Forage Res., **38** (2) : pp. 74-79 (2012) **http://forageresearch.in**

IMPACT OF PLANTING MATERIAL, CUTTING MANAGEMENT AND FERTILIZER LEVELS ON NUTRITIONAL QUALITY OF BAJRA X NAPIER HYBRID

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(Received: 28 May, 2013, Accepted: 20 July, 2013)

SUMMERY

Field experiment was conducted to study the effect of planting material, cutting management and fertilizer levels on the growth, yield and quality of Bajra x Napier hybrid during 2009-10 to 2010-11. The quality parameters *viz.*, DMY, CPY, CFY and silica were significantly higher with rooted slips planted at 90 cm x 60 cm, However, CPC, CFC, NDF, ADF, IVDMD, oxalic acid, ash, cellulose, hemi-cellulose and chlorophyll content were not influenced significantly due to different planting material used for propagation of Bajra x Napier hybrid. The quality parameters also differed significantly with various cutting management treatments. The quality parameters *viz.*, DMY, CPY, CFY were significantly higher with 60 days cutting interval, while the values of CPC, IVDMD, oxalic acid and ash were significantly higher at 45 days cutting interval. Whereas, CFC, NDF, ADF and ADL were found significantly higher at 75 days cutting interval indicating the inferior quality of green forage yield of Bajra x Napier hybrid. The significantly higher values of DMY, CPC, CPY, CFC, CFY, IVDMD, and silica content either at 45 days or 60 days cutting interval indicating desirable quality of GFY. Application of 150 % RDF registered significantly higher values of most of the forage quality parameters namely DMY, CPC, CFY, CFC, CFY, IVDMD, oxalic acid , ash, cellulose and hemi-cellulose content and chlorophyll content as compared to rest of the fertilizer levels. However, the maximum values of CFC, NDF, ADF, ADL and silica content was observed with 100 % RDF.

Key words : planting material, cutting management, fertilizer, forage quality parameters and Bajra x Napier hybrid

The forage resources in India are mainly derived from crop residues, cultivated forages and grazing from pastures and grasslands. Chronic shortage of feeds and forages together with poor nutritive value of available feeds has lowered the productive capacity and fertility of Indian live-stock. This gap in requirement and availability would further aggravate due to increase in livestock population. One of the main impediments in the way of improvement of livestock production is quantitative and qualitative insufficiency of fodder. Cereal fodder and crop residues are major sources of forage but the nutritive value of these forage is not adequate for getting high milk production.

The work on effect of use of different planting material on quality aspect of Bajra x Napier hybrid is very meager under Indian condition hence, there is need to evaluate the influence of different planting material *viz.*, rooted slips, one and two eye bud sets on various quality parameters. Cutting management is another most important aspect since it governs the quality as well as quantity of GFY. However, the crude protein content decreased with increasing cutting interval (Ram *et al*. 2007). Bajra x Napier hybrid is a heavy feeder crop and due to multicut ability its nutritional requirement is also very high as it gives better response to evaluated level of fertilizers. Hence, it was felt necessary to study the different agronomic management techniques *viz.*, different planting material, cutting management and fertilizer levels in present investigation to maximize the quantity and quality of green forage.

MATERIALS AND METHODS

The field experiment was conducted during

2009-10 and 2010-11 on *Vertic haplustept* in consecutive two years at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapith Rahuri, Dist Ahmednagar (Maharashtra State). The soils of the experimental field were clayey in texture. The chemical analysis indicated that the soil was low in available nitrogen (198.00 kg ha^{-1}), medium in available phosphorus (17.37 kg/ha) and high in available potassium (515.00 kg/ha). It was moderately alkaline in reaction (pH 8.02) with 0.24 dS m^{-1} electrical conductivity. The organic carbon content was 0.41 %.

