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Research Article

Influence of Growth and Yield Attributes of Sesame (*Sesamum indicum* L.) by Sulphur and Phosphorus Different Combination Fertilizer Levels under the Rainfed Condition

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ABSTRACT

Implication of phosphorus and sulfur in soil assumes a key job in crop development and nature of protein what's more, oil substance, its sustenance in agro-biological system. The experiment was conducted at research farm, Rajoula, MGCGV, Chitrakoot, Satna (MP). This study was conducted to investigate the efficiency combined application sulphur and phosphorus on response of sesame impacts of the different growth parameter and crop productivity. Twelve different sulphur and phosphorus treatments along with one control were tested in Randomized Block Design with three replications. The plant growth parameters maximum recorded among the treatment under T_{12}*.* P_2S_3 *= 60 kg* P_2O_5 *+ 45 kg sulphur* ha^{-1} *and minimum (*T_1*)* P_0S_0 *= Control at 45, 60 DAS and yield parameters maximum recorded among the treatment under* T_{12}*.* P_2S_3 *= 60 kg* P_2O_5 *+ 45 kg sulphur* ha^{-1} *and minimum (*T_1*)* P_0S_0 *= Control at harvest. This study showed that the application of different combination fertilizers sulphur and phosphorus produced maximum grain yield and stover yield in sesame under rainfed condition.*

Keywords: *Sulphur and Phosphorus Combination, Growth and Yield Attributes, Sesame*

INTRODUCTION

Sesame (*Sesamum indicum* L.) ordinarily known as "til, ellu, beniseed, simsim" and sesame is regularly alluded to by the appellation "the sovereign of oil seeds" since it is valued for its nutritive incentive as well as for the quality and amount of its oil which is plentiful in nutrient E and has a lot of linoleic corrosive that can control blood cholesterol levels.

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The protein substance of seed is about 26.25% - 50 % oil, 18-20 % protein and the sulfur-containing amino corrosive methionine is available at a convergence of about 3.4% (Mosjidis, 1982). Sesame seed oil is impervious to oxidation and rancidity under ordinary stockpiling conditions. Even with the application of recommended doses of NPK fertilizers, the high potential of yield could not be achieved with presently available high yielding varieties due to the inadequacy of the micronutrients. Among secondary nutrients sulphur (S) is vital for protein synthesis in oil seed crops (Dharwe et al., 2019a, b).

India and China are the world's largest producers of sesame, followed by Myanmar, Sudan, Uganda, Ethiopia, Nigeria, Tanzania, Pakistan and Paraguay (FAOSTAT, 2008). India ranks first in world with 19.47 Lakh ha area and 8.66 Lakh tones production. Organic agriculture should support and improve the soundness of soil, plant, creature, human what's more, planet as one and resolute (Dotaniya et al., 2019, Mohbe et al., 2019). The nutrient element of major significance for yield and quantity of fodder crops are nitrogen, phosphorus and sulphur. Fodder and nutritional security for livestock population plays a vital and catalytic role in Indian farming system (Malvi et al., 2019). Optimum nutrition is required for getting maximum production of fodder of good quality. The average yield of sesame (413 kg ha^{-1}) in India is low as compared with other countries in the world (535 kg ha^{-1}). The principle purposes behind low profitability of sesame are its rainfed development in minor and sub minimal terrains under helpless administration and information starved conditions. Notwithstanding, improved assortments and agro creation advances fit for expanding the efficiency levels of sesame are currently produced for various agro environmental circumstances in the nation. A very much oversaw harvest of sesame can yield 1200 - 1500 kg/ha under flooded and 800 - 1000 kg/ha under rainfed conditions. The harvest is developed in practically all pieces of the nation. Over 85% creation of sesame originates from West Bengal, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, Andhra Pradesh and Telangana.

