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Influence of nutrients on yield and nutrient uptake of bajra napier hybrid grass

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Abstract
A field experiment was conducted with bajra napier hybrid grass – a perennial fodder crop. Organic and inorganic nutrients were used as nutrient sources during the year 2014-2016. The study was conducted at University Research Farm, Madhavaram, Tamil Nadu Veterinary and Animal Sciences University. The experiment was laid out in Randomized Block Design with twelve treatments *viz.*, F_1- FYM 25 t ha^{-1}, F_2- FYM 12.5 t ha^{-1}, F_3- FYM 25 t ha^{-1}+ 50% RDF (50% NPK as basal + balance through drip), F_4- FYM 25 t ha^{-1}+ 100% RDF (50% NPK as basal + balance through drip), F_5- FYM 25 t ha^{-1}+ 100% RDF through drip, F_6- FYM 12.5 t ha^{-1}+ 50% RDF (50% NPK as basal + balance through drip), F_7- FYM 12.5 t ha^{-1}+ 100% RDF (50% NPK as basal + balance through drip), F_8- FYM 12.5 t ha^{-1}+ 100% RDF through drip, F_9- 50% RDF (50% NPK as basal + balance through drip), F_{10}-100% RDF (50% NPK as basal + balance through drip), F_{11}-100% RDF through drip and F_{12}- Control and replicated thrice. The different combinations with organic and inorganic sources of nutrients were equated to Nitrogen content of the sources of nutrients. Nutrient recommendation for bajra napier hybrid grass was 150:50:40 kg of NPK ha^{-1}. Based on the nitrogen content, the organic and inorganic sources of nutrients, the treatments were formulated. The irrigation was given through drip irrigation. During both the years of experimentation, application of Farmyard Manure at the rate of 25t ha^{-1} and 100% recommended dose of nutrients applied basally and the remaining through drip resulted in higher yield, however on par with the application of inorganic nutrients through drip alone. The total nitrogen uptake by bajra napier hybrid grass is higher with the application of FYM 25 t ha^{-1} + 100% recommended dose of fertilizers through drip. Similarly, with respect to phosphorous and potassium uptake, application of 100 % recommended dose of fertilizers through inorganic nutrients along with 25 t of Farm Yard manure to bajra napier hybrid grass resulted in higher uptake.

Keywords: Bajra Napier Hybrid grass, organic and inorganic nutrient source, yield, total nutrient uptake

Introduction
Animal has a significant participation in general agricultural production and forms an important part of the country`s growth and income. The animal productivity and production efficiency depends on the quantitative and quantitative feed fed to the animals, to make it sustainable (Dias-Filho, 2012) [4]. To enhance the quantity and quality, the best alternative is to improve the plant and soil management. Hence, the fodder productivity should aim at maintaining the yield along with maintaining soil fertility at adequate levels and improving the fertilizer use efficiency (Primavesi *et al.*, 2004) [13]. The forages with high potential yield respond effectively to managements. However, the forage production in our country is mostly with low input supply system, because most farmers assume that fodder production requires low nutrients (Oenema *et al*., 2003) [9]. Selection of forage with high potential yield can respond effectively to managements (Alves Filho *et al.*, 2003) [2].

The removal of nutrients through high yielding crops especially perennial crops causes nutrient imbalances over the time, with degradation of soil reserves of nutrients (Martha Júnior *et al*., 2004) [8]. Hence, to increase the yield and to replenish the soil, nutrient uptake of a particular crop should be known. As nitrogen is the limiting factor in the soils, for biomass production (Lemaire. 1989) [7], it should be supplied through various sources in order to boost up the yield.

Various fodder crops are available in the country such as bajra napier hybrid grass, guinea grass, cenchrus, stylosanthus, desmanthus, desmodium, maize, sorghum etc. Among these crops bajra napier hybrid grass is one of the high yielding crops there are various varieties of high yielding bajra napier grass. Out of the various varieties, Co CN (4) is a widely cultivated

crop. Bajra Napier hybrid grass is a valuable, high biomass producing tropical grass and is well recognized through out our country for its palatability and good fodder quality. Variety COC (N) 4 is widely cultivated in Tamil Nadu as an irrigated perennial grass. This is a crop that requires higher nitrogen application for its better productivity and to provide palatable fodder throughout the year. It contains 9.5%crude protein, 2.5% oxalate and IVDMD % of 60.65%, and hence supplementation of nutrients both micro and micro nutrients are essential (Purusotham, 1998) [14].

