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Effect of microbial consortia enriched vermicompost on physico-chemical properties of soil and nutrient content and uptake by summer sesame (*Sesamum indicum* L.)

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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 content of N, P and K in seed and stalk, uptake of N, P and K by sesame, available N, P₂O₅ and K₂O in soil at harvest were significantly higher under RDF (50-25-0 N-P₂O₅-K₂O kg/ha) and being at par with 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). While, significantly higher sulphur, organic carbon, water holding capacity and lower bulk density were recorded under the treatment of FYM (5 t/ha), followed by 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).

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, 8]. 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 physico-chemical properties of soil and nutrient content and uptake by 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: T₁- Absolute control, T₂- Vermicompost (2 t/ha), T₃- Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha), T₄- Vermicompost (2 t/ha) + *Trichoderma harzianum* (3 kg/ha) + *Pseudomonas fluorescens* (3 kg/ha), T₅- Vermicompost (2 t/ha) + *Beauveria bassiana* (3 kg/ha), T₆- 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), T₇- FYM (5 t/ha) and T₈- RDF (50-25 N-P₂O₅ kg/ha) with three replications. The treatments T₁ to T₇ were kept under organic plot and T₈ 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 fluorescens* (kg/ha), *Beauveria bassiana* (3 kg/ha) microbial cultures according to treatments and incubated for 10 days before application.

The soil samples were collected and analyzed for available N by alkaline KMnO₄ method (Subbaiah and Asija, 1956), P by colourimetrically (Olsen *et al.*, 1954) [13], K by flame photometer method (Jackson, 1974) [6], S by turbidimetric method (Williams and Stainbergs, 1959) [20], OC by Walkley and Black's method (Jackson, 1974) [6], BD by Core method. (Blake, 1965) and WHC by Air keen Raczkowski method as described by Piper (1950) [15]. The nitrogen from plant samples were estimated separately by micro Kjeldahls method as described by Kanwar and Chopra (1976) [9]. The phosphorus determined by Vanadomolybdo Phosphoric Yellow Colour method as described by Jackson (1974) [6] and potassium by Flame Photometer as described by Jackson (1974) [6] and uptake was computed.

Results and discussion

Effect on nutrients content and uptake

Significantly higher N, P and K content in seed 3.98, 0.89 and 0.98 % and stalk 2.20, 0.79 and 1.56 %, respectively (Table-1) and total uptake of N (77.56 kg/ha), P (17.35 kg/ha) and K (37.28 kg/ha) by the sesame crop (Table-2) were recorded under the application of recommended dose (50-25-0 N-P₂O₅-K₂O kg/ha) of chemical fertilizer (T₈), which was statistically comparable with treatment T₆ [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 T₃ [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha)]. While, the treatment T₁ (Absolute

control) registered significantly the lowest N, P and K content in seed and stalk and uptake by crop. The increase in nutrients content and uptake in plant might be due to increased availability of nutrients through chemical fertilizer at optimum quantity which has resulted increase in nutrient content and uptake. The increase in nutrients content and uptake by plant with the application of enriched vermicompost might be due to quickly build-up of soil micro flora and fauna which has consequently increased the enzymatic activity and helped in mineralization, solubilisation of native and applied nutrients and making them available in the soil for plant uptake. Further enriched vermicompost improved biological, physical and chemical environment of the soil might have helped in vigorous growth of the plant and root proliferation, and the increased biomass production resulted in higher uptake of the nutrients. The present findings are in accordance with those reported earlier by Babaria *et al.* (2010) [5], Sadhu *et al.* (2017) [16], Takar *et al.* (2017) [18] and Patel (2016) [14].

Effect on soil available nutrients (N, P, K and S)

Application of recommended dose (50-25-0 N-P₂O₅-K₂O kg/ha) of chemical fertilizer (T₈) recorded significantly higher value of available nitrogen (274 kg/ha), phosphorus (35.63 kg/ha) and potash (265 kg/ha), which remained statistically equivalent to treatment T₆ [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 T₃ [Vermicompost (2 t/ha) + *Azotobacter* (2 L/ha) + PSB (2 L/ha) + KSB (2 L/ha)] over control (Table 2). While, significantly higher sulphur (8.81 mg/kg) was recorded with the treatment T₇ [FYM (5 t/ha)], which remained statistically at par with the treatments T₆ and T₃ (Table 2). On other hand, the lowest status was recorded with the treatment T₁ (Absolute control). Enriched vermicompost, it is considered as a store house of almost all essential nutrients required for plant growth and biofertilizers have a natural mechanism to supply nutrients to plants by solubilizing phosphorus, nitrogen fixation and by synthesis of plant growth promoting substances. There are microbes present in biofertilizers that increase the soil natural nutrient cycle and help in building soil organic matter and nutrients content in soil and maintain the soil fertility. The results of present investigation are in close agreement with the findings of Shukla and Tyagi (2009) [17], Mahanta *et al.* (2012) [10] and Arvind and Rai (2018) [4].

