1000 ml of nutrients solution pot^{-1} week^{-1} from 7-30 DAE, and 2000 ml pot^{-1} week^{-1} there after. The amount of nutrient solution was applied in two equal splits at every 4th day and stopped 15 days before harvest. The pots were flushed with water at 15 days interval. After maturity, the plants were harvested, and observations on yield recorded.

Field experiment

Field experiment was conducted during Kharif 1996 season at the Research Farm of the National Research Centre for Groundnut, Junagadh, India in a medium black, calcareous, clayey soil containing 19 % $CaCO_3$, 0.75 % organic carbon, 6.5 g/kg Ca, 570 mg/kg K, 7.5 mg/kg P, 590 mg/kg total N, 11 mg/kg heat soluble S (available S), 0.32 ppm B and pH 7.6. The experiment was laid out in a factorial randomized-block design with two groundnut genotypes (TG 19A a large seeded and GG 2 as an ordinary groundnut) and eight treatments, as per the details given in table 1. There were three replications.

The field was prepared by ploughing and labeling and 5-7 cm deep furrows were opened at 45 cm spacing. The field was then divided into 48 small plots of 20 m^2 (5 m x 4 m) by raising bunds. A basal dose of 20 kg N and 22.5 kg P/ha as di-ammonium phosphate were uniformly mixed in the soil before sowing. The treatment of 100 kg/ha Ca as gypsum , 100 kg/ha K_2O as muriate of potash and 2 kg/ha B as borax were applied in soil 50% as basal and 50 % on 50 days after emergence (DAE). The groundnut genotypes were sown at 45 cm x 10 cm spacing and grown under recommended package of practices. The crop was harvested at maturity, dried in sun for a week and pod yield, shelling percent, percentage sound mature seeds and 100-seed mass recorded.

The oven dried plant and seed samples were ground to a fine powder and analyzed for Ca, and K, by atomic absorption spectrophotometer. All the data were analyzed statistically.

RESULTS AND DISCUSSIONS

Sand culture pot studies

The pot-culture experiments revealed that large-seeded groundnut cultivars differed from other cultivars in their behavior of nutrition. Increasing the levels of Ca or K, alone, in the nutrient solution was not beneficial as the application of increasing levels of both these nutrients and their best combinations were 100 ppm K + 200 ppm Ca for large-seeded groundnut and 100 ppm K + 50 ppm Ca for other cultivars (Table 1). However, increasing level of Ca up to 400 ppm was detrimental to all these genotypes. Application of Ca alone, in general increased the concentration of Ca in all the tissues and more particularly of pods and kernel, but reduced the concentration of K and to encounter this effect, application of K is must. In our earlier study a concentration of 200 ppm K and 400 ppm of Ca were also tried for large-seeded groundnut that could not show proper nutrition and yield (Singh, 1999). Hence the intermediate dose of 100 ppm K and 200 ppm Ca was suggested for these large-seeded groundnut and here it was found to be a balance dose. Individual application of increasing levels of Ca or K was not beneficial mainly due to antagonistic effect exerted by these nutrients on the uptake of each other.

Hewitt (1966) compiled the different nutrient solution used by various laboratories for a variety of crops and observed a vide range of variation in concentration of macronutrients but mostly the normal solution referred contained, 39-312 ppm K and 20-200 of Ca. Singh (1996) in a study observed that the concentrations of macronutrients in leaves at 60 DAE and seeds at harvest were the main indicators to assess the mineral nutrient status of groundnut crop. The concentration of Ca in ordinary groundnut genotype, at 50 and 200 ppm of Ca in the nutrient solution, was 2.5-2.6 and 3.0-3.1 % in leaves at 60 DAE and, 440-470 and 510-650 ppm in seeds at harvest, respectively (Singh 1996). However, the respective concentrations of K was 1.81-1.89 and 1.5-1.6 % in leaves at 60 DAE and 0.75-0.95 and 0.74-0.84 % in seeds, in that order. Increasing the levels of any of these macronutrients in the nutrient solution increased the concentrations of that particular element, up to a certain level, but K decreased Ca and Mg concentrations and Ca decreased K and Mg concentrations in plant tissues. Thus both K and Ca are important nutrients for large seed groundnut and need to be applied in such proportions that will facilitate optimum uptake of both of these.

Field studies in Calcareous soil

Application of 100 kg/ha Ca, 100 kg/ha K_2O and 2 kg/ha B alone or in combinations improved pod filling (increased shelling percent and seed mass) pod yield and increased the nutrient concentration of seed (Table 2). On an average application of Ca, K, and B increased 15.0, 20.2 and 10.2 % pod yield, respectively. However the combined application of Ca + K, and Ca + K + B increased 29.5 and 35.3% pod yield over control, respectively. Application of these nutrients showed improvement in kernel filling, as a result the shelling percent and 100 seed mass increased (Table 2). The Ca and K increased 4.6 and 4.7 % seed mass and 2.8 and 2.7 % shelling percentage, respectively. There was improvement in the SMS (sound mature seeds) percentage, which increased from 78 to 89 per cent in bold seeded groundnut and from 82 to 87 per cent in ordinary one.

