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Effect of different levels of nitrogen and potassium on growth and yield of Sesame (*Sesamum indicum* L.)

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Abstract
A Field experiment was conducted during *kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.57%), available N (230 kg/ha), available P (32.10 kg/ha) and available K (235 kg/ha). The treatments consist of three levels of nitrogen and three levels of potassium. The experiment was laid out in randomized block design with nine treatments each replicated thrice. The result showed that *viz*: Plant height (140.97 cm), number of branches per plant (3.62) and dry weight (14.94 g/plant) were recorded significantly higher with application of Nitrogen 50 kg/ha + Potassium 30 kg/ha. Whereas, crop growth rate (7.71 g/m^2/day) at 30-45 DAS interval and relative growth rate (0.092 g/g/day) at 30-45 DAS interval recorded significantly higher with application of Nitrogen 50 kg/ha + Potassium 30 kg/ha. Number of capsules per plant (28.51), number of seeds per capsule (46.63), seed yield (1242.74 kg/ha), stalk yield (1695.68 kg/ha) and were recorded significantly higher with the application of Nitrogen 50 kg/ha + Potassium 30 kg/ha.

Keywords: Sesame, nitrogen, potassium, seed yield, economics

Introduction
Sesame (*Sesamum indicum* L.) is one of the most important oilseed crop. Sesame is a queen of oil seed crops by virtue of its excellent oil quality. Sesame crop can be grown in wide range of environments, extending from semiarid tropics and subtropics regions. It is mostly cultivated under rainfed conditions on marginal and sub-marginal lands with sub-optimal rate of fertilizer and poor management practices. Sesame is grown in areas rainfall of 625-1100 mm and temperature >27ºC the crop is tolerant to drought, but not top water logging. This probably indicates in sesame productivity in India. The main reason for low productivity of sesame is use of low yielding varieties, poor soil fertility and imbalanced nutrition (Engoru and Bashaasha, 2001) [4]. The oilseed scenario in the country has undergone a sea change. The main contributors to such transformation are availability of improved oil seeds production technology long with its adoption and expansion of cultivated area. Large number of technologies evolved in the field of agriculture is not being accepted and adopted to its fullest extent by the farmers. The gap between recommendations made by the scientists and actual use by farmers is frequently encountered (Rohit and Singh, 2019) [8].

Materials and Methods
In order to study the three levels nitrogen of and three levels of potassium on the growth and yield characters of sesame. The experiment was conducted at during *Kharif* 2021 Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28ºN latitude, 81.54ºE longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha). The treatments consist of three levels of nitrogen (40, 45 and 50 kg/ha) soil application and four levels of potassium (0, 15 and 30 kg/ha) respectively. The experiment was laid out in randomized block design with nine treatments each replicated thrice and control *i.e.*, recommended N, P and K (50:40:30 kg/ha) alone. The plots were prepared with dimension of 5 m × 3 m and seeds of variety G-1 were sown with a spacing of 45cm × 10 cm.

At 4-5 leaf stage plants were thinned to appropriate density. Weeds were controlled manually at 5-leaf stage, stem elongation and flowering stage to maintain a uniform plant population. Growth characteristics plant height (cm), number of branches per plant, dry weight per plant (g), crop growth rate (g/m^2/day) and relative growth rate (g/g/day) were recorded, with following formulas (A & B). Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their biometric observations such as number of capsules per plant, number of seeds per capsule, 1000 seed weight (g), seed yield (kg/ha), stalk yield (kg/ha) and were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984) [5].

Formulas

A. Crop growth rate (CGR) denotes overall growth rate of the crop plants and measured after fixed period of time, irrespective of the previous growth rate (Leopold and Kridemann, 1975) [6].

$$CGR = \frac{W_2 - W_1}{P\,(t_2 - t_1)}$$

Where, W_2 and W_1 are dry weight of plant (g) recorded at time t_2, t_1 (days) and P is ground area respectively.

