Forage Res., **50**(3) : pp. 272-277 (2024) **http://forageresearch.in**

PERFORMANCE EVALUATION OF DIFFERENT BAJRA NAPIER HYBRID VARIETIES UNDER VARIOUS IRRIGATION LEVELS IN SOUTHERN KERALA

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(Received: 12 November 2024; Accepted: 30 December 2024)

SUMMARY

A field experiment was conducted at Instructional farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during the period March 2023 to August 2024 to standardize the irrigation levels for popular bajra napier hybrid varieties in Kerala. The experiment was laid out in split plot with 4 irrigation levels as main plot and 3 varieties as subplot, replicated thrice. The treatment comprised of 4 irrigation levels (i_1 – IW/CPE 1.0, i_2 – IW/CPE 0.8, i_3 – IW/CPE 0.6 and i_4 – Rainfed) and 3 varieties (v_1 – Susthira, v_2 – Suguna, and v_3 – CO-5. Results revealed that irrigation at IW/CPE 1.0 produced the tallest plants (198.02 cm), highest tiller number (17.01 per hill), and largest leaf area (232.04 cm²), significantly improving GFY and DFY. Variety CO-5 outperformed others, achieving the highest total GFY (186.74 t/ha) and DFY (39.05 t/ha). Interaction effects showed optimal yields with CO-5 under IW/CPE 0.8 (206.06 t/ha GFY) and IW/CPE 1.0 (52.46 t/ha DFY). The study concluded that CO-5 cultivated with IW/CPE 1.0 irrigation is ideal for maximizing fodder productivity in southern Kerala, ensuring consistent feed availability and efficient water use.

Key words: Bajra napier hybrid, fodder, irrigation level, variety

India is mainly an agricultural country, with two-thirds of its rural population relying on livestock for their livelihoods. The livestock sector contributes 25.6 per cent to the total agricultural GDP and accounts for 4.1 per cent of the nation's overall GDP (GOI, 2021).

In order to ensure food security, livestock rearing is crucial, particularly for small and marginal farmers. However, the productivity of these livestock is 20-60 per cent lower than the global average due to improper feeding and lack of health care. Being the first in buffalo and cattle population, the present fodder production of our country is not able to meet the fodder demand. The area covered by permanent pastures and other grazing land is 10.34 M ha (GOI, 2021) and has been decreasing over time. The fodder availability is 400.6 mt with a requirement of 1097 mt and there is a deficit gap of nearly 63.5 percent (Roy *et al.,* 2019). Dairy farmers in India are increasingly turning to cultivating perennial grasses in fodder rotations to ensure a consistent supply of green and dry fodder for their animals throughout the year (Singh *et al*., 2002). Therefore, it is crucial to increase the productivity of existing cultivated fodder crops to satisfy the rising demand for cattle feed. One of the major challenges in the cultivation of fodder crops is its huge requirement of water for irrigation. Optimizing the irrigation scheduling for fodder crops can enhance water use efficiency, contributing to greater conservation of water resources. So, overcoming these difficulties in fodder cultivation may attract a greater number of farmers to invest in fodder cultivation, and the present deficit in feed for livestock can be overcome.

MATERIALS AND METHODS

The experiment was conducted at Instructional farm, College of Agriculture, Vellayani, Kerala, geographically located at $8^0 25' 41.3''$ N latitude and

$76^0 59' 16.7''$E longitude, at an altitude of 29 m above mean sea level, during the period March 2023-September 2024. The soil in the experimental site was identified as sandy clay loam in texture, moderately acidic pH (5.73), low status of nitrogen (225.79 kg/ha) and medium level of available phosphorus (21.62 kg/ha) and available potassium (187 kg/ha). A total rainfall of 346.1 cm was received during the entire growing season. The experiment was laid out in split plot with 4 irrigation levels as main plot and 3 varieties as subplot, replicated thrice. The treatment comprised of 4 irrigation levels (i_1 – IW/CPE 1.0, i_2 – IW/CPE 0.8, i_3 – IW/CPE 0.6 and i_4 – Rainfed) and 3 varieties (v_1 – Susthira, v_2 – Suguna, and v_3 – CO-5). The crop was managed as per the Package of Practices recommendation (KAU, 2024). Crop was irrigated to a depth of 2.5 cm. First 6 months were taken as establishment period and after that, observations were recorded for 12 months. The stem cuttings with three nodes were used as planting material.

