



Effect of organic manure on fodder yield and carbon sequestration potential of Fodder Cowpea (*Vigna Unguiculata*)

A.Thennarasu, T.Sivakumar, S.M.Sundaram, V.M.Sankaran and T.T.Vanan
Tamilnadu Veterinary and Animal Sciences University, Chennai, India.

ARTICLE INFO

Article history:

Received: 5 May 2014;
Received in revised form:
19 June 2014;
Accepted: 30 June 2014;

Keywords

Fodder yield
Carbon sequestration
Fodder cowpea
Manure.

ABSTRACT

The study was under taken to find out the effect of different organic manure on the yield and carbon sequestration potential of fodder cowpea. Result revealed that green fodder yield were significantly ($P < 0.01$) higher in improved farmyard manure, vermicompost and enriched farmyard manure application. Similarly carbon sequestration potential was significantly higher in improved followed by vermicompost and enriched methods. It was concluded that the application of vermicompost, improved and enriched manure increased fodder yield and sequestered higher carbon from the atmosphere than other treatments.

© 2014 Elixir All rights reserved.

Introduction

Farmyard manure is the most important input in organic farming which is being widely practiced worldwide to promote environmental, social and economic sustainability. Shifting from mixed arable livestock farming to intensified farming has adverse effects like excess nitrate in fertilizers on crop being dissolved by rain and contaminating water bodies through runoff, ammonia emission, effluent influx, impending toxic residues etc. Scientific interest is recently being focused towards evaluation of organic fertilizers produced from locally available resources including crop residues, animal manure and green manure. The capacity of manure to provide nutrients, especially N, P and K and thereby improving soil properties such as cation exchange capacity (CEC), pH, water holding capacity, hydraulic conductivity, infiltration rate etc., have been thoroughly studied and well accepted. Organic wastes originating from animal production, agriculture and related by-products and from the food processing industries have become major contributors towards environmental pollution which has a great social impact throughout the world in both developed and developing countries (Rashad *et al.*, 2010). Manures also contribute towards serious pollution resulting from the huge accumulation of such materials. Being untreated these animal wastes are known to be heavily contaminated with pathogenic bacteria and parasites which may lead to various health hazards or zoonosis (Hanajima *et al.*, 2006). Application of organic manure act as good source for fodder production as well as it accumulate higher carbon dioxide from the atmosphere. The study has been under taken to find out the effect of different organic manure treatment methods like improved farmyard manure, vermicompost, enriched farmyard manure and conventional farmers practices on the yield and carbon sequestration potential of fodder maize.

Materials and Methods

Experiment was carried out to test the efficiency of different manure treatments in field trials at North Eastern Zone of Tamil Nadu ($12^{\circ}41'08.26''$ N and $79^{\circ}55'27.39''$ E) during the year 2013. The crop studied was fodder cowpea (*Vigna unguiculata*) in randomized block design. Treatment imposed were T1, as

control-without farmyard manure, T2 as vermicompost with 2.40 t/ha, T3 as inorganic fertilizer (Recommended dose of NPK) with Urea: 55 kg/ha, Super Phosphate: 250 (kg/ha) Potash: 33 kg/ha, T4 as farmyard manure –farmers practice with 2.60 t/ha, T5 as enriched farmyard manure (Composted enriched with rock phosphate in manure pit) with 2.44 t/ha, T6 was improved farmyard manure (dung, feed refusal and urine mixed properly composted in the covered manure pit and turned at fortnight interval) with 2.54 t/ha. Quantity of manure application was calculated based on nitrogen content, equating to N requirement of the plant. The main plot was allotted to fodder cowpea and sub-plots were the different manure treatments. The size of each plot was 4 x 6 m and standard agronomical practices were followed for cultivation.

Fodder cowpea was harvested at 60th day to assess the yield and biomass content. The collected fodder samples were shade dried, ground in pestle and mortar, ground to pass through <2 mm mesh and subjected to analysis total organic carbon by carbon analyzer. The carbon sequestration of the plant was calculated by biomass multiplied by carbon per cent (Negi *et al.*, 2003). Green fodder yield was recorded from one square meter area in each plot and expressed in tones/ha, which was again oven dried to estimate the dry weight.

