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Influence of Phosphorus and Potassium Levels on Growth, Yield and Economics of Sesame (*Sesamum indicum* L.) under eastern Uttar Pradesh Condition

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ABSTRACT: The field experiment was conducted during *Zaid*-2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.). The experiment was laid out in Randomized block design and having nine treatment consisted of 40 kg P/ha + 30 kg K/ha, 40 kg P/ha + 20 kg K/ha, 40 kg P/ha + 10 kg K/ha, 30 kg P/ha + 30 kg K/ha, 30 kg P/ha + 20 kg K/ha, 30 kg P/ha + 10 kg K/ha, 20 kg P/ha + 30 kg K/ha, 20 kg P/ha + 20 kg K/ha, 20 kg P/ha + 10 kg K/ha which replicated thrice. The result shown significantly higher in growth parameter *viz.,* Plant height (116.9 cm), Number of Branches per plant (3.73), Leaf area (2568.7 cm^2), Plant dry weight (15.24 g) and yield parameters *viz.,* Seed yield (361 kg/ha) and Stover yield (1641.15 kg/ha) were recorded with application of 40 kg P/ha + 20 kg K/ha. Harvest index (18.05%) was found to be non-significant. Maximum Gross return (62390 INR/ha), Net return (27498.3 INR/ha) and B:C ratio (1.79) also resulted under application of 40 kg P/ha plus 20 kg K/ha. The challenges experienced during the research work mostly due to application of 40 kg P/ha as DAP which significantly increasing all the parameters and application of MOP enhance the ability of plants to resist diseases and insect attacks.

Keywords: Growth, Economics, Phosphorus, Potassium, Sesame, Yield

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an ancient oil seed crop, one among the oldest cultivated plants in India since the Harappan period. Sesame is an archipelago flower bearing annually cultivated oil crop under the family Pedaliaceae and plant genus *Sesamum* with chromosome number 2n = 26. Sesame is variously referred to as Til, Sesamum, Ellu, Beniseed, Rasi, Sim sim, Gergelim etc. Sesame is that the fifth most vital important oilseed crop in India next to Ground nut, Rapeseed-Mustard, Soyabean and Sunflower. It is also referred to as poor man's substitute for ghee. Sesame seed is a rich source of oil (38-54%) and protein (18-20%) consisting of both methionine and tryptophan, Vitamin- B_5 (niacin) and minerals (Ca & P). Sesame seed also contain sesamine and sesamolin, sesamolin on hydrolysis yields sesmol, which has pronounced antioxidant activity, so it has higher shelf life and is caused "Seed of immortality" (Valiki *et al.,* 2015). It has anti-bacterial, anti-viral, anti-fungal and antioxidant properties due to presence of lignin and tocopherol. Nearly 73% of the oil is used for edible purpose and 14.5% preferred for cooking due to zero cholesterol. White seeded sesame is extensively used in Bakery products, whereas black seeded sesame used for medicinal purposes. Whereas 8.3% used for hydrogenization and 4.2% for industrial purposes like in the manufacture of paints, perfumed, oils pharmaceuticals and insecticides (Bedigian, 2014). The oil cake is an edible cake, rich in methionine, cysteine, arginine and tryptophan and used as cattle feed contains 6 – 6.2% N, 2 -2.2% P_2O_5 and 1- 1.2% of K_2O and can be used as manure. Sesame is the heavy feeders of nutrients to produce good quality of yield.

Phosphorus has significant effect in the production of oil seed plant, also essential for the growth and yield of sesame plant. Phosphorus (P) is usually associated to increased root density proliferation, which aids in extensive exploration, supply of nutrients and water to growing plant parts, thus increase growth and yield (Jahan *et al.,* 2019). Potassium (K) is an essential nutrient for plant growth. In photosynthesis, Potassium regulates the opening and closing of stomata, and transfer to regulate Co_2 uptake. Potassium plays an important role in many metabolic processes in plants. The oil and protein content of the crop were influenced with the application of potash. Potash is involved in the transport of the products of photosynthesis to the pods and transformation into oil. Ideal crop response to phosphorus and potassium improve the yield of sesame. The present study was therefore undertaken to determine the phosphorus and potassium level for well result in terms of quantity and quality of sesame crop.

