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Evaluating the Performance of Organic, Inorganic and Liquid Sheep Manure on Growth, Yield and Nutritive Value of Hybrid Napier CO-3

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***Abstract*—**Less availability of high quality green forages leads to low productivity of national dairy herd of Sri Lanka. Growing grass and fodder to suit the production system is an efficient and economical solution for this problem. CO-3 is placed in a higher category, especially on tillering capacity, green forage yield, regeneration capacity, leaf to stem ratio, high crude protein content, resistance to pests and diseases and free from adverse factors along with other fodder varieties grown within the country. An experiment was designed to determine the effect of organic sheep manure, inorganic fertilizers and liquid sheep manure on growth, yield and nutritive value of CO-3. The study was consisted with three treatments; sheep manure (T1), recommended inorganic fertilizers (T2) and liquid sheep manure (T3) which was prepared using bucket fermentation method and each treatment was consisted with three replicates and those were assigned randomly. First harvest was obtained after 40 days of plant establishment and number of leaves (NL), leaf area (LA), tillering capacity (TC), fresh weight (FW) and dry weight (DW) were recorded and second harvest was obtained after 30 days of first harvest and same set of data were recorded. SPSS 16 software was used for data analysis. For proximate analysis AOAC, 2000 standard methods were used. Results revealed that the plants treated with T1 recorded highest NL, LA, TC, FW and DW and were statistically significant at first and second harvest of CO-3 ($p< 0.05$) and it was found that T1 was statistically significant from T2 and T3. Although T3 was recorded higher than the T2 in almost all growth parameters; it was not statistically significant ($p >0.05$). In addition, the crude protein content was recorded highest in T1 with the value of 18.33±1.61 and was lowest in T2 with the value of 10.82±1.14 and was statistically significant ($p< 0.05$). Apart from this, other proximate composition crude fiber, crude fat, ash, moisture content and dry matter were not statistically significant between treatments ($p >0.05$). In accordance with the results, it was found that the organic fertilizer is the best fertilizer for CO-3 in terms of growth parameters and crude protein content.

***Keywords*—**Fertilizer, growth parameters, Hybrid Napier CO-3, proximate composition.

I. Introduction

DAIRY industry is the most important of all livestock subsectors in Sri Lanka. At present agricultural sector contributes 16.8% to national Gross Domestic Production (GDP). The livestock subsector contributes around 1.2% of national GDP [4]. Sri Lanka is self-sufficient in most animal products apart from dairy. The performance of dairy cattle is largely influenced by the feeding and other related management practices. Sri Lanka has low productivity of national dairy herds when compared with the South and Southeast Asian countries, mainly due to less availability of good quality green forages together with poor nutritional quality [3]. To enhance the milk production, it is necessary to feed animals with high nutritious green fodder. Subsequently, high yielding forages including numbers of Hybrid Napier varieties are introduced recently in Sri Lanka [3]. In terms of hybridization, CO-3 is an inter specific hybrid between Bajra (*Pennisetum americanum* (L.) Leeke) and a selection of a Napier (*Pennisetum purpureum* Schumach) [5]. It is one of the high yielding and nutritious perennial tropical fodder grass and considered as cut and carry fodder for stall feeder system [3]. CO-3 Hybrid Napier grass was developed by the scientists at Tamil Nadu Agricultural University (TNAU) at Coimbatoor, India and forwarded for commercial cultivation in 1997 [7]. After that Animal Husbandry Department, Government of Tamil Nadu, India has taken action to familiarize this grass among farmers (Policy Note, 2005/2006). Also, this grass is introduced to Sri Lanka in 1999 by the Livestock Breeding Project to encourage and motivate the forage development activities [1].

CO-3 can be categorized in higher rank due to high tillering capacity, green forage yield, leaf stem ratio, regeneration capacity, crude protein content and in resistance to pest and diseases with compare to other livestock forages grow with in the country [3]. Suitable management practices along with correct application methods of fertilizer, irrigation in drought condition, harvesting at the recommended interval is a must for maximum outcome and sustainability of the crop. With the correct management and harvested at correct stage of life, CO-3 grass contains 18-20% dry matter and 15-16% crude proteins, 9.8-12.8% ash, 34-37% crude fiber on dry matter basis.

