



Impact of different organic compost on seed germination and seedling growth performance of mungbean (*Vigna radiata*)

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The implementation of an environment friendly management strategy for solid waste is recognized as an urgent need worldwide, whereas reuse and recycling of these wastes through compost preparation are categorised as the most preferable approaches in integrated solid waste management systems under the clean India programme and smart city programme (Sayara *et al.* 2020). To improve soil aggregation, restore soil organic carbon and nitrogen, and increase agricultural sustainability, compost application is being advocated as a substitute for synthetic fertilizers (Choudhary *et al.* 2018). Almost all the previous literature provides information regarding the physical properties of the compost during the compost production stage. The physical properties of commercially available composts, ready for application are not much studied. Hence the present study was carried out to evaluate the physico-chemical characteristics of three different composts at its application stage. Also, an early seedling growth assessment was undertaken in all the composts with certified seeds of mungbean [*Vigna radiata* (L.) R. Wilczek] during 2020–21 at School of Life Sciences, Bharathiar University, Coimbatore, Tamil Nadu to evaluate the quality of these composts to check whether they possess any phytotoxicity and their suitability for field application.

Three different composts of diverse feedstock compositions were selected for the study, in which, each compost was of the local (prepared at households without any controlled conditions for domestic use) and standard preparation (prepared under controlled conditions with standard procedures). Thus, a total of six compost samples were used for the study. The samples were local plant compost (LPC); standard plant compost (SPC); local vermicompost (LVC); standard vermicompost (SVC); local

coir pith compost (LCPC) and standard coir pith compost (SCPC). SVC and SCPC were procured from Tamil Nadu Agricultural University, Coimbatore and Central Coir Research Institute (CCRI), Alappuzha, Kerala respectively. All other samples were collected from an eco-shop of the Kudumbasree unit of Alappuzha Town, Kerala.

Physico-chemical analysis: The pH and electrical conductivity (EC) of the compost samples were determined using their 1:10 (w/v) aqueous suspension using digital pH, conductivity meter (LT-23, Labtronics Instruments). Moisture content was analysed using Moisture Analyser MA35 (Sartorius AG, Germany). Ash content was determined using AOAC method. The bulk density of the samples was analysed by following Ahn *et al.* (2008). Nitrogen percentages in the samples was quantified using Kjeldhal Nitrogen Analyser (Kjelplus Classic-DX Vats (B), Pelican Equipments). Flame photometric analysis (Labtronics, LT-671, India) was carried out to estimate the amount of sodium, potassium, calcium and lithium in the compost samples.

Extraction of humic substances: Extraction of humic substances from the sample was done by a modified method by Ramdani *et al.* (2015).

Mineral analysis: Mineral analysis of triacid digested compost samples was done through ICP-MS (Agilent-7800, US).

Germination and seedling growth performance: Certified seeds of mungbean procured from the Tamil Nadu Agricultural University seed centre were used for the study. Approximately 180 g of all compost samples were taken in seedling trays of 200 g capacity. For each sample, triplicates were run with 24 seeds for each treatment. The average temperature and humidity during the study period were 28.9°C and 50.33% respectively and the crop intercepted nearly 6–8 h of sunlight during the growth period. The plants were carefully uprooted after the study period and the above-ground and below-ground responses were recorded. Agro-botanical characters, viz. germination percentage, shoot length, root length, total plant length,

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number of leaves, and leaf length were recorded. The fresh weight as well as dry weight of total plant, leaf, root and stem were also noted.

Chlorophyll content and carotenoids: The Chlorophyll pigments were extracted with 60% acetone and the contents of chlorophyll a, chlorophyll b and total chlorophyll were estimated following the methods of Arnon (1949).

Statistical analysis: The data were subjected to a one-way analysis of variance (ANOVA), and the significance of difference between means was determined by Duncan's multiple range test ($P < 0.05$) using SPSS (version 21, SPSS Inc., Waker drive Chicago, USA). Values expressed are means of triplicate determination $\pm$ standard deviation.

Physico-chemical analysis: The composts to be used in soil or field should satisfy several quality demands, which should be confirmed before field applications. All the composts analysed in this study differed in a range of properties (Table 1). SPC and LPC showed superior results in pH (8.80 and 8.25) and EC (0.87 and 0.306) respectively. Moisture percent by weight was higher in LCPC and least in SPC. With an increase in moisture content, a decrease in bulk density was observed in all the samples. The total N content of all the composts ranged from 0.12% (SCPC) to 1.27% (SVC). Compost with dried materials has shown lower nitrogen contents than fresh grass clippings and plant residues as feedstock. Phosphorous content also showed a similar pattern of concentration in the compost i.e. higher in SVC (1.9 g/kg) and least in SCPC (0.06 g/kg). Whereas potassium concentration was higher in SPC (1.3%) and lowest in LCPC (0.015%) but higher in standard coir pith compost (SCPC) than both SVC and LVC. While comparing the NPK contents with the Indian Fertilizer order control (1985), the N and P concentrations seem to be slightly higher than the minimum concentration in vermicompost. The total

organic carbon was higher observed in vermicompost and lower values in coir pith composts.

