Effect of Sulphur, Goat Manures and Intercropping on Morphophysiological and Yield Performance of Sesame (*Sesamum indicum* L.)

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Received:- 05 June 2025/ Revised:- 13 June 2025/ Accepted:- 20 June 2025/ Published: 30-06-2025
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Abstract— *A field experiment was conducted in Kharif season of 2024–2025 at the Agricultural Research Farm, Department of Agronomy, Himalayan University, Jollang, Itanagar, Arunachal Pradesh. The soil of experimental plot was sandy loam and loamy sandy in texture with pH ranges from 4 to 6. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments each replicated thrice three. The treatments which are T_1: Control, T_2: Sulphur level 40kg/ha + Goat Manure 14 ton/ha.+ intercropping (2:1), T_3: Sulphur level 40kg/ha + Goat Manure 14 ton/ha. +intercropping (2:2), T_4: Sulphur level 40kg/ha.+ Goat Manure 15 ton/ha.+ Intercropping (2:1), T_5: Sulphur level 40kg/ha. + Goat Manure 15 ton/ha + intercropping (2:2), T_6: Sulphur level 40kg/ha + Goat Manure 16 ton/ha + intercropping (2:1), T_7: Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2). The results showed maximum morphological of plant height (103cm), number of branches (7.90), dry weight (19.40) were recorded significantly higher in the treatment T_7 which is Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+Intercropping (2:2).The Physiological and yield attributes the maximum number of capsule/plant (81.00), capsule length (3cm), seeds/capsule (78.53), test weight (3.37g), seed yield (0.46t/ha), biological yield (0.398t/ha), harvest index (1.01%) were recorded in the treatment T_7 as compared to all other treatments.*

Keywords— Sesame, Sulphur, Goat manure, Intercropping, Morph-physiological traits and yield.

I. INTRODUCTION

Sesame (*Sesamum indicum L.*) family of ***pedaliaceae***, Sesame or gingelli is commonly known as til, is one of the oldest cultivated oilseed crops, known for its resilient growth in arid conditions and highly valued seeds for their oil and nutritional content. Sesame is considered as a drought tolerant crop. Often hailed as the "Queen of Oilseeds", it owes this distinction to its remarkably high oil content, which can reach to 63%, surpassing the quality of other oilseed crops such as groundnut (45%–56%), sunflower (45%), rapeseed (40%), and soybean (20%) (Teklu *et al*., 2021). The oilseeds are very important because of its capability of synthesis of sulphur containing amino acids, vitamins, and constituent in human dietary system next to carbohydrates, protein and fats (Mohsana, 2009). Sesame seed cake contains 32% crude protein and 8–10% oil, making it an essential feed for livestock, poultry, and small ruminants (Kabinda *et al.*, 2022). To address these issues, improving seed quality, optimizing sowing times, applying recommended fertilizer dosages, and implementing effective pest management strategies can help increase sesame productivity and profitability for farmers.

Intercropping, the practice of growing two or more crops in proximity, is a promising strategy for enhancing sesame (Sesamum indicum) production. Research by **Ghosh *et al.*, (2004)** highlights its potential to optimize land use, boost biodiversity, and improve soil health. Intercropping sesame with legumes like cowpeas can enhance soil fertility through nitrogen fixation, as noted by **Khan *et al.*, (2017).** Additionally, diverse cropping systems can disrupt pest life cycles, contributing to sustainable pest management, a finding supported by (**Pérez *et al.*, (2019).** Intercropping is the practice of growing more than one crop simultaneously in alternating rows of the same field (Beets 1990).

Sulphur play a key role in plant metabolism, indispensable for the synthesis of essential oils, chlorophyll formation, required for development of cells and it also increase cold resistance and drought hardiness of crops especially for oil seeds crops (Patel

et al., 1995). In oilseeds, Sulphur plays significantly increasing the yield and oil content of sesame (Deshmukh *et al.,* 2010) and helps in improving quality and boldness in seeds. Therefore, oilseed crops require large amount of sulphur for better development and growth to obtain higher yield (Salwa *et al.,* 2010).

Sulphur deficiency is becoming more critical with each passing year which is severely restricting crop yield, produce quality and nutrient use efficiency. Sulphur, therefore, is now very much a part of balanced fertilization because in S deficient areas. Its deficiency results in reduced plant height and stunted growth, impairs tillering capacity and delayed maturity. Sulfur deficient plants have also less resistance under stress conditions (Dobermann 2000). Sulphur application not only improved the grain yield but also improved the quality of crops. (Kathiresan 2002).

Among several types of organic manures, goat manure is significantly known for high level of potassium which is a major component of ash and also potentially require for protein synthesis. N, P, K, Ca, Mg, pH, growth and yield parameters increase with the application of goat manure. (Barlow & Curran (2015). It not only improves soil conditions but also enhances the growth of sesame. Goat manure is rich in essential macronutrients, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S), which are critical for plant health (Hartatik and Widowati, 2006).Goat manure is a new technique that doesn't hurt the environment and can allow nutrient-rich organic soil fertilizer development. Goat manure is reported to contain enough nutrients to meet the needs of plants for optimal growth. It is still shameful that manure is not usually put on agricultural land in Sub-Saharan African (SSA) nations (Washaya *et al*., 2023).

