Effect of variable doses of potassium, sulphur and calcium on pod yield of short duration summer groundnut (*Arachis hypogaea* L.)

R.A. Singh
Directorate of Research, C.S. Azad University of Agriculture & Technology, KANPUR (U.P.) INDIA

ABSTRACT
A study was carried out for two consecutive years during 2003-2004 at Zonal Agricultural Research Station, Mainpuri, C.S.Azad University of Agriculture and Technology, Kanpur. The main purpose was to findout the suitable dose of K_2O and S + Ca for irrigated summer groundnut to sandy soils of Uttar Pradesh. The summarized results of two years experiment indicate that summer groundnut responded to the application of 60 kg K_2O ha^{-1} which was registered significantly higher pod yield (29.02 q/ha^{-1}) over 45 kg K_2O ha^{-1} (25.90 q/ha^{-1}). Similarly, application of 45 Kg S + 60 kg Ca/ha^{-1} through gypsum gave significantly higher pod yield by 32.47 q/ha^{-1} compared with lower installments of S + Ca to summer groundnut under irrigated condition. The growth and yield traits noted in groundnut under variable doses of K_2O and S + Ca were concordant to the pod yield of groundnut. Therefore, integration of 60 kg K_2O + 45 kg S + 60 kg Ca with 20 kg N + 30 kg P_2O_5 ha^{-1} can be used for higher production of pods of groundnut during summer season.

Key words : Summer groundnut, Sulphur, Calcium, Gynophores, Pops, Black heart.

INTRODUCTION

Groundnut is a recent introduction in summer season after potato, mustard, vegetable pea and field pea in Gangetic alluvial soils of Uttar Pradesh. The productivity is remarkably higher (25-30 q/ha^{-1}) as compared to rainy season groundnut. In groundnut, flowers, pegs formation and developing pods are major yielding factors, thus, the application of potassium, sulphur and calcium is too essential for better production. Though potassium is not a constituent of any compound or structurally bound in groundnut, it is required for translocation of assimilates and involved in maintenance of water status of plant especially the turgor pressure of cells and opening and closing of stomata and increase the availability of metabolic energy for the synthesis of starch and proteins. Besides, it increased peg formation, nodulation, synthesis of sugar and starch and help in pod growth and filling. The productivity of groundnut under water deficit conditions increased due to K application. Though the response of K upto 100 kg K_2O ha^{-1} is observed depending upon the agro climatic situation and groundnut varieties, the recommended dose of K are 25 –45 kg K_2O ha^{-1} for rainy season and 40-75 kg K_2O ha^{-1} for post rainy season/summer season irrigated crop.

Sulphur is a constituent of protein and plays an important role in oil synthesis. Since groundnut is rich both in oils and protein, requirement of sulphur for this crop is substantial. In addition application sulphur in soil also regulates the pH and increase the availability of other nutrients. It improves nodulation and pod yield reduces the incidence of diseases. Sulhpur increases chlorophyll and decreases chlorosis. In most of the groundnut-growing tracts of South-Western Semi-Arid and Central Plain Agro-climatic zones of Uttar Pradesh, the level of available sulphur reaches below the limit and groundnut crop is bound to suffer on account of sulphur deficiency.

Calcium is more important of groundnut and often lack of Ca reduces the yield and quality more than any other elements. Calcium maintains the cell integrity and membrane permeability, enhances pollen germination, activates the number of enzymes for cell division and takes part in protein synthesis and carbohydrate transfer in groundnut. Recently it has been implicated as second messenger in certain hormonal and environmental responses and regulating enzyme activities. In its physiological effects Ca is usually regarded as counter part of K. In general, the calcium requirement is greater for pod filling than flowering and it is greater for flowering than vegetative growth. The high Calcium is required in the 5-10 cm of soil for groundnut.

The actual requirement of potassium, sulphur and calcium is not known for summer season groundnut to sandy soils of Uttar Pradesh because its cultivation recently introduced, therefore, the present experiment was planned and carried out.

