

Assessment of BxN Hybrids for Fodder Productivity in South Gujarat, India

ABSTRACT:

A field experiment was conducted at Krishi Vigyan Kendra (KVK), Bharuch, Gujarat to evaluate eight Bajra x Napier (BxN) hybrids viz. BNH-10, BNH-11, CO-5, CO-6, DHN-5, DHN-15, Phule Jaywant, and Phule Gunwant for their fodder yield potentials and quality parameters over three years (2021-2024). A Randomized Block Design (RBD) with three replications was employed for the experiment. The pooled results of three years revealed that significant variations were observed in hybrids investigated. The hybrid BNH-11 consistently and significantly outperformed other tested hybrids, demonstrating superior performance across multiple parameters, including plant height (143.25 cm), tillers per plant (26), leaf-to-stem ratio (1.14), green fodder yield (207.05 MT ha⁻¹), dry matter yield (80.36 MT ha⁻¹) and crude protein yield (6.06 MT ha⁻¹). Phule Gunwant closely followed BNH-11, performing on par across all evaluated parameters. These findings indicate that BxN hybrids exhibit substantial potential for fodder production, supporting their use in sustainable livestock farming systems in the region.

Key words : *Hybrid Napier*, green fodder yield, dry matter yield, crude protein.

INTRODUCTION

Animal husbandry in India is closely linked with agriculture and plays a critical role in the socio-economic development of rural households, significantly contributing to the national economy (Birthal, 2016). Despite this, only 4% of the cropped area in India is allocated for fodder cultivation, limiting fodder availability. Gujarat has a prominent position in India's livestock sector, with 26.9 million livestock (5.02% of the country's total) according to the 20th Livestock Census (2017). The state has approximately 9.70 million cattle and 10.4 million buffaloes, making it one of the leading buffalo milk producers in India. However, the current fodder production in Gujarat is insufficient to meet the demands of its large livestock population. The total availability of green forage is estimated to be 608 lakh metric tonnes, while dry fodder availability is 139 lakh metric tonnes, leading to deficits of 25% and 44%, respectively (Kalamkar *et al.*, 2020). The average green fodder yield is 40 metric tonnes per hectare per year for cultivated land and 0.75 metric tonnes per hectare per year for common grazing land.

The South Gujarat region, blessed with the highest rainfall in the state and a well-developed irrigation network, has seen a shift in farming practices with many farmers replacing traditional food and fodder crops with cash crops. Although some dairy farmers have attempted to grow seasonal fodder to address the shortage, these efforts have proven neither economical nor sustainable, falling short of meeting the rising demand driven by the growing livestock population. Moreover, the shift from cereal crops—an important source of crop residues—to commercial crops has further aggravated the fodder scarcity (Patil *et al.*, 2018). To address this gap between fodder demand and supply, there is a need to intensify forage production per unit area and time.

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. This can be achieved through the adoption of improved, high-yielding fodder crops and better management practices, which will help increase productivity and ensure adequate nutrition for the state's livestock population. A promising perennial source of green fodder is Bajra x Napier hybrid and it is widely used for its excellent yield, palatability, and tolerance to diverse soil and climatic conditions (Faruqui *et al.*, 2009). With this background a field experiment was conducted to study the production potential of different BxN hybrids under irrigated conditions of South Gujarat which could provide a viable option to dairy farmers for growing the best new BxN hybrid.

MATERIALS AND METHODS:

Total eight Bajra x Napier hybrids (perennial) viz. BNH-10, BNH-11, CO-5, CO-6, DHN-5, DHN-15, Phule Jaywant, and Phule Gunwant) were evaluated for assessing their fodder yield potentials during 2021-22 to 2023-24 at KVK, Chaswadin Bharuch district of Gujarat. The experiment site at KVK farm is located at an altitude of 138 meter on above mean sea level on 21°34'31 "N latitude and 73°21'56 "E longitudes. The temperatures were raised up to 40°C in summer and comes closer to 17°C during the winter season. The average annual rainfall is around 960 mm per annum and the maximum was received during the months of June to August. The soil of the experimental field was clayey in texture having medium available nitrogen (269.7 kg ha⁻¹) and organic carbon (0.53 %), high available phosphorus (62.05 kg ha⁻¹) and available potassium (498 kg ha⁻¹), neutral in soil reaction (pH 6.95) and EC of 0.42 dSm⁻¹. The field experiment was laid out in Randomized Block Design (RBD) with eight hybrids and replicated thrice. The plot size was 5.0 m x 3.0 m. The varieties were planted in June 2021 with a common row spacing of 100 cm and 60 cm between plants. The crop was cultivated following the standard package of agronomic practices. The dry

matter yield was measured after drying the green fodder samples. Quality parameters of the dry fodder samples were analyzed using standard protocols. Total nitrogen content in the samples was estimated using the conventional Micro-Kjeldahl method, and the nitrogen content was converted to crude protein percentage by multiplying by a factor of 6.25.

