Original Research Article

Dry matter accumulation and biomass partitioning of groundnut(*Arachis hypogaea* L.) as influenced bygenotypes and sulphur levels

ABSTRACT

Groundnut is an important oilseed crop and belongs to the family Fabaceae. However, the productivity of groundnut in India is less as compared to average productivity of the world. Variety is a key factor that affects the development, productivity, and quality of groundnut.The main cause of thelow groundnut production is an unbalanced and insufficient usage of nutrients.Because groundnut is a legume-oilseed crop, it has a high phosphorus, calcium, and Sulphur demand. Therefore, this field experiment was conducted during the *Kharif* season of 2023 at Crop Physiology Field Laboratory, Department of Agronomy, CCS Haryana Agricultural University, Hisar.The experiment was laid out in split plot design with four genotypes (G_1-MH 4, G_2-HNG 10, G_3-HNG 69and G_4- GNH 804) in main plots and four sulphur levels (S_1-Control, S_2-20 kg S/ha,S_3-40 kg S/haand S_4-60 kg S/ha) in sub-plots with three replications. Theresults revealed that among genotypesGNH 804 recorded significantly higher total dry matter accumulation and its partitioning into different plant parts at different growth stages in groundnut. This was followed by HNG 69.Among thesulphur levels, the60 kg S/ha treatmentrecorded thehighestdry matter accumulation, and this was closely followed by thesulphur level 40 kg S/ha.So, to obtain higher total dry matter accumulation and its partitioning, the genotype GNH 804 may be fertilized with 40 kg S/ha.

Key words: Groundnut, genotypes, sulphur, biomass partitioning

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the best-known oilseed crops and belongs to the family Fabaceaeand sub-family Papilionaceae. It is believed that it originated in South America [1, 2].The major groundnut producing states in India are Gujarat, Rajasthan and Tamil Nadu. Groundnut accounts for 31.7% of India total oilseed production and about 28.3 % of the cultivated area of total oilseeds [3, 4].There is less productivity of groundnut in India as compared to globalaverage productivity due to uncertainty in monsoon rainfall and different bio-stresses such as diseases, insect pests and weeds. The main cause of low groundnut production is the unbalanced and insufficient usage of nutrients. Because groundnut is a legume-oilseed crop, it has a high phosphorus, calcium, and sulphur demand [5, 6].

The type of variety and nutrient, especially sulphur is crucial for the physiological growth and yield of crops like groundnut. Selecting the appropriate variety is crucial for groundnut production. The adoption of high-yielding varieties has surged in recent years, bringing the country close to self-sufficiency in groundnut. Varieties suited to early *Kharif* differ significantly in growth habits compared to those suited for other seasons. Certain groundnut varieties have demonstrated that a poor source-to-sink relationship leads to the formation of more unfilled pods and a lower seed yield. Variety is therefore a key factor that affects the development, productivity, and quality of groundnut[7, 8].

Sulphur plays a crucial role in several metabolic enzyme processes in plants, as it affects productivity both quantitatively and qualitatively [9]. Sulphur is essential in the process of synthesis of amino acids that contain sulphur, such as methionine and cysteine and it plays an important role in the synthesis of proteins, chlorophyll and oil [10]. The Sulphur containing enzyme is also responsible for the synthesis of vitamins (biotin and thiamine), as well as co-enzyme A and metabolism of carbohydrates, proteins and fats. Biomass partitioning is the most influential physiological factor in yield determination of groundnut.The high yield is associated with rapid increase in pod number and near cessation of vegetative growth during pod filling. Based on the above reasons, a study was conducted to investigate how genotypes and varying sulphur levels influence dry matter accumulation and biomass partitioning of groundnut.

