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Effect of compost, biofertilizers and organic spray on soil fertility and yield of summer sesame

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Abstract
An experiment was conducted during summer 2016-17, entitled "Effect of different organic sources on soil fertility, nutrient uptake and yield of summer sesame". at Centre for organic agriculture research and training Department of Agronomy, Dr. PDKV, Akola with ten treatments replicated thrice in randomize block design. On the basis of results obtained in the present investigation, application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @ 10.0 kg ha^{-1} + 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic Sulphur (T_9) recorded the significantly highest yield of sesame seed and stover followed by application of compost @ 3.3 t ha^{-1} + soil application of Azotobacter and PSB @ 10.0 kg ha^{-1} + 3 foliar spray of liquid organic NPK (T_6).

Keywords: compost, azotobacter, PSB, yield, fertility N, P, K, S, micronutrient and summer sesame

Introduction
Sesame (*Sesamum indicum* L.) is a flowering herbaceous annual plant in the genus *Sesamum*. It belong to the family Pedaliaceae and origin is South-Western Africa (Indu and Savithri, 2003) [9]. It is also known as gingelly, til, benne seed and popularly as 'Queen of Oilseeds' due to its stabilized keeping quality contributed by high degree of resistance to oxidation and rancidity (Bedigian and Harlan, 1986) [7]. Sesame grown on an area of 7.54 million hectares with a production of 3.34 million tonnes in the world with a productivity of 443 kg ha^{-1}(Anonymous, 2012[a]) [2]. India ranks first in area (29%), production (26%) and export (40%) of sesame in the world (Anonymous 2010) The productivity of sesame in India is 474 kg ha^{-1} (Anonymous, 2017[a]) [3]. India is a major exporter to number of countries and has earned the foreign exchange of `2800 crore (Ranganatha *et al.*, 2014) [13].

During the year 2015-16 Maharashtra state has area under kharif, rabi and summer sesame as 0.28,0.02 and 0.30 lakh hectares respectively with production as 0.03, 0.01 and 0.04 lakh tonnes respectively. The productivity of sesame during 2015-16 was 107, 500 and 133 kg ha^{-1} in kharif, rabi and summer season (Anonymous, 2017[b]) [4]. In Vidarbha region has 117 ha area with 40 tonnes production and with an average productivity 341 kg ha^{-1} in 2010-11 (Anonymous, 2012[b]) [5]. The use of organic manures has been the traditional means of maintaining soil fertility. Most of the organic compost provide a balanced sources of nutrients for crops. Organic compost have a direct effect on plant growth like any other commercial fertilizer. These compost contain nutrient in small amount, therefore the quantity requirement of these organic sources is more to fulfill the crop needs. Besides, the major nutrients, organic compost also contain traces of micro-nutrients and also provide food for soil microorganisms. This increases activity of microbes which in turn helps to convert unavailable plant nutrients into available and fixing the atmospheric nitrogen apart.

Material and Methods
A field experiment was conducted during summer 2016-2017 under irrigated condition at the Centre for organic agriculture research and training, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. It is situated in subtropical region between $22^0$42`N latitude and $77^0$02`E longitudes. The altitude of the place is 304.42 m above mean sea level. The soil of the experimental area was medium deep black, clay loam texture with, high water holding capacity and moderately alkaline in reaction.

The result of the chemical analysis indicated that, the soils have pH 8.3 with electrical conductivity 0.30 dSm^{-1}, $CaCO_3$ was 3.60 % and organic carbon content was 5.10 g kg^{-1}. The available nitrogen and phosphorus content of soil was low i.e. 210.8 and medium 17.94 kg ha^{-1} respectively. However, soils were sufficiently higher in available potash content (406.8kg ha^{-1}). Bulk density, hydraulic conductivity, MWD and AWC were recorded as 1.34 Mg m^{-3}, 0.60 cm hr^{-1}, 0.57 mm and 19.07 % respectively.

The experiment was laid out in randomized block design with ten treatments each replicated thrice. There were ten treatments combination comprising of different organic sources viz., Control (T_1), Compost @ 3.3 t ha^{-1} (T_2), soil application of Azotobacter and PSB @10.0kg ha^{-1} (T_3), liquid organic NPK 3 foliar spray (T_4), liquid organic sulphur one foliar spray (T_5), Compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0 kg ha^{-1} + liquid organic NPK 3 foliar sprays (T_6), Compost @ 3.3 t ha^{-1}+ liquid organic NPK 3 foliar spray+ liquid organic Sulphur one foliar spray (T_7), soil application of Azotobacter and PSB @10.0 kg ha^{-1}+ liquid organic NPK 3 foliar spray+ liquid organic sulphur one foliar spray (T_8), Compost @3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ liquid organic NPK 3 foliar spray+ liquid organic Sulphur one foliar spray(T_9) and Compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1} (T_{10}). The crop variety AKT – 101 was used with gross plot size of 5.4 m x 7.0 m and net plot size of 4.5 m X 6.6 m. Compost was applied at treatments $T_{2,}$ T_6, T_7, T_9 and T_{10} before sowing by broadcasting. Soil application of Azotobacter and PSB at the time of planting in $T_{3,}$ T_6 and T_9 treatments. Three foliar application of liquid organic NPK at 20 DAS, 40 DAS and 60 DAS and one foliar application of liquid organic sulphur at 45 DAS through carried out in T_4, T_5, T_7, T_8 and T_9 treatments.

