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Influence of intercrops and nutrients on growth and yield of BN hybrid grass

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Abstract
Fodder management plays a vital role in livestock management. For better better biomass yield of the fodder crop optimum management of the available land and nutrients is essential. With that background a field experiment was conducted at Zonal Agriculture Research Station, UAS, GKVK, Bengaluru during 2020-21 to study the influence of intercrops and nutrients on growth and yield of BN hybrid grass. The experiment was laid out in a randomized block design with the factorial concept with three replications. The experiment was conducted with two levels of spacing (S1:60-240-60 cm and S2:90-180-90 cm), two levels of intercrops (C1: Fodder cowpea and C2: Mukuna or velvet bean) and three levels of nutrient management (N1: 25% BDLM N equivalent + 75% RDN, N2: 50% BDLM N equivalent + 50% RDN, N3: 75% BDLM N equivalent + 25% RDN, respectively). The experimental results indicated that spacing of 60-240-60 cm with intercropping of mukuna or velvet bean along with 25% biodigested liquid manure (BDLM) N equivalent + 75% recommended dose of nitrogen (RDN) resulted in the higher plant height, higher leaf: stem ratio, fresh and dryfodder yield and drymatter accumulation of BN hybrid as well as intercrops resulting higher BN hybrid fodder equivalent yield.

Keywords: Bajra napier hybrid, velvet bean, Bio digested liquid manure, fodder production

Introduction

Livestock is an important asset and livelihood option for people in rainfed areas. India has the proud distinction of having the largest livestock population of 535.78 million heads in the world. Out of which it constitutes 192.5 million heads of cattle and it is the world's largest single milk producer with 176 mt in 2019-2020 (Anon., 2020) [2]. The productivity of milk in India is low due to poor quality of feed and fodder supply apart from gradual genetic deterioration and neglect for the adoption of general scientific management of animals. but poor feed quality and dry season feed shortages are serious limitations for sustainable livestock production.

Plant configuration (geometry) plays an important role in fodder production. Normally, Bajra Napier hybrid grass is cultivated in ridges and furrow method. When paired row planting system is adopted, possibilities are there to increase the yield and income compared to conventional planting due to the availability of sufficient sunlight and better aeration coupled with effective utilization of space and nutrients. Bajra Napier hybrid grass (BN) (*Pennisetum americanum* (L.) Leek × *Pennisetum purpureum* (L.) Schumach) is valuable, high biomass producing tropical grass and is well recognized throughout our country for its palatability and good fodder quality. It has a profuse tillering habit, quick re- growth, sparsely hairy, high leaf-stem ratio and erect. It has a high herbage yield capacity and is highly palatable and nutritious. Overall, possess the adaptability for varying climatic conditions, tolerance to insect-pest and diseases.

Cowpea (*Vigna ungiculata L*) is gaining importance as a fodder legume crop and is grown during the summer and *Kharif*. It is a heavy forage yielder, raised as a pure crop or in association with cereals like maize, sorghum and bajra so as to enrich nutritive value due to its higher protein content and improve fertility of the soil. Mukuna or velvet bean is suitable in intercropping systems where it is grown with maize, pearlmillet, sorghum and sugarcane. The crop gives reliable yields in dry farming and low soil fertility condition that do not allow the profitable cultivation of most of the other legumes. Apart from yielding when these are grown as an intercrops might improve the BN napier hybrid equivalent yield because of higher biomass production per unit area and complementary interaction between BN napier grass and legume intercrops.

