Journal on New Biological Reports
JNBR 9(2) 234 – 239 (2020)

ISSN 2319 – 1104 (Online)

Published by
www.researchtrend.net

Impact of vermicompost on the productivity of two edible legumes

Suvarna Geetha[1], Balakrishna S. Bhagya[1], Kandikere R. Sridhar[1,2,*]

[1]Centre for Environmental Studies, Yenepoya (deemed to be) University, Mangalore, Karnataka, India
[2]Department of Biosciences, Mangalore University, Mangalagangotri, Mangalore, Karnataka, India

Corresponding author: kandikere@gmail.com

| **Received**: 24 April 2020 | **Accepted**: 23 May 2020 |

How to cite: Geetha S, Bhagya BS, Sridhar KR 2020. Impact of vermicompost on the productivity of two edible legumes. J New Biol Rep 9(2): 234–239.

ABSTRACT

Vermicompost produced by earthworms (*Eudrilus eugeniae*) using lignocellulosic organic matter (leaf litter, vegetable wastes and paper wastes) was amended with soil (1:3) to evaluate the productivity of cowpea (*Vigna unguiculata*) and winged bean (*Psophocarpus tetragonolobus*). The nine parameters tested in two legumes (seed germination, plumule emergence, first leaf emergence, plant height, number of leaves, number of flowers, number of pods, pod length and number of root nodules) were significantly higher in vermicompost than the control. The ideal duration to harvest the tender pods in cowpea was 10-11 weeks, while for winged bean it was about 30 weeks. This study demonstrated the improved production of protein-rich indigenous legumes using vermicompost produced by lignocellulosic wastes.

Key words: Earthworms, *Eudrilus eugeniae*, lignocellulosic wastes, organic agriculture.

INTRODUCTION

In soil ecosystem, elemental cycling mainly occurs through saprophytic pathway by below-ground biota (Bonkowski et al. 2002; Newington et al. 2004). Diverse faunal communities in soil are known for habitat modifications (abiotic and biotic) towards global multiple ecosystem functions (e.g. plant productivity and nutrient cycling) by strengthening the interaction of microbes with saprophagous fauna for vital agricultural sustenance (Liu et al. 2019; Phillips et al. 2019). The global production of lignocellulosic organic wastes amounts more than 20-50 billion tons per annum, but only about 8-20% exploited for benefit (Kelly and Peterson 1997). Organic matter processing towards production of vermicompost is one of the most popular approaches to manage agricultural and other organic residues (Gajalakshmi and Abbasi 2004; Nagavallemma et al. 2004; Pathma and Sakthivel 2012). In spite of increased agricultural productivity in India, the agrowastes are not fully utilized for production of food, energy and fertilizer (e.g. mushrooms, biofuels and vermicompost). The rate of organic matter degradability determines the quality as well as its utilization for ecofriendly bioconversion (Jiang et al.

2018). Accordingly, the organic matter could be categorized into fast and slow degradable groups (Tremier et al. 2005). The components of organic matter has been further classified into six groups such as carbohydrates, cellulose, hemicellulose, lignin, lipids and proteins (Sole-Mauri et al. 2007).

Some of the educational institutions in Southern India are attempting to be self efficient by processing the sewage, waste waters and solid wastes (garden, kitchen, fruits, vegetables and cellulosic wastes) towards recycling and production of compost to cater the needs of their gardens. The earthworm *Eudrilus eugeniae* is known to be a suitable candidate to a wide geographic conditions of Southern India for production of vermicompost (Bano and Kale 1988; Kale and Bano 1988; Chowdappa et al. 1999). The present study is aimed at understanding the effect of vermicompost produced by *E. eugeniae* on lignocellulosic wastes on the seed germination, growth and productivity of two indigenous edible legumes (cowpea and winged bean) under field conditions in the southwest coastal region of Karnataka.