Thakur *et al.,* (2015) conducted a field experiment at Jagdalpur in Chhatisgarh. They stated that application of P at 60 kg/ha increased highest plant height (109.09 cm), number of leaves per plant (38.45) and number of branches per plant (2.98) significantly recorded during than (0, 30, 45 and 60) phosphorus levels. They stated that application of K at 30 kg/ha increased highest plant height (109.23 cm), number of leaves per plant (38.13) and number of branches per plant (2.90) significantly recorded during both the years than other potassium levels.

Ahmad *et al.,* (2018) revealed that, taller plant (76.97 cm), maximum number of branches per plant (3.93), more number of capsules per plant (42.77), more number of seeds per capsules (59.36), maximum seed yield (617 kg/ha), maximum Stover yield (1043 kg/ha), more oil content (48.65%) and maximum oil yield (286.6 kg/ha) were recorded from 50 K/ha potassium treatments.

Jahan *et al.,* (2019) was conducted a field trial at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. They reported that, the highest plant height of sesame (136.30 cm), the highest no. leaves/plant of sesame (34.44), number of primary branches per plant (5.56), and number of secondary branches per plant (7.61), the highest number of capsule/plant (25.87), number of seed/capsule (70.47), 1000 seed weight (3.54), Seed yield (1581.00 kg/ha), Stover yield (3034.42 kg/ha), biological yield (4615.76 kg/ha), harvest index (34.11%), oil content (43.92%) was recorded from 20% of phosphorous application.

Adisu *et al.,* (2020) concluded that, from three levels of phosphorus fertilizer (0, 10 and 20 kg P/ha), higher mean yield (998.9 kg/ha) and highest net benefit (29502.8 ETB) was obtained from 10kg P/ha.

MATERIALS AND METHODS

The experiment was carried out during *Zaid* season of 2020 at Crop Research farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at 25º 24′ 42″ N latitude, 81º 50′ 56″ E longitude and 98 m altitude above the mean sea level. The soil of experimental site was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), EC (0.34 dS/m), low in available N (203.7 kg/ha), medium in available P (17.2 kg/ha) and medium in available K (208.8 kg/ha). The Experiment was carried out in Randomized Block Design having nine treatment consisted of Phosphors levels *viz.,* (40, 30 and 20) kg P/ha and Potassium levels *viz.,* (30, 20 and 10) kg K/ha which replicated thrice and effect was observed on Gujarat Til-4 sesame variety. Sowing was done by line sowing method on 21st April 2020 with row spacing 30 cm and plant spacing 10 cm. The recommended cultural practices were under taken as per recommendation. The economic per ha were worked out from different treatments considering prevailing market prices of commodity. Data on various variables *viz.,* Plant height (cm), Number of Branches per plant, Leaf area (cm), Plant dry weight (g), Seed yield (kg/ha), Stover yield (kg/ha) and Harvest index (%) were analyzed by analysis of variance (ANOVA) (Panse and Sukhatme, 1967). Data on Cost of cultivation, Gross return, Net return and B:C ratio were analyzed from fixed and variable cost.

The finding of the present study in Prayagraj conditions is based on one season which appears to be inadequate on a single location. Hence, further trials are needed to confirm the findings of the present experiment. Where the drawbacks of previous study were the variety (Gujurat Til-4) may not perform well with these treatment combinations and yield was comparatively less compared to actual yield of this variety in Eastern Uttar Pradesh conditions.

RESULTS AND DISCUSSION

A. Growth attributes

Crop growth and development in sesame was measured in terms of plant height (cm), Number of Branches per Plant, Leaf area (cm^2) and Plant dry weight (g) at harvesting stage of crop are shown in Table 1. At harvest, the data on plant height shown significantly increase with maximum plant height (116.91 cm) was recorded with application of 40 kg P/ha + 20 kg K/ha as compared to other treatment combinations. The plant height was increased with the advancement in crop stage, irrespective of the treatment and reached maximum at the time of harvest. The progressive increase in levels of phosphorus i.e. 20% of P significantly increased the growth attributing characters of sesame *viz.,* plant height was reported by Jahan *et al.,* (2019).

