J. Soils and Crops 30 (1) 63-68, June 2020

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)
NAAS Rating - 4.46
Scientific Journal Impact Factor - 7.375

EFFICACY OF ENRICHED LEAF LITTER COMPOST AS NUTRIENT SOURCE IN VEGETABLE COWPEA (*Vigna unguiculata* sub sp. *unguiculata*)

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ABSTRACT

Composting of leaf litters and effect of the enriched litter compost in vegetable cowpea were assessed in a field experiment at College of Agriculture,Vellayani during December 2018 to March 2019 in randomized block design with three replications.Mango litter compost recorded higher nutrient contents with enrichment than that in cashew litter composts, irrespective of the method of composting. The results of the field experiment revealed the better yield attributes and highest vegetable pod yields(7.82 t ha^{-1})in the treatment involving mango leaf litter composted with glyricidia leaves and earthworms, nearly 9.85 per cent greater than the Kerala Agricultural University package of practices recommendation for cowpea. Available soil nutrient status (NPK) showed improvements from the initial status with compost application and cowpea cultivation and significant variations were recorded in available P and K status.Based on the results, it can be concluded that composting converts leaf litter to valuable organic manures and the enriched composts are suitable nutrient inputs for the cultivation of vegetable cowpea.

(Key words: Compost, enrichment, glyricidia, leaf litters, vermicompost, yield)

INTRODUCTION

Modern and intensive agricultural practices have warranted the food production of the country. But the indiscriminate use of chemical fertilizers has led to the creation of nutrient imbalances, contamination and deterioration of soil physical properties that has adverse effects, both from human health and environmental point of view. It is interpreted that inclusion of organic manures in the nutrient management practices will help to counter the ill effects of sole chemical usage in farming. However, the non availability of quality nutrient inputs in adequate amounts has necessitated the development of technologies for *insitu* production of these inputs. Recycling the biowastes that are available in the different cropping systems is a viable technology for on farm waste management and production of quality manures (Thomas *et al*., 2012; Chaudhari *et al*., 2013).

Trees are integral components of many farming systems. The continuous litter fall from trees add substantial amounts of biowastes to the system which can be effectively utilized through composting (Prabhu *et al*.,1998, Gajalekshmi *et al*.,2005; Sannigrahi, 2009). Nutrient release from leaf litters has been established (Jamaludeen and Kumar, 1999; Isaac and Nair,2005) implying the possibility of using the litter as nutrient sources in agriculture. The present study explores the efficacy of leaf litter compost as nitrogen source in vegetable cowpea cultivation and the effects on soil chemical properties.

MATERIALS AND METHODS

The experiment was conducted in the Instructional Farm, College of Agriculture Vellayani, Thiruvananthapuram, Kerala during December 2018 to March 2019, located 8°30'N latitude, 76°54' E longitude at an altitude of 29 m above mean sea level. 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 vegetable variety of cowpea, Bhagyalakshmy released from Kerala Agricultural University (KAU) was used for the study. Seeds were sown in plots of 3.0 m x 1.5 m at a spacing 30 cm x 15 cm. Litter composts of mango and cashew leaves prepared by different composting methods as listed in table 1 and were enriched with biofertilizer consortium, plant growth promoting rhizobacteria (PGPR Mix I- containing N fixers, *Azospirillum lipoferum, Azotobacter chroococcum,* P

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solubilizer, *Bacillus megaterium* and K solubilizer, *Bacillus sporothermodurans.* Enrichment was done by mixing the compost with PGPR @ 20 g kg^{-1} and rock phosphate @ 150g kg^{-1}. The enriched composts(T_1 to T_8) along with control, (package of practices recommendations of KAU)- T_9 and absolute control (no fertilizer) – T_{10} formed the treatments of the experiment. The NPK contents in the different enriched composts are detailed in table 2.

The enriched composts were used as nitrogen sources at 50 per cent substitution of the POP recommendation (20 kg N ha^{-1}) *i.e.*, 10 kg N ha^{-1} and the remaining 10 kg N through urea. Farm yard manure was applied @ 20 t ha^{-1} in all treatments, P and K (30 and 10 kg ha^{-1} respectively) through the chemical sources, rajphos and muriate of potash. 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 of KAU. The crop was ready for harvest in two and half months and the plotwise yields were recorded and expressed in t ha^{-1}.

