QUANTIFICATION OF DIFFERENT COMPOSTING TECHNIQUES AND EVALUATION OF THEIR PERFORMANCE ALONG WITH BIOFERTILIZERS ON GROWTH AND YIELD OF *KHARIF* GREENGRAM (*Vigna radiata* L.)

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ABSTRACT

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, to study the quantification of different composting techniques and evaluation of their performance on growth and yield of kharif greengram (Vigna radiata L.) during 2013 on loamy sand soil. Quantification of agricultural waste through various composting techniques indicated that recovery of all the composting techniques was more than 60 per cent and maximum recovery was obtained with NADEP composts. The highest nutrient content of nitrogen, phosphorus and organic carbon were recorded in vermicompost, whereas the highest potash content was recorded in both vermicompost and FYM. The results further revealed that application of 100 per cent RDN from vermicompost (T_5) treatment significantly influenced the growth and yield attributes viz; plant height, number of branches per plant, number of pods per plant, test weight, seed and stover yield as well as protein content (%) over control. Application of 50 per cent RDN from vermicompost along with bio-fertilizers significantly increased root nodules over control.

KEY WORDS: FYM, greengram, INDORE compost, NADEP, vermicompost

INTRODUCTION

The success of sustainable agriculture is very much dependent upon the availability of cheap and good quality organic manures. Composting of agricultural waste materials makes an appreciable contribution in improving the organic matter content of the soil, which plays an important role in sustaining soil fertility by improving physico-chemical as well as biological properties of the soil and thereby increasing the yield. There are various techniques for preparing composts from agricultural waste materials. Different composting techniques have their own pros and cons, particularly under aerobic and anaerobic conditions differ in their time of composting, labour cost as well as chemical properties and quantity. Composting of agricultural waste materials in conjunction with bio-fertilizers play an important role in improving the organic matter content of the soil and thereby improving soil productivity and yield along with partial replacement of mineral fertilizers (Sutaria *et al.*, 2010).

Green gram being a leguminous crop, meets its nitrogen requirements through symbiotic nitrogen fixation. Nodule formation can fix about 35 kg/ha atmospheric nitrogen through *Rhizobium* bacteria (Yadav, 1992). Similarly, *Phosphorus Solubilizing Bacteria* (PSB) plays an important role in supplementing phosphorus to the plants. Since no study has been carried out for quantifying different composting techniques and determining the performance of composts prepared by different methods and their effects along with biofertilizers like *Rhizobium* and PSB on *kharif* greengram; this experiment was planned and conducted.

MATERIALS AND METHODS

Different composts *viz*, NADEP, Indore, vermicompost and FYM were prepared at Compost and FYM Unit, Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University. Anand.

NADEP compost

The NADEP compost was prepared by mixing maize straw and cattle dung in the ratio of 75:25 in a tank like structure made of brick masonry with all sides perforated, having internal dimensions of 3 x 2 x 1 m^3 size. Total foruty numbers of holes, each of seven inch size were kept for aeration in the tank. Bottom of the tank was covered with an impervious layer to prevent possibility of seepage of any liquid waste into the soil. The tank was first filled up with 75 kg maize straw in the bottom, followed by cattle dung of 30 kg in the second layer and 55 kg of soil in the third layer of the compost pit. Thereafter, the tank continued to be filled up with same sequence repeatedly for six times. Instead of 30 kg of cattle dung used initially for filling of first layer, 20 kg of cattle dung was taken in the rest of the layers. During the filling of the pit care was taken that pit was filled up in single instant within 24 hours. Then it was plastered with cattle dung slurry. Total 450 kg maize straw, 150 kg cattle dung and 330 kg soil were used in the experiment. There was no turning of material in this method. Compost was completely ready for removal after 125 days.