The data collected on different parameters during the course of investigations were subjected to analysis using the analysis of variance (One-Way ANOVA) procedure of SPSS 11.5 to test the hypothesis and to find out, if there is any significant difference between manure treatments and carbon sequestration potential of fodder cowpea as per the procedure described by Gomez and Gomez (1984).

Result and Discussion

Plant organic carbon

The plant organic carbon content of fodder cowpea was presented in Table 1. It could be observed from the result that the plant organic carbon content of fodder cowpea in T6, T5 and T2 treatments (48.42, 48.32 and 48.23 per cent respectively) were significantly higher than T4 (44.52 per cent), T3(44.33 per cent) and T1(38.93 percent) treatment groups. The values of plant

organic carbon in fodder cowpea recorded in the present study were in concurrence with the values reported by Etana *et al.* (2013), who had evaluated different cowpea accessions and found that the organic carbon content ranged from 43.71 per cent to 45.83 per cent. Similarly, Kasangi *et al.*, (2010) analyzed the proximate composition of cowpea leaves and found that organic carbon content ranged from 50.41 per cent to 52.25 per cent.

In general, as plant grows there will be absorption of carbon-dioxide from the atmosphere and stored in leaves, stems and also in the root. During harvesting stage due to abundant growth of the plant large amount of carbon gets accumulated in the plant and hence the increase of carbon content was noticed in different manure treated plots. This was in agreement with the findings of Suksombat and Buakeeree (2006), who conducted an experiment to find out the effect of different cutting interval on the chemical composition of leguminous fodder Hedge Lucerne and found that the organic carbon content increased from 53.79 per cent (30 days) to 54.5 per cent (50 days). Further they stated that the organic carbon of the fodder increased as a result of maturation of plant growth as a result of utilization of plant nutrients. The higher carbon content observed in treatment T2 was mainly due to the application of vermicompost. This shall be attributed to the enhanced mineralization of soil nutrients due to higher microbial population and presence of nutrients in ionic form in the vermicompost making it a good source of plant nutrients that encouraged abundant plant growth leading to accumulation of higher amount of carbon in the plant. These findings were in concurrence with the findings of Suthar and Singh (2008).

In T5 treatment application of enriched manure with high P content, positively contributed to the biomass yield of cowpea. Also phosphate compounds acted as an energy currency in plants, and played an important role in photosynthesis and the metabolism of carbohydrates (Islam *et al.*, 2010). Similarly, higher carbon content in T6 treatment might be due to the higher NPK content and well decomposed organic matter that provided readily available nutrients to the plants which encouraged the plant growth and root biomass. Further the effect of FYM which contained large amount of organic matter, and constant pressure on active microorganisms encouraged the fodder growth. Also it reduced the bulk density of the soil which in turn increased the organic carbon content of the fodder.

Table 1. Impact of different manure treatments on organic carbon (%), biomass (t/ha) and carbon sequestration potential (t/ha) in fodder cowpea

Manure	Organic carbon (%)	Green fodder Yield (t/ha)	Dry matter yield(t/ha)	Carbon potential(t/ha)
Control (T1)	38.93 ^a	14.92 ^a	2.18 ^a	0.85 ^a
Vermicompost (T2)	48.23 ^c	18.47 ^c	2.70 ^c	1.31 ^c
Inorganic fertilizer (T3)	44.33 ^b	18.30 ^c	2.68 ^c	1.19 ^b
Farmers practice (T4)	44.52 ^b	16.72 ^b	2.45 ^b	1.09 ^b
Enriched FYM (T5)	48.32 ^c	18.35 ^c	2.69 ^c	1.30 ^c
Improved FYM (T6)	48.42 ^c	18.68 ^c	2.74 ^c	1.33 ^c
Level of significance	**	**	**	**