Material and Methods

A field experiment was conducted during the *Kharif* 2020-21 at Zonal Agricultural Research Station (ZARS), University of Agricultural Sciences, Bangalore to study the "Influence of intercrops and nutrients on growth and yield of BN hybrid grass**".** The soil of the experimental site was red sandy loam in texture, classified under the order of *Alfisols*, The soil of the experimental site was low in organic carbon (0.43%), available nitrogen (272 kg ha^{-1}), available phosphorus (16.5 kg ha^{-1}) and medium in potassium (248 kg ha^{-1}). The experiment consists of twelve treatments laid out in Randomized Complete Block Design with a factorial concept and replicated thrice. Two spacings (S1:60-240-60 cm and S2:90-180-90 cm), Two intercrops (C1: Fodder cowpea and C2: Mukuna or velvet bean) and three nutrient management practices (N1: 25% BDLM N equivalent + 75% RDN, N2: 50% BDLM N equivalent + 50% RDN, N3: 75% BDLM N equivalent + 25% RDN, respectively. As per the treatments sowing of setts done at two spacings accommodating 21,978 setts ha^{-1} and 16428 setts ha^{-1} respectively and intercrops fodder cowpea at 19.8 kg ha^{-1} and 7.4 kg ha^{-1}, mukuna or velvet bean at 27.7 kg ha^{-1} and 10.3 kg ha^{-1} and basal application of fertilizers was given at sowing and top dressing of fertilizers done according to respective treatments. Observations on growth and yield parameters were recorded during harvest.

Table 1: Effect of spacing, intercrops and nutrient management practices on plant height (cm), number of tillers/clump, number of branches/ plant and leaf: stem ratio of BN hybrid and intercrops at harvest

Treatments	Plant ht. BN Hybrid(cm)	Plant ht. Intercrops (cm)	No. of tillers/clump of BN hybrid	No. of branches/plant of intercrops	Leaf: Stem BN hybrid	Leaf: Stem Intercrops
Spacing (S)						
S1: 60-240-60 cm	176.00	75.25	14.39	7.94	0.65	0.70
S2: 90-180-90 cm	163.00	71.23	16.44	11.33	0.46	0.61
F-test	*	*	*	*	*	*
S.Em±	3.21	1.36	0.48	0.31	0.01	0.02
CD (5%)	9.42	4.00	1.42	0.90	0.03	0.06
Intercrops(C)						
C1: Fodder cowpea	165.08	67.12	14.06	8.56	0.52	0.62
C2: Mukuna or Velvet bean	173.90	79.37	16.78	10.72	0.59	0.68
F-test	NS	*	*	*	*	*
S.Em±	3.21	1.36	0.48	0.31	0.01	0.02
CD (5%)	NS	4.00	1.42	0.90	0.03	0.06
Nutrient management practices(N)						
N1: 25% BDLM N equivalent + 75% RDN	178.35	76.12	18.25	10.92	0.69	0.77
N2: 50% BDLM N equivalent + 50% RDN	172.50	73.65	16.00	9.58	0.56	0.69
N3: 75% BDLM N equivalent + 25% RDN	157.63	69.96	12.00	8.42	0.42	0.49
F-test	*	*	*	*	*	*
S.Em±	3.93	1.67	0.59	0.37	0.01	0.02
CD (5%)	11.53	4.90	1.74	1.10	0.04	0.07

Table 2: Effect of spacing, intercrops and nutrient management practices on dry matter content, green fodder yield and fodder equivalent yield of BN hybrid and intercrops at harvest

Treatments	Dry matter content of BN hybrid (%)	Dry matter content of Intercrops (%)	Green fodder yield of BN hybrid (q/ha)	Green fodder yield of intercrops (q/ha)	Dry fodder yield of BN hybrid (q/ha)	Dry fodder yield of intercrops (q/ha)	Fodder equivalent yield of BN hybrid (q/ha)
Spacing (S)							
S1: 60-240-60 cm	20.25	19.63	322.97	164.37	66.15	33.49	603.50
S2: 90-180-90 cm	17.38	16.89	304.42	143.27	53.43	24.39	543.78
F-test	*	*	*	*	*	*	*
S.Em±	0.59	0.46	5.70	5.81	2.34	1.35	13.79
CD (5%)	1.72	1.36	16.72	16.03	6.88	3.96	40.43
Intercrops(C)							
C1: Fodder cowpea	17.95	17.58	305.33	145.30	56.34	26.96	553.40
C2: Mukuna or Velvet bean	19.68	18.94	322.06	162.34	63.23	30.93	593.87
F-test	*	*	*	*	*	*	*
S.Em±	0.59	0.46	5.70	5.81	2.34	1.35	13.79
CD (5%)	1.72	1.26	16.72	16.03	6.88	3.96	40.43
Nutrient management practices(N)							
N1: 25% BDLM N equivalent + 75% RDN	21.65	20.91	338.22	173.36	72.65	36.97	629.88
N2: 50% BDLM N equivalent + 50% RDN	19.54	18.71	312.70	160.56	62.46	30.47	588.49
N3: 75% BDLM N	15.25	15.15	290.17	127.53	44.25	19.40	502.54