INDORE compost

The INDORE compost was prepared by taking maize straw and cattle dung in the ratio of 75:25 in the underground tank made of brick masonry having an internal dimension of 3 x 2 x 1 m^3. The bottom of the tank was covered with an impervious layer to prevent possibility of seepage of any liquid waste into the soil. In this method, the maize straw of about 75 kg was spread in the pit. Then cattle dung of about 30 kg was mixed with the maize straw thoroughly. About 1 lit of cattle urine diluted with 5 liters of water was sprayed over this material. Then, five kg of wood ash was spread over it. Sufficient water was sprinkled over the pit to wet the material. The pit was filled in this way layer by layer for six times with the same quantity of maize straw, cattle dung and cattle urine for the first three layers. The amount of cattle dung was reduced to 20 kg from the initial 30 kg in the last three layers. Same quantity of wood ash and cattle urine was applied till the fifth layer. In the last sixth only diluted cattle urine was spread, wood ash was not layered. After filling up the six layer 60 kg of soil was spread over the layer and was plastered with cattle dung slurry. Care was taken to avoid compaction of the material. The material was turned three times during the whole period of composting at 18th, 35th and 67th days after filling up the pit. In the experiment total of 450 kg of maize straw, 150 kg of cattle dung, 70 kg soil, 15 kg of wood ash and 7 liters of cattle urine was used for preparing INDORE compost. The compost was ready after 130 days.

Vermicompost

For preparing vermicompost, maize straw and cattle dung was taken in the ratio of 25:75. Vermicomposting was carried out under a shed in a heap size of 2 x 1 x 0.5 m^3.

Maize straw was used as the bedding material at the lower most layer and sufficient water was sprinkled over it. Above this layer, partially decomposed cattle dung was spread making five to six cm layer and water was again sprinkled over it. This layer served as immediate food for the earthworms and prevented them from the excessive heat generated during vermicomposting as well as during shortage of water in the upper layers. One kg of earthworm species *Eisenia foetida* was placed uniformly over the second layer. After the inoculation of earthworms, the raw material in different heaps was layered in alternate layers with 15 days stale cattle dung. The layers were repeated in similar fashion till the heaps attained a height of 50 cm. The entire heap was then covered with jute cloth to prevent moisture loss from it and also to protect earthworm from external influences. Moisture content was maintained throughout the period of vermicomposting by sprinkling water over the jute cloth covering the heap. The heap was turned once at 35th days after final layering. Vermicompost was ready for removal in 70 days. At this point, jute cover was removed and sprinkling of water was stopped. This caused the earthworm to move down to the lower most layers where they got accumulated. The vermicompost remained at the upper layer was collected, sieved and used in the experiment. Total 150 kg maize straw and 450 kg cattle dung was used for the experiment.

FYM

The farm yard manure (FYM) was prepared in trenches having 1 m depth, 1.5 m width and 6 m length. The trench was filled by depositing 15 kg of cattle dung and 5 kg of urine soaked litter in the trenches as first layer. Subsequently four such layers were made. About 60 kg of soil was used for covering the trenches and then plastered with mud paste. Before plastering, sufficient water was added to the manure pit for decomposition of the organic matter as it conserves moisture and nitrogen and also prevents housefly nuisance. No turning was done. Total 125 kg maize straw, 375 kg cattle dung and 60 kg soil was required. The manure was removed from the trench after 161 days after plastering.

After preparation of these composts, they were chemically analyzed for OC (%), N, P and K content (kg/ha) by the methods suggested by Jackson (1973).

Field experiment

For evaluating performance of these composts, a field experiment was conducted during *kharif* season of the year 2010 on greengram (Var. GM 4) at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat in sandy loam soils, which is low in available nitrogen (187.4 kg/ha), medium in available phosphorus (38.7 kg/ha), high in potash (361.8 kg/ha) and low in O.C (0.30 %) content with pH 7.8. The experiment was laid out in randomized block design (RBD) with four replications and ten treatments comprising of absolute control (T_1), 100 % RDF (20-40-00 N-P-K kg/ha)(T_2), 100 % RDN from NADEP compost (T_3), 100 % RDN from INDORE compost (T_4), 100 % RDN from Vermicompost (T_5), 100 % RDN from FYM (T_6), 50 % RDN from NADEP compost + biofertilizers (T_7), 50 % RDN from INDORE compost + biofertilizers (T_8), 50 % RDN from Vermicompost technique + biofertilizers (T_9) and 50 % RDN from FYM + biofertilizers (T_{10}). At the time of sowing, seeds were treated with *Rhizobium* culture @ 5 ml/kg of seeds; whereas PSB culture was applied in the soil @ 1 l/ha for the treatments T_7 to T_{10}. Phosphorus was applied through SSP in treatments T_2 to T_{10}. For the treatments T_3 to T_{10}, phosphorus was adjusted according to the quantity of organic material applied and the rest of phosphorus was compensated through SSP. Greengram variety GM 4 was sown by drilling at a spacing of 30 × 10 cm under dry condition followed by light irrigation with recommended seed rate of 20 kg/ha.