Statistical Analysis:

For growth and yield-attributing parameters, five plants were randomly selected from each net plot area for observation. Each crop within the net plots was harvested separately according to the treatment, and the values were converted to a hectare basis and expressed in quintals. The statistical analysis of the data was performed using ANOVA at a 0.05 probability level.

RESULTS AND DISCUSSION:

The observations recorded on plant height, number of tillers per plant, leaf to stem ratio, green fodder yield, dry matter yield and crude protein yield of eight BxN hybrids are provided in Table 1-3.

Plant height:

Significantly highest plant height was noticed with CO-6 (T4), however, which was comparable with BNH-10 (T1) during the first year of the study. (Table 1). However, BNH-10 and BNH-11 recorded significantly highest plant height in second and third year, respectively. The lowest plant height was recorded with DHN-6 (T2) in all three years. Pooled data of three year showed significant variation in plant height among different BxN hybrids tried under south Gujarat irrigated ecosystem. The significantly highest plant height obtained in BNH-10 (153.39 cm) which was followed by CO-6 (148.34 cm) and BNH-11 (143.25 cm). The increase in plant height among the varieties may be attributed to differences in their genetic makeup, internodal length, nutrient absorption capacity, and the ability to convert radiant energy in the presence of chlorophyll. The findings of Jindal and Tokas (2021) and Tomar *et al.* (2024) supported the above results.

Number of tillers per plant:

The significantly highest number of tillers per plant was noticed with Phule Gunwant in the first year and BNH-11 in the last two years which was significantly superior to other BxN hybrids investigated (Table 1). The pooled data of three years revealed that number of tillers per plant was significantly highest in BNH-11 (26) followed by Phule Gunwant (25). The variety CO-5 produced the lower number of tillers per plant among the hybrids tested.

This could be mainly due to their genetic makeup. The number of tillers is typically controlled by genetic factors, hormonal influences, light intensity and quality, maximum and minimum temperatures, and a favorable rhizosphere environment. This environment supports various resources, including minerals, and the mineral content and their proportions in the roots and basal stem parts also play a crucial role (Gardner *et al.*, 1985). Increased assimilatory surface area per plant might have led to increased biomass production, ultimately accumulating a large number of photo assimilates.

Table 1: Performance of BxN hybrids for growth parameters over three years

Treatment	Plant Height (cm)				Number of tillers per plant			
	2021-22	2022-23	2023-24	Pooled	2021-22	2022-23	2023-24	Pooled
T1: BNH-10	171.94	166.86	121.36	153.39	26	22	17	22
T2: BNH-11	148.26	158.02	123.47	143.25	28	27	23	26
T3: CO-5	133.12	129.43	120.03	127.53	18	15	12	15
T4: CO-6	169.74	159.21	116.08	148.34	21	18	14	18
T5: DHN-6	95.18	96.54	73.87	88.53	19	17	13	16
T6: DHN-15	103.16	103.16	88.97	98.43	20	18	14	17
T7: Phule Gunwant	147.97	137.84	109.16	131.66	34	22	21	25
T8: Phule Jaywant	134.67	134.67	106.09	125.14	25	22	17	21
S.Em.±	9.09	7.54	7.48	4.66	1.75	1.25	0.98	0.79
CD P=(0.05)	27.58	22.88	22.68	13.31	5.00	4.00	3.00	2.00

Leaf-to-stem ratio:

Significant differences were also found with respect to leaf and stem ratio in each year as well as in the pooled data. The data revealed that BNH-11 showed a highest leaf-stem ratio (1.14) as compared to other hybrids and it was on par with Phule Gunwant (1.12). The increase in the leaf-to-stem ratio was primarily due to the rapid expansion of dark green foliage, which efficiently intercepted and utilized incident solar radiation for the production of photosynthates, ultimately enhancing meristematic activity. These results are in conformity with the findings of Shashikanth *et al.* (2013) and Biradar *et al.* (2020).

Green Fodder Yield (GFY):

In the first year, the BxN hybrid Phule Gunwant recorded the highest green fodder yield at 234.60 MT ha⁻¹ significantly outperforming the other BxN hybrids. This was followed by BNH-11 at 221.91 MT ha⁻¹, while DHN-6 had the lowest yield of 111.41 MT ha⁻¹. In the second year, a general decline in yield was observed across most varieties, but BNH-11 maintained its strong performance with a significantly higher yield of 218.00 MT ha⁻¹, demonstrating consistency. The third year showed a further decline in yield for all varieties; however, BNH-11 continued to lead with 181.25 MT ha⁻¹.

The pooled analysis of the three years revealed BNH-11 as the top-performing BxN hybrids, with a cumulative yield of 207.05 MT ha⁻¹, closely followed by Phule Gunwant at 195.51 MT ha⁻¹. Both varieties demonstrated stable performance under varying conditions. In contrast, DHN-6 consistently had the lowest yield, with a pooled value of 111.39 MT ha⁻¹, indicating that it may be less suited to the climatic conditions of south Gujarat. The highest green fodder yield is due to characters like plant height, regeneration capacity and leaf stem ratio. Similar results are also reported by Jindal and Satpal (2020), Singh *et al.* (2020) and Meena *et al.* (2023).