equivalent + 25% RDN							
F-test	*	*	*	*	*	*	*
S.Em±	0.72	0.57	6.98	7.11	2.87	1.65	16.88
CD (5%)	2.11	1.66	20.47	20.86	8.42	4.85	49.52

Result and Discussion

Plant height

The plant height of BN hybrid at harvest varied significantly with respect to different levels of spacing, and nutrient management practices but was statistically non-significant with respect to intercrops (Table 1). The spacing 60-240-60 cm recorded significantly higher plant height (176.00 cm) as compared to spacing of 90-180-90 (163.00 cm). Taller plant height (173.90 cm) was recorded with velvet bean followed by fodder cowpea (165.08 cm) and was found to be non-significant. Among nutrient management practices, taller plant height was recorded with 25% BDLM N equivalent +75% RDN (178.35 cm) which was on par with 50% BDLM N equivalent RDN +50% BDLM (172.50 cm). The spacing 60-240-60 cm of intercrops recorded significantly higher plant height (75.25 cm) as compared to spacing of 90-180-90 cm (71.23 cm). Taller plant height (79.37 cm) was recorded with velvet bean followed by fodder cowpea (67.12 cm) and was found to be significant. Among different nutrient management practices, taller plant height was recorded with 25% BDLM N equivalent +75% RDN (76.12 cm) differed significantly and was on par with 50% BDLM N equivalent + 50% RDN (73.65 cm), lower plant height recorded with 75% BDLM N equivalent +25% RDN (69.96 cm). The increase in plant height of fodder crops is mainly due to lesser spacing that increases the capacity of BN hybrid for competing for maximum solar radiation and legumes which are spreading in habit cover the interspaces of grass and competes with it for interception of solar radiation that resulted in increased height of BN hybrid grass and intercrops as reported by Paneerselvam (1986) [17].The findings are in accordance with Sushma *et al.* (2020) [22], Verma *et al.* (2011) [24], Babu *et.al* (1994) [3], The increase in plant height with increased levels of nitrogen might be due to enhanced synthesis of chlorophyll, induced cell division and cell expansion leading to stimulated cell elongation along the main axis, which resulted in increase in number and length of internodes and conspicuous increase in plant height. Similar results have also been reported by Hani Eltelib *et al*. (2006) [9].

Number of tillers/clump and Number of branches/plant

The number of tillers per clump of BN hybrid at harvest varied significantly with respect to different levels of spacing, intercrops and nutrient management practices. Among different spacing 90-180-90 cm recorded higher number of tillers/clump (16.44) than 60-240-60 cm (14.39). Intercropping of velvet bean recorded significantly higher number of tillers per clump (16.78) than cowpea (14.06). Among different nutrient management practices, number of tillers per clump recorded higher in 25% BDLM N equivalent +75% RDN (18.25) compared to 50% BDLM N equivalent +50% RDN (16.00) and 25% BDLM N equivalent +75% RDN (12.00). The number of branches per plant of intercrops at harvest varied significantly with respect to different levels of spacing, intercrops and nutrient management practices. The spacing 90-180-90 cm recorded a higher number of branches per plant at harvest (11.33) than 60-240-60 cm (7.94). Intercropping of velvet bean recorded higher number of branches per plant (10.72) than fodder cowpea (8.56). Among different nutrient management practices, number of branches per plant is higher in 25% BDLM N equivalent +75% RDN (10.92) followed by 50% BDLM N equivalent +50% RDN (9.58) and lower branches per plant 75% BDLM N equivalent +25% RDN (8.42). The variation in number of tillers per clump and branches was higher in higher spacing 90-180-90 and was due to tillering. The wider space between paired rows allowed taking full advantage of light and plant nutrients, resulting in the production of more number of tillers as reported by Gardner *et al*. (1985) [10]. Tillering was highly influenced by factors such as light, temperature, spacing, moisture and nitrogen supply. During the initial stages, the rate of tillering and branching habit was moderate due to establishment and environment that prevailed during this period as reported by Dhillon and Panwar (1979) [8]. Among intercropping, velvet bean produced higher number of tillers per clump compared to cowpea and is mainly due to better canopy cover than cowpea and legumes contributed greater nutrient availability to the soil which efficiently utilized by BN hybrid grass to enhance crop growth. The results are in accordance with the findings of Veeraraghaviah *et al*. (1979) [23], Sushma *et al*. (2020) [22].

