ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Effect of Mulching and Sulphur Doses on Growth and Yield of Groundnut in Rampur, Chitwan, Nepal

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Article Information

Received: 14 November 2025
Revised version received: 15 December 2025
Accepted: 17 December 2025
Published: 22 December 2025

Cite this article as:
P. Bhattarai et al. (2025) Int. J. Appl. Sci. Biotechnol. Vol 13(4): 171-179. DOI: 10.3126/ijasbt.v13i4.86456

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Peer reviewed under authority of IJASBT

Abstract

Groundnut *(Arachis hypogea. L)* commonly known as peanut, is valued for its multiple uses including both human and animal consumption in the form of food, oil, and fodder, as well as acting as an effective fertilizer. Its productivity is affected by different management practices as well as nutrients. This study examines the effects of mulching (no mulch vs. rice husk mulch) and various doses of Sulphur (0, 25, 35, and 45 kg/ha) on growth, yield attributes, and yield of groundnut under field conditions. The research conducted showed that rice husk mulching positively correlated with vegetative growth, including plant height, number of branches, canopy area, number of flowers, pod weight, and biological yield compared to no mulching. Similarly, among different Sulphur levels, 35-45kg/ha showed outstanding performance on pod yield, kernel number, shelling percentage, and harvest index. So, integration of mulching with an appropriate Sulphur dose can help both increase the vegetative as well as reproductive growth of groundnut.

Keywords: Groundnut; Mulching; Sulphur dose; Yield Parameters; Biological Yield; Growth.

Introduction

Groundnut, known as the king of oilseed crops, is a leguminous crop that belongs to the Fabaceae family (Biswas&Bhattacharjee, 2019) and is the fourth major crop for oilseed production worldwide(Ojha *et al.*, 2024). The total area of cultivation of groundnut is 87,616.31 hectares, and the production is 144,525.4 tons annually (Tadesse & Nepir, 2024). Similarly, the total area of cultivation is 37,805 hectares and the production is 3,254 metric tons (Central Bureau of Statistics, 2022). The leaves of groundnut are arranged opposite, pinnate with four leaflets, each leaflet of 1 to 7 cm long and 1 to 3 cm wide (Arunkumar *et al.*, 2021). Since the groundnut crop is rich in nutritional value so its nutritional value has been manipulated to treat malnutrition in children (Kumar *et al.*, 2014).

Although it is a leguminous crop, some nutrients and management practices are crucial for groundnut development and yield production. In many parts of the world, mulching practices are providing more suitable

conditions for growth and development, as well as effective crop production (Minh *et al.*, 2023). Mulching plays a crucial role in modifying microclimate, which in turn helps in root extension, weed suppression, and early germination in the field (Abonmai *et al.*, 2023). Similarly, in groundnut, Sulphur plays a major role in peg development, which ultimately affects the yield of groundnut. Sulphur helps in root nodulation, lowers hydrogen cyanide content, and increases the quality and quantity of the yield (Singh *et al.*, 2019).

Groundnut is used for multiple purposes. However, the production cannot meet the current demand for groundnuts. This may be due to the gap between the extension workers and the farmers. Farmers are not conscious of the importance of mulching and the role of Sulphur in the yield of groundnuts. So, rice husk mulching and Sulphur have so much potential, and are still underutilized. Similarly, the above problems can be tackled by reducing the gap between the extension services and farmers. So, the conducted experiment helps to fill the gaps and plays a positive role in increasing the productivity of groundnut.

Materials and Methods

The study was carried out at the agronomy field of Agriculture and Forestry University, Chitwan, Nepal. The study site is located 228 meters above mean sea level at latitudes 27° 37′ N and 84° 25′ E. The texture of soil in the site was sandy loam having soil pH of 5.31. Furthermore, a high level of nitrogen, a medium level of potassium, as well as a high level of phosphorus, was found in the soil test report.

Experimental Design

The type of block design conducted for the experiment was a randomized complete block design conducted in 3 replications. The experiment features two factors: the first is different Sulphur doses, including 0kg/ha,25kg/ha,35kg/ha,45kg/ha, and the second factor is mulching, including controlled and mulching with rice husk. The total area of the research field was 252m2 with 24 plots of each 3.2m*2m. The plot consists of 8 rows per plot with 10 plants per row. Eighty seeds were used with a spacing of 40*20 cm.