Previous studies have been already revealed that the plant treated with organic fertilizer yielded higher than recommended inorganic fertilizer [3]. Few studies have been conducted on the effect of liquid sheep manure, which has been prepared using bucket fermentation method under aerobic condition; on growth, yield and nutritional composition of CO-3. Liquid sheep manure is a liquid extract

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of sheep manure consisting with essential plant nutrients and beneficial microorganisms which recycle the organic matter. Liquid sheep manure boost the plant and soil enhancing activity of soil life. This has been a multiple use and can be used as a fertilizer, pesticide and fungicide [2]. Hence, the objective of this study was to determine the effect of sheep manure, recommended inorganic fertilizers and liquid sheep manure on growth parameters and nutritional composition of CO-3.

II. Methodology

A. Site Description

This study was carried out at the farm unit of Department of Livestock and Avian Sciences, Wayamba University of Sri Lanka, Makandura, Gonawila in Sri Lanka (IL1a) from March to August 2015.

TABLE I
WEATHER DATA FOR THE STUDY PERIOD [9]

Month	Day temperature °C		Average rainfall mm
	Maximum	Minimum	
March	33.4	22.9	138
April	33.1	24.1	238
May	31.9	25.2	270
June	30.9	24.9	160
July	30.6	24.9	100
August	30.9	24.9	90

B. Arranging Treatments

Three treatments were used in this study as dried sheep manure (T1), recommended inorganic fertilizers (T2) and liquid sheep manure (T3). Each treatment was consisted with three replicates and those were assigned randomly. Treatments were laid with randomized complete block design. Irrigation and weeding were done frequently for each plot.

C. Preparation of Fertilizer Solutions

In case of liquid sheep manure, 800g of sheep manure was placed in a water container with 4 L of water using a cotton cloth sack, 1 week prior to application. Tea-bag (the sac) was securely tightened and immersed in water. Liquid was aerated by manual agitation twice a day. The Electrical conductivity (EC) and pH of the tea was analyzed prior to application.

Properly, filtered liquid solutions were applied for plants before a week of plant establishment, 7-8 days of plant establishment and after first harvest.

D. Planting Material

Stem cuttings of CO-3 with 2-3 active nodes were used as planting material. Pure planting materials were selectively cut from the cultivated fields of Walpita Government Farm, Sri Lanka.

E. Planting Beds and Holes Preparation

Raised beds of 1m x1m were prepared for each replicates. Each bed was consisted with four planting holes with the dimensions of 30 cm x 30 cm x 30 cm. Cuttings were established in spacing of 60 cm x 60 cm.

F. Fertilizers (Treatments) Application Pattern

Fertilizer was applied in various stages of CO-3 life cycle as a week before plant establishment, 7-8 days after plant establishment and after each harvest.

TABLE II
INORGANIC FERTILIZER APPLICATION PATTERN

	1 week before establishment (g/m^2)	After 7-8 days of establishment (g/m^2)	After 1st cutting (g/m^2)
Urea	10	20	10
TSP	6	12	27.5
MOP	5	10	22.5

In addition to above applications, 10g of urea was applied to each planting hole under treatment.

For the T1, 2Kg of dried sheep manure was applied per planting hole.

In case of liquid sheep manure, 2L of the solution was added per planting hole.

pH was measured throughout the experimental period after each fertilizer application round. pH of the soil ranges from 6.8-7.0 throughout the experimental period.

G. Data Collection

The first harvest was obtained 40 days after plant establishment and following data were recorded. Number of Leaves (NL) was counted manually, Leaf Area (LA) was measured using LI COR leaf area meter, Tillering Capacity (TC) was also counted at the time of harvesting. Fresh Weight (FW) was obtained using the scale and fresh samples were oven dried for 24 hours at 105 °C to obtain Dry Weights (DW). The second harvest was obtained 30 days after first harvest and the same data were recorded as above.

H. Proximate Analysis

Proximate composition including Ash, Crude Protein (CP), Crude Fat, Crude Fiber (CF), Moisture content (MC) and Dry matter (DM) content were analyzed using AOAC, 2000 standard methods. Crude Protein was measured using Kjeldhal method. Crude Fat was obtained through solvent extraction methods and moisture level and Dry weight was obtained using oven dried methods and Ash content was analyzed using muffle furnace methods.

I. Statistical Analysis

The collected data were analyzed using standard SPSS 16 and Microsoft Excel. The effect of fertilizers on growth and yield on CO-3 was analyzed using ANOVA and mean comparison techniques with the aid of SPSS 16 software. Each and every test 95% of confident level was used. In addition to evaluate the effect of fertilizers on nutritive value of Hybrid Napier CO-3 grass, the resulted mean proximate composition such as crude protein, crude fat, crude fiber, ash, moisture content and dry matter content were analyzed with Standard SPSS 16 software at 95% confidence level.

