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Influence of organic manure on fodder yield and carbon sequestration potential in fodder maize *(Zea mays L.)*

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ABSTRACT

The study was under taken to find out the effect of different organic manure on the yield and carbon sequestration potential of fodder maize. Result revealed that green fodder yield were significantly (P<0.01) higher in improved, enriched and vermicompost method. Similarly carbon sequestration potential was significantly higher in improved (4.19 t/ha) followed by enriched (4.16 t/ha) and vermicompost (4.09 t/ha) 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.

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°.41' 08.26'' N and 79° 55' 27.39'' E) during the year 2013. The crop studied was fodder maize *(var. African Tall)* in randomized block design. Treatment imposed were T1, as control-without farmyard manure, T2 as vermicompost with 6.50 t/ha, T3 as inorganic fertilizer (Recommended dose of NPK) with Urea: 130 kg/ha, Super Phosphate: 250 (kg/ha) Potash: 33 kg/ha, T4 as farmyard manure –farmers practice with 7.62 t/ha, T5 as enriched farmyard manure (Composted enriched with rock phosphate in manure pit) with 6.63 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 5.95 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 maize 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.

Plant organic carbon

Fodder maize 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 maize as per the procedure described by Gomez and Gomez (1984).

Result and Discussion

It could be observed from the results that the plant organic carbon content of fodder maize in T2, T5 and T6 treatments (56.87, 56.77, 56.67 per cent respectively) were significantly

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higher than T4(52.86 per cent), T3(52.57 per cent) and T1 (48.50 per cent) treatment groups and similar trend was observed in summer. The values of plant organic carbon in fodder maize recorded in the present study were in concurrence with the values reported by Ayub *et al.* (2002) in fodder maize (52.10 to 53.26 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 Shehzad *et al.* (2012), who studied the effects of nitrogen fertilization rate and harvest time on Maize (*Zea mays* L.), fodder yield and its quality attributes. They observed that the organic matter of the fodder maize increased from 89.20 percent at 45th day of harvest to 91.40 percent on 65th day, implying that the plant organic carbon increased from 51.86 percent on 45th day to 53.14 percent on 65th day. 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, subsequently 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 had high P content which positively contributed to the biomass yield of maize. 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 maize

Manure	Organic carbon (%)	Green fodder Yield (t/ha)	Dry matter yield(t/ha)	Carbon potential(t/ha)
Control (T1)	48.50^{a}	34.40 ^{a}	6.07 ^{a}	2.94 ^{a}
Vermicompost (T2)	56.87^{c}	40.77 ^{c}	7.20 ^{c}	4.09 ^{c}
Inorganic fertilizer (T3)	52.57^{b}	40.20^{c}	7.10 ^{c}	3.70 ^{b}
Farmers practice (T4)	52.86 ^{b}	37.47 ^{b}	6.61 ^{b}	3.50 ^{b}
Enriched FYM (T5)	56.77 ^{c}	41.53 ^{c}	7.33 ^{c}	4.16 ^{c}
Improved FYM (T6)	56.67 ^{c}	41.93 ^{c}	7.40 ^{c}	4.19 ^{c}
Level of significance	**	**	**	**

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

Green fodder yield

The results revealed that during monsoon the treatments T6, T5, T3 and T2 recorded higher green fodder yield than the other treatment groups and similar trend was observed during summer. T6, T5, T3 and T2 treatments had the higher NPK content than other treatment groups leading to increased availability of soil nitrogen and other macro and micronutrients might have enhanced meristematic growth and resulted in higher fodder yield. These were in accordance with the findings of Yong *et al.* (2006) and Kannan *et al.* (2006). The fodder yield increase was due to the result of higher plant height, stem diameter and more dry matter production per plant. Also the two possible mechanisms 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 application of vermicompost with high amount of essential plant micronutrients viz., copper, iron, manganese and zinc as reported by Suthar (2009) and Sable *et al.* (2007).

The higher yield in T5 treatment shall be due to the availability of P in the T5 treatment group enriched with rock phosphate which might have positively contributed to biomass yield of maize. This finding was in agreement with the finding of Biswas *et al*. (2006) who stated that phosphate compounds acted as an energy currency in plants and played an important role in photosynthesis and the metabolism of carbohydrates. 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, farm yard manure increased the availability of nutrients and improved the soil fertility and enhanced fodder production. This was in accordance with the findings of Ahmed *et al.* (2007).

Carbon sequestration potential of fodder maize

It was evident from the result T6 (4.11 t/ha), T5 (4.05 t/ha) and T2 (4.00 t/ha) treatments had significantly (P<0.01) higher carbon sequestration potential (CSP) than other treatments and similar trend was noted in summer. This could be due to higher

carbon content in plant as evidenced from table recorded by the treatments T6, T5 and T2. Though T2 recorded higher OC content that did not reflect as such in the CSP, where as T6 has recorded higher CAP than T2. This was possible by increased dry matter yield recorded by T6 compared to T2. Though there were minor differences among these two treatments (T6 and T2), the CSP recorded was found to be significantly on par between T6, T5 and T2. Similar results attributing higher CSP to higher biomass and carbon stock was earlier 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) attributed 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 organic manures like vermicompost, improved farmyard manure and enriched farmyard manure increased fodder yield and sequestered higher carbon from the atmosphere than other treatments.

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