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Effect of Phosphorus and Sulphur Levels on Nutrient Content and Uptake of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT: Due to unbalanced nutrient application, productivity of groundnut is lower than anticipated in India. The efforts to enhance groundnut production can be achieved by proper nutrient management practices. So, keeping this in view, the field experiment was conducted during the *Kharif* season of 2021 at crop physiology field lab, Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The experiment was laid out in split plot design with four phosphorus levels (0, 40, 50, 60 kg P_2O_5 ha^{-1}) in main plots and four sulphur levels (0, 25, 50, 75 kg Sha^{-1}) in sub-plots with three replications. The highest uptake of N (82.9 kg ha^{-1}), P (12.7 kg ha^{-1}), K (14.6 kg ha^{-1}), S (8.2 kg ha^{-1}) by kernel and N (97.6 kg ha^{-1}), P (16.7 kg ha^{-1}), K (81.7 kg ha^{-1}), S (15.0 kg ha^{-1}) by haulm were obtained with application of 60 kg P_2O_5 ha^{-1}, which were significantly higher over control by 90.5, 92.4, 75.9, 95.2 and 47.2, 81.5, 46.4, 78.5 percent, respectively. Among sulphur levels, highest uptake of N (79.0 kg ha^{-1}), P (12.3 kg ha^{-1}), K (14.2 kg ha^{-1}), S (8.0 kg ha^{-1}) by kernel and N (93.7 kg ha^{-1}), P (15.4 kg ha^{-1}), K (77.8 kg ha^{-1}), S (13.9 kg ha^{-1}) by haulm were obtained with 75 kg Sha^{-1}, which were significantly higher over control by 51.0, 55.6, 46.3, 63.2 and 25.4, 38.7, 24.0, 43.2 percent, respectively.

Keywords: Groundnut, phosphorus levels, sulphur levels, nutrient uptake.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the best-known oilseed crop which belongs to the family Leguminosae and sub-family Papilionaceae. It is believed that it has been originated in South America. China is the world's largest producer of groundnut with 4.6 million ha area, 17 million tonnes production and productivity of 37.0 quintal ha^{-1} followed by India (Anonymous, 2020). Groundnut account for 25% of India total oilseed production (Manan and Sharma 2018). Groundnut covers an area of 4.8 million ha with production of 9.9 million tonnes and productivity of 20.6 quintal ha^{-1} in India during 2019-20 (Anonymous, 2020). There is less productivity of groundnut in India as compared to average productivity of world due to unbalanced and insufficient usage of nutrients. Being a legume-oilseed crop, groundnut has a high phosphorus, calcium, and sulphur demand. Application of phosphorus determines plant reproductive efficiency and promotes plant growth, development and increased nutrient uptake in groundnut (Bairagi *et al.,* 2017). The phosphorus in legumes plays an essential role as part of the membrane system of the cell, chloroplast and the mitochondria. Plants use it for energy transfer in metabolic processes such as photosynthesis (in the form of ATP and ADP), starch and sugar transformation and nutrient movement.

In addition to NPK, sulphur is a key dietary component that plays a crucial role in the metabolism of carbohydrates, the production of glycosides, oils, and a variety of other compounds involved in the N-fixing process and photosynthesis of plants. Its nourishment to crop is important both according to quality and quantity perspective (Devi *et al.,* 2022). Sulphur is essential in the process of synthesis of amino acids that contain sulphur, such as methionine and cysteine. Sulphur containing enzyme is also responsible for the synthesis of vitamins (biotin and thiamine), as well as co-enzyme A. Sulphur deficiency disrupts nitrogen metabolism and reduces the uptake of nutrients (Singh and Mann 2007).

Keeping above points in mind present investigation was conducted. The objective of the investigation to study the impact of phosphorus and sulphur levels on nutrient content and uptake of groundnut.