MATERIALS AND METHODS

Production of vermicompost

Vermicompost was prepared by lignocellulosic wastes (leaf litter, paper waste and vegetable waste) generated in the Yenepoya University Campus, Mangalore. In the vermibin unit, coconut sheath bed was prepared and shredded waste materials were added layer by layer, mixed with cow dung slurry at a ratio 10:1. The set up was left for primary decomposition for about four weeks and the contents were mixed once in 2-3 days by sprinkling water. After primary decomposition, earthworms (*Eudrilus eugeniae*) were introduced into the bin for secondary decomposition for about 40-50 days. Contents were mixed once in 2-3 days by sprinkling water, while harvesting, the compost was sieved, earthworms were retrieved and the vermicompost was stored for further analysis.

Impact on plant productivity

Cowpea (*Vigna unguiculata*) is an annual legume widely grown in Southern Asia. It serves as a grain crop, vegetable and pasture. The winged bean (*Psophocarpus tetragonolobus*) is a twining, perennial herbaceous plant that is characterized by its tuberous roots and winged (ridged) pods. Winged bean is an edible crop as its leaves, flowers, immature pods, seeds and tubers are highly nutritious with high protein content.

The efficacy of the vermicompost prepared was studied on cowpea and winged bean. Vermicompost was mixed with soil (sandy loam) in 1:3 ratio (referred as vermicompost hereafter), whereas sandy loam soil served as control. Vermicompost (experimental) and soil (as control) were filled in nursery polythene bags (size, 30 × 30 cm). Seeds were collected from the horticulture department of Yenepoya University and soaked up to 12 hr before sowing. The polythene bags were maintained in the open shade, where it was watered regularly. The agro-botanical parameters studied were percent seed germination, day of plumule emergence, first leaf emergence, plant height, number of leaves, number of flowers, number of pods, pod length and number of root nodules.

RESULTS AND DISCUSSION

There was a drastic increase in percentage of seed germination, plumule emergence and first leaf emergence in cow pea as well as winged bean in vermicompost than control (Fig. 1A, B). Figure 2 (A-H) shows growth of plants, roots and pods in control and vermicompost. The height of the legumes showed a gradual increase from week three to six with higher growth rate in vermicompost than control (Fig. 3A, B). The number of leaves in legumes also gradually increased from 3-6 weeks with higher leaf number in vermicompost than control (Fig. 4A, B). The number of flowers produced in cowpea and winged bean was also higher in vermicompost than control (Fig. 4C, D). However, the time elapsed for production of flowers in winged bean was slower than cowpea (30-32 vs. 8-13 weeks). The number of pods produced was higher in vermicompost than control in cowpea with a gradual increase in control up to 13 weeks, while it was up to 11 weeks in vermicompost and decreased thereafter (Fig. 5A). Similar to flower production, pod production was delayed in winged bean with higher number of pods in vermicompost than control, it was at peak at 31 weeks (Fig. 5B). The pod length of both legumes increased in vermicompost compared to control (Fig. 5C). As seen in leaves, flowers and pods, the nodule number in both legumes were higher in vermicompost than control, however, the number of nodules was higher in cowpea compared to the winged bean (Fig. 6).

Nine parameters tested in two legumes were significantly higher in vermicompost than control. This shows the impact of vermicompost in plant production and yield. The vermicompost showed positive effects on many parameters of legumes owing to presence of growth factors. In addition, vermicompost increased the root nodules of legumes that in turn increases the protein content of the pods. The ideal time to harvest the tender pods in cowpea was 10-11 weeks, while for winged bean it was about 30 weeks. Further studies need to focus on the nutritional quality of pods obtained in vermicompost and control to justify the claim. The plants nourished in vermicompost was healthy, lush green without any disease symptoms, while those plants grown with soil showed faster leaf yellowing than vermicompost possibly due to mineral deficiency.

The impact of vermicompost on the growth and production of several vegetable crops (brinjal, carrot, legumes, paprika and tomato) and flowering plants have been tested (Hari et al. 2007; Bhat and Limaye 2012; Mamta et al. 2012; Porkodi and

Amruththa 2014; Kashem et al. 2015; Hasan et al. 2018). In these studies, the vermicompost has positive effect on growth as well as yield. The plants grown with vermicompost were disease-free owing to resistance against pests (Al-Dahmani et al. 2003). Furthermore, vermicompost enhances the growth-promoting microbes in rhizosphere (nitrogen fixing bacteria and phosphate solubilizing microbes). It also supports polysaccharide synthesis by rhizosphere microbes, which serve as conditioner to enhance moisture retention and in turn protect plants under water deficiency or stress (Hari et al. 2007). In addition, vermicompost possesses beneficial bacteria for sustainable agriculture and waste management (Pathma and Sakthivel 2012).