MATERIALS AND METHODS

A field trial was carried out for two consecutive years during summer season of 2003 and 2004 at Regional Research Station, Mainpuri, C.S.Azad University of Agriculture and Technology, Kanpur. The soil of experimental site was sandy loam having pH 8.5, organic carbon 0.45%, total nitrogen 0.04%, available phosphorus 10 kg ha^{-1} and available potash 278 kg ha^{-1}, therefore, the fertility status of experimental soil was low. Groundnut crop was grown under four levels of sulphur and calcium (0+0, 15+20, 30+40 and 45+60 kg ha^{-1} in the integration of two levels of potassium (45 and 60 kg ha^{-1}). The experiment was conducted in factorial RBD with three replications. A uniform dose of 20 kg N + 30 kg P_2O_5 ha^{-1} was applied to crop with variable doses of K_2O, S & Ca. The full doses of NPK and half doses of S & Ca. were given at sowing and remaining half doses of S & Ca were top dressed after first irrigation and mixed in to soils at flower initiation stage. Well-

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powdered 30-mesh gypsum (S-18.6% and Ca 24%) was applied to groundnut. The requirement of 15 kg S + 20 kg Ca, 30 kg S + 40 kg Ca and 45 kg S + 60 kg Ca met from 80, 160 and 240 kg gypsum ha^{-1}, respectively. The groundnut Cv Dh 86 was planted in rows 30 cm apart with 8 cm plants to plants distance. Four irrigations were given to crop. Groundnut seeded in March, 13, 2003 and March 14, 2004 harvested after 87 days on June 8, 2003 and June 9, 2004. Well-dried pods was graded, weighed and stored after 15 days of harvesting at 7-8% moisture content.

The variances for error were found homogeneous. Hence, the pooling of the data for each character was done for the two years by the standard method suggested by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Effect of sulphur + calcium on growth parameters:

Main shoot height and branches $plant^{-1}$ showed an significantly increasing trend with increasing level of S + Ca upto 45 kg S + 60 kg Ca/ha^{-1} (Table 1). It might have been owing to better utilization of resources under improved S supply, as it plays multiple role in plant metabolism being an essential constituent of S containing amino acids and as such of protein, vitamins, acetyl CO-A, ferrodoxin and glutathione. Similarly, calcium maintained the cell integrity and membrane permeability, activated the number of enzymes for cell division and taken part in protein syntheses and carbohydrate transfer. These results are in close conformity with the findings of Dayanand and Meena (2000), Sachidanand *et al.* (1980) and Singh *et al*. (2005).

Effect of sulphur + calcium on yield traits:

Yield traits i.e. filled pod $plant^{-1}$, filled pod weight $plant^{-1}$, kernel weight $plant^{-1}$, kernel pod^{-1} and 100-kernel weight increased significantly upto 45 kg S + 60 kg Ca/ha^{-1} compared with lower installments of both nutrients (Table 1). Improvement in vegetative structures for nutrient absorption and photosynthesis, strong sink strength through development of reproductive structures and production of assimilates under influence of applied S maintained balance source-sink might have resulted in increased yield attributes. Similarly Ca played an important role in the reproductive development of groundnut. This is probably because in the absence of both xylem and phloem supply of Ca, the penetrating gynophores have modified themselves into absorbing organs of Ca from the immediate fruiting zone. Thus developing pods absorbed Ca directly from the soil and the adequate supply of Ca reduced the “Pops” or blackened plumule inside the seed known as “Black heart” and yielded the sound pods. This is in close agreement with the findings and recommendation of Rao and Shaktawat (2000), Devakumar and Giri (1998), Sachidanand *et al.* (1980) and Dayanand and Meena (2000).