Land Preparation and Intercultural Operations

Weeds and other plastics were removed from the field. After that, one deep ploughing, followed by light ploughing, followed by 2-3 harrowing was performed at the field in June 25. Two seeds per hole at a depth of 3-5cm were covered firmly with a thin layer of soil. Light irrigation was provided immediately after the seeds were sown (Table 1).

Table 1: Timeframe of Operation Performed

Date (B.S.)	Operation Performed
Jestha 28	First irrigation
Jestha 29	Second irrigation
Jestha 30	Weeding, thinning, and gap filling
Ashadh 3	Second weeding
Ashadh 10	First earthing up
Ashadh 24	Scraping
Shrawan 6	Raised bed + removal of weeds between plots
Shrawan 12	Removal of intra-plot weeds

Data Collection and Analysis

From each plot, five plants were chosen randomly as a sample plant. The parameters that were observed during the experiment are Plant height, Number of branches, Number of flowers, pod number per plant, peg number per plant, canopy number, biological yield, and vine weight. For comparing the treated means, standard statistical methods were used in R-studio. Experiment layout is shown in Table 2.

Table 2: Experiment layout

R1	R2	R3
T1	T9	T3
T7	T6	T4
T2	T4	T5
T6	T8	T1
T3	T7	T6
T5	T2	T7
T8	T3	T2
T4	T1	T8

T1 – 0 Sulphur + no mulching = A
T2 – 0 Sulphur + mulching = B
T3 – 25kg/ha Sulphur + no mulching = C
T4 –25kg/ha Sulphur + mulching = D
T5 – 35kg/ha Sulphur + no mulching = E
T6 – 35kg/ha Sulphur + mulching = F
T7 – 45kg/ha Sulphur + no mulching = G
T8 – 45kg/ha Sulphur + mulching = H

