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# EFFECT OF PHOSPHORUS AND SULPHUR ON GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

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## ABSTRACT

A field experiment was conducted in the crop research farm of SHUATS, Prayagraj to know the effect of phosphorus and Sulphur on growth and yield of groundnut. The experiment consisted of 10 treatments which includes three levels of phosphorus (40, 55 and 70 kg/ha) and Sulphur (20, 30 and 40 kg/ha). The treatment receiving 70 kg phosphorus + 40 kg Sulphur/ha produced significantly higher plant height (60.36 cm), Kernel (2.37 t/ha), pod yield (3.26 t/ha), total number of pods/plant (20) and 100 kernel weight (43.33 g). However, Net returns (138787.30 rs/ha) and B: C ratio (1.82) was also obtained maximum with the application of 70 kg phosphorus + 40 kg Sulphur/ha. This experiment shown treatment receiving 70 kg phosphorus+ 40 kg Sulphur/ ha was more productive as well as economic also.

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual legume native to South America. It is grown in most tropical, sub-tropical and warm temperate regions of world between 400 N and 400 S latitudes. Groundnut is one of the most important oilseed crop of India which occupies first in terms of area and second in terms of production. Groundnut crop area in India is at 40.12 lakh ha in 2018-2019. Similarly, production and yield are estimated at 37.70 lakh tones and 931 kg/ha respectively. Inadequate and/or imbalance use of fertilizers has been identified as one of the critical constraints in groundnut production under rainfed farming situation. Balanced nutrition is considered as one of the basic needs "to achieve the potential yield" (Yadav *et al.*, 2017). Phosphorus is important for root and kernel development and it leads to early flowering and pegging. Groundnut showed response to the application of phosphorus at 40 to 75 kg/ha. Sulphur is one of the essential plant nutrients which are best known for its important and specific role in the synthesis of Sulphur containing amino acids like methionine, cysteine, and synthesis of proteins, chlorophyll and oil. It lowers the HCN content of certain crops, promotes nodulation in legumes and produces heavier grains of oilseeds. Sulphur is also known to promote nodulation in legumes thereby N fixation and associated with the crops of spurious nutrition and market quality. The positive response of Sulphur application to groundnut has been reported by Ramdevputra, 2010 and Dash *et al.*,2013. Keeping in view the above fact, the experiment was conducted to assess the effect of phosphorus and Sulphur on nodulation, yield attributes and yield of groundnut.

## MATERIALS AND METHODS

A field experiment was conducted at Crop Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) located at 25º 39′ 42" N latitude, 81º 67′ 56" E longitude and 98 m altitude above the mean sea level, during rainy (kharif) season of 2019 on sandy loam soil, having moderately basic pH (7.5), organic carbon (0.58%), available nitrogen (219 kg/ha), phosphorus (19.6 kg/ha), potassium (239.2 kg/ha) and Sulphur (15.38 ppm). The climate of the region is semi-arid subtropical. Treatments comprised of $T_1$ - 40 kg $P_2O_5$ + 20 kg S/ha, $T_2$ - 40 kg $P_2O_5$ + 30 kg S/ha, $T_3$ - 40 kg $P_2O_5$ + 40 kg S/ha, $T_4$ - 55 kg $P_2O_5$ + 20 kg S/ha, $T_5$ - 55 kg $P_2O_5$ + 30 kg S/ha, $T_6$- 55 kg $P_2O_5$ + 40 kg S/ ha, $T_7$ - 70 kg $P_2O_5$ + 20 kg S/ha, $T_8$ - 70 kg $P_2O_5$ + 30 kg S/ha , $T_9$ - 70 kg $P_2O_5$ + 40 kg S/ ha and $T_{10}$ – control. These were replicated three times in Randomized Block Design. Recommended dose of fertilizers were applied at the time of sowing in the form of Urea, SSP, MOP and gypsum (for Sulphur). Seeds were placed in roe to row spacing 30 cm and plant to plant spacing 10 cm.

### Chemical analysis of soil

Collected soil samples were analyzed for organic carbon by rapid titration method (Sparks, 1996), Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956), available phosphorus by Olsen's method as outlined by Jackson (1967), available potassium was determined by extracting with neutal normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) and available S was estimated by turbid metric method as described by Sparks (1996).

### Statistical analysis

Experimental data collected was subjected to statistical analysis by adopting Fishers method of Analysis of variance (ANOVA) as outlined by Gomez and Gomez (2010). Critical Difference (CD) values were calculated the 'F' test was found significant at 5% level.

