

Original Research Article

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Impact of Irrigation and Nutrients on the Performance of Bajra Napier Hybrid Grass Grown under Light Sandy Soil

C. Vennila* and T. Ananthi

Department of Agronomy, Madras Veterinary College, Chennai 7, Tamil Nadu, India

*Corresponding author

ABSTRACT

The study was carried out at university Research Farm, Tamil Nadu Veterinary and Animal Sciences University, under light textured soils. The treatments consisted of three irrigation levels viz., I₁: drip irrigation at 100% Potential Evapo transpiration (PE), I₂: drip irrigation at 75% PE and I₃: surface irrigation, and three nutrient levels viz., F₁: Farm Yard Manure (FYM) 25 t ha⁻¹ + 50% recommended dose of fertilizers (RDF), F₂: FYM 25t ha⁻¹ + 100% RDF and F₃:100% RDF. Cumulative irrigation water was calculated and applied as per the treatment schedule. Plant samples were analyzed for macro nutrients and uptake of nutrients by plants was calculated. Chlorophyll content was estimated periodically. Plant vegetative growth and yield contributing characteristics were measured to relate with irrigation frequency and nutrients. The nutrient uptake by plants had more influence on growth and yield of plants. Irrigation through drip at 100 % PE maintained the moisture availability throughout the crop growth period. Highest leaf chlorophyll content (SPAD Values) (38.8 and 25.7) was obtained with application of FYM 25 t ha⁻¹ + 100 % RDF and drip irrigation at 100% PE. The yield was found higher with the application of FYM 25 t ha⁻¹ + 100 % RDF and drip irrigation at 100% PE. Crude protein content of bajra napier hybrid grass was significantly influenced with nutrient and irrigation levels.

Keywords

Irrigation methods,
Nutrient sources,
Leaf stem ratio,
Nutrient uptake,
Fodder quality

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Introduction

Fodder is cheap source of nutrient supply than concentrate feed and needs to be given more emphasis so as to make the dairy industry economically viable. In India limited land (8.6 m ha) is available for fodder cultivation (Kumar *et al.*, 2012) and our country face the shortage of both green as well as dry fodder by about 61.1 and 21.95, respectively (Sathyanarayan *et al.*, 2017). Bajra napier hybrid grass is an important perennial fodder

crop of India and widely cultivated. Among the varieties of bajra napier hybrid grass, variety Co CN 4 is the predominantly cultivated due to its high yielding potential and perennial in nature (Anthony and Thomas, 2014).

Bajra napier hybrid grass is a perennial crop and can be maintained in the field for about 4 to 6 years (Rahman and Talukder, 2015). Hence, it requires continuous irrigation for better productivity. However, farmers have

tendency to apply huge quantity of water with large irrigation interval creating water logging condition (Marathe *et al.*, 2001) especially in surface irrigation method. Bajra napier hybrid grass have large feeder roots on the top layer. Whenever, irrigation water is led in on surface layers that lead to imbalance in nutrient uptake thereby adversely affecting growth of the plants (Marathe *et al.*, 2016).

The irrigation frequency defined by interval between two successive irrigations should be used in a way so as not to compromise the water needs of the plant in their critical phenological stages (Sousa *et al.*, 2014). Earlier studies have shown significant results under different irrigation frequencies on high value crops (Lal and Kumar, 1997, Jain and Tiwari, 2012) under different soil and climatic conditions. Application of water in small doses at frequent intervals ensures their optimum utilization and higher crop yields. This also reduces percolation and evaporation losses, and improves water use efficiency by maintaining optimum soil moisture in the vicinity of the root zone.

Apart from water, nutrients are also essential for the better growth and productivity of crops. The removal of nutrients by the high yielding crops especially perennial crops causes nutrient imbalances over the time, with degradation of soil reserves of nutrients (Martha Júnior *et al.*, 2004). Hence, to increase the yield and to replenish the soil, nutrient uptake of a particular crop should be known and replenished accordingly. Various nutrient sources are available and applied to boost the growth and yield of crops (Lemaire, 1989)

In bajra napier hybrid grass, information on irrigation requirement, method of irrigation, frequency and nutrient application is meager. In this perspective, the present investigation was undertaken to evaluate the influence of

different frequencies on yield, quality and nutrient uptake of bajra napier hybrid grass grown on light textured soils of North Eastern zone of Tamil Nadu.