Effect of Sulphur + Calcium on pod yield:

The pod yield of groundnut increased significantly with each successive increment of S + Ca application upto 45 kg S + 60 kg Ca/ha^{-1}. Application of 45 kg S + 60kg $Caha^{-1}$ gave pod yield by 32.47 q ha^{-1} which was significantly higher by a margin of 9.14 q/ha^{-1}, 7.69 q/ha^{-1} and 3.22 q/ha^{-1} over control, 15 kg S + 20 kg Ca and 30 kg S + 40 kg Ca/ha^{-1}, respectively (Table 1). The influence of sulphur + calcium on growth and yield attributes was found significant, resulted in, the pod yield of groundnut increased significantly upto higher tested dose of sulphur + calcium. The results of present investigation confirm the findings of Rao and Shaktawat (2000).

Table 1 : Effect of variable doses of potassium, sulphur and calcium on growth, yield traits and pod yield of groundnut during summer season, 2003 & 2004.

Treatment	Pooled growth, yield traits of 2003 and 2004							Pod yield (q ha^{-1})		
	Main shoot height (cm)	Branches $plant^{-1}$	Filled pods $plant^{-1}$	Filled pod weight $plant^{-1}$ (g)	Kernel weight $plant^{-1}$ (g)	Kernels pod^{-1}	100-kernel weight (g)	2003	2004	Pooled
S + Ca (kg ha^{-1})										
0 + 0	17.38	13.19	33.03	27.43	17.55	1.84	36.50	23.06	23.61	23.33
15 + 20	17.95	14.01	35.34	29.33	18.76	1.94	38.00	24.50	25.06	24.78
30 + 40	18.63	14.54	43.24	35.89	22.96	2.00	40.50	28.78	29.73	29.25
45 + 60	18.78	14.87	47.36	39.31	25.15	2.00	42.50	32.39	32.56	32.47
SE ±	0.02	0.08	0.15	0.12	0.08	0.50	0.42	0.35	0.18	0.28
CD at 5%	0.06	0.24	0.45	0.36	0.24	N.S.	1.27	1.06	0.54	0.84
K_2O (kg ha^{-1})										
45	17.89	13.90	37.51	31.13	19.91	1.92	38.50	25.56	26.25	25.90
60	18.48	14.40	41.99	34.85	22.30	1.97	40.25	28.81	29.23	29.02
SE ±	0.01	0.05	0.10	0.08	0.05	0.35	0.29	0.25	0.13	0.20
CD at 5%	0.03	0.15	0.30	0.24	0.15	N.S.	0.87	0.75	0.39	0.60

Unform dose of 20 kg N + 30 kg P_2O_5 applied in the integration of variable doses of K_2O & S + Ca.

Effect of potassium on growth parameters:

Application of 60 kg K_2O ha^{-1} increased significantly main shot height and branches plant^{-1} compared with lower installment of 45 kg K_2O ha^{-1}. The improvement in growth parameters by application of higher dose of potassium may be due to decreased transpiration and increased the stomata resistance, solar energy harvesting efficiency and nodulation. These results are in line with those of Dwivedi (1989) and Singh (1999a).

Effect of potassium on yield traits:

Filled pods plant^{-1}, field pods weight plant^{-1}, kernel weight plant^{-1} and 100-kernel weight significantly increased with increasing levels of potassium upto 60 kg K_2O ha^{-1} whereas increase in kernels pod^{-1} was recorded statistically at par with 45 kg K_2O ha^{-1}. Singh (2003) reported that the 100-kernel weight, shelling percentage etc. yield traits improved due to potassium application.

Effect of potassium on pod yield:

The increase in pod yield of groundnut with application of 60 kg K_2O ha^{-1} was significantly higher by a margin of 3.12 q/ha^{-1} or 12.05% over the lower installment of 45 kg K_2O ha^{-1} (Table 1). This increase may be due to best ratio of K : Ca (4 : 4) for higher production of summer groundnut i.e. 60 kg K_2O and 60 kg Ca/ha^{-1}. Upsetting this balance towards K may be harmful (Basu and Dayal, 2003). The response of K_2O upto 40-75 kg K_2O ha^{-1} for summer groundnut under irrigated condition has also been reported by Singh *et al.* (2004). The results also substantiated the findings of Balasubramaniyan (1997).

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