B. The relative growth rate (RGR) indicates the amount of growth per unit dry weight of plant per unit time (Leopold and Kridemann, 1975) [6]. It is expressed as grams of dry matter produced by a gram of existing dry matter in a day.

$$RGR = \frac{\mathrm{Log_e}\, W_2 - \mathrm{Log_e}\, W_1}{t_2 - t_1}$$

Where $\mathrm{Log_e}$: Logarithm to the base, W_1: Dry weight of the plant at t_1, W_2: Dry weight of the plant at t_2.

Result

Growth parameters

Table. 1 pertaining that details of influence of nitrogen and potassium on sesame growth attributes.

Table 1: Influence of nitrogen and potassium on growth of sesame crop

Treatment	Plant height (cm)	Number of branches/plant	Dry weight (g)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
Nitrogen 40 kg/ha + Potassium 0 kg/ha	133.01	3.30	13.54	5.40	0.081
Nitrogen 40 kg/ha + Potassium 15 kg/ha	134.03	3.36	13.64	5.56	0.082
Nitrogen 40 kg/ha + Potassium 30 kg/ha	135.49	3.40	13.76	5.64	0.082
Nitrogen 45 kg/ha + Potassium 0 kg/ha	138.78	3.48	14.14	6.13	0.084
Nitrogen 45 kg/ha + Potassium 15 kg/ha	139.30	3.50	14.30	6.32	0.085
Nitrogen 45 kg/ha + Potassium 30 kg/ha	139.75	3.53	14.44	6.68	0.088
Nitrogen 50 kg/ha + Potassium 0 kg/ha	140.46	3.51	14.59	7.07	0.089
Nitrogen 50 kg/ha + Potassium 15 kg/ha	140.85	3.55	14.85	7.55	0.092
Nitrogen 50 kg/ha + Potassium 30 kg/ha	140.97	3.62	14.94	7.71	0.092
SEM (±)	0.29	0.02	0.04	0.04	0.0001
CD (p=0.05)	0.29	0.02	0.04	0.04	0.0001

Plant height (cm)

At harvest significantly higher plant height was observed in treatment with the application of Nitrogen 50 kg/ha + Potassium 30 kg/ha (140.97 cm) which is statistically at par to Nitrogen 50 kg/ha + Potassium 15 kg/ha (140.85 cm) and Nitrogen 50 kg/ha + Potassium 0 kg/ha (140.46 cm).

Number of branches per plant: At harvest the significantly highest number of branches per plant were observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (3.62).

Dry weight (g/plant)

At harvest the significantly higher dry weight was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (14.94 g/plant) which was statistically at par with Nitrogen 50 kg/ha + Potassium 15 kg/ha (14.85 g/plant).

Crop growth rate (g/m^2/day)

At 30-45 DAS the significantly higher crop growth rate was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (7.71 g/m^2/day).

Relative growth rate (g/g/day)

At 30-45 DAS the significantly higher relative growth rate was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha, Nitrogen 50 kg/ha + Potassium 15 kg/ha (0.092 g/g/day). Which was statistically at par with the application of Nitrogen 50 kg/ha + Potassium 0 kg/ha, (0.089 g/g/day).

Yield attributes

Table 2 pertaining that details of influence of nitrogen and potassium on sesame yield attributes.

Table 2: Influence of nitrogen and potassium on yield and yield attributes of sesame crop

Treatment	Number of capsules per plant	Number of seeds per capsule	Test weight (g)	Seed yield (kg/ha)	Stalk yield (kg/ha)
Nitrogen 40 kg/ha + Potassium 0 kg/ha	24.05	45.36	2.31	996.84	1528.02
Nitrogen 40 kg/ha + Potassium 15 kg/ha	24.44	45.37	2.31	1012.50	1509.97
Nitrogen 40 kg/ha + Potassium 30 kg/ha	24.75	45.39	2.32	1048.46	1584.27
Nitrogen 45 kg/ha + Potassium 0 kg/ha	24.99	45.86	2.32	1078.25	1594.19
Nitrogen 45 kg/ha + Potassium 15 kg/ha	25.65	45.87	2.33	1098.15	1597.92
Nitrogen 45 kg/ha + Potassium 30 kg/ha	26.07	45.88	2.32	1103.91	1625.96