Three BN hybrid varieties *viz.,* Suguna, Susthira and CO-5 were included in the experiment. Suguna and Susthira were released from Kerala Agricultural University and CO-5 from Tamil Nadu Agricultural University. Pre-sowing irrigation was given to all the plots uniformly. Uniform irrigation was given up to the first 6 months, which was considered as the establishment period. There after irrigation was given as per the treatments. Daily cumulative pan evaporation was recorded from USWB open pan evaporimeter. Based on the evaporation data and depth of irrigation, irrigation was given to the respective plots. A total of five harvest were taken during the study period. The height of sample plants were measured from the base of the plant to the tip of the longest leaf. The average was worked out at each harvest and expressed in cm. The crop was harvested at regular cutting interval, fresh weight of the plants was measured using spring balance immediately after harvesting. The total weight of forage per plot was converted to per hectare yield and was expressed in t/ha. Total yield for one year was also calculated and expressed in t ha^{-1}. The crop samples collected from each plot for all the harvests were sun dried and then oven dried to a constant weight at 70^0 C. The dry matter content was computed and dry fodder yield was worked out for each harvest in t/ha. Total dry fodder yield for one year was calculated and expressed in t/ha.

RESULTS AND DISCUSSION

Growth characters

The results on the effect of different irrigation levels and varieties on the growth characters of bajra napier hybrid are presented in Table 1. The experimental data revealed that the different irrigation levels and varieties had a significant effect on growth characters.

Data on plant height revealed that different irrigation levels and varieties had a significant influence on plant height and interaction had no significant effect on plant height. Taller plants (198.02 cm) were recorded with the irrigation level i_1 (IW/CPE – 1.0) and was statistically on par with the irrigation level i_2 (IW/CPE – 0.8). The plants grown under water stress conditions caused reduction in plant height by reduction of photosynthesis and consequent reduction in internode length as reported by Anita (2014). This was in accordance with the results of Purbajanti *et al.* (2012) in guinea and napier grass. The effect of variety alone indicated that CO-5 recorded the tallest (208.07 cm) mean plant height. The differences in plant height among the varieties may be due to variations in the distribution of photosynthates among the different varieties. Similar results were also reported by Pankaj *et al.* (2022). However, the interaction effect failed to elicit any significant difference in plant height of bajra napier hybrid.

Data revealed that different irrigation levels, varieties and their interactions had significant influence on number of tillers per hill. Significantly more number of tillers per hill (17.01) was recorded by the irrigation at IW/CPE of 1.0 (i_1) which was on par with i_2 (IW/CPE – 0.8). The result is in agreement with the observations of Anita (2014) in fodder cowpea. This increase in tiller number can be attributed to the adequate availability of moisture under IW/CPE 1.0 ratio, which would have improved nutrient availability, supported better root development, and ultimately resulted in a higher number of tillers per square metre (Singh *et al*., 2024). Among the varieties, Suguna (V_2) resulted in highest number of tillers per hill (16.94) and lowest number of tillers per hill was recorded by CO-5. This may be because of the genetic variances among different varieties. The interaction effect of irrigation levels and variety on number of tillers indicated that higher number of tillers per hill was recorded by i_2v_2 which was statistically on par with i_1v_2.