Materials and Methods

The field experiment was conducted at University Research Farm, Tamil Nadu Veterinary and Animal Sciences University, Chennai. Tamil Nadu. The climate of the study area is tropical with hot summer and moderate winter with average annual rainfall of 800-1400 mm occurring mostly during North East monsoons (October to December). Average monthly minimum and maximum temperature during the experimental period varied from 19 and 41.9°C during 2014-2015 and 16.7 and 41.6°C during 2015-2016, respectively. Cumulative pan evaporation for six days ranged between 6.6 mm to 13.8 mm. The weather condition during both the years of study was close to normal. The field capacity and permanent wilting point of soil was 26.2% and 12.3% respectively. The soil of the experimental field was sandy in texture and had low levels of organic carbon (0.37%) and medium levels of available nitrogen (242.8 kg ha⁻¹), available phosphorus (18.6 kg ha⁻¹) and available potassium (248.6 kg ha⁻¹), with a pH of 7.64.

The experiment was arranged in factorial randomized block design with three irrigation levels and three nutrient levels in four replications in a plot size of 4 m x 3.5m. The irrigation levels included I₁: drip irrigation at 100% PE, I₂: drip irrigation at 75% PE and I₃: surface irrigation while, nutrients: F₁: Farm Yard Manure (FYM) 25 t ha⁻¹ + 50% Recommended dose of fertilizers (RDF), F₂: FYM 25t⁻¹ + 100% RDF and F₃:100% RDF. The quantity of recommended nutrients for bajra napier hybrid grass is 150:50:50 kg NPK ha⁻¹. The calculated quantity of fertilizers viz., urea, single super phosphate

and muriate of potash were applied as per the treatment schedule. For drip irrigation treatments, the amount of water applied corresponded to the sum of ETc in the corresponding period. The crop water requirement of bajra napier hybrid grass was computed using

$$V = E_p \times K_p \times K_c \times S_c \times W_p$$

Where, V - Volume of water (litre day⁻¹ plant⁻¹), E_p - Open Pan Evaporation (mm day⁻¹), K_p - Pan Coefficient, K_c - Crop coefficient, S_c - Crop spacing (row to row x plant to plant in m) and W_p - Wetting factor (Mane *et al.*, 2006). Irrigation efficiency of drip was considered as 90%. The effective rainfall was calculated by balance sheet method from the actual rainfall received and was used for daily water requirement of crop. Irrigation was provided using drip method of irrigation, having one dripper for two rows of plants. Measured quantity of irrigation water was provided to the plants using water meters and separate valve adjustments for every treatment. Quantity of irrigation water was applied based on the calculated quantity. On an average, the irrigation water was applied once in 6 days.

The crop was planted during the first week of January 2014 and the trial was under study for two years with repeated harvest. The intercultural operations, like weed management were done well in time in all plots judiciously after every harvest during both the years of study. The first harvest of Bajra Napier hybrid grass was done at 75 days after planting and subsequently once in 45 days. About six harvests were done during first and second years of the study. Cumulative yield was calculated per year per hectare. Leaf stem ratio was worked out based on leaf weight (g plant⁻¹) and stem weight (g plant⁻¹). From the yield of total dry matter and contents of nitrogen, phosphorus and potassium the total uptake of respective

nutrients was worked out using the procedure suggested by Piper (1966) and expressed in kg ha⁻¹.

Nutrient uptake (kg ha⁻¹) =

$$\frac{\text{Nutrient content (\%)} \times \text{Total DMP in kg ha}^{-1}}{100}$$

Crude protein content was computed by multiplying the N content (estimated from the di-acid digest by micro-kjeldhal method) with the factor 6.25 and expressed in per cent. Crude fibre was estimated gravimetrically by successive digestion and washing a weighed plant sample with dilute acid and alkali. The material left un-dissolved was considered as crude fibre and expressed in percentage. Ether extract (an estimate of crude fats and oils) was estimated gravimetrically by subjecting a weighed, powdered plant sample to continuous extraction with petroleum ether at 40 to 50° C in a Soxhlet extraction apparatus and expressed in percentage.

Statistical analysis: All the recorded data from the experiment were statistically analyzed using the F-test as per the standard statistical procedure (Gomez and Gomez, 1984) and values of critical difference (CD) (P = 0.05) were used to determine the significance of difference between the treatment means.

