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Effect of integrated nutrient management (INM) practices on growth and yield of CO-4 hybrid Napier

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Abstract
A field experiment was conducted during *kharif* of 2020, 2021 and 2022 at Veterinary College, Shivamogga to study the integrated nutrient management in hybrid napier cultivar CO-4. The experiment was laid out in a randomized complete block design with eight treatments comprises T_1: recommended package of practices, T_2: 50 percent N through inorganic fertilizer + 50 percent N through FYM, T_3: 50 percent N through inorganic fertilizer + 50 percent N through poultry manure, T_4: 50 percent N through inorganic fertilizer + 50 percent N through horse manure, T_5: 50 percent N through inorganic fertilizer + 50 percent N through vermicompost, T_6: 50 percent N through inorganic fertilizer + 50 percent N through swine manure, T_7: 50 percent N through inorganic fertilizer + 50 percent N through sheep and goat manure, T_8: recommended package of practices + *Azotobacter* were replicated thrice. The pooled data of experimental results revealed that integrated application of 50 percent N through inorganic fertilizer + 50 percent N through vermicompost recorded significantly superior growth parameters of the CO-4 hybrid napier *viz*., plant height, number of tillers and number of leaves/tillers and green fodder yield (254.27 t $ha^{-1}year^{-1}$) as compared to other treatments.

Keywords: Fodder yield, forage crops, green fodder, Napier grass, organic manures

Introduction
The hybrid Napier is an important grass fodder that can be grown throughout the year as green fodder because of its luxuriant growth, good palatability, and highly nutritious nature. This is an interspecific hybrid between Napier grass (*Pennisetum purpureum*) and Bajra (*Pennisetum typhoides)* (Kaur *et al.*, 2019) [7]. Its common names include Elephant Grass and Bajra-Napier Hybrid. Perennial hybrid Napier grass can be left in the field for two to three years. The leaves of hybrid Napier grass are bigger and softer than those of Napier grass. The nutrient requirement of hybrid Napier is comparatively higher than that of other fodder crops. To meet this demand, higher doses of inorganic fertilizers are required, which is uneconomical for fodder production, and the indiscriminate and continuous use of high amounts of chemical fertilizers has a deleterious effect, leading to a decline in productivity due to the limitation of one or more micronutrients (Nambiar & Abrol, 1989) [8]. Hence, combination of organic and inorganic nutrient sources helps in greater availability of nutrients with improved soil health condition.

Organic manures which contain plant nutrients in complex organic forms are derived from animal, human and plant residues. They release nutrients after their decomposition. Broadly, manures are classified into two types i.e., bulky and concentrated organic manures based on concentration of the nutrients. Bulky organic manures include farmyard manure, compost, green manure, horse manure, swine manure, poultry manure, sheep and goat manure. They contain small percentage of nutrients hence they are applied in large quantities. Fertilizers are synthetically manufactured chemicals containing plant nutrients. They were absorbed directly by the plants. Excess application of fertilizers damages the roots of plants and their tissues thus plants can die, it also reduces the soil quality by affecting naturally occurring microorganisms, they also change the nature of soil, making it either too acidic or too alkaline, it can also reduce the organic matter and humus content in soil. For sustainable agriculture calibrating fertilizer application is an important issue because it can reduce the negative effects on surrounding environment (Zebarth *et al*., 2009) [10]. Although, chemical fertilizers play a pivotal role to meet the nutrient demand of the crop, but due to its negative effect on soil it is posing a serious hazard to sustainable agriculture.

Therefore, there is a crucial need to reduce the usage of inorganic fertilizers and in turn increase the usage of organics. In plant growth organic manures plays a direct role as a source of all necessary macro and micronutrient, they also help in improving the physical properties of soils such as enhancement of soil structure, texture, aeration and water holding capacity of soil. Further, it also enhances the activity of microorganisms that favorable for the plant to get the nutrients through amplifying biological processes, adjust soil salinity, sodicity and pH, it also helps in increasing nutrient solubility, (Alabadan *et al*., 2009) [1]. Hence, indeed manure with low nutrient content per unit volume have longer residual effect besides improving soil physical properties compared to fertilizer with high nutrient content. Hence, keeping all the data in view an assessment was conducted to test the CO-4 hybrid napier grass on growth and yield parameters by comparing the efficiency of different types of manures such as farm yard manure, horse manure, vermicompost, swine manure, poultry manure, biofertilizer, sheep and goat manure.

