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# Yield, quality and soil fertility status as influenced by different nutrient sources in Cumbu Napier hybrid fodder grass

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**Abstract**
To study the impact of different nutrient sources (organics, inorganics INM) on yield and quality of important perennial fodder, Cumbu Napier Hybrid Grass CO (CN) 4 an experiment was carried out. Three year data of the experiment reveals that the basal application of FYM @105 t/ha (N equivalent basis) + 2 kg Azospirillum+2 kg PhosPhobacteria recorded the highest green fodder yield of 360.7 t/ha/y. The crude protein content got increased in the FYM applied treatment. The higher organic carbon content of 1.28% from the initial carbon status of 0.62% recorded in the FYM treatment. The poultry manure (PM) applied plot recorded higher available N content of 185, kg/ ha from the initial soil available N content of 165 kg/ha. The higher available K content of 578 kg/ha was recorded in the same treatment. The higher uptake of N,P,K,Ca,Mg,S,Fe,Mn,Zn and Cu was recorded in the FYM applied plots. The PM applied plot recorded the highest net returns of Rs. 2, 70,000/ha/yr and B: C ratio of 4.3 per ha.

**Keywords:** Cumbu Napier Hybrid grass, Farm Yard Manure, Poultry Manure, fodder yield, quality, nutrient uptake, soil nutrients, Economics

## 1. Introduction

Cumbu Napier grass grows faster and produces more herbage. Nitrogen is an important agronomic input for bajra napier production. Historically, inorganic source has been a major N source. Nowadays because of rising costs of natural gas which is used in N fertilizer synthesis, fuel for fertilizer transport, the organic manures also represent one of sources of N which can be used in forages. The challenge to supplying crop nutrient requirements through manure source is balanced supply and demand because the ratio of N:P in nutrient source is very different from that required by crops. Essential elements locked up in the organic manures are slowly mineralized and made available to the crops, which increased the crop yield, soil fertility and nutrition of crops (Clarson, 1998) [9]. The organic manures greatly enhanced the soil microbial population and produce more microbial biomass than inorganic which directly stimulating the activity of microorganism (Shanthi *et al*., 2012) [23]. Manure can be a valuable source of nutrients for grass. It is a "complete" fertilizer, containing varying amounts of all the major and minor plant nutrients. Manure applications may also improve soil physical properties such as water infiltration rate, aggregate size and stability, pore size and crust strength. These improvements in turn translate into better soil quality and improved productivity. Besides the differences in N concentration, different N sources may not be equally effective when applied to fodder crops. A number of factors, including soil type, rate and method of application, forage management and environmental conditions can impact the effectiveness of different fertilizer sources to provide N to Crops(Mubarak *et al*., 2010) [20].

The required amount of nutrients for napier grass may be supplied through both inorganic and organic for grass. But due to the farmers demand on organic way of grass fodder production, the research work is started with organic sources alone and compared with Integrated Nutrient Management and inorganics. The multicut cumbu napier hybrid grass needs heavy nutrient for its robust growth at basal and different cutting stages (seven cuttings per annum).Required N for whole year meet through organic manure application as a full dose at basal itself will fulfill the N needs. Organic fertilizer sources can satisfactorily provide N to forage grasses. Because the whole dose of N required for the perennial grass given in the initial development itself. These organic sources will be slowly available as and when required and as the organic compounds mineralize, N and other essential nutrients become available (Goswami, 2007) [12].