MATERIALS AND METHODS

The field experiment was conducted during the *Kharif* season of 2023 at the Crop Physiology Field Laboratory of the, Department of Agronomy, CCS Haryana Agricultural University, Hisar.Geographically, Hisar is situated on 29°10' N latitude and 75°46' E longitude at an elevation of 215 m above mean sea level. The total rainfall received during the crop growing period was 176.1 mm. Weekly maximum and minimum temperatures remained under a suitable range for different crop growth stages. Average temperature on sowing date for crop season was 35.2°C, while average temperature at harvesting was 24.9°C.On the other hand, mean weekly maximum and minimum temperatures ranged between 30.5-39.1°C and 15.6-28.3°C, respectively during crop season. The experiment was laid out in split plot design with four genotypes (G_1-MH 4, G_2-HNG 10, G_3-HNG 69 and G_4- GNH 804) in the main plots and four sulphur levels (S_1-Control, S_2-20 kg S/ha, S_3-40 kg S/ha and S_4-60 kg S/ha) in the sub-plots with three replications.The soil of the field was sandy in texture, slightly alkaline in pH (8.1), having normal EC (0.15 ds/m), low organic carbon (0.12%), low available N

(130.8kg/ha), mediumavailable P (17.9 kg/ha), mediumavailable K (138.8 kg/ha) and lowavailable S (21.4 kg/ha). Standard cultural practices were followed for all treatments which was recommended for groundnut crop.

Dry Matter Accumulation (g) and Partitioning

Three plants were randomly taken from each replication for recording the biomass of leaves, stem, root and pods at different growth stages (30, 60, 90 days after sowing and at maturity) of all the treatments. Plants were taken out with roots after thorough washing of the sand by water jet gently. The plants sampled from each replication were separated into leaves, stem, root and pod and were first dried in the sun and then in oven at 80°C for about 72 hours or more until a constant weight was obtained and then weighed. Dry matter accumulation per plant was calculated by adding the dry weights of individual plant parts and expressed in g/plant.

Percent Contribution of Plant Parts

Per cent contribution of individual plant parts at 30, 60, 90 days after sowing (DAS) and at maturity was computed by using the following formula:

$$\text{Contribution of leaves to total dry weight of plant(\%)} = \frac{\text{Weight of leaves at a particular time}}{\text{Total dry weight of plant at the same time}} \times 100$$

$$\text{Contribution of stem to total dry weight of plant(\%)} = \frac{\text{Weight of stem at a particular time}}{\text{Total dry weight of plant at the same time}} \times 100$$

$$\text{Contribution of root to total dry weight of plant(\%)} = \frac{\text{Weight of root at a particular time}}{\text{Total dry weight of plant at the same time}} \times 100$$

$$\text{Contribution of pod to total dry weight of plant(\%)} = \frac{\text{Weight of pod at a particular time}}{\text{Total dry weight of plant at the same time}} \times 100$$

All the data recorded were analyzed with the help of analysis of variance (ANOVA) technique [11] for split plot design. The least significance test was used to decipher the effect of treatments at 5% level of significance.

RESULTS AND DISCUSSION

I. Effect of genotypes on dry matter, partitioning and percent contribution of plant parts:

The data pertaining to dry matter accumulation in various plant parts at 30 DAS are presented in Table 1. Significant variation among genotypes regarding dry matter accumulation in various plant