MATERIALS AND METHODS

The field experiment was conducted during the *Kharif* season of 2021 at crop physiology field lab, Department of Agronomy, CCS Haryana Agricultural University, Hisar. The experiment was laid out in split plot design with four phosphorus levels (0, 40, 50, 60 kg P_2O_5 ha^{-1}) in main plots and four sulphur levels (0, 25, 50, 75 kg Sha^{-1}) in sub-plots with three replications. The soil of the field was sandy in texture, slightly alkaline in pH (8.1), EC (0.14 dsm^{-1}), low in organic carbon (0.12%), low in available N (131.4 $kgha^{-1}$), medium in available P (15.8 $kgha^{-1}$), medium in available K (137.6 $kgha^{-1}$) and low in available S (19.4 $kgha^{-1}$). Standard cultural practices were followed for all treatments which were recommended in groundnut crop. Nitrogen, phosphorus, potassium and sulphur content in kernel and haulm at harvest were determined. For analysis of Nitrogen, phosphorus, potassium and sulphur, oven dried plant material (kernel and haulm at harvest) from each plot were grinded separately with grinder and analyzed for Nitrogen (Nessler's reagent method, Lindner, 1944), phosphorus (Vanadomolybdo-phosphoric acid yellow colour method, Jackson (1973), potassium (Flame photometer method, Richards, 1954) and sulphur (Chesnin and Yien 1950) contents in sample. The uptake of each nutrient was computed as:

Nutrient uptake ($kgha^{-1}$) =

$$\frac{\text{Percent nutrient in kernel and haulm} \times \text{Yield (kgha}^{-1}\text{)}}{100}$$

All the data recorded were analyzed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez 1984) for split plot design. The least significance test was used to decipher the effect of treatments at 5% level of significance.

RESULTS AND DISCUSSION

A. Effect on N content and uptake by kernel and haulm

A close perusal of data in Table 1 revealed that application of 60 kg $P_2O_5ha^{-1}$ significantly improved the N content by 8.1 and 17.3 percent in kernel and 2.3 and 5.3 percent in haulm over 40 kg P_2O_5 ha^{-1} and control, respectively, which were statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg Sha^{-1} significantly improved the N content by 9.0 and 3.5 percent in kernel and haulm over control, which were remained at par with 25 and 50 kg Sha^{-1}. Data presented given in Table 2exhibited that significantly highest uptake of N by kernel (82.9 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1} which was 25.2 and 90.5 percent higher over 40 kg P_2O_5 ha^{-1} and control respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Similarly, significantly highest uptake of N by haulm (97.6 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1}, which was 20.0 and 47.2 percent higher over 40 kg P_2O_5 ha^{-1} and control, respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg Sha^{-1} recorded significantly higher uptake of N by 6.3, 19.1 and 51.0 percent in kernel over 50 kg Sha^{-1}, 25 kg Sha^{-1} and control, respectively. Similarly, significantly highest uptake of N by haulm (93.7 $kgha^{-1}$) was recorded at 75 kg Sha^{-1}, which was 25.4 percent higher over control and it was statistically at par with 50 and 25 kg Sha^{-1}.

B. Effect on P content and uptake by kernel and haulm

An attentive perception of data given in Table 1 indicated that application of 60 kg $P_2O_5ha^{-1}$ significantly improved the P content by 7.4 and 16.0 percent in kernel and 11.1 and 30.4 percent in haulm over 40 kg P_2O_5 ha^{-1} and control respectively, which were statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg Sha^{-1} significantly improved the P content by 9.6 and 16.0 percent in kernel and haulm over control, which were remained at par with 25 and 50 kg Sha^{-1}. Data mentioned in Table 2 reflected that significantly highest uptake of P by kernel (12.7 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1} which was 27.0 and 92.4 percent higher over 40 kg P_2O_5 ha^{-1} and control respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Similarly, significantly highest uptake of P by haulm (16.7 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1}, which was 29.4 and 81.5 percent higher over 40 kg P_2O_5 ha^{-1} and control, respectively, which was statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg Sha^{-1} recorded significantly higher uptake of P by 11.8, 24.2 and 55.6 percent in kernel over 50 kg Sha^{-1}, 25 kg Sha^{-1} and control, respectively. Similarly, significantly highest uptake of P by haulm (15.4 $kgha^{-1}$) was recorded at 75 kg Sha^{-1}, which was 38.7 percent higher over control but it was statistically at par with 50 and 25 kg Sha^{-1}.