## RESULTS AND DISCUSSION

### Plant height

At harvest, maximum plant height was found with application of 70 kg/ha Phosphorus + 40 kg/ha Sulphur (60.36 cm) which was significantly superior over rest of the treatments except with 55 kg/ha Phosphorus +40 kg/ha Sulphur (59.98 cm) and 70 kg/ha Phosphorus + 20 kg/ha Sulphur (59.74 cm) which were statistically at par with 70 kg/ha Phosphorus + 40 kg/ha Sulphur which was 3.5% higher than control. Increased plant height was due Phosphorus is involved in cell division, elongation, multiplication and development. Barik *et al*. (1994) was reported that plant height increased linearly by the application of Phosphorus at 80 kg/ha. The increase in growth might be ascribed to better root formation due to Sulphur, which in turn activated.

### Number of nodules/plant

In present investigation, no. of nodules per plant was increased with increasing crop age upto 50 DAS, after that they were decreased to at harvest. At 50 DAS maximum no.of nodules were found with 70 kg/ha Phosphorus + 40 kg/ha Sulphur which was significantly superior over rest of the treatments except with 70 kg/ha Phosphorus + 30 kg/ha Sulphur (192.66) and 70 kg/ha Phosphorus + 20 kg/ha Sulphur (182.11) which were statistically at par with 70 kg/ha Phosphorus + 40 kg/ha Sulphur which was 13.64 % higher than control. Phosphorus plays an important role in nodules formation thereby increases in the number of nodules in groundnut. 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).

### Plant dry weight g/plant

At harvest, highest dry weight (32.02 g/plant) was recorded with application of 70 Kg/ha Phosphorus + 30 Kg/ha Sulphur, which was superior over rest of all the treatments except with application of 55 Kg/ha Phosphorus + 30 Kg/ha Sulphur (31.54 g/plant), 55 Kg/ha Phosphorus + 40 Kg/ha Sulphur (29.48 g/plant), 70 Kg/ha Phosphorus + 20 Kg/ha Sulphur (29.48 g/plant) and 70 Kg/ha Phosphorus + 40 Kg/ha Sulphur (29.42 g/plant), which was 11.49% higher than control.

### Yield attributes and Yield

Application of 70 kg/ha Phosphorus + 40 kg/ha Sulphur recorded significantly maximum pods/plant (20) which was

**Table 1: Effect of Phosphorus and Sulphur on plant height of Groundnut**

| TREATMENTS | Plant height (cm) | | | |
|---|---|---|---|---|
| | 25 DAS | 50 DAS | 75 DAS | At harvest |
| 40 kg/ha Phosphorus + 20 kg/ha Sulphur | 13.21 | 49.8 | 57.53 | 58.14 |
| 40 kg/ha Phosphorus + 30 kg/ha Sulphur | 12.37 | 46.94 | 58.58 | 59.14 |
| 40 kg/ha Phosphorus + 40 kg/ha Sulphur | 12.5 | 50.1 | 57.97 | 58.45 |
| 55 kg/ha Phosphorus + 20 kg/ha Sulphur | 13.94 | 52.96 | 58.9 | 59.44 |
| 55 kg/ha Phosphorus + 30 kg/ha Sulphur | 13.72 | 50.64 | 58.61 | 59.09 |
| 55 kg/ha Phosphorus + 40 kg/ha Sulphur | 13.04 | 49.84 | 58.97 | 59.98 |
| 70 kg/ha Phosphorus + 20 kg/ha Sulphur | 13.48 | 53.14 | 59.06 | 59.74 |
| 70 kg/ha Phosphorus + 30 kg/ha Sulphur | 14.4 | 51.71 | 58.81 | 59.57 |
| 70 kg/ha Phosphorus + 40 kg/ha Sulphur | 14.89 | 53.18 | 59.54 | 60.36 |
| Control | 12.61 | 49.14 | 58.08 | 58.23 |
| SEm (±) | 0.94 | 1.14 | 0.28 | 0.26 |
| CD (5%) | NS | 3.4 | 0.85 | 0.78 |