Most assortments show an uncertain development propensity, which is appeared as a consistent creation of new leaves, blossoms and containers as long as the earth stays reasonable for development. In recent years, sesame has had a low ranking in the world production of edible oil crop due to several factors including low yield and strong competition from other oil crops such as soybean, sunflower, peanut. Natural variables impact the oil substance and unsaturated fat pieces in sesame (Carlsson et al., 2008). Despite the fact that sesame oil is, as referenced previously, a phenomenal vegetable oil due to its high substance of cell reinforcements, for example, sesamin, sesamol and sesamolin and its unsaturated fat sythesis (Suja et al., 2004). The antioxidants make the oil very stable and it has therefore a long shelf life. In sesame oil, oleic and linoleic acids are the predominant fatty acids and make up more than 80% of the total fatty acids. The high levels of unsaturated (UFA) and polyunsaturated fatty acids (PUFAs) increase the quality of the oil for human consumption (Nupur et al., 2010). Sesame seed flour has a high protein content with high levels of the essential amino acids methionine and tryptophan, contains about 10 to 12% of oil and has three times more calcium than milk (Doutaniya, 2018). A potential problem though with sesame when used for human consumption is that it contains one of the top food allergens.

Keeping in view of above facts, sesame lines were evaluated in the present investigation was undertaken with following objectives: most suitable different combination dose phosphorus and sulphur on quality and production of Sesame under rainfed condition. (Pal & Gangwar, 2004,). Application Sulphur not only improved the grain yield but also improved the quality of crops (Dharwe et al., 2018). Utilization of high examination sulfur free manures, substantial sulfur evacuation by the yields under serious development and disregard of sulfur recharging added to across the board sulfur lacks in arable soils. Hence, this study was attempted to study the importance of sulphur in realizing the better growth, yield and quality of sesame crops (Parmar et al., 2018). Phosphorus (P) application to legumes plays a key role in formation of energy rich bonds, phospholipids and for development for root system (Dotaniya et al., 2013, Pingoliya et al., 2014, Bangre et al., 2020). Sulphur application increases oil and protein contents in seeds (Khinchi et al., 2017). It also increases the availability of other nutrients such as phosphorus, potassium and suppresses the uptake of sodium and chlorine which are toxic to plant growth and development. In general, the sufficient amount of sulphur application significantly increases crop growth and improves the quality of sesame by increasing protein and oil contents (Ahmad et al., 2018).

MATERIALS AND METHODS

A field experiment was conducted at research Farm Rajola of MGCGVV Chitrakoot during kharif season. It is situated between at $25^0$10' to $25^0$10' N latitude $80^0$52' E longitude. The altitude of place is nearly 200 meter above mean sea level. The climate conditions are semi-arid with extremes of summer and winter. The average minimum temperature prevails around 4.5^0C to 5.0^0C and maximum temperature is between 46^0C and 47^0C. The annual rainfall 950 mm with major precipitation between first weeks of July to last week of Chitrakoot spreads is located in Kymore Plateau in Madhya Pradesh. The experiment was laid out in a completely randomized block design comprising of twelve treatment combinations with control each replicated three times. About 30 genetically pure sesame seeds were sown in each pot and after germination and establishment 12 healthy plants were maintained. Recommended agronomic practices and plant protection measures were adopted to raise a good crop. A field experiment was carried out to assess the response of sesame to sulphur and phosphorus. In each sowing plot size of 5x3 m2, physico-chemical properties of soil were determined before start of experiment and recorded in along with other details. These 12 treatments combination were T_1- P_0S_0 = control, T_2 P_0S_1 =15 kg sulphur ha^{-1}, T_3- P_0 S_2 = 30 kg sulphur ha^{-1}, T_4- P_0S_3 = 45 kg sulphur ha^{-1}, T_5- P_1S_0= 40 kg P_2O_5 ha^{-1}, T_6- P_1S_1= 40 kg P_2O_5 +15 kg sulphur ha^{-1}, T_7- P_1 S_2= 40 kg P_2O_5 + 30 kg sulphur ha^{-1}, T_8- P_1S_3= 40 kg P_2O_5 + 45 kg sulphur ha^{--1}, T_9- P_2 S_0= 60 kg P_2O_5 ha^{-1}, T_{10}- P_2 S_1 = 60 kg P_2O_5 +15 kg sulphur ha^{-1}, T_{11}- P_2 S_2= 60 kg P_2O_5 + 30 kg sulphur ha^{-1}., T_{12}- P_2 S_3= 60 kg P_2O_5 +45 kg sulphur ha^{-1}. Time to time weeding and plant protection operation were done for better standing of crops. Time to time weeding and plant protection operation were done for better standing of crops. Morphological observation viz. Plant height (cm), Number of leaves, Number of branches, Number of capsules per plant, Seed yield and Straw yield kg per hectare were recorded and kept in table – 3,4 Statistical analysis of data were done following at $P < 0.05$ confidence level using ANNOVA statistics as outlined by (Gomez & Gomez, 1983).