Result and Discussion

Effect of organic sources on yield of summer sesame

The yield data pertaining to seed and stover of summer sesame is given in Table 1. Yield of seed and stover of sesame were found statistically significant under different organic treatments over control. The significantly highest yield of seed (11.51 q ha^{-1}) and stover (36.83 q ha^{-1}) were recorded by application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_9) which was statistically at par with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK (T_6), compost @3.3 t ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_7), compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1} (T_{10}). These treatments were significantly superior over control (T_1), compost @ 3.3 t ha^{-1} (T_2), soil application of Azotobacter and PSB @ 10.0kgha-^{1}(T_3), 3 foliar spray of liquid organic NPK (T_4), one foliar spray of liquid organic S (T_5) and soil application of Azotobacter and PSB @10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_8), whereas lowest yield was obtained in control (T_1) as 6.02 q ha^{-1}. The increase in seed and stover yield might be due to application of organic sources *viz.*, compost, biofertilizer and organic sprays, might be created maximum nutrient availability to sesame crop during growth and productive phase. These results are in conformity with Khaled *et al.* (2012) [1], Abdel Rahman (2014) [1] and Tomer and Khajanji (2009) [16].

Table 1: Effect of organic sources on yield of summer sesame

Treatment		Yield (q ha^{-1})	
		Seed	Stover
T_1	Control	6.02	26.02
T_2	Compost @ 3.3 t ha^{-1}	9.52	31.27
T_3	Soil application of Azotobacter and PSB@10.0kg ha^{-1}	6.82	27.18
T_4	3 foliar sprays of liquid organic NPK	6.34	26.67
T_5	One foliar spray of liquid organic sulphur	6.21	26.30
T_6	T2 + T3 + T4	10.78	35.93
T_7	T2 + T4 + T5	9.94	34.91
T_8	T3 + T4 + T5	7.09	27.94
T_9	T2 + T3 + T4 + T5	11.51	36.83
T_{10}	T2 + T3	9.85	33.94
SE (m) ±		0.56	1.20
CD at 5%		1.66	3.56

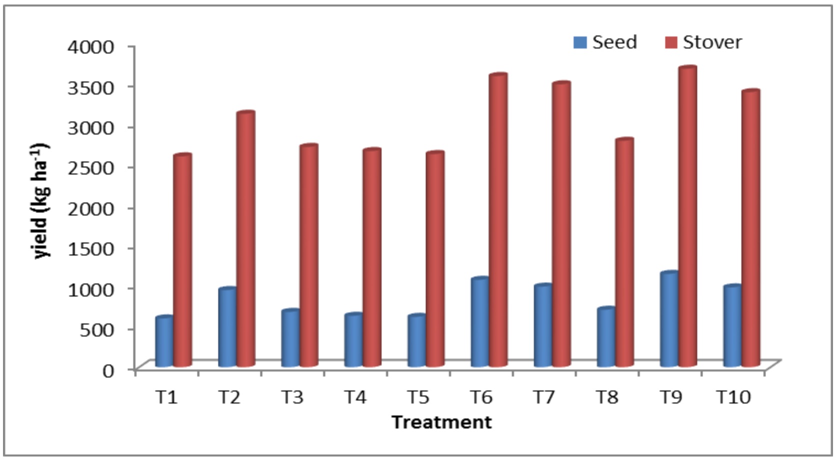

Fig 1: Effect of organic sources on yield of summer sesame

Effect of organic sources on fertility status of soil

The data pertaining to the fertility status of soil as influenced by various organic treatment are presented in Table 2 and depicted in Fig. (2).

Available N, P, K and S status of soil

Available N status of soil after harvest of sesame was significantly increased with the use of organic sources. The available N in soil varied from 206.2 to 218.6 kg ha^{-1} indicating that the soil was low in available N content. The maximum available N (218.6 kg ha^{-1}) was observed with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_9) and which was at par with T_6 and T_{10}. The lower value of available N was found in treatment T_1 *i.e.* control (206.2 kg ha^{-1}).

Available P content of soil varied significantly and it ranged from 16.82 to 19.88 kg ha^{-1} indicating that the soil was medium in available phosphorus content. The highest (19.88 $kgha^{-1}$) available P was found with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) and which was at par with T_6. The lower value of available P was found in treatment T_1 *i.e.* control (16.82 kg ha^{-1}). The higher values of available phosphorus in treatment T_9 and T_6 may be due to the compost and phosphate solubilizing bacteria (PSB) which has increased the availability of P in the soil by converting insoluble phosphorus into soluble P.

