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Effect of microbial consortia enriched vermicompost on growth, yield and quality of summer sesame (*Sesamum indicum* L.)

Mokariya LK, Vaja RP, Malam KV and Jani CP

Abstract
A field experiment was carried out at certified organic plot, Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during summer season of 2018-19 on medium black calcareous soil. The experiment containing 8 treatments was arranged in randomized block design with 3 replications. The results revealed the RDF (50-25-0 N-P_2O_5-K_2O kg/ha), being statistically equivalent to Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha) and Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha), which enhanced growth parameters *viz*., plant height (23.30 cm, 59.83 cm and 73.47 cm at 30 DAS, 60 DAS and harvest respectively), dry matter per plant at 30 DAS (1.73 g), CGR during 30 DAS - 60 DAS (15 g/m^2/day) and leaf SPAD meter reading (42.88 and 56.33 at 30 and 60 DAS respectively), yield attributes *viz*., number of capsule per plant (49.40), 1000-seed weight (3.88 g), seed weight per plant (4.91 g) and ultimately gave higher seed yield (959 kg/ha) and stalk yield (1791 kg/ha), quality parameters *viz*., protein content (24.86%) and oil yield (439 kg/ha).

Keywords: Sesame, enriched vermicompost, *Azotobacter*, *Beauveria bassiana*, KSB, PSB, *Pseudomonas fluorescens*, *Trichoderma harzianum*

Introduction
The oilseeds sector has been one of the most dynamic components of world agriculture. Oilseeds are the second largest agricultural product after cereals in India. Sesame (*Sesamum indicum* L.) is fourth important oilseed crop next to groundnut, rapeseed and mustard in India. In India, during 2019 sesame is cultivated in an area of 13.71 lakh ha with a production of 7.55 lakh tonnes annually and productivity of 431 kg/ha (Anon., 2019a) [1]. It is widely cultivated in the states of Uttar Pradesh, Rajasthan, Orissa, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal, Bihar and Assam. The cultivated area of sesame in Gujarat is about 0.97 lakh ha and production of 0.48 lakh tonnes with average productivity of 498 kg/ha (Anon., 2019b) [2] under major growing districts of Rajkot, Amreli, Sabarkantha, Mehsana, Bhavnagar, Bhuj, Jamnagar, Junagadh and Surendranagar.

Vermicompost is literally the best nutrient rich, organic fertilizer and soil conditioner. The process of vermicomposting results in the increase of microbial diversity and activity dramatically and the vermicompost produced could be a ultimate source of plant growth regulators produced by interactions between microorganisms and earthworms which could contribute significantly to increased plant growth, flowering and yields (Arancon and Edwards, 2009; Jayashree *et al*., 2011) [3, 6]. Most of the organic manures are very low in nutrient contents, which are not sufficient to meet the nutritional requirement of the crops, especially when inorganic fertilizers are not applied. The enrichment of the organic manures with beneficial microbial cultures will further contribute to the enhancement of N and P contents through nitrogen fixation and phosphate solubilization. Hence, the enriched organic manures and their combination provide an ideal nutrition strategy for the crop. Vermicompost is best organic carrier for microbial cultures, hence it can be enriched by to combine all biofertilizers and bioagents in a single product and to increase the manurial and biological value of the vermicompost. By considering of above fact, the experiment "Effect of microbial consortia enriched vermicompost on growth, yield and quality of summer sesame (*Sesamum indicum* L.)" was undertaken.

Materials and Methods

A field research was carried out at the Organic Farming Plot, Instructional farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during the summer season of the year 2018-19 with test crop sesame (Var. GJT-5). The experiment comprising of eight treatments *viz;* T_1- Absolute control, T_2- Vermicompost (2 t/ha)**,** T_3-Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha), T_4- Vermicompost (2 t/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha), T_5- Vermicompost (2 t/ha) + *Beauveria bassiana* (3 kg/ha), T_6- Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha), T_7-FYM (5 t/ha) and T_8- RDF (50-25 N-P_2O_5 kg/ha) with three replications. The treatments T_1 to T_7 were kept under organic plot and T_8 was kept outside the organic plot. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction with pH 7.9 and EC 0.52 dS/m.