The nutrient analysis of kernels reveals that the large seeded groundnut contained higher concentrations of both K and Ca in their seed than the ordinary genotypes and application of K and Ca further increased the concentration of these nutrients in seed of both the genotypes (Table 2). Here in this calcareous soil, interestingly application of K also increased the Ca content in seed, but Ca application did not increase K content of seed. The K is reported to be involved in the maintenance of water status and increase the solar energy harvesting efficiency and the availability of metabolic energy for the synthesis of starch and proteins (Beringer, 1978; Mengel and Kirkby, 1987; Dwivedi, 1989) and there is beneficial effect of K, Ca and B in calcareous soil (Singh, 2000). The Ca is immobilized in the leaves as it is transported exclusively in the xylem tissues upward with transpiration stream and its downward movement from leaves through phloem is practically nil (Mengel and Kirkby, 1987). The developing fruit absorb phloem-immobile Ca^{2+} directly from the soil solution as the groundnut fruit develop underground and it will not transpire root-absorbed water. Thus the Ca content of leaf do not serve the reference for groundnut in this calcareous soil, but the Ca content of seed do serve as seed is the final sink. The reported minimum Ca content in seed needed for maximum germination and seedling survival are 368-414 and 361-445 ppm, respectively (Adams et al., 1993). Similarly to have good germination and healthy seedling establishment more than 400 ppm of Ca is needed in seed that was achieved only at high levels of Ca (Singh, 1999). However, in this field study the sufficient Ca concentration in seed was noticed.

CONCLUSIONS

It was therefore, concluded that both K and Ca are important nutrients for proper pod-filling in large-seeded groundnut genotypes and thereby maintaining the export quality of the produce. In calcareous soils, however, Ca being present in abundance, K becomes the limiting nutrient and hence the same should be applied for obtaining good quality large-seeded groundnut.

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Table 1. Potassium and Ca nutrition of large (bold) seeded groundnuts in sand culture pot experiment

S.N.	Treatments (ppm concentrations of nutrient solution)	Pod yield (g/pot) of groundnut genotypes			
		Ordinary	Large-seeded		
		FeESG 8	JSP 19	BAU13	Mean
1.	K_{50} Ca_{50}	13.98	13.42	11.27	12.89
2.	K_{50} Ca_{200}	17.02	15.39	11.11	14.51
3.	K_{50} Ca_{400}	13.73	18.43	8.27	13.48
4.	K_{100} Ca_{50}	22.28	19.95	11.38	17.87
5.	$K_{100}Ca_{200}$	17.56	21.67	16.62	18.62
6.	K_{100} Ca_{400}	10.64	13.96	7.24	10.61
	Mean	15.87	20.3	10.98	
	LSD (0.05)				
	1. Treatments		1.2		
	2. Genotypes		1.9		
	3. Interactions		3.6		

Table 2. Yield, shelling, seed-mass and nutrient concentrations of ordinary and large seeded groundnut genotypes as influenced by application of Ca, K and B in calcareous soil.

S. N.	Treatments details	Pod yield (kg/ha)			Shelling (%)			100 seed wt (g)			Nutrient concentrations in seed			
											% K		% Ca	
		O	B	Mean	O	B	Mean	O	B	Mean	O	B	O	B
1.	Control	1200	1459	1330	68.4	66.1	67.3	35.6	66.8	51.2	0.92	1.01	0.26	0.28
2.	B_2	1332	1599	1466	69.7	67.6	68.8	36.0	65.1	50.5	0.94	1.02	0.25	0.29
3.	K_{100}	1465	1730	1598	69.9	68.3	69.1	37.9	69.2	53.6	1.11	1.11	0.29	0.34
4.	K_{100}+ B_2	1459	1599	1529	70.0	68.7	69.4	38.0	68.0	53.0	1.04	1.19	0.30	0.35
5.	Ca_{100}	1378	1671	1525	70.2	68.1	69.2	38.3	68.6	53.5	0.92	1.04	0.33	0.38
6.	Ca_{100}+B_2	1474	1718	1596	70.0	68.6	69.3	38.0	69.2	53.6	1.04	1.03	0.34	0.37
7.	Ca_{100}+K_{100}	1586	1860	1723	70.8	68.9	69.9	39.0	69.3	54.2	1.18	1.17	0.33	0.39
8.	Ca_{100}+K_{100}+B_2	1649	1951	1800	70.7	69.1	69.9	39.0	69.1	54.0	1.12	1.21	0.33	0.41
	Mean	1443	1698		69.9	68.2		37.7	68.2		1.03	1.10	0.30	0.35
	LSD (0.05)													
	Treatments	164			1.61			2.0			0.09		0.04	
	Genotypes	82			0.81			0.9			0.05		0.02	
	Interactions	NS			NS			NS			0.13		0.06	

B and O represents bold (TG 19A a large-seeded) and ordinary (GG 2) groundnut genotypes, respectively