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Influence of Organic Manure Amendment on the Soil Nutrient Status in the Cultivation of *Desmanthus virgatus* and Cumbu Napier Hybrid Grass

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Abstract

Organic manures are the promising alternative fertilizer for crop growth and soil health. A study was carried out for 48 months in four different agro climatic zones of Tamil Nadu, India to assess the use of cow dung manure and the effective utilization of soil nutrients, utilizing Desmanthus virgatus and Cumbu Napier hybrid grass as a response crop. Fodder cultivation was adopted by following standard cultivation practices and cow dung manure and urine were applied to the fodder crops strategically calculating the area and sowing rate as per recommendations for Desmanthus virgatus and Cumbu Napier hybrid grass. At the end of the study, in Desmanthus field, the pH, phosphorus and potassium have reduced in three zones; soil organic carbon reduced in two zones; and EC reduced in all the four zones. But, the nitrogen content increased in three zones except in the institutional land of north eastern zone. Likewise, in the Cumbu Napier hybrid grass field, the pH and EC reduced in all the four agroclimatic zones; potassium and soil organic carbon reduced in three zones; and phosphorus reduced in two zones only. But the nitrogen increased in three zones, except in Cauvery delta zone.

Keywords: Cow Dung Manure, Cumbu Napier Grass, Desmanthus, Organic manure

Introduction

Indian livestock population registered 535 million mark in the last 20th livestock census of the country (Report, 2020), which is 3.5% more than the previous 19th census. Almost 15% of the World's livestock population lives in India. They totally depend on green fodder, because feeding green fodder is cost effective. However, the shortage of green and dry roughage is about 35% from the total requirement. Green fodder is deficit in the country despite large area under fodder cultivation (9.2 m ha) and permanent pasture & common grazing land (10.2 m ha). Low green fodder yield of cultivated fodder and pastures is the main reason of green fodder deficit. Cultivated fodder is main source of green fodder and producing about 70 % of total green fodder. According to a Report (2019) from NDDB, the estimated annual green fodder yield of cultivated fodder is around 40 tonnes per hectare, which is much below the potential of high yielding newly notified varieties/ hybrids of fodder crops. The interest in organic dairying is increasing at rapid pace worldwide with faster growth in demand of organic milk and milk products. Under Indian conditions, the technical knowledge of the Indian farmers are the base for successful organic livestock farming (Singh *et al.*, 2014).

Plant soil nutrient relationship is the key factor and thus soil available nutrients *viz.*, nitrogen, phosphorus, potassium and organic carbon are the vital parameters. The relationship between land, plants and animals should be always mutually beneficial under organic livestock farming (Shubeena *et al.*, 2017). Soil fertility management options for increasing fodder production in relation to nutrient balance by incorporating organic manure has been tried in this study with a concept of feeding the fodders to the cows and goats; and applying the manure collected from the cows and goats to the fodder crops, as a means of recycling the animal waste for fodder production.

The soil fertility status varies widely in different regions. Throughout the world the nutrient deficiency or depletion in the soil is unavoidable, for example, organic carbon, nitrogen, phosphorous, potassium and sulphur deficiencies are common. This is the big concern to the world. The increased fertilizer consumption from 1 million tons to 17 million tons poses impact to agriculture. As an alternate, cow dung manure is most preferred since, the phosphate solubilisation property of cow dung microorganisms is the natural ability to increase soil fertility Gupta *et al.*, 2016). Sahu *et al*. (2016) reported that the cow urine mainly contains water (95%), urea and mineral salts (2.5%), hormones and enzymes (2.5%).The cow urine contains sodium, nitrogen, sulphur, Vitamin A, B, C, D, E, minerals, manganese, iron, silicon, chlorine, magnesium, citric, succinic, calcium salts, phosphate, lactose, carbolic acid, enzymes, creatinine and hormones. In the soil, 82 percent of total nitrogen and 63 percent of di-ammonium phosphate consumption comes through urea alone. It is felt the role of organic manure is very significant in the supply of nutrients for maintaining soil fertility. Hence, this work was undertaken to study the influence of cow urine and cow dung manure as organic fertilizers for leguminous fodder (*Desmanthus virgatus*) and fodder grass (Cumbu Napier hybrid grass) production.

Materials and Methods

The present research was carried out from 2014 to 2018, in four different agro climatic zones of Tamil Nadu, India to assess the use of cow dung manure and the effective utilization of soil nutrients. Four locations were selected namely, one institutional land at North eastern agroclimatic zone (Kancheepuram) of Tamil Nadu and three private farmers land (about 1 acre in each location for each crop) at Cauvery delta zone (Trichy), Western agroclimatic zone (Erode) and Southern agroclimatic zone (Madurai) of Tamil Nadu. Soil profile was analyzed from the experimental fields before the start of the study. Standard agronomical practices were adopted to cultivate Hedge lucerne (*Desmanthus virgatus*) and Cumbu Napier hybrid grass (*Pennisetum perpureum* X *Pennisetum americanum*; VAR. Co (CN)4).