** Significant at P < 0.01; Mean bearing small letters in superscript differs significantly between treatments

Green fodder yield

Highly significant (P>0.01) difference were observed among various treatments with regard to green fodder yield. The green fodder yield for T6 (18.68 t/ha), T2 (18.47 t/ha), T5 (18.35 t/ha) and T3 (18.30 t/ha) treatments were significantly (P<0.01) higher than the T4 (16.72 t/ha) and T1 (14.92 t/ha) treatments. This might due to the increased availability of soil nitrogen and other macro and micronutrients that might have enhanced meristematic growth and resulted in higher fodder yield. Further organic manure acted as buffer for nutrients. These were in accordance with the findings of Yong *et al.* (2006), Kannan *et al.*, (2006) and Kumar *et al.*, (2009). The fodder yield increase was due to the result of higher plant height, stem diameter and more dry matter production per plant. This was due to the regulatory role of nitrogen in production of amino acids and plant hormones responsible for cell division and enlargement and higher nitrogen facilitating optimum development of photosynthetic apparatus which captured the incident light more efficiently. Moreover among the aerial plant parts, the leaves were more responsive for additional nitrogen supply than stems and also the nitrogen influenced the total biomass production of crops. This was in agreement with the findings of Tariq *et al.* (2011). The higher yield in T2 might be due to the application of vermicompost with high amount of essential plant micronutrients viz., copper, iron, manganese and zinc that resulted in better plant growth and productivity. A similar increase in higher fodder yield in fodder cowpea with the application of vermicompost was also reported by Suthar (2009). The higher yield in T5 treatment could be due to the higher availability of P that has increased photosynthetic activity and stimulation of early growth and higher biomass yield of cowpea. The results were in agreement with the findings of Cheema., (2000), who stated that phosphorus played a major role in photosynthesis and stimulated early growth and root formation resulting in higher fodder yield. T6 treatment (improved farmyard manure) had the benefits of organic matter providing N, P, and K supply which resulted in improvement of microbial activity, better supply of macro and micro nutrients such as S, Zn, Cu and B (Bhattacharya *et al.*, 2008). Moreover, organic manure acted as a reservoir of nutrients and these nutrients were released during humification, thus supplying the necessary elements for plant growth. This was in accordance with the findings of Chiezey and Odunze (2009).

Carbon sequestration potential of fodder cowpea

The carbon sequestration potential of fodder cowpea revealed that highly (P<0.01) significant difference was observed among various treatments with regard to carbon sequestration potential (CSP). The CSP was significantly (P<0.01) higher for T6 (1.33 t/ha), T2 (1.31 t/ha) and T5 (1.30 t/ha) than T4 (1.09 t/ha) and T1 (0.85 t/ha) treatments. The carbon sequestration potential of fodder cowpea was due to its biomass and as a result of carbon sequestration (organic carbon) in terms of carbon-dioxide from the atmosphere (Schuman *et al.*, 2002). It was evident from the table that T6, T2 and T5 treatments had significantly (P<0.01) higher carbon sequestration potential (CSP) than the other treatments. This could be due to higher carbon content in plant and dry matter yield as evidenced from table, recorded by the treatments T6, T5 and T2. Similar results attributing higher CSP to higher biomass and carbon stock was also reported by Montagnini & Nair (2004) and Yadava, (2010). Similarly, Montagu *et al.*, (2006) reported that biomass was an important indicator in carbon sequestration. Likewise Walker, et al (2008) stated that the above ground biomass had a high influence on the carbon

sequestration potential in energetic crops. Our studies also suggested that plant organic carbon as well as the dry matter yield had positive influence on CSP individually and complementarily in which case the offset in one may be compensated by the other.

Conclusion

The application of vermicompost, improved farmyard and enriched farmyard manure increased fodder yield and sequestered higher carbon from the atmosphere than other treatments in fodder cowpea, implying the benefit for reducing the impact of carbon, a potential green house gas.

Acknowledgement

The authors thank the Tamilnadu Veterinary and Animal Sciences University for their continuous support, Encouragement and valuable suggestions.