**Table 2: Effect of Phosphorus and Sulphur on number of nodules of Groundnut**

| TREATMENTS | Number of nodules/plant | | | |
|---|---|---|---|---|
| | 25 DAS | 50 DAS | 75 DAS | At harvest |
| 40 kg/ha Phosphorus + 20 kg/ha Sulphur | 39.22 | 156.11 | 68.77 | 42.88 |
| 40 kg/ha Phosphorus + 30 kg/ha Sulphur | 45.22 | 158.66 | 70.22 | 42.77 |
| 40 kg/ha Phosphorus + 40 kg/ha Sulphur | 42.22 | 158.33 | 68.66 | 41.55 |
| 55 kg/ha Phosphorus + 20 kg/ha Sulphur | 49.22 | 169.33 | 65.55 | 40.66 |
| 55 kg/ha Phosphorus + 30 kg/ha Sulphur | 46.22 | 171.66 | 77.55 | 44.55 |
| 55 kg/ha Phosphorus + 40 kg/ha Sulphur | 45.7 | 167.33 | 79.33 | 40.22 |
| 70 kg/ha Phosphorus + 20 kg/ha Sulphur | 49 | 182.11 | 75 | 45.33 |
| 70 kg/ha Phosphorus + 30 kg/ha Sulphur | 50.22 | 192.66 | 79.77 | 43.44 |
| 70 kg/ha Phosphorus + 40 kg/ha Sulphur | 52.88 | 193 | 79.88 | 45.77 |
| Control | 42.77 | 166.66 | 76.21 | 42.33 |
| SEm (±) | 2.53 | 4.27 | 2.7 | 1.57 |
| CD (5%) | 7.52 | 12.71 | 8.02 | NS |

**Table 3: Effect of Phosphorus and Sulphur on plant dry weight of Groundnut**

| TREATMENTS | Plant dry weight (g/plant) | | | |
|---|---|---|---|---|
| | 25 DAS | 50 DAS | 75 DAS | At harvest |
| 40 kg/ha Phosphorus + 20 kg/ha Sulphur | 4.38 | 13.28 | 24.85 | 27.89 |
| 40 kg/ha Phosphorus + 30 kg/ha Sulphur | 5.11 | 14.3 | 26.1 | 28.6 |
| 40 kg/ha Phosphorus + 40 kg/ha Sulphur | 4.94 | 14.67 | 26.72 | 28.32 |
| 55 kg/ha Phosphorus + 20 kg/ha Sulphur | 4.92 | 16.11 | 25.1 | 28.72 |
| 55 kg/ha Phosphorus + 30 kg/ha Sulphur | 4.93 | 15.57 | 26.51 | 31.54 |
| 55 kg/ha Phosphorus + 40 kg/ha Sulphur | 5.29 | 15.55 | 26.58 | 29.48 |
| 70 kg/ha Phosphorus + 20 kg/ha Sulphur | 5.09 | 16.2 | 26.74 | 29.48 |
| 70 kg/ha Phosphorus + 30 kg/ha Sulphur | 5.09 | 16.4 | 28.38 | 32.02 |
| 70 kg/ha Phosphorus + 40 kg/ha Sulphur | 5.21 | 17 | 27.62 | 29.41 |
| Control | 4.32 | 13.55 | 24.17 | 28.34 |
| SEm (±) | 0.34 | 0.38 | 0.76 | 1.08 |
| CD (5%) | 1.01 | 1.15 | 2.27 | 2.60 |

**Table 4: Effect of Phosphorus and Sulphur on yield attributes and yield of Groundnut**

| TREATMENTS | Number of pods /plant | Number of Kernels /pod | Seed index (g) | Pod yield (t/ha) | Haulm yield (t/ha) | Kernel yield (t/ha) | Shelling % | HI (%) |
|---|---|---|---|---|---|---|---|---|
| 40 kg/ha Phosphorus + 20 kg/ha Sulphur | 15.77 | 1.66 | 36.66 | 1.88 | 4.38 | 1.33 | 70.75 | 33.4 |
| 40 kg/ha Phosphorus + 30 kg/ha Sulphur | 17.77 | 1.77 | 39.33 | 2.37 | 4.71 | 1.7 | 71.75 | 33.43 |
| 40 kg/ha Phosphorus + 40 kg/ha Sulphur | 16.11 | 1.88 | 38.33 | 2.48 | 4.84 | 1.83 | 73.96 | 33.9 |
| 55 kg/ha Phosphorus + 20 kg/ha Sulphur | 18.55 | 2 | 40.33 | 2.47 | 5.13 | 1.82 | 73.25 | 31.68 |
| 55 kg/ha Phosphorus + 30 kg/ha Sulphur | 18.55 | 2 | 38.33 | 2.67 | 5.14 | 1.92 | 72.34 | 34.18 |
| 55 kg/ha Phosphorus + 40 kg/ha Sulphur | 18.77 | 2 | 40.66 | 2.62 | 5.31 | 1.85 | 70.78 | 33.75 |
| 70 kg/ha Phosphorus + 20 kg/ha Sulphur | 19.66 | 2 | 43 | 2.73 | 5.34 | 1.98 | 72.89 | 33.83 |
| 70 kg/ha Phosphorus + 30 kg/ha Sulphur | 19.77 | 2 | 42 | 2.82 | 5.41 | 2 | 71.04 | 34.26 |
| 70 kg/ha Phosphorus + 40 kg/ha Sulphur | 20 | 2 | 43.33 | 3.26 | 5.61 | 2.37 | 72.87 | 36.48 |
| Control | 17.55 | 1.88 | 38 | 2.79 | 4.47 | 1.95 | 70.19 | 33.24 |
| SEm (±) | 0.27 | 0.05 | 2.43 | 0.15 | 0.12 | 0.11 | 1.3 | 1.5 |
| CD (5%) | 0.81 | 0.16 | NS | 0.46 | 0.38 | 0.33 | NS | 4.45 |