C. Effect on K content and uptake by kernel and haulm

A perusal of data in Table 1 depicted that application of 60 kg P_2O_5 ha^{-1} significantly improved the K content by 8.06 percent in kernel over control, which was statistically at par with 50 kg and 40 kg P_2O_5 ha^{-1}. Non significant difference was recorded among phosphorus levels for K content in haulm. Sulphur levels failed to produce significant variation for K content in Kernel and Haulm. A disquisition to data given in Table 2 exhibited higher uptake of K by kernel (14.6 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1}, which was 19.6 and 75.9 percent significantly higher over 40 kg P_2O_5 ha^{-1} and control, respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Similarly, highest uptake of K by haulm (81.7 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1}, which was 20.3 and 46.4 percent significantly higher over 40 kg P_2O_5 ha^{-1} and control, respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg S ha^{-1} recorded significantly higher uptake of K by 6.7, 20.3 and 46.3 percent in kernel over 50 kg, 25 kg Sha^{-1} and control, respectively. Similarly, significantly highest uptake of K by haulm (77.8 kg ha^{-1}) was recorded at 75 kg Sha^{-1}, which was 24.0 percent higher over control but it was statistically at par with 50 and 25 kg Sha^{-1}.

D. Effect on S content and uptake by kernel and haulm

A probe to data presented in Table 1 unveiled that application of 60 kg $P_2O_5ha^{-1}$ significantly improved the S content by 2.7, 15.1 and 22.5 percent in kernel and 8.0, 17.4 and 28.6 percent in haulm over 50 kg, 40 kg P_2O_5 ha^{-1} and control, respectively. Application of 75 kg Sha^{-1} significantly improved the S content by 15.1 and 22.5 percent in kernel over 25 kg Sha^{-1} and control, respectively which were remained statistically at par with 50 kg Sha^{-1}. Application of 75 kg Sha^{-1} significantly improved the S content by 4.0, 8.3 and 18.1 percent in haulm over 50 kg, 25 kg Sha^{-1} and control, respectively. A delve to data exhibited in Table 2 revealed that significantly highest uptake of S by kernel (8.2 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1}, which was 32.2 and 95.2

percent higher over 40 kg P_2O_5 ha^{-1} and control, respectively, which was statistically at par with 50 kg P_2O_5 ha^{-1}. Similarly, significantly highest uptake of S by haulm (15.0 $kgha^{-1}$) was recorded at 60 kg P_2O_5 ha^{-1} which was 35.1 and 78.5 percent higher over 40 kg P_2O_5 ha^{-1} and control, respectively, but it was statistically at par with 50 kg P_2O_5 ha^{-1}. Application of 75 kg Sha^{-1} recorded significantly higher uptake of S by 9.5, 26.9 and 63.2 percent in kernel over 50 kg Sha^{-1}, 25 kg Sha^{-1} and control, respectively. Similarly, significantly highest uptake of S by haulm (13.9 $kgha^{-1}$) was recorded at 75 kg Sha^{-1}, which was 18.8 and 43.2 percent higher over 25 kg Sha^{-1} and control, respectively and it was statistically at par with 50 kg Sha^{-1}.

The significant improvement in N, P, K and S status in kernel and haulm with the increase in levels of phosphorus up to 60 $kgha^{-1}$ could be attributed to increased nutrient availability in soil environment. Increased food availability in the root zone enhanced cellular metabolic activity of plant, which may have increased nutrient uptake and accumulation in vegetative plant parts. Thus, increased nutrient availability with additional phosphorus appears to have maintained critical concentrations at the cellular level, met their requirements for profuse plant growth and facilitated their efficient translocation towards sink components. Similar findings have been also reported by Kumar *et al.* (2014); Singh *et al.* (2014). The beneficial effect of sulphur fertilization on crop nutrient concentration appears to be due to a better nutritional environment in both the rhizosphere and the plant system, which resulted in increased N, P, K and S translocation to reproductive parts, resulting in higher nutrient concentrations in kernel and haulm. Increased food availability in the root zone, combined with enhanced metabolic activity at the cellular level, may have increased nutrient uptake and accumulation in diverse plant sections. Higher nutrient buildup in vegetative plant parts, along with better metabolism, resulted in more nutrient transfer to the reproductive sections of the crop. The observed relationship is in close agreement with findings of Yadav *et al.* (2020); Kumar *et al.* (2020).