Reference

- [1] Rashad, F.M., W.D. Saleh and M.A. Moselhy, 2010. Bioconversion of rice straw and certain agro-industrial wastes to amendments for organic farming systems: 1. Composting, quality, stability and maturity indices. *Bioresour. Technol.*, 101 : 5952-5960.
- [2] Hanajima, D., K. Kuroda, Y. Fukumoto, and K. Haga, 2006. Effect of addition of organic waste on reduction of *Escherichia coli* during cattle feces composting under high-moisture condition. *Bioresour. Technol.*, 97: 1626-1630.
- [3] Negi et al. (2003). Carbon allocation in different components of some tree species of India. A new approach for carbon estimation. *Current Sci.*, 85(11): 101 - 104
- [4] Gomez, K.A., Gomez, A.A., 1984. Statistical procedures for agricultural research. John Wiley and Sons, New York.
- [5] Etana, A., E. Tadesse, A. Mengistu, and A. Hassen, 2013. Advanced evaluation of cowpea (*Vigna unguiculata*) accessions for fodder production in the central rift valley of Ethiopia. *J. of Agric. Extension and Rural Development*, 5(3): 55-61.
- [6] Kasangi, D.M., A.A. Shalo, P.L. Shalo, and S.K. Mbugua, 2010. Effect of spontaneous fermentation of cowpea leaves (*Vigna unguiculata*) on proximate composition, mineral content, chlorophyll content and beta-carotene content. *Int. Food Res. J.*, 17: 721-732.
- [7] Suksombat, W., and K. Buakeeree, 2006. Effect of cutting interval and cutting height on yield and chemical composition of Hedge Lucerne (*Desmanthus virgatus*). *Asian-Aust. J. Anim.Sci.*, 19(1): 31-34.
- [8] Suthar, S and S. Singh, 2008. Vermicomposting of domestic waste by using two epigeic earthworms (*perionyx excavates* and *Perionyx sansibaricus*). *Int. J. of Environ. Sci. and Technol.*. 5(1) : 99-106
- [9] Islam, M.R., S.M.E. Rahman, M.M.Rahman, D.H. Oh and C.S.Ra, 2010. The effects of biogas slurry on the production and quality of maize fodder. *Turk.J.Agric.For.* 34 : 91-99.
- [9] Yong et al. (2006). Long term effect of fertilizer and manure application on soil-carbon sequestration and soil fertility under the wheat-wheat-maize cropping system in north west china. *Nutrient Cycling in Agroecosyst.*, 75: 285-295.
- [10] Kannan et al. (2006). Organic farming on tomato yield and quality. *Crop Res.*, 32 (2): 196-200.
- Kumar, M.D., K.M. Devaraju, D. Madaiah and K.V. Shivakumar, 2009. Effect of integrated nutrient management on yield and nutrient content by cardamom (*Elettaria cardamomum* L.Maton.). *Karnataka J. of Agri. Sci.*, 22(5): 1016-1019.
- [11] Tariq, M., M.Ayub, M.Elahi, A.H.Ahmad, M.N.Chaudhary and M.A.Nadeem, 2011. Forage yield and some quality attributes of millet (*Pennisetum americanum* L.) hybrid under various regimes of nitrogen fertilization and harvesting dates. *African J. of Agric. Res.*, 6 (16): 3883 – 3890.
- [12] Suthar, 2009. Impact of vermicompost and composted farmyard manure on growth and yield of garlic (*Allium stivum* L.) field crop. *International Journal of Plant Production*, 3(1):27-38.
- [13] Cheema, H.N.A., 2000. Yield and quality response of maize (*Zea mays* L) fodder grown on different levels of phosphorus and seedling densities. *M.Sc. (Hons) Thesis, Dept. Agron., Univ. Agric. Faisalabad, Pakistan.*
- [14] Bhattacharyya, R., Kundu, S., Praksh, V., Gupta, H.S., 2008. Sustainability under combined application of mineral and organic fertilizers in a rainfed soybean-wheat system of the Indian Himalayas. *European Journal of Agronomy*, 28, 33-46.
- [15] Chiezey, U.F., and A.C. Odunze, 2009. Soybean response to application of poultry manure and phosphorus fertilizer in the Sub-humid Savanna of Nigeria. *J. of Ecology and Natural Environ.*, 1(2): 25-31.
- [16] Schuman, G.E., H.H.Janzen and J.E.Herrick, 2002. Soil carbon dynamics and potential carbon sequestration by rangelands. *Environ.Pollut.*, 116: 391-396.
- [17] Montagnini, F., and N.K.R Nair, 2004. Carbon sequestration: An underexploited environmental benefit of agroforestry systems. *Agroforestry Syst.*, 61-62(1-3): 281-295.
- [18] Yadava, A.K., 2010. Biomass production and carbon sequestration in different agro-forestry systems in Tarai region of Central Himalaya. *Indian Forester*, 136(2): 234-244.
- [19] Montagu et al. (2006). Developing general allometric relationships for regional estimates of carbon sequestration- an example using *Eucalyptus pilularis* from seven contrasting sites. *Forest Ecology and Management*, 204(1): 115-129
- [20] Walker et al. (2008). Evaluation of carbon sequestration in energetic crops (*Miscanthus* and Coppice willow). *Int. Agrophysics.*, 22: 185-190.