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The recently developed cumbu napier hybrid grass variety CO $(CN)_4$ has the greatest potential to grow under various soil fertility and nutrient condition. In the present research work the easily available organic sources such as FYM and poultry manures are tried as N source. FYM is a well-recognized and considered as balanced bulky organic manure which increases the moisture retention of the soil and helps in dissolution of nutrients. The organics were applied along with bio fertilizers (Azospirillam). The beneficial effect of azospirillam on plant is associated not only with the process of N fixation and improved nutrition of plants. Also with the synthesis of complex biologically active compounds such as pyridoxine, biotin, gibberellins and other compounds which accelerate plant growth under favourable environmental conditions. Among the various nutrient management practices, the current issue of identifying suitable organic source to cumbu napier grass will be highly useful to the thirty organic forage growers. Of the major nutrient elements, nitrogen has special significance in increasing green biomass yield and its quality. Nitrogen fertilization has been reported to improve not only the yield but also the crude protein content. With the above points in mind this study was attempted with different locally available organic sources such as FYM and poultry manure on N equivalent basis and compared with INM and inorganics to get sustained optimum yield. Bama (2014) [3] reported the higher carbon sequestration potential of the Cumbu napier hybrid grass type. Results of the field experiment revealed that the application of spentwash @ 50 kilo litre per ha at full dose with recommended dose of nitrogen and phosphorus increased the quality parameters, nutrient parameters and green fodder yield over recommended dose of fertilizers (Latha *et al*.,2015) [16].

## 2. Materials and methods

Experiment was carried out at the Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore, Tamil nadu to study the impact of different nutrient sources (organics, inorganics INM) on yield and quality of important perennial fodder Cumbu Napier hybrid grass $CO(CN)_4$ during the year 2009 to 2012. The nutrient sources viz., Farm Yard Manure (FYM) on N equivalent basis(105 t/ha0 with 2 kg Azospirillam+ 2 kg phosphobacteria (S1), Poultry Manure (44 t/ha) with 2 kg Azospirillam+ 2 kg phosphobacteria (S2), INM (Inorganics + 25 t FYM/ha/yr) (S3) and inorganics alone (75:50:50 kg N P K /ha/yr as basal and 75 kg N /ha/yr after each harvest, totally 7 cuts /year) (S4) 525 kg N/ha were tried in this experiment. The FYM and Poultry manure applied on N equivalent basis and for inorganics treatment, NPK recommendation is 75:50:50 kg/ha. Each time N was top dressed @75 kg/ha and for INM (inorganics + 25 t of FYM /ha) and inorganics. Totally seven cuts harvested per annum and total N requirement @ 525 kg/ha/yr was applied. The soil analysis report before the commencement of experiment revealed that, the soil is slightly alkaline (7.8) and free from excessive salts (0.12dS/m). It is medium in organic carbon (0.65%) and low in available N (165 kg/ha), medium in available P (15 kg/ha) and high in available K (510 kg/ha). The green fodder yield was recorded as such in the field. The dry fodder yield recorded by keeping the samples in electric oven at 65ºC. The available N in soil was estimated by alkaline potassium permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et al.*, 1954), available K by flame photometer method (Stanford and English, 1949) and micronutrients by DTPA extraction technique (Jackson, 1973). The plant samples were analysed at cutting stage for N, P, K, S, Ca, Mg, S and micronutrients by acid digestion technique. (Piper, 1966) [21]. The fodder quality parameters viz., crude protein, crude fibre and crude fat contents were estimated by the procedure outlined by Van Soest and Moore (1965) [29]. The data was analysed statistically by using simple RBD.

## 3. Results and Discussion

### Fodder yield

The first year data of this experiment showed that, among the different source of nutrients tried to improve the green fodder yield of Cumbu Napier Hybrid grass, the FYM applied on N equivalent basis (105 t FYM/ha/yr) recorded the highest green fodder yield of 341.3 t/ha/yr followed by poultry manure applied on N equivalent basis (44 t PM/ha/yr) which recorded 314 t/ha/yr (Table1). Though the INM (282.4 t/ha/yr) recorded numerically higher yield than inorganics, it was statistically on par with inorganics alone (275.2 t/ha/yr). During second and third year also same trend of result observed. The pooled analysis of three year data showed that the application of FYM @105 t/ha/yr recorded 360 t/ha/yr which is 25 percent increase over inorganics (fig1). The higher dry fodder yield was recorded in FYM (79.18 t/ha/yr) and the lowest was recorded in the inorganics alone (63.85 t/ha/yr). These findings are in close conformity to those of Gill *et al*. (1988) [10] and Kumar and Sharma (2002) [15] in fodder sorghum. The higher green fodder yield in the organics applied plot might be attributed to better supply of nutrients by conducive physical environment leading to better root activity and higher nutrient absorption, which resulted in better plant growth and superior yield (Hati *et al*., 2007; Selvi *et al*., 2005; Mishra *et al.,2008*; Thakur *et al*., 2011) [13, 22, 18, 28]. Golada *et al*. (2012) [11] reported that application of FYM significantly increased the green fodder yield of pearl millet.