Crossbred cows and goats were fed with Hedge Lucerne and Cumbu Napier hybrid grass according to the requirement for maintenance and production. The dung was collected and stored as heaps till three months and left for another two months. During this storage period, the dung was fermented and changed as farmyard manure. This manure was applied to the same land where crop was grown for feeding the animals. During the period of Hedge Lucerne and Cumbu Napier hybrid grass cultivation, the urine was collected from the cows with the help of a specially designed floor and urine collecting pit with bucket and irrigated along with water once in 15 days to ensure the availability of nitrogen in the place of urea for its growth. In this way, the nutrients were conserved through recycling of dung and urine with interrelationship of soil, plant and animal. It was observed that the incidence of disease was controlled due to the ammonical odour of urine which restricted the entry of pest during the experiment.

Initial soil samples were collected in every January and July of the year, from the respective fields *viz.* Cumbu Napier hybrid and *Desmanthus virgatus* by following standard procedure. Six samples from each field were collected and stored in polythene bags for analysis of soil type, pH (Jackson, 1973), EC (Jackson, 1973), N (Subbiah and Asija, 1956), P (Olsen *et al.*,1954), K (Stanford and English, 1949) and soil organic carbon (SOC) (Walkley and Black, 1934) following standard analytical procedures. The data thus collected were subjected to standard statistical analysis suggested by Snedecor and Cochran (1989).

Results and Discussion

Soil pH and Electrical Conductivity

From the results in Table 1, it is seen that the soil pH varied significantly between the agroclimatic zones. The pH was higher in Cauvery delta zone (8.3 ±0.42) and southern zone (8.02 ±0.42) than the other two zones. If the sodium is present in the soil, then the soil pH must be above 8.0 and sometimes it may reach upto 10.0. The reason for high alkalinity must be lack of rainfall and the settlement of calcium, magnesium and sodium in the soil. In addition to this, carbonates may also add to the pH. Hence, to control the pH an amendment of gypsum, elemental sulfur, H_2SO_4, $FeSO_4$ etc. may be helpful but they take a long time and ferrous sulphate and sulphuric acind addition does this job quicker (Uygur, 2019).

Table 1: Changes in soil profile of *Desmanthus virgatus* field (Mean* ± SE)

Soil parameters	North Eastern Zone		Cauvery Delta Zone		Western Zone		Southern Zone	
	At start	At the end of 4th year	At start	At the end of 4th year	At start	At the end of 4th year	At start	At the end of 4th year
pH	6.93 ±0.35	6.94 ± 0.36	8.3 ±0.42	6.5 ±0.34	8.02 ±0.42	7. 2 ±0.38	7.06 ±0.37	6.3 ±0.32
EC (dSm^{-1})	0.56 ±0.03	0.04 ±0.01	0.83 ±0.04	0.12 ±0.01	0.49 ±0.03	0.024 ±0.01	0.84 ±0.04	0.56 ±0.03
N (Kg/ha)	250.5 ±12.53	258.0 ±13.42	213.75 ±10.90	134 ±6.97	187.6 ±9.76	251 ±13.08	200.75 ±10.48	250.2 ±12.76
P (Kg/ha)	11.65 ±0.58	12.2 ±0.63	23.3 ±1.19	7.9 ±0.41	19.25 ±1.00	16.8 ±0.88	18.25 ±0.95	9.2 ±0.47
K (Kg/ha)	194.8 ±9.74	118.2 ±6.15	280 ±14.28	67 ±3.48	220 ±11.44	148 ±7.71	238.5 ±12.45	289.5 ±14.76
SOC (%)	0.46 ±0.02	0.42 ±0.02	0.45 ±0.02	0.22 ±0.01	0.24 ±0.01	0.41 ±0.02	0.60 ±0.03	0.65 ±0.03

**Mean of six samples*

Alkaline soils in many north western parts of India are less productive and which can be corrected by the addition of gypsum and cultivating rice as the first crop (Pal, 2017). The high pH values of the soil tend to reduce the availability of many nutrients namely iron, zinc, copper, and manganese. It is a right practice to add organic manure to bring down the soil pH over time. This also favours the soil by increasing microbial life and improving the structure of the soil (Singh, 2017). In the present study, composted cow dung and cow urine were added to the soil over a long time for four years, which might have reduced the soil pH at the end of the trial. This is very much evident from the results that the pH has come down from 8.3 to 6.5 in Cauvery delta zone, 8.02 to 7.2 in western zone and 7.06 to 6.3 in southern zone. Singh (2017) also stated that phosphate deficiency may arise due to its precipitation in the alkaline soils, A soil pH value above 8.5 indicates the presence of sodium. High-sodium soils may reach pH values up to 10. Such high-sodium soils are termed as "sodic soils. More salinity in the soil tends to increase the EC of the soil. But, in the present study, the EC was much reduced after four years of trial. Paulo (2012) reported that addition of organic matter or clay can also help by adsorption of cations in the soil. In the present study, continuous application of cow dung manure and urine might reduce the EC at the completion of the study.