Effect on organic carbon, bulk density and water holding capacity

The results presented in Table-3 indicated that the treatment T₇ i.e. application of FYM (5 t/ha) gave significantly higher organic carbon (0.85 %), water holding capacity (44.87 %) and lower bulk density (1.36 Mg/m³), which remained statistically at par with the treatments T₆ and T₃. On other hand, the lowest status was recorded with the treatment T₁ (Absolute control). The increase in organic carbon and water holding capacity and decreased in bulk density with the application of organic sources such as FYM and enriched vermicompost might be due to presence microbes in FYM which help in building soil organic matter, better soil aggregation and larger macro pore space ultimately reduced the bulk density. Similar results were also reported by Shukla and Tyagi (2009) [17], Jat *et al.* (2012) [7], Mahanta *et al.* (2012) [10], Ojha *et al.* (2014) [12] and Motaka *et al.* (2016) [11]

Table 1: Effect of enriched vermicompost on NPK content (%) in seed and stalk of sesame

Treatment	N content	P content	K content	N content	P content	K content
	Seed			Stalk		
T ₁	2.34	0.61	0.72	1.43	0.29	1.19
T ₂	2.94	0.70	0.81	1.73	0.34	1.32
T ₃	3.69	0.83	0.92	2.02	0.45	1.47
T ₄	3.10	0.73	0.86	1.85	0.39	1.38
T ₅	3.34	0.75	0.89	1.97	0.41	1.42
T ₆	3.89	0.86	0.94	2.11	0.47	1.52
T ₇	2.71	0.66	0.78	1.59	0.32	1.24
T ₈	3.98	0.89	0.98	2.20	0.49	1.56
S. Em.±	0.10	0.03	0.03	0.07	0.02	0.05
C.D. at 5%	0.29	0.08	0.08	0.20	0.05	0.17
C.V.%	5.15	6.17	5.24	6.26	7.10	6.82

Table 2: Effect of enriched vermicompost on NPK uptake and available N, P₂O₅, K₂O and S in soil after harvest of crop

Treatment	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Soil available nutrients (kg/ha)			Sulphur (mg/kg)
				N	P	K	
T ₁	32.64	7.37	19.59	217	23.53	204	8.23
T ₂	47.81	10.42	25.62	237	29.20	223	10.18
T ₃	65.70	14.75	32.51	258	32.67	244	10.99
T ₄	53.06	11.79	28.15	239	29.83	229	10.14
T ₅	58.86	12.74	29.75	239	30.80	231	10.55
T ₆	72.09	16.10	34.71	268	34.87	260	11.46
T ₇	42.99	9.52	23.74	235	27.93	222	12.43
T ₈	77.56	17.35	37.28	274	35.63	265	8.81
S.Em.±	2.65	0.72	1.56	11.52	1.57	10.86	0.61
C.D. at 5%	8.04	2.18	4.75	35	4.77	33	1.84
C.V.%	8.15	9.95	9.37	8.11	8.91	8.02	10.16

Table 3: Effect of enriched vermicompost on organic carbon, bulk density and water holding capacity

Treatment	OC (%)	BD (Mg/m ³)	WHC (%)
T ₁	0.60	1.50	39.08
T ₂	0.66	1.41	40.26
T ₃	0.75	1.37	42.25
T ₄	0.68	1.39	40.49
T ₅	0.70	1.38	41.53
T ₆	0.77	1.37	43.37
T ₇	0.85	1.36	44.87
T ₈	0.63	1.49	39.33
S.Em.±	0.04	0.03	1.07
C.D. at 5%	0.12	0.10	3.24
C.V.%	9.37	4.12	4.45

Conclusion

On the basis of the results obtained, it seems quite logical to conclude that higher and nutrients content and uptake by summer sesame (var. GJT-5) and soil available nutrients N, P₂O₅ and K₂O at harvest 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), whereas higher sulphur, organic carbon, water holding capacity and lower bulk density were recorded under the application of FYM (5 t/ha) on medium black calcareous soil.

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