Mineral nutrition, especially nitrogen contributes to the structural organization of the leaf blade and thereby enhances the quantity and quality of leaves (Taiz and Zeiger, 2010) [21]. It is found that, given the increasing amount of nitrogen fertilizer, the increase yield is proportional (Kano *et al*., 2007) [5]. Further more, the nitrogen nutrients are essential for the accumulation of sugars, increase the juice content and palatability of crops (Ota and Kagawa, 1996) [10]. The balance between the nutrient utilization and fertilizer amendment is desired in a production system. The objectives of this research were to evaluate the total nutrient uptake of bajra napier hybrid grass and the productivity potential of bajra napier hybrid grass with various doses of nitrogen equivalent.

Materials and methods

The experiment was carried out in 2014-2016 at University Research Farm, Tamil Nadu Veterinary and Animal Sciences University, Madhavaram, Chennai. The experimental site is located at 13.1478°N of latitude, 80.231°E of longitude at an average altitude of 30 m above Mean Sea Level. The temperature ranged between 24.6 °C to 42 °C. Average rainfall during the study period is 1276.41 mm. Bajra Napier Hybrid grass was established during December 2014 and the fertilization was started as per the schedule given in crop production guide of Tamil Nadu Agricultural University. The soil of the experimental site was sandy with a pH of 7.64, EC of 0.38 dSm^{-1}, Bulk Density of 1.52 g cc^{-1}, soil available nitrogen of 242.8 kg ha^{-1}, soil available phosphorous of 19.6 kg ha^{-1} and soil available potassium of 182.6 kg ha^{-1}. Bajra napier hybrid grass was irrigated with drip irrigation. The field was applied basally with well decomposed farm yard manure, top dressing of nitrogen was with urea, phosphorous fertilization with single super phosphate and potassium fertilization with muriate of potash. The twelve treatments included organic and inorganic nutrients in combination, organic alone and inorganic alone with various levels and are given in Table. 1. The design adopted was completely randomized with three replications. The ingredients of different nutrients present in different sources of nutrients were considered for determination of quantity of nutrients. As the Bajra Napier Hybrid grass is a perennial grass, fertilization was done after every harvest according to the treatment schedule.

The first cutting was made at 75 days after planting and subsequent cutting was carried out at every 45 days interval. Totally 12 harvests were taken from two consecutive years. Five clumps were tagged for making observations. The mean values of green fodder yield recorded from twelve harvests were subjected to statistical analysis. The plant samples were analyzed for determination of N, P and K concentration. Nitrogen in the processed sample was determined by Kjeldhal digestion method as described in AOAC (1960). The P and K were determined by spectrophotometer and flame photometer respectively. From the yield of total dry matter and contents of nitrogen, phosphorus and potassium the total uptake of respective nutrients was worked out using following formula suggested by Piper (1966) and expressed in kg ha^{-1}.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x Total DMP in kg ha}^{-1}}{100}$$

where, DMP: Dry Matter Production

The experimental data pertaining to nutrient uptake and yield were analysed statistically as per the procedure (Panse and Sukhatme, 1978).

Table 1: Treatment details

	F1	F2	F3*	F4*	F5	F6*	F7*	F8	F9*	F10*	F11	F12
FYM	25.0	12.5	25.0	25.0	25.0	12.5	12.5	12.5	0	0	0	0
RDF%	-	-	50	100	100	50	100	100	50	100	100	0
basal	-	-	+	+	-	+	+	-	+	+	-	-
drip	-	-	+	+	+	+	+	+	+	+	+	-

* 50% NPK as basal + balance through drip

Treatments (F_1-F_{12}): Farmyard manure (FYM: t ha^{-1}) and 150 N + 50 P_2O_5 + 40 K_2O kg ha^{-1} Recommended dose of fertilizer (RDF) applied as basal and drip fertilization (in percent: 100% = 150 N + 50 P_2O_5 + 40 K_2O kg ha^{-1}, in 50%= 75 N + 25 P_2O_5 + 20 K_2O kg ha^{-1})

Results and Discussion

Yield attributing parameters

Data on yield attributing parameters of bajra napier hybrid grass is given in Table 2. Application of nutrients with basal application of farm yard manure and 100% recommended dose of nutrients with inorganic fertilizers recorded the higher plant height, number of leaves per plant and number of tillers per plant. However, application of organic and inorganic nutrients at 50 and 100% level recorded higher plant height and were on par with each other. Application of organic and inorganic nutrients alone recorded the least plant height at the time of harvest. The maximum plant height, number of leaves and number of tillers per plant was recorded with application of FYM 25 t ha^{-1} along with 100% recommended dose of fertilizers during 2014-2015 and 2015-2016 respectively. Soni *et al.*, 1991 [19] reported that in hybrid Napier grass, the yield attributing parameters increased linearly with increasing nitrogen levels. There was marked difference in number of tillers due to application of nutrients. Significant influence was noticed in number of tillers per plant with application of 25t of farm yard manure and 100 percentage of recommended dose of fertilizers and comparable with application of 25 t of farm yard manure and 50 percentage of recommended dose of fertilizers as basal and remaining 50 % of recommended dose of fertilizers through drip. However, inclusion of farm yard manure along with inorganic source of nutrients improves soil nutrient status and their availability, which is essential for plant growth and development. It also improves the physical, chemical and biological conditions of the soil and ultimately results in better growth (Singh and Nepalia, 2009) [17].

