

Effects of various organic composts on mungbean (*Vigna radiata*) seed germination and seedling growth performance

Hariprakash

Department of Rural Development and Agricultural Extension,

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Abstract

Reuse and recycling of these wastes through compost preparation are categorised as the most preferred approaches in integrated solid waste management systems under the clean India program and smart city program, while the implementation of an environmentally friendly solid waste management strategy is acknowledged as an urgent need worldwide (Sayara et al. 2020). Compost application is being promoted as an alternative to synthetic fertilisers in order to enhance soil aggregation, recover soil organic carbon and nitrogen, and boost agricultural sustainability (Choudhary et al. 2018). The physical characteristics of the compost during the compost manufacturing stage are covered in almost all of the earlier literature. Not much research has been done on the physical characteristics of commercially available composts that are prepared for use. In order to assess the physio-chemical properties of three distinct composts during the application stage, the current research was conducted. Additionally, during 2020–2021, an early seedling growth assessment was conducted in all the composts containing certified mungbean seeds [*Vigna radiata* (L.) R. Wilczek] at the School of Life Sciences, Bharathiar University, Coimbatore, Tamil Nadu. The purpose of this assessment was to determine whether the composts were suitable for field application and whether they contained any phytotoxicity.

Introduction

For the research, three distinct composts with a range of feedstock compositions were used. Each compost was made using both standard (prepared under controlled circumstances using standard techniques) and local (prepared at houses without any controlled conditions for domestic use) methods. For the investigation, a total of six compost samples were used. The samples included local vermicompost (LVC), standard vermicompost (SVC), standard plant compost (SPC), local coir pith compost (LCPC), and standard coir pith compost (SCPC). Tamil Nadu Agricultural University in Coimbatore provided SVC, while the Central Coir Research Institute (CCRI) in Alappuzha, Kerala, provided SCPC. The eco-shop in the Kudumbasree neighbourhood of Alappuzha Town, Kerala, provided the remaining samples. Physical-chemical evaluation: Using a digital pH and conductivity meter (LT-23, Labtronics Instruments), the compost samples' pH and electrical conductivity (EC) were measured in a 1:10 (w/v) aqueous solution. Moisture Analyser MA35 (Sartorius AG, Germany) was used to assess the moisture content. The AOAC technique was used to determine the ash content. Following Ahn et al. (2008), the bulk density of the samples was examined. The Kjeldhal Nitrogen Analyser (Kelplus Classic-DX Vats (B), Pelican Equipments) was used to measure the proportion of nitrogen in the samples. The quantity of sodium, potassium, calcium, and lithium in the compost samples was estimated by flame photometric analysis (Labtronics, LT-671, India).

Humic substance extraction: Ramdani et al. (2015) used a modified approach to extract humic compounds from the sample. Mineral analysis: ICP-MS (Agilent-7800, US) was used to analyse the minerals in triacid digested compost samples. Germination and seedling growth performance: The research employed certified mungbean seeds that were purchased from the Tamil Nadu Agricultural University seed center. Approximately 180 g of all compost samples were obtained in seedling trays of 200 g size. 24 seeds for each treatment were used in triplicate for every sample. The crop received around 6–8 hours of sunshine throughout the growing period, and the average temperature and humidity during the study period were 28.9°C and 50.33%, respectively. Following the research period, the plants were carefully removed, and both above-ground and below-ground responses were noted. Agro-botanical characteristics were recorded, including germination %, shoot length, root length, total plant length, number of leaves, and leaf length. Additionally recorded were the fresh and dry weights of the whole plant, leaf, root, and stem.

Carotenoids and chlorophyll content: 60% acetone was used to extract the chlorophyll pigments, and Arnon's (1949) techniques were used to estimate the levels of total chlorophyll, chlorophyll a, and chlorophyll b.