## Quality Parameters

### Fodder quality

The important fodder quality parameters viz., crude protein, crude fibre and crude fat content were analysed. Among the treatments, the FYM applied plot recorded higher crude protein content (8.8%). Bama *et al* (2013) [6] reported that poultry manure application @18.8 t/ha+2 kg Azospirillum+2 kg Phosphobacteria recorded 167.6 t green fodder yield/ ha/year. There was no significant difference observed in the crude fibre and crude fat analytical data (Table 1).

### Nutrient uptake

The data on the uptake of nitrogen indicated that there was significant increase in FYM applied plot of 1215 kg/ha which was followed by PM applied (1074 kg/ha) and INM (974 kg/ha) (Table2).The higher P uptake of 518 kg/ha was recorded in the FYM plot which was on par with PM applied plot (502 kg/ha). The lowest P uptake recorded in the inorganics plot (332 kg/ha). The potassium uptake recorded during first year indicated that there was significant increase in FYM applied plot of 1476 kg/ha recorded which was on par with PM applied (1383 kg/ha) followed by INM (1286 kg/ha). The lowest K uptake was recorded in inorganics plot of 1014 kg/ha (fig2). Forage crops require high amount of N and P (Latha *et al*., 2013) [16]. The increase in uptake of nutrients in the organic applied plots may be due to slow release of nutrients by the organics might have met the fodder crop requirement (Vijayakumar, 2006: Suganya, 2008) [30, 27].

Highest Ca uptake of 967 kg/ha was recorded in the FYM plot which was followed by INM applied plot (842 kg/ha) and

PM plot (825 kg/ha). The lowest Ca uptake recorded in inorganic alone plot (664 kg/ha).The uptake of Magnesium indicated that the FYM applied plot recorded of 328 kg/ha which was on par with PM applied plot (324 kg/ha) followed by INM plot (271 kg/ha). The lowest Mg uptake was recorded in inorganics plot of 213 kg/ha. The sulphur uptake recorded during first year indicated that there was significant increase of S uptake in FYM applied plot of 95 kg/ha recorded which was on par with PM applied (88 kg/ha) followed by INM (82 kg/ha). The lowest N uptake was recorded in inorganics plot of 65 kg/ha. The increased secondary nutrients such as Ca, Mg and S uptake might be due to higher biomass production by the organics application as weel as higher nutrient content in the organics. This is in line with Hati *et al.* (2007) [13].

Highest Fe uptake of 176 kg/ha was recorded in the FYM plot which was on par with PM applied plot (165 kg/ha) followed by INM plot (153 kg/ha). The lowest Fe uptake was recorded in inorganics plot (121 kg/ha). The uptake of Manganese indicated that the FYM applied plot recorded 23.0 kg/ha recorded which was on par with PM applied plot (21.5 kg/ha) and followed by INM plot (20.0 kg/ha). The lowest uptake was recorded in inorganics plot of 15.8 kg/ha. Higher Zn uptake of 15.9 kg/ha was recorded in the FYM plot which was on par with PM applied plot (14.9 kg/ha) followed by INM plot (13.8 kg/ha). The lowest Zn uptake was recorded in inorganics plot (10.9 kg/ha). The same trend of results observed in second and third year also. Non-significant copper uptake was observed. Organics had significant influence on the micro nutrients compared to recommended dose of fertilizer. This might be due to that high micro nutrient content with FYM application. This is in line with findings of Bhalerao *et al.* (2006) and Madhumitadas *et al.* (2010).The increased nutrient uptake by the poultry manure alone applied plot in the multicut sorghum was reported by Bama *et al.*(2013) [6].