II. MATERIALS AND METHODS

The experimental trial was carried out during kharif 2024 at Agriculture research farm of Himalayan University. The agriculture Research Farm is situated at 27.14ºN latitude and 93.62º E longitudes. The location of jollang was tropical climate zone with an average rainfall of 3500-4000mm at an average meters from mean sea level. The soil of experimental plot was sandy loam and loamy sandy in texture with pH ranges from 4 to 6. The recommended dose of NPK: 20:20:30 and sulphur was applied according the treatment details. After sowing gap filling was done and there was no need of irrigation due to frequent rainfalls. Between the period of germination to harvest several plant growth parameters was recorded at equal intervals and after harvest yield parameters were recorded. In growth parameters plant height (cm), plant dry weight (g) and number of branches/plant were recorded and yield parameters like capsules/plant, seeds/capsule, Test weight (1000 seed weight), seed yield t/ha) Biological yield (t/ha) and harvest index %) were recorded and statisticall analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

III. RESULTS AND DISCUSSION

3.1 The statistical data regarding morphophysiological parameters is presented in Table no:1:

3.1.1 Plant height (cm):

Significantly highest plant height (103.00cm) was observed in treatment T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2)and followed by T_2 (Sulphur level 40kg/ha + Goat Manure 14 ton/ha.+ intercropping (2:1) i.e., (98.67cm). Lowest plant height (10.20cm) was noted in T_1, Control. This might be due to different application of organic manures and micronutrients from goat manure and sulphur and nutrient utilization through intercropping which increase the plants and enhances the vegetative growth of the plant thus, leading to significant increase in plant height. These findings corroborate with the results obtained by Tiwari *et al*., (2000) Aripta *et al*., (2015), Aripta *et al.* , (2018), Singarvel *et al.,* (2019). Sujatha *et al*., (2021).

3.1.2 Number of branches plant^{-1}:

Significantly highest no. of branches^{-1} (7.90) was recorded in the T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 (Sulphur level 40kg/ha + Goat Manure 14 ton/ha.+ intercropping (2:1) i.e., (7.80) and lowest number of branches (3.33) was noted in T_1 Control. The increase in branching may be due to sulphur which helps in stimulation of cell division and photosynthetic process as well as chlorophyll and better growth conditons under intercropping. Application of sulphur might be the reason that is causes improvement in soil properties and hence nutrients availability to the crop during vegetative growth and development period of plant.These results were accordance with those of Srinivasan and Sankaran (2001), Aripta *et al.,* (2018) Swapan Kumar *et al.,* (2019) Aripta *et al.,* (2021), Kumar *et al., (*2017), Sujatha *et al*., (2021). Nadeem *et al.,* (2015).

TABLE 1
EFFECT OF SULPHUR, GOAT MANURES AND INTERCROPPING ON MORPHOPHYSIOLOGICAL PARAMETERS OF SESAME

Treatments	Plant height(cm)	Dry weight^{-1}(g)	No. of branches plant^{-1}
T_1	80.00	10.67	3.33
T_2	98.67	19.33	7.80
T_3	97.33	16.07	7.70
T_4	92.67	14.07	5.00
T_5	95.33	16.00	7.00
T_6	95.00	15.73	6.00
T_7	103.00	19.40	7.90
SEd	4.18	0.37	0.53
SEm(±)	2.95	0.26	0.37
CD	9.10	0.82	1.16

3.1.3 Dry weight^{-1} (g):

Data recorded maximum dry weight (33.47g) was recorded in treatment T_7 Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 (Sulphur level 40kg/Ha + Goat Manure 14 ton/ha.+ intercropping (2:1) i.e., (33.43g).Lowes dry weight (23, 30g) was observed in treatment T_1 (Control). It has been reported that the Sulphur application not only improves the availability itself but also improves availability of other nutrients too, which are essential for growth and development of plant. The improved of dry weight under T_7 may be attributed to enhanced the availability and better resource It has been also reported that Sulphur helps in reducing soil pH, which helps in the greater availability and mobility of nutrients especially P, Fe, Mn, and Zn. Aripta *et al.* , (2015), Aripta *et al.* , (2018) Aripta *et al.,* (2021) Kumar *et al.* (2012), (Hilal *et al*., 1992).

3.2 The statistical data representing yield and yield attributes presented in Table no. 2:

3.2.1 No. of capsule plant^{-1}:

Data recorded on number of capsule plant^{-1} was statiscally analysed and maximum number of capsule plant^{-1} was (81.00) recorded under treatment T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 (80.44) under treatment T_2 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:1) and minimum number of capsule plant^{-1} (70.33) was noted in T_1, Control. This is due to different application of goat manure which allow nutrient- rich in essential macronutrients and enhances the vegetative growth of the plant thus, leading to significant increase in number of capsule per plant.Hartatik *et al.,* (2006) Ojeniyi *et al., (*2010) B.Arpita *et al*., (2015).

