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Research Article

Effect of Biofertilisers and Sulphur on Growth, Yield, Economics and Post Harvest Soil Chemical Properties in Sesame (*Sesamum Indicum* L.)

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Abstract

A field trial was conducted during *rabi* season of 2014-15 and 2015-16 in farmer's field in two locations of Angul district in Odisha. Three treatments consisting farmer's practice of injudicious application of fertilizers, soil test based fertilizer dose (STD) and 75% STD +*Azospirillum, Azotobacter* and *PSB*@ 4 kg each incubated with 300 kg of FYM ha^{-1} at 30% moisture for 7 days + Sulphur@30 kg ha^{-1} were arranged in randomized block design with ten replications. Among the treatments, 75% STD+*Azospirillum, Azotobacter* and *PSB*@ 4 kg + Sulphur@30 kg ha^{-1} recorded maximum mean growth, yield parameters, grain yield (8.91q ha^{-1}) and net return(Rs.17824.12 ha^{-1}) and profitability(Rs.48.83 ha^{-1} day^{-1}). The soil chemical properties *viz*. pH, electrical conductivity, soil organic carbon, available nitrogen, phosphorus and potassium content was significantly higher in the same treatment and were found better in 2nd year in comparison to 1st year. Thus, it is effective, economically viable for crop growth, higher yield and improvement in post harvest soil chemical properties in sesame.

Keywords: Biofertilisers, dry matter accumulation, net return, sesame, soil chemical properties, yield

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Introduction

India is the major producer of sesame (*Sesamum indicum* L.) and ranks first in both area (1.78 M ha) and production (0.81 Mt) with average productivity of 455 kg ha^{-1}. Odisha produces 0.09 million tonnes sesame seeds annually with average productivity of 403 kg ha^{-1} [1]. Higher nutritional, medicine and cooking quality has recognized it as 'the queen of oilseeds'. There is a decline in productivity in sesame due to its cultivation in marginal and sub-marginal lands and moreover poor crop management practice. Balanced fertilization including nitrogen and phosphorus is beneficial to the oilseed crops for maximising the soil fertility and plant nutrient status. Nitrogen, phosphorus and biofertilizers like *Azotobacter* and *phosphate solubilizing bacteria* play a vital role in the nutrition of plants. Indian soils are mostly deficient in microorganisms and nutrients. So application of biofertilizers and inorganic fertilizers are necessary to increase the crop productivity [2]. Sulphur and recommended NPK is required for achieving higher yield in seed and oil of sesame [3]. Application of *Azotobacte*r and *Azospirillum* incubated with FYM with 50 per cent moisture in soil resulting 13 and 14 times increase in population respectively, as compare to initial microbial population and increase in yield by 46 per cent in okra [4]. Growth and yield of crop is enhanced by the presence of sufficient quantities of available form of nutrients in the soil for plant uptake. So application of organics like FYM, biofertilisers and chemical fertilizers in integrated manner is beneficial to achieve higher seed yield and yield attributes [5]. Integrated nutrient management is a need for increasing crop yield and soil fertility. Plant nutrient uptake is increased by biological nitrogen fixation and solubilization [6]. Seed yield and quality of sesame is improved by application of Sulphur [7]. Hence, the present study was undertaken to find out effect of biofertilisers and sulphur on growth, yield, economics and post harvest soil chemical properties in sesame.

Materials and Methods

A field trial was conducted during *rabi* season of 2014-15 and 2015-16 in farmer's field at two locations, one at *Bauligarh* village and another at *Thelkonali* village of Angul district in Odisha to study the effect of biofertilisers and sulphur on growth, yield, economics and post harvest soil chemical properties in sesame. The average rainfall in both the year during the study period from February to May was 122 mm. The mean maximum and mean minimum temperature registered in both the year was 41.0° C and 16.0°C respectively. Three treatments consisting T$_1$- Farmers practice (Injudicious application of fertilizers of 20:10:10 NPK kg ha^{-1}), T$_2$-Soil test based fertilizer dose(STD) and T$_3$-75% STD+*Azospirillum, Azotobacter & PSB*@ 4 kg each incubated with 300 kg of FYM ha^{-1} at 30% moisture for