Weather conditions:

Data regarding weather condition during the period of experimental was maintained in Table 1. Lowest rainfall 21.25mm was recorded in the month of September maximum 296 mm in the month of July. Month wise weather data has been given below. The mean lowest temperature 18.44 ^{0}C was recorded in October whereas the maximum temperature 33.8^0C was observed in the month of July. Relative humidity was highest 96.35% during October whereas, it was lowest 41.29% during October.

Table 1: Monthly weather data record during experimental period

	Temperature (^{0}C)		Relative humidity		Rainfall
	Max.	Min.	Max.	Min.	(mm.)
July	33.20	25.44	89.67	54.32	296
August	32.32	25.10	90.19	58.19	11.84
September	32.22	23.06	94.43	54	21.25
October	30.96	18.44	96.35	41.29	86.75

Experimental Soil

The soil of the experimental site was medium black to fine montmorillonitic, hyperthermic family of Typic Haplustert. The top soil (0-15 cm) was textural class "sandy loam", low in available N (148 mg kg^{-1}), alkaline permanganate method, medium in available P (7.21 kg ha^{-1}) and low in available K (170 kg ha^{-1}). The pH (1:2) and EC, of the surface soil were 7.2, and 0.27 dSm^{-1}, respectively.

RESULT AND DISCUSSION

Data were statistically analyzed and shifted in tables 2 and 3. After perusal of analyzed data following results were observed in various parameters.

Growth parameters

Plant height:

From the analyzed data given in table 2 result revealed that plant height with four levels *i.e.* 15, 30, 45 and 60 DAS, respectively. The maximum plant height observed 12.03 (T_{12}) and minimum 7.25 (T_1) with a general mean 10.20 at 15 DAS while, 30 DAS maximum plant height observed 62.67 (T_{12}) and minimum 43.50 (T_1) with a general mean 55.40. The 45 DAS, highest plant height observed 111.40 (T_{12}) and minimum 100.53 (T_1) with a general mean 108.12 and 60 DAS maximum plant height observed 136.27 (T_{12}) and minimum 116.93 (T_1) with a general mean 129.16. The maximum plant height observed under 60 kg P_2O_5 + 45 kg sulphur ha^{-1} (T_{12}) and minimum control T_1 at 15 30, 45 and 60 DAS (day after sowing) respectively. The above finding was supported by (McIntosh et al., 1985, Scott et al., 1985, Craighead et al., 1990, Mohbe et al., 2015).

Leaves:

The data on the impact of different treatments on leaves of sesame as influenced by different treatments have been presented in table 2. The maximum no. of leaves observed 6.33 (T_{10}) and minimum 5.33 (T_1) with a general mean 5.88 at 15 DAS while, 30 DAS maximum no. of leaves observed 21.53 (T_{12}) and minimum 14.27 (T_1) with a general mean 17.38. At 45 DAS, highest no. of leaves observed 60.20 (T_{12}) and minimum 25.13 (T_1) with a general mean 50.02 and 60 DAS maximum No. of leaves observed 78.20 (T_{12}) and minimum 41.00 (T_1) with a general mean 64.12. The maximum no. of leaves observed (T_{10}) and minimum (T_1) at 15 DAS while, then similarly result recorded maximum no. of leaves observed under 60 kg P_2O_5 + 45 kg sulphur ha^{-1} (T_{12}) and minimum control (T_1) different days at 30, 45 and 60 DAS. The above finding is broadly in agreement with report of in sesame (Shelke et al., 2014 and Raja et al., 2007).

Table 2: Effect of sulphur and phosphorus on growth parameters of Sesame under rainfed condition