TABLE 1
Effect of different irrigation levels and varieties on the plant height, number of tillers per hill and leaf area of bajra napier hybrid

Treatments	Plant height (cm)	Number of tillers/ hill (nos.)	Leaf area (cm^2)
Main plot treatment- Irrigation levels-I (4)			
i_1 : IW/CPE- 1.00	198.02[a]	17.01[a]	232.04[a]
i_2 : IW/CPE- 0.80	194.69[a]	16.59[a]	219.55[b]
i_3 : IW/CPE- 0.60	186.48[b]	15.04[b]	211.69[c]
i_4 : Rainfed	176.07[c]	13.45[c]	189.32[d]
S. Em (±)	1.01	0.23	0.85
CD (0.05)	3.500	0.796	2.946
Sub plot treatment- Varieties- V (3)			
v_1 : Susthira	176.27[b]	16.15[b]	198.33[c]
v_2 : Suguna	182.12[b]	16.94[a]	212.25[b]
v_3 : CO-5	208.07[a]	13.25[c]	228.87[a]
SEm (±)	2.01	0.17	1.17
CD (0.05)	6.043	0.514	3.503
Interaction (I x V)			
i_1v_1	182.64	18.20	210.64
i_1v_2	191.85	18.38	228.01
i_1v_3	219.59	14.44	257.48
i_2v_1	186.44	15.96	208.70
i_2v_2	184.18	19.29	213.30
i_2v_3	213.45	13.62	236.66
i_3v_1	171.95	17.02	196.25
i_3v_2	183.51	16.09	214.08
i_3v_3	203.99	12.02	224.73
i_4v_1	164.05	13.42	177.75
i_4v_2	168.93	14.02	193.63
i_4v_3	195.24	12.91	196.59
S. Em (±)	4.03	0.34	2.34
CD (0.05)	NS	1.030	7.007

Data on leaf area showed that different irrigation levels had a significant influence on leaf area of the crop. Irrigation at IW/CPE of 1.0 (i_1) showed highest leaf area (232.04 cm^2). This increase can be attributed to sufficient availability of moisture, which enhanced nutrient absorption and resulted in fully turgid leaves, a higher number of green leaves with larger sizes, ultimately leading to higher leaf area (Singh *et al.*, 2024). Conversely, the lowest leaf area was recorded under rainfed condition (i_4), and it may be due to the limited supply of nutrients and moisture in the root zone. Under moisture stress situation, even though the number of epidermal cells and stomata increases, their size gets reduced. Additionally, unfavourable moisture conditions limit leaf area and speed up leaf senescence. These results closely align with the findings of Pal *et al.* (2020). Data on leaf area revealed that among the varieties CO-5 (v_3) recorded highest leaf area (228.87 cm^2). This may be due to broader leaf character of CO-5 compared to other varieties. Similar results were reported by Deepthi and Thomas (2023). CO-5 under irrigation at IW/CPE of 1.0 (i_1v_3) recorded highest leaf area (257.48 cm^2). When the soil is wet, the water has high potential energy and water can be easily taken up by roots (Inkham *et al.,* 2022). Therefore, the best performance of CO-5 at i_1v_3 might be due to sufficient availability of moisture and high yielding nature of the variety compared to other varieties under the study.

Yield characters

Data on green and dry fodder yield of different BN hybrid varieties under varying moisture regimes is represented in Table 2 and Table 3. The data revealed that different irrigation levels and varieties and their interactions had significant influence on the fodder yield. Irrigation at IW/CPE of 1.0 (i_1) recorded significantly highest yield in first (49.92 t ha^{-1}) and second harvest (29.35 t ha^{-1}). However, in third, fourth and fifth cut, i_1 (IW/CPE – 1.0) produced higher green fodder yield (37.82 t ha^{-1}, 32.91 t ha^{-1} and 25.45 t ha^{-1} respectively) and was statistically on par with i_2 (IW/CPE – 0.8). Considering the total green fodder yield, among the different irrigation levels, irrigation at IW/CPE of 1.0 (i_1) recorded significantly highest green fodder yield (175.45 t ha^{-1}). The lowest green fodder yield (119.90 t ha^{-1}) was recorded with rainfed (i_4).