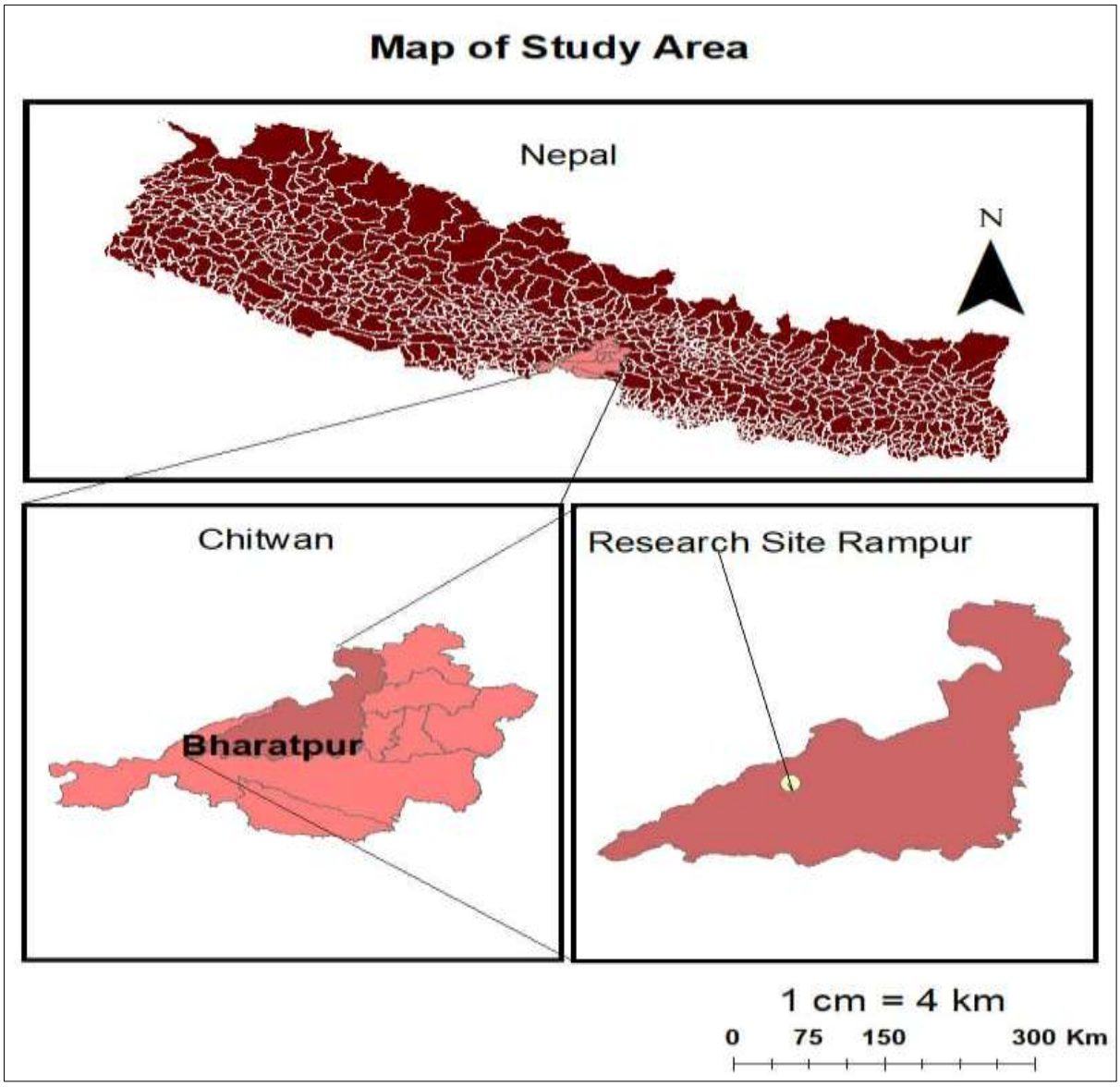

Fig 1: Experimental site

Results and Discussion

Vegetative Parameters

Plant Height (cm) under Different Treatments

The Table 3 shows that rice husk mulching significantly increases plant height at all growth stages than no mulching. Plant height at 20DAS was observed to be 19.24cm with rice husk mulching compared to 17.64cm at the non-mulching condition. At harvest, the differences observed are 97.91cm for rice mulch and 90.43cm for the non-mulching crop. Similarly, among different Sulphur levels, the highest plant height can be observed at 0kg/ha and 25 kg/ha, but the differences were less consistent (Fig. 1). Straw mulching generally helps to store moisture in the soil up to 55% than in a non-mulch situation (Krishi & Sewa, 2020). This may be the reason for increased plant height in a mulching situation than a non-mulch situation.

Number of Branches

The study reveals that the number of branches was highest at 60DAS (11.76), followed by at the time of harvest (10.92) in rice husk mulching (Table 4). However, in non-mulch conditions at 60 DAS, only 9.44 were observed, followed by 9.90 at harvest. Likewise, different Sulphur levels affected the number of branches. Significant differences in the number of branches were observed at 60DAS, and they are 11.13 at 35kg/ha, followed by 11 at 0kg/ha, followed by 10.56 at 25kg/ha, and 9.75cm at 45kg/ha. Organic mulches help to conserve soil moisture, maintain soil temperature, and also play a significant role in weed suppression and disease control (Adnan *et al*., 2020). Sulphur at 35kg/ha helps plants grow better and produce an appropriate amount of protein, which ultimately leads to an increased number of branches (Tandon & Messick, 2002).

Table 3: Plant height (cm) of groundnut under different mulching and Sulphur levels

Treatments	Time intervals			
Mulching	**20DAS**	**40DAS**	**60DAS**	**At-HARVEST**
No-mulch	17.646[b]	34.76 [b]	61.25[b]	90.43[b]
Rice husk mulch	19.24[a]	41.11[a]	67.64[a]	97.91[a]
F-probability	*	***	***	**
SEM (±)	0.23	0.34	0.53	0.82
LSD (=0.05)	1.40	2.04		4.99
Sulphur levels(kg/ha)				
0	18.95	36.43	64.67 [ab]	100.5[a]
25	18.57	37.94	67.45 [a]	94.24[ab]
35	18.37	38.3	64.42 [ab]	91.81[b]
45	17.88	39.08	61.24 [b]	90.13[b]
F-probability	NS	NS	.	*
SEM (±)	0.16	0.24	0.37	0.58
LSD	1.98	2.88	4.55	7.06
CV (%)	8.69	6.14	5.70	6.06
Grand Mean	18.44	37.94	64.45	94.18