7 days+ Sulphur@30 kg ha^{-1} were arranged in randomised block design with ten replications. The soil of the experimental site was sandy loam in texture, slightly acidic in reaction with average pH (5.27), electrical conductivity (0.121 dSm^{-1}), organic carbon (0.45 %), nitrogen (203.64 kg ha^{-1}), phosphorus (9.82 kg ha^{-1}) and potassium (152.62 kg ha^{-1}) content [8].

Sesame variety (*Amrit*) was sown in the trial field with recommended package of practices. The crop was sown during 2nd week of February and harvested during 1st week of May in both the year. The crop was sown with 30×10 cm spacing and the recommended fertilizer dose was 30:20:20 N:P:K kg ha^{-1} respectively. Full dose of P and K as basal and N in two splits *i.e* 50% as basal and 50% at 15 DAS. Sulphur 30 kg ha^{-1} through chemical fertilizer (Sulfex 80% WP) was applied at time of sowing. Three numbers of irrigations were supplied as pre sowing, flower initiation and capsule development.

Data on growth, yield performance, economics and post harvest soil status were recorded as per standard formula. The datas were statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05 [9].

Results and Discussion

Growth parameters

Results (**Table 1**) indicated that the growth parameters of sesame significantly increased by different treatments. The farmers practice (T_1) consisting of 20:10:10 NPK kg ha^{-1} was lowest in plant height, number of branches $plant^{-1}$ and dry matter accumulation at harvest with a mean value of 88.38 cm, 3.49 and 467.06 g m^{-2} respectively. The maximum plant height, number of branches $plant^{-1}$ and dry matter accumulation at harvest during both the year was recorded in T3 (75% STD+*Azospirillum, Azotobacter & PSB*@ 4 kg each incubated with 300 kg of FYM ha^{-1} at 30% moisture for 7 days+ Sulphur@30 kg ha^{-1}) 91.33 cm, 4.69 and 589.41 g m^{-2} respectively which were significantly higher than T_2 (Soil test based fertilizer dose). This might be due to application of nutrients in the integrated form resulting in the efficient photosynthetic structural system which intercept higher amount of radiation energy and converted the same into chemical energy [10]. Free living nitrogen fixing microorganisms in *Azospirillum, Azotobacter* helps in uptake of water and mineral by root and ultimately responsible for enhancement of growth parameters. Chemical fertilizers with biofertilisers significantly increase the growth parameters *viz.*dry matter accumulation [11, 12].

Table 1 Effect of treatment on growth parameters of sesame

Treatment	Plant height(cm)			No of branches $plant^{-1}$			Total dry matter accumulation at harvest (g m^{-2})		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T_1	82.42	87.53	88.38	3.56	3.42	3.49	461.46	472.66	467.06
T_2	84.37	89.39	90.33	4.25	3.51	3.88	520.47	534.24	527.35
T_3	85.17	91.22	91.33	4.76	4.61	4.69	582.48	596.53	589.41
S. Em. $\pm$	3.64	1.85	2.33	0.85	0.08	0.05	10.17	10.41	8.43
CD (P=0.05)	10.8	5.50	6.91	0.25	0.25	0.16	30.2	30.94	25.05

Yield attributes

The nutrient management treatment imposed in the trial (**Table 2**) indicated that significantly higher number of average capsules $plant^{-1}$ (21.48), seeds $capsule^{-1}$ (50.94) and 1000 seed weight (30.15g) was observed in T_3 followed by T_2. The minimum number of average capsules $plant^{-1}$, seeds $capsule^{-1}$and 1000 seed weight was found in T_1 *viz.* 16.80, 42.93 and 27.98g respectively. The combined effect of organic, inorganic and biofertilers increases rate of photosynthesis as well as metabolic and physiological process resulting higher capsule and seed production [13]. The seed inoculation with biofertilisers helps in supplying nutrient to plant growth at subsequent growth stages lead to increase in the plant growth parameters. Application of sulphur enhances the uptake and translocation of food assimilates from source to sink effectively [14, 15].