Results and Discussion

Fodder biomass

Pertaining to irrigation levels, drip irrigation at 100% PE resulted in higher biomass yield of 259.17 t ha⁻¹ and 296.78 t ha⁻¹ and leaf stem ratio of 0.72 and 0.76 during 2014 and 2015 respectively. Application of FYM 25 t ha⁻¹ + 100% RDF resulted in higher biomass of 332.35 t ha⁻¹ and 354.2 t ha⁻¹ during the first and second years of experimentation respectively but comparable with the application of FYM 25 t ha⁻¹ + 50% RDF

during both the years of experimentation. Higher yield of fodder obtained due to addition of irrigation at optimum soil moisture and nutrients may be attributed to the fact that N is an important constituent of amino acids and chloroplasts which directly influenced plants leaf area, growth and development through greater photosynthates. Higher leaf area captures more photosynthetically active radiation with higher photosynthesis as there is more number of leaves which ultimately reflected on the yield of the crops. Similar findings were also reported by Kumar and Sharma, (1997) and Singh and Nepalia (2009).

Combined application of FYM and inorganic fertilisers had synergistic effect on increasing the source to sink ratio, thereby the yield (Vennila *et al.*, 2017). Application of Farm yard manure @25 t ha⁻¹ along with 100% RDF resulted in higher nutrient uptake by plants followed by application of 25 t ha⁻¹ of FYM along with 50% RDF. Nutrient application through drip irrigation had beneficial effect on enhanced crop growth such as plant height, number of tillers and number of leaves which in turn has resulted in higher biomass yield per plant and per hectare. This might be due to the fact that nutrients are evenly distributed in the root zone area of the crop when applied through fertigation plots and thereby reducing the loss of nutrients by volatilization and leaching. Hence, continuous availability of soil moisture could result in continuous availability of moisture, in turn resulting in higher plant nutrient uptake. This is in line with the findings of Vennila and Sankaran (2017). Further, as there is optimum availability of water and nutrients for the plants, there is limited wastage of nutrients in the soil, hence resulting in higher uptake of nutrients by the plants (Sureshkumar *et al.*, 2016). The interaction effects between irrigation and nutrients were significant

indicating that soil moisture is essential for nutrient uptake by the plants (Singh, 2002).

Nutrient uptake

Amongst macronutrients, maximum nitrogen and potassium uptake of bajra napier hybrid grass was observed with the application of irrigation through drip at 100% PE followed by irrigation through drip at 75% PE. Water application at 100% PE and 75 %PE were found most effective due to irrigation water application at proper interval i.e. dependent on the potential evapo transpiration. Most of the nutrient absorption processes are aerobic in nature and periodical application of irrigation might have maintained good aeration in soil which resulted in higher uptake of these nutrients by the plants.

The greater N, P and K uptake with continuous availability of water was reported earlier by Rad (2011). Treatments with surface irrigation recorded significantly low nutrient uptake in plants. In this treatment, application of higher amount of water initially might have favoured leaching of nutrients from the soil. Similarly, occurrence of low soil moisture content between two subsequent high interval irrigations treatments favoured poor nutrient absorption by the plants. The findings corroborates with the findings of Haneef *et al.*, (2014) and Sharma *et al.*, (2015) who reported decreased uptake of N, P and K with lower soil moisture levels.

Chlorophyll content in the leaves of the plants, as expressed by SPAD values, significantly varied amongst the treatments (Table 1). It was the highest in irrigation through drip at 100 % PE and application of 100 % RDF along with FYM 25 t ha⁻¹. Thus indicating better photosynthetic capacity of the plants, this might be due to better nutrient uptake and availability of ample water to the plants (Table 2).

Table.1 Yield and nutrient uptake of bajra napier hybrid grass as influenced by irrigation and nutrients