Yield

The plant weight and leaf stem ratio of bajra napier hybrid grass is depicted in Table 2. and yield of cumbu napier hybrid

grass is given in Table 3. Application of farm yard manure 25 t ha^{-1} along with 100% recommended dose of fertilizers through drip resulted in higher fresh weight per plant but comparable with the application of FYM 25 t ha^{-1} along with 100% recommended dose of fertilizers (50% NPK as basal + balance through drip). This is followed by application of farm yard manure 25 t ha^{-1}+ 50% recommended dose of fertilizers (50% NPK as basal + balance through drip), farm yard manure 12.5 t ha^{-1}+ 100% recommended dose of fertilizers through drip and farm yard manure 12.5 t ha^{-1}+ 100% recommended dose of fertilizers (50% NPK as basal + balance through drip).

N application through drip irrigation had beneficial effect on the green fodder yield because of enhanced crop growth such as plant height, number of tillers and number of leaves which in turn has resulted in higher biomass yield per plant and per hectare. This might be due to the fact that nutrients received through fertigation plots had equal distribution of nutrients through out and thereby reducing the loss of nutrients by volatilization and leaching. Hence, continuous availability of soil moisture could result in higher growth parameters, in turn resulting in higher plant biomass. This is in line with the findings of Ismail, 2012. Higher green fodder yield was the cumulative effect of plant height and leaf area index at later stages of crop growth. Similar results were reported by Venkatesh *et al*. (2002) [23] and Surendra and Sharanappa (2000) [20]. Higher yield of fodder obtained due to addition of N may be attributed to the fact that N is an important constituent of amino acids and chloroplasts which directly influenced plant growth and development through greater photosynthates. Higher leaf area captures more photosynthetically active radiation with higher photosynthesis as there is more number of leaves (Singh and Dubey, 2007) [18]. Similar findings were also reported by Kumar and Sharma (1997) [6] and Singh *et al*. (2000) [16]. Application of either FYM or synthetic fertilizer N or both induced crop to yield more compared to non-fertilized plot. Combined use of FYM and N had synergistic effect on advancing the date of maturity.

There was no significant difference in leaf stem ratio due to different nutrient levels. However, applications of farm yard manure 25 t ha^{-1}+ 100% recommended dose of fertilizers through drip resulted in higher leaf stem ratio during both the years. Leaf stem ratio cannot be altered by external factors like application of nutrients as it is a parameter of genetic control. This corroborates with the findings of vennila and sankaran, 2017 [24]. Increase in higher leaf-stem ratio with application of farm yard manure along with inorganic sources of nutrients is indicative of better plant growth and development (Singh and Nepalia, 2009) [17]. Higher availability of N induced photosynthesis and triggered growth and development, as indicated by higher plant height and LAI. Therefore, leaf-to-stem ratio with increase in N levels was higher and leaf growth was better with higher N availability during the later growth stages. These findings are in close agreement with the findings of Bakht *et al*. (2006) [3].

Uptake of nitrogen, phosphorous and Potassium

The uptake of nutrients such as nitrogen, phosphorus and potassium are dependant on total yield of bajra napier hybrid grass and significantly correlated. The uptake of nitrogen was significantly related to total biomass production (Y) as Y = 4.105x - 38.60 with R^2 = 0.987 during first year y = 4.257x - 54.89 with R^2 = 0.985 during second year. The total uptake of nitrogen by the plants ranged from 40.4 kg ha^{-1} to 199.1 kg ha^{-1} and 54.6 kg ha^{-1} to 207.2 kg ha^{-1} during first and second years of experimentation. The maximum uptake of nitrogen by bajra napier hybrid grass was with the application of 25 t of farm yard manure along with recommended dose of fertilizers through drip irrigation alone followed by application of 25t of farm yard manure along with recommended dose of fertilizers as basal and through drip irrigation. The total uptake of phosphorous ranged from 9.2 kg ha^{-1} to 58.2 kg ha^{-1} and 6.0 kg ha^{-1} to 62.3 kg ha^{-1} with the maximum being with the application of 25 t of farm yard manure along with recommended dose of fertilizers through drip irrigation alone during first year of experimentation. However, during second year of the study, phosphorous uptake was higher with the application of 25t of farm yard manure along with recommended dose of fertilizers as basal and through drip irrigation followed by application of 25t of farm yard manure along with 50 % recommended dose of fertilizers as basal and through drip irrigation. The uptake of phosphorous was significantly related to total biomass production as y = 1.254x - 14.73 with R^2 = 0.988 and y = 1.212x - 16.22 with R^2 = 0.8 during first and second years respectively. The total potassium uptake of bajra napier hybrid grass ranged from 36.1 kg ha^{-1} to 185.4 kg ha^{-1} and 47.7 kg ha^{-1} to 194.5 kg ha^{-1}. The maximum uptake of potassium by bajra napier hybrid grass was with the application of 25 t of farm yard manure along with recommended dose of fertilizers through drip irrigation alone followed by application of 25t of farm yard manure along with recommended dose of fertilizers as basal and through drip irrigation. The uptake of potassium was significantly related to (Y) as y= y = 3.855x - 38.45 with R^2 = 0.986 and y = 4.065x - 56.83 with R^2 = 0.986 during first and second year of study. Better crop growth, higher crop yield and improvement in nutrient contents due to increased availability of nutrients could be the reason for higher uptake of macro nutrients such as nitrogen, phosphorous and potassium (Velayudham *et al*., 2011) [22].