parts and total dry weight was recorded at 30 DAS. Numerically, higher values for total dry matter accumulation at 30 DAS were recorded in GNH 804 genotype (2.73 g/plant) followed by HNG 69 (2.63 g/plant). Among genotypes significantly higher dry matter accumulation at 30 DAS in various plant parts leaves (1.23 g/plant), stem (0.66 g/plant) and root (0.84 g/plant) were recorded in GNH 804 genotype, which were 54.00, 69.23 and 147.05 percent higher over MH 4, respectively.Figure 1 showed that the per cent contribution to total dry matter at 30 DAS was more towards leaves followed by stem and root.The data presented in Table 2 showed thatdry matter accumulation in various plant parts at 60 DAS of groundnut was significantly affected by genotypes. Among genotypes significantly higher dry matter accumulation in leaves (7.23 g/plant), stem (10.32 g/plant), root (3.01 g/plant) and pod (2.86 g/plant) were recorded with GNH 804 which were 34.88, 69.73, 67.22and 146.55 percent higher over control, respectively. The higher values for total dry matter accumulation at 60 DAS were recorded in GNH 804 (23.42 g/plant), which was 62.63 per cent higher over MH 4. Figure 2 showed that the per cent contribution to total dry matter at 60 DAS towards stem was more followed by leaves, root and pod. The data presented in Table 3 showed that dry matter accumulation in various plant parts at 90 DAS of groundnut was significantly affected by genotypes. Amongst genotypes, significantly higher dry matter accumulation in leaves (16.60 g/plant), stem (16.72 g/plant), root (3.95 g/plant) and pod (8.59 g/plant) were recorded with GNH 804 which were 41.15, 45.89, 36.20 and 60.60 percent higher over MH 4, respectively but dry matter accumulation in leaves and pods were statistically at par with HNG 69. The higher values for total dry matter accumulation at 90 DAS were recorded in GNH 804 (45.86 g/plant) which was 45.81 per cent higher over MH 4. Figure 3 showed that the maximum per cent contribution to total dry matter at 90 DAS was towards leaves followed by stem, pod and root.The data presented in Table 4 showed thatthe total dry matter per plant was increased significantly with genotype variation.At the time of maturity, GNH 804 resulted in significantly higher dry matter accumulation in root (1.75 g/plant), stem (17.44 g/plant),leaves (15.38 g/plant) and pod (19.05 g/plant). The lowest dry matter in root (0.60g/plant), stem (13.08g/plant), leaves (10.33 g/plant) and pods (10.92 g/plant) were recorded with MH 4.It was also clear from data that at the time of maturity groundnut genotype GNH 804 accumulated significantly higher total dry matter per plant (53.62 g/plant) as compared to other genotypes.Figure 4 showed that the per cent contribution to total dry matter at maturity was more in pod followed by stem, leaves and root.The yield of groundnut genotypes differs mainly because of differences in their ability to develop the reproductive sink rather than differences in their leaf area or crop growth rate (Source). The growth of groundnut fruit was influenced by the time of initiation relative to the changes in assimilates supply of the crop. The preponderant effect of genotypic variation on various growth of groundnut due to increased utilization of carbohydrates for protein synthesis and physiological capacity to translocate them to organ of vegetative growth, resulting in increased growth characteristics. The dry matter

accumulation per plant shows an increasing trend up to maturity in different genotypes.Similar results have been reported by [12, 13, 14].

II. Effect of sulphur levels on dry matter, partitioning and percent contribution of plant parts:

The data presented in Table 1 showed non significant variation was recorded among sulphurlevels regarding dry matter accumulation for stem and leaves at 30 DAS. Among sulphur levels higher dry matter accumulation at 30 DAS inroot (0.71 g/plant) was recorded with 60 kg/ha sulphur level, which was 31.48 percent higher than the control, respectively. Numerically, higher values for total dry matter accumulation at 30 DAS were recorded in sulphur level 60 kg/ha followed by 40 kg/ha.Figure 1 showed that among sulphur levels, the per cent contribution to total dry matter at 30 DAS was more towards leaves followed by stem and root. The data presented in Table 2showed that sulphur levels also affected dry matter accumulation significantly in different plant parts at 60 DAS. Significantly higher dry matter accumulation in leaves (7.16 g/plant), stem (9.36 g/plant), root (2.73 g/plant) and pod (2.57 g/plant) were recorded in 60 kg S/ha sulphur level, which were 26.31, 16.66 and 55.75 percent higher over control, respectively. Significantly higher total dry matter accumulation was recorded in 60 kg S/ha (21.82 g/plant) compared to all other levels.Figure 2 showed that among sulphur levels,the per cent contribution to total dry matter at 60 DAS towards stem was more followed by leaves, root and pod. The data presented in Table 3showed that sulphur levels also affected dry matter accumulation significantly in different plant parts.Significantly higher dry matter accumulation in leaves (16.12 g/plant), stem (15.57 g/plant), root (3.71 g/plant) and pod (8.25 g/plant) were recorded in 60 kg S/ha level which were 21.61, 14.90, 13.80 and 22.58 per cent higher over control, respectively. Significantly higher total dry matter accumulation was recorded in 60 kg S/ha (43.65 g/plant), which was 18.46 per cent higher over control.Figure 3 showed that among sulphur levels, the maximum per cent contribution to total dry matter at 90 DAS was towards leaves followed by stem, pod and root. The data presented in Table 4showedthat sulphur levels 60 kg/ha produced higher dry matter accumulation in leaves (14.40 g/plant), stem (16.50 g/plant), root (1.49 g/plant) and in pod (17.20 g/plant) which were statistically similar with 40 kg S/ha. Sulphur level 60 kg/ha was found significantly superior in terms of total dry matter accumulation per plant (49.59g/plant) at maturity, which was at par with 40 kg S/ha (48.47g/plant).Figure 4 showed that among sulphur levels, the per cent contribution to total dry matter at maturity was more in pod followed by stem, leaves and root.The growth at higher levels of sulphur might be due to the crucial role that sulphur plays in severalmany physiological and biochemical processes that are essential for plant development. In addition, its application to deficient soils can promote overall plant growth. Sulphur is associated with the improvement of sulphur containing amino acids and vitamins, which play a direct role in the vegetative and reproductive growth of plants. Improved growth due to sulphur fertilizer, in combination with higher photosynthesis on one hand and greater mobilization of photosynthates towards reproductive structures on the other hand, may have contributed to the increase in groundnut