Treatments	Biomass		Leaf stem ratio		N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Chlorophyll content (SPAD value) (Mean)
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	
Irrigation											
I₁	206.51	262.93	0.63	0.48	103.3	129.6	34.0	42.6	93.0	116.6	19.7
I₂	259.17	296.78	0.72	0.76	136.1	153.9	51.0	56.5	123.7	139.6	25.7
I₃	185.23	235.95	0.51	0.33	86.0	111.8	27.9	36.5	77.5	100.1	15.4
Nutrients											
F₁	261.83	317.30	0.58	0.53	145.7	156.2	48.5	51.9	131.8	141.2	21.6
F₂	332.35	354.20	0.63	0.59	179.9	192.7	78.3	81.3	164.5	175.9	38.8
F₃	195.43	247.42	0.49	0.48	93.5	119.2	30.8	39.3	83.8	88.3	19.1
CD (5%)											
I	8.62	6.9	-	-	11.98	9.86	5.39	4.65	11.04	8.99	1.18
F	7.69	7.01	-	-	9.92	8.44	4.49	3.93	9.13	7.94	1.93
I at F	12.89	13.21	-	-	20.13	16.78	9.09	7.92	18.53	15.65	2.16

I₁: Drip irrigation at 100% PE, I₂: Drip irrigation at 75% PE and I₃: Surface irrigation, F₁: Farm Yard Manure 25 t ha⁻¹ + 50% RDF, F₂: FYM 25t ha⁻¹ + 100% RDF and F₃:100% RDF alone.

Table.2 Proximates of Bajra Napier hybrid grass as influenced by irrigation and nutrients

Treatments	Crude protein content (%)		Crude fibre content (%)		Ether content (%)		Ash content (%)		Acid insoluble ash content (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Irrigation										
I₁	6.89	7.41	24.62	21.5	1.7	1.57	12.72	10.91	5.38	6.94
I₂	7.84	7.63	25.01	21.6	1.87	1.62	10.86	9.40	4.13	3.68
I₃	7.41	7.24	25.64	22.09	1.88	1.78	13.28	8.04	5.00	5.6
CD (5%)										
Nutrients										
F₁	7.64	7.38	26.54	21.24	1.75	1.72	12.73	8.67	4.98	5.52
F₂	7.83	7.94	24.29	23.64	1.60	1.51	12.70	9.20	5.42	5.06
F₃	6.53	7.30	25.21	21.18	1.90	1.76	13.81	9.55	4.48	4.54
CD (5%)										
I	0.53	0.32	NS	NS	0.14	0.05	NS	NS	NS	NS
F	0.46	0.75	NS	NS	0.16	0.07	NS	NS	0.19	0.25

I₁: Drip irrigation at 100% PE, I₂: Drip irrigation at 75% PE and I₃: Surface irrigation, F₁: Farm Yard Manure 25 t ha⁻¹ + 50% RDF, F₂: FYM 25t ha⁻¹ + 100% RDF and F₃:100% RDF alone

Increased uptake of Fe due to enhanced uptake of nutrients might also play an important role in chlorophyll formation (Marathe *et al.*, 2017). Increased contents of chlorophyll in leaves due to alternated drip irrigation was reported earlier (Liu, 2016) in coffee trees. Drastic reduction in leaf chlorophyll content was recorded in surface irrigated plots and with the application of inorganic nutrients alone.

Fodder quality

Different irrigation and nutrients had significant influence on quality parameters like crude protein, ether extract and Acid insoluble ash (AIA), whereas, treatments did not show significant influence on crude fibre content and total ash content of Bajra Napier hybrid grass. Among different treatments, irrigation at 75 % PE registered significantly maximum crude protein content (7.84 %) but was at par with surface irrigation. Whereas, during second year, irrigation at 75 % PE registered higher crude protein content of 7.63 % and was comparable with crude protein content registered from irrigation through drip at 100 % PE. Nutrient application to Bajra Napier hybrid grass resulted in significant production of crude protein content. Application of FYM 25 t ha⁻¹+ 100% RDF through drip at 100% PE recorded the higher crude protein content but at par with treatment which received inorganic nutrients alone. There was no significant difference in crude fibre and total ash content due to irrigation and nutrient application. However, surface irrigation to plants resulted in higher crude fibre and total ash content of the plants. With respect to nutrients, lower the application of nutrients, higher the crude fibre and total ash content. The AIA content of bajra napier hybrid grass was not influenced by irrigation treatments. However, application of nutrients had significant influence on the AIA content. The results showed that application of FYM

25 t ha⁻¹+ 100% RDF through drip resulted in higher AIA % followed by application of FYM 25 t ha⁻¹ + 50% RDF through drip, during both the years of experimentation. The present findings are in conformity with the findings of Vijayakumar *et al.*, (2009) and Senthil *et.al.* (2016). It has been concluded that better performance of bajra napier hybrid grass could be achieved by application of tested irrigation methods and nutrient in light sandy soils.

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