Table 1: Effect of phosphorus and sulphur levels on N, P, K and S content (%) in kernel and haulm.

Treatment	N content		P content		K content		S content	
	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm
Phosphorus levels (kg P_2O_5 ha^{-1})								
Control	3.28	1.68	0.50	0.23	0.62	1.40	0.31	0.21
40	3.56	1.73	0.54	0.27	0.65	1.44	0.33	0.23
50	3.77	1.76	0.56	0.28	0.66	1.46	0.37	0.25
60	3.85	1.77	0.58	0.30	0.67	1.48	0.38	0.27
SEm ±	0.040	0.010	0.004	0.006	0.009	0.043	0.002	0.001
CD at 5%	0.140	0.040	0.014	0.02	0.032	NS	0.006	0.004
Sulphur levels (kg S ha^{-1})								
Control	3.41	1.70	0.52	0.25	0.63	1.42	0.31	0.22
25	3.62	1.73	0.54	0.27	0.65	1.45	0.34	0.24
50	3.70	1.74	0.55	0.28	0.66	1.46	0.36	0.25
75	3.72	1.76	0.57	0.29	0.67	1.46	0.37	0.26
SEm ±	0.040	0.010	0.010	0.008	0.010	0.043	0.003	0.002
CD at 5%	0.120	0.030	0.030	0.023	NS	NS	0.010	0.007

Table 2: Effect of phosphorus and sulphur levels on N, P, K and S uptake ($kgha^{-1}$) in kernel and haulm.

Treatment	N uptake			P uptake			K uptake			S uptake		
	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total
Phosphorus levels (kg P_2O_5 ha^{-1})												
Control	43.5	66.3	109.8	6.6	9.2	15.8	8.3	55.8	64.1	4.2	8.4	12.6
40	66.2	81.3	147.5	10.0	12.9	22.9	12.2	67.9	80.2	6.2	11.1	17.4
50	79.3	95.6	174.9	11.8	15.5	27.3	14.0	79.7	93.8	7.8	14.0	21.8
60	82.9	97.6	180.5	12.7	16.7	29.4	14.6	81.7	96.4	8.2	15.0	23.3
SEm ±	1.6	3.7	4.7	0.4	0.5	0.7	0.5	3.8	4.0	0.20	0.5	0.5
CD at 5%	5.8	13.3	16.8	1.3	1.7	2.5	1.5	13.4	14.4	0.70	1.6	1.9
Sulphur levels (kg S ha^{-1})												
Control	52.3	74.7	127.1	7.9	11.1	19.1	9.7	62.7	72.4	4.9	9.7	14.6
25	66.3	82.5	148.8	9.9	13.1	23.0	11.8	69.0	80.9	6.3	11.7	18.1
50	74.3	89.8	164.2	11.0	14.6	25.6	13.3	75.7	89.0	7.3	13.1	20.5
75	79.0	93.7	172.7	12.3	15.4	27.7	14.2	77.8	92.1	8.0	13.9	21.9
SEm ±	1.4	2.6	2.7	0.3	0.6	0.7	0.2	3.5	3.4	0.1	0.4	0.4
CD at 5%	4.3	7.7	8.0	1.0	1.8	2.0	0.7	10.2	10.2	0.3	1.2	1.2

CONCLUSIONS

Based on the above cited results of the experiment it could be concluded that application of 60 kg P_2O_5 ha^{-1} and 75 kg S ha^{-1} significantly improved nutrient uptake of groundnut but it was statistically at par with application of 50 kg P_2O_5 ha^{-1} and 50 kg S ha^{-1}. So, to obtain better uptake of nutrient groundnut, crop may be fertilized with phosphorus and sulphur levels of 50 kg ha^{-1} each.

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Conflict of Interest. None.

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