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Effect of Integrated Nutrient Management on Hybrid Napier Production under Irrigated Conditions

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A B S T R A C T

A field experiment was conducted during 2013-14 and 2014-15 at Izatnagar, Uttar Pradesh, to study the effect of integrated nutrient management in napier hybrid grass production under irrigation. Experiment was conducted with application of 100 % RDF (Recommended dose of fertilizers), 75% RDF along with 5t/ha Vermi-compost + bio-fertilizers, 75% RDF along with 5t/ha FYM + bio-fertilizers and 75% RDF alone. Four cuttings were taken at the interval of 90 days after planting during both the years. Plant height, green fodder yield, dry yield, crude protein yield, etc. were estimated. Application of 75% RDF along with 5t/ha Vermi-compost + bio-fertilizers gave significant higher plant growth and mean yield of fodder (69.75 t/ha/cut) than 100 % RDF alone (65.35t/ha/cut) followed by 75% RDF +5t/ha FYM + bio-fertilizers application (67.73 t/ha/cut). It has been observed that 25 % of RDF can spared successfully without compromising the fodder production if Vermi-compost and or FYM added @ of 5 tones per hectare along with bio-fertilizers. Result also shows that 75 % RDF alone significantly lowers the yield of green fodder (58.48t/ha) and dry matter yield (11.07 t/ha). First cut produced significantly higher yield of fodder, DM, CP, CF over the 3rd and 4th cut. However, it was at par with second cut of Napier hybrid grass.

Introduction

Hybrid Napier is a popular fodder grass among farmers due to its high yielding potential and nutritive value with the advent of some high yielding cultivars such as 'CO-3' and 'CO-4' which yields 300-400 t/ha/year fresh fodder. Hybrid Napier (bajra-Napier hybrid) is the F1 hybrid of bajra (*Pennisetum glaucums* (L.) R.Br.) and Napier grass (*Pennisetum purpeureum* Schum.). Anthony and Thomas (2014) reported that hybrid Napier cultivars such as 'CO-3' and 'CO-4' can be recommended for rain-fed conditions also as they can survived during summer drought periods. 'Co-3' and 'Co-4' are cultivars released from Tamilnadu Agricultural University. Optimum crop

productivity can only be achieved by a combination of managemental strategies of effective and efficient nutrient management, large amount of nutrients is being exported from the soil through produce and stubble, however ex-situ or in-situ green manures, animal manure, cover crops, or different types of organic matters are used individually or in combination to replenish exported nutrients in organic systems. L. Shukla *et al.,* 2009 reported that high concentration of bacteria around the roots (i.e. in the rhizosphere); presumably occurs because of the presence of high levels of nutrients (especially small molecules such as amino acids, sugars and organic acids) that are exuded from roots of most plants and can thus be used to support bacterial growth and metabolism also replenish the nutrients.

In the tropics, where soil fertility is generally low which decline the crop yields, even in conventional cropping systems due to excess soil mining, calls for the inclusion of organic matter to maintain soil fertility therefore, addition of organic matter becomes very important.

Significant efforts have been made to economise the use of fertilizers in field crops through application of bio-fertilizers and farm yard manure (FYM). Long-term fertilizer effects show that application of fertilizer alone has a deleterious effect on soil health and crop productivity. Integration of various sources of nitrogenous (organic and inorganic) fertilizers is more suitable because it reduces the application of chemical fertilizers and cost of cultivation, besides it is an environment friendly approach too (Sharma *et al.,* 2007).

Napier hybrid is one of the important perennial forage crops of the country is mostly grown under irrigated conditions in the western Uttar Pradesh to supply green fodder for livestock production. Therefore, the present study was conducted to study the effect of replacing 25 % RDF through vermi-compost and /or FYM along with bio-fertilizers in Bareilly district of U.P.

Materials and Methods

A field experiment was conducted at ICAR-IVRI, Izatnagar, Uttar Pradesh, during 2013-14 and 2014-15 on sandy loam soil, having pH 7.5. The soil was low in organic carbon (0.45%), low in available nitrogen (253kg/ha), medium in available phosphorus (13.5 kg/ha) and very high in available potassium (201 kg/ha).

