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Soil fertility changes with leaf litter compost application in vegetable cowpea

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Abstract

The experiment to assess the effects of litter compost application as nutrient source in cowpea revealed the improvement in the soil properties from the initial status with compost application and cowpea cultivation. Significant variations with the treatments were recorded for available P and K only. However, soil N status was improved considerably and acidity was lowered by nearly 18 to 28 per cent with compost application. Soil microbial counts were also higher indicating the proliferation and growth of soil micro organisms with the organic manure addition. Significant variations were recorded with the maximum count were in glyricidia + vermicomposted mango leaf litters. The study brings to light the favourable effects of composted leaf litters on soil fertility and suitability for enhanced microbial activity with its application in vegetable cowpea.

Key words: litter compost, proliferation, microbial, vegetable cowpea

Introduction

The declining productivity of soil due to indiscriminate chemical fertilizer usage, imbalances of nutrients and deterioration of soil physical properties have created drawbacks in the crop production scenario. Attempts to revive the fertility status have led to the promotion of organic farming practices in the country. However, this has been greatly hampered by the non availability of quality nutrient inputs in adequate amounts to meet the crop requirements. Purchase of organic nutrient inputs add to the cost of cultivation (Sheela*et al*., 2010) and this necessitates development of suitable technologies for *insitu* production of the inputs. Recycling of organic wastes by composting has been widely proclaimed as suitable technology for on farm waste management and production of quality manures (Zucconi*et al*., 1981, Inckel*et al*., 1996). Leaf litter is an important biowaste in tree based ecosystems. Composting of leaf litters have been studied by several authors (Vasanthi *et al*., 2013, Alok and Tripathi, 2010, Karmegam*et al*., 2012) and nutrient release from leaf litters has been established (Jamaludeen and Kumar, 1999; Isaac and Nair,2006). This paper attempts to assess the effect of litter compost application on the soil properties under field conditions.

Materials and methods

The experiment was conducted in the Instructional Farm, College of Agriculture Vellayani, Thiruvananthapuram Kerala during December 2018 to March 2019 with vegetable cowpea as test crop. The soil was sandy clay loam in texture, strongly acidic, medium in organic carbon, low in nitrogen, high in available P and medium in available K. The microbial counts were 17 x 10^6cfu g^{-1} in bacteria, 11 x 10^4cfu g^{-1}in fungi and 20 x 10^4cfu g^{-1}in actinomycetes. Seeds of cowpea variety Bhagyalakshmi were sown in plots of 3.0m x 1.5 m at a spacing of 30 cm x 15 cm. Litter composts of mango and cashew leaves prepared by different composting methods (Table 1) and enriched with biofertilizer consortium, plant growth promoting rhizobacteria (PGPR Mix I) along with control, Kerala Agricultural University package of practices recommendation and absolute control (no fertilizer) formed the treatments of the experiment. Enrichment was done with PGPR that contained N fixers (*Azospirillum lipoferum, Azotobacter chroococcum),* P solubilizer (*Bacillus megaterium*) and K solubilizer (*Bacillus sporothermodurans*) @20g kg^{-1} and rock phosphate @150g kg^{-1} and kept for 10 days. The chemical properties of the different composts are given in Table 2. The enriched composts were used as nitrogen sources at 50 per cent

Table 1: Treatment details

Treatment	Details
T_1	Cashew leaf litter co-composted withpoultry manure @ 10% w/w
T_2	Cashew leaf littercomposted with compost inoculum+ vermicomposting
T_3	Cashew leaf litter co-composted with glyricidia leaves in 1:1 + vermicomposting
T_4	Naturally decomposed cashew litter compost
T_5	Mango leaf litter co-composted withpoultry manure @ 10% w/w
T_6	Mango leaf littercomposted with compost inoculum+ vermi composting
T_7	Mango leaf litter co-composted with glyricidia leaves in 1:1 + vermicomposting
T_8	Naturally decomposed mango litter compost
T_9	Control (KAU POP)
T_{10}	Absolute control (No fertilizers)

(T_1 to T_8- composts were enriched with bio fertilizer and rock phosphate)

substitution of the POP recommendation,20 kg N ha^{-1}(KAU, 2016). Farm yard manure was applied @ 20t ha^{-1}in all treatments. P and K (30 and 10 kg ha^{-1} respectively) were given through the chemical sources. In the control treatment, entire dose of N, P and K were given through chemical fertilizers. All cultural operations were carried out as per the package recommendations. The crop was ready for harvest in one and half months.

After harvest, soil samples were collected from each plot, shade dried, sieved and oven dried at 105^{0}C for nutrient analysis. Standard procedures were adopted for chemical analysis. The biological propertieswere assessed in freshly collected soil samples by serial dilution and plate count method. The data were subjected to statistical analysis and critical differences were computed where ever the variations were found to be significant.

Results and Discussion

The data on the chemical analyses of litter compost after enrichment are presented in Table 2. Perusal of the data revealed significant differences in the N and lignin content in the litter composts after enrichment. NPK contents were highest in the compost prepared by co-composting with glyricidia leaves followed by vermicomposting (T_7). Lignin content was also the lowest indicating its suitability as organic manure. The inclusion of N rich glyricidia leaves coupled with the benefits of vermicomposting would have contributed to the comparatively better chemical properties of the compost in $T_{7.}$

The changes in soil properties with litter compost application and cropping are presented in Table 3a and b. Perusal of the data revealed improvement in soil fertility parameters with compost application. The initial pH of the soil was strongly acidic and the acidity was found to be lowered and as no significant variations were recorded among the treatments, the decline may be attributed to the lime applied (600 kg ha^{-1}) based on the soil test data.