Five plants were selected randomly and tagged as observation plants in the net plot area of each plot. Observations were recorded from these observation plants and the mean values were worked out. The number of pods $plant^{-1}$ was calculated by summing the number of pods harvested from each observation plant during each picking. Average length and weight of pods were determined by measuring the length and weight of twenty pods that were randomly selected from the pods harvested. The pod yield $plant^{-1}$ was calculated by taking the weight of pods harvested from the observation plants and average computed.The weight of pods harvested from the net plot area in each plot were recorded and used to compute the pod yield ha^{-1}. After harvest, soil samples were collected from each plot,shade dried, sieved and oven dried at 105°C for nutrient analysis. Standard procedures were adopted for chemical analysis. Available N status in soil was estimated by alkaline permanganate method (Subbaih and Asija, 1956), P by Bray No.1 extraction and spectrophotometry (Jackson, 1973), K by neutral normal ammonium acetate extraction and flame photometry (Jackson, 1973) and organic carbon by wet digestion method (Walkley and Black, 1934). Soil samples taken from different treatments were mixed with water in the ratio 1: 2.5 and pH and EC were measured using pH meter with glass electrode and conductimetry methods (Jackson, 1973) respectively.The data were subjected to statistical analysis and critical differences were computed wherever the variations were found to be significant (Snedecor and Cochran, 1975).

Table 1. Treatment details

Treatments	Details
T_1	Cashew leaf litter co-composted with poultry manure @ 10% w/w
T_2	Cashew leaf litter composted 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 with poultry manure @ 10% w/w
T_6	Mango leaf litter composted with compost inoculum+ vermicomposting
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 biofertilizer and rock phosphate)

RESULTS AND DISCUSSION

The data on the nutrient contents of the different enriched composts are given in table 2. Mango litter composts recorded a comparatively higher NPK contents than in cashew irrespective of the method of composting, indicating that a lower quantity of the compost was required for meeting the N requirement of vegetable cowpea.

The results on the effects of leaf litter compost application on the yield attributes and yield of cowpea are presented in table 3.Litter composts exerted significant influence on the vegetable yields in cowpea. Enriched leaf litter composts had significant influence on the number and weight of pods $plant^{-1}$. The maximum number of pods (33.96) was recorded in the treatment involving mango litter composted with poultry manure and on par with cashew litter composted with poultry manure (33.40) and glyricidia + earthworms composted mango litter (31.88). The highest $plant^{-1}$ yield was in the treatment of glyricidia + earthworm composted mango litter (126.61 g) followed by poultry manure composted litter (122.11g), which were 115 and 107 per cent more than absolute control (58.87 g). The average pod length and weight did not record any significant variation due to the treatments.

Significantly superior pod yields (7.80 t ha^{-1}) was recorded with the application of mango litter composted with glyricidia + earthworms (T_7)and was on par with T_5, poultry manure composted mango litter (7.14 t ha^{-1}), T_9, 100 per cent chemical fertilizer (7.10 t ha^{-1}) and T_1 co-composted cashew litter (6.50 t ha^{-1}). The yield in T_7 (mango litter composted with glyricidia + earthworms) was9.85 per cent greater than that T_9(100 per cent chemical fertilizer), but 2.7 fold that in absolute control (2.90 t ha^{-1}). The significantly higher yields in T_7 (mango litter + glyiricidia + earthworms) might be due the higher number of pods plant^{-1} as evidenced from the comparatively higher number of harvests recorded. The efficacy of vermicompost prepared from weeds (*Amaranthus spinosus* and *Parthenium hysterophorus*) @ 25 per cent RDN in realizing yields on par with that of 100 per cent RDF was documented by Khadtare *et al.* (2006).The better yield attributes would be a manifestation of the significantly efficient vegetative system, photosynthesis and translocation for better filling due to the better availability of nutrients and growth promoting effects associated with vermicomposting. Sinha *et al.* (2009) reported that vermicompost is not only a source of major and minor nutrients but also rich in microbial population and diversity, plant growth promoting hormones, enzymes, with acceptable C:N ratio and good homogenous consistency. The nutrient availability from vermicompost is also rated as high. Sailajakumari (1999) had earlier documented increased plant height and number of branches in cowpea with the application of rock phosphate enriched vermicompost. This along with beneficial effects of enrichment of compost (Table 2) might be the reason for the better growth observed in the vermi + glyricidia composted mango litter applied plots.

Sreeja (2015) illustrated the efficacy of mineral enriched vermicompost in conjunction with PGPR Mix I in increasing the yield in yardlong bean. In the present study, yields were significantly lowest with cashew naturally decomposed litter addition which may be due to the higher lignin content (27.5 %) and C : N (20.3: 1) of the compost used. Yields were also low in cashew vermicomposted litter.Lignin is a factor that slows down the mineralization of nutrients from crop residues on the time scale of a cropping season (Frei, 2013). This would have interfered with the nutrient availability from the litter used as nutrient source in the experiment. The plant growth inhibiting effect of lignin has been documented by Maia *et al.*(2012).

