Role of pod and seed size in P and Ca nutrition of groundnut

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The groundnut (*Arachis hypogaea* L) which is also known as peanut, is an important food legume in tropical and subtropical areas and presently grown in about 90 countries. The average groundnut productivity of the world is around 1300 kg ha^{-1}, however, about 70% of the world groundnut production occurs in the semi-arid tropics where the average yield is only around 800 kg ha^{-1}. Presently, India has the largest groundnut area (32% of the world), but China is the highest producer of groundnut due to higher productivity than India. This is mainly because, in India, the crop is mostly grown as rain fed in dry lands with minimum fertilizers and often subject to the vagaries of the weather conditions.

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. Optimization of the mineral nutrition is the key way to optimize the production of groundnut. Among various elements Ca, P play a vital role in the pod development. Also unlike other crop most of the mineral absorption in groundnut pods, which develops under soil, is directly from soil to pod and very little through root to shoot and shoot to pod. Thus, the pod plays an important role in the nutrient absorption from soil and, probably the structure and size of the pod may be responsible for variation in mineral nutrient content of seed. As there are enough variation in size and structure of pod and seed in groundnut, it was imperative to study the Ca and P nutrition by groundnut genotypes varying in pod and seed size.

MATERIALS AND METHODS

Soil culture pot experiment was conducted at the National Research Centre For Groundnut, Junagadh, India during Kharif season of 2003. The soil was medium black, calcareous, clayey containing 19 % $CaCO_3$, 0.75 % organic carbon, 6.5 g kg^{-1} Ca, 570 mg kg^{-1} K, 7.5 mg kg^{-1} P, 590 mg kg^{-1} total N, 11 mg kg^{-1} heat soluble S, 0.32 ppm B and pH 7.6. Fifteen kg of soil was filled in a number of pots and seeds of groundnut genotypes were sown at a rate of 4 seeds pot^{-1} in 3 replicates. Thirty six groundnut genotypes, varying from small to very large pod and seed size selected from the germplasm available at NRCG were grown in pots with and without P and Ca.

The experiment was laid out in a factorial complete randomized-block design with three treatments and 36 groundnut genotypes. The treatments were, T_1- Control, T_2-Phosphorous (P as NaH_2PO_4, 50 kg P ha^{-1}), and T_3- Calcium (Ca as $CaCl_2$, 100 kg Ca ha^{-1}). The P and Ca treatments were applied 50% as basal and 50 % 45 days after emergence (DAE). A basal dose of 40 kg N ha^{-1} as Ammonium sulphate and 40 kg K ha^{-1} as muriate of potash were common in all the pots, which were mixed in the soil before sowing. Proper care was taken to grow the crop during the season. The crop was harvested at maturity, dried in the sun and yield pod and seed size and 100 seed weight recorded.

RESULTS AND DISCUSSION

Pod size

The pod and seed yield of various groundnut genotypes, ranged from 2.51 – 26.6 g pod pot^{-1} and 1.8-19.7 g seed pot^{-1}, respectively. The average pod and seed yield of all the genotypes was 14.4 g pod pot^{-1} and 9.4 g seed pot^{-1} which increased to 17.1 g pod pot^{-1} and 11.4 g seed pot^{-1} with application of P. The application of Ca had varied effect with genotypes; with limited genotype it showed positive response, however, with few genotypes there was no response.[1]

The pod size in various genotypes under investigation varied from small to large size in which rang of pod length was 1.5 – 3.72 cm and pod width 0.85 – 1.66 cm. For categorizing the groundnut into various pod and sizes only a few study has been conducted. Though, Varisai Muhammad et al. (1973) divided the groundnut into five classes depending on the mean pod length and pod weight, the pod width was not

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considered by them which reflect the actual pod size. Accordingly, taking into consideration the pod length and width, the pod sizes in groundnut were classified by the author in three classes: small (pod length less than 2 cm and width less than 1 cm), medium (pod length 2.1 – 3.5 cm and width 1.0 – 1.5 cm) and large (pod length more than 3 cm and width more than 1.5 cm).

The mean pod, seed and shell yields of various pod size groundnut genotypes as influenced by P and Ca are given in Table 1. The key factor for pod and seed nutrition of groundnut is the size of pod and seed inside it and the surface area of the pod. It was observed that high yielding groundnut genotypes were of medium and large pod and seed sizes (Table 1 and 2). However, the low yielding genotypes were always of small pod and seed size. The large pod and seed size genotype probably due to not getting proper nutrition did not show their full potential and showed their yield at par with medium sized pod and seed. The shelling percentage is determining factor for pod and seed size. In various genotypes under investigation it ranged from 37.4 – 76.8%. The shell yield of large pod size groundnut was highest, however the small size showed lowest shell wt. There was slight decrease in shell wt. causing increase in shelling percent with application of Ca.

Gowda et al. (1991) reported that pops percentage was negatively correlated with shelling percentage and was positively correlated with pod surface area and shell thickness, indicating poor translocation of Ca to seeds in pods. The proportion of pops ranged from 0.1 % in the early-maturing cv. Chico to 14.5-15.3% in the smooth pod cv. JL 24, TGS 2 and DH 40. Rao and Savitharamma, (1998) observed that the pod size was positively correlated to Ca^{2+} and CaM contents and bold seeded cv. ICGV-86590 showed higher levels of sodium, potassium, calcium, total protein and CaM contents than the medium (ICGS-5) and small (ICGS-1) seeded cultivars at all stages of pod development.