The field experiment was laid out in split plot design. The treatment consisted of nine main plot of combinations including three planting material { P_1 - Rooted slip two $hill^{-1}$ (90 cm x 60 cm), P_2–One eye bud sets one $hill^{-1}$ (90 cm x 30 cm) and P_3 –Two eye bud sets one $hill^{-1}$ (90 cm x 60 cm)}, three cutting management {C_1-45 days cutting interval (7 cuttings $year^{-1}$), C_2-60 days cutting interval (6 cuttings $year^{-1}$) and C_3-75 days cutting interval (5 cuttings $year^{-1}$)} and three fertilizer levels { F_1- 100 % RDF (150:60:60 kg N, P_2O_5, K_2O ha^{-1}), F_2-125 % RDF (187.5:75:75 kg N, P_2O_5, K_2O ha^{-1}) and F_3-150 % RDF (225:90:90 kg N, P_2O_5, K_2O ha^{-1})} as sub plot treatments. Thus, there were twenty seven treatment combinations replicated four times. The standard analytical methods were used for plant analysis *viz.*, nitrogen (%) estimated through Parkinson and Allen (1975), phosphorus and potassium (%) by Jackson (1973), crude protein and crude fibre content (%) by A.O.A.C.,(2005) while, NDF ADF, ADL, IVDMD, silica, cellulose and hemi-cellulose (%) was estimated by Van Soest (1975, oxalic acid by Abaza *et al*. (1968) and Chlorophyll (mg g^{-1} of fresh weight of tissue) through Arnon's (1949)

RESULT AND DISCUSSION

Effect of Planting Material

Planting of Bajra x Napier hybrid by rooted slips recorded significantly the highest dry matter yield (53.07 t ha^{-1}), crude protein yield (35.30 q ha^{-1}) and crude fibre yield (164.15 q ha^{-1}) as compared to one and two eye bud sets on pooled mean basis. The crop planted by rooted slips was superior in vegetative growth with respect to plant height, number of leaves, number of tillers and leaf: stem ratio than that of one and two eye bud sets which resulted in more accumulation of dry matter. The single eye bud and two eye bud sets registered significantly minimum crude protein yield because of inferior growth attributes *viz.*, plant height, number of leaves, number of tillers and leaf : stem ratio which was reflected in less dry matter accumulation and thereby lower amount of crude protein yield.

A close observation of Table 1 indicates that crude protein and crude fibre content as well as, NDF, ADF, ADL and IVDMD, oxalic acid, ash, cellulose, hemi cellulose and chlorophyll content in Bajra x Napier hybrid were not influenced significantly due to different planting material on pooled mean basis which further indicated that the afforest quality parameters were not altered due to use of different types of planting material, because the planting material was of same origin. Whereas, the silica content in Bajra x Napier hybrid was found significant due to use of different planting material on pooled mean basis. Two eye bud sets registered significantly the lowest silica content as compared to one eye bud sets and rooted slips.

Effect of Cutting Management

The total dry matter, crude protein and crude fibre yield were significantly increased with increase in cutting interval from 45 to 75 days on pooled mean. The mean dry matter (53.35 t ha^{-1}), crude protein (35.23 q ha^{-1}) and crude fiber yield (172.01q ha^{-1}) of B x N hybrid were significantly maximum at 60 days cutting interval. Considerable variation in herbage yield (green and dry) with extended cutting interval might be attributed to the improvement in yield attributes such as more plant height, number of leaves per bunch, number of tillers per bunch, leaf: stem ratio and dry matter accumulation. Increase in dry matter, crude protein and crude fiber yield of grasses with increase in cutting interval has also been reported by Ram *et al*. (2007), Bora *et al.* (2011) and Reddy and Reddy (2012).

