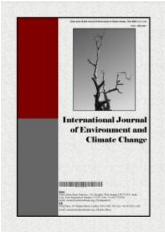

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Effect of Treated Wastewater Irrigation Combined with Manure and Inorganic Nutrients on Fodder Yield and Proximate Parameters of Bajra Napier Hybrid Grass in Cauvery Delta Region of Tamil Nadu

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: In arid and semi-arid areas recycling of water may have a greater impact on future usable water supply than any of the other technologies aimed for increasing water supply. Efforts have been taken on maximizing the benefit and minimizing the detrimental effects on people or the environment due to continuous usage of treated wastewater. Hence, the current experiment was aimed to study the effect of treated wastewater in combination with organic and inorganic nutrients on bajra napier hybrid grass on yield and quality parameters.
Study Design: The field experiment was conducted using secondary treated wastewater, manure and inorganic nutrients in Bajra Napier hybrid grass variety CO(BN) 5 with a strip plot design and four replications.
Place and duration of study: The experiment was conducted in Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamil Nadu, during 2018-19 (10.62° N latitude and 79.26° East longitude).

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Methodology: The five ratios of irrigation water were used in horizontal factor treatments and four different nutrient combination treatments were allotted in the vertical factor. The plot was divided into 27 m2 with 2 m space between the plots. The two budded setts of bajra napier hybrid grass variety CO (BN)-5 were planted at 60 x 50 cm spacing. The flood irrigation and nutrients (basal and top-dressing) were applied as per the treatments.

Results: The use of treated wastewater for irrigation combined with manure and inorganic nutrients significantly increased the total green and dry fodder yields. Irrigation treatment with treated wastewater alone + 100% inorganic nutrients (I5N1) recorded significantly higher total green and dry fodder yields of 431.0 and 76.7 t ha-1 yr-1, respectively, than all other treatment combinations. Irrigated with groundwater alone (control) without nutrients (I1N4) recorded the lowest total green and dry fodder yields (222.5 and 47.6 t ha−1 yr-1, respectively). The average crude protein content of all total cuttings was significantly higher (13.53%) in I5N1 than all other treatments. On the other hand, the average crude fibre content (28.03%) was significantly lower in the treatment I5N1 as compared to irrigated with groundwater without nutrients (31.18%).

Conclusion: The perennial fodder crop Bajra Napier hybrid grass variety CO (BN) 5 cultivated under-treated wastewater combined with manure and inorganic nutrients increased the total green and dry fodder yields with beneficial proximates. The use of treated wastewater for fodder cultivation helps conserve groundwater and effectively utilize available nutrients in treated wastewater.

Keywords: Treated wastewater irrigation; Bajra Napier hybrid grass; green fodder yield; dry fodder yield; crude protein; crude fibre.

1. INTRODUCTION

Agriculture and livestock production are inextricably intertwined, mutually dependent and essential for total food security. In 2018-19, livestock production contributed 5.1 per cent of the total national value added at current prices, making it the backbone of Indian agriculture [1]. India is the world's largest milk producer (198 million tonnes); however, per capita, milk production is poor due to a massive shortage of feedstuffs. On a 2.0 per cent geographical area, the country houses 15 per cent of the world's livestock population, indicating the extent of livestock pressure on our resources compared to other countries. However, tfodder to meet the rising cattle population, only 8.4 million hectares of cultivated feed are available [2], which is insufficient. Also, only 40 per cent of the required green forage is available from diverse sources. Therefore, bridging this crater is a significant priority.

On the other side, the agricultural sector is the largest water user in this country and the quantity of water allocated for irrigation is expected to fall by 10-15 per cent in the next two decades [3]. The estimated utilizable water resources of the country are 1,122 billion cubic metre yr^{-1} (BCM per year), out of which the share of surface water and groundwater is 690 BCM [4] and 432 BCM [5] per year, respectively. In 2050, a total of 1,180 BCM has been estimated as available water for a high projection scenario, out of which irrigation will be accounted for nearly 68 per cent followed by domestic use (9.5%), industries (7%), power development (6%) and other activities claimed about (9.5%), including evaporation losses, environment and navigational requirements. In India, this reduction in agriculture is predicted to be 10 - 12 per cent in 2025, whereas overall water demand is expected to increase by 22 per cent in 2025 and 32 per cent in 2050 [6]. Consequently, the majority of wastewater (80%) is released into water bodies (rivers, lakes and seas) with little or no treatment and only a small percentage (14% in Indonesia, 10% in Philippines, 24% in India and 4% in Vietnam) is treated mostly or partially [7] and discharged into environmental media. However, water contamination is a severe problem in emerging countries like India.