Analysis of statistics: Using SPSS (version 21, SPSS Inc., Waker Drive, Chicago, USA), the data underwent a one-way analysis of variance (ANOVA), and Duncan's multiple range test ($P < 0.05$) was used to evaluate the significance of the difference between means. Means of triplicate determination $\pm$ standard deviation are used to represent values. Physico-chemical analysis: Before being used in the field, the composts must meet a number of quality requirements. A variety of characteristics varied across all the composts examined in this research (Table 1). In terms of pH (8.80 and 8.25) and EC (0.87 and 0.306), respectively, SPC and LPC performed better. The percentage of moisture by weight was lower in SPC and greater in LCPC. All of the samples showed a reduction in bulk density as the moisture content increased. All of the composts had total N contents ranging from 0.12% (SCPC) to 1.27% (SVC). Compared to fresh grass clippings and plant wastes as feedstock, compost including dried materials has been shown to have lower nitrogen concentrations. The concentration of phosphorus in the compost likewise followed a similar trend, with SVC having the highest concentration (1.9 g/kg) and SCPC having the lowest (0.06 g/kg). In contrast, the content of potassium was greater in standard coir pith compost (SCPC) than in both SVC and LVC, while it was lower in LCPC (0.015%) and higher in SPC (1.3%). The N and P concentrations seem to be somewhat greater than the minimal concentration in vermicompost when comparing the NPK contents with the Indian Fertiliser Order Control (1985). Vermicompost had greater levels of total organic carbon than coir pith composts.

Even after composting, most heavy metals are still present in the finished product, which raises serious concerns from an agricultural and environmental standpoint (Bazrafshan et al. 2016). When compared to CPCB guidelines for municipal solid waste compost, the heavy metals found in the samples (Table 2) were all within allowable levels. Although they were under CPCB standards, nickel, aluminium, and iron were noticeably higher than other heavy metals. The amounts of fulvic acid and humic acid were lower in LCPC (0.05 g/kg, 0.27 g/kg) and greater in SPC (0.39 g/kg, 0.589 g/kg). There is a real increase in the amount of organic matter in the soil, and the humic compounds created during the composting process aid in the development of soil fertility.

Agrobotanical characteristics: Every plant exhibited growth, with the exception of SPC. In comparison to the other five composts, the average overall length of the plant was greater in SVC (28.5 ± 1.7 cm), while the average root length was much higher in LCPC (30.5 ± 5.5 cm). This may be attributed to the compost's lower bulk density, which gives more room for root development. Therefore, in horticulture and other agricultural operations, coir pith might be used as an environmentally acceptable, soilless platform for plant development (Machado et al. 2021). Plants planted in SVC exhibited generally greater growth and healthier plants when all above-ground and below-ground responses were evaluated, whereas plants cultivated in LVC and LCPC showed less growth than plants grown in other composts. Table 3 lists every plant growth metric that was noted. Germination percentage: With the exception of 12 seedlings from compost LPC that perished before harvest, all of the germinated seeds grew until the day of harvest. The highest