The desirable good quality parameters *viz.*, crude protein content (6.75%), IVDMD (70.45%), ash (13.16%) and chlorophyll content (0.206 mg g^{-1} of fresh weight tissue) in B x N hybrid was significantly higher at 45 days cutting interval as compared to 60 and 75 days intervals. Similar results of crude protein content were reported by various investigators *viz.*, Tessema and Alemayehu (2010), Bora *et al*. (2011), and Reddy and Reddy (2012). The crude protein content decreased with increased in cutting interval which might be due to

TABLE 1
Quality of B x N hybrid as influenced by planting material, cutting management and fertilizer levels on pooled mean basis (2009-11)

Treatment	DMY (q/ha)	CPC (%)	CPY (q/ha)	CFC (%)	CFY (q/ha)	NDF (%)	ADF (%)	ADL (%)	IVDMD (%)	Oxalic acid (%)	Silica (%)	Ash (%)	Cellulose (%)	Hemi-cellulose (%)	Chlorophyll (mg/g) of fresh weight tissue
A. Planting materials (Main plot)															
P_1- Rooted slips	53.07	6.63	35.30	31.38	164.15	65.05	39.62	6.35	63.78	1.98	2.58	12.76	33.26	25.43	0.192
P_2- One eye bud sets	49.93	6.61	33.08	31.47	154.23	65.01	39.58	6.30	63.65	1.97	2.57	12.75	33.10	25.42	0.192
P_3- Two eye bud sets	47.13	6.59	31.11	31.52	148.55	64.88	39.45	6.42	63.68	1.97	2.55	12.74	32.99	25.43	0.194
S.E. m +	0.50	0.00	0.35	0.14	2.03	0.16	0.17	0.06	0.24	0.003	0.015	0.041	0.074	0.04	0.001
CD P=(0.05)	1.63	NS	1.15	NS	6.63	NS	NS	NS	NS	NS	0.048	NS	NS	NS	NS
B. Cutting management															
C_1- 45 days interval	44.78	6.75	30.41	30.23	135.37	63.37	37.87	6.04	70.45	2.05	2.43	13.16	32.34	25.31	0.206
C_2- 60 days interval	53.35	6.58	35.23	31.52	11.52	65.09	39.61	6.50	63.53	1.99	2.56	12.78	33.21	25.43	0.198
C_3-75 days interval	52.00	6.50	33.86	32.63	166.35	66.47	41.17	6.52	57.13	1.87	2.71	12.31	33.81	25.55	0.173
S.E. m +	0.50	0.00	0.35	0.14	2.06	0.16	0.17	0.06	0.24	0.003	0.015	0.041	0.073	0.04	0.001
CD P=(0.05)	1.63	0.01	1.15	0.44	6.63	0.49	0.47	0.19	0.73	0.009	0.048	0.122	0.221	0.12	NS
C. Fertilizer levels (Sub plot)															
F_1- 100 % RDF	44.63	6.38	28.42	33.75	150.63	67.32	42.49	7.20	62.33	1.94	2.90	11.25	31.42	24.83	0.180
F_2- 125 % RDF	50.39	6.61	33.30	31.60	157.79	65.31	39.60	6.35	63.72	1.97	2.58	12.94	33.16	25.68	0.195
F_3- 150 % RDF	55.09	6.84	37.78	29.02	161.07	62.30	36.57	5.51	65.06	2.01	2.23	14.06	34.77	25.77	0.202
S.E. m +	0.15	0.00	0.10	0.24	1.27	0.20	0.02	0.03	0.27	0.001	0.008	0.052	0.086	0.04	0.001
CD P=(0.05)	0.44	0.01	0.29	0.70	3.79	0.57	0.06	0.09	0.79	0.003	0.024	0.151	0.247	0.12	0.003
CV %	6.53	6.17	8.51	8.92	12.17	3.60	5.42	6.48	4.24	3.30	4.64	5.14	4.35	4.88	5.63
General mean	50.04	6.61	33.17	31.46	156.65	64.98	39.55	6.36	63.70	1.97	2.57	12.75	33.12	25.43	0.193

the leaf fraction which was found to contain high proportion of crude protein than stem in early stage of growth. Increased accumulation of carbohydrates and other structural material such as lignin and silica with maturity of the crop and reduction in leaf to stem ratio could be attributed to decrease in the crude protein content with crop maturity. Similarly, 60 and 75 days cutting interval produced more biomass, the biomass production dilutes the concentration of protein. The nitrogen concentration in hybrid Napier was diluted by the higher biomass production; hence, the crude protein content was varied according to cutting intervals.