**Soil Fertility**

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 (Table 3). The FYM applied on N equivalent basis recorded higher organic carbon content of 1.28%, followed by poultry manure applied treatment (0.91%), from the initial carbon status of 0.62%.The increase in organic carbon content in the manorial treatment is attributed to direct addition of organic manure in the soil which stimulated the growth and activity of microorganisms and also due to better root growth resulting in the higher production of biomass, crop stubbles and residues (Yilmaz and Alagoz, 2010; Singh *et al*.,2011; Moharana *et al*.,2012) [32, 26, 19]. The subsequent decomposition of these materials might have resulted in the enhanced carbon content of soil these results are in agreement with the findings of Singh *et al.* (2008) [25] and Kumar *et al.* (2008) [25]. Further the addition of FYM might have created environment conducive for formation of humic acid, which ultimately resulted in an increase in the organic carbon content of the soil. (Bajpai *et al*., 2006) [2]. The analytical data of the available nitrogen status of the soil showed that, the poultry manure applied plot recorded higher available N content of 185 kg $ha^{-1}$ followed by FYM applied treatment of 180 kg $ha^{-1}$ compared to rest of the treatments. The increase in available N might be attributed to the enhanced multiplication of microbes by the incorporation of manures for the conversion of organically bound N to inorganic form and release of N bearing organic compound during FYM decomposition. The favourable soil conditions under organic manure application might have facilitated the mineralization of soil N leading to build up of higher available N (Vipin Kumar and Singh, 2010) Singh *et al.* (2000) [24]. The higher available P content of 20.2 kg/ha observed in the poultry manure applied plot which was followed by FYM applied plot (19.8 kg $ha^{-1}$). The increased availability of P with organics could be ascribed to their solubilising effect on the native soil P and consequent contribution of the P as solubilised to labile pool. Organic matter may also reduce the fixation of phosphate by providing protective cover and reduce the phosphate fixing capacity and increase the available P in soil. (Bharadwaj and Omanwar, 1994; Agarwal and Kumar,1996) [8, 1].

Higher available K content of 578 kg $ha^{-1}$ recorded in the FYM applied treatment. The higher exchangeable Ca content was recorded in the FYM plot (17.5 cmol (p+)/kg) which was followed by PM plot (15.2 cmol (p+)/kg).The INM (14.3 cmol (p+)/ kg) and inorganics (13.5 cmol (p+)/kg) recorded comparable values. Higher exchangeable Mg was recorded in FYM plot (7.2 cmol (p+)/ kg) which is followed by 6.8 cmol (p+)/ kg. The DTPA extractable micro nutrient results revealed that higher Fe content recorded in FYM applied plot (10.2 ppm) followed by INM (7.9 ppm) and inorganics (7.8 ppm). The same trend of results observed in Zn Mn and Cu contents.

**Soil nutrient balance sheet**

The major nutrients available in the soil after completing three year period indicated that, there was a drastic depletion of almost all nutrients in the soil (Table 4). 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. If that crop is recommended widely the fertilizer schedule has to be restudied. Especially the potassium was highly mined from the soil. Hence the K study related to pools of K, sources and doses of K have to be taken care. Bama (2016) [4] also reported same results with Lucerne crop.

**Effect of source of nutrients on economics of fodder cultivation**

Data pertaining to influence of inorganic and organic source of nutrients on economics of fodder cultivation are presented in Table5. The results showed that the PM applied plot recorded the highest net returns (Rs. 2,70,000) and B:C ratio (4.3) per ha followed by INM (Rs2,46,915) and PM(Rs 2,28,500). But the FYM application recorded lower B/C ratio of 2.5.Apart from economics according to Bama and Babu (2016) [4], forages particularly grass type fodder contributes to carbon sequestration and most part of the long time carbon storage from roots i. e. below ground portion. This type of fodder crop can saturate carbon level quickly wherever the climate change mitigation is essential. Among the various forage crops, Cumbu napier hybrid grass removed higher carbon removal by above ground biomass and in the below ground biomass. Among the sources, farm yard manure. This information add an another important point to this article.