yield. Sink strength is reflected in its higher demand for photosynthates and sufficient supply of sulphur also aids in the development of floral primordial or reproductive parts, which might have resulted in the development of pods and kernels in plants. The distribution of available photosynthate to reproductive components could be improved by selecting for more determinate types that cease stem growth as soon as the kernels start growing, and which have the capacity for growth in the kernel to use all the assimilate produced during the reproductive phase. For high yield peak kernel growth had to occur while leaf area was adequate to achieve the full potential of the kernel sink. It has been observed that the yield continues to increase because of continued pod setting, even though assimilate (source) shortage are likely. Thus,it can be concluded that both source and sink are limiting factors in groundnutdepending upon the varieties, though in most cases the source is adequate and only sink is the limiting factor. Stimulation of photosynthesis of a large sink and the utilization of materials accumulated in vegetative structures could contribute to increasing the yield of groundnut.Similar results have been reported by[3, 10].

CONCLUSIONS

The results of the present study revealed that genotypes and sulphur application significantly improved the dry matter accumulation and biomass partitioning in groundnut. Among the four genotypes under study,GNH 804 resulted in significantly higher total plant biomass and its partitioning into different plant parts *viz*, leaves, stem, root and pod at different growth stages in groundnut. This wasfollowed by HNG 69.Therefore, in order to obtain higher total dry matter accumulation and its partitioning, the genotype GNH 804 may be fertilized with 40 kg S/ha.Among thesulphur levels, 60 kg S/ha recorded higher dry matter accumulation. This was closely followed by sulphur level 40 kg S/ha.Therefore, in order toobtain higher total dry matter accumulation and its partitioning, the genotype GNH 804 may be fertilized with 40 kg S/ha.

Table: 1. Effect of groundnut genotypes and sulphur levels on dry matter accumulation (g/ plant) in various plant parts at 30 DAS

Treatment	Dry matter accumulation (g) in various plant parts at 30 DAS			
	Root	Stem	Leaves	Total
Genotypes				
MH 4	0.34	0.39	0.69	1.42
HNG 10	0.65	0.56	1.09	2.30

HNG 69	0.79	0.63	1.21	2.63
GNH 804	0.84	0.66	1.23	2.73
SEm ±	0.01	0.05	0.09	0.09
CD at 5%	**0.03**	**0.17**	**0.33**	**0.03**
Sulphur levels (kg S /ha)				
Control	0.54	0.51	0.92	1.97
20	0.65	0.55	1.05	2.25
40	0.71	0.58	1.10	2.39
60	0.71	0.60	1.12	2.43
SEm ±	0.01	0.04	0.07	0.08
CD at 5%	**0.03**	**NS**	**NS**	**0.25**

Table 2. Effect of groundnut genotypes and sulphur levels on dry matter accumulation (g/ plant) in various plant parts at 60 DAS

Treatment	**Dry matter accumulation (g) in various plant parts at 60 DAS**				
	Root	**Stem**	**Leaves**	**Pod**	**Total**
Genotypes					
MH 4	1.80	6.08	5.36	1.16	14.40
HNG 10	2.52	8.38	6.54	2.14	19.58
HNG 69	2.85	9.67	6.66	2.66	21.84
GNH 804	3.01	10.32	7.23	2.86	23.42
SEm ±	0.03	0.04	0.04	0.01	0.08
CD at 5%	**0.11**	**0.13**	**0.13**	**0.03**	**0.27**
Sulphur levels (kg S /ha)					
Control	2.34	7.41	5.26	1.65	16.66
20	2.51	8.56	6.36	2.15	19.58
40	2.60	9.11	7.01	2.45	21.17
60	2.73	9.36	7.16	2.57	21.82
SEm ±	0.03	0.06	0.03	0.02	0.05
CD at 5%	**0.09**	**0.17**	**0.09**	**0.05**	**0.15**