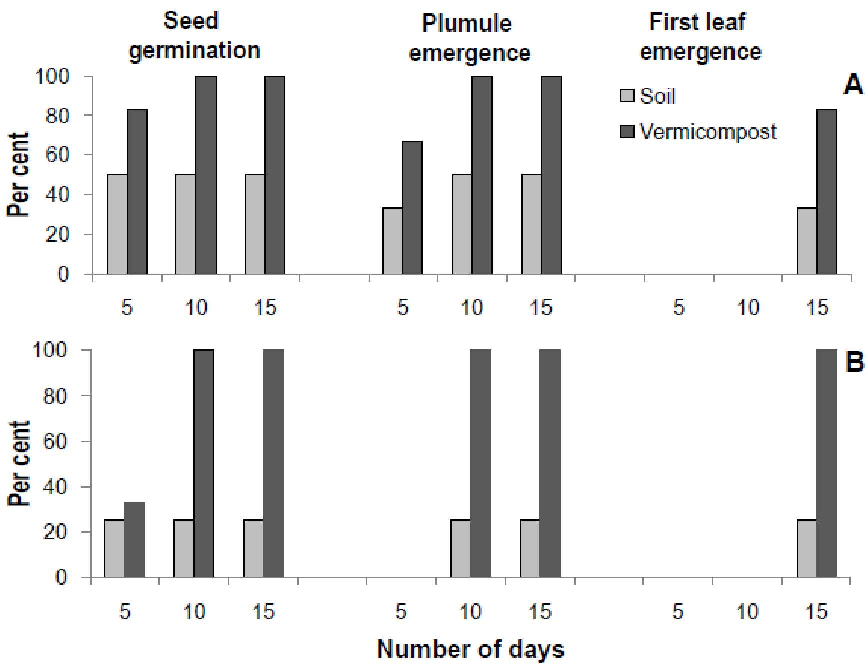

Fig. 1. Seed germination, plumule emergence and first leaf emergence in cowpea (A) and winged bean (B) during 5-15 days in soil and vermicompost (n=3, mean).