Considering DFY upto fourth harvest, significantly highest dry fodder yield of 10.03 t/ha, 8.12 t/ha, 9.48 t/ha and 9.01 t/ha, respectively were recorded by i_1 (IW/CPE - 1.0). However, during fifth harvest, higher yield was recorded by irrigation at IW/CPE of 1.0 and was on par with i_2. The effect of irrigation at 1.0 IW/CPE had improved growth attributes and had a significant influence on yield attributes also. The higher yield may be attributed to improved soil moisture throughout the growth stages, facilitated by frequent irrigation, which would have enhanced water availability and nutrient absorption compared to water-deficit conditions. Niwas *et al.* (2020) reported that the improvement in yield is the result of better growth, which is correlated with proper moisture availability to the plant at the proper time with appropriate quantity. Water deficits leads to the overproduction of reactive oxygen species (ROS), including hydrogen peroxide (H_2O_2) and superoxide anion radicals (O_2^-) (Wallace *et al.*, 2016), which may result in reduced growth and yield. Among the varieties, v_3(CO-5) recorded the maximum total GFY (186.74

TABLE 2
Effect of different irrigation levels and varieties on green and dry fodder yield of bajra napier hybrid

Treatments	Green fodder yield (t/ha)					
	1st Cut	2nd Cut	3rd Cut	4th Cut	5th Cut	Total yield
Main plot treatment- Irrigation levels-I (4)						
i_1 : IW/CPE- 1.00	49.92[a]	29.35[a]	37.82[a]	32.91[a]	25.45[a]	175.45[a]
i_2 : IW/CPE- 0.80	46.67[b]	26.01[b]	36.78[a]	31.53[a]	24.25[a]	165.25[b]
i_3 : IW/CPE- 0.60	39.74[c]	22.86[c]	30.96[b]	25.60[b]	20.82[b]	139.99[c]
i_4 : Rainfed	39.30[c]	15.87[d]	25.64[c]	20.44[c]	18.64[c]	119.90[d]
SEm (±)	0.51	0.77	0.83	1.01	0.39	2.48
CD (0.05)	1.775	2.667	2.877	3.506	1.362	8.590
Sub plot treatment- Varieties- V (3)						
v_1 : Susthira	35.90[c]	19.98[b]	28.98[b]	23.95[c]	18.99[c]	127.81[c]
v_2 : Suguna	38.88[b]	19.42[b]	29.95[b]	26.93[b]	20.71[b]	135.89[b]
v_3 : CO-5	56.95[a]	31.18[a]	39.47[a]	31.98[a]	27.16[a]	186.74[a]
SEm (±)	0.65	0.46	0.73	0.74	0.29	1.41
CD (0.05)	1.953	1.392	2.177	2.219	0.883	4.241
Interaction (I x V)						
i_1v_1	44.40	31.56	36.00	26.55	22.11	160.62
i_1v_2	46.86	21.16	34.01	33.54	24.38	159.96
i_1v_3	58.48	35.34	43.46	38.64	29.86	205.78
i_2v_1	38.55	19.84	32.22	28.06	20.03	138.70
i_2v_2	42.52	25.51	31.46	26.36	25.13	150.98
i_2v_3	58.96	32.69	46.67	40.15	27.59	206.06
i_3v_1	28.72	16.44	28.06	23.15	17.57	113.95
i_3v_2	33.45	18.52	28.16	28.63	18.33	127.08
i_3v_3	57.07	33.64	36.66	25.04	26.55	178.95
i_4v_1	31.93	12.09	19.65	18.05	16.25	97.98
i_4v_2	32.69	12.47	26.17	19.18	15.02	105.54
i_4v_3	53.29	23.05	31.08	24.09	24.66	156.18
SEm (±)	1.30	0.93	1.45	1.48	0.59	2.83
CD (0.05)	3.906	2.785	4.355	4.438	1.765	8.481

t/ha) and DFY (39.05 t/ha) and highest yield in all the five harvests. Higher yield of CO-5 may be attributed to higher plant height, broader leaves, and other growth contributing characters. It is generally accepted that the rate of fodder production is a functions of tiller production ,plant height and leaf growth (Baldaniya *et al.*, 2024).

