Full Length Research Article

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Research Journal of Agricultural Sciences **14**(6): 1711–1715 (Nov-Dec 2023)
DOI: http://rjas.org/Article/Article/5671

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Influence of Composts and Industrial By-products on Sesame Yield and Post Harvest Nutrient Status

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Received: 01 Apr 2023; Revised accepted: 24 Oct 2023; Published online: 09 Nov 2023

Abstract

Sesame is the oldest Indigenous oil seed crop with longest history of cultivation in India. The Indian Agricultural Scenario become grimmer due to unabated depletion of nutrients. Soil fertility is the most limiting factor for crop production in sandy clay loam soil. The problems severely affect the productivity of sesame in this region. The present investigation was carried out to study the effect of conventional and non-conventional organic sources and industrial by-products in yield and post-harvest nutrient status. The treatments include 100% RDF as control (25:50:75 N:P_2O_5:K_2O kg ha^{-1}) 100% and 75% RDF with municipal solid waste compost, poultry manure compost, bagasse ash and wood ash @ 5 t ha^{-1} and 10 t ha^{-1}. There were 9 treatments combination and design followed was RBD and replicated 3 times. Among various treatments combined applications of 75% RDF + Poultry manure @ 10 t ha^{-1} through soil application (T_5) recorded the highest seed yield (1157.84 kg ha^{-1}) and stalk yield (2262.5 kg ha^{-1}). The same treatment recorded highest post-harvest soil organic carbon (3.11 kg ha^{-1}), available N (186.41 kg ha^{-1}), available P (19.45 kg ha^{-1}), available K (438.72 kg ha^{-1}), exchangeable Ca (5.35 mg kg^{-1}), Mg (2.08 mg kg^{-1}) and available S (9.46 mg kg^{-1}).

***Key words*:** *Sesamum indicum*, Poultry manure, Seed yield, Stalk yield, Post harvest nutrient status

Sesame (*Sesamum indicum*) or gingelly is commonly known as ellu (Tamil) – Sesame seed (Contain 50% oil, 25% protein and 15% carbohydrate) is used in baking, candy making and other food industries. It is an integral part of rituals, religion and culture sesame meal is an excellent high-quality protein (40%) feed for poultry and livelihood India ranks first in world with 27.04 million hectares area and 33.42 million tones production [1]. A well-managed crop of sesame can yield 1200-1500 kg ha^{-1} under irrigated and 800-100 kg ha^{-1} under rainfed conditions [2].

Municipal solid waste compost used as treatment for non-conventional organic source to be included as one of the components in trial waste generation rates will be more than double over the next 20 years in lower income waste management costs have been increased about 5 times in low-income countries and form times in lower-middle income countries [3]. These ever-growing large amount of wastes are associated with environmental and public health problems, and odor from the landfills. The reuse of wastes for agricultural purpose to improve soil properties and increase crop yield in a good solution for minimizing these problems poultry manure.

Poultry population is raising every year leaving large amount of poultry ripens. Poultry manure contains nutrient elements that can support crop production and enhance the physical and chemical properties of soil. Poultry manure application improves soil retention and uptake of plant nutrients [4]. Bagasse is an important agro-industrial waste by-products that in generally used as a food in sugar milling industry. The ash is an alkaline material, certain K, Ca, Mg and P. The main goal of this study was to assess the potential use of ash from combination of sugarcane bagasse as a fertilizer [5]. Wood ash is the inorganic and organic residue remaining after combination of wood or unbleached wood fibre. Ash is composed of many major minor elements which trees need for growth. Field research confirms the safety and practically of recycling wood ash on agricultural levels. The objective of field experiment was to study the direct effect of organic manures like municipal solid waste compost, poultry manure, industrial by-products like bagase ash and wood ash on yield and post-harvest nutrient status of N, P, K, Ca, Mg and S [6].