Leaf: stem ratio

The leaf: stem ratio of BN hybrid was higher at spacing of 60-240-60 cm (0.65) compared to 90-180-90 cm (0.46). Higher leaf: stem ratio was noticed with intercropping of velvet bean (0.59) compared to fodder cowpea (0.52). Among nutrient management practices, 25% BDLM N equivalent + 75% RDN recorded higher leaf: stem ratio (0.69) compared to 50% BDLM N equivalent + 50% RDN (0.56) and 75% BDLM N equivalent + 25% RDN (0.42). The leaf: stem ratio of intercrops was higher at spacing of 60-240-60 cm (0.70) spacing compared to 90-180-90 cm (0.61). Higher leaf: stem ratio was noticed with intercropping of velvet bean (0.68) compared to fodder cowpea (0.62) and were on par. Among nutrient management practices, 25% BDLM N equivalent + 75% RDN recorded higher leaf: stem ratio (0.77) followed by 50% BDLM N equivalent + 50% RDN (0.69) and lower leaf: stem ratio at 75% BDLM N equivalent + 25% RDN (0.49). Higher leaf: stem ratio was found at narrow spacing and is due to narrow spacing with more seed rate lead to the development of increased leaf size and decreased stem girth whereas wider spacing with lesser seed rate more space is available for crop growth and development resulted in more stem girth which led to lower leaf: stem ratio as reported by Verma *et al.* (2005) [25]. Leaf stem ratio of BN hybrid was found maximum at cutting interval of 5 weeks cutting interval and decreased marginally when the interval of cutting proceeded to 9 weeks and stem weight of BN hybrid increased with increase in cutting interval thereby decreasing leaf stem ratio. There is very little reduction in leaf stem ratio was noted with the advancement in the stages of cutting from maximum tillering stage to 50% flowering in the forage pearlmillet as reported by Paroda (1975) [18]. Among different intercropping systems intercrop more with more leaf size and tender stem recorded higher leaf: stem ratio compared to less leaf and more stem thickness as reported by Sushma *et al*. (2020) [22]. Among nutrient management practices 25% BDLM N equivalent + 75% RDN recorded a higher leaf: stem ratio. This is mainly due to the rapid expansion of dark foliage which could intercept and utilize the incident solar radiation in the production of photosynthates and finally resulting in higher meristematic activity and increased leaf stem ratio as reported by Manjangouda *et al.* (2017). The results are in accordance with Bishnoi *et al.* (2005) [5], Somashekar *et al.* (2018) [21], Begum *et al.* (2018) [4], Dahipahale *et al.* (2015) [7].