Organic manures are often referred to as slow release fertilizers. However, the results of the study revealed that growth and yields with mango litter composts (T_5– co-composting with poultry manure, T_6– composting inoculum + earthworms, T_7– glyricidia + earthworms) and co-composted cashew litter (T_1) could record yields on par with 100 per cent chemical fertilizer (T_9) application, proving the better availability of nutrients from the composts and its suitability as nutrient source in cowpea. Vermicomposting of mango litter after enrichment with glyricidia leaves was found to yield the highest. The higher microbial activity in the litter composts would have created an environment conducive for growth and better yields in cowpea.

Data pertaining to the changes in soil properties with litter compost application and cropping are presented in table 4 and fig.1. It is evident that there were improvements in soil fertility parameters with compost application. The soil was initially strongly acidic (pH-4.48) but was found to be lowered after the experiment in all treatments and as no significant variations were recorded among the treatments, the decline may be attributed to the lime applied (600 kg ha^{-1}) to correct the acidity, based on \the soil test data. The changes in electrical conductivity (EC) and organic carbon content soil were non significant.

Although there was a two fold increase in soil available N status from the initial value, it did not record any significant variation. It is well known that plants belonging to the family Fabaceae have the unique property of N fixation (Zahran, 1999) in symbiotic association with *Rhizobium* resulting in increases in the soil N status (Ghosh *et al.,*2007). The increase in the available N status in all treatments can be ascribed to the N fixing ability of cowpea, the crop being a leguminous vegetable.

The available P and K status varied significantly with 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(cashew litter + poultry manure), T_6(mango litter + composting inoculum + earthworms) and T_8(naturally decomposed mango litter). Lowest P content (45.36 kg ha^{-1}) was recorded for the treatment T_{10} (absolute control). The initial soil P status was estimated as high (46.48kg ha^{-1}) and hence it is inferred that additions through the nutrient sources, rajphos and composts, added to the P status in soil. Further enriched composts contribute to the solubilisation of P fixed in soil and enhances microbial activity (Uehara and Gilman, 1981). Significant variations recorded may be attributed to the differences in the quantum of organic acids, chelates, enzymes and P solubilizing micro organisms in the enriched compost that was added. The values were high for naturally composted litter too. Similar reports on significant effects of municipal solid waste compost application along with P solubilizer and rock phosphate as in the enriched 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). Improvement in soil nutrient status with litter compost application has been elucidated in amaranthus by Harishma (2017). Kala and Jothi Naga (2019) emphasized that vermicompost application is important for improved soil quality, plant growth and productivity. The multiple benefits offered with the inclusion of earthworms in the composting process influenced the crop performance favourably.

The response of vegetable cowpea to enriched litter composts as observed in the present study, coupled

Table 2. Chemical properties of enriched litter compost

Composted leaf litters	Cashew			Mango		
	N	P	K	N	P	K
Co-composting with poultry manure	2.05	1.55	0.65	2.33	1.74	0.65
Composting with compost inoculum + vermicomposting	1.59	1.61	0.53	2.15	1.68	0.62
Co-composting with glyricidia leaves in 1:1 + vermicomposting	1.96	1.88	0.59	2.43	2.02	0.67
Natural decomposition	1.12	1.59	0.47	1.31	1.67	0.51