MATERIALS AND METHODS

Field experiment

A field experiment at Annamalai Kottai village, Kodumudi taluk, Erode district to be carried out to study the effect of soil application of RDF as control, RDF with municipal solid waste compost @ t ha^{-1} and 10 t ha^{-1} RDF with poultry manure compost @ 5 t ha^{-1} and 10 t ha^{-1}, RDF with Bagasse ash @ 5 t ha^{-1} and 10 t ha^{-1} RDF with wood ash @ 5 t ha^{-1} and 100 t ha^{-1}. The experiment was conducted in a randomized block design (RBD) with the following nine treatments and each treatment was replicated 3 times.

The objectives of this experiment to evaluate seed yield and stalk yield and post-harvest nutrient status of NPK and secondary nutrients.

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Citation: Venkatakrishnan D, Manojkumar M, Srinivasan S, Sivakumar K. 2023. Influence of composts and industrial by-products on sesame yield and post-harvest nutrient status. *Res. Jr. Agril. Sci.* 14(6): 1711-1715.

Treatment details of the field experiment
T_1: Control – 100% RDF (25:50:75 N:P_2O_5:K_2O kg ha^{-1})
T_2: 100% RDF + Municipal solid waste compost @ 5 t ha^{-1}
T_3: 100% RDF + Municipal solid waste compost @ 10 t ha^{-1}
T_4: 100% RDF + Poultry manure @ 5 t ha^{-1}
T_5: 100% RDF + Poultry manure @ 10 t ha^{-1}
T_6: 100% RDF + Bagasse ash @ 5 t ha^{-1}
T_7: 100% RDF + Bagasse ash @ 10 t ha^{-1}
T_8: 100% RDF + Wood ash @ 5 t ha^{-1}
T_7: 100% RDF + Wood ash @ 10 t ha^{-1}

The chemical composition of municipal solid waste compost, poultry manure, bagasse ash and wood ash are furnished in (Table 1).

Table 1 Chemical composition of municipal solid waste compost poultry manure, bagasse ash and wood ash

Manures and industrial by-products	OC (g kg^{-1})	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)
Municipal solid waste compost	27.0	1.13	2.92	0.53	7.88	0.50	0.25
Poultry manure	14.9	2.23	0.83	2.35	1.42	0.58	0.50
Bagasse ash	71.5	0.014	0.0052	0.024	1.38	0.75	0.13
Wood ash	18.5	0.000006	0.09	5.91	1.93	0.68	0.01

Seed yield (kg ha^{-1})

Seed yield of the net plot was recorded after hand threshing and air drying. After recording the seed yield of net plot area, seed yield ha^{-1} was worked out and expressed in kg ha^{-1}.

Stalk yield (kg ha^{-1})

The plants from the net plot area after threshing were dried and weight was recorded. Stalk yield per ha was worked out and expressed as kg ha^{-1}. Soil samples were collected just before the commencement of field experiment and at harvest to determine the various physico-chemical characteristics and nutrient status of soil. The collected soil sample were air dried in shade ground in wooden mallet passed through 2 mm sieve and stored in polythene bags. These samples were analyzed for pH, EC, organic carbon, available NPK, exchangeable Ca and Mg and extractable sulphur. The details of procedure followed for the analysis for the analysis of soil samples are listed in (Table 2).

Table 2 Methods of analysis of soil

Parameters	Methodology	References
	A. Mechanical fraction	
Textural fractions	International pipette method	[7]
Bulk density, Practice density and pore space	Measuring cylinder method	[8]
Soil colour	Munsell soil colour chart	[9]
	B. Physico-chemical properties	
Soil reaction, pH	Potentiometry (1:2:5 soil:suspension)	[10]
Electrical Conductivity	Conductometry (1:2.5 soil: suspension)	[10]
Cation exchange, CEC	Neutral normal ammoniumacetate method	[10]
	C. Chemical properties	
Organic carbon	Chromic acid wet digestion method	[11]
Available nitrogen ($KMNO_4$-N)	Alkaline permanganate method	[12]
Available phosphorus (Olsen-P)	Ascorbic acid blue method (spectrophotometry)	[13]
Available potassium (NH_4 OAcK)	(Neutral 1N NH_4OAc extract) flame photometry	[14]
Ca,Mg	Versenate method	[10]
S	Turbidometric method using spectrophotometric at 420 nm	[15]