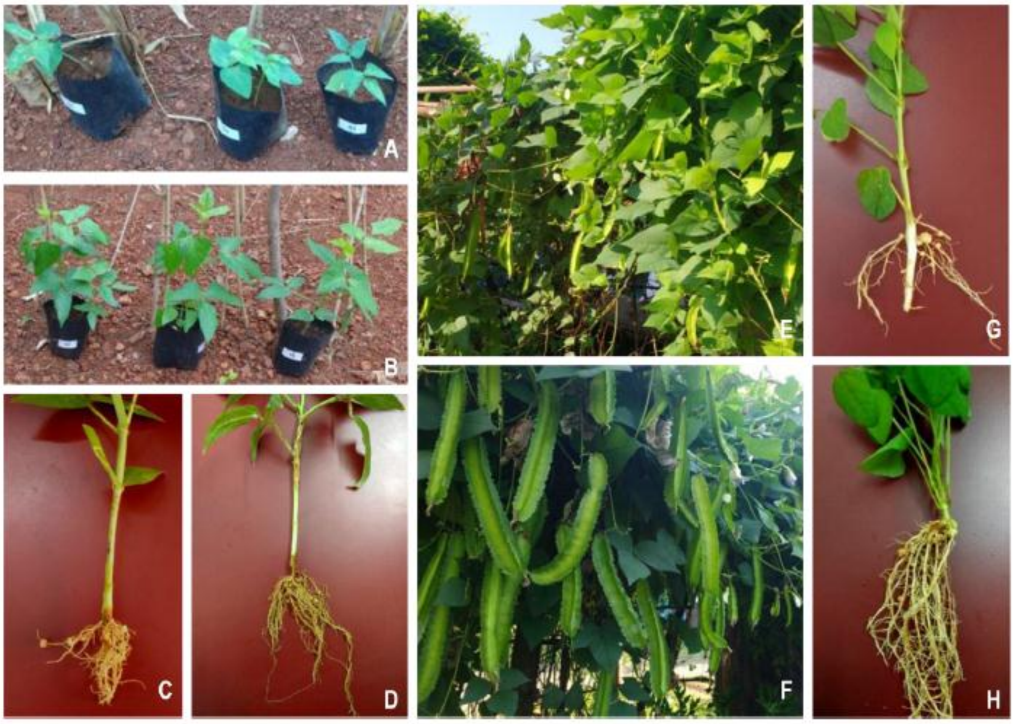

Fig. 2. Growth of cowpea in soil (A) and vermicompost (B) in 4 weeks; roots and nodules of cowpea in soil (C) and vermicompost (D) in 4 weeks; pod yield of winged bean in 31 weeks in soil (E) and vermicompost (F); roots and nodules of winged bean in soil (G) and vermicompost (H) in 4 weeks.

Solid waste management is one of the pressing problems owing to increased population. However, organic wastes could be properly managed to protect the environment and convert into compost to boost the plant production. Food wastes produced by households constitutes about 50-63% of fruits and vegetables (Laurentiis et al. 2018). In addition, avenue and horticulture trees generate huge amount of leaf litter. Besides, paper waste is another discarded resource. Thus, there is ample scope to utilize such wastes tangibly for production of foodstuff (e.g. mushrooms), biofuel (e.g. methane) and compost (e.g. vermicompost). Vermicompost production is an environment-friendly technology helpful to improve the soil nutrients and supports sustainable agriculture (Lazcano and Dominguez 2011; Pathma and Sakthivel 2012).

Overall, this study demonstrated the improvement in production of protein-rich legumes by application of vermicompost produced by lignocellulosic wastes. In addition to horticultural activities, small institutes (or higher educational institutions and industries) could adapt vermicompost production by biodegradable wastes to educate the students and public to follow such ecofriendly approaches in urban and rural localities as a sustainable measue to manage the biodegradable solid wastes.

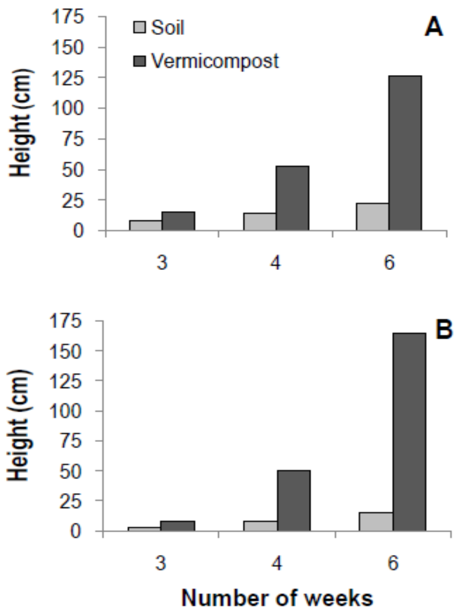

Fig. 3. Height of cowpea (A) and winged bean (B) during 3-6 weeks in soil and vermicompost (n=3, mean).

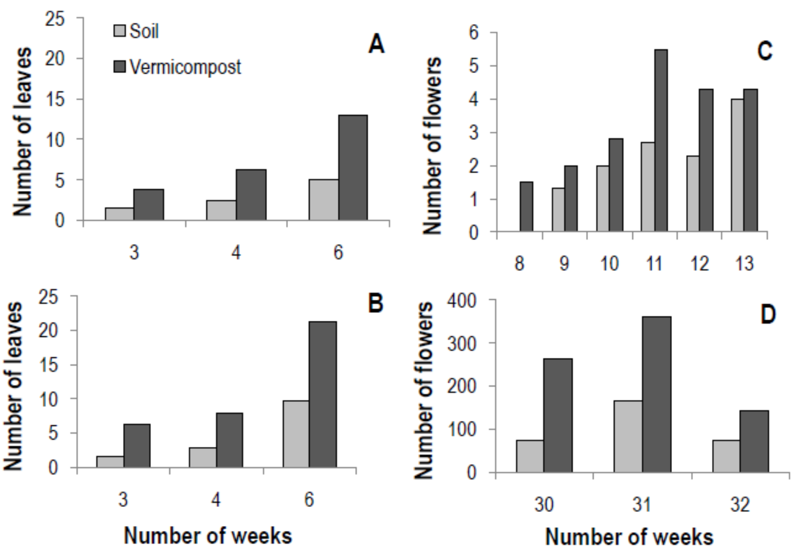

Fig. 4. Number of leaves in cowpea (A) and winged bean (B) in soil and vermicompost during 3-6 weeks; number of flowers in cowpea during 8-13 weeks (C) and winged bean in soil and vermicompost during 30–32 weeks (D) (n=3, mean).