Grain yield, stover yield and harvest index

Data pertaining to yield of grain and stover of sesame for both years are presented in (**Table 3**). The grain yield was significantly increased by fertilizer treatments to the extent of 6.14 to 8.91 q ha^{-1}. The lowest value was recorded in farmers practice (T_1). The maximum grain yield was obtained in the treatment T_3 *viz.*8.56 and 9.26 q ha^{-1} during 1st and 2nd year, respectively followed by T_2 which gave the mean yield 7.45 q ha^{-1}. The increase in grain yield is due to increased capsules plant^{-1}, seeds capsule^{-1} and better crop growth and also application of sulphur improved plant metabolism and photosynthetic activity resulting better growth and development of plant and ultimately the yields [16]. Combined application of macro, micronutrients, sulphur also helped for higher yield [17].

Table 2 Effect of treatment on yield parameters of sesame

Treatment	No of capsules plant^{-1}			No of seeds capsule^{-1}			1000 seed wt (g)		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T_1	16.25	17.34	16.80	40.62	45.23	42.93	27.73	28.23	27.98
T_2	19.23	18.71	18.97	46.34	47.82	47.08	29.06	29.76	29.41
T_3	20.46	22.51	21.48	49.57	52.32	50.94	29.85	30.45	30.15
S. Em. $\pm$	0.24	0.24	0.18	0.68	0.71	1.73	0.43	0.44	0.33
CD (P=0.05)	0.70	0.72	0.54	2.03	2.12	1.31	1.27	1.30	0.99

The average stover yield varied from 15.44 to 20.12 q ha^{-1}. Increase stover yield in different treatments was owing to balanced application on STD. T_3 was found to be superior and recorded significantly higher mean stover yield (20.12q ha^{-1}) than other treatments due to balance fertilizer and better crop growth. Farmers practice produced minimum stover yield (15.44 q ha^{-1}) may be due to less availability of nutrients and their translocation [18].

The harvest index was comparatively higher in 1st year than 2nd year in all the treatment and with a mean value of 28.55 % in T_1 and 30.78 % in T_3.

Table 3 Effect of treatment on grain yield, stover yield and harvest index of sesame

Treatment	Grain yield (q ha^{-1})			Stover yield (q ha^{-1})			Harvest index (%)		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T_1	5.87	6.42	6.14	14.72	16.15	15.44	28.58	28.52	28.55
T_2	7.25	7.64	7.45	17.43	20.16	18.79	29.49	27.59	28.54
T_3	8.56	9.26	8.91	18.95	21.28	20.12	31.17	30.38	30.78
S. Em. $\pm$	0.17	0.16	0.13	0.44	0.50	0.34	0.57	0.56	0.41
CD (P=0.05)	0.51	0.55	0.40	1.30	1.49	2.00	1.70	1.68	1.23

Economics

The economic analysis (**Table 4**) reveals that maximum response over farmers practice was noted with net return Rs.17824.12 ha^{-1} and BCR (1.73) in T_3 followed by T_2 due its higher yield and lower cost of cultivation. Comparatively higher cost of cultivation was observed in 1st year than 2nd year with a mean amount of Rs.24595.63 ha^{-1} in T_3 due to higher input cost towards both organic and chemical fertilizer application. Similar trends were found in other treatments [19]. The maximum profitability (**Figure 1**) was obtained in the treatment T_3 *viz.* Rs.43.43 and Rs. 54.24 ha^{-1} day^{-1} during 1st and 2nd year, respectively followed by T_2 which gave the profitability Rs.32.86 and Rs.39.45 ha^{-1} day^{-1}. Minimum profitability was achieved in T_1 due to lower return.