Materials and Methods

The study was conducted during *kharif*, 2020, 2021 and 2022 at department of livestock farm complex, experimental block (A2), Veterinary College, Shivamogga (13º 96ˈN to 14º 27ˈN Lat and 75º 53ˈE to 76º 43ˈ E Long) situated in southern transition zone (STZ) of Karnataka. A composite soil sample was collected at a depth of 0 - 15 cm in all the experimental fields prior to the study and analyzed for the physio chemical properties. The soil of the experimental site was sandy clay, moderately acidic in reaction (5.72), low in nitrogen and potassium (201.68 and 105.45 kg ha^{-1}, respectively), but medium concerning phosphorous (23.64 kg ha^{-1}) status. The experiment was laid out with three replications per treatment in all the fields *viz*., T_1-Recommended practices, T_2- 50 percent N through Farm yard manure (FYM @ t/ha) + 50 percent N through inorganic fertilizer, T_3- 50 percent N through Poultry manure (PM @ t/ha)+ 50 percent N through inorganic fertilizer, T_4- 50 percent N through Horse manure (HM @ t/ha) + 50 percent N through inorganic fertilizer, T_5- 50 percent N through Vermicompost (VC @ t/ha) + 50 percent N through inorganic fertilizer, T_6- 50 percent N through Swine manure (SM @ t/ha) + 50 percent N through inorganic fertilizer, T_7- 50 percent N through Sheep and Goat manure (S&G @ t/ha) + 50 percent N through inorganic fertilizer, T_8- Recommended practices + Biofertilizer. The land was ploughed twice by a tractor with chisel ploughing followed by harrowing in all the experimental fields. The fields were brought to fine tilth and laid out in to proper plot size (m). The CO-4 Hybrid Napier fodder slips were planted at 90 x 60 cm spacing and the first irrigation was done on the same day of planting and thereafter as and when required. The necessary after care operations such as hand weeding were done as per the requirement. Also 5 plants were tagged in each plot initially on 15th day to study the growth parameters of the fodder crop on 90 days after planting (DAP) as first cut and subsequent cut at 45 days. The growth and green yield observations were recorded from the net plots. Totally 7 cuttings were taken in a year and yield data were pooled for further analysis. The data collected on growth parameters between treatments were subjected to one way Analysis of Variance (ANOVA) by SPSS 13.0 to find the significant difference between treatments and days and interpretation of data was done as per the procedure described by Gomez and Gomez (1984).

Results and Discussion

Growth and Yield parameters of hybrid napier

The results of the experiment were presented based on the pooled data of 2020, 2021 and 2022. The data on growth components *viz*., plant height, number of leaves, number of tillers and number of leaves/ tillers as well as yield components *i.e*., per plant yield and total yield (t/ha/year) as influenced by different treatments were presented in Table 1 and 2 respectively. The data pertaining to plant height, number of leaves, number of tillers and number of leaves/ tillers were recorded at 1st cut at 90 DAP and subsequent cut at 45 days after each cut whereas per plant yield (kg) and total green fodder yield (t/ha/year) as influenced by different combination of organic and inorganic nutrient sources. The pooled data results revealed that plant height of CO-4 hybrid napier at all the stage of crop growth, varied significantly among the different nutrient combination 50 percent recommended N + 50 percent N through vermicompost recorded significantly taller plants (122.73 cm) as compared to other combination and 100 percent RDF (Recommended dose of fertilizer) with and without biofertilizer but significantly on par with 50 percent recommended N + 50 percent N through poultry manure (115.44 cm). Shorter plants (84.73 cm) were recorded in recommended practices. Same trend was noticed at different cuts. Number of leaves $plant^{-1}$ differed significantly due to different combination of organic and inorganic nutrient sources. Significantly maximum number of leaves $plant^{-1}$ (407.64) was noticed with T_5 as compared to other combinations but significantly on par with T_3 (358.32). However, minimum number of leaves $plant^{-1}$ (238.54) was observed in T_1. Similar trend was observed in number of tillers and number of leaves per tillers.