The soil was medium in available nitrogen (257 kg/ha), available phosphorus (28.67 kg/ha), available potassium (249 kg/ha) and low in heat soluble sulphur (9.36 mg/kg).

Vermicompost was enriched with *Azotobacter* (2 L/ha), Phosphorus Solubilizing Bacteria (PSB) (2 L/ha), Potash Solubilizing Bacteria (KSB) (2 L/ha), *Trichoderma harzianum* (3 kg/ha), *Pseudomonas fluorescence* (kg/ha), *Beauveria bassiana* (3 kg/ha) microbial cultures according to treatments and incubated for 10 days before application.

Results and discussion

Effect on growth parameters

Significantly the highest values of growth parameters *viz*., plant height at 30 DAS, 60 DAS and at harvest, dry matter per plant at 30 DAS, 60 DAS and at harvest, CGR during 30 DAS- 60 DAS and 60 DAS-harvest, number of branches per plant, leaf SPAD meter value at 30 DAS and 60 DAS were observed under the treatment T_8 [RDF (50-25-0 N-P_2O_5-K_2O kg/ha)], but it was found statistically at par with the treatment T_6 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha)] and T_3 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha)] in most of the cases. While, the lowest values of growth parameters were recorded under the treatment T_1 (Absolute control). Among different treatments, T_8 [RDF (50-25-0 N-P_2O_5-K_2O kg/ha)] found superior in respect to all growth parameters. The progressive increase in plant height might be due to favorable influence of nitrogen contribution in cell division and cell elongation, which promoted vegetative growth and ultimately increased plant height. Similarly, it is fact that nitrogen enhances the development of strong cell walls and therefore stiffer branches which might be resulted into profuse branches of sesame as well as increases in N supply are also associated with increase in leaf area and weight, photosynthetic activities of leaf and ultimately dry matter production and crop growth rate. In addition to its role in the formation of proteins, initial boost of nitrogen which might have helped in higher chlorophyll formation. Application of nitrogen and phosphorus created a favourable situation for higher uptake of nutrients by plant and resulted in higher plant growth. Similar findings have been reported by Sawant *et al*. (2013) [13], Nayek *et al*. (2014) [10], Patel *et al*. (2014) [11] and Patel (2016) [12].

Effect on yield attributes and yield

The treatment T_8 [RDF (50-25-0 N-P_2O_5-K_2O kg/ha)] excelled yield attributes and yields *viz*., number of capsule per plant, number of seeds per capsule, 1000-seed weight, seed weight per plant, seed yield, stalk yield and harvest index followed by treatment T_6 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha)] and T_3 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha)]. While, significantly the lowest values of these yield attributes were recorded under the treatment T_1 (Absolute control). As, yield of the crop is the complex function of physiological processes and biochemical activities which modify plant anatomy and morphology of the growing plants. For instance, most of growth and yield attributes contributed in seed yield of sesame evidently resulted in higher yield in treatments which get nitrogen and phosphorus through chemical fertilizers. As, yield of the crop is the complex function of physiological processes and biochemical activities which modify plant anatomy and morphology of the growing plants. For instance, most of growth and yield attributes contributed in seed yield of sesame evidently resulted in higher yield in treatments which get nitrogen and phosphorus through chemical fertilizers. Proper fertilization with increased net photosynthesis and greater mobilization of photosynthates towards reproductive structures, which might have increased the yield attributes and finally the seed and stalk yield. The present findings are in close agreement with the results obtained by Patel *et al*. (2014) [11], Patel (2016) [12], Vani *et al*. (2017) [14] and Vora *et al.* (2018) [15].

Effect on quality parameters

Significantly the highest seed protein content and oil yield observed under treatment T_8 [RDF (50-25-0 N-P_2O_5-K_2O kg/ha)], which was at par with treatment T_6 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha)] and T_3 [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha)]. Such improvement in protein content in seed might be due to nitrogen is radially available in initial stages of crop growth with the application of chemical fertilizer. Also in case of application of enrich vermicompost nitrogen consumption of plant increases due to the nitrogen mineralization of vermicompost and biological nitrogen fixation by biofertilizer (*Azotobactor*) which helps in boosting nitrogen uptake by plants thereby increases the N content of seeds (Jnawali *et al*., 2015) [7]. Oil content is an intrinsic property which is governed by various genetically traits and under normal condition it is not changed. This finding closely associated with those of Kachot *et al*. (2001) [8], Dikshit and Khatik (2002) [5], Lakhran *et al.* (2015) [9], Patel (2016) [12], Choudhary *et al.* (2017) [4] and Vani *et al*. (2017) [14].