Four treatments T_1 (75% RDF alone) T_2 [75% RDF + 5 t /ha Vermi-compost + bio-fertilizers (Azolobacter + PSB)], T_3 [75%RDF + 5t/ha FYM + bio-fertilizer (Azolobacter + PSB)] and T_4 (100% RDF alone) were applied. The experiment was laid out in randomized block design with three replications. The crop was transplanted manually on 31st March, 2013. The plot size was 5 x 4 meters. The experiment was conducted by planting roots slips per hill at 60 x 50 cm spacing and the crop was maintained as a perennial crop for two years. After sowing, the plots were immediately irrigated for proper moisture level and crop growth. Field was hand weeded at 25-30 days after sowing and after every cutting. Farm yard manure 5t/ha and vermi-compost 5t/ha enriched with bio-fertilizers (Azotobacter and PSB) were applied at the time of land preparation. Recommended dose of inorganic fertilizers consisting of 200kg N and 60kg each of P_2O_5 and K_2O /ha in the form of Urea, SSP and MOP were applied to the crop. Full dose of phosphorous potassium and one fifth of nitrogen (i.e. 40kg N/ha) was applied as a basal dose under control treatment. Remaining doses of nitrogen 40kg/ha under 100% RDF and 30 kg/N /ha under 75% RDF according to treatment were top dressed at 30 days after transplanting and

after every harvest except last. After completion of one year of experiment, again equal basal dose of FYM + bio-fertilizer, Vermi- compost + bio-fertilizers, Phosphorus and potash were mixed in soil between row spacing. During the experiment, four cuttings in each year were taken at 12-15 cm from ground level at regular interval of 90 days.

Weight of fresh fodder from each plot was recorded immediately after cutting and expressed in tones /ha. Dry matter was recorded by randomly selecting five plants from each plots and drying them @ $80+5^0$C for 24 hours or until constant weight was achieved. Sample obtained from first cut in each year were analyzed for crude protein and crude fiber which was used for calculating the yield of crude protein and crude fiber of the fodder.

Statistical analysis

For analyzing the effect of treatments and cuts on fodder yield the following general linear model was applied.

$$y_{ij} = \mu + G_i + C_j + (GC)_{ij} + e_{ij}$$

Where

y_{ij} = observed value of the response variable for i-th group at j-th day

μ = General mean effect

C_j = Effect of j-th cut

$(GC)_{ij}$ = Interaction of i-th treatment and j-th cut

The multiple comparisons between groups and cuts were done by using Tukey HSD test at 5% level of significance.

Results and Discussion

Hybrid Napier is a popular fodder grass among cultivated fodders, due to its high yielding potential and nutritive value. A field trial was conducted at ICAR-IVRI, Izatnagar, Uttar Pradesh, during the 2013-14 and 2014-15 on sandy loam soil, having pH around 7.0 and four treatments viz. T-1(75% RDF alone) T-2 [75% RDF + 5 t /ha Vermi-compost + bio-fertilizers (Azolobacter + PSB)], T-3 [75% RDF + 5t/ha FYM + bio-fertilizer (Azolobacter + PSB) and T-4 (100% RDF alone] were tested. The results obtained from the experiment are presented below.

Plant height

The results of plant height during 1st year and 2nd year are presented in table 1. Plant height was maximum (152.12 cm, 13.05 t/ha) with 75% RDF + Vermi-compost + bio-fertilizers and significantly superior to those recorded in 100% RDF as a control treatment. (148.39 cm, 11.86 t/ha) followed by 75% RDF + 5t/ha FYM + bio-fertilizer. The performance of Napier was better with the combined application of organic, inorganic and bio-fertilizers than that of the control.

Fodder yield

Fodder yield during 1st and 2nd year is presented in table 2. The crop performance in respect to green fodder yield was significantly improved by combined application of organic, inorganic and bio-fertilizers than the inorganic alone. The pooled mean analyses of green fodder yield/cut showed that both the Integrated Nutrient Management (INM) treatments were at par with each other. Yield recorded in T_1 (75 % RDF alone) was lowest (Table 2). The pooled analysis of fodder yield showed significantly higher yield (69.75 t/ha) with T_2 (75% RDF + Vermi-compost + bio-fertilizer) followed by T_3 (75% RDF + 5t/ha FYM + bio-fertilizer) (67.73 t/ha) and T_4 (100

% RDF) (65.35 t/ha). The higher fodder yield in these treatments may be attributed to higher number of tillers in corresponding treatment. This increase in yield might be due to the additional amount of nutrients supplied by vermi-compost and FYM as well as the beneficial effects of organic matter addition which were derived in connection with the physical and chemical properties of the soil.