The increase in plant height could partly be attributed due to the beneficial effect of potassium fertilization, reported by Jadav (2004) and Bhosale (2009) in sesame. Number of branches per plant at harvest shown significant increase with higher number of branches (3.73) was recorded in application of 40 kg P/ha + 20 kg K/ha than other treatment combination. Sesame bears 4-5 branches and close spacing between plants i.e. 10 cm resist the canopy spread due to competition. These results are in conformity with Chakraborty (2013). The progressive increase in levels of phosphorus i.e.40 kg P/ha significantly increased the growth attributing characters of sesame i.e. number of primary and secondary branches per plant was reported by Jahan *et al.*, (2019). The increase in levels of potassium up to 50 kg K/ha significantly increased the number of primary and secondary branches per plant of sesame were confirmed by Ahmad *et al.,* (2018).

Table 1: Influence of Phosphorus and Potassium levels on growth attributes of Sesame (At Harvest).

Treatments	Plant height (cm)	Branches per plant (number)	Leaf area (cm^2)	Plant dry weight (g/plant)
40 kg P/ha+ 30 kg K/ha	112.07	3.13	2200.12	14.66
40 kg P/ha + 20 kg K/ha	116.91	3.73	2568.70	15.24
40 kg P/ha + 10 kg K/ha	109.39	2.73	2192.17	12.39
30 kg P/ha + 30 kg K/ha	105.83	2.60	1747.82	11.42
30 kg P/ha + 20 kg K/ha	108.33	2.67	2121.41	12.32
30 kg P/ha + 10 kg K/ha	104.36	2.53	1569.66	10.74
20 kg P/ha + 30 kg K/ha	95.55	2.47	1435.49	10.41
20 kg P/ha + 20 kg K/ha	104.43	2.67	1625.35	10.88
20 kg P/ha + 10 kg K/ha	94.09	2.27	1199.31	10.24
SEm±	2.68	0.27	182.55	1.13
CD (P=0.05)	8.02	0.80	547.27	3.39

The positive effect of potassium on this growth character may be due to augment of cell division and cell expansion. These results are found similar with the results of Jadav (2004) in sesame with 40 kg K/ha. Phosphorus and Potassium levels had significant influenced on mean leaf area per plant at all stages of crop growth. The higher leaf area (2568.70 cm^2) was recorded with application of 40 kg P/ha + 20 kg K/ha which was significantly superior overall treatment combinations. The progressive increase in levels of phosphorus i.e. 40 kg P/ha significantly increased the growth attributing characters of sesame i.e. leaf area was reported by Jahan *et al.,* (2019) in Sesame. This is mainly due to optimum moisture in root zone which favors uptake of phosphorus; resulting better growth of the crop was reported by Unde *et al.,* (2017). The increase in levels of potassium up to 49.8 kg K/ha also significantly increased the leaf area of sesame was reported Sarkar and Pal (2005) in sesame. The plant dry weight was increased with the advancement in crop stage, irrespective of the treatments with irrigation reached maximum at the time of harvest. Plant dry weight is the cumulative growth of various plant parts. The higher plant dry weight (15.24 g) was recorded with application of 40 kg P/ha + 20 kg K/ha which was significantly superior overall treatment combinations. Application of 25.8 kg/ha phosphorous with irrigation water as per requirement ensures steady availability of soil moisture to crop, which consequently improve uptake of P, fertilizer use efficiency, growth and development. It ultimately reflects on accumulation of higher dry matter in aerial parts. Results found similar with Sarkar *et al.,* (2005). The positive effect of potassium on dry matter might be due to pronounced role of potassium in transport of photosynthates, photosynthesis and cell elongation resulting in the increase of leaf area. As a result enhancement inn production of photosynthates and their subsequent vis-a-versa dry weight favored by potassium. These results are in agreement with Saxena *et al.,* (2003).