The demand for water to meet the needs of homes, industries and other farm operations necessitate the regeneration of wastewater, a cost-effective and appealing alternative to irrigating crops in arid and semi-arid places to sustain productivity [8]. As a result, water reclamation and reuse are the most effective technique for fulfilling present and future water demands for irrigating crops. Therefore, the reuse of treated wastewater in agriculture for fodder crops appears viable in this changing water demand scenario. Based on this background, the current study was carried out to determine the effect of secondary treated wastewater irrigation, manure and inorganic fertilizers on fodder yields and proximate parameters of the Bajra Napier hybrid grass variety CO (BN) 5 in the Cauvery Delta region of Orathanadu, Thanjavur of Tamil Nadu.

2. MATERIALS AND METHODS

2.1 Site Description

Orathanadu is one of the leading agriculture production areas under the old Cauvery delta irrigation scheme of Thanjavur, Tamil Nadu, India. Rice, greengram, blackgram, sesame, sugarcane and coconut are the major crops and dairy, sheep and goats are central livestock units. Orathanadu belongs to the town panchayat with a population of 1.60 lakhs (2011 census) and 40,383 residents consume an average of 14.2 lakh litres of water every day. The outlet wastewater from households was collected by Orathanadu town panchayat, Tamil Nadu. The secondary treated wastewater was supplied to the Veterinary College and Research Institute, Orathanadu. In this college, the secondary treated wastewater is utilized for cultivating fodder crops, especially Bajra Napier hybrid grass and multicut sorghum. This treated wastewater was used for irrigation purposes for the experimental study to cultivate the Bajra Napier (*Pennisetum americanum* x *P. purpureum*) hybrid grass (10.62º N latitude and 79.26º East longitude) and the characteristics of water parameters were presented in Table 1.

The study area has a semi-arid climate, with less than 792 mm of annual rainfall and summer temperatures often exceeding 40.4^0 C. The soil of the experimental field is sandy clay loam in texture and coarse sand (41.63%) was the dominant constituent with an infiltration rate of 3.06 cm hr^{-3}. The experimental site's soil bulk density is 1.42 g cm^{-3} and a particle density of 2.98 g cm^{-3}.

2.2 Experimental Design

A field experiment was laid out in a strip plot design with four replications on a total of 80 plots, each of 6.0 m length and 4.5 m width. The gross plot size was 27 m^2 with 2 m space between the plots to avoid the influence of water seepage. Irrigation was applied through the flood irrigation method. The five ratios of irrigation water were used as horizontal factor treatments, *viz*., I_1 - Groundwater alone (GW), I_2 - Alternate irrigation with GW and treated wastewater (TWW), I_3 - Two irrigations with GW + one irrigation with TWW, I_4 - One irrigation with GW + two irrigations with TWW and I_5 - Irrigation with TWW alone and in vertical factors, nutrients *viz*., N_1 - 100% Inorganic nutrients (IN), N_2 - 100% Organic nutrients (ON) on N basis, N_3 - 50% Organic + 50% Inorganic nutrients and N_4 - Control (without nutrients). In addition, perennial fodder crop Bajra Napier hybrid grass variety CO (BN) 5 was cultivated for experimental purposes.

2.3 Planting and Fertilizer Application

The fodder crop Bajra Napier hybrid grass CO (BN)-5 was planted with two budded setts on 28th December 2018, with a spacing of 0.60 m between rows and 0.50 m between plants. The nutrient treatments were imposed after calculating the doses at the time of planting. Fertilizers and manure were applied through broadcasting to the individual plots and mixed manually. Nitrogen, phosphorus and potassium were applied as urea, single super phosphate and muriate of potash, respectively. In addition, organic manure in the form of farmyard manure was applied. After every harvest, the ratoon crop was applied with nitrogen as top-dressing as per the treatments. The details of the nutrient application are furnished in Table 2.