It could be observed from the results that there is gradual increase in the growth stages of the fodder crop is mainly due to organic manure acted as a reservoir of nutrients. This material incorporated into the soil undergo decomposition from the original residue until it become a brown black organic complex humus is formed. For plant growth, necessary nutrients are released from organic manures during humification process. Increased vegetative growth resulted in high photosynthetic activity and protein synthesis, which promotes cell division and elongation is mainly due to application of nutrients. These results are in testimony with the findings of Tisdale *et al.* (1995) [9]. In general nitrogen promotes rapid vegetative growth. Nitrogen being a major constituent of chlorophyll, ATP, enzymes and nucleic acid, plays a vital role in metabolic activities and cellular respiration. Hence, application of N promotes both growth (plant height, leaves per plant, stem diameter, leaf area, green fodder yield and dry matter percentage) and quality characteristics (Ayub *et al*., 2003) [3]. Also, application of organic manure during initial stages provides uniform distribution of nutrients in soil profile due to application of the nitrogen fertilizer on timely and proper manner (Iqbal *et al*., 2012) [4]. Among the several treatments, application of vermicompost recorded significantly higher plant height. This might be due to application of phosphorus resulted in greater uptake of nutrients due to greater root extension containing microorganisms and earthworms play a major role for conversion of nutrients in non-available to available form

thereby increasing the availability of nutrients improved the growth parameters of hybrid napier. Furthermore, better translocation within plants and favorable sink source ratio of photosynthates enhanced number of tillers and leaves. In the soil, application of vermicompost treatments boost the micronutrient levels (Jaikishaun *et al.* 2014) [5]. The nutrients are slowly released into the soil thereby helping the plants to absorb the available nutrients (Ansari and Sukhraj 2010) [2]. Vermicompost contains nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, iron, copper, manganese and zinc. Greater number of leaves/ tillers is due to vermicompost is a good source of organic matter which ameliorate the physio-chemical properties of soil and it also includes growth hormones such as auxins, cytokinin and gibberellic acid (Jamir *et al*., 2017) [6]. Finally, it could be interpreted that application of vermicompost along with 50 percent inorganic nutrient combination showed significant increase in growth parameters when compared to other treatments.

The data on different yield aspects *viz*., per plant yield (kg) and total green fodder yield (t/ha/year) were recorded at 90 DAP as influenced by different combination of organic and inorganic nutrient sources. Results of pooled data showed that per plant yield of CO-4 hybrid napier on 90th day of harvest and subsequent cut at 45 days interval, among the different nutrient combination 50 percent recommended N + 50 percent N through vermicompost recorded significantly maximum quantity of per plant yield (3.30 kg plant^{-1}) as compared to other combination but significantly on par with T_3 (3.07 kg plant^{-1}) and minimum quantity of per plant yield (1.74 kg plant^{-1}) recorded in recommended practices. Yield (t ha^{-1}) differed significantly due to different combination of organic and inorganic nutrient sources. Significantly maximum tonnage of green fodder (254.27 t ha^{-1} year^{-1}) was noticed with T_5 as compared to other combinations but significantly on par with T_3 (238.58 t ha^{-1} year^{-1}) while that of minimum tonnage of green fodder (140.04 t ha^{-1} year^{-1}) was observed in T_1.

The increased green fodder yield was due to the result of higher plant height, number of leaves, number of tillers and number of leaves/tillers. Among the various treatment, application of vermicompost along with inorganic fertilizer recorded significantly higher fodder yield due to phosphorus application helped in prominent root extension for better uptake of nutrients which ultimately increased the fodder yield. Vermicompost acts as a store house of all plant nutrients including micronutrients due to controlled and steady release which helped towards better and balanced plant nutrition, resulting in greater yield (Jamir *et al.*, 2017) [6]. Hence, for sustainable agriculture farmers could use a combination of inorganic and organic sources like vermicompost as an environment-friendly technique.