III. Results and Discussion

A. Growth Parameters at First Harvest

TABLE III
GROWTH PARAMETERS AT FIRST HARVEST

	TC	LA(cm^2)	NL	FW(g)	DW(g)
T1	13.08±2.50[a]	6542±409.73[a]	87.5±11.71[a]	332.42±14.32[a]	40.92± 2.64[a]
T2	4.08±0.76[b]	1053±507.06[b]	28.16±12.79[b]	65.03±49.04[b]	12.73±5.42[b]
T3	6.5±3.73[b]	1439±905.15[b]	43.26±25.56[b]	90.83±67.79[b]	13±8.5[b]

For each variable, means followed by the same letter are not significantly different at P=0.05 level.

B. Growth Parameters at Second Harvest

TABLE IV
GROWTH PARAMETERS AT SECOND HARVEST

	NL	TC	FW(g)	DW(g)
T1	134.08±19.24[a]	13.58±1.13[a]	925±191.62[a]	247.33±59.42[a]
T2	28.66±2.96[b]	6.61±2.96[b]	136.89±6.58[b]	27.69±6.58[b]
T3	40.06±24.95[b]	6.2±3.62[b]	148.25±23.92[b]	37±23.92[b]

For each variable, means followed by the same letter are not significantly different at P=0.05 level.

The effect of fertilizers on NL, LA, TC, FW and DM were statistically significant between each treatment at first and second harvest. NL and LA were significantly highest in T1, where plants treated with dried sheep manure compared to the rest of T2 and T3, where plants treated with recommended inorganic fertilizers and liquid sheep manure at both harvest, respectively. Although T3 was recorded higher than T2 in case of NL and LA, it was not statistically significant at both harvests. As a result, there is a good potential for the plants treated with dried sheep manure for higher sunlight interception. This may lead for higher dry matter production and increase the potential for higher dry matter assimilation. This may be the reason for having the significantly highest fresh weight and dry weights in the plants treated with dried sheep manure (T1).

The increased photosynthetic tissues and dry matter assimilation may have positive effect on higher dry matter partitioning to produce more number of tillers which was observed in T1 at first and second harvest compared to T2 and T3. In addition, T1 was statistically significant from T2 and T3 (Tables II and III); T3 was recorded higher than T2 but it was not statistically significant on TC at both harvest. In terms of FW and DW were recorded highest T1 and it was statistically significant from T2 and T3.

Highest NL, highest LA highest TC and highest FW are indicators of highest yield resulted in the plants treated with dried sheep manure. However statistical analysis revealed that there was no significant difference between T2 and T3 at both harvests. Overall all growth parameters in each treatment were resulted higher in second harvest since the root systems were already established.

C. Proximate Composition of Each Treatments

In terms of nutritive value ash, crude fiber, crude fat, moisture level, dry matter was not statistically significant between each treatment. However statistical analysis revealed that there was a significant different between T1, T2 and T3 on crude protein content, where it was recorded highest in T1 with the value of 18.33±1.61 and lowest in T3 with value of 10.82±1.14. The concept of liquid sheep manure is to optimize the nutrient absorption by CO-3 (Table IV).

TABLE V
PROXIMATE ANALYSIS OF EACH TREATMENT

	CP (DM %)	Ash (DM %)	CF (DM %)
T1	18.33±1.61[a]	12.39±1.73[a]	18.07±2.66[a]
T2	13.6±0.99[b]	8.25±2.08[a]	10.86±4.13[a]
T3	10.82±1.14[c]	7.84±1.58[a]	11.86±2.9[a]

For each variable, means followed by the same letter are not significantly different at P=0.05 level.

TABLE VI
PROXIMATE ANALYSIS OF EACH TREATMENT

	Crude Fat (DM %)	ML (DM %)	DM (DM %)
T1	14.48±1.15[a]	87.66±1.19[a]	12.34±1.20[a]
T2	10.23±1.31[a]	81.94±6.46[a]	18.05±6.46[a]
T3	14.48±2.16[a]	82.07±7.15[a]	17.54±7.15[a]

For each variable, means followed by the same letter are not significantly different at P=0.05 level.