Table 1 Physio-chemical parameters of compost samples

Parameter	LPC	SPC	LCPC	SCPC	LVC	SVC
pH	8.25 ^b $\pm$ 0.035	8.80 ^a $\pm$ 0.04	7.68 ^e $\pm$ 0.03	7.79 ^d $\pm$ 0.02	7.87 ^c $\pm$ 0.02	7.83 ^{cd} $\pm$ 0.04
Conductivity (mS)	0.306 ^b $\pm$ 0.002	0.87 ^a $\pm$ 0.0057	0.05 ^f $\pm$ 0.0057	0.203 ^c $\pm$ 0.003	0.195 ^d $\pm$ 0.003	0.096 ^e $\pm$ 0.0017
Moisture content (%)	59.84 ^c $\pm$ 0.03	25.53 ^f $\pm$ 0.49	89.2 ^a $\pm$ 0.2	84.07 ^b $\pm$ 0.1	55.03 ^d $\pm$ 0.65	40.9 ^e $\pm$ 0.24
Ash content (%)	45.36 ^c $\pm$ 0.30	49.1 ^b $\pm$ 0.2	6.56 ^e $\pm$ 0.057	4.06 ^f $\pm$ 0.20	40.05 ^d $\pm$ 0.35	55.13 ^a $\pm$ 0.37
Bulk density (kg/m ³)	8.62 $\times 10^{-4}$	7.76 $\times 10^{-4}$	1.21 $\times 10^{-3}$	4.74 $\times 10^{-4}$	7.94 $\times 10^{-4}$	8.15 $\times 10^{-4}$
TOC (%)	54.6 ^d $\pm$ 0.30	59.7 ^c $\pm$ 0.47	50.9 ^e $\pm$ 0.2	44.86 ^f $\pm$ 0.37	93.4 ^b $\pm$ 0.05	96 ^a $\pm$ 0.20
Nitrogen (%)	0.55 ^d $\pm$ 0.015	1.15 ^b $\pm$ 0.015	0.16 ^e $\pm$ 0.002	0.12 ^f $\pm$ 0.002	0.67 ^c $\pm$ 0.015	1.27 ^a $\pm$ 0.015
Phosphorous (g/kg)	0.33 ^d $\pm$ 0.02	0.38 ^c $\pm$ 0.035	0.07 ^e $\pm$ 0.015	0.066 ^e $\pm$ 0.011	1.53 ^b $\pm$ 0.02	1.9 ^a $\pm$ 0.02
Potassium (%)	0.19 ^c $\pm$ 0.0015	1.3 ^a $\pm$ 0.2	0.015 ^d $\pm$ 0.0015	0.39 ^b $\pm$ 0.001	0.20 ^c $\pm$ 0.002	0.017 ^d $\pm$ 0.002
Sodium (%)	0.211 ^b $\pm$ 0.001	0.73 ^a $\pm$ 0.001	0.07 ^d $\pm$ 0.002	0.22 ^b $\pm$ 0.02	0.16 ^c $\pm$ 0.002	0.04 ^e $\pm$ 0.001
Calcium (%)	0.06 ^f $\pm$ 0.001	0.213 ^a $\pm$ 0.002	0.07 ^e $\pm$ 0.002	0.09 ^d $\pm$ 0.002	0.17 ^b $\pm$ 0.001	0.11 ^c $\pm$ 0.001
Humic acid (g/kg)	0.225 ^b $\pm$ 0.0012	0.39 ^a $\pm$ 0.0006	0.055 ^e $\pm$ 0.0006	0.057 ^e $\pm$ 0.0006	0.18 ^c $\pm$ 0.0006	0.15 ^d $\pm$ 0.005
Fulvic acid (g/kg)	0.5 ^b $\pm$ 0.0005	0.589 ^a $\pm$ 0.0005	0.277 ^f $\pm$ 0.0005	0.315 ^e $\pm$ 0.001	0.436 ^c $\pm$ 0.0005	0.416 ^d $\pm$ 0.006
Lithium (%)	0.003 ^b $\pm$ 0.002	0.005 ^a $\pm$ 0.001	BDL*	0.001 ^b $\pm$ 0.0005	0.002 ^b $\pm$ 0.001	BDL*

Values of triplicate determinations (mean $\pm$ SD; n=3) in same column with different letters are significantly different ($P < 0.05$); *BDL, Below detectable level. LPC, Local plant compost; SPC, Standard plant compost; LVC, Local vermicompost; SVC, Standard vermicompost; LCPC, Local coir pith compost; SCPC, Standard coir pith compost.

Table 2 Micro-macro nutrients and heavy metals content of compost samples

Elements (mg/100 g)	SPC	LPC	SCPC	LCPC	SVC	LVC	Concentration not to exceed in mg/kg (CPCB 2006)
Be	0.0006	0.0006	0.0006	0.0006	0.0004	0.0005	
Mg	0.922	1.0545	1.015	0.3205	0.5987	0.9062	
Al	5.2375	5.3075	5.455	6.375	5.5475	5.515	
Ti	0.6915	0.6807	0.6482	0.7887	0.755	0.7552	
V	0.2082	0.1784	0.1826	0.2076	0.2090	0.2052	
Cr	0.8537	0.8475	0.8387	0.8702	0.8607	0.8642	50.00
Mn	0.1380	0.2274	0.2389	0.271	0.2434	0.2527	
Fe	8.765	8.9025	9.88	13.132	10.972	11.235	
Co	0.0116	0.0119	0.0144	0.0170	0.0141	0.0147	
Ni	11.895	11.537	10.135	5.1875	9.865	8.895	50.00
Cu	0.0649	0.1299	0.1786	0.2997	0.2364	0.2363	300.00
Zn	0.3615	0.0819	0.0024	0.3592	0.507	0.4347	1000.00
As	0.5947	0.6005	0.605	0.613	0.604	0.6045	10.00
Se	0.0750	0.0608	0.0467	0.0603	0.0689	0.0649	
Sr	0.0346	0.0507	0.0354	0.0324	0.0037	0.0105	
Mo	0.0163	0.0022	0.0080	0.0173	0.0179	0.0169	
Ag	0.0033	0.0022	0.00007	0.0035	0.0038	0.0036	
Cd	0.0048	0.0039	0.0040	0.0040	0.0055	0.0046	5.00
Sn	0.0149	0.0022	0.0014	0.0136	0.0135	0.0134	
Sb	0.0226	0.0125	0.0123	0.0196	0.0209	0.0216	
Ba	0.0149	0.0680	0.0811	0.0229	0.0071	0.0224	
Tl	0.0003	0.0006	0.0016	0	0.00005	0.0003	
Pb	0.0247	0.0247	0.0184	0.0313	0.0399	0.0256	100.00