Treatment	Plant height (cm)				Number of leaves/plants				No of primary branches/plants			No of capsules / plants	
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	45 DAS	60 DAS
T_1	7.25	43.50	100.53	116.93	5.33	14.27	25.13	41.00	2.00	2.00	2.00	14.67	32.27
T_2	9.27	45.93	107.00	123.61	5.67	15.07	41.67	47.20	2.00	2.40	2.40	27.87	42.13
T_3	9.63	50.30	107.93	128.27	6.00	16.13	44.27	54.67	2.67	2.73	2.47	37.00	57.33
T_4	10.00	55.67	108.90	129.99	6.33	16.80	54.73	62.27	2.67	2.67	2.80	42.40	62.80
T_5	9.29	56.20	107.90	121.87	6.00	15.87	53.93	61.20	2.93	2.93	2.67	44.33	67.27
T_6	10.01	57.93	108.94	131.40	5.67	17.33	58.67	68.00	3.60	3.60	3.33	49.33	72.33
T_7	10.70	58.20	109.47	132.33	6.00	16.93	53.33	68.33	2.93	2.93	2.80	50.00	74.00
T_8	11.21	59.20	110.13	133.67	6.00	18.07	55.87	70.87	3.20	3.20	3.00	50.93	76.00
T_9	11.03	58.70	108.40	130.87	5.67	16.67	49.40	72.67	2.73	2.73	2.73	41.33	69.20
T_{10}	11.37	59.80	110.20	134.80	6.33	18.93	59.87	76.73	3.33	3.33	3.33	54.87	74.20
T_{11}	11.67	61.27	111.00	135.00	6.00	19.87	57.87	77.33	3.47	3.47	3.33	58.20	79.33
T_{12}	12.03	62.67	111.40	136.27	5.67	21.53	60.20	78.20	3.60	3.60	3.60	58.57	82.27
SEm±	0.21	0.47	0.24	2.40	0.28	0.54	1.50	1.67	0.11	0.11	0.11	1.77	2.04
CD 5%	0.63	1.40	0.73	7.19	0.84	1.61	4.51	4.99	0.33	0.35	0.34	5.32	6.13

Branches:

The data of no. of primary branches showed in table 2 four levels *i.e.* 15, 30, 45 and 60 DAS, using different combinations treatments phosphorus and sulphur. The maximum no. of primary branches observed in T_{12} (3.60) and minimum T_1 and T_2 (2.00 in each) with a general mean 2.91 at 30 DAS while, at 45 DAS, highest no. of primary branches observed 3.60 (T_{12}) and minimum 2.00 (T_1) with a general mean 2.94 and 60 DAS maximum no. of primary branches observed 3.60 (T_{12}) and minimum 2.00 (T_1) with a general mean 2.86. This finding is broadly in agreement with report of primary branches (Shelke et al., 2014, Mohbe et al., 2018).

Capsule per plants

Sulphur is an important major nutrient source which determines the oil content of sesame. The response of sesame to inorganic fertilizer (phosphorus and sulphur) mode of nutrition is a primary concern in its cultivation. The data of no. of capsule per plants showed in table 2 four levels *i.e.* 15, 30, 45 and 60 DAS, using Three levels of phosphorus and four levels of sulphur with twelve combinations (T_1 to T_{12}). At both, 15 and 30 DAS have could not capsule formation because capsule formation starts after vegetative growth phase. At 45 DAS maximum No. of capsule per plants observed 58.57 (T_{12}) and minimum 1.67 (T_1) with a general mean 43.05 and 60 DAS highest No. of capsule per plants observed 82.77 (T_{12}) and minimum 32.27 (T_1) with a general mean 6.55. Significant increases in number of capsules per plant were observed with each increment level of different sulphur and phosphorus combinations showed increase the number of capsules per plant. no. of capsule per plants showed in table 2 data observed i.e. 15, 30, 45 and 60 DAS, using phosphorus and sulphur combinations. At both, 15 and 30 day after sowing have could not capsule formation because capsule formation starts after vegetative growth phase. At 45, 60 both day after sowing maximum no. of capsule per plants was observed (T_{12}) and minimum (T_1). Significant increases in number of capsules per plant were observed with each increment level of different sulphur and phosphorus combinations showed increase the number of capsules per plant. Similar results were reported by (Fredrick et al., 2001, Shelke et al., 2014, Verma et al., 2014).