The majority of the heavy metals tend to remain in the final product even after composting, which becomes a significant concern from both environmental and agricultural perspectives (Bazrafshan *et al.* 2016). The heavy metals present in the samples (Table 2) were compared with CPCB standards for municipal solid waste compost which were all under the permissible limits only. Nickel, Aluminium and Iron were exceptionally higher than other heavy metals, but within the limits of CPCB. Humic and fulvic acid contents were at higher concentrations in SPC (0.39 g/kg, 0.589 g/kg) and lower in LCPC (0.05 g/kg, 0.27 g/kg) respectively. The humic substances formed during the composting process promote the building of soil fertility, and there is an actual increase in organic matter content in the soil.

Agrobotanical characters: All the plants showed growth except in SPC. The average total length of the plant was observed higher in SVC (28.5 ± 1.7 cm) whereas the average root length was exceptionally higher in LCPC (30.5 ± 5.5 cm) compared to other 5 composts which is relatable to the lower bulk density of the same hence providing more space for root growth. Hence, coir pith could be used as an eco-friendly and soilless substrate for plant growth in horticulture and other agricultural practices (Machado *et al.* 2021). While comparing all the above and below-ground responses recorded, plants grown in SVC showed an overall better growth and healthy plants whereas in LVC and LCPC growth was less compared to plants grown in other composts. All the plant growth parameters observed are given in Table 3.

Germination percentage: All the germinated seeds showed growth till the day of harvest except 12 seedlings from compost LPC which died before 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.

germination percentage was observed in LCPC (94.4%) followed by SCPC (56.9%) indicating its non-toxicity, whereas comparatively, all the other compost had low germination percentages such as LVC (18%), SVC (11.1%), LPC (6.9%) and SPC with no germination at all. The less germination in LPC and zero germination in SPC may be due to elevated pH, conductivity and nutritional values of the same when compared with the other compost. Immature composts may also show fewer germination percentages (Jagadabhi *et al.* 2019). Among the six composts used in this study, LPC and SPC only showed less/and or no germination and variations in the physiochemical characteristics which are purely made from fresh plant residues. Therefore, there is a considerable scope that allelopathic crops may be included while preparing this compost, which could change its characteristics and have an adverse effect on plant growth. The less germination/ no germination of mungbean

cannot be generalised to all seeds/plants. Some other seeds, which have more resistance potential may germinate in the same compost. Because different plant species have different preferences and tolerance levels for biochemical characteristics.

Leaf pigments

Chlorophyll and carotenoids: The observed values for leaf pigments of the harvested plants are given in Fig. 1. The least chlorophyll content was found in LCPC (8.11 ± 0.08) and

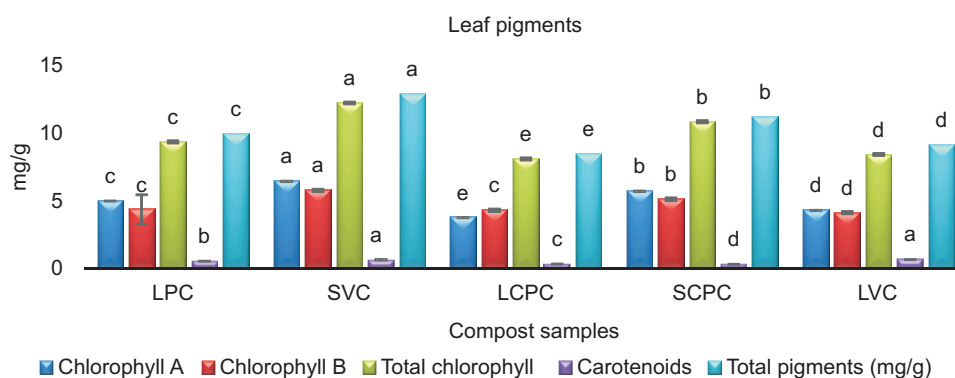


Fig. 1 Effect of biocompost on leaf pigments. LPC, Local plant compost; SPC, Standard plant compost; LVC, Local vermicompost; SVC, Standard vermicompost; LCPC, Local coir pith compost; SCPC, Standard coir pith compost.

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.

the highest was found in SVC (12.25±0.07). The total plant length, number of leaves and total biomass were also found to be higher in SVC which corresponds to a significantly ($P < 0.05$) higher value of total chlorophyll when compared to other organic compost treatments. The carotenoid content of the leaves was analyzed and the least carotenoid content was observed in SCPC (0.324±0.003) and the highest was observed in LVC (0.676±0.004).

SUMMARY

A better understanding of the physical and biological properties of compost enables us to use the compost wisely in agricultural practices. Besides the bright side of compost on plant growth and soil fertility, immature or unstable compost may be harmful to plants, soil, and soil microorganisms too. Therefore, quality assessment of compost is essential before using it for any type of agricultural activities which will lead to environmentally safe and sustainable farming practices. In the present study, compost was used as a substrate for seed germination and not as a fertilizer. So, more investigations must be done in the future to interpret the growth of different crops, their yield and the role of these different composts in it. Using the composts by mixing with soil in different ratios may also give different results, as one of our treatments didn't show any germination. However, such nutrient-enriched compost materials can appropriately be diluted with a mixture of other organic composts or soil, and further application may provide adequate nutrient sources for crop productivity in the field conditions. This may also reduce the biodegradable waste accumulation in urban and semi-urban vicinity.

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