Conclusion

The study indicates that inclusion of organic source of nutrients along with inorganic source of nutrients to bajra napier hybrid grass results in increased yield attributes, yield and nutrient uptake. Application of recommended dose of nutrients (FYM 25 t ha^{-1} + 150:50:40 kg NPK ha^{-1}) through drip would be an ideal practice to achieve higher biomass and in turn resulting in higher uptake of bajra napier hybrid grass.

Table 2: Effect of nutrient levels on yield attributes of Bajra Napier hybrid grass variety CO (CN) 4 during 2014-2015 and 2015-2016

Treatments	Plant height (cm)		No. of tillers per plant		No. of leaves per plant		Leaf stem ratio		Plant weight (g)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
F_1	104.1	125.8	17.2	21.4	271.3	305.6	0.26	0.54	635.4	1042.1
F_2	109.7	126.8	17.8	20.7	273.6	310.2	0.21	0.42	655.3	896.2
F_3	141.8	152.1	21.3	23.9	297.3	348.6	0.31	0.59	1203.7	1512.8
F_4	145.4	156.7	22.8	24.4	302.2	367.7	0.38	0.53	1299.4	1647.5
F_5	143.3	157.9	26.4	31.4	358.7	396.3	0.44	0.59	1337.2	1700.6

F_6	140.6	150.3	21.1	23.8	292.6	351.6	0.27	0.46	1175.8	1490.7
F_7	142.0	153.5	21.2	24.1	298.6	343.7	0.32	0.48	1215.8	1570.9
F_8	131.4	148.6	20.8	24.2	292.1	318.8	0.37	0.44	1263.0	1608.9
F_9	105.7	128.8	16.3	21.7	272.0	308.5	0.25	0.52	765.2	1088.7
F_{10}	121.6	137.5	18.6	22.3	281.1	308.6	0.24	0.52	895.3	1208.9
F_{11}	125.5	138.8	18.8	22.4	281.7	309.7	0.24	0.48	927.2	1248.0
F_{12}	95.8	111.3	12.1	18.8	263.7	285.0	0.21	0.52	519.53	751.8
S.Ed	4.93	4.85	1.60	1.32	13.68	16.61	-	-	108.2	83.4
$CD_{0.05}$	9.81	9.65	3.19	2.63	27.21	33.04	-	-	215.3	165.9

Table 3: Effect of nutrient levels on yield and nutrient uptake of Bajra Napier hybrid grass variety CO (CN) 4 during 2014-2015 and 2015-2016

Treatments	Yield (t ha^{-1})		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
F_1	22.5	33.1	58.1	84.5	14.9	21.1	52.6	77.2
F_2	23.6	29.6	53.0	73.0	13.0	33.4	47.6	63.5
F_3	43.6	52.9	134.2	167.6	38.7	53.2	123.5	153.8
F_4	50.2	57.5	168.3	194.6	48.4	62.3	155.9	179.6
F_5	55.4	59.0	199.1	207.2	58.2	52.3	185.4	194.5
F_6	42.9	51.7	131.8	161.2	37.7	48.4	121.2	148.2
F_7	46.3	54.0	148.1	174.3	41.6	49.8	136.7	160.2
F_8	43.6	53.9	144.5	173.5	40.3	38.7	133.8	165.2
F_9	24.7	34.3	64.8	90.2	16.8	28.1	58.6	80.9
F_{10}	31.2	39.9	85.5	109.6	23.7	32.1	77.7	99.7
F_{11}	32.6	41.2	90.3	109.1	25.1	22.8	82.2	103.7
F_{12}	17.4	23.3	40.4	54.6	9.2	6.0	36.1	47.7
S.Ed	3.26	3.93	8.35	11.18	2.70	3.03	7.97	10.57
$CD_{0.05}$	7.28	7.82	18.84	23.48	5.11	6.09	15.78	23.49

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