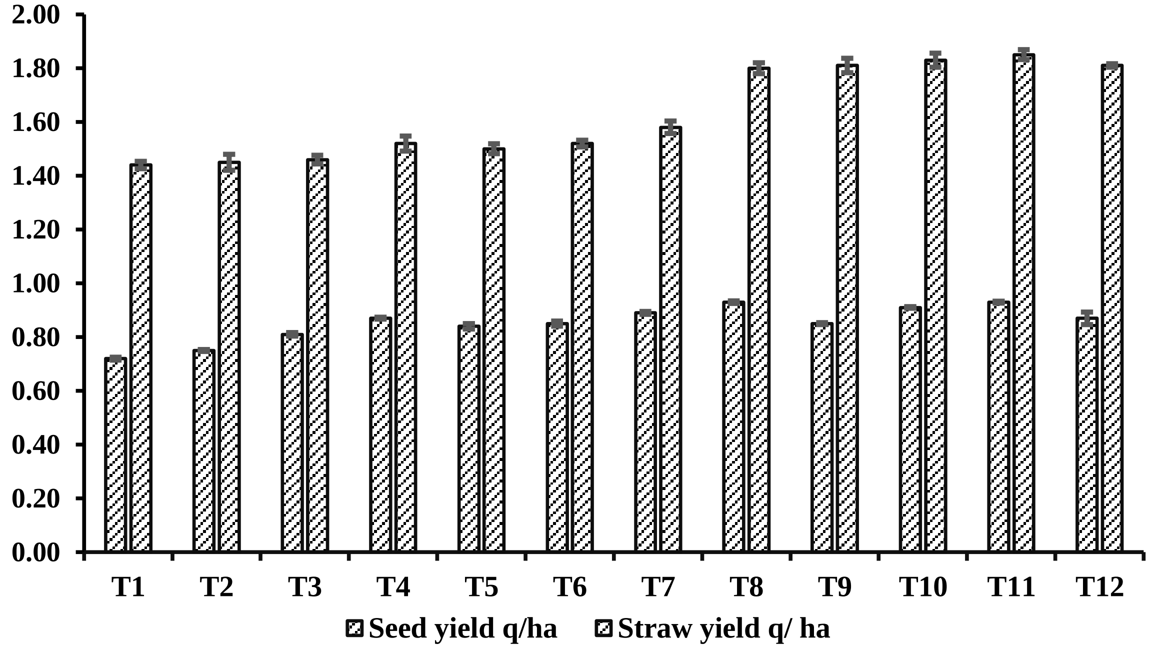
Seed and Straw Yield crop performance

A study of table 3 reveals that the seed yield and straw yield of sesame significantly increased with different chemical application. The seed yield q ha^{-1} of sesame with using inorganic fertilizer (phosphorus and sulphur) mode of nutrition is a primary concern in its cultivation showed in table 3 and fig-1, data recorded at the time of harvesting. The maximum seed yield (q ha^{-1}) were observed 0.87 (T_{12}) followed by 0.93 (T_{11}), 0.91 (T_{10}), 0.85 (T_9), 0.93 (T_8), 0.89 (T_7), 0.85 (T_6), 0.84 (T_5), 0.87 (T_4), 0.81 (T_3), 0.75(T_2) and minimum 0.72 (T_1) with a general mean 0.99. Similar results were reported by (Verma et al., 2014 and Shelke et al., 2014).

Table 3: Effected by phosphorus and sulphur doses yield of sesame under rainfall condition

Treatment	Seed yield q ha^{-1}	Straw yield q ha^{-1}
T_1 P_0 S_0 = control	0.72	1.44
T_2 P_0 S_1 = 15 kg S ha^{-1}	0.75	1.45
T_3 P_0 S_2 = 30 kg S ha^{-1}	0.81	1.46
T_4 P_0 S_3 = 45 kg S ha^{-1}	0.87	1.52
T_5 P_1 S_0= 40 kg P_2O_5 ha^{-1}	0.84	1.5
T_6 P_1 S_1= 40 kg P_2O_5 +15 kg S ha^{-1}	0.85	1.52
T_7 P_1 S_2= 40 kg P_2O_5 + 30 kg Sha^{-1}	0.89	1.58
T_8 P_1 S_3= 40 kg P_2O_5 + 45 kg S ha^{-1}	0.93	1.8
T_9 P_2 S_0= 60 kg P_2O_5 ha^{-1}	0.85	1.81
T_{10} P_2 S_1 = 60 kg P_2O_5 +15 kg S ha^{-1}	0.91	1.83
T_{11} P_2 S_2= 60 kg P_2O_5 + 30 kg Sha^{-1}	0.93	1.85
T_{12} P_2 S_3= 60 kg P_2O_5 +45 kg S ha^{-1}	0.87	1.81
SEm±	0.34	0.1
CD 5%	0.1	0.31