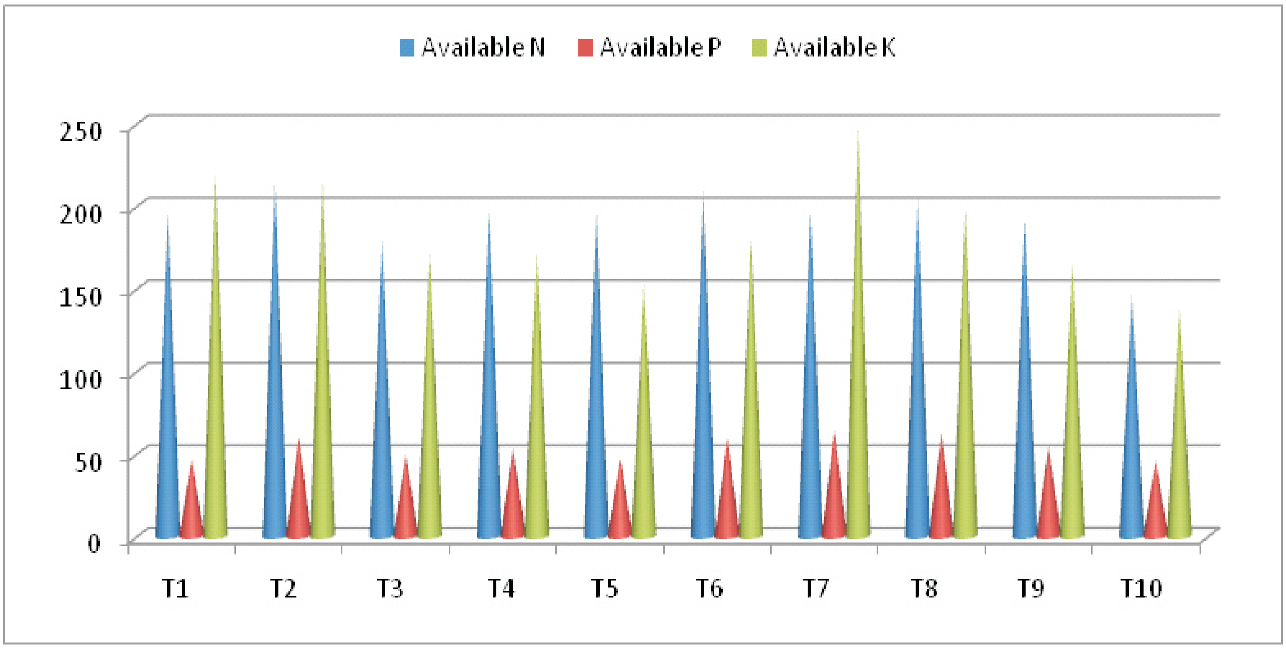
Table 3.Effect of composted litters on the yield attributes and yield in vegetable cowpea

Treatments	Number of pods $plant^{-1}$	Pod length (cm)	Pod weight (g)	Pod yield $plant^{-1}$ (g)	Pod yield ha^{-1} (t)
T_1 (PM composted cashew)	33.40	16.38	3.83	101.15	6.50
T_2 (CI + EW composted cashew)	27.13	15.52	3.86	78.25	4.81
T_3 (Glyricidia + EW composted cashew)	22.96	16.03	4.00	91.50	4.56
T_4 (Naturally decomposed cashew)	21.58	14.86	3.36	69.95	3.23
T_5 (PM composted mango)	33.96	16.16	3.96	122.11	7.14
T_6 (CI + EW composted mango)	25.25	15.73	4.30	100.30	5.77
T_7 (Glyricidia + EW composted mango)	31.88	16.21	4.17	126.61	7.80
T_8 (Naturally decomposed mango)	26.78	16.80	4.03	96.73	5.07
T_9 (Control)	28.80	15.86	4.03	104.76	7.10
T_{10} (Absolute control)	19.36	13.33	3.56	58.87	2.90
SEm(±)	1.67	0.72	0.30	9.50	0.87
CD (0.05)	5.004	-	-	28.465	2.614

(CI- composting inoculum : EW- earthworm)

Table 4. Effect of enriched litter compost on chemical properties of soil

Treatments	pH	EC(dS m^{-1})	Organic carbon(%)
T_1 (PM composted cashew)	5.47	0.17	1.31
T_2 (CI + EW composted cashew)	5.53	0.17	1.29
T_3 (Glyricidia + EW composted cashew)	5.62	0.14	1.39
T_4 (Naturally decomposed cashew)	5.32	0.12	1.45
T_5 (PM composted mango)	5.54	0.13	1.41
T_6 (CI + EW composted mango)	5.76	0.14	1.35
T_7 (Glyricidia + EW composted mango)	5.65	0.16	1.33
T_8 (Naturally decomposed mango)	5.69	0.17	1.49
T_9 (Control)	5.49	0.14	1.47
T_{10} (Absolute control)	5.24	0.16	1.27
SEm(±)	0.18	0.01	0.059
CD (0.05)	-	-	-



[CD- 7.61 (P) and 46.06 (K)]

Fig. 1. Effect of enriched compost on available NPK status in soil (kg ha^{-1})

with the improvement in the soil fertility status highlight the potential of using mango and cashew leaf litter as nutrient source in vegetable cultivation.Mango leaf litter composted with glyricidia and earthworms was identified as the best source in vegetable cowpea. The study also brings to focus the prospects of recycling leaf litter, an often neglected organic source, through composting and its utilization in crop production.

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Rec. on 10.01.2020 & Acc. on 20.01.2020