Table 2: Performance of BxN hybrids for yield parameters over three years

Treatment	Leaf: Stem Ratio				GFY (MTha ⁻¹)			
	2021-22	2022-23	2023-24	Pooled	2021-22	2022-23	2023-24	Pooled
T1: BNH-10	1.07	1.00	0.76	0.94	162.45	142.50	126.25	143.73
T2: BNH-11	1.27	1.20	0.94	1.14	221.91	218.00	181.25	207.05
T3: CO-5	1.04	0.95	0.74	0.91	164.34	160.00	131.50	151.95
T4: CO-6	0.99	0.86	0.66	0.84	168.12	152.00	132.20	150.77
T5: DHN-6	0.83	0.78	0.60	0.73	118.75	111.14	104.00	111.30
T6: DHN-15	0.85	0.76	0.59	0.73	124.42	105.00	113.50	114.31
T7: Phule Gunwant	1.25	1.12	0.87	1.08	234.60	207.27	144.67	195.51
T8: Phule Jaywant	0.89	0.78	0.60	0.76	161.19	136.73	145.92	147.95
S.Em.±	0.06	0.05	0.04	0.03	8.53	6.90	8.34	8.46
CD P=(0.05)	0.18	0.16	0.13	0.09	25.88	20.93	25.31	25.66

Dry Matter Yield:

The table 3 presents the dry matter yield (MTha⁻¹) and crude protein yield (MTha⁻¹) of different treatments over three years, along with their pooled averages.

The treatment T2(BNH-11) consistently produced significantly highest dry matter yield across all years, with a pooled average of 80.36 MTha⁻¹, showing its strong performance over time. Phule Gunwant also showed competitive results, especially in 2021-22, where it had the highest yield (93.46 MTha⁻¹), but its performance dropped in subsequent years, leading to a pooled average of 78.48 MTha⁻¹. On the other hand, DHN-15 had the lowest dry matter yield in all three years, with a pooled average of 35.90 MTha⁻¹, indicating it may be less suitable in terms of biomass production compared to other treatments. Napier hybrids typically demonstrate improved photosynthetic capacity due to optimized leaf structure and arrangement, allowing for better light interception. This increased photosynthetic efficiency translates to higher accumulation of photosynthates, resulting in greater overall biomass and dry matter yield. These results are in agreement with

the findings of Pathan *et al.* (2012) and Jindal and Tokas (2021), which also reported similar trends.

Crude Protein Yield:

In terms of crude protein yield, BNH-11 again performed the best, with a pooled average of 6.06 MTha⁻¹, followed closely by Phule Gunwant with 5.86 MTha⁻¹. These treatments not only produced high dry matter yields but also had high crude protein yields, making them ideal for both biomass production and protein content. Higher crude protein yields may be attributed to increased photosynthetic activity, which promotes greater cell division and elongation. This leads to the accumulation of more photosynthates, resulting in increased dry matter production and, ultimately, higher crude protein content. These results are also in line with the findings of Rahmati *et al.* (2012), Basbaget *et al.* (2015) and Prajapati *et al.* (2020).

Table 3: Performance of BxN hybrids for quality parameters over three years

Treatment	DMY (MTha ⁻¹)				CPY (MTha ⁻¹)			
	2021-22	2022-23	2023-24	Pooled	2021-22	2022-23	2023-24	Pooled
T1: BNH-10	61.00	52.73	45.45	53.06	3.54	2.99	2.37	2.97
T2: BNH-11	83.55	85.02	72.52	80.36	6.56	6.51	5.11	6.06
T3: CO-5	55.74	54.27	65.79	58.60	3.30	3.14	3.50	3.31
T4: CO-6	68.62	63.07	52.90	61.53	3.90	3.50	2.70	3.37
T5: DHN-6	52.78	49.39	46.86	49.68	3.44	3.14	2.73	3.10
T6: DHN-15	37.65	33.60	36.44	35.90	3.31	3.00	2.99	3.10
T7: Phule Gunwant	93.46	84.30	57.68	78.48	7.23	6.36	4.00	5.86
T8: Phule Jaywant	68.67	57.44	61.23	62.45	5.20	4.24	4.17	4.54
S.Em.±	4.82	3.25	3.12	4.30	0.31	0.25	0.19	0.32
CD P=(0.05)	14.62	9.87	9.47	13.04	0.95	0.76	0.59	0.98

CONCLUSION:

The study concludes that Bajra x Napier hybrids, particularly BNH-11 and Phule Gunwant, demonstrate exceptional performance in terms of growth, green fodder yield, dry matter yield and crude protein content under the irrigated conditions of south Gujarat. The observed traits such as high plant height, tillering capacity, and favorable leaf-to-stem ratios contribute significantly to their productivity. These hybrids are well-suited for fodder production, making them ideal candidates for enhancing the nutritional value of livestock diets in the region. Further research may focus on optimizing management practices and exploring the adaptability of these hybrids in varying climatic conditions to maximize their yield potential.

Disclaimer (Artificial intelligence):

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

UNDER PEER REVIEW

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