Table 1: Plant height (cm), Number of leaves, Number of tillers, Number of leaves/tillers as influenced by integrated nutrient management in Hybrid Napier (CO-4)

Treatments	Plant height (cm)				Number of leaves				Number of tillers				Number of leaves/tillers			
	2020	2021	2022	Pooled mean	2020	2021	2022	Pooled mean	2020	2021	2022	Pooled mean	2020	2021	2022	Pooled mean
T_1- Recommended practices	83.66	91.44	79.10	84.73^{d}	185.53	327.5	202.6	238.54^{d}	42.73	56.5	33.3	44.18^{e}	8.47	8.10	6.20	7.59^{c}
T_2 -50% N through FYM + 50% N through Inorganic fertilizer	97.56	104.62	87.30	96.49^{cd}	223.07	509.7	230.2	320.99^{bc}	56.60	89.3	37.3	61.07^{cd}	9.75	9.50	8.00	9.08^{bc}
T_3 -50% N through PM + 50% N through Inorganic fertilizer	118.71	120.62	107.00	115.44^{ab}	255.26	552.1	267.6	358.32^{ab}	75.97	104.7	48.9	76.52^{ab}	11.53	10.90	11.50	11.31^{ab}
T_4 -50% N through HM + 50% N through Inorganic fertilizer	94.30	103.69	84.10	94.03^{cd}	208.55	430.9	219.8	286.42 ^{bcd}	48.94	84.1	37.0	56.68^{cde}	9.32	9.20	8.00	8.84^{c}
T_5- 50% N through VC + 50% N through Inorganic fertilizer	125.22	127.77	115.20	122.73^{a}	287.33	637.7	297.9	407.64 ^{a}	84.68	116.8	53.5	84.99^{a}	12.48	11.70	13.00	12.39^{a}
T_6 -50% N through SM + 50% N through Inorganic fertilizer	96.42	104.31	86.40	95.71^{cd}	211.14	432.4	229.1	290.88 ^{bcd}	52.74	84.7	36.7	58.05^{cd}	9.53	9.30	8.40	9.08^{bc}
T_7 -50% N through S&G + 50% N through Inorganic fertilizer	108.62	111.53	96.10	105.42^{bc}	241.11	517.8	254.8	337.90^{abc}	71.74	93.3 ^{c}	44.3	69.78^{bc}	10.29	10.10	9.40	9.93^{bc}
T_8 -Recommended practices + Biofertlizer	91.61	94.71	81.80	89.37^{cd}	201.63	393.6	206.8	267.34^{cd}	49.63	66.6	34.0	50.08^{de}	9.13	8.80	6.60	8.18^{c}
S.Em ±	3.96	4.91	4.2	2..84	8.15	29.8	10.4	22.41	2.89	6.1	2.6	4.026	0.44	0.40	0.70	0.39
CD at 5%	12.02	14.88	12.8	8.61	24.72	90.4	31.5	68.63	8.77	18.4	7.8	12.331	1.32	1.20	2.20	1.19

Table 2: Yield/plant (kg) and Yield (t/ha) as influenced by integrated nutrient management in Hybrid Napier (CO-4)

Treatments	Yield/plant (kg)				Yield (t/ha/year)			
	2020	2021	2022	Pooled mean	2020	2021	2022	Pooled mean
T_1- Recommended practices	1.94	1.79	1.49	1.74^{e}	129.79	141.68	148.66	140.04^{d}
T_2 -50% N through FYM + 50% N through Inorganic fertilizer	2.96	2.46	2.10	2.51^{bcd}	180.55	184.44	183.31	182.77^{c}
T_3 -50% N through PM + 50% N through Inorganic fertilizer	3.48	3.07	2.66	3.07^{ab}	235.10	256.40	224.25	238.58^{a}
T_4 -50% N through HM + 50% N through Inorganic fertilizer	2.41	2.17	1.88	2.15^{cde}	163.71	167.40	167.85	166.32^{c}
T_5- 50% N through VC + 50% N through Inorganic fertilizer	3.64	3.47	2.79	3.30^{a}	252.91	269.28	240.63	254.27^{a}
T_6 -50% N through SM + 50% N through Inorganic fertilizer	2.56	2.33	2.07	2.32^{cde}	170.56	175.06	194.43	180.02^{c}
T_7 -50% N through S&G + 50% N through Inorganic fertilizer	3.18	2.52	2.18	2.63^{bc}	197.37	213.03	202.86	204.42^{b}
T_8 -Recommended practices + Biofertlizer	2.17	1.85	1.59	1.87^{de}	143.05	158.89	188.63	163.52^{cd}
S.Em ±	0.10	0.17	0.16	0.07	5.86	5.35	5.19	4.03
CD at 5%	0.31	0.52	0.50	0.22	17.76	16.22	15.74	12.22

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