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# Effect of Mineral Fertilizer on Yield, Quality and Nutrient Uptake of Black Sesame [*Sesamum radiatum* (L.)]

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

A field study aimed to evolve efficient nutrient management for improving yield and quality of sesamum was conducted during pre-rabi season of 2022. The experiment was laid out in a factorial randomized block design replicated thrice with twelve treatments. Treatments consisting of two levels of nitrogen (25 and 50 kg/ha), two levels of phosphorus (12.5 and 25 kg/ha) and three levels of sulphur (0, 20 and 30 kg/ha). Seed and stover yield as well as total nutrient uptake were recorded significantly higher with the application of 50 kg/ha N, 25 kg/ha P and 30 kg/ha S. The application of 50 N and 30 kg S was recorded significantly higher oil content and oil yield over the rest of the nitrogen and sulphur levels. N content in seed (3.13%) and stover (1.226%) were found significantly influenced by 50 kg/ha N. Phosphorus @ 25 kg/ha was recorded significantly higher P content in

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seed (0.493 %) and stover (0.392%).S content in seed (0.325%) and stover (0.171%) were found significantly influenced by 50 kg/ha S. Significantly higher available nitrogen (281.22 kg/ha) was found under application of nitrogen @ 50 kg/ha. Significantly the higher residual phosphorus (28.81 kg/ha) was obtained with the application of 25 kg P/ha. Significantly the higher residual sulphur (7.63 mg/kg) was obtained with the application of 30 kg S/ha.

*Keywords: Nitrogen; phosphorus; sulphur; sesame; yield.*

## 1. INTRODUCTION

"Sesame (*Sesamum radiatum* L.) belongs to family pedaliacae is an annual self-pollinated indeterminate minor and an ancient kharif oilseed crop of the world. Sesamum seeds contain 5 % moisture, 20 % protein, 50 % oil, 16 % carbohydrate and 5 % fibre. The oil consists of glycerides, fatty acids and constituents chiefly oleic and liolenic acids with small proportions of stearic, palmatic and arachidic acids. Sesame is essentially a crop of tropical and sub-tropical regions. It is mainly grown in Gujarat, Uttar Pradesh, Madhya Pradesh, Karnataka, Orissa, Bihar, Jharkhand, Andhra Pradesh, Kerala and Tamil Nadu. In Gujarat, sesame is cultivated in the area of 2.59 lakh hectares with the production of 122.58 million tones and a productivity of 473.47 kg/ha" [1]. "A well-managed crop of sesame can yield 1200-1500 kg/haunder irrigated and 800-1000 kg/ha under rainfed conditions. Sesame is grown in areas with annual rainfall of 625-1100 mm and temperature of >27 $^0$C. The crop is tolerant to drought, but not to water logging and excessive rainfall. Sesame is well adapted to a wide range of soils, but requires deep, well-drained, fertile sandy loams" [2].

"The area, production and productivity of sesame are higher in summer season than those of post-*kharif* and *kharif* season, but the productivity of sesame in general is much lower than its potential yield. Lower productivity is due to use of sub-optimal rate of fertilizer, poor management and cultivation of sesame in marginal and sub-marginal lands, where deficiency of macronutrients such as nitrogen, phosphorus, potassium and micronutrients is predominant. Balanced fertilization with N, P, K and S is proved beneficial in all the oilseed crops to minimize the unfavourable exploitation of soil fertility and plant nutrient, thus maintain the soil health and plant nutrient at optimum level" [2].

## 2. MATERIALS AND METHODS

The sesame variety GT-10 was released from Oilseed Research Station, Junagadh Agricultural University, Amreli. The field experiment was carried out at College Farm, Navsari Agricultural University, Campus Bharuch during pre-*rabi* season of 2022. The soil was clayey in texture and slightly alkaline in reaction. The soil was low in available N (243 kg ha$^{-1}$), low in available $P_2O_5$ (26.13 kg/ha), low in available sulphur (7.96 mg/kg) and high in available $K_2O$ (327 kg/ha).

The field experiment was laid out in FRBD with 12 treatment combinations consisting of three factors *viz.*, Nitrogen [$N_1$: 25 kg/ha, $N_2$:50 kg/ha], Phosphorus [$P_1$: 12.5 kg/ha, $P_2$: 50 kg/ha] and Sulphur [$S_1$: 0 kg/ha, $S_2$: 20 kg/ha, $S_3$: 30 kg/ha] with three replications. Sesame variety GT-10 was sown by opening of furrow at a distance of 45 × 10 cm. Application of fertilizers were given before the sowing of seeds in the open furrow. The half dose of nitrogen and full dose of phosphorus and sulphur was applied at the time of sowing and the remained half dose of nitrogen was applied after 30 DAS. The different dose of nitrogen, phosphorus and sulphur was applied in form of urea, DAP and elemental sulphur, respectively as per the treatment in each plot. For all the growth and development studies during the crop growth period, five plants were selected randomly from the net plot and tagged in each plot for recording plant height, number of capsules per plant, length of capsule and seeds per capsule. 1000 seeds were randomly taken from the bulk produce of each net plot and were counted and weighed. The weight was expressed as 1000- seed weight in grams. The data on pod and haulm yield were recorded from net plot and converted on a hectare basis. Data were statistically analyzed by the procedure suggested by Panse and Sukhatme [3].