RESULTS AND DISCUSSION

Quantification of various composting techniques and nutrient status:

Data presented in Table 1 showed duration, recovery % and nutrient content (%) of various composting techniques tested for the experiment. Quantification of agricultural waste through various composting techniques *viz*; NADEP, INDORE, Vermicompost and FYM indicated that recovery of all the composting techniques was more than 60 per cent and maximum recovery was obtained with NADEP (66%) among different composts and FYM tested. It might be due to continuous aeration throughout the composting period leading to enhanced activities of aerobic microbes which help to decompose the cellulose and lignin rapidly and efficiently. This result was in line with the results reported by Verma *et al*. (1999).

The maximum nutrient content of N (0.97%), P (0.93%) and OC (3.17%) was observed in vermicompost, whereas the utmost K content (0.53 %) was recorded in vermicompost as well as in FYM. Higher content of nutrients and OC in vermicompost might be attributed to proportion of raw material (75:25 cattle dung, maize straw) and constant activity of earthworms which kept the soil moisture and air proportion in perfect harmony throughout the composting period.

Growth and yield attributes

Data pertaining to growth and yield attributes are presented in Table 2. Results indicated significant differences when composts prepared by different techniques were applied with and without bio-fertilizers as compared to control. Significantly higher plant height (66.98 cm) and number of branches per plant (9.70) were observed with 100 % RDN from vermicompost (T_5) which was found comparable with 50 % vermicompost along with biofertilizer (T_9) and 100 % RDF from chemical fertilizer (T_2). However, significantly higher number of root nodules per plant (17.88) was recorded under treatment T_9 i.e. 50 % RDN from Vermicompost technique + biofertilizers, which was followed by 100 % RDN from vermicompost (T_5). Similar trend was observed for yield attributes and significantly higher number of pods per plant (24.60) and test weight (44.24 g) of greengram were observed for 100 % RDN from vermicompost (T_5). Yield attributing characters like number of seeds per pod and harvest index were not influenced significantly due to different composting techniques with and without biofertilizers treatments. This might be attributed to high microbial mass from vermicompost might contribute to plant growth by supplying various plant growth regulating substances and hormones (Frankenberger and Arshad 1995). Furthermore, higher availability of organic carbon from vermicompost might influence soil physical and chemical properties leading to improved nutrient availability for a longer period of time resulting in maximum growth and yield attributes of plant. Similar trends were also observed by Rajkhowa *et al*. (2002) and Kumar and Uppar (2007).

Yield and quality

Judicious quantity of available nutrients throughout the crop growth period is a basic requirement for running of all the physiological processes. The seed yield and stover yield (Table 3) remarkably influenced due to different composting techniques. Application of 100 % RDN from vermicompost (T_5) recorded higher seed (868 kg/ha) and stover (3660 kg/ha) yield which was comparable with application of 50 % RDN from vermicompost along with biofertilizer (T_9) and application of 100 % RDF from inorganic source (T_2). Application of 100 % RDN from vermicompost (T_5) showed 24.1 per cent and 23.5 per cent higher seed yield and stover yield over control (T_1). This might be due to increased number of branches and number of pods per plant, plant height, number of nodules per plant and test weight under this treatment. Moreover, improved soil OC % (Table 3) also resulted into constant availability of soil moisture ultimately resulted into better uptake of nutrients, released of phytohormones and organic acids which provided food for the beneficial bacteria. The higher availability of N and P might have contributed to higher yield by the application of vermicompost. Besides this, slow release of nutrients from decomposed organic matter, improved soil physical condition and significant nitrogen fixation might be the reasons for the maximum plant growth and grain yield. These results are in agreement with those of Kumari and Kumari (2002) and Saha *et al.* (2008).