RESULTS AND DISCUSSION

Seed yield

The first and foremost aim of the present investigation is to increase the sesame productivity through suitable INM practices. Associated with improved growth and yield character the sesame yield also increased with the application of 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). The increase in yield with application of poultry manure and chemical fertilizers could be attributed to better uptake of essential nutrients and the transformation of economic parts as well as improving in yield attributing characters like number of capsules plant^{-1}, number of seeds plant^{-1}, seed weight plant^{-1} and 1000 seed weight. The pronounced effect of poultry manure might have helped in enhancing the enzyme and photosynthetic activities, accumulation of photosynthates there by higher seed yield. Further increased in photosynthesis during growth stages might the contributed for greater assimilates supply to the capsules which resulting in better seed setting and also betterment of higher seed yield of sesame [16].

Among the industrial by-products the application of 100% RDF + Bagasse ash @ 5 t ha^{-1} (T_6) registered highest seed yield. This is due to the supply of nutrients, conductive physical environment leading to better aeration, increase in soil moisture holding capacity, root activity and nutrient absorption and the consequent complementary effect due to bagasse ash have resulted in higher seed yield of 1044.31 kg ha^{-1} [17].

Stalk yield

The highest stalk yield of 2262.5 kg ha^{-1} was recorded in application of 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). The significant increase in stalk yield is due to the addition of poultry manure to an agricultural soil increased the contents of nutrients available with biochemical and microbiological transformation in soil. The beneficial changes in soil properties with compost amended treatments positively affect the stalk yield [18]. Among the industrial by-products the highest stalk yield was recorded in the treatment T_6 (2092.19 kg ha^{-1}). This may be due to bagasse ash resulted in higher concentration in sesame stalk and in turn better growth of crop [19].

Table 3 Effect of conventional, non-conventional organic source and industrial by-products on seed yield and stalk yield

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
T_1 – Control 100% RDF	922.9	1974.56
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	1045.43	2117.8
T_3 – 100% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	1100.51	2185.81
T_4 – 100% RDF + Poultry manure @ 5 t ha^{-1}	1124.12	2219.64
T_5 – 100% RDF + Poultry manure @ 10 t ha^{-1}	1157.84	2262.5
T_6 – 100% RDF + Bagasse Ash @ 5 t ha^{-1}	1044.31	2092.19
T_7 – 100% RDF + Bagasse Ash @ 10 t ha^{-1}	1007.21	2025.64
T_9 – 100% RDF + Wood Ash @ 5 t ha^{-1}	1006.09	2023.39
T_7 – 100% RDF + Wood Ash @ 10 t ha^{-1}	938.64	1976.02
Mean	1038.56	2097.54
S.Ed.	3.32	4.37
CD (p=0.05)	6.90	9.26

Post harvest soil nutrient status

Post harvest organic carbon

The highest post-harvest soil organic carbon (3.81 g kg^{-1}) was recorded in the treatment receiving 75% RDF + Municipal solid waste compost @ 10 t ha^{-1} (T_3). The highest organic carbon content in soil applied with municipal solid waste compost might have stimulated the microbes by serving as source of carbon, energy and other nutrients essential for their growth and multiplication and thus increased the soil activities. Residual organic carbon content was higher in organic manure treated soils that in control slow mineralization of organic matter might lead to the buildup of organic carbon [20].

Table 4 Effect of conventional, non-conventional organic source and industrial by-products on post-harvest organic carbon, NPK status of soil

Treatments	OC (kg ha^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1 – Control 100% RDF	2.36	173.96	18.8	420.1
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	3.67	178.91	19.58	433.5
T_3 – 100% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	3.81	179.1	19.6	434.28
T_4 – 100% RDF + Poultry manure @ 5 t ha^{-1}	3.08	184.83	19.37	436.9
T_5 – 100% RDF + Poultry manure @ 10 t ha^{-1}	3.10	186.41	19.45	438.72
T_6 – 100% RDF + Bagasse Ash @ 5 t ha^{-1}	2.39	177.2	19.0	421.91
T_7 – 100% RDF + Bagasse Ash @ 10 t ha^{-1}	2.41	176.72	18.9	422.62
T_9 – 100% RDF + Wood Ash @ 5 t ha^{-1}	3.43	175.8	19.19	446.35
T_7 – 100% RDF + Wood Ash @ 10 t ha^{-1}	3.29	175.69	19.21	448.46
Mean	3.06	178.73	19.23	433.65
S.Ed.	0.0243	0.174	0.0117	0.423
CD (p=0.05)	0.0515	0.37	0.0249	0.897

