Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 2843-2847
Received: 21-05-2018
Accepted: 24-06-2018

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Effect of compost, biofertilizer and organic sprays on yield, nutrient content and uptake of N, P, K and S by summer sesame

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Abstract
The field experiment was conducted during the summer season of 2016-17, to study the "Effect of different organic sources on soil fertility, nutrient uptake and yield of summer sesame" on the research field of Agronomy Farm, Department of Agronomy, Dr. PDKV, Akola. The experiment was laid out in Randomize block design with ten treatments and three replications with the application of different organic sources. 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 spray of liquid organic NPK + one foliar spray of liquid organic S (T_9) recorded the significantly highest yield, nutrient content and uptake of N, P, K and S 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, biofertilizers, organic spray, yield, nutrient content and uptake of N, P, K and S 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) [12]. 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) [9]. 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]) [4]. India ranks first in area (29%), production (26%) and export (40%) of sesame in the world (Anonymous 2010) [3] The productivity of sesame in India is 474 kg ha^{-1} (Anonymous, 2017[a]) [6]. India is a major exporter to number of countries and has earned the foreign exchange of `2800 crore (Ranganatha *et al.*, 2014) [19].
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]) [7]. 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.

Materials 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.

Results 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) [10], Abdel Rahman (2014) and Tomer and Khajanji (2009) [20].

Effect of organic sources on nutrient content of summer sesame

Nitrogen, Phosphorus, Potassium and Sulphur content of sesame in seed and stover was highest with application of compost @ 3.3t 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 followed by application of compost @ 3.3 t ha^{-1}+ soil application of *Azotobacter* and PSB @10.0kgha^{-1}+ 3 foliar spray of liquid organic NPK (T_6) compost @ 3.3 to t ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray liquid organic S (T_7) whereas, lowest nitrogen content was observed under control plot (T_1). Increase in nutrient content might be due to increased availability of nutrient through compost, biofertilizer and foliar spray which has resulted increase in nitrogen content. Similarly Jain and Tiwari (1995) [13] and Malik *et al.* (2014) [15], also reported that use of different organic sources helped to increased nutrient content in various crop.

Effect of organic sources on uptake of nutrient by summer sesame

Uptake of nitrogen by summer sesame

Total uptake of nitrogen was calculated considering the nitrogen uptake by sesame seed as well as stover. The uptake of nitrogen was found statistically significant under different organic treatment over control. The highest uptake of nitrogen in sesame seed was observed in treatment 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 statistically at par with (T_6) that receiving compost @ 3.3 t ha^{-1}+ soil application of *Azotobacter* and PSB @10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK, over other treatments and lowest uptake of nitrogen was found in control (T_1). The highest uptake of N in sesame stover was observed in treatment 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 (T9) and which was statistically at par with T_6 and T_7 over other treatments.

The total uptake of nitrogen was observed highest in treatment 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 statistically at par with treatment T_6. This might be due to use of compost along with *Azotobacter* that has favoured higher availability of nitrogen for higher uptake of Nitrogen. Similar findings are reported by Badole *et al.* (2000). They have reported that the application of organics recorded higher nitrogen uptake. Similarly Helkiah *et al*. (1981) [11], Rajkhowa *et al*. (2003) [17] Jeevan Rao and Ramalakshmi (2009) and Prasanna Kumar *et al.* (2008) also reported about high nitrogen uptake through use of organic sources.

Uptake of phosphorus by summer sesame.

The uptake of phosphorus was found statistically significant under different organic treatment. 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) was recorded significantly highest uptake of P in sesame seed and which was statistically at par with (T_6) receiving compost @ 3.3 t ha^{-1}+ soil application of *Azotobacter* and PSB @10.0kgha-^{1}+ 3 foliar spray of liquid organic NPK. Lowest uptake was found in control (T_1). The highest uptake of phosphorus in sesame stover was observed in treatment 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 statistically at par with treatment T_6 over remaining treatments. The total uptake of phosphorus was observed highest in treatment 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 statistically at par with T_6 over remaining treatments. This might be due to use of compost along with PSB that has favoured higher availability of phosphorus for higher uptake of phosphorus. Similarly Babajide *et al*. (2014) [8]. Malik *et al*. (2014) [15] and Ahmed *et al*. (2015) also reported about high phosphorus uptake through use of organic sources.

Uptake of potassium by summer sesame

Total uptake of potassium was calculated considering the potassium uptake by sesame seed as well as stover. The uptake of potassium was found statistically significant under different organic treatment. The highest uptake of potassium in sesame seed was observed in 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 statistically at par with T_6 over other treatments. Lowest uptake was found in control (T_1). The highest uptake of potassium in sesame stover was observed in treatment 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 statistically at par with treatment T_6 and T_7 over other treatments. The total uptake of potassium was observed highest in treatments 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 statistically at par with treatment T_6 over other treatments. This might be due to application of compost along with liquid organic NPK spray that has increased uptake of potassium. Similar findings are reported by Singh *et al.* (1999).

Uptake of Sulphur by summer sesame

The highest uptake of sulphur in sesame seed was observed in treatment, 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 lowest uptake was found in control (T_1). The highest uptake of sulphur in sesame stover was observed in treatment 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 lowest uptake was found in control (T_1). The total uptake of sulphur was observed highest in treatments 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).This might be due to use of compost along with liquid organic sulphur spray that has increased uptake of sulphur. Similar findings are reported by Malik *et al.* (2014) [15]. They have reported that the application of organic manure recorded higher sulphur uptake.