LPC, Local plant compost; SPC, Standard plant compost; LVC, Local vermicompost; SVC, Standard vermicompost; LCPC, Local coir pith compost; SCPC Standard coir pith compost.

In contrast, all other composts had low germination percentages, including LVC (18%), SVC (11.1%), LPC (6.9%), and SPC with no germination at all. The highest germination rate was found in LCPC (94.4%), followed by SCPC (56.9%), demonstrating its non-toxicity. When compared to the other compost, the higher pH, conductivity, and nutritional qualities of LPC and SPC may be the cause of the lower germination in LPC and zero germination in SPC. Additionally, germination percentages may be lower in immature composts (Jagadabhi et al. 2019). Only two of the six composts utilised in this study—LPC and SPC—showed less or no, which cannot be applied to all seeds or plants. In the same compost, some seedlings with more resistance potential could sprout. due to the fact that various plant species have varying tolerances and preferences for biochemical traits.

Pigments in leaves

Chlorophyll and carotenoids: Fig. 1 shows the measured values for the harvested plants' leaf pigments. LCPC had the lowest amount of chlorophyll (8.11 ± 0.08), as well as differences in the physiochemical properties and germination of leaf pigments that are only derived from fresh plant leftovers. As a result, there is a good chance that this compost will include allelopathic crops, which might alter its properties and negatively impact plant development. The mungbean that germinates less or not at all

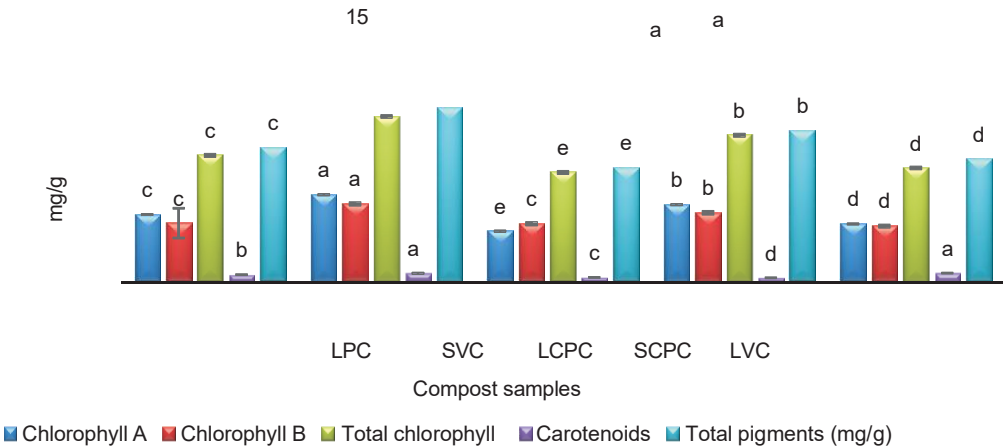


Fig. 1 Effect of biocompost on leaf pigments. LPC, Local plant compost; SPC, Standard plant compost; LVC, Local vermicompost; SVC, Standard vermicompost; LCPC, Local coir pith compost; SCPC, Standard coir pith compost.