Post harvest soil nitrogen

The maximization post-harvest soil N recoded 186.41 kg ha^{-1} in the treatment T_5 receiving 75% RDF + Poultry manure @ 10 t ha^{-1}. The mixing of RDF and poultry manure reduced N loss and increased post-harvest N content [21]. The soil physical and chemical properties improved by the addition of poultry manure increasing total nitrogen [22].

Post harvest soil phosphorus

The highest post-harvest soil P recorded 19.45 kg ha^{-1} in the treatment receiving 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). The increased P availability to plants to the solubilization of P by organic acids present in the poultry manure [23]. An increase in the inorganic P concentration in the soil is due to the application of poultry manure. The higher soil liable P was increased with the addition of composted poultry litter [24].

Post harvest soil potassium

The highest post-harvest soil potassium (438.72 kg ha^{-1}) was recorded in the treatment 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). The higher available K content under combined poultry manure and fertilizer treatment in the current study may be ascribed to the release of organic acids during decomposition, which generates negative electron charges in the soil with a preference for di or trivalent cations such as Al^{3+}, Ca^{2+} and Mg^{2+} leaving K^+ to be absorbed by negatively charged soil colloids. This phenomenon might help to reduce K fixation and enhance its availability in soil [25].

Post harvest Ca, Mg and S

The maximum post-harvest soil Ca (5.35 Cmol (P^+) kg^{-1}), Mg (2.08 Cmol (P^+) kg^{-1}), in the treatment receiving 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). Ca and Mg levels increased with the rate of poultry manure application [26]. The higher exchangeable Mg observed in poultry manure treated tools implies higher rate of mineralization of Mg. The higher organic content of the poultry manure could have probably accounted for the residual exchangeable Mg content of soil [27]. The highest post-harvest soil of the sulphur (9.46 mg kg^{-1}) was recorded in the treatment receiving 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5). The integrated role of applied organic manure is more pronounced for availability of sulphur in the soil, may be released active organic acids during microbial activity that enhanced the oxidation of sulphur (S^0) from the native and added sources to sulphate form (SO_2^4). The combined application of fertilizer with poultry manure, the available content of sulphur in soil significantly increased [28].

CONCLUSION

Considering the salient findings in perspective, study revealed that application of 75% RDF + Poultry manure @ 10 t ha^{-1} (T_5) was found to be the best combination for maximizing yield and post-harvest and nutrient status of NPK, Ca, Mg and Sulphur (S).

Table 5 Effect of conventional, non-conventional organic source and industrial by-products on post-harvest Ca, Mg and S status of soil

Treatments	Ca (c mol (P^+) kg^{-1})	Mg (c mol (P^+) kg^{-1})	S (mg kg^{-1})
T_1 – Control 100% RDF	5.30	2.01	8.83
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	5.42	2.03	9.10
T_3 – 100% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	5.48	2.05	9.25
T_4 – 100% RDF + Poultry manure @ 5 t ha^{-1}	5.33	2.06	9.44
T_5 – 100% RDF + Poultry manure @ 10 t ha^{-1}	5.35	2.08	9.46
T_6 – 100% RDF + Bagasse Ash @ 5 t ha^{-1}	5.32	2.13	9.08
T_7 – 100% RDF + Bagasse Ash @ 10 t ha^{-1}	5.31	2.14	9.0
T_9 – 100% RDF + Wood Ash @ 5 t ha^{-1}	5.38	2.09	8.9
T_7 – 100% RDF + Wood Ash @ 10 t ha^{-1}	5.36	2.11	8.85
Mean	5.36	2.08	9.10
S.Ed.	0.0025	0.0027	0.0094
CD (p=0.05)	0.0053	0.0058	0.02

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