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Effect of sulphur and calcium on growth and yield of groundnut [*Arachis hypogea* L.]

Mannem Rajanarasimha, Rajesh Singh and Ekta Singh

Abstract
A field experiment was executed during *Zaid* season of 2020-21 at crop research farm of SHUATS, Prayagraj to study about the influence of different methods of Sulphur and Calcium on growth and yield of Groundnut. The experiment was laid out in most commonly encountered Randomized Block Design (RBD) with three replication of each treatment for all traits. In view of this experiment two methods are applied Sulphur and Calcium. Sulphur levels S_1(15 kg/ha), S_2(30 kg/ha), S_3(45 Kg/ha) Calcium C1(20kg/ha); C(40kg/ha),C3(60kg/ha). Results were revealed that maximum number of Plant height (73.56), dry weight (32.06 g/plant), effective nodules/plant (19.46), no of pods /plant (21.33), no. of kernels/pod(2), Seed index (42.80 gm) were found to be significantly higher with application of treatment Sulphur 45kg/ha + Calcium 60kg/ha as compared to the other treatments. Maximum values were recorded higher in the application of Sulphur 45kg/ha + Calcium 60kg/ha in plant height (73.56 cm), kernel yield (2.17 t/ha) and Haulm Yield. (5.60) harvest index (36.40%) was recorded. Therefore, I concluded that the Sulphur 45kg/ha+ Calcium 60kg/ha can produce more no of pods/plant and kernels/pod and will be economically effective.

Keywords: Sulphur, calcium and yield

Introduction
Groundnut (*Arachis hypogea* L.) it belongs to Leguminoceae Family is one of the most important Edible oilseed crop in the world India occupying two third areas under oilseeds which constitute the second major agricultural crop in the country. It is premier oilseed crop of India popularly known as peanuts, monkeynuts etc. It is commercially grown in more than Hundred countries like India, China, USA, West Africa. Groundnut was introduced in India in the middle of 19th Century on east coast of the South Aricot district in Tamil Nadu. The crop grows best on Sandy loam and loamysoil and in Black soil with good Drainage. Heavy and stiff clays are unsuitable for groundnut cultivation. The percentage of oil content is about 50%, 25% to 30% protein 20 percent carbohydrate and 5% Ash and Fibre. It is valuable sources of vitamins E, K and B. It is richest source of Thiamine and also rich in niacin which is low in Cereals. Groundnut provides raw material for industrial serving as concentrated Animal Feed and organic manure. It contributed to Sustainable Agriculture being a Legume and cultivated in both Kharif and Summer season by Farmer. Globally the crop is raised on 26.4 million hectares with a total production of 37.1 million tonnes in India. It is cultivated over an area of 4596.33 in hectares with production of 6733.33MT. The average productivity is 1400 Kg per ha^{-1} [Anonymous].

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 of Sulphur significantly increased photosynthesis rate thereby increased the haulm yield and its also increased the pod yield (Wali and Shivraj 1994). Sulphur deficiency and consequent crop response, particularly in oilseed crops like groundnut are quite ostensible (Schonhof *et al*., 2007) [30]. Deficiency of Sulphur has been frequently observed due to a number of reasons like increased removal of Sulphur by the crop, high yielding fertilizer responsive crop varieties, increasing cropping intensity and extensive use of Sulphur free fertilizers. The positive response of Sulphur application to groundnut has been reported by Ramdevputra, 2010 and Dash *et al*., 2013 [26].

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. In General, the calcium requirement is greater for pod filling than flowering and it is greater for flowering then vegetative growth the high calcium

is required in the 5-10 cm of Soil for Groundnut. Calcium plays an important role in Reproductive development of Groundnut. Calcium 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), Sachidanant *et al*. (1980) and Dayanand and Meena (2000) [7].