Different composting techniques exerted its significant influence on protein content also. Treatment T_5 (100 % RDF from vermicompost) gave the highest protein content among the different treatments. Enhancement in the protein content might be attributed to the significant role of these treatments in root enlargement; better microbial activities resulted in more availability and uptake of nitrogen and increased protein content in seed. These results are in agreement with those of Parthasarathi *et al*. (2008).

Soil nutrient status

The highest available N, available P and organic carbon were recorded in the treatment T_5 (100 % RDN from vermicompost) with 219 kg/ha available N, 51.46 kg/ha available P and 0.42 % organic carbon, respectively (Table 3). Saha *et al*. (2008) reported that this might be due to decomposition of organic matter present in vermicompost released organic acid which might have helped in improving the N and P availability in soil by fixing atmospheric nitrogen and dissolution of fixed and unavailable phosphorus in the soil. Addition of vermicompost also enhances the organic carbon content in the soil as casts deposited by earthworm may participate in the accumulation of organic matter produced in the ecosystem. Same result was reported by Parthasarathi *et al*. (2008).

CONCLUSION

From the results and discussion, it can be concluded that NADEP compost proved better in case of recovery per cent, however, as far as nutrient content, quick decomposition and response to the crop is concerned, vermicompost was found better over the rest of the composts and FYM. The results in view of crop yield suggested that application of nutrients to greengram either through vermicompost (100% RDN) or vermicompost (50 % RDN) along with biofertilizers or chemical fertilizers (100% RDF) gave equivalent effect. However, the nutrient content in soil after harvest indicates quick exhaustion of nutrients by the use of chemical fertilizers. Therefore, to sustain soil fertility and crop yield, application of vermicompost (100 % RDN) or vermicompost (50 % RDN) + biofertilizers is better option of nutrient management in *kharif* greengram.

REFERENCES

Frankenberger, W. T. and Arshad, M. (1995). *Phytohormones in Soils: Microbial Production and Function.* Marcel and Deckker, New York, pp.503.

Jackson, M. L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, pp: 183-192.

Kumar, S. H. A. and Uppar, D. S. (2007). Influence of Integrated Nutrient management on seed yield and quality of mothbean. *Karnataka J. Agric. Sci*., **20**(2): 394-396.

Kumari, M. S. S. and Kumari, K. U. (2002). Effect of vermicompost enriched with Rockphosphate on the yield and uptake of nutrients in cowpea (*Vigna unguiculata* L.). *J. Tropical Agric*., **40**: 27-30.

Parthasarathi, K.; Balamurugan, M. and Ranganathan, L. S. (2008). Influence of vermicompost on the physico-chemical and biological properties in different types of soil along with yield and quality of the pulses crop-blackgram. *Iran J. Environ. Health Sci. Eng*., **5**(1): 51-58.

Rajkhowa, D. J.; Saikai, M. and Rajkhowa, K. M. (2002). Effect of vermicompost with and without fertilizer on greengram. *Legume Res*., **25**(4): 295-296.

Saha, S.; Mina, B. L.; Gopinath, K. A.; Kundu, S. and Gupta, H. S. (2008). Relative changes in phosphates activities as influenced by source and application rate of organic composts in field crops. *Bioresource Tech*., **99**: 1750-1757.

Sutaria, G. S.; Akbari, K. N.; Vora, V. D.; Hirpana, D. S. and Padmani, D. R. (2010). Response of legume crops to enriched compost and vermicompost on *Verticustochrept* under rainfed agriculture. *Legume Res.*, **33**(2): 128-130.

Verma, L. N.; Rawat, A. K. and Rathore, G. S. (1999). Composting process as influenced by the method of aeration. *J. Indian Soc. Soil Sci.*, **47**(1): 368-371.

Yadav, D. S. (1992). *Pulse Crop*. Kalyani Publishers, New Delhi.pp: 14-21.