Table 4 Effect of treatment on economics of sesame

Treatment	Cost of cultivation (Rs ha^{-1})			Net Return (Rs ha^{-1})			Benefit cost ratio (BCR)		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T_1	20325.37	19657.24	19991.30	7999.62	10682.26	9340.94	1.39	1.54	1.47
T_2	22953.51	21754.06	22353.78	11992.99	14397.94	13195.47	1.52	1.66	1.59
T_3	25327.65	23863.60	24595.63	15851.84	19796.40	17824.12	1.63	1.83	1.73
S. Em. $\pm$	325.91	306.09	252.06	639.85	689.9166	446.74	0.13	0.03	0.02
CD (P=0.05)	968.23	909.32	748.83	1900.87	2049.61	1327.18	0.08	0.09	0.05

Post harvest soil chemical properties

A perusal of data on available nitrogen, phosphorus and potassium content of soil after harvesting of sesame as affected by different nutrient management practices (**Table 5**) clearly revealed that gradually improvement in soil mean available nitrogen (210.10 to 225.2 kg ha^{-1}), phosphorous (10.48 to 14.89 kg ha^{-1}, potassium (162.5 to 175.32 kg ha^{-1} were observed as compared to initial soil status and farmers practice (T_1) mainly due to improvement in soil physical properties with application of biofertilisers. Minimum available average nutrients content was recorded in T_1 *viz.* 201.4, 9.64, 158.7 NPK kg ha^{-1} respectively [20]. Higher available nitrogen, phosphorus and potassium content was recorded during 2nd year than 1st year and it was (216.02 to 234.38), (14.84 to 14.95) and (170.68 to 179.96) N, P and K respectively for the treatment T_3.