**Table 5: Effect of Phosphorus and Sulphur on Economics of Groundnut**

| TREATMENTS | Cost of cultivation | Gross Return | Net Return | Benefit Cost Ratio |
|---|---|---|---|---|
| 40 kg/ha Phosphorus + 20 kg/ha Sulphur | 73052.22 | 146479 | 73426.78 | 1 |
| 40 kg/ha Phosphorus + 30 kg/ha Sulphur | 73086.55 | 158083.8 | 84997.28 | 1.16 |
| 40 kg/ha Phosphorus + 40 kg/ha Sulphur | 73119.25 | 164854 | 91734.75 | 1.25 |
| 55 kg/ha Phosphorus + 20 kg/ha Sulphur | 74608.47 | 165570.8 | 90962.36 | 1.21 |
| 55 kg/ha Phosphorus + 30 kg/ha Sulphur | 74642.7 | 177177.2 | 102534.5 | 1.37 |
| 55 kg/ha Phosphorus + 40 kg/ha Sulphur | 74675.5 | 174495.8 | 99820.33 | 1.33 |
| 70 kg/ha Phosphorus + 20 kg/ha Sulphur | 76164.72 | 181358.7 | 105193.9 | 1.38 |
| 70 kg/ha Phosphorus + 30 kg/ha Sulphur | 76199.05 | 187511.5 | 111312.5 | 1.46 |
| 70 kg/ha Phosphorus + 40 kg/ha Sulphur | 76231.75 | 215019 | 138787.3 | 1.82 |
| Control | 75060.2 | 148342.5 | 73282.3 | 0.97 |
| SEm (±) | | 11076.37 | 11076.37 | 0.14 |
| CD (5%) | | 32909.58 | 32909.59 | 0.43 |

12.25% higher over control, kernel/pod (2) which was 6% higher over control, seed index (43.33 g) which was 12.30% higher than control, kernel yield (2.37 t/ha) which was 17.72% higher than control, pod yield (3.26 t/ha) which was 14.41% higher than control, haulm yield (5.61 t/ha) which was 20.32% higher than control, harvest index (36.48 %) which was 8.88% higher than control. Whereas 40 kg/ha Phosphorus + 40 kg/ ha Sulphur recorded maximum shelling % (73.96%1) which was 5.09% higher than control. The improvement in yield attributes of groundnut might be due to the Sulphur plays vital and important role in energy storage and transformation, carbohydrate metabolism and activation of enzymes also increase the photosynthetic activity of plants. These findings endorse the results of Kadam *et al*. (2000); Jamal *et al*. (2006); Kader and Mona (2013) and Ram Katiyar (2013).The marked improvement in pods, kernel and haulm yields due to applying Sulphur could be ascribed to overall improvement in vigor and crop growth, as reflected in plant height, dry matter accumulation and number of nodules/plant. 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).

**Effect of Phosphorus and Sulphur on Economics of Groundnut**

Application of 70 kg/ha phosphorus+ 40 kg/ha Sulphur recorded significantly maximum net return (138787.30 /ha) and Benefit-Cost Ratio (1.82) which was significantly superior over other treatments except with 70 kg/ha phosphorus + 30 kg/ha Sulphur (111312.50 rs/ha) and 1.46 respectively). The higher pod yield adds in getting higher farm profit with use of gypsum as source of Sulphur. Similar findings were also reported by Dash *et al*. (2013).

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