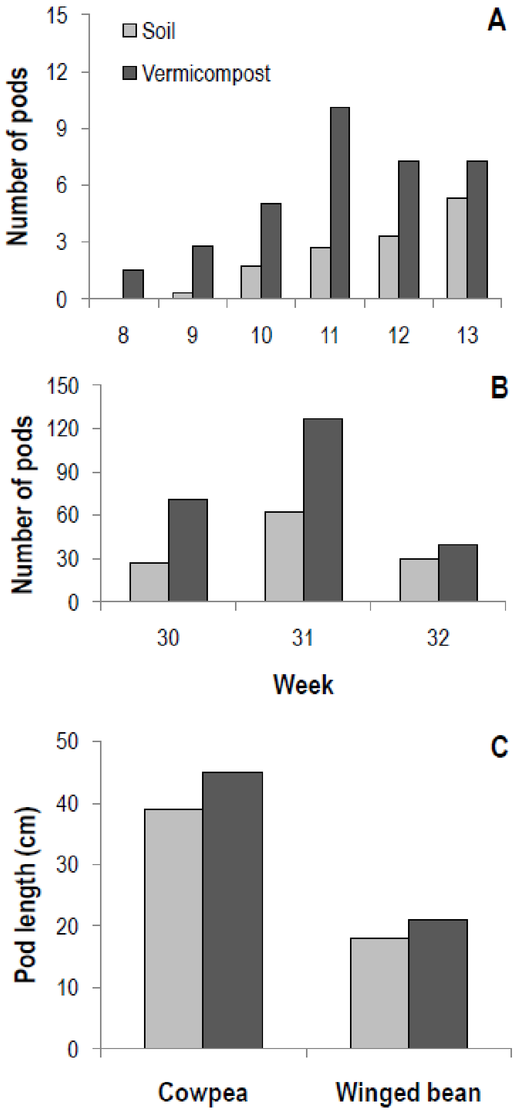

Fig. 5. Number of pods in cowpea during 8-13 weeks (A) and winged bean during 30-32 weeks (B) in soil and vermicompost; pod length of cowpea in 11 weeks and winged bean in 31 weeks (C) in soil and vermicompost (n=3, mean).

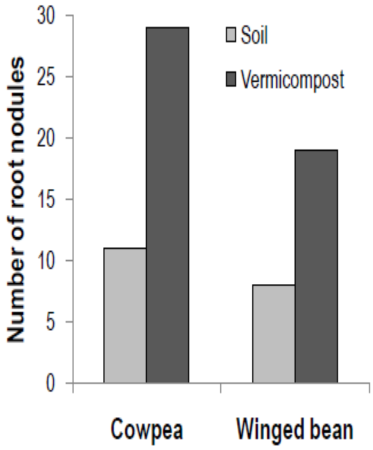

Fig. 6. Number of root nodules in cowpea and winged bean in 4 weeks in soil and vermicompost (n=3, mean).

ACKNOWLEDGEMENTS

The authors are thankful to authorities of the Yenepoya University for providing necessary laboratory and field facilities to carry out this study. S. Geetha is grateful to the Yenepoya University for the award of Junior Research Fellowship.

REFERENCES

Al-Dahmani JH, Abbasi PA, Miller SA, Hoitink HA. 2003. Suppression of bacterial spot of tomato with foliar sprays of compost extracts under greenhouse and field conditions. Plant Dis 87: 913-919.

Bano K, Kale RD. 1988. Reproductive potential and existence of endogenous rhythm in reproduction of earthworm *Eudrilus eugeniae*. Proc Zool Soc India 38: 9-14.