**4. Conclusion**

The experiment taught that, the basal application of FYM @105 t/ha+ 2 kg Azospirillum+2 kg Phosphobacteria may be recommended for highest green fodder yield and crude protein yield and soil fertility. However from economic point of view if the farmer want to adopt organic farming practice the PM 44 t/ha +2 kg Azospirillum+2 kg Phosphobacteria can be recommended. However, the negative nutrient balance of almost all nutrient reveals the grass was a voracious feeder of nutrients. Hence these nutrients have to be recommended with required dose to grass type fodder crops. If grass type cumbu napier hybrid grass is recommended for cultivation the fertilizer schedule has to be researched.

**Table 1:** Effect of source of nutrients on yield and quality yield cumbu napier hybrid grass

| Treatments | Green fodder yield(t/ha/yr) | | | | Dry fodder yield (t/ha/yr) | | | | Quality (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | I year | II year | III year | Mean | I year | II year | III year | Mean | Crude protein | Crude fibre | Crude fat |
| S1-FYM | 373.5 | 341.3 | 365.2 | 360.7 | 86.3 | 79.18 | 84.73 | 83.4 | 8.8 | 31.9 | 2.3 |
| S2-PM | 350.2 | 314.0 | 342.1 | 335.4 | 80.9 | 72.84 | 79.37 | 77.7 | 8.3 | 31.5 | 2.2 |
| S3-INM | 325.7 | 282.4 | 314.3 | 307.5 | 75.2 | 65.52 | 72.92 | 71.2 | 8.1 | 32.1 | 2.1 |
| S4-Inorganics | 256.9 | 275.2 | 269.4 | 267.2 | 59.3 | 63.85 | 62.50 | 61.9 | 7.6 | 32.5 | 2.1 |
| CD (5 %) | 20.1 | 26.8 | 21.3 | | 5.1 | 6.8 | 6.3 | | 0.4 | NS | NS |

**Table 2:** Effect of source of nutrients on nutrient uptake of Cumbu Napier hybrid grass

| Treatments | Nutrient uptake( kg/ha/yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | S | Fe | Zn | Mn | Cu |
| S1-FYM | 1215 | 518 | 1476 | 967 | 328 | 95 | 176 | 15.9 | 23.0 | 4.83 |
| S2-PM | 1074 | 502 | 1383 | 825 | 324 | 88 | 165 | 14.9 | 21.5 | 4.53 |
| S3-INM | 975 | 451 | 1286 | 842 | 271 | 82 | 153 | 13.8 | 20.0 | 4.21 |
| S4-Inorganics | 721 | 332 | 1014 | 664 | 213 | 65 | 121 | 10.9 | 15.8 | 3.32 |
| CD (5 %) | 102 | 56 | 152 | 96 | 35 | 9 | 19 | 1.8 | 2.0 | Ns |

**Table 3:** Effect of source of nutrients on soil nutrient status of Cumbu napier hybrid grass grown soil

| Treatments | SOC | Major nutrients (kg/ha) | | | Secondary nutrients cmol p(+)/kg) | | DTPA extractable Micronutrients (ppm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (%) | N | P | K | Ex.Ca | Ex.Mg | Fe | Zn | Mn | Cu |
| S1 | 1.28 | 180 | 19.8 | 578 | 17.5 | 7.2 | 10.2 | 6.8 | 7.2 | 7.2 |
| S2 | 0.91 | 185 | 20.2 | 561 | 15.2 | 6.8 | 8.7 | 5.9 | 6.7 | 6.8 |
| S3 | 0.80 | 160 | 19.5 | 553 | 14.3 | 6.2 | 7.9 | 5.1 | 6.2 | 6.2 |
| S4- | 0.70 | 153 | 18.5 | 532 | 13.5 | 5.7 | 7.8 | 4.5 | 5.7 | 5.7 |
| CD (5%) | 0.10 | 17 | 0.3 | 16 | 1.8 | 0.8 | 0.7 | 0.5 | 0.8 | 0.8 |