Application of organic manure in conjunction with lower doses of NP and K resulted in high growth and yield in fodder.

Dry matter

The dry matter yield of Napier during 1st and 2nd year is presented in Table 3. The dry matter yield was significantly improved by combined application of organic, inorganic and bio-fertilizers than the inorganic alone.

The pooled mean analyses of dry matter yield/cut showed that both the Integrated Nutrient Management (INM) treatments were at par with each other. Yield recorded in T_1 (75 % RDF alone) was lowest (Table 2). The pooled analysis of fodder yield showed significantly higher values (13.05 t/ha) with T_2 (75% RDF + Vermi-compost + bio-fertilizer) followed by T_3 (75% RDF + 5t/ha FYM + bio-fertilizer (12.73 t/ha) followed by T_4 (100 % RDF treatment) (11.86 t/ha). The higher fodder yield in these treatments may be attributed to higher number of tillers in corresponding treatment. This increase in yield might be due to the additional amount of nutrients supplied by vermi-compost and FYM as well as the higher dry matter yield per cut accumulation may be attributed to the more plant height of the corresponding treatment. Similar to our results Anthony and Thomas (2015) found higher dry matter yield of DHN-6 variety may due to combination of better plant height and dry matter contents.

Fodder production in different cuts

During the experiment, four cuttings in each year were taken at regular interval of 90 days. First cut gave maximum yield of green fodder, D.M., CP, and CF (Table 1, 2, 3, 4 and 5) which were significantly lower in fourth cut. This may be due to winter low temperature during the last cut however, during first and second cut climate conditions were more suitable for growth and better fodder production. Similarly Khadda *et al.,* (2013) also reported mean green fodder yields of 97 t/ha in front line demonstrations of BN hybrid grass.

Table.1 Plant height (cm) of Napier hybrid (Pooled data) under integrated nutrient management

Treatment	Cut 1	Cut 2	Cut 3	Cut 4	Treatment Mean
T1	141.04	146.28	129.41	66.74	120.86 c
T2	189.66	178.23	164.84	76.13	152.12 a
T3	183.62	172.83	174.53	73.07	151.02 ab
T4	181.28	175.68	162.04	74.54	148.39 b
Mean (Cut)	173.90 a	168.25 b	157.62 c	72.62 d	

The treatments/cuts with common letters do not differ significantly at 5% level of significance.

Table.2 Green fodder yield (t/ha) of Napier hybrid (Pooled data) under integrated nutrient management

Treatment	Cut 1	Cut 2	Cut 3	Cut 4	Treatment Mean
T1	78.87	76.09	54.68	26.11	58.48 c
T2	89.20	81.08	70.51	38.21	69.75 a
T3	84.27	81.20	68.11	37.35	67.73 ab
T4	92.40	69.85	61.18	37.98	65.35 b
Mean(Cut)	86.18 a	77.05 b	63.62 c	34.91 d	

The treatments/cuts with common letters do not differ significantly at 5% level of significance.

Table.3 Dry matter yield (t/ha) of Napier hybrid (Pooled data) under integrated nutrient management

Treatment	Cut 1	Cut 2	Cut 3	Cut 4	Treatment Mean
T1	16.77	16.19	9.26	2.06	11.07 c
T2	18.86	17.94	12.09	3.30	13.05 a
T3	18.09	18.00	11.28	3.55	12.73 a
T4	18.36	14.92	10.13	4.10	11.86 b
Mean (Cut)	18.02 a	16.76 b	10.69 c	3.25 d	

The treatments/cuts with common letters do not differ significantly at 5% level of significance.