Table 1: Quantification of different composting techniques and its nutrient status

Different Compost / FYM	Initial Quantity (MS+CD+S+WA) = kg	Duration (Days)	Final Quantity (kg)	Recovery %	% Nutrient Content			
					N	P_2O_5	K_2O	O.C
NADEP compost	450+150+330+0=930	92	610	66	0.33	0.21	0.43	2.81
INDORE compost	450+150+70+15=685	130	423	62	0.36	0.26	0.31	2.87
Vermi-compost	150+450+0+0=600	71	366	61	0.97	0.93	0.53	3.17
FYM	125+375+60+0=560	268	326	58	0.42	0.22	0.53	3.03

Where, MS- Maize straw, CD- Cattle dung, S-Soil, WA-Wood ash

Table 2: Effect of different composts and biofertilizers on growth, yields and quality of *kharif* green gram

Treatment	Plant Height (cm) at Harvest	Number of Branches/ Plant	Number of Root Nodules/ Plant	Number of Pods/ Plant	Number of Seed/pod	1000 Seed Weight (g)	Harvest Index (%)
T_1: Absolute Control	52.88	7.95	11.50	17.35	9.25	37.77	
T_2: 100% RDF (20-40-00 N-P-K kg ha^{-1})	61.35	9.30	13.60	21.00	10.40	41.15	19.01
T_3:100% RDN from NADEP compost	57.95	8.65	12.55	19.35	9.60	38.56	19.81
T_4:100% RDN from INDORE compost	59.15	8.70	12.58	18.85	9.65	39.34	19.09
T_5:100% RDN from Vermicompost	66.98	9.70	15.20	24.60	10.65	44.24	18.98
T_6:100% RDN from FYM	58.80	8.70	12.83	19.85	9.85	39.24	19.16
T_7:50%RDN from NADEP compost+ biofertilizers	57.70	8.75	14.50	19.80	9.90	38.76	19.10
T_8:50% RDN from INDORE compost+ biofertilizers	58.35	8.65	14.05	20.10	9.95	38.75	19.22
T_9:50 % RDN from Vermicompost technique + biofertilizers	61.43	9.45	17.88	21.48	10.30	41.91	19.15
T_{10}:50% RDN from FYM + biofertilizers	58.90	8.75	15.00	19.90	10.05	39.32	19.75
S.Em±	2.37	0.31	0.98	1.25	0.29	1.28	19.49
CD	6.88	0.91	2.85	3.63	NS	3.71	NS
CV %	8.00	7.08	14.04	12.37	5.79	6.40	5.35

Table 3: Effect of different compost and biofertilizers on yield, protein content and nutrient status at harvest

Sr. No.	Yield (kg/ha)		Protein Content (%)	Available Nutrient (kg/ha)			
	Seed	Stover		O.C (%)	N	P_2O_5	K_2O
T_1: Absolute Control	658	2797	19.86	0.30	176.44	33.98	411.16
T_2: 100% RDF(20-40-00 N- P-K kg ha^{-1})	828	3303	22.43	0.32	184.43	36.08	435.16
T_3: 100% RDN from NADEP compost	715	3032	20.82	0.34	190.77	38.05	423.93
T_4: 100% RDN from INDORE compost	723	3085	21.49	0.33	193.71	40.35	415.61
T_5: 100% RDN from Vermicompost	868	3660	26.29	0.42	219.37	51.46	447.90
T_6: 100% RDN from FYM	723	3078	21.01	0.34	192.50	42.52	430.14
T_7: 50%RDN from NADEP compost+ biofertilizers	735	3161	22.00	0.35	196.37	45.72	436.30
T_8: 50% RDN from INDORE compost+ biofertilizers	738	3159	21.01	0.35	195.05	44.68	438.62
T_9: 50 % RDN from Vermicompost technique+ biofertilizers	830	3379	23.71	0.39	208.99	48.96	443.96
T_{10}: 50% RDN from FYM + biofertilizers	740	3103	22.14	0.36	195.80	45.09	434.55
S.Em (±)	40.44	152.27	1.05	0.02	7.85	1.94	8.77
CD at 5%	117.34	441.85	3.03	0.05	22.79	5.64	NS
CV %	10.70	9.59	9.47	9.62	8.04	9.11	4.06

Initial soil status: OC (%): 0.40, Av. N (kg ha^{-1}): 187.4, Available P_2O_5 (kg ha^{-1}): 38.7, Available K_2O (kg ha^{-1}): 361.8

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