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Nitrogen

#### 3.1.1 Yield

The nitrogen application at increasing levels showed a significant effect on yield parameter. Significantly higher seed (880 kg/ha) and stover

yield (2186 kg/ha) were recorded under the application of 50 kg/ha nitrogen. Nitrogen is important for flower and seed formation. It is involved in various physiological processes that influence plant growth and development. Sufficient nitrogen levels encourage the initiation, development and growth of shoots, plant height, leaf area, and overall biomass production and flowers in sesame plant. It is involved in the production of nucleic acid and enzymes required for DNA synthesis and cell division, which are crucial processes during flower and seed development. Adequate nitrogen supply can promote plant height, higher flower, a greater number of capsules and seed set, resulting in increased seed as well as stover yield. Similar result was also found by Sawant et al. [4], Patel et al. [5].

#### 3.1.2 Quality

Nitrogen application at increasing levels showed a significant effect on oil content and oil yield. The highest oil content (45.80 %) and oil yield (405 kg/ha)were recorded under the application of nitrogen @ 50 kg/ha which was significantly higher over other treatments. The highest oil content and oil yield might be due to a higher concentration of nitrogen. It is a key component of amino acids, proteins, and chlorophyll. It is a major constituent of proteins, and sesame seeds contain a high proportion of oil-rich protein. Adequate nitrogen supply promotes protein synthesis, which, in turn, affects the oil content of seeds. The present results corelate with the study done by Tripathy and Bastia [6] and Bijarnia et al. [7].

#### 3.1.3 Nutrient content and uptake

N content in seed and stover was found significantly influenced by the effect of nitrogen. Treatment $N_2$ (50 kg/ha) recorded significantly higher N content in seed (3.130 %) and stover (1.226 %) over $N_1$ (2.628 %). In the present study nitrogen application significantly increased availability of nitrogen which could have resulted in a significant increase in N content in seed because plant absorbed a proportionately high amount of N as the pool of available nitrogen increased in the soil by adding higher 50 doses of nitrogen. This result is supported by the research finding of Vaghani et al. [8] and Patil [9]. P, K and S content in seed of sesame did not influenced by different level of nitrogen. However, P, K and S content in seed were increased with an increase in levels of nitrogen but the increase was not remarkable.

Different nitrogen levels significantly influenced the total N, P, K and S uptake by sesame. Crop fertilized 50 kg/ha nitrogen resulted in significantly the highest total N, P, K and S uptake by sesame (54.49, 11.89, 20.24 and 6.41 kg/ha, respectively). An increase in grain and stover yield as well as an increase in nutrients content in grain and stover with an increase in amount of nitrogen, phosphorus and sulphur fertilizers application has resulted in higher uptake of nitrogen, phosphorus, potassium and sulphur by sesame.The results were closely related with finding Nayek et al. [10].

### 3.2 Effect of Phosphorus

#### 3.2.1 Yield

Application of phosphorus 25 kg/ha ($P_2$) recorded significantly the highest seed yield (854 kg $ha^{-1}$) and stover yield (2180 kg/ha) over other applications of phosphorus ($P_1$). Phosphorus is essential for root development and nutrient uptake. It is involved in formation of root hair and mycorrhizal associations, which might be attributed to higher uptake of nutrients. Improved nutrient uptake due to adequate phosphorus levels results in better nutrient availability for sesame plants, supporting their overall growth and seed yield. Similar result was also found by Sawant et al. [4], Kalegore et al. [11], Patel et al. [5], and Salame et al. [12].

### 3.3 Quality

#### 3.3.1 Nutrient content and uptake

P content in seed and stover was found significantly influenced by the effect of phosphorus. Among all the P treatments, treatment $P_2$ (25 kg/ha) was recorded significantly higher P content in seed (0.493 %) and stover (0.392 %). In the present study phosphorus application significantly increased the availability of phosphorus which could have resulted in a significant increase in P content in seed and stover due to the fact that plant absorbed proportionately high amount of P as the pool of available phosphorus increased in the soil by adding higher doses of phosphorus. Similar results were also recorded by Choudhary et al. [13] and Bumbadiya et al. [14]. N, K and S content in seed of sesame did not influenced by different level of phosphorus.