Table 1: Effect of enriched vermicompost on growth parameters of sesame

Treatment	Plant height (cm) at			Dry matter per plant (g) at			CGR (g/m²/day) during		Number of branches per plant	Leaf SPAD meter value	
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS-60 DAS	60 DAS-Harvest		30 DAS	60 DAS
T_1	13.53	44.43	56.97	0.72	8.40	14.10	8.54	5.14	1.47	32.15	45.31
T_2	17.03	48.90	60.53	1.15	9.80	17.80	9.61	7.21	2.20	34.60	47.53
T_3	21.47	52.87	65.83	1.58	12.87	22.93	12.54	9.07	2.73	41.89	54.75
T_4	20.20	51.83	63.63	1.36	11.90	19.90	11.71	7.21	2.50	37.47	49.83
T_5	18.90	52.23	63.10	1.29	11.67	20.50	11.53	7.96	2.67	37.49	49.01
T_6	22.90	58.50	72.30	1.67	14.60	24.97	14.37	9.34	3.13	42.47	55.03
T_7	16.33	49.13	61.73	0.92	9.63	17.50	9.68	7.09	2.13	35.66	47.83
T_8	23.30	59.83	73.47	1.73	15.23	25.93	15.00	9.64	3.20	42.88	56.33
S.Em.±	0.99	2.32	3.05	0.08	0.76	0.88	0.84	0.66	0.12	0.99	1.54
C.D. at 5%	3.01	7.04	9.25	0.25	2.29	2.68	2.54	2.00	0.36	3.01	4.68
C.V.%	8.95	7.70	8.17	11.02	11.12	7.49	12.50	14.59	8.28	4.51	5.27

Table 2: Effect of enriched vermicompost on yield attributes and yield of sesame

Treatment	Number of capsule per plant	Number of seeds per capsule	1000-seed weight (g)	Seed weight per plant (g)	Seed yield (kg/ha)	Stalk yield (kg/ha)	Harvest index (%)
T_1	30.67	55.53	2.77	2.85	612	1275	32.58
T_2	37.73	64.87	3.06	4.02	759	1475	33.95
T_3	44.40	72.87	3.54	4.46	867	1661	34.35
T_4	39.33	67.00	3.20	4.08	790	1538	33.98
T_5	42.20	68.53	3.31	4.24	833	1574	34.59
T_6	47.53	75.00	3.70	4.72	919	1724	34.75
T_7	36.60	62.47	2.97	3.79	734	1448	33.75
T_8	49.40	77.47	3.88	4.91	959	1791	34.86
S.Em.±	2.10	2.85	0.18	0.22	40	70	1.80
C.D. at 5%	6.37	8.63	0.53	0.66	122	213	NS
C.V.%	8.87	7.25	9.21	9.12	8.61	7.81	9.14

Table 3: Effect of enriched vermicompost on quality of sesame

Treatment	Protein content in seed (%)	Oil content (%)	Oil yield (kg/ha)
T_1	14.63	44.18	270
T_2	18.38	45.36	344
T_3	23.08	45.58	395
T_4	19.40	45.42	359
T_5	20.85	45.49	379
T_6	24.29	45.65	419
T_7	16.94	44.50	328
T_8	24.86	45.83	439
S.Em.±	0.60	0.88	20
C.D. at 5%	1.83	NS	62
C.V.%	5.15	3.36	9.59

Conclusion

On the basis of the results obtained, it seems quite logical to conclude that higher production of summer sesame (var. GJT-5) under organic farming can be secured by application of Vermicompost (2 t/ha) enriched with microbial consortia contain *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha) + *Beauveria bassiana* (3 kg/ha) on medium black calcareous soil under South Saurashtra Agro-climatic Zone.

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