Note: the common letter(s) within the column indicate non-significant differences based on Duncan multiple range test (DMRT) at 0.05 level of significance.
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

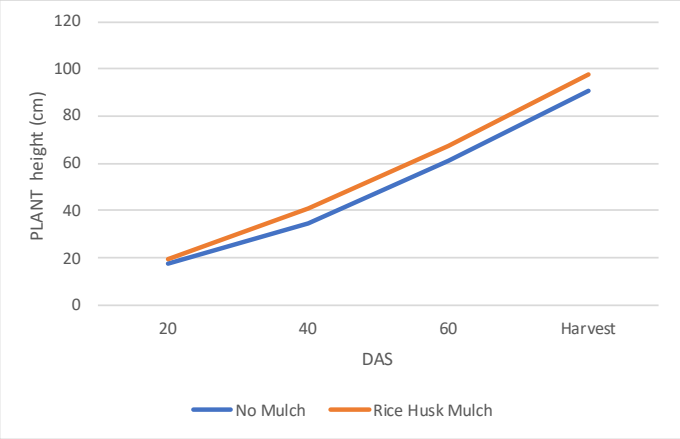

Fig. 1: Plant height of groundnut under mulching and Sulphur levels

Table 4: Number of branches per plant of groundnut under different mulching and Sulphur levels

Treatments	Time intervals			
Mulching	**20DAS**	**40DAS**	**60DAS**	**At-HARVEST**
No-mulch	6.52[b]	8.30[b]	9.44[b]	9.90[b]
Rice husk mulch	7.35[a]	9.47[a]	11.76[a]	10.92[a]
F-probability	**	***	***	*
SEM (±)	0.072	0.80	0.11	0.14
LSD (=0.05)	0.14	1.60	0.22	0.28
Sulphur levels(kg/ha)				
0	6.57[b]	8.85	11[a]	10.22[ab]
25	6.78[ab]	8.92	10.52[ab]	11.02[a]
35	7.10[ab]	8.77	11.13[a]	10.86[a]
45	7.30[a]	9	9.75[b]	9.55[b]
F-probability	.	NS	*	.
SEM (±)	0.050	0.06	0.08	0.097
LSD	0.10	0.12	0.16	0.194
CV (%)	7.20	6.22	7.41	9.13
Grand Mean	6.94	8.88	10.60	10.41

Canopy Spread

Table 5 shows that rice husk mulching leads to continuous increments of canopy spread from 20DAS to 60DAS compared to the non-mulch condition. There was a huge and significant difference between the mulching and non-mulching conditions. At rice husk mulching, canopy number at 20DAS was observed to be 547.02cm^2 compared to non-mulch 459.69cm^2 on the same day. Similarly, at 60DAS, the number observed was 3661.06cm^2, which was significantly higher than 3014.69cm2 at non-mulch conditions. Likewise, the highest canopy spread observed was 4193.23cm^2 under 35kg/ha Sulphur level at 60DAS, and the lowest canopy spread observed was 2682.10cm^2 under 0kg/ha at 60DAS. Top soil is full of nutrients so, mulching preserves top soil, acts as a home for many microorganisms and helps in nutrient absorption and nitrogen cycling(Demo & Asefa Bogale, 2024). Hence, mulching provides a favorable environment and helps improve canopy area compared to non-mulch conditions. Sulphur application helps in the availability of both Sulphur itself and other nutrients too which, promote growth and development of the crop (Kale, 2001).

Reproductive Attribute

Number of Peg Per Plant

The study reveals that the number of pegs observed was 116per plant under rice husk mulching which was significantly higher than 108 peg per plant under controlled conditions. Similarly, at 45kg/ha, 143peg per plant were observed, followed by 35kg/ha and least number of peg per plant was found at 0kg/ha i.e 76peg/plant. More number of pegs leads to a greater number of pods per plant (Table 6).