Table: 3. Effect of groundnut genotypes and sulphur levels on dry matter accumulation (g/ plant) in various plant parts at 90 DAS

Treatment	**Dry matter accumulation (g) in various plant parts at 90 DAS**				
	Root	**Stem**	**Leaves**	**Pod**	**Total**
Genotypes					
MH 4	2.90	11.46	11.76	5.33	31.45

HNG 10	3.51	14.78	15.21	8.23	41.73
HNG 69	3.82	16.33	16.71	8.52	45.38
GNH 804	3.95	16.72	16.60	8.59	45.86
SEm ±	0.02	0.06	0.09	0.05	0.12
CD at 5%	**0.07**	**0.22**	**0.31**	**0.19**	**0.38**
Sulphur levels (kg S /ha)					
Control	3.26	13.55	13.28	6.73	36.82
20	3.54	14.80	15.09	7.63	41.06
40	3.67	15.36	15.79	8.04	42.86
60	3.71	15.57	16.12	8.25	43.65
SEm ±	0.03	0.14	0.09	0.06	0.21
CD at 5%	**0.09**	**0.41**	**0.28**	**0.18**	**0.63**

Table: 4. Effect of groundnut genotypes and sulphur levels on dry matter accumulation (g/ plant) in various plant parts at maturity

Treatment	**Dry matter accumulation (g) in various plant parts at maturity**				
	Root	**Stem**	**Leaves**	**Pod**	**Total**
Genotypes					
MH 4	0.60	13.08	10.33	10.92	34.93
HNG 10	1.31	15.96	13.65	15.05	45.97
HNG 69	1.62	16.83	14.75	17.74	50.94
GNH 804	1.75	17.44	15.38	19.05	53.62
SEm ±	0.02	0.21	0.22	0.19	0.29
CD at 5%	**0.06**	**0.76**	**0.78**	**0.66**	**1.03**
Sulphur levels (kg S /ha)					
Control	1.63	14.56	11.95	13.44	41.58
20	1.32	15.82	13.60	15.66	46.40
40	1.44	16.42	14.16	16.45	48.47
60	1.49	16.50	14.40	17.20	49.59
SEm ±	0.03	0.18	0.23	0.17	0.30
CD at 5%	**0.09**	**0.53**	**0.67**	**0.50**	**0.89**