Material and Methods

An experiment was conducted during the Zaid season of 2021, at Crop Research Farm of Department of Agronomy at Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj which is found at 25o 24'42" N latitude, 810 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the Effect of Sulphur and Calcium on Growth and Yield of Groundnut. [*Arachis hypogeal* L]. The experiment was laid move into in Randomized Block Design with Ten treatments which was replicated thrice. The treatment combination has two factors. The primary comprises of three Levels S1 -15 kg/ha S2 - 30Kg/ha S3 -45kg/ha while the second factor has three Calcium levels C1 – 20 kg/ha, C2- 40 kg/ha, C3- 60 kg/ha. The treatment combination are as follow (T1) Sulphur 15kg/ha+Calcium 20kg/ha (T2) Sulphur 15kg/ha + Calcium 40kg/ha (T3) Sulphur 15kg/ha +Calcium60kg/ha (T4) Sulphur30kg/ha+Calcium 20kg/ha, (T5) Sulphur30kg/ha+ Calcium40kg/ha, (T6) Sulphur30kg/ha+ Calcium60kg/ha, (T7) Sulphur 45kg/ha+Calcium 20kg/ha (T8) Sulphur45kg/ha+Calcium40kg/ha (T9) Sulphur45kg/ha+Calcium60kg/ha.(T10) Control. Ten treatments are replicated thrice within the Randomized Block Design. As fertilizers are applied as basal dose to fulfil the N and another nutrient requirement at early growth stages and rest half dose of N requirement is fulfilled through Dap as top dressing at 30 DAS. The recommended dose of fertilizer is 20-60-40 kg/ha.

Chemical analysis

Composite soil samples are collected before the layout of the experiment to work out the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, more matured 2 mm sieve and were analysed for organic carbon by rapid titration method by Nelson (1975). The type of soil in the experiment field is sandy clay with a pH of 7.5, EC of 0.47dSm-1, organic carbon was 0.46%. The Nitrogen status of the experiment field was (219kg/ha), available Phosphorus (19.6 kg/ha) while the available potassium status was in the higher range (239.2 kg/ha). Growth parameters *viz.*, plant height (cm), No. of tillers per plant, dry weight (g/plant) were recorded manually on five randomized selected representative plants from each plot of each replication separately as likewise as yield and yield attributing character *viz*., kernel yield (t/ha) and Haulm yield (t/ha) recorded as per the quality method. Soil texture by Bouyoucos Hydrometer Method (Gee and Baudev, 1986). Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956) [35], available phosphorous by Olsen *et al*., (1954) and available potash was decided by Flame photometric method (Jackson 1973) [13].

Statistical analysis

The data recorded were different characteristics were subjected to stastical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significantly at 5% level.

Result and Discussion

Effect on growth parameters

Observations regarding the plant height (cm) of groundnut are given in Table 1 and there was an increased with crop growth duration. At harvest, maximum plant height was recorded with the application of 45 kg/ha Sulphur + 60 kg/ha Ca (73.56 cm) and which was statistically at par with the treatment combination of 45 kg/ha Sulphur + 40 kg/ha Ca (72.40 cm). Increased growth components observed under gypsum might be by attributed to readily available sulphate form of Sulphur, enhanced uptake of nutrients even at initial stages of crop growth. Similar findings were earlier reported by Rao *et al.* (2013) [27] At harvest, maximum no. of nodules (19.46) was recorded with application of 45 kg/ha sulphur + 40 kg/ha calcium which was significantly superior over all the treatments and which was statistically at par with treatment combination of 45 kg/ha sulphur + 40 kg/ha calcium (18.53). Dekhane (2011) also obtained similar results and reported in garden pea; increase in number of nodules with increase in phosphorus levels. Similar results were also noticed by Nkaa *et al*. (2014), Baboo and Mishra (2001). At harvest, maximum dry weight (32.06 g/plant) was recorded with application of 45 kg/ha Sulphur + 60 kg/ha calcium which was significantly superior over of all the treatments and which was statistically at par with application of 45 kg/ha sulphur + 40 kg/ha calcium (31.70 g/plant). Increasing phosphorus rates increased dry weight/plant. These findings were also confirmed the results obtained by Dutta *et al*. (2004). The increase in dry matter production with P might be due to better nodulation of crop owing to better availability of P. The improvement in nodulation might have resulted in higher amount of nitrogen fixation and there by better vegetative growth and dry matter production. These results were similar with findings of Mukherjee and Rai (2000).

Yield attributes on Groundnut

Observations regarding yield attributes are given in Table 2. No of pods/plant maximum was obtained with application of 45 kg/ha sulphur + 60 kg/ha calcium (21.33), which was significantly superior over all the treatments and which was statistically at par with application of 45 kg/ha sulphur + 40 kg/ha calcium (20.56). No. of kernels/pod, maximum was obtained with application of 45 kg/ha sulphur + 60 kg/ha calcium (2) which was significantly superior over 45 kg/ha sulphur + 40 kg/ha calcium (1.73) were at par with each other. Singh *et al.* (2005) [34] were reported that the increased the main shoot height and branches of plant. Similarly calcium maintained the cell integrity and membrane permeability activated the number of enzymes for cell division and taken part in protein synthesis and carbohydrate transfer. Results in development of kernels per pod in plants. Seed index (g) maximum was obtained with application of 45 kg/ha sulphur + 60 kg/ha calcium (42.8 g) which was superior over rest of the treatments and statistically at par with the application of 45 Kg/ha sulphur + 40 Kg/ha calcium (41.63 g).