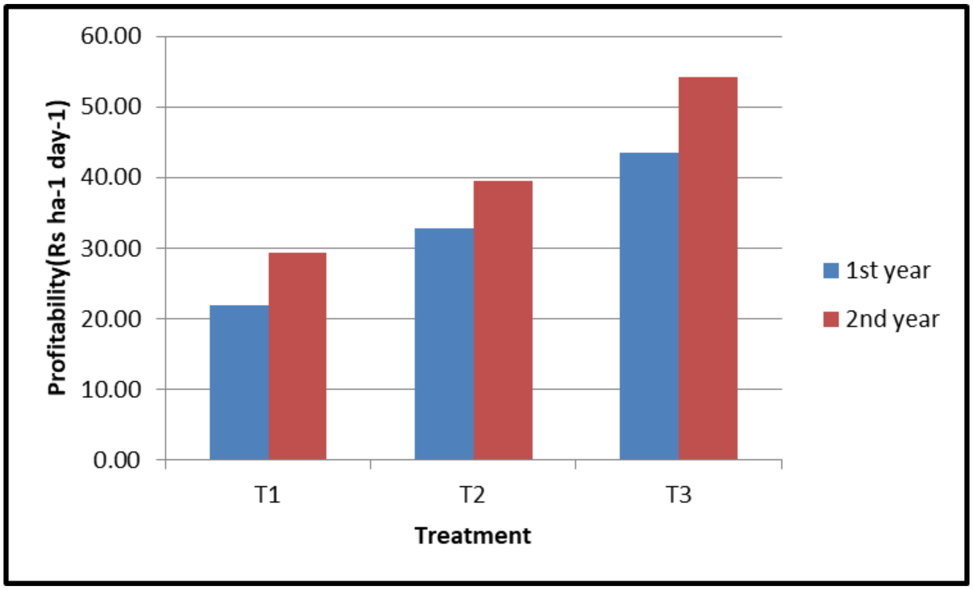

Figure 1 Effect of treatment on profitability of sesame

Table 5 Effect of treatment on post harvest soil chemical properties

Treatment	Available Nutrients in soil (kg ha^{-1})								
	Nitrogen			**Phosphorus**			**Potassium**		
	2014	**2015**	**Mean**	**2014**	**2015**	**Mean**	**2014**	**2015**	**Mean**
T_1	193.39	209.41	201.40	9.32	9.96	9.64	154.91	162.48	158.7
T_2	201.69	218.51	210.10	10.20	10.76	10.48	158.52	166.47	162.5
T_3	216.02	234.38	225.20	14.84	14.95	14.89	170.68	179.96	175.32
S. Em. ±	3.48	3.81	3.64	0.21	0.20	0.21	2.71	2.92	2.82
CD (P=0.05)	10.34	11.32	10.80	0.63	0.60	0.61	8.05	8.70	8.37
Initial status			203.64			9.82			152.62

There is slight increase in mean soil pH (5.62 to 5.81), reduction in electrical conductivity (0.116 to 0.106 dSm^{-1}) and change in organic carbon (0.40 to 0.47) as compared to initial soil status (**Table 6**). It could be attributed to addition of root and leaf biomass of sesame and biofertilisers. Minimum pH in farmer's practice might be due to application of higher dose of inorganic fertilizers in soil and electrical conductivity also increased with application of fertilizers [21]. The soil chemical properties *viz*. pH, electrical conductivity and soil organic carbon was significantly higher in 2nd year than 1st year. The soil pH, electrical conductivity and soil organic carbon was (5.52 to 6.10), (0.101 to 0.110 dSm^{-1}) and (0.45 to 0.49%) respectively for T_3 [22].

Table 6 Effect of treatment on post harvest soil chemical properties

Treatment	pH			Electrical conductivity (dSm^{-1})			Soil organic carbon (%)		
	2014	**2015**	**Mean**	**2014**	**2015**	**Mean**	**2014**	**2015**	**Mean**
T_1	5.34	5.90	5.62	0.118	0.130	0.124	0.38	0.42	0.40
T_2	5.36	5.92	5.64	0.110	0.121	0.116	0.43	0.47	0.45
T_3	5.52	6.10	5.81	0.101	0.110	0.106	0.45	0.49	0.47
S. Em. ±	0.092	0.10	0.098	0.002	0.002	0.002	0.007	0.008	0.008
CD (P=0.05)	0.276	0.30	0.291	0.006	0.006	0.006	0.022	0.024	0.023
Initial status			5.27			0.121			0.45

Conclusion

Thus, application of biofertilisers *viz. Azospirillum, Azotobacter and PSB@* 4 kg each incubated with FYM ha^{-1} and Sulphur@30 kg ha^{-1} along with 75% STD through chemical fertilizers is considerably appeared to be effective, economically viable for crop growth, higher grain yield and improvement in post harvest soil chemical properties in sesame and may be recommended for the farmers for higher productivity, profitability and soil fertility.