Nitrogen, Phosphorus, Potassium and SOC

There is an increase in the level of soil available nitrogen at the end of the four years trial except in Cauvery delta zone, where the initial level was 213.75 ±10.90 Kg per ha and the final level was 134 ±6.97 Kg per ha. This might be due to the application of farmyard manure during the cropping period as reported by Meena *et al.* (2018). Whereas, the phosphorus, potassium and SOC were reduced at the end of four years of trial in majority of the zones. Han *et al.* (2016) found out that the increase in the soil pH was due to addition of organic manure In contrast, the decrease the soil pH and exchangeable calcium concentration, did not affect the soil concentrations of nitrogen and

magnesium, and increased the concentrations of available phosphorus and exchangeable potassium, when NPK inorganic fertilizers are applied. In another study, the supply of 25% to 80% additional C input to the soil was due to the application of organic manure (Maltas *et al.,* 2018). In the present study, intensive crop production in the same field and no crop rotation since four years might have resulted in reduction in phosphorus, potassium and SOC.

Similar results were observed (Table 2) for all the parameters in the soil where the CN hybrid grass were cultivated, except that the EC has reduced drastically. In a study with CN hybrid grass, Sathiyabama (2017) reported that the major of nutrients available in the soil after completing three-year period, there was a drastic depletion of almost all nutrients in the soil. The nutrient uptake pattern of Cumbu Napier hybrid grass indicated that, N, P and K content was removed heavily from the soil. The secondary and micronutrients also heavily removed from the soil. Sathiyabama (2017) also reported that in the Cumbu Napier Hybrid Grass, there was a drastic improvement in the organic carbon status of the soil by the application of organic manures. In the present study, most of the nutrients are depleted except in north western zone, *i.e.* at institutional land, Kattupakkam, the SOC has improved from 0.22 per cent to 0.48 per cent.

Table 2: Changes in soil profile of Cumbu Napier grass field (Mean* ± SE)

Soil parameters	North Eastern Zone		Cauvery Delta Zone		Western Zone		Southern Zone	
	At start	At the end of 4th year	At start	At the end of 4th year	At start	At the end of 4th year	At start	At the end of 4th year
pH	7.52±0.38	7.03±0.37	7.45±0.38	6.81±0.35	7.08±0.37	6.52±0.34	7.09±0.37	6.25±0.32
EC(dSm^{-1})	0.46±0.02	0.03±0.01	0.45±0.02	0.15±0.01	0.86±0.04	0.04±0.01	0.94±0.05	0.52±0.03
N (Kg/ha)	188.51 ±9.43	252.42±13.12	188.51±9.61	165 ±8.58	112.51 ±5.85	162.25 ±8.44	160.52±8.38	274 ±13.97
P (Kg/ha)	10.51±0.53	20.11±1.05	13.25±0.68	5.5±0.29	18.50 ±0.96	18.60 ±0.97	17.35±0.89	11.50 ±0.59
K (Kg/ha)	140.00 ±7	83±4.32	185.25±9.44	78.24±4.06	190.00±9.88	92.22±4.79	185.75±9.7	244.50±12.47
SOC (%)	0.22±0.01	0.48±0.02	0.58±0.03	0.42±0.02	0.82±0.04	0.48±0.03	0.72±0.04	0.56±0.03

** Mean of six samples*

Conclusion

From the results in Table 1 and 2, it could be concluded that there is an influence of organic manure on the soil parameters, i.e., change in pH, electrical conductivity, soil available potassium and soil organic carbon in all the four agro climatic zones of Tamil Nadu over 4 years. There is an increase in the level of soil nitrogen which might be due to the application of organic fertilizers for both the crops subjected to this experiment and *Desmanthus virgatus* being a legume crop fixes atmospheric nitrogen in the soil (Frankow-Lindberg and Dahlin, 2013). Moreover, when continuous mono-cropping without crop rotation is practiced, it is clear that the soil nutrients including pH and EC reduce to moderate to drastic amounts.

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Conflict of Interests

There is no conflict of interest.

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