B. Yield

Observations regarding yield like Seed yield (kg/ha), Stover yield (kg/ha) and Harvest index (%) of sesame depicted in Table 2. Application of higher dose of inorganic fertilizers brought significant improvement in seed yield over all the treatments. The maximum seed yield was recorded significantly superior seed yield (361 kg/ha) with application of 40 kg P/ha + 20 kg K/ha. The favorable effect of phosphorus and potassium on seed yield of sesame might be due to the stimulating effect of phosphorus on different yield attributing character *viz.,* Number of Capsules per plant, Number of Seeds per capsule and Test weight etc.

Table 2: Influence of Phosphorus and Potassium levels on Yield of Sesame.

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
40 kg P/ha+ 30 kg K/ha	311.67	1459.93	17.58
40 kg P/ha + 20 kg K/ha	361.00	1641.15	18.05
40 kg P/ha + 10 kg K/ha	297.67	1431.37	17.13
30 kg P/ha + 30 kg K/ha	292.00	1364.20	17.66
30 kg P/ha + 20 kg K/ha	299.00	1454.93	17.05
30 kg P/ha + 10 kg K/ha	281.33	1316.27	17.65
20 kg P/ha + 30 kg K/ha	270.00	1287.73	17.47
20 kg P/ha + 20 kg K/ha	271.67	1307.70	17.22
20 kg P/ha + 10 kg K/ha	254.33	1171.40	17.87
SEm±	19.04	71.78	1.05
CD (P=0.05)	57.08	215.20	-

These results are conformity with Choudhari (2007) and Bhosale (2009) in sesame. The application of higher dose of inorganic fertilizers brought significantly improvement in stover yields over all the treatments. The maximum stover yield was recorded significantly superior (1641.15 kg/ha) with application of 40 kg P/ha + 20 kg K/ha.

The stover yield of sesame increased steadily with increase in phosphorous levels. It might be attributed to higher uptake of nutrients and higher dry matter accumulation and translocation to reproductive plant parts. These results are similar with Patel (2007) in sesame. The positive effect of potassium on stover yield might be due to the pronounced role of potassium in photosynthesis and to its requirement in carbohydrates synthesis, cell elongation more ever; higher nutrient uptake under this level resulted in higher plant height and number of branches per plant and ultimately helped in realization of higher stover yield. These results are in corroboration with those reported by Jadav (2004) and Bhosale (2009) in sesame. Harvest index was found to be non-significant due to phosphorus and potassium levels. This might be due to proportional effects on seed and stalk yields turned out the harvest index to be non-significant was reported by Jadav (2004) in sesame.

C. Economics

The data on cost of cultivation, Gross return, Net returns and B:C ratio as influenced by different treatments as presented in Table 3 and depicted in Fig. 1. The treatment containing higher dose of applied inorganic fertilizers showed highest cost of cultivation per unit area over rest of the treatments during the year. It was perceptible from the data with application of 40 kg P/ha + 20 kg K/ha recorded highest cost of cultivations per unit area (INR 35247.7/ha) in sesame. The data clearly revealed that gross monetary return per unit area was maximum (INR 62390/ha) with application of 40 kg P/ha + 20 kg K/ha, also recorded maximum net return per unit area (INR 27498.30/ha). While data pertaining to economics of sesame cultivation clearly revealed that the treatment containing higher dose of inorganic fertilizer increased the B:C ratio as compared to lower dose of fertilizer. The maximum B:C ratio of (1.79) was associated with application of 40 kg P/ha + 20 kg K/ha in sesame.

Table 3: Economics of different treatments in Sesame.