Dry matter content (%)

The dry matter content (%) of BN hybrid was higher at spacing 60-240-60 cm (20.25%) followed by 90-180-90 cm (17.38%). Intercropping of velvet bean recorded higher dry matter content (19.68%) followed by intercropping with fodder cowpea (17.95%). Among nutrient management practices, 25% BDLM N equivalent + 75% RDN recorded higher dry matter content (21.65%) and was on par with 50% BDLM N equivalent + 50% RDN (19.54%) and lower dry matter content recorded with 50% BDLM N equivalent + 50% RDN (15.25%). Total dry matter content (%) of intercrops at harvest varied significantly due to different levels of spacing, intercrops and nutrient management practices. The dry matter content (%) was higher at spacing 60-240-60 cm (19.63%) followed by 90-180-90 cm (16.89%). Intercropping of velvet bean recorded higher dry matter content (18.94%) and was on par with intercropping with fodder cowpea (17.58%). Among different nutrient management practices, 25% BDLM N equivalent + 75% RDN recorded higher dry matter content (20.91%) followed by 50% BDLM N equivalent + 50% RDN (18.71%) and 75% BDLM N equivalent + 25% RDN (15.15%). The higher dry matter content at narrow spacing was mainly due to increased photosynthetic activity of the crop that resulted in the greater height of main crops and intercrops compared to wider spacing resulting in greater dry matter content as reported by Pathan and Bhilare (2008) [19]. Among intercropping lower dry matter content was with cowpea mainly due to more succulent stems compared to velvet bean as reported by Manoj *et al.* (2020) [14]. The dry matter content was significantly higher with the application of more nitrogen in easily available form. This may be attributed to nitrogen is an essential constituent of plant tissue and is involved in cell division and cell elongation, its beneficial effect on the growth characters *viz*., plant height and stem diameter. The results are in accordance with, Somashekar *et al.* (2018) [21], Eltelib *et al.* (2006) [9], Manjanagouda *et al.* (2017) [13].

Green fodder yield (q/ha)

Green fodder yield of BN hybrid varied significantly with different levels of spacing, intercrops and nutrient management practices. The crop at a spacing of 60-240-60 cm recorded a higher green fodder yield (322.97 q ha^{-1}) compared to 90-180-90 cm (304.42 q ha^{-1}). The highest green fodder yield was obtained by intercropping of velvet bean (322.06 q ha^{-1}) higher than intercropping of fodder cowpea (305.33 q ha^{-1}). Among different nutrient management practices, Application of 25 % BDLM N equivalent + 75% RDN recorded higher green fodder yield (338.22 q ha^{-1}) followed by 50% BDLM N equivalent + 50% RDN (312.70 q ha^{-1}) and lower green fodder yield recorded with 75% BDLM N equivalent + 25% RDN (290.17 q ha^{-1}). Green fodder yield of intercrops varied significantly with different levels of spacing, intercrops and nutrient management practices. The crop at a spacing of 60-240-60 cm recorded higher green fodder yield (164.37 q ha^{-1}) compared to 90-180-90 cm (143.27 q ha^{-1}). The highest green fodder yield was obtained by intercropping with velvet bean (162.34 q ha^{-1}) than intercropping with fodder cowpea (145.30 q ha^{-1}). Among different nutrient management practices, Application of 25% BDLM N equivalent + 75% RDN recorded higher green fodder yield (173.36 q ha^{-1}) followed by 50% BDLM N equivalent + 50% RDN (160.56 q ha^{-1}) and lower green fodder yield recorded with 75% BDLM N equivalent + 25% RDN (127.53 q ha^{-1}). The possible reasons for higher fodder yield in narrow spacing is due to increased plant population per unit area as compared to normal plant population that resulted in greater plant height and ultimately increased yield (Kashinath, 2014) [12]. Intercropping of annual legumes in perennial grasses leads to greater exploitation of roots from different soil layers for moisture and nutritional requirements and thus resulted in a higher yield of grasses as reported by Vinod shankar and shivanath ram (1997) [20]. Higher fodder yield was mainly due to improved plant growth parameters like plant height, leaf to stem ratio and dry matter content due to higher nutrient content and quick release of nitrogen from inorganic sources might be the reason for higher green fodder yield compared to slow release from the inorganic source. The results are in accordance with Begum *et al.* (2018) [4] and Naveena *et al.* (2021) [15].