The I x V interaction effect on green and dry fodder yield was found to be significant in all the five harvests. Considering the total GFY, the higher yield (206.06 t ha^{-1}) was registered in the treatment combination i_2v_3 (CO-5 under IW/CPE – 0.8) and was comparable with CO-5 under IW/CPE – 1.0 (i_1v_3). The results of total DFY showed that CO-5 under IW/CPE – 1.0 (i_1v_3) recorded highest yield (52.46 t ha^{-1}). Frequent irrigations in IW/CPE of 1.00 and better growth characters of CO-5 might have resulted in high fodder yield of the crop.

CONCLUSION

The study revealed that growth and yield attributes of different bajra napier hybrid varieties were significantly influenced by different irrigation levels. From this study, it can be concluded that for highest fodder production in southern part of Kerala, Bajra Napier Hybrid Variety CO-5 may be cultivated with irrigation scheduling of 1.0.

ACKNOWLEDGEMENT

Authors are thankful to Kerala Agricultural

TABLE 3
Effect of different irrigation levels and varieties on green and dry fodder yield of bajra napier hybrid

Treatments	Dry fodder yield (t/ha)					
	1st Cut	2nd Cut	3rd Cut	4th Cut	5th Cut	Total yield
Main plot treatment- Irrigation levels-I (4)						
i_1 : IW/CPE- 1.00	10.03[a]	8.12[a]	9.48[a]	9.01[a]	4.72[a]	41.37[a]
i_2 : IW/CPE- 0.80	8.49[b]	6.09[b]	7.76[b]	6.82[b]	4.50[a]	33.67[b]
i_3 : IW/CPE- 0.60	7.29[c]	5.42[b]	6.56[c]	5.56[c]	3.75[b]	28.58[c]
i_4 : Rainfed	5.56[d]	4.07[c]	4.66[d]	4.53[d]	2.91[c]	21.75[d]
SEm (±)	0.10	0.22	0.13	0.10	0.16	0.33
CD (0.05)	0.362	0.777	0.452	0.359	0.552	1.16
Sub plot treatment- Varieties- V (3)						
v_1 : Susthira	6.54[c]	5.13[b]	5.80[b]	5.62[c]	3.52[b]	26.61[c]
v_2 : Suguna	6.80[b]	5.19[b]	6.00[b]	6.75[b]	3.62[b]	28.36[b]
v_3 : CO-5	10.20[a]	7.45[a]	9.55[a]	7.06[a]	4.78[a]	39.05[a]
SEm (±)	0.08	0.20	0.08	0.09	0.13	0.32
CD (0.05)	0.244	0.606	0.255	0.262	0.383	0.95
Interaction (I x V)						
i_1v_1	8.28	8.89	7.62	7.35	3.95	36.08
i_1v_2	8.30	6.15	7.96	8.82	4.33	35.55
i_1v_3	13.52	9.34	12.85	10.86	5.89	52.46
i_2v_1	6.65	4.93	6.05	5.59	3.81	27.02
i_2v_2	1.26	6.83	6.26	7.50	4.77	32.61
i_2v_3	11.56	6.52	10.99	7.37	4.93	41.37
i_3v_1	6.2	4.01	5.92	5.50	3.42	25.04
i_3v_2	6.40	4.65	5.43	5.41	3.04	24.94
i_3v_3	9.28	7.60	8.35	5.77	4.78	35.78
i_4v_1	5.03	2.71	3.61	4.06	2.90	18.31
i_4v_2	5.23	3.15	4.35	5.28	2.34	20.35
i_4v_3	6.43	6.35	6.03	4.27	3.50	26.58
SEm (±)	0.16	0.40	0.17	0.17	0.25	0.63
CD (0.05)	0.487	1.211	0.510	0.524	0.766	1.90

University, Kerala for providing necessary facilities to conduct the experiment.

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