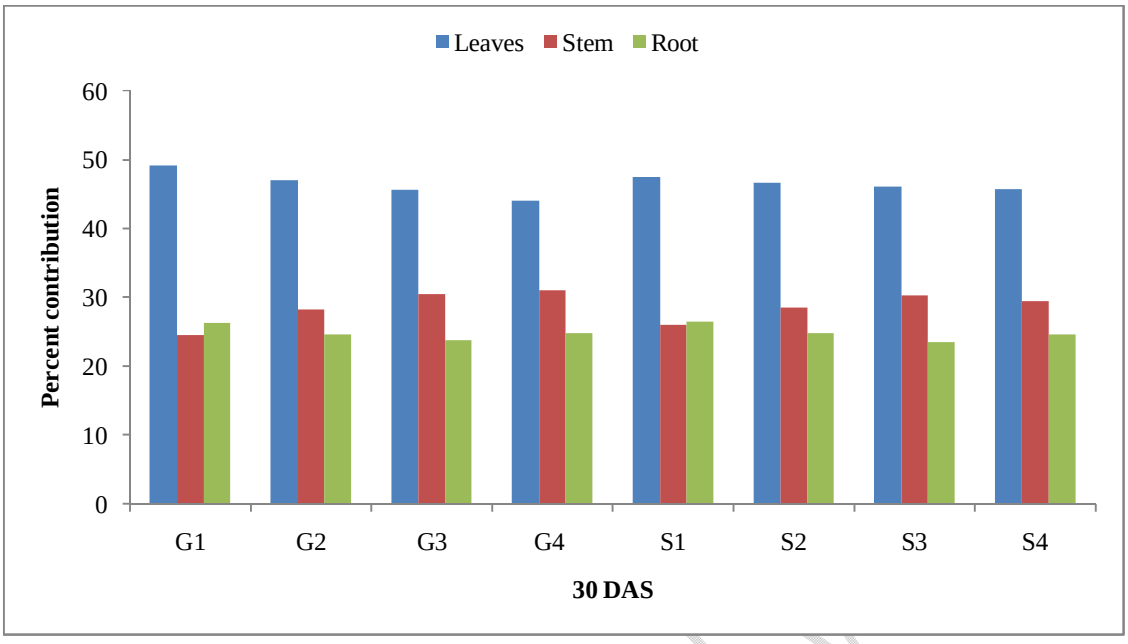

Figure 1: Effect of groundnut genotypes and sulphur levels on per cent contribution in variousplant parts at 30 DAS

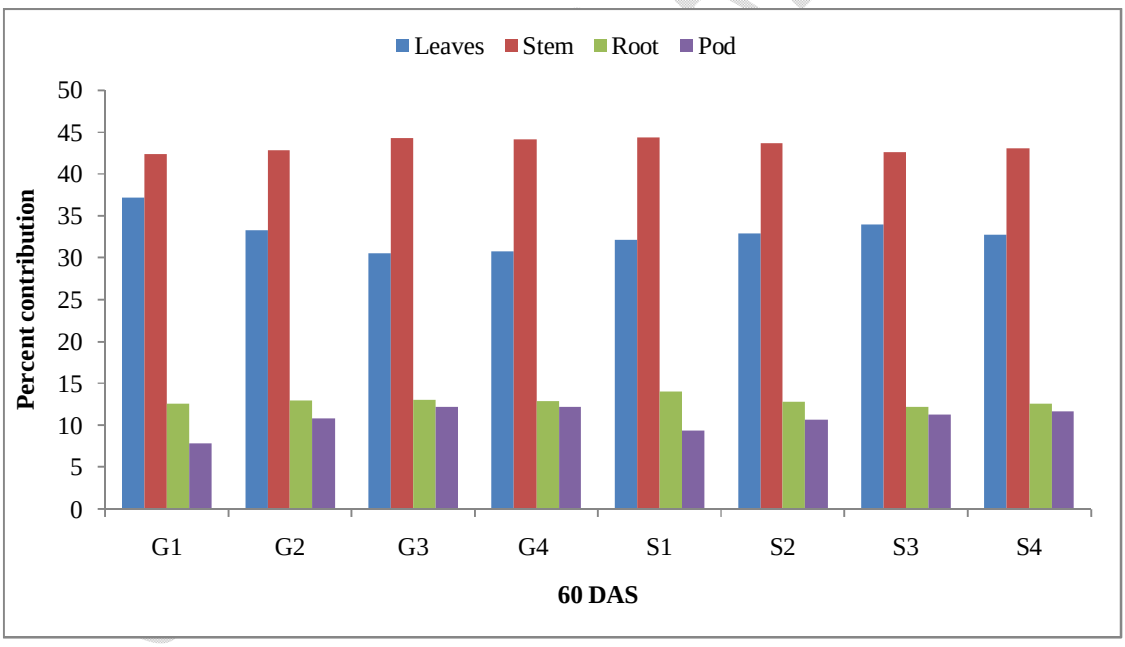

Figure 2: Effect of groundnut genotypes and sulphur levels on per cent contribution in various plant parts at 60 DAS