3.2.2 No. of seed capsule^{-1}:

Significantly maximum number of seed per capsule (78.53) was recorded in treatment T_7 Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 (Sulphur level 40kg/Ha + Goat Manure 14 ton/ha.+ intercropping (2:1) i.e., (65.77).Lowest number of seed per capsule (38.60) was observed in treatment T_1 (Control). The increased seed number in T_7 is due to goat manure improves the seed quality which increase the plants and enhances reproductive development, and intercropping which promote efficient nutrient use and better pollination leads to significant increase in number of capsule per plant. Hartatik *et al.,* (2006), B.Arpita *et al*., (2015).

3.2.3 Capsule Length (cm):

Data recorded on capsule length (cm) revealed that maximum (3.2cm) capsule length was observed in the T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2)) and closely followed by T_2 (3.1cm) (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:1). Whereas minimum capsule length (2.8cm) was noted in T_1, Control. The improvement in T_7 may be due to Sulphur, goat manure which play energetic role in nutrition of plants and it also improved the quality of seeds. (Adeyemo *et al.,* (2019); Sharma *et al*., (2020); Ogunyemi *et al*., (2018).

TABLE 2
EFFECT OF SULPHUR, GOAT MANURES AND INTERCROPPING ON YIELD AND YIELD ATTRIBUTES OF SESAME

Treatments	No. of capsule plant^{-1}	No. of seed capsule^{-1}	Capsule length(cm)	Test weight(g)	Seed/Economic yield(t/ha)	Biological yield(t/ha)	Harvest index(%)
T_1	70.33	38.60	2.8	2.80	0.22	0.378	0.58
T_2	80.44	65.77	3.1	3.30	0.38	0.397	0.95
T_3	80.33	66.00	3.1	3.27	0.36	0.394	0.91
T_4	74.44	60.67	2.3	2.93	0.31	0.393	0.78
T_5	78.55	62.60	3.0	3.23	0.36	0.393	0.91
T_6	76.00	63.10	3	3.07	0.34	0.391	0.86
T_7	81.00	78.53	3.2	3.37	0.46	0.398	10.1
SEd	1.03	2.63	0.17	0.11	0.01	1.81	0.00
S.Em (±)	0.72	1.86	0.12	0.07	0.00	1.28	0.00
CD	2.24	5.74	0.38	0.23	0.02	3.95	0.01

3.2.4 Test weight (g):

Data recorded on the test weight of sesame seed was statistically analyzed and presented in Table-3. The effect of different treatments were found to be significant in case of test weight of sesame. The highest (3.37g) test weight of sesame was under treatment T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 i.e., 3.30g.The lowest number (2.80g) of test weight was recorded at T_1 (Control). Which is due to application goat manure and sulphur and intercropping (green gram + sesame) which improves nutrient availability and assimilation during seed filling which enhanced the better crop synergy through intercropping. Olowe *et al.,* (2003) Nadeem *et al*., (2015) Aripta *et al*., (2015) Kumar *et al.* (2012).

3.2.5 Seed yield (t/ha^{-1}):

Significantly maximum seed yield (0.46/ha) was recorded in treatment T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) and followed by T_2 i.e., 0.38t/ha. The lowest number of seed yield was recorded at T_1 (control) i.e., 0.22t/ha. These is due to application of Goat manure and sulphur and intercropping (green gram + sesame) sulphur played important role in improving yield attributes an increase yield seed yield. Which together promote better seed development and harvest output. A.R.F Suaad *et al*., (2025) Washaya *et al*., (2023) Sujatha *et al., (*2021) Oloniruha *et al*., (2021) Myini *et al*., (2020) Vekeriya *et al*., (2020).

3.2.6 Biological/ Stover yield (t/ha):

Data recorded on biological yield of sesame was statistically analyzed and highest biological yield was recorded in T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) i.e., 0.398 t/ha^{-1}.The lowest biological yield was recorded in T_1 control i.e., o.378 t ha^{-1}. The increase in T_7 can be linked to better plant growth and seed yield due to the combined effect of

slow- release of sulphur and goat manure and improved resource utilization in the intercropping system. Haruna *et al*., (2012) Kundu C.K *et al*., (2014) Nadeem *et al*., (2015).

3.2.7 Harvest index (%)

The significant and highest harvest index (10.1%) was recorded in T_7 (Sulphur 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2).The lowest harvest index (0.58%) was recorded in T_1 control. The higher harvest index in T_7 suggests better partitioning of assimilates towards economic yield and lower value may be T_2 is due to greater vegetative biomass reducing the proportion of economic yield. Sharma *et al*.,(2020), Kumar *et al.* (2012) Nadeem *et al*.,(2015).

IV. CONCLUSION

Based on the findings of the investigation it may be concluded that T_7 (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) performed expecptionally in all growth and yield parameters and in obtaining maximum seed yield of sesame. Hence, (Sulphur level 40kg/ha. + Goat Manure 16 ton/ha.+ Intercropping (2:2) is beneficial for future use.

ACKNOWLEDGMENT

The author are thankful to Department of agronomy, Himalayan University, jullang, Itanagar 791111, Arunachal Pradesh, India for providing us necessary facilities to undertake the studies.

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