**Table 1. Effect of nitrogen, phosphorus and sulphur on yield and quality of black sesame**

| Treatments | Seed yield (kg/ha) | Stover yield (kg/ha) | Oil content in seed (%) | Oil yield (kg/ha) |
|---|---|---|---|---|
| **(1) Nitrogen level (N)** | | | | |
| $N_1$– 25 kg/ha | 700 | 1962 | 44.15 | 310 |
| $N_2$– 50 kg/ha | 880 | 2186 | 45.80 | 405 |
| S.Em. ± | 20.86 | 56.36 | 0.52 | 10.90 |
| CD at 5 % | 65 | 165 | 1.52 | 32 |
| **(2) Phosphorus level (P)** | | | | |
| $P_1$– 12.5 kg/ha | 725 | 1967 | 44.39 | 324 |
| $P_2$– 25 kg/ha | 854 | 2180 | 45.56 | 391 |
| S.Em. ± | 20.86 | 56.36 | 0.52 | 10.90 |
| CD at 5 % | 80 | 165 | NS | 32 |
| **(3) Sulphur level (S)** | | | | |
| $S_1$– 0 kg/ha | 699 | 1929 | 43.78 | 306 |
| $S_2$ – 20 kg/ha | 797 | 2039 | 44.41 | 356 |
| $S_3$– 30 kg/ha | 873 | 2253 | 46.74 | 410 |
| S.Em. ± | 25.55 | 69.03 | 0.64 | 13.35 |
| CD at 5 % | 74 | 202 | 1.86 | 39 |
| **Interaction** | **NS** | **NS** | **NS** | **NS** |
| **CV%** | **11.92** | **11.53** | **4.89** | **12.95** |

**Table 2. Effect of nitrogen, phosphorus and sulphur on nutrient content in black sesame**

| Treatments | Nutrient content (%) in seed | | | | Nutrient content (%) in stover | | | |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | S | N | P | K | S |
| **(1) Nitrogen level (N)** | | | | | | | | |
| $N_1$– 25 kg/ha | 2.628 | 0.463 | 0.691 | 0.298 | 1.033 | 0.344 | 0.641 | 0.164 |
| $N_2$– 50 kg/ha | 3.130 | 0.465 | 0.696 | 0.307 | 1.226 | 0.353 | 0.644 | 0.169 |
| S.Em. ± | 0.033 | 0.006 | 0.007 | 0.004 | 0.016 | 0.005 | 0.008 | 0.002 |
| CD at 5 % | 0.097 | NS | NS | NS | 0.05 | NS | NS | NS |
| **(2) Phosphorus level (P)** | | | | | | | | |
| $P_1$– 12.5 kg/ha | 2.833 | 0.435 | 0.602 | 0.297 | 1.126 | 0.305 | 0.633 | 0.163 |
| $P_2$– 25 kg/ha | 2.925 | 0.493 | 0.665 | 0.307 | 1.132 | 0.392 | 0.652 | 0.168 |
| S.Em. ± | 0.033 | 0.006 | 0.007 | 0.004 | 0.016 | 0.005 | 0.008 | 0.002 |
| CD at 5 % | NS | 0.016 | NS | NS | NS | 0.013 | NS | NS |
| **(3) Sulphur level (S)** | | | | | | | | |
| $S_1$– 0 kg/ha | 2.831 | 0.451 | 0.689 | 0.283 | 1.111 | 0.344 | 0.640 | 0.162 |
| $S_2$ – 20 kg/ha | 2.848 | 0.466 | 0.694 | 0.298 | 1.119 | 0.349 | 0.638 | 0.167 |
| $S_3$– 30 kg/ha | 2.958 | 0.475 | 0.697 | 0.325 | 1.158 | 0.352 | 0.650 | 0.171 |
| S.Em. ± | 0.040 | 0.007 | 0.008 | 0.005 | 0.02 | 0.006 | 0.010 | 0.002 |
| CD at 5 % | NS | NS | NS | 0.014 | NS | NS | NS | 0.006 |
| **Interaction** | NS | NS | NS | NS | NS | NS | NS | NS |
| **CV%** | 4.86 | 5.04 | 4.04 | 5.39 | 5.94 | 5.56 | 5.38 | 4.40 |

Total nutrient uptake (N, P, K and S) by sesame was found significantly influenced by the effect of phosphorus. Among all the P treatments, treatment $P_2$ (25 kg/ha) was recorded significantly higher total nutrient uptake (N, P, K and S) $P_1$. The application of phosphorus increased seed yield and content in sesame by providing balanced nutritional environment to the plant and higher photosynthetic efficiency. Uptake of nutrients is the function of their concentration in plant, seed and stover yields, the higher concentration of these nutrients coupled with significantly higher seed yield improved the uptake of nutrients. Similar results were observed by Choudhary et al. [13].