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References

[1] Anonymous. Odisha Agriculture Statistics 2012-13. Directorate of Agriculture and Food production, Bhubaneswar, 2014, Odisha.
[2] Patel, H.A. and Raj, A.D. 2017. Nutrient content as well as uptake of summer sesame as affected by nitrogen, phosphorus and biofertilisers under south Gujarat conditions. International Journal of Chemical studies, 5(6), 01-04.
[3] Deshmukh, M.R., Duhoon, S.S. and Jyotishi, A. 2010. Effect of sources and levels of sulphur on oil content and economics of sesame(Sesamum indicum L.) under different agro climatic situation of India. Journal of Oilseeds Research, 27(1), 34-34.
[4] Pattanayak, S.K., Mohanty, R.K. and Sethy, A.K. 2001. Response of Okra to Azotobacter and Azospirillum inoculation grown in Acid soil amended with lime and FYM. II North Eastern Regional Conference on Biofertilisers, AAU, Jorhat, Assam.
[5] Gable, D.B., Kubde, K.J., Katore, J.R., Fiske, A.V. and Deshmukh, M.R. 2008. Effect of integrated nutrient management on growth and yield of maize-chickpea cropping system. Journal of Soil and Crops, 18(2), 392-397.
[6] Manne, S.S., Hadgaonkar, A.K.,Suryawansi, A.P. and Salunke, S.D. 2000. Response of pearlmillet to inoculation of phosphorus solubilizing bacteria and Azospirillum. Journal of Indian Society of Soil Science, 48, 617-619.
[7] Tiwari, K.N. and Gupta, B.R. 2006. Sulphur for sustainable high yield agriculture in Uttar Pradesh. Indian J. Fert., 1(11), 37-52.
[8] Jackson. M.L. 1973. Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi
[9] Cochran, W.G. and Cox, G.M. 1977. Experimental Designs. Asia Publishing House. Kolkata, p. 95-132 & 142-181.
[10] Lamani, K., Uppar, D.S. and Jamadar, M.I. 2014. Integrated nutrient management on plant growth and seed yield of cowpea(Vigna unguiculata L. Wail) cv, DC-15. Research Journal of Agricultural Sciences, 5(5),1031-1033.
[11] Rani, S., Kumar, P. and Yadav, A.K. 2017. Effect of biofertilizers in conjunction with chemical fertilizers on growth behavior and profitability of field pea (Pisum sativum L.) Grown In Western Plains of Haryana. Chemical Science Review and Letters, 6(22), 801-805.
[12] Jaishankar, S. and Wahab, K. 2012. Effect of integrated nutrient management on growth, yield components and yield of sesame, Bioinfolet 9(4), 576-579.
[13] Jain, N.K., N.L. Jat, N.L. and Choudhary, G.R. 2007. Response of fennel(Foenicuculum vulgare) to inorganic nitrogen, farmyard manure and Azospirillum. Indian J.Agric. Sci., 77: 376-378.
[14] Duhoon, S.S., Deshmukh, M.R., Jyotishi, A. and Jain, H.C. 2005. Effect of source and levels of sulphur on seed and oil yield of sesame(Sesamum indicum L.) in Keymore Plateau Zone of Madhya Pradesh(India). Journal of Oilseeds Research, 22(1), 199-200.
[15] Selvakumar, G., Reetha, S. and Thamizhiniyan P. 2012. Response of biofertilisers on growth and yield of blackgram(Vigna mungo L.). World Applied Science., 15,1368-1374.
[16] Ghosh, M.K. and Joseph, S.A. 2008. Influence of biofertilizers, foliar application of DAP and sulphur sources on yield and yield attributes of summer green gram (Vigna radiata L. Wilczek).Legume Res., 31(3), 232–33.
[17] Sahu, G., Chatterjee, G.N and Ghosh, G.K. 2017. Effect of Inntegrated Nutrient Management in yield, growth attributes and microbial population of sesame (Sesamum indicum L.). International Journal of Current Microbiology and Applied Sciences, 6(7), 642-648.
[18] Samant, T.K. and Panigrahi, D. 2018. Effect of sowing dates and nutrient management practiceson important parameters in Toria (Brassica rapa L. var. Toria) Journal of Oilseed Brassica, 8(6), 871-876.
[19] Sharma, P.B. 2005. Fertiliser management in sesame (Sesamum indicum L.) based intercropping system in tawa command area. Journal of Oilseeds Research, 22(10), 63-65.
[20] Rekha, D.L.M., Lakshmipathy, R. and Gopal, G.A. 2018. Effect of integrated use of biofertilisers,chemical

fertilisers and farmyard manure on soil health paramers of pearl millet (Pennisetum glaucum L.) Journal of Soil Science & Plant Health, 2(2), 1-4.

[21] Ghosh, A.K., Duary, B. and Ghosh, C. 2013. Nutrient management in summer sesame (sesamum indicum l.) and its residual effect on black gram (vigna mungo l.) International Journal of Bio-resource and Stress Management, 4(4), 541-546.

[22] Samant, T.K. 2015. Changes in soil chemical environment by integrated nutrient management practices and its effect on yield, economics under rice-fallow cropping system. Chemical Science Review and Letters, 4(13), 129-135.

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