Yield Attributes

The influence of mulching and Sulphur application on the number of plants, pod weight, biological yield, and vine weight was found to be significant (Table 7 & 8). The application of rice husk mulch resulted in the highest plant density (110,677 plants/ha) when compared to no mulch (97,989 plants/ha), suggesting that mulching aids in retaining soil moisture and enhances crop establishment. The number of pods per plant, the number of kernels per pod, and the shelling percentage were found to be non-significant. Likewise, pod weight was increased with rice husk mulching (4323 kg/ha) in contrast to the control group (3827 kg/ha), likely due to an improved soil environment that promotes reproductive growth. Supporting this statement, rice husk mulching has also been reported to produce significantly higher numbers of pods (29 pods per plant) with the highest benefit–cost ratio (1.15), whereas black polythene mulching resulted in a lower number of pods (23 pods per plant). Conclusively, these findings suggest that rice husk is an effective mulching material for enhancing groundnut productivity (Bhattarai *et al.*, 2023)

The highest number of plants per hectare was 110677 at 45kg/ha, followed by 35kg/ha, i.e 105468 and the lowest was observed under control Sulphur, i.e 98958 plants. So, a higher level of Sulphur helps to increase plant population. Similarly, pod weight was highest at 45kg/ha (4323kg), followed by 35kg/ha (4119kg), and lowest was at 0kg/ha (3865kg). Among different Sulphur levels, 45kg/ha followed by 35kg/ha, has shown the effective results on the number of pods per plant, the number of kernels per pod, Shelling%, biological yield and vine weight, which suggest that a higher level of Sulphur positively correlated with productivity. Application of Sulphur at 45kg increases the pod weight of groundnut (Singh *et al.*, 2005). Application of S at 45 kg ha^{-1} significantly increased the pod yield, shelling percentage and uptake of Sulphur in rainfed groundnut(Yadav *et al.*, 2019).

Table 5: Canopy spread (cm²) of groundnut under different mulching and Sulphur levels

Treatments	**Time intervals**		
Mulching	**20DAS**	**40DAS**	**60DAS**
No-mulch	459.69^{b}	1873.19^{b}	3014.69^{b}
Rice husk mulch	547.02^{a}	2202.34^{a}	3661.06^{a}
F-probability	***	**	**
SeM±	7.88	30.53	67.13
LSD (=0.05)	22.3	86.3	189.8
Sulphur levels(kg/ha)			
0	478.49^{ab}	1773.84^{c}	2682.10^{b}
25	519.10	2060.44^{b}	3223.20^{b}
35	536.61	2507.29^{a}	4193.23^{a}
45	463.21	1809.49^{bc}	3252.96^{b}
F-probability	NS	***	***
SEM (±)	5.57	21.59	47.47
LSD	67.57	269.93	575.90
CV (%)	1.58	1.50	2.1
Grand Mean	499.35	2037.76	3337.87

Table 6: Number of pegs per plant of groundnut as influenced by mulching and Sulphur levels

Treatments	**Peg number per plant**
Mulching	
Non-mulching	108.8[b]
Rice husk mulching	116.91[a]
F-probability	***
SEM (±)	0.5
LSD (0.05)	3.033
Sulphur level(kg/ha)	
0kg/ha	79.06[d]
25kg/ha	92.38[c]
35kg/ha	136.19[b]
45kg/ha	143.85[a]
F-probability	***
SEM (±)	0.353
LSD	4.289
CV (%)	0.31
Grand Mean	112.87

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Table 7: Number of pods per plant, number of kernels per pod and shelling percentage of groundnut as affected by mulching and Sulphur levels

Treatments	**Study Parameters**			
	Pod weight (kg/ha)	**Biological yield (kg/ha)**	**Total number of plant /ha**	**Vine weight (kg/ha)**
Mulching				
No-mulch	3827.41b	31121.19b	97989b	22959.28 b
Rice husk mulch	4323.32a	39382.80 a	110677.08a	29426.17 a
F-probability	***	***	***	***
SEM (±)	22.73	222.60	581.98	159.58
LSD (=0.05)	137.91	1350.37	3530.53	968.07
Sulphur levels (kg/ha)				
0	3865c	28887.43 c	98958.33 c	21619.47 c
25	3993bc	34816.34 b	102213.54bc	26224.87 b
35	4120b	38064.68 a	105468.75	28387.24 a
45	4323a	39239.52 a	110677.08 a	28539.32 a
F-probability	***	***	**	***
SEM (±)	16.08	157.40	411.52	112.84
LSD	195.04	1909.71	4992.93	1369.06
CV (%)	0.39	2.99	0.39	0.43
Grand Mean	4075	5251.99	104329.4	26192.72