**Table 4:** Soil nutrient balance sheet for Cumbu Napier Hybrid Grass

| Treatments | Nitrogen | | | | | |
|---|---|---|---|---|---|---|
| | Initial(a) | Applied(b) | Uptake© | Postharvest(d) | Actual gain(d-a) | N balance (a+b)-(c+d) |
| S1 | 165 | 525 | 1174 | 180 | -15 | -664 |
| S2 | 165 | 525 | 1032 | 185 | -20 | -527 |
| S3 | 165 | 525 | 923 | 160 | 5 | -393 |
| S4- | 165 | 525 | 753 | 153 | 12 | -216 |
| Treatments | | Phosphorus | | | | |
| S1 | 15 | 210 | 500 | 19.8 | -4.8 | -294.8 |
| S2 | 15 | 176 | 482 | 20.2 | -5.2 | -311.2 |
| S3 | 15 | 50 | 427 | 19.5 | -4.5 | -381.5 |
| S4- | 15 | 50 | 347 | 18.5 | -3.5 | -300.5 |
| Treatments | | Potassium | | | | |
| S1 | 510 | 525 | 1426 | 578 | -68 | -969 |
| S2 | 510 | 176 | 1329 | 561 | -51 | -1204 |
| S3 | 510 | 50 | 1218 | 553 | -43 | -1211 |
| S4- | 510 | 50 | 1058 | 532 | -22 | -1030 |

**Table 5:** Effect of source of nutrients on monitory benefits of different fodder crops

| Treat ments | Cumbu Napier | | | |
|---|---|---|---|---|
| | CC | GR | NR | B/C |
| S1-FYM | 145000 | 373500 | 228500 | 2.5 |
| S2-PM | 80200 | 350200 | 270000 | 4.3 |
| S3-INM | 78785 | 325700 | 246915 | 4.1 |
| S4- | 53785 | 256900 | 203115 | 4.7 |

CC- Cost of cultivation (Rs), GR- Gross return (Rs),NR- Net return (Rs),B/C-Benefit cost ratio

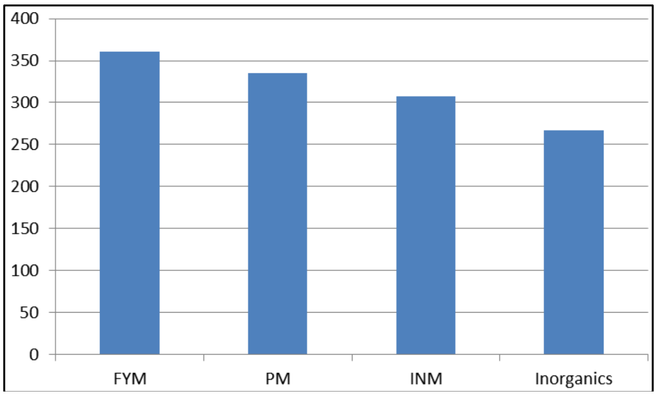


**Fig 1:** Influence of nutrient sources on green fodder yield (t/ha)

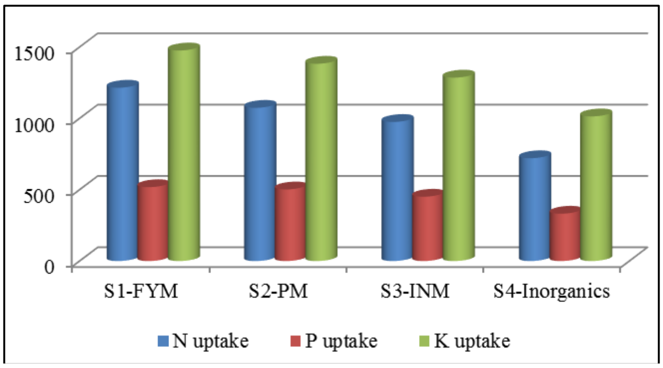


**Fig 2:** Influence of nutrient sources on major nutrient uptake (kg/ha)

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