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

Table 2: Effect of organic sources on N content and uptake of summer sesame

Treatment		N content		N uptake (kg ha^{-1})		Total uptake (kg ha^{-1})
		Seed	**Stover**	**Seed**	**Stover**	
T_1	Control	2.98	0.78	17.94	20.33	38.26
T_2	Compost @ 3.3 t ha^{-1}	3.08	0.96	29.32	30.06	59.39
T_3	Soil application of *Azotobacter* and PSB@10.0kg ha^{-1}	3.05	0.83	20.77	22.46	43.23
T_4	3 foliar sprays of liquid organic NPK	3.05	0.83	19.33	22.08	41.40
T_5	One foliar spray of liquid organic sulphur	3.05	0.83	18.91	21.75	40.66
T_6	T2 + T3 + T4	3.17	1.10	34.19	39.46	73.65
T_7	T2 + T4 + T5	3.17	1.10	31.46	38.51	69.97
T_8	T3 + T4 + T5	3.05	0.83	21.62	23.20	44.82
T_9	T2 + T3 + T4 + T5	3.21	1.19	36.94	43.91	80.85
T_{10}	T2 + T3	3.14	1.02	30.95	34.51	65.46
SE (m) ±				1.76	2.37	2.85
CD at 5%				5.24	7.05	8.47

Table 3: Effect of organic sources on P content and uptake of summer sesame

Treatment		P content		P uptake (kg ha^{-1})		Total uptake (kg ha^{-1})
		Seed	Stover	Seed	Stover	
T_1	Control	0.44	0.22	2.65	5.74	8.39
T_2	Compost @ 3.3 t ha^{-1}	0.46	0.24	4.38	7.49	11.87
T_3	Soil application of *Azotobacter* and PSB@10.0kg ha^{-1}	0.46	0.24	3.13	6.51	9.64
T_4	3 foliar sprays of liquid organic NPK	0.45	0.23	2.86	6.13	8.99
T_5	One foliar spray of liquid organic sulphur	0.45	0.23	2.79	6.06	8.85
T_6	T2 + T3 + T4	0.48	0.26	5.18	9.33	14.51
T_7	T2 + T4 + T5	0.47	0.25	4.67	8.72	13.39
T_8	T3 + T4 + T5	0.46	0.24	3.26	6.69	9.96
T_9	T2 + T3 + T4 + T5	0.49	0.27	5.65	9.94	15.58
T_{10}	T2 + T3	0.47	0.26	4.62	8.82	13.44
SE (m) ±				0.26	0.30	0.40
CD at 5%				0.78	0.89	1.19

Table 4: Effect of organic sources on K content and uptake of summer sesame

Treatment		K content		K uptake (kg ha^{-1})		Total uptake (kg ha^{-1})
		Seed	Stover	Seed	Stover	
T_1	Control	0.53	0.76	3.19	19.76	22.95
T_2	Compost @ 3.3 t ha^{-1}	0.55	0.78	5.24	24.40	29.64
T_3	Soil application of *Azotobacter* and PSB@10.0kg ha^{-1}	0.53	0.77	3.62	20.92	24.54
T_4	3 foliar sprays of liquid organic NPK	0.54	0.77	3.42	20.54	23.97
T_5	One foliar spray of liquid organic sulphur	0.53	0.76	3.29	19.98	23.27
T_6	T2 + T3 + T4	0.57	0.81	6.14	29.09	35.23
T_7	T2 + T4 + T5	0.57	0.81	5.68	28.28	33.96
T_8	T3 + T4 + T5	0.54	0.77	3.83	21.50	25.33
T_9	T2 + T3 + T4 + T5	0.59	0.82	6.79	30.21	37.00
T_{10}	T2 + T3	0.57	0.80	5.60	27.17	32.77
SE (m) ±				0.31	0.95	0.97
CD at 5%				0.93	2.83	2.88

Table 5: Effect of organic sources on S content and uptake of summer sesame

Treatment		S content		S uptake (kg ha^{-1})		Total uptake (kg ha^{-1})
		Seed	Stover	Seed	Stover	
T_1	Control	0.18	0.13	1.08	3.42	4.50
T_2	Compost @ 3.3 t ha^{-1}	0.23	0.16	2.16	4.97	7.13
T_3	Soil application of *Azotobacter* and PSB@10.0kg ha^{-1}	0.18	0.13	1.24	3.63	4.87
T_4	3 foliar sprays of liquid organic NPK	0.18	0.13	1.17	3.58	4.75
T_5	One foliar spray of liquid organic sulphur	0.19	0.15	1.15	3.82	4.97
T_6	T2 + T3 + T4	0.25	0.17	2.64	5.95	8.59
T_7	T2 + T4 + T5	0.26	0.18	2.54	6.25	8.80
T_8	T3 + T4 + T5	0.19	0.14	1.36	3.84	5.20
T_9	T2 + T3 + T4 + T5	0.27	0.20	3.09	7.34	10.43
T_{10}	T2 + T3	0.24	0.17	2.35	5.72	8.07
SE (m) ±				0.14	0.34	0.29
CD at 5%				0.43	1.02	1.02

Conclusions

The higher yield of summer sesame variety AKT-101 was achieved with application of compost @ 3.3 t ha^{-1}+ soil application of Azatobactor and PSB @ 10.0 kg ha^{-1}+ 3 foliar spray of liquid organic NPK + one foliar spray of liquid organic S (T_9). Nutrient content and uptake of sesame seed and stover were found significantly highest with application of compost @ 3.3 t ha^{-1}+ soil application of Azatobactor 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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