Seed size

The seed size of various genotypes under investigation varied from small to very large seed. The length of seed ranged from 0.46 – 1.9 cm and width ranged from 0.6 – 1 cm. The 100 seed weight of groundnut genotypes under observation ranged from 19.6–71.6 g. For seed-size, as there is no clear cut classification available, the 100-seed weight was measured and the groundnut genotypes were classified by the author, into small (less than 30 g 100-seed weight), medium (30-50 g 100-seed weight), large (more than 50 g 100-seed weight). Following this criteria, the 36 genotypes when categorized there were 5 small seeded genotypes, 20 medium seeded genotypes and 11 large (bold) seeded genotypes (Table 2).

The average pod and seed yield of the small size genotypes were 8.5 and 5.4 g pot^{-1} without any fertilizer which increased to 10.5, and 7.8 g pot^{-1}, respectively, with P and 9.5 and 6.4 g pot^{-1}, respectively with Ca application (Table 2). In large seeded groundnut genotypes, the mean value were 12.3 g pod pot^{-1} and 8 g seed pot^{-1} in control pots, which increased to 14.7 g pod pot^{-1} and 10.4 g seed pot^{-1}, respectively, with application of P and 14.1 g pod pot^{-1} and 9.6 g seed pot^{-1} with application of Ca. The groundnut with small size seed showed less pod and seed yield and less response to P and Ca application indicating that the seed size also plays role in pod and seed nutrition. The shelling percentage of small size groundnut genotypes did not increase with the application of P and Ca, the medium size seed showed slight increase in shelling percentage. However, the large seeded genotypes showed significant increase in shelling percentage due to P and Ca application (Table 2). However, Singh et al., (1998) in a study did not observed any yield differences when the selected seed size of same variety were sown in the field and recommended the smaller and medium size seed for sowing and bold size seed for consumption purpose.

Phosphorous (P) and calcium (Ca) play an important role and their fertilization in the pegging zone is essential for high yield of quality groundnut. The inadequate supply of Ca results in pods without seeds called "Pops" or blackened plumule inside the seed known as "Black heart". Since calcium is immobilized in the older leaves, the pod always face scarcity of Ca. As soon as peg penetrates soil it ceases to transfer root absorbed water and hence looses access to root absorbed Ca, thus developing fruit absorbed Ca from the soil and to maintain a gradient, it is necessary that calcium is to be supplied in the zone of pod development.

In general, the Ca and P requirement is greater for pod filling than flowering, and it is greater for flowering than vegetative growth. The runner genotypes disperse their pods more than bunch genotypes typically providing double the soil volume available for P and Ca exploitation to pods. The minimum Ca content in seed needed for maximum germination and seedling survival are 368-414 and 361-445 ppm, respectively (Adams et al., 1993). Kvien et al. (1988) reported that accumulation of Ca in pod is positively correlated with the pod surface area, days required to maturity and negatively correlated with the pod thickness. At proper nutrition the healthy seed contained 0.08-0.12 % Ca and more than 400 ppm Ca in seeds is essential for proper germination (Singh 1999).

The quantity of Ca/fruit and percentage Ca in the fruit, pericarps and seeds of groundnut were measured in 25 fruits from each of 19 cv. with a wide range of seed size where there was no relationship between the seed size and percentage Ca content, but there was a linear relationship between total Ca content and seed wt. (Keisling et al , 1982.). The relationship between seed wt. and volume was also linear. Using these relationships, an equation was produced to determine the influence of seed size on the distance over which Ca must be taken from the soil to meet the Ca requirements of the fruit and hence explain the known differences in response to Ca fertilization of small and large-seeded cultivars.

Conclusions

Thus it is concluded that the pod and seed size plays an important role in pod and seed nutrition of groundnut from soil and to obtain the quality seed, in large seeded groundnut, fertilization with P and Ca is must.

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Table 1. Influence of P and Ca treatments on pod, seed and shell yields of various pod size groundnut genotypes.

Treatments	Yield (g pot^{-1}) of various pod size groundnut genotypes								
	Small (Mean of 4 genotypes)			Medium (Mean of 26 genotypes)			Large (Mean of 6 genotypes)		
	Pod wt.	Seed wt.	Shell wt	Pod wt.	Seed wt.	Shell wt.	Pod wt.	Seed wt.	Shell wt.
Control	8.3	5.3	3	12.8	8.5	4.3	13.3	8.3	5.1
P	8.7	6.4	2.2	15.1	10.7	4.4	18.1	12.4	5.7
Ca	11	8.1	2.9	14.9	10.1	4.6	11.8	7.7	4.2

Table 2. Influence of P and Ca treatments on pod and seed yields, 100 seed wt. and shelling % of various seed size groundnut genotypes.

Treatments	Yield (g pot^{-1}) of various seed size groundnut genotypes											
	Small (Mean of 5 genotypes)				Medium (Mean of 20 genotypes)				Large (Mean of 11 genotypes)			
	Pod wt.	Seed wt.	Sh. %.	100 seed wt. g	Pod wt.	Seed wt.	Sh. %	100 seed wt. g	Pod wt.	Seed wt.	Sh %	100 seed wt. g
Control	8.5	5.4	68.9	23.1	11.3	7.6	65.8	35.5	12.3	8	65.3	58.8
P	10.5	7.8	68.5	25.9	12.5	8.6	66.6	39.1	14.7	10.4	67.5	60.7
Ca	9.5	6.4	68.9	24.9	13.5	9.3	67	39.1	14.1	9.6	67.5	62