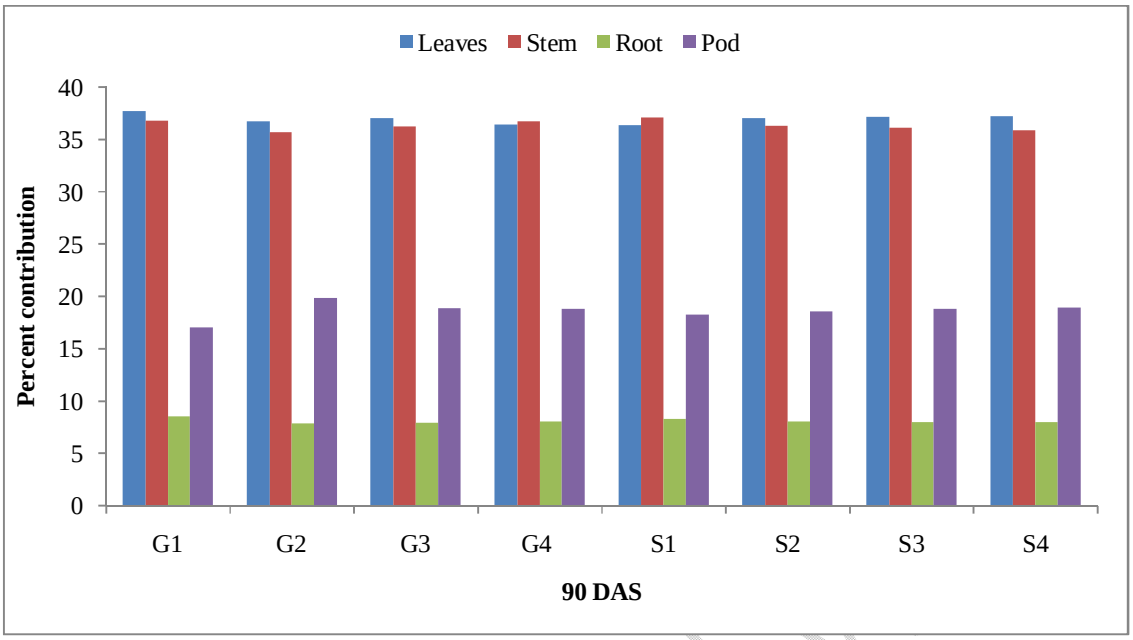

Figure 3: Effect of groundnut genotypes and sulphur levels on per cent contribution in various plant parts at 90 DAS

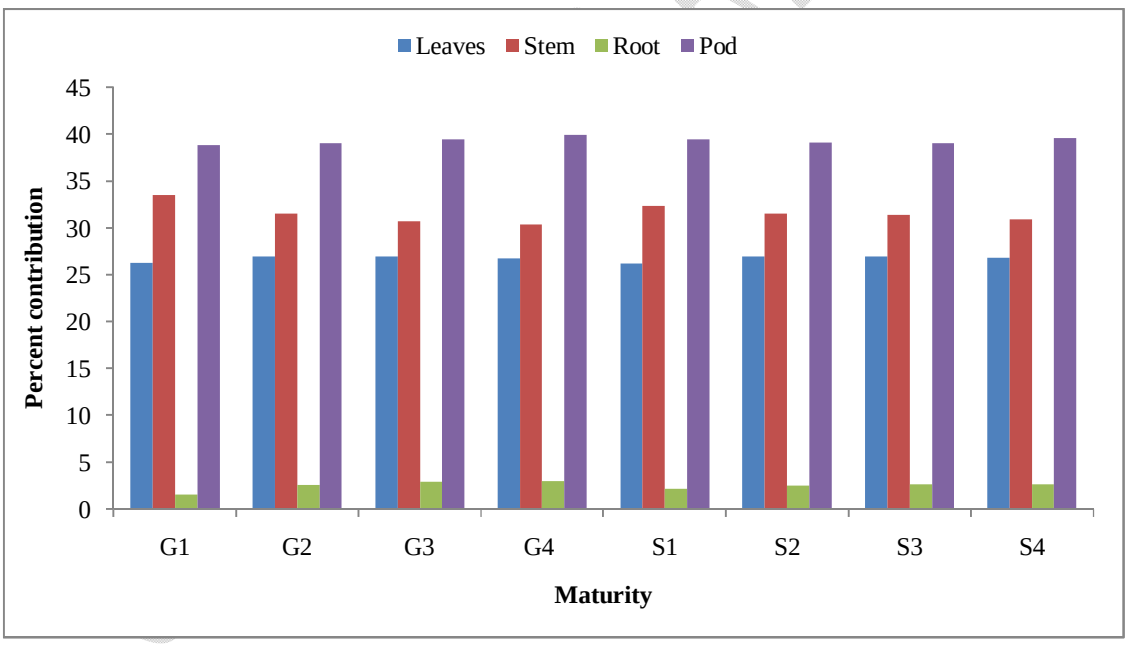

Figure 4: Effect of groundnut genotypes and sulphur levels on per cent contribution in various plant parts at maturity

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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