Table 3 Effect of biocompost on plant growth parameters

Growth parameter	LPC	SVC	LCPC	SCPC	LVC
Total length (cm)	22.4 ^{ab} ±6.47	27.06 ^a ±1.76	15.2 ^c ±2.30	20.23 ^{bc} ±1.35	16.46 ^{bc} ±2.69
Root length (cm)	9.9 ^b ±3.915	16.4 ^b ±12.057	30.5 ^a ±5.51	16.06 ^b ±5.60	9.46 ^b ±3.06
Leaf length (cm)	6.2 ^{ab} ±3.48	9.55 ^a ±1.68	3.13 ^b ±1.79	7.8 ^a ±0.519	6.4 ^{ab} ±1.47
Shoot length (cm)	16.2 ^a ±2.98	16.9 ^a ±2.61	12.1 ^b ±0.79	12.4 ^b ± 1.43	10.6 ^b ±1.70
No. of leaves	3.66 ^b ±1.52	4 ^a ±0	3 ^b ±0.577	4 ^a ±0	3 ^b ±0.577
Germination (%)	6.9	11.1	94.4	56.9	18
Total plant fresh weight (g)	1.1 ^{ab} ±0.54	1.1 ^{ab} ±0.38	0.41 ^c ±0.08	1.47 ^a ±0.15	0.8 ^{bc} ±0.18
Total plant dry weight (g)	0.2 ^{ab} ±0.08	0.22 ^a ±0.08	0.1 ^b ±0.01	0.23 ^a ±0.01	0.15 ^{ab} ±0.02
Leaf fresh weight (g)	0.79 ^c ±0.008	1.7 ^a ±0.006	0.2 ^d ±0.004	0.9 ^b ±0.002	0.23 ^d ±0.01
Leaf dry weight (g)	0.16 ^b ±0.03	0.25 ^a ±0.01	0.04 ^c ±0.009	0.05 ^c ±0.005	0.06 ^c ±0.007
Root fresh weight (g)	0.07 ^c ±0.0006	0.09 ^b ±0.0008	0.2 ^a ±0.0009	0.07 ^c ±0.001	0.02 ^d ±0.001
Root dry weight (g)	0.03 ^b ±0.003	0.05 ^a ±0.006	0.02 ^{bc} ±0.006	0.02 ^b ±0.005	0.01 ^c ±0.006
Stem fresh weight (g)	0.38 ^b ±0.015	0.6 ^a ± 0.006	0.12 ^d ±0.007	0.32 ^c ± 0.002	0.08 ^c ±0.0004
Stem dry weight (g)	0.05 ^c ±0.003	0.09 ^a ±0.004	0.01 ^d ±0.003	0.06 ^b ±0.002	0.01 ^d ±0.002

Values of triplicate determinations (mean ± SD; n=3) in same column with different letters are significantly different (*P*<0.05).

LPC, Local plant compost; SPC, Standard plant compost; LVC, Local vermicompost; SVC, Standard vermicompost; LCPC, Local coir pith compost; SCPC, Standard coir pith compost.

SVC had the greatest (12.25±0.07). When compared to other organic compost treatments, SVC was shown to have a considerably (*P*<0.05) greater value of total chlorophyll due to increased plant length, leaf count, and total biomass. Analysis of the leaves' carotenoid content revealed that LVC had the greatest carotenoid content (0.676±0.004) and SCPC had the lowest (0.324±0.003).

SUMMARY

We can employ compost in agricultural techniques more effectively if we have a deeper grasp of its physical and biological characteristics. In addition to its positive effects on soil fertility and plant development, immature or unstable compost may also be detrimental to soil microbes, plants, and soil. Therefore, before utilising compost for any kind of agricultural activity that would result in ecologically safe and sustainable farming methods, its quality must be evaluated. Compost was not employed as fertiliser in the current research, but rather as a medium for seed germination. Therefore, more research is needed to understand the development of various crops, their yield, and the part these various composts play in it. Since one of our experiments showed no germination, using the composts in varying ratios with soil may potentially provide various outcomes. Nonetheless, these nutrient-enriched compost materials may be suitably diluted with a blend of other organic composts or soil, and further application can provide sufficient nutrient sources for crop yield under field circumstances.

Additionally, this might lessen the buildup of biodegradable garbage in urban and semi-urban areas.

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