Yield

Data pertaining to kernel yield are recorded after harvest and embodies in Table 3. kernel yield (t/ha) maximum was

obtained with application of 45 kg/ha sulphur + 60 kg/ha calcium (2.17 t/ha), which was significantly superior over all the treatments and which was statistically at par with the application of 45 Kg/ha sulphur + 40 Kg/ha calcium (2.07 t/ha). Haulm yield (t/ha) was obtained maximum with application of 45 kg/ha sulphur + 60 kg/ha calcium (5.60 t/ha) which was significantly superior over all the treatments and which was statistically at par with application of 45 kg/ha sulphur + 40 kg/ha calcium (5.47 t/ha). Harvest index (%) was obtained maximum with application of 45 kg/ha sulphur + 60 kg/ha calcium (36.40%) which was statistically at par with the application of 45 Kg/ha sulphur + 40 Kg/ha calcium (35.97%) and minimum was obtained with control (33.27%). Watering and Patrick, 1975 [37] also reported that improvement in yields was attributed to diversion of greater proportion of assimilates to the developing pods due to increased sink strength reflected through its larger demand of photosynthates. Supply of Sulphur in adequate amount also helps in the development of floral primordial i.e. reproductive parts, which results in the development of pods and kernels in plants. Similar findings have also been reported earlier by Patel *et al*., (2009) [24].

Table 1: Effect of Sulphur and Calcium on growth attributes of Groundnut

Treatments	Growth attributes of Groundnut at harvest		
	Plant height (cm)	No. of Nodules/plant	Dry weight (gm/plant)
Sulphur 15kg/ha+Calcium 20 kg/ha	70.77	4.93	13.66
Sulphur 15kg/ha+ Calcium 40 kg/ha	75.74	6.40	15.01
Sulphur 15kg/ha+Calcium 60 kg/ha	74.77	9.13	16.90
Sulphur 30kg/ha+ Calcium 20 kg/ha	72.14	5.13	13.99
Sulphur 30kg/ha +Calcium 40 kg/ha	76.46	6.63	15.36
Sulphur 30kg/ha +Calcium 60 kg/ha	75.76	9.40	17.19
Sulphur 45kg/ha +Calcium 20 kg/ha	73.49	4.90	14.31
Sulphur 45kg/ha +Calcium 40 kg/ha	79.89	7.20	15.53
Sulphur 45kg/ha +Calcium 60 kg/ha	78.14	9.50	17.46
SEm(±)	0.62	0.19	0.28
CD (p=0.05)	1.84	0.59	0.84

Table 2: Effect of Sulphur and Calcium on Yield attributes of Groundnut

Treatments	No of pods/plant	No of kernels/pod	Seed index (g)	Kernel yield (t/ha)	Haulm yield (t/ha)	Harvest Index (%)
15 kg/ha Sulphur + 20 kg/ha Ca	15.17	1.47	37.40	1.31	4.27	33.40
15 kg/ha Sulphur + 40 kg/ha Ca	15.87	2.00	38.60	1.39	4.67	33.42
15 kg/ha Sulphur + 60 kg/ha Ca	16.97	2.00	38.73	1.41	4.93	33.86
30 kg/ha Sulphur + 20 kg/ha Ca	17.23	1.73	37.10	1.50	5.10	33.63
30 kg/ha Sulphur + 40 kg/ha Ca	17.70	2.00	37.37	1.70	5.27	33.69
30 kg/ha Sulphur + 60 kg/ha Ca	20.57	2.00	40.40	1.96	5.33	35.43
45 kg/ha Sulphur + 20 kg/ha Ca	18.63	2.00	39.73	1.77	5.10	34.53
45 kg/ha Sulphur + 40 kg/ha Ca	20.56	2.00	41.63	2.07	5.47	35.97
45 kg/ha Sulphur + 60 kg/ha Ca	21.33	2.00	42.80	2.17	5.60	36.40
Control	14.13	1.57	36.83	1.24	4.10	33.27
SEm (±)	0.28	0.09	1.01	0.04	0.09	0.19
CD (5%)	0.84	0.27	3.01	0.14	0.27	0.55

Conclusion

On the basis of one season experimentation application of Sulphur45kg/ha+ Calcium60kg/ha was found to be more productive (3.37 t/ha).

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