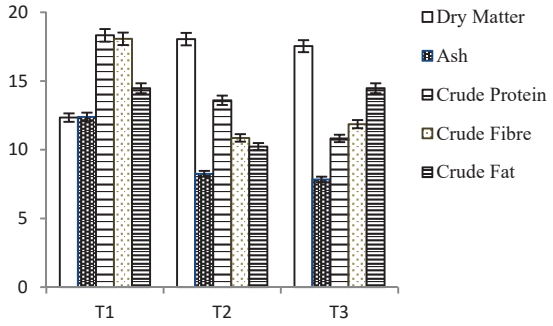

Fig. 1 Comparison of proximate composition

In overall, according to the results, T3 was not performed well than T2 and T1. This may be due to the lower EC value in the liquid sheep manure (0.945 dS/m). EC is an indirect indication of the strength of the nutrient (hydroponic) solution. The optimum EC from plant growth ranges from 1.5 -2.5 dS/m.EC more than 2.5dS/m hinders nutrient absorption due to increase in osmotic pressure and lower EC may severely affects the plant health and yield [6]. Accordingly, it seemed that most of the nutrients have not been extracted for the liquid through fermentation. Another reason for poor performance of innovative sheep manure liquid may be the high pH of about 8.13. In general plants prefer a pH of about 5.5-6.5. In this pH range elements N and P are less available for plants to uptake. Nitrogen is essential for vegetative growth and development. Therefore, the significantly lower amount of leaves and leaf area in the plants treated with liquid manure may be due to lower EC value. However, K, Ca, Mg and S are available for the plants at that pH range values. In addition, unavailability of the essential micro nutrients likes Fe, Mn, B, Cu, and Zn may have a negative impact on plant performance in this treatment.

The purpose of liquid application to increase absorption rate of plants while reducing the need of frequent irrigation. However, another reason for poor performance under T3

would be the leaching losses and runoff as it was directly applied to the soil in open field. The chance for evaporation is also high. This also makes less availability of nutrients for plants to uptake.

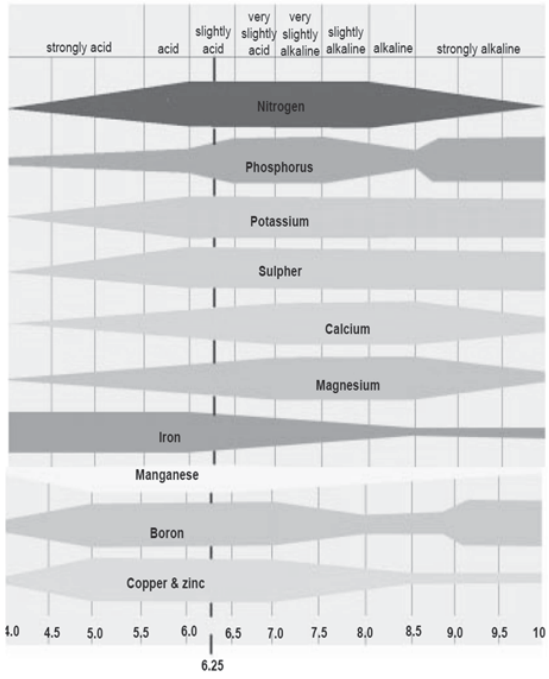

Fig. 2 Nutrient availability chart with different pH values [8]

The higher vegetative performance of plants at both harvests under the T1 with dried sheep manure may be because fertilizer is available for long period of time to uptake gradually. The possible wastages through leaching, run off and evaporation are much negligible when applied as solids fertilizers. And also pH of the soil becomes average of 6.8 after fertilizer application. This pH makes N, P, K, Ca, Mg, S essential macro elements available for plants in absorption where even micro elements B, Cu and Zn are also available for plants.

IV. Conclusion

Plants treated with dried sheep manure resulted highest values in all most all growth parameters of both harvest. However, impact on fertilizers on plants treated with recommended inorganic fertilizers and liquid sheep manure were statistically not significant at both harvest on CO-3. The impact of fertilizers on moisture content, ash, crude fiber, crude fat and dry matter content were statistically not significant. The effect of fertilizers on crude protein content was statistically significant; where it was recorded highest in plants treated with dried sheep manure and was recorded lowest in plants treated with liquid sheep manure.

As dried sheep manure performed better with higher yield in CO-3, it can be suggested to use dried sheep manure in pasture fields with CO-3.

Though inorganic fertilizers were showed as the second highest performer, it has to rethink in organic systems for sustainable agriculture. However, Further studies to be recommended to find out the suitable dilution trials to obtain the liquid sheep manure at optimum EC level to stimulate the growth of the plant and it is recommended to introduce new methods to increase the retention capacity of the liquid sheep manure to avoid losses such leaching, runoff, seepages etc.

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