Dry fodder yield (q/ha)

The dry fodder yield (q ha^{-1}) of BN hybrid varied significantly due to different levels of spacing, intercrops and nutrient management practices. Higher dry fodder yield was obtained with a spacing of 60-240-60 cm (66.15 q ha^{-1}) than the spacing of 90-180-90 cm (53.43 q ha^{-1}). Intercropping of velvet bean recorded higher dry fodder yield (63.23 q ha^{-1}) compared to fodder cowpea (56.34 q ha^{-1}). Among different nutrient management practices, application of 25% BDLM N equivalent + 75% RDN recorded higher dry fodder yield (72.65 q ha^{-1}) followed by 50% BDLM N equivalent + 50% RDN (62.46 q ha^{-1}) and lower green fodder yield recorded with 75% BDLM N equivalent + 25% RDN (44.25 q ha^{-1}). The dry fodder yield (q ha^{-1}) of intercrops varied significantly due to different levels of spacing, intercrop and nutrient management practices. Higher dry fodder yield was obtained with a spacing of 60-240-60 cm (33.49 q ha^{-1}) than the spacing of 90-180-90 cm (24.39 q ha^{-1}). Intercropping of velvet bean recorded higher dry fodder yield (30.93 q ha^{-1}) compared to fodder cowpea (26.96 q ha^{-1}). Among nutrient management practices, application of 25% BDLM N equivalent + 75% RDN recorded higher dry fodder yield (36.97 q ha^{-1}) followed by 50% BDLM N equivalent + 50% RDN (30.47 q ha^{-1}) and lower green fodder yield recorded with 75% BDLM N equivalent + 25% RDN (19.40 q ha^{-1}). The highest dry fodder yield was observed in narrow row spacing mainly due to increased plant population compared to wider row spacing as reported by Kashinath (2014) [12]. Among different intercropping, intercropping with velvet bean recorded higher yield and is mainly due to higher creeping nature of crop that resulted in more dry matter content of crops as reported by Sushma *et al.* (2020) [22]. Higher amount of application of an inorganic source of nitrogen with an organic source of nitrogen recorded higher dry fodder yield and is mainly due to nitrogen on cell division and elongation, formation of nucleotides and co-enzymes resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates, which reflected in higher yield. The increased nitrogen application significantly improved all growth and yield attributes. The results are in accordance with Gill *et al.* (1984) [11] and Vinod Shankar and shivanath ram (1997) [20] and Naveena *et al.* (2021) [15].

BN hybrid fodder equivalent yield (q/ha)

The fodder equivalent yield (q ha^{-1}) of BN hybrid varied significantly due to different levels of spacing, intercrops and nutrient management practices. Higher fodder equivalent yield was obtained with spacing of 60-240-60 cm (603.50 q ha^{-1}) was significantly higher than spacing of 90-180-90 cm (543.78 q ha^{-1}). Intercropping of velvet bean recorded significantly higher dry fodder yield (593.87 q ha^{-1}) compared to cowpea (553.40 q ha^{-1}). Among different nutrient management practices, application of 25% BDLM N equivalent + 75% RDN recorded significantly higher fodder equivalent yield (629.88 q ha^{-1}) and was on par with 50% BDLM N equivalent + 50% RDN (588.49 q ha^{-1}) and lower green fodder yield recorded with 75% BDLM N equivalent + 25% RDN (502.54 q ha^{-1}). Higher fodder equivalent yield (q ha^{-1}) was recorded at narrow spacing compared to wider spacing mainly due to higher plant population coupled with higher fodder price of bajra napier hybrid crop. Intercropping of velvet bean also recorded higher yield compared to cowpea mainly due to higher yield of velvet bean fodder coupled with higher price. Among different nutrient management practices, higher dose of inorganic nitrogen coupled with organic source resulted higher fodder yield. This is mainly due to higher yield coupled with higher price of fodder. The results are in accordance with Verma *et al*. (2011) [24], Chaudhary *et al*. (2020) [6], Pal *et al*. (2014) [16], Amedie *et al*. (2004) [1].

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