## 3.4 Effect of Sulphur

### 3.4.1 Yield

The seed yield of sesame was significantly influenced by the effect of sulphur. Among the

**Table 3. Effect of nitrogen, phosphorus and sulphur on total nutrient uptake by plant and available nutrient status of soil after harvest of black sesame**

| Treatments | Total nutrient uptake (kg/ha) | | | | Available nutrients in soil | | | |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | S | N | $P_2O_5$ | $K_2O$ | S |
| **(1) Nitrogen level (N)** | | | | | | | | |
| $N_1$– 25 kg/ha | 38.70 | 10.05 | 17.39 | 5.31 | 237.92 | 25.44 | 309.94 | 6.50 |
| $N_2$– 50 kg/ha | 54.49 | 11.89 | 20.24 | 6.41 | 281.22 | 26.70 | 292.19 | 6.88 |
| S.Em. ± | 1.17 | 0.26 | 0.46 | 0.12 | 4.75 | 0.47 | 6.62 | 0.14 |
| CD at 5 % | 3.44 | 0.78 | 1.34 | 0.36 | 13.93 | NS | NS | NS |
| **(2) Phosphorus level (P)** | | | | | | | | |
| $P_1$– 12.5 kg/ha | 43.09 | 9.15 | 17.57 | 5.39 | 254.65 | 23.34 | 295.36 | 6.59 |
| $P_2$– 25 kg/ha | 50.10 | 12.79 | 20.07 | 6.33 | 264.50 | 28.81 | 306.77 | 6.80 |
| S.Em. ± | 1.17 | 0.26 | 0.46 | 0.12 | 4.75 | 0.47 | 6.62 | 0.14 |
| CD at 5 % | 3.44 | 0.78 | 1.34 | 0.36 | NS | 1.38 | NS | NS |
| **(3) Sulphur level (S)** | | | | | | | | |
| $S_1$– 0 kg/ha | 41.62 | 9.84 | 17.15 | 5.09 | 253.75 | 25.05 | 299.19 | 5.91 |
| $S_2$ – 20 kg/ha | 45.92 | 10.91 | 18.53 | 5.79 | 256.75 | 26.02 | 314.00 | 6.54 |
| $S_3$– 30 kg/ha | 52.24 | 12.17 | 20.78 | 6.70 | 268.21 | 27.15 | 290.00 | 7.63 |
| S.Em. ± | 1.44 | 0.32 | 0.56 | 0.15 | 5.82 | 0.57 | 8.11 | 0.18 |
| CD at 5 % | 4.21 | 0.95 | 1.64 | 0.44 | NS | NS | NS | 0.52 |
| **Interaction** | NS | NS | NS | NS | NS | NS | NS | NS |
| **CV%** | 10.68 | 10.24 | 10.31 | 8.82 | 7.76 | 7.64 | 9.33 | 9.13 |

different level of sulphur, application of sulphur 30 kg/ha ($S_3$) recorded significantly the highest seed (873 kg/ha) and stover yield (2253 kg/ha). Sulphur plays vital and important role in energy transformation, carbohydrate metabolism and activation of enzymes as well as respiration, photosynthesis which in turn accelerates development of yield attributes. The present results corelate with the study done by Sawant et al. [4], Kalegore et al. [11] and Salame et al. [12].

## 3.5 Quality

### 3.5.1 Nutrient content and uptake

The effect of various level of sulphur on S content in seed and stover were found to be significant. Significantly higher sulphur content in seed (0.325 %) and stover (0.2171 %) were recorded with the application of sulphur @ 30 kg/ha. The application of sulphur does not directly increase the sulphur content in seeds and stover. However, it can indirectly affect the sulphur content in seed and stover by improving their ability to take up and utilize sulphur from soil. The present finding was in accordance with the findings of Choudhary et al. [13] and Vaghani et al. [8].

Different nutrient levels as soil application significantly influenced the total N, P, K and S uptake by sesame. Crop fertilized with 30 kg $ha^{-1}$ sulphur resulted in significantly the highest total N, P, K and S uptake by sesame (52.24, 12.17, 20.78 and 6.70 kg/ha, respectively). Similar results were observed by Choudhary et al. [13].

## 4. CONCLUSION

Lower productivity is due to use of sub-optimal rate of fertilizer, poor management and cultivation of sesame in marginal and sub-marginal lands, where deficiency of macronutrient such as nitrogen, phosphorus, potassium and micronutrient is predominant. Balanced fertilization with N, P, K and S is proved beneficial in all the oilseed crops to minimize the unfavourable exploitation of soil fertility and plant nutrient, thus maintain the soil health and plant nutrient at optimum level.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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