Bhat MR, Limaye SR. 2012. Nutrient status and plant growth promoting potential of prepared vrmicompost. Int J Environ Sci 3: 312-321.

Bonkowski M, Chengh W, Griffiths B. et al. 2002. Microbial faunal interactions in the rhizosphere and effects on plant growth. Eur J Soil Biol 36: 135-147.

Chowdappa P, Biddappa CC, Sujatha S. 1999. Efficient recycling of organic wastes in arecanut (*Areca catechu*) and cocoa (*Theobroma cacao*) plantation through vermicomposting. Ind J Agric Sci 69: 563-566.

Gajalakshmi S, Abbasi SA. 2004. Earthworms and vrmicomposting. Ind J Biotech 3, 486-494.

Hari GS, Rao PV, Reddy YN, Reddy MS. 2007. Effect of nitrogen and potassium levels on yield and nutrient uptake in paprika (*Capsicum annuum* L.) under irrigated conditions of Northern Telangana Zone of Andhra Pradesh. Asian J Hort 2: 193-196.

Hasan MM, Ali MA, Rubel MMK et al. 2018. Influences of vermicompost and organic mulching on growth, yield and profitability of carrot (*Daucus carota* L.). J Agric Biotech 3: 19-31.

Jiang Y, Wang J, Muhammad S. et al. 2018. How do earthworms affect decomposition of residues with different quality apart from fragmentation and incorporation? Geoderma 326: 68-75.

Kale RD, Bano K, 1988. Earthworm cultivation and cultivation techniques for production of VEE Comp. 83, UAS. Mysore J Agric Sci 2: 339-341.

Kashem MA, Sarker A, Hossain I, Islam MS. 2015. Comparison of the Effect of Vermicompost and Inorganic Fertilizers on Vegetative Growth and Fruit Production of Tomato (*Solanum lycopersicum* L.). Open J Soil Sci 5: 53-58.

Kelley J, Paterson R. 1997. Crop residues as a resource - the use of fungi to upgrade lignocellulosic wastes. Biol Int 35: 16-20.

Laurentiis VD, Corrado S, Sala S. 2018. Quantifying household waste of fresh fruit and vegetables in the EU. Waste Manag 77: 238-251.

Lazcano C, Dominguez J. 2011. The use of vermicompost in sustainable agriculture: Impact on plant growth and soil fertility. In: Soil nutrients. Miransari M. (Ed.), Nova Science Publishers Inc., 1-23.

Liu T, Chen X, Gong X. et al. 2019. Earthworms coordinate soil biota to improve multiple ecosystem functions. Curr Biol 29: 1-10.

Mamta, Wani KA, Rao RJ. 2012. Effect of vermicompost on growth of brinjal plant (*Solanum melongena*) under field conditions. J New Biol Rep 1: 25-28.

Nagavallemma KP, Wani SP, Lacroix S. et al. 2004. Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agrecosystems Report # 8. International Crops Research Institute for the Semi-Arid Tropics, Andhra Pradesh, India.

Newington JE, Setälä H, Bezemer TM, Jones TH. 2004. Potential effects of earthworms on leaf-chewer performance. Fun Ecol 18: 746-751.

Pathma J, Sakthivel N. 2012. Microbial diversity of vermicompost bacteria that exhibit useful agricultural traits and waste management potential. SpringerPuls 1: 26, http://www.springerplus.com/content/1/1/26

Phillips HPR, Guerra CA, Bartz MLC. et al. 2019. Global distribution of earthworm diversity. Science 366: 480-485.

Porkodi P, Amruththa M. 2014. Comparative Studies on the Nutrient Levels of Vermicomposts by *Eisenia fetida* and *Eudrilus eugeniae* and Their Effects on *Vigna radiata*. IOSR J Environ Sci Toxicol Food Technol 8: 78-82.

Sole-Mauri F, Illa J, Magry A, et al. 2007. An integrated biochemical and physical model for the composting process. Bioresource Technol 98: 3278-3293.

Tremier A, de Guardia A, Massiani C. et al. 2005. A respirometric method for characterizing the organic composition and biodegradation kinetics and the temperature influence on the biodegradation kinetics, for a mixture of sludge and bulking agent to be co-composted. Bioresource Technol 96: 169-180.