Treatments	COC (INR/ha)	Gross Retur (INR/ha)	Net Return (INR/ha)	B:C Ratio
40 kg P/ha+ 30 kg K/ha	35247.70	52989	17741.30	1.50
40 kg P/ha + 20 kg K/ha	34891.70	62390	27498.30	1.79
40 kg P/ha + 10 kg K/ha	34583.70	50609	16025.30	1.46
30 kg P/ha + 30 kg K/ha	34912.00	49640	14728.00	1.42
30 kg P/ha + 20 kg K/ha	34556.00	50830	16274.00	1.47
30 kg P/ha + 10 kg K/ha	34248.00	47821	13573.00	1.40
20 kg P/ha + 30 kg K/ha	34609.20	45900	11290.80	1.33
20 kg P/ha + 20 kg K/ha	34253.20	46189	11935.80	1.35
20 kg P/ha + 10 kg K/ha	33945.20	43231	9285.80	1.27

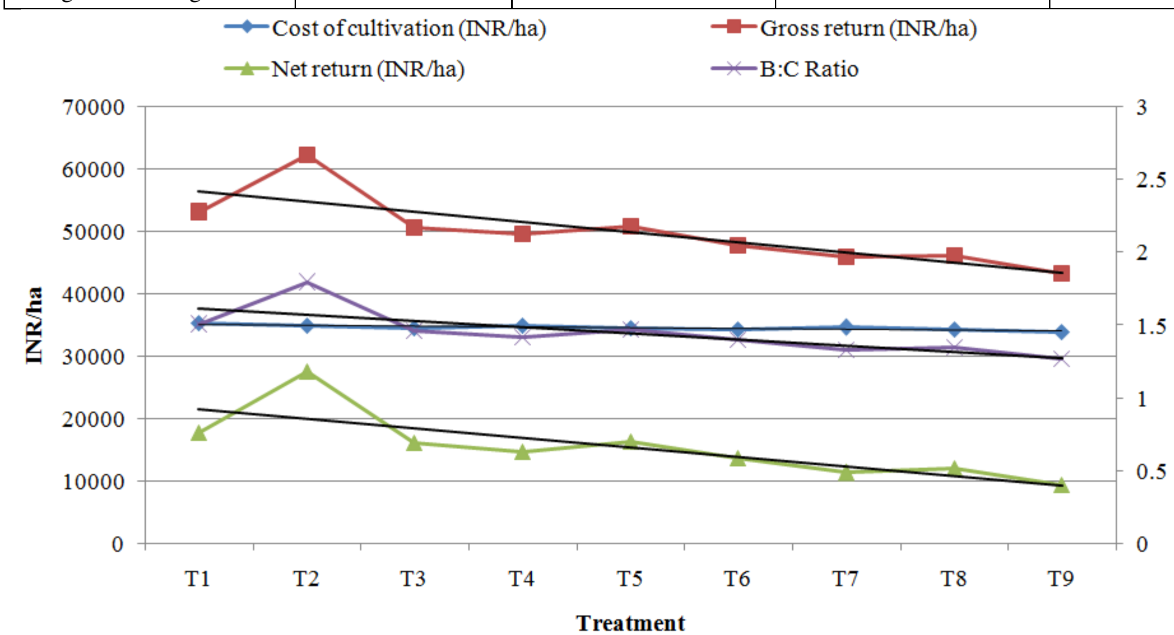

Fig. 1. Economics of different treatments in Sesame.

CONCLUSION

It is concluded that application of 40 kg P/ha + 20 kg K/ha recorded significantly higher Plant height, number of Branches Per plant, Leaf area, Plant dry weight, Seed yield, Stover yield, maximum Gross return, Net return, and Benefit Cost ratio as compared to other treatment combinations in sesame under Eastern Uttar Pradesh conditions.

FUTURE SCOPE

Based on research work done, it can be used as reliable work for further reference. Higher levels of phosphorus would be tested along with the present investigation to obtain higher yield of Sesame.

Conflict of interest. I have personally worked on M. Sc. Agronomy thesis without facing any financial issues and all the work regarding my crop was done by University support and finance. The data presented in the thesis were obtained during the work were collected from the field during the crop growth. This manuscript has not been submitted to, any other journal or other publishing venue.

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