Fig-1 Phosphorus and Sulphur Doses Yield of Sesame under Rainfall Condition



After perusal of data, it was noticed that straw yield (q ha^{-1}) were observed 1.81(T_{12}) followed by 1.81 (T_{11}), 1.70 (T_{10}), and minimum 1.44 (T_1 & T_2) treatments with a general mean 1.63. The data of seed yield exhibited maximum seed yield (q ha^{-1}) were observed (T_{12}) followed by (T_{11}), and minimum (T1) while, maximum straw yield (q ha^{-1}) were observed (T_{12}) followed by (T_{11}), (T_{10}), and minimum (T_1 and T_2). Similar results were reported by (Raja et al., 2007 and Patra, 2001) in sesame thus, the synergistic relationship of N and S in plant metabolism and the maximum yield response to these elements is achieved when the supply of them are balanced in oilseed crops (Jaggi et al., 1977). Optimum nutrition, among other agro-techniques is very important for realizing full yield potential and the role of sulfur is next only to nitrogen in the nutrition of this crop. Little effort is made to reclaim optimum S requirement for the growth and yield of sesame using tracer techniques (Ravinder et al., 1996).

Analysis of variance for the design of experiment:

Analysis of variance for the design of the experiment indicated highly significant differences for all the characters *viz.* plant height, no. of leaves, no. of capsule per plant for 15, 30, 45 and 60 day after sowing. Except no. of capsule per plant at 45 and 60 DAS and no. of primary branches per plant showed non-significant. Seed yield exhibited significant with treatment. Non-significant differences due to replications were observed for all the characters. Significant differences due to treatment were observed for characters with four levels *i.e.* at 15, 30, 45 and 60 DAS *viz.* Plant height, no. of leaves, no. of primary branches per plant, capsule per plant and seed yield per plot and non-significant difference observed to be no. of capsule per plant at 15 and 30 DAS for all the treatment combinations.

Table 4: Analysis of variance for RBD for quantitative characters in sesame

Character	DAS	**Replication**	**Treatment**	**Error**
Plant height	15 DAS	1.06	**4.54****	0.13
	30 DAS	1.09	**5.61****	0.87
	45 DAS	12.77	**23.38****	0.18
	60 DAS	**69.24****	**99.64****	17.27
No. of leaves	15 DAS	0.9	0.3	0.23
	30 DAS	1.09	**5.61****	0.87
	45 DAS	**55.51****	**325.30****	6.78
	60 DAS	**33.32****	**399.70****	8.32
No. of primary branches	15 DAS	0	0	0
	30 DAS	0.12	0.635	0.04
	45 DAS	0.1	0.64	0.04
	60 DAS	0.41	0.647	0.04
No. of capsule per plant	15 DAS	0.00	0.00	0.00
	30 DAS	0.00	0.00	0.00
	45 DAS	**14.91****	**445.3****	9.45
	60 DAS	**26.78****	**656.9****	12.54
Seed yield (q ha^{-1})		0.22	**0.27***	0.36
Straw yield (q ha^{-1})		**0.10***	**0.13***	0.33

*Correlation is significant at the p<0.05 level, ** correlation is significant at the p<0.01 level

Different combination of phosphorus and sulphur fertilizer exhibited significant in respect of seed yield per plant, seed and straw yield kg ha^{-1}, number of capsules per plant of sesame and nutrient status. Analysis of variance for the design of the experiment indicated highly significant variation differences for all the characters viz. plant height, no. of leaves, no. of capsule per plant and no. of primary branches per plant for 15, 30, 45 and 60 day after sowing respectively, except no. of capsule per plant at 45 and 60 DAS (Table 5) This data has been also supported by (Heidari et al., 2011) in sesame and (Fredrick et al., 2001, Ravinder et al., 1996) stated that growth and biological yield of soybean.

CONCLUSIONS

The present investigation was undertaken with the fallowing objectives, about the integrated application of fertilizer proved to be a key factor of the quality and sustainable productivity of sesame, while imbalanced fertilizer uses *i.e.* application of P and S alone and/or growing of crops without addition of fertilizer had adversely affected on crop growth and yield potentials. The highest level of crop productivity and quality was found to be sustained with 60 kg P_2O_5 + 45 kg sulphur ha^{-1} results better than all other fertilizer treatments. Lowest percent of sesame was observed under control in grain yield as well as in straw of both. most suitable application different combination doses of phosphorus and sulphur significantly increases crop growth and improves the quality of sesame by increasing protein and oil contents. When sulphur and phosphorus in the soil was below critical limits both plant growth and quality were adversely affected.

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