Whereas, the IVDMD indicates how much feed is digested to animal after feeding. I*n-vitro* digestibility is measured by creating rumen environment outside of the animal body by using artificial temperature, $CO_{2,}$ anaerobic condition and rumen enzymes. In the present study, the increase in cutting interval decreased the IVDMD in B x N hybrid. The decline in IVDMD has been linked to increase in the portion of grass. Another possible reason of reduction of digestibility in grass with maturity might be due to low portion percentage in advanced dry matter digestibility with 45 days cutting interval may be explained by high leaf: stem ratio and lower lignin content in plant. Our results fall in the line with the report of Tessema and Alemayehu (2010) and Bora *et al*. (2011).

Ash content in B x N hybrid decreased with increase in cutting interval. Higher ash content at 45 days cutting interval might be due to higher mineral absorption at initial growth stage which was reflected in higher DMY yield. These results are correlated with the result of Tessema and Alemayehu (2010). The chlorophyll content is an indicator of photosynthesis. The chlorophyll content in B x N hybrid leaves was significantly maximum at 45 days cutting interval as compared to 60 and 75 days cutting interval. The significantly higher chlorophyll content was observed at early cutting interval might be due to higher nitrogen content. The decrease in chlorophyll content with increase in cutting interval was also reported by Singh (1994).

The inferior quality parameters from digestibility point of view *viz*., crude fiber content (32.63%), NDF (66.47%) , ADF (41.17%), ADL (6.52%) silica (2.71%), cellulose (33.81%) and hemi-cellulose content (25.55%) in B x N hybrid was significantly higher at 75 days cutting interval as compared to 45 and 60 days cutting intervals on pooled mean basis. The crude fiber content was increased with increase in cutting interval. Cutting of B x N hybrid at an interval of longer duration leads to conversion of sugar to cellulose as long chain polysaccharides, resulted formation of fiber like structure, ultimately enhanced the fiber content over shorter period of cutting interval. The similar results were also reported by Bora *et al.* (2011) and Reddy and Reddy (2012).

The NDF, ADF and ADL content in B x N hybrid were significantly lowest at 45 days cutting interval (63.37, 37.87 and 6.04 %) than 60 days and 75 days cutting intervals during both the year. The increase in cutting interval increases the NDF, ADF and ADL content in Bajra x Napier hybrid. The similar trend was also indicated by Tessema and Alemayehu (2010), Bora *et al*. (2011), and Reddy and Reddy (2012). The digestibility and potential intake values are determined from NDF, ADF and ADL. NDF measures all the fiber found in forage (cellulose, hemi-celluloses, lignin and heat damaged protein). The NDF fraction is partially digestible depending on forage species and stage of maturity therefore; the NDF is the best indicator of how much forage an animal will eat. Low NDF containing forage preferred by animals than high NDF ones. High NDF content in forages not only decreases intake, but limits the effectiveness of forage in supporting higher milk production. ADF is also partially digestible part of forage; the increase in ADF levels decreases the fibre digestion. Because of this negative relationship between ADF and digestibility, thus low ADF is desirable. As the plant matures, the stem becomes more fibrous largely due to lignin. Therefore, the decline in forage quality with maturity is primarily due to the increasing lignifications of the stem and an increasing proportion of stem compared to leaf. Tessema and Alemayehu (2010) reported that the forage quality was decreased with increase in the NDF and ADF. Whereas, the ADL content in B x N hybrid was significantly lowest at 45 days cutting interval (6.04 %) over 60 days and 75 days cutting intervals on pooled mean. The increase in cutting interval increases the ADL content in B x N hybrid. The similar trend was also indicated by Bora *et al*. (2011), and Reddy and Reddy (2012).