Soil available N status were also not significantly different although there was a two fold increase from the initial status. Legumes, plants belonging to the family Fabaceae have the unique property of N fixation (Zahran, 1999) and significant increases in the soil N status after a legume crops is well documented (Ghosh *et al.,*2007). The increase in the available N status in all treatments can be ascribed to the N fixing ability of cowpea, although raised as a vegetable.

The available P and K status varied significantly among the treatments. The treatment in which mango litter composted with glyricidia + earthworms was applied recorded the highest available P content (63.84 kg ha^{-1}) and was on par with T_2, T_6 and T_8. Lowest P content (45.36 kg ha^{-1}) was recorded for the treatment T_{10} (absolute control). The initial soil P status was recorded as highand hence it is inferred that additions through nutrient sources added to the P status in soil. Significant variations recorded may be attributed to the differences in the quantum of organic acids, chelates, enzymes and P solubilzingmicro organisms in the enriched compost that was added. The values were high for naturally composted litter too. Uehara and Gilman (1981) reported the importance of organic matter in reducing P fixation and increasing availability of P in soils. Similar reports on significant effects of municipal solid waste compost application along with P solubilizer and rock phosphate as in the enriched

Table 2: Chemical properties of enriched litter compost

Treatments	N %	P %	K %	C: N ratio	Lignin %
T_1	2.05	1.55	0.65	14.6	14.9
T_2	1.59	1.61	0.53	15.7	13.2
T_3	1.96	1.88	0.59	18.5	16.5
T_4	1.12	1.59	0.47	20.3	27.5
T_5	2.33	1.74	0.65	11.1	13.1
T_6	2.15	1.68	0.62	12.8	10.9
T_7	2.43	2.02	0.67	15.5	11.6
T_8	1.31	1.67	0.51	18.9	17.7
SEm (±)	0.17	0.114	0.05	2.0	1.4
CD(0.05)	0.518	-	-	-	4.08

Table 3a: Effect of enriched litter compost on chemical properties of soil

Treatments	pH	EC (dS m^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1 (PM composted cashew)	5.47	0.17	196.52	46.41	219.59
T_2 (CI + EW composted cashew)	5.53	0.17	213.25	59.92	216.42
T_3 (Glyricidia + EW composted cashew)	5.62	0.14	179.80	49.09	170.09
T_4 (Naturally decomposed cashew)	5.32	0.12	196.52	53.54	172.52
T_5 (PM composted mango)	5.54	0.13	196.52	47.30	153.18
T_6 (CI + EW composted mango)	5.76	0.14	209.07	60.14	180.10
T_7 (Glyricidia + EW composted mango)	5.65	0.16	196.52	63.84	246.66
T_8 (Naturally decomposed mango)	5.69	0.17	204.89	62.87	198.54
T_9 (Control)	5.49	0.14	192.34	54.77	166.06
T_{10} (Absolute control)	5.24	0.16	146.35	45.36	138.06
SE m(±)	0.18	0.01	16.37	2.39	14.38
CD (0.05)	-	-	-	7.161	46.065

Table 3b: Effect of enriched litter compost on total microbial count of soil after experiment

Treatments	Total microbial count (cfu g^{-1})		
	Bacteria (x 10^6)	Fungi (x 10^4)	Actinomycetes (x 10^4)
T_1 (PM composted cashew)	52.66	21.00	33.00
T_2 (CI + EW composted cashew)	39.33	15.66	24.66
T_3 (Glyricidia + EW composted cashew)	45.33	14.33	25.66
T_4 (Naturally decomposed cashew)	34.00	11.33	22.00
T_5 (PM composted mango)	48.00	22.66	31.33
T_6 (CI + EW composted mango)	53.33	20.00	26.66
T_7 (Glyricidia + EW composted mango)	57.33	17.33	30.66
T_8 (Naturally decomposed mango)	47.33	13.33	22.66
T_9 (Control)	39.66	16.66	25.00
T_{10} (Absolute control)	30.66	13.00	20.00
SE m(±)	2.56	1.42	2.33
CD (0.05)	7.684	4.258	7.00

compost was reported by Jamil *et al.* (2018).

Soil K content (246.66 kg ha^{-1}) was also significantly highest with application of mango litter compost (glyricidia + earthworms) recorded. The bacterial population was significantly highest in the enriched compost prepared by co- composting with glyricidia leaves which would have contributed to the increased availability in soil.

Variations in the total microbial count due to application of enriched compost as nutrient source are depicted in the Table 3b.Increased counts with the treatments and cowpea cultivation may be ascribed to the addition of composts and/ FYM. Further, the organic exudates from the legume roots would have rejuvenated the microbial population. However, the effects were more prominent in treatments with litter compost application as these serve as energy sources for the microbes. The differences in the population could also be ascribed to the variations in the compost quality, microbial counts in composts added and the soil properties that favoured its multiplication. Co-composting was found to contribute significantly to the microbial population and the increased nutrient status also bears testimony to the increased microbial activities. In general, as expected the significantly lowest counts were observed in the treatment which did not receive any nutrient addition, control. Improvement in soil nutrient status and microbial population with litter compost has been elucidated in amaranthus by Harishma (2017).

Inclusion of enriched litter compost in vegetable cowpea cultivation significantly improved the soil fertility status. The available nutrient status and microbial counts were comparatively higher in the compost applied treatments and this gives an indication of the suitability of the recycled biowaste in crop production. Leaf litter, that are otherwise considered as wastes interfering with the hygiene and aesthetic value in urban life, may be recycled by composting and used as manure in agriculture.

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