Table 8: Number of pods, Number of kernels & Shelling percentage per plant

Treatments	Study Parameters		
Mulching	**Number of pods per plant**	**Number of kernels per plant**	**Shelling percentage**
No-mulch	28.43a	1.711a	68.758a
Rice husk mulch	28.43a	1.723a	71.340a
F-probability	NS	NS	NS
SeM±	0.345	0.012	0.656
LSD (=0.05)	2.098	0.077	3.984
Sulphur levels (kg/ha)			
0	22.733b	1.333d	70.464a
25	25.021b	1.471c	67.649a
35	34.00a	1.890b	71.417a
45	31.533a	2.175a	70.667a
F-probability	***	***	NS
SEM (±)	0.2445	0.0090	0.464
LSD	2.967	0.1094	5.635
CV (%)	8.460	5.1455	6.496
Grand Mean	28.322	1.7175	70.049

Table 9: Dry matter yield of pod, vine, total biological yield, and harvest index of groundnut under different mulching and Sulphur levels

Treatments	Study Parameters			
Mulching	**DW of pod (kg/ha)**	**Vine DW (kg/ha)**	**Biological yield (DW)**	**Harvest index (HI)**
No-mulch	3718.25b	7987.06b	11705.32b	31.873a
Rice husk mulch	4407.93a	10981.13a	15389.07a	28.545b
F-probability	***	***	***	***
SEM (±)	39.147	56.836	80.87	0.185
LSD (=0.05)	237.48	344.79	490.57	1.125
Sulphur levels(kg/ha)				
0	3274.48d	7396.08d	10670.56 d	31.033a
25	3846.09c	9426.51c	13272.60 c	29.264b
35	4941.15a	10815.83a	15756.99 a	31.363a
45	4190.66b	10297.97b	14488.63b	29.175b
F-probability	***	***	***	*
SEM (±)	27.681	40.189	57.18	0.13
LSD	335.849	487.607	693.76	1.59
CV (%)	4.063	4.15	4.13	4.25
Grand Mean	4063.09	9484.09	13547.2	30.21

Dry Weights of Yield Attributes

The study shows that using a rice husk helps to increased pod dry weight at a rate of 4407.9 kg/ha, vine dry weight at a rate of 10,981.1 kg/ha, and total biological yield at a rate of 15,389.1 kg/ha when compared to the non- mulching, that is only 3718.3 kg/ha, 7987.1 kg/ha, and 11,705.3 kg/ha respectively. While the harvest index was moderately higher in non-mulch (31.87%) than with mulch, i.e 28.54%, the overall production was significantly greater in the mulched condition. Likely, different Sulphur levels indicated that the highest pod dry weight (4941.2 kg/ha), vine biomass (10,815.8 kg/ha), and biological yield (15,756.9 kg/ha) were at the rate of 35 kg S/ha, and the lowest yields were recorded at 0 kg S/ha (3274.5, 7396.1, and 10,670.6 kg/ha, respectively). At a dosage of 45 kg S/ha, there was a slight reduction in yields (4190.7, 10,297.9, and 14,488.6 kg/ha), confirming that 35 kg/ha is the ideal application level. Ultimately, the combination of rice husk mulching and the application of Sulphur at 35 kg/ha established the optimal conditions for groundnut growth, leading to enhanced pod development and overall yield (Table 9).

Conclusion

The yield and growth of parameter significantly increased in straw mulching with 35kg/ha of Sulphur. The combination resulted in increased plant height, branch number and yield of the groundnut crop. Therefore, for sustainable groundnut cultivation and higher yield, straw mulching with an appropriate dose of Sulphur is better.

Conflict of Interest

Authors declare no conflict of interest with the present publication.

Authors' Contribution

P Bhattarai, S Lohani & SD Kalauni designed the research plan; P Bhattarai, S Lohani, S Sapkota & SD Kalauni performed experimental works & collected the required data. M Pokhrel analyzed the data; M Pokhrel, S Sapkota & B Khadaka prepared the manuscript. P Bhattarai & S Sapkota critically revised and finalized the manuscript. Final form of manuscript was approved by all authors.

Acknowledgement

The authors want to sincerely acknowledge Agriculture and Forestry University, Rampur, Chitwan for the support and facilities provided for conducting the research.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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