Available K content of soil varied significantly from 402.1 to 432.4 kg ha^{-1} indicating that soil was very high in available K content.The highest available K (432.4 kg ha^{-1}) was observed with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) and which was statistically at par with T_6 T_7 and T_{10}. The lower value of available K was found in treatment T_1 *i.e.* control (402.1 kg ha^{-1}).

Available S content of soil varied significantly from 12.11 to 18.15 mg kg^{-1} indicating that soil was high to very high in available S content. The highest available S (18.15 mg kg^{-1}) was observed with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) and which was at par with T_6 T_7 and T_{10}. The lower value of available S was found in treatment T_1 *i.e.* control (12.11 mg ha^{-1}). Similarly Jain and Tiwari (1995) [10], Malik *et al.* (2014) and Shahein *et al.* (2014) [14] also reported that use of different organic sources helped to increased nutrient content in various crop.

Micronutrient status of soil

The higher available zinc (0.73 mg kg^{-1}) was observed with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) and it was statistically at par with compost @ 3.3 t ha^{-1}+soil application of Azotobacter and PSB @10.0 $kgha^{-1}$ + 3 foliar sprays of liquid organic NPK (T_6), compost @ 3.3 to t ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray 0f liquid organic S (T_7) and compost @ 3.3 t ha^{-1} + soil application of Azotobacter and PSB @10.0kg ha^{-1} (T_{10}). The lowest available zinc (0.60 mg kg^{-1}) was recorded in treatment control (T_1). The higher available iron (7.16 mg kg^{-1}) was observed with the application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @10.0kg ha^{-1}+ 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) which was statistically at par with application of compost @ 3.3 t ha^{-1}+soil application of Azotobacter and PSB @10.0 $kgha^{-1}$ + 3 foliar spray of liquid organic NPK(T_6), compost @3.3 t ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_7) and compost @ 3.3 t ha^{-1} + soil application of Azotobacter and PSB @10.0kg ha^{-1} (T_{10}). The significantly higher available copper (1.71 mg kg^{-1}) was observed with the application of compost @ 3.3 t ha^{-1} + soil application of Azotobacter and PSB @10.0 kg ha^{-1} + 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9) which was statistically at par with T_6, T_7 and T_{10}. While the lowest available copper (1.54 mg kg^{-1}) was recorded in control treatment (T_1). The effect of organic sources on available manganese was found significant. The higher available manganese (4.91 mg kg^{-1}) was observed with the application of compost @ 3.3 t ha^{-1} + soil application of Azotobacter and PSB @10.0 kg ha^{-1} + 3 foliar sprays of liquid organic NPK + one foliar spray of liquid organic S (T_9), it was stasistically at par with T_6, T_7 and T_{10}. The lowest available manganese (4.20 mg kg^{-1}) was recorded in control treatment (T_1). Similarly Bellakki and Badanur (1997), Sharma *et al.* (2000) Khaled *et al.* (2012) [1] and Abdel-Rahman (2014) [1]. also reported about increase in available Zn, Fe, Cu and Mn with the application of organics.

Table 2: Effect of organic sources on fertility status of soil

Treatment		Available Nutrients							
		N ($kg\ ha^{-1}$)	P ($kg\ ha^{-1}$)	K ($kg\ ha^{-1}$)	S ($mg\ kg^{-1}$)	Zn ($mg\ kg^{-1}$)	Fe ($mg\ kg^{-1}$)	Cu ($mg\ kg^{-1}$)	Mn ($mg\ kg^{-1}$)
T_1	Control	206.2	16.82	402.1	12.11	0.60	6.83	1.54	4.20
T_2	Compost @ 3.3 t ha^{-1}	212.4	17.74	424.9	16.35	0.65	6.94	1.63	4.38
T_3	Soil application of Azotobacter and PSB@10.0kg ha^{-1}	210.4	17.10	403.7	12.39	0.62	6.86	1.54	4.24
T_4	3 foliar sprays of liquid organic NPK	206.2	16.82	402.1	12.11	0.60	6.83	1.54	4.24
T_5	one foliar spray of liquid organic sulphur	206.2	16.82	402.1	12.11	0.60	6.83	1.54	4.24
T_6	T2 + T3 + T4	215.6	19.20	429.7	17.94	0.73	7.02	1.69	4.60
T_7	T2 + T4 + T5	212.4	18.14	428.6	17.05	0.73	7.02	1.69	4.60
T_8	T3 + T4 + T5	210.4	17.20	403.7	14.05	0.62	6.86	1.54	4.24
T_9	T2 + T3 + T4 + T5	218.6	19.88	432.4	18.15	0.76	7.16	1.71	4.91
T_{10}	T2 + T3	213.6	18.20	426.0	16.82	0.73	7.02	1.69	4.60
SE (m) ±		1.68	0.44	2.47	0.57	0.02	0.05	0.01	0.05
CD at 5%		5.01	1.32	7.35	1.71	0.06	0.15	0.02	0.15

Conclusions

The higher yield of summer sesame variety AKT-101 was achieved with application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_9). Fertility status like available N, P, K, S and micronutrient status was found significantly highest with application of compost @ 3.3 t ha^{-1}+ soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_9)

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