The significantly lowest silica content was recorded with crop cut at an interval of 45 days (2.43 %). There was linear response of silica content with increasing time of cutting interval and maximum silica content was observed where crop was cut at an interval of 75 days. This might be due to the fact that increase in cutting interval will provide more time for absorption of more silica content which accumulate in the plant. Similar result was also reported by Reddy and Reddy (2012). The cellulose is a digestible fraction of the fiber as it was digested by the enzyme cellulose of rumen micro-flora. However, hemi-cellulose is partly digestible fiber as the values are result of subtracting ADF from NDF. The cellulose and hemi-cellulose content in B x N hybrid was significantly higher at 75 days than 45 and 60 days cutting intervals on pooled mean. The increase in cutting interval significantly increased the cellulose and hemi-cellulose content in B x N hybrid. This might be due to fact that as the plant matures the dry matter and cell wall contents increase whereas, crude proteins decreases. The fiber contents such as cellulose and hemi-cellulose in forage varied in accordance with the stage of cut and fertilizer application. Similar findings were also reported by Bora *et al*. (2011) and Reddy and Reddy (2012).

The higher level of oxalate content in forages adversely affects the nutritional quality of animal feed. It is recommended to adopt desirable harvesting practice to minimize the oxalate content in B x N hybrid up to acceptable levels. Young plants contain more oxalate than older plants. During early stage of growth, there is a rapid rise in oxalate content followed by a decline in oxalate levels as the plant matures. The decline in oxalate content with maturity of the crop may be due to degradation of oxalate to carbonates or bicarbonates due to dilution of oxalates and oxalic acid with calcium of plant to form calcium oxalates at prolonged interval of cutting management as a result there was reduction in oxalic acid content. In the present investigation oxalic acid content in B x N hybrid was significantly lowest (1.87 %) at 75 days cutting interval than 45 (2.05 %) and 60 (1.99 %) days cutting intervals during both the year and on pooled mean. Further, the oxalic acid content declined as the cutting interval of B x N hybrid increased. These results are in close vicinity to those reported by Rahman and Kawamura (2011).

Effect of Fertilizer Levels

Application of 150 % RDF to B x N hybrid recorded significantly maximum total dry matter yield (55.09 t ha^{-1}) over 100 % and 125 % RDF applied on pooled mean. Increase in RDF significantly increases the dry matter yield of Bajra x Napier hybrid. The application of higher level of RDF produced more herbage yield, accumulation of more dry matter these results are in agreement with those were reported by Jayanthi (2007), Pathan and Bhilare (2008 a and b).

Application of RDF specially nitrogen significantly increased crude protein content as ammonium ions and some of the carbohydrates synthesized in leaves were converted into amino acid more readily. In the present investigation the application of 150 % RDF to B x N hybrid recorded significantly higher average crude protein content (6.84 %), total crude protein yield (37.78 q ha^{-1}) over 100 % and 125 % RDF (6.38 % and 6.61 %, respectively) on pooled mean basis. This might be also due to higher nitrogen supply, more rapidly the synthesized carbohydrates were converted to protein and protoplasm and smaller proportion was left available for cell wall material, thus carbohydrate and nitrogen provided skeleton for protein synthesis. Since application of higher level of RDF produced more herbage yield, accumulation of more dry matter and crude protein content in plants which in turn increased crude protein yield. These results are on the line of Pathan and Bhilare (2008a), Bora *et al*. (2011) and Velayudham *et al.* (2011).