Table.4 Crude protein yield (t/ha) of Napier hybrid (Pooled data) under integrated nutrient management

Treatment	Cut 1	Cut 2	Cut 3	Cut 4	Treatment Mean
T1	1.47	1.42	0.81	0.18	0.97 c
T2	1.68	1.57	1.06	0.29	1.15 a
T3	1.66	1.58	0.99	0.31	1.13 a
T4	1.65	1.31	0.89	0.36	1.05 b
Mean (Cut)	1.62 a	1.47 b	0.94 c	0.28 d	

The treatments/cuts with common letters do not differ significantly at 5% level of significance.

Table.5 Crude fiber yield (t/ha) of Napier hybrid (Pooled data) under integrated nutrient management

Treatment	Cut 1	Cut 2	Cut 3	Cut 4	Treatment Mean
T1	1.67	1.61	0.92	0.20	1.10 c
T2	1.88	1.79	1.20	0.32	1.30 a
T3	1.80	1.79	1.12	0.35	1.27 a
T4	1.83	1.48	1.01	0.40	1.18 b
Mean (Cut)	1.79 a	1.67 b	1.06 c	0.32 d	

The treatments/cuts with common letters do not differ significantly at 5% level of significance.

Crude protein yield

Nitrogen management significantly influenced the crude-protein yield of hybrid Napier fodder (Table 4). Significantly higher crude protein yield (1.15 t/ha) was found under application of T_2 (75% RDF+ 5t/ha vermi-compost + bio-fertilizer) than with 100% RDF alone (1.05 t/ha).

Both treatments T_2 (75% RDF + 5t/ha vermi-compost + bio-fertilizer) and T_3 (75%, RDF + 5t/ha FYM + Bio-fertilizers) were found at par by giving 1.15 t/ha and 1.13 t/ha which was higher compared as with T_4 (100% RDF (1.05t/ha). These results confirm the findings of Sadhu *et al.,* (1990).

The treatments with Azotobacter + PSB application registered significantly higher total crude protein compared with no bio-fertilizer application (1.05t/ha, 0.97t/ha). This increase could be ascribed to increased dry matter yield. The results are in line with the findings of Kumar and Sharma (2002). Mean crude protein of Hybrid Napier varied from 6.46% to 8.7% as reported by Anthony and Thomas (2014).

Crude fiber

Total fibre yield is given in table 5. Integrated Nitrogen Management significantly influenced the crude-fibre yield of hybrid Napier fodder (Table 5). Significantly higher crude protein yield (1.30 t/ha) was found under application of T_1 (75% RDF) and T_2 (5t/ha vermi-compost + bio-fertilizer) than with T_4 (100% RDF) alone (1.18 t/ha). INM significantly influenced the crude fiber content. Application of T_3 (75% RDF + 5t/ha FYM + BF) recorded minimum (24.7%) content and it was at par with T_2 (75% RDF + 5t/ha vermi compost + VC + BF (25.2%). The lowest CF content was observed under T_2 (75% RDF + 5t/ha VC + BF) and T_3 (75% RDF + 5t/ha FYM + BF) indicating improvement in fodder quality by these treatment.

The CF content was significantly influenced due to bio-fertilizer treatments. Maximum CF content (26.6%) and (25.5%) were recorded under no bio-fertilizers treatment and lowest CF (24.7%, 25.2%) was recorded with azotobacter and PSB application treatment, indicating better quality of fodder. The reduction in CF content and the improvement in fodder quality under optimum organic and inorganic sources might be due to the increase in succulence. The increase content of CF in plant under 75% RDF and no bio-fertilizer application may reduce the palatability and digestibility.

The fertilizer applied to Napier showed significant influence on the performance of Napier. Application of T_2 (75% RDF+5t/ha Vermi-compost + B.F.) and with 5t/ha FYM + B.F. recorded significantly higher values of plant height, dry matter and yield of green fodder. The minimum value was recorded with 75% green RDF alone indicating saving of the fertilizers up to the extent of 25%. This might be owing to availability of nitrogen during entire growth season because of slow mineralization of organic nitrogen from vermi-compost and FYM applied to Napier hybrid fodder crop for round the year supply of green fodder. The present study clearly indicates that the application T_2 (75% RDF + 5t VC + bio-fertilizer) or T_3 (5t/ha FYM along with bio-fertilizer) improved the fodder quality and gave maximum forage production of multi cut forage Napier hybrid in sandy loam soils under irrigated conditions of western Uttar Pradesh.

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