Nitrogen 50 kg/ha + Potassium 0 kg/ha	27.63	46.02	2.33	1186.35	1658.70
Nitrogen 50 kg/ha + Potassium 15 kg/ha	28.28	46.36	2.32	1203.63	1684.53
Nitrogen 50 kg/ha + Potassium 30 kg/ha	28.51	46.63	2.33	1242.74	1695.68
SEM (±)	0.13	0.04	0.01	3.15	10.60
CD (p=0.05)	0.39	0.10	-	9.44	31.78

Number of capsules per plant

The significantly higher number of capsules per plant was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (28.51). Which was statistically at par with the application of Nitrogen 50 kg/ha + Potassium 15 kg/ha (28.28).

Number of seeds per capsule

The significantly higher number of seeds per rows was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (46.63).

Test weight (g)

The higher test weight was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (2.33 g). And lowest was observed in Nitrogen 40 kg/ha + Potassium 0 kg/ha and Nitrogen 40 kg/ha + Potassium 15 kg/ha (2.31 g). There was no significant difference among the treatments.

Seed yield (kg/ha)

The significantly higher grain yield was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (1242.74 kg/ha).

Stalk yield (kg/ha)

The significantly higher stalk yield was observed in Nitrogen 50 kg/ha + Potassium 30 kg/ha (1695.68 kg/ha). Which was statistically at par with the application of Nitrogen 50 kg/ha + Potassium 15 kg/ha (1684.53 kg/ha).

Discussion

Enhanced height of sesame plants in response to the combined application of the two nutrients might be attributed to the synergistic effects of the nutrients, which were supplied to the soil. Possibly, the application of the two nutrients might have enhanced cell division and growth, which subsequently resulted in increased plant height. Higher plant height with increased nitrogen application levels might be due the fact that higher doses of nitrogen enhanced the metabolic and meristematic activities of crop resulting in optimum growth, plant height and branches per plant of sesame. Similar results are also reported by Shilpi *et al.* (2012) and Reddy *et al.* (2021) [10, 7].

The reason might be higher number of branches per plant the availability of more nutrients due to higher level of N application enabled crop to uptake more nutrients and grow vigorously and thus resulted in improved crop growth and more branches per plant. Similar results reported by Ahmad *et al.* (2018) [1]. Increase in number of dry matter yield could be as a result of nitrogen being involved in carbohydrate and protein metabolism that promotes cell division and enlargement resulting in more productive pods and dry matter yields. The results are in line with Malik *et al.* (2003) who reported increase in number of pods per plant with increasing N rate.

Which might be due to better availability of nitrogen leading to higher photosynthesis and more leaf formation. Due to increase in plant height the number of branches might have permitted accommodation of more number of leaves. This could be attributed to interception of higher solar radiation by the larger leaf area and resulting in higher accumulation of photosynthates. Which might have influenced the yield attributes afterwards. Reported by Sahoo *et al.* (2010) [9].

Balanced nutrition under favorable environment might have helped in production of new tissues and development of new shoots which have ultimately increased the plant height, dry matter accumulation, number of branches per plant, and CGR. Relatively higher relative growth rate resulted, similar results reported by Damdar *et al.* (2014) [3].

The progressive effect of potassium on yields may be due to the pronounced role of potassium in carbohydrates synthesis, photosynthesis and cell elongation. The present results are also strongly agreed with Application of 50 kg/ha Nitrogen + Potassium 30 kg/ha exhibited augmentation of yield components and seed yield because good supply of N and K promotes root proliferation and density which in turn aids in exploration and more supply of nutrients and water to the growing parts. The increase in oil yield and protein content with the application of potassium is consequence of the increase in oil content and protein content and grain yield (Mondal *et al.*, 2001) [11]. There was a spectacular increase in oil and protein content under balanced fertilization (Brar *et al.*, 2010) [2].

Conclusion

It can be inferred from the present study that application of 50 kg nitrogen per ha, 30 kg potassium per ha is sufficient to sustain the higher growth, physiological parameters and productivity of sesame under irrigated north Indian conditions. These findings are based on one season; therefore, further trail may be required for further confirmation.

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