Significantly higher total crude protein yield (37.78 q ha^{-1}) was registered with application of 150 % RDF over 100 % and 125% RDF applied on pooled mean. Significantly lowest crude protein yield (28.42 q ha^{-1}) was recorded under 100% of RDF during the period of investigation. Total crude protein yield increased with increase in RDF from 100% to 150%, the beneficial effect of NPK on the green forage yield may be attributed to the production of superior yield attributes and higher dry matter production.

Application of 150% RDF to B x N hybrid recorded significantly lowest average crude fibre content (29.02 %) over 100 % and 125 % RDF on pooled mean. Significantly maximum crude fibre content (33.75 %) was observed with 100 % RDF. The crude fibre content decreased with increase in RDF because higher dose of fertilizer application to B x N hybrid delayed the maturity particularly by nitrogen application, whereas lower dose of fertilizer application to the B x N hybrid leads to forced maturity within a short span of time. This might have governed the phenomenon of fibre synthesis. Whereas, the application of 150 % of RDF to B x N hybrid recorded significantly higher crude fibre yield (185.89 q ha^{-1}) as compared to 100 % and 125 % RDF whereas, application of 100 % RDF registered significantly lowest crude fibre yield (130.26 q ha^{-1}) during both the year and on pooled mean. Total crude fibre yield increases with increase in RDF from 100 % to 150 %, the beneficial effect of NPK on the green forage yield may be attributed to the production of superior yield attributes and higher dry matter production. The similar trend was also reported by Bora *et al.* (2011).

An application of 150 % of RDF to B x N hybrid registered significantly minimum NDF (62.30 %) ADF (36.57 %), ADL (5.51 %) and silica content (2.90%) of B x N hybrid than 100 % and 125 % RDF on pooled mean basis. Whereas, significantly maximum NDF (67.32 %), ADF (42.49 %), ADL (7.20 %) and silica content (2.90%) was observed with application of 100 % RDF. This might be due to the fact that, increased supply of nitrogen and other nutrients increased the protein content, whereas it decreased the NDF, ADF, ADL and silica content as reported by Bora *et al*. (2011), Sharma *et al.* (2012). The silica content in B x N hybrid was decreased with increase in RDF. This might be because of higher doses of fertilizer application resulted increase in the total biomass production which diluted the mineral constituents in B x N hybrid. These results are in conformity to the findings of Pathan and Bhilare (2008b) and Reddy and Reddy (2012).

Application of 150 % of RDF to B x N hybrid recorded significantly highest IVDMD (65.06 %), oxalic acid content (2.01%) , ash (11.25%), cellulose (34.77%), hemi cellulose content (25.77%) and chlorophyll (0.202 mg g^{-1}) of fresh weight tissue content than 100 % and 125 % RDF on pooled mean. Application of 100 % of RDF to B x N hybrid recorded significantly lowest IVDMD content (62.33 %), oxalic acid content (1.94 %), ash (11.25%), cellulose (31.42%), hemi cellulose content (24.83%) and chlorophyll (0.180 mg g^{-1}) of fresh weight tissue were noticed in 100 % RDF. The present results indicated that increase in fertilizer level increased the IVDMD in B x N hybrid. The results reported in present investigation are in accordance with findings of Bora *et al*. (2011).The oxalic acid content in B x N hybrid increased with increase in RDF. This might be due to application of higher dose of fertilizers resulted more vegetative growth and development and increases metabolic activities. The higher metabolic activity increased the oxalic acid content in B x N hybrid.

Fibre content such as cellulose and hemi-cellulose in forage varied in accordance with the fertilizer application. The cellulose and hemi-cellulose content in B x N hybrid increased with increase in RDF which might be due to fact that as the fertilizer levels increased, the dry matter and cell wall contents were also increased. The chlorophyll content in the present study was found highest on application of 150 % of RDF thus increase in chlorophyll content correlated with increases in fertilizer levels in B x N hybrid. Similar results were reported by Bora *et al*. (2011) and Reddy and Reddy (2012).

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