Table 1. Characteristics of treated wastewater and groundwater

S. No.	Name of the parameter	Treated wastewater	Groundwater
1	pH	7.49 ± 0.15	7.28 ± 0.211
2	EC (mg L^{-1})	0.89 ± 0.11	0.58 ± 0.026
3	TDS (mg L^{-1})	570.59 ± 68.10	368.74 ± 6.840
4	COD (mg L^{-1})	17.18 ± 3.06	2.13 ± 0.67
5	BOD (mg L^{-1})	29.55 ± 4.18	7.21 ± 1.09
6	Total N (mg L^{-1})	8.32 ± 0.89	1.86 ± 0.448
7	Total P (mg L^{-1})	2.93 ± 0.24	0.87 ± 0.134
8	Total K (mg L^{-1})	10.49 ± 0.56	7.56 ± 0.333
9	Total organic carbon (mg L^{-1})	16.26 ± 1.71	0.31 ± 0.05

Table 2. Manure and fertilizers applied to the experimental field

S. No.	Vertical factor	Basal application (ha^{-1})	Top-dressing after every harvest (ha^{-1})
1.	N_1 – 100% Inorganic nutrients	25 t of FYM Inorganic fertilizers: 75:50:40 kg NPK + 75 kg nitrogen at 30 DAP as top dressing	75 kg nitrogen after every harvest
2.	N_2 – 100% Organic nutrients on N basis	18.75 t of FYM (based on the nitrogen content of 0.8 %)	9.37 t of FYM (on 0.8 % N basis)
3.	N_3 – 50% Organic + 50% Inorganic nutrients	12.5 t of FYM + 37.5:25:20 kg NPK + 37.5 kg nitrogen at 30 DAP as topdressing	4.69 t of FYM (on 0.8 % of N basis) + 37.5 kg N
4.	N_4 – Control	No manure and fertilizers	No manure and fertilizers

2.4 Yield and Proximate Analysis

The main crop was harvested at 70 days after planting (DAP). The succeeding six ratoon crops were harvested at 45 days intervals. The green and dry fodder yields (t ha^{-1}) of the main crop and six ratoon crops were recorded at harvesting time and presented in total green and dry fodder yields (t ha^{-1} yr^{-1}). In addition, the plant samples from each treatment in each harvest were also collected. These samples were dried and subjected to proximate analysis *viz*., crude protein and crude fibre.

2.5 Statistical Analysis

All the data obtained from the treatment plots and proximate parameters were analyzed in the lab and were subjected to a statistical analysis using analysis of variance (ANOVA). The least significant difference (LSD) at the probability of 5 % ($p<0.05$) was performed to compare means using SPSS software for Windows (Released version 26) according to the standard methods [9].

3. RESULTS AND DISCUSSION

3.1 Green and Dry Fodder Yields

The effect of treated wastewater irrigation, manure and inorganic nutrients and their interaction differed significantly ($P<0.05$) on green and dry fodder yields (Table 3 and 4) of Bajra Napier hybrid grass. The irrigation with treated wastewater alone (I_5) produced a significantly higher total green fodder yield of 383.8 t $ha^{-1}yr^{-1}$ than all other irrigation treatments and it was on par with one irrigation with groundwater and two irrigations with treated wastewater (I_4). This might be due to the fact that the application of treated wastewater as irrigation throughout the cropping period provides an important source of plant nutrients, especially nitrogen and mineralization of organic matter, which can increase forage crop growth and yield. Since. The treated wastewater contains 8.32 per cent average nitrogen and the TDS, respectively. Subsequently, Bajra Napier hybrid grass is a C_4 plant that has a higher photosynthetic nitrogen usage efficiency (NUE) than C_3 plants, it can metabolize high nitrogen levels in reclaimed water [10]. Similar results were obtained in sorghum, bajra napier and barley crops [11,12,13,14]. The lowest total green fodder yield (278.0 t ha^{-1} yr^{-1}) was registered in the control (irrigation with groundwater alone - I_1).

Among the nutrient management, 100% inorganic nutrients (N_1) observed a higher total green fodder yield of 408.3 t $ha^{-1}yr^{-1}$ than other treatments and control (267.5 t ha^{-1} yr^{-1}). The favourable growth parameters might be attributed to the increase in green fodder production under recommended doses of manure and inorganic fertilizer application. The presence of nitrogen might have promoted cell division and as a result, internode elongation and in turn, overall growth parameters. The results were in accordance with other researchers [15,16].

The interaction effect of secondary treated wastewater irrigation and inorganic nutrient treatments revealed that the treated wastewater alone and 100% inorganic nutrients (I_5N_1) recorded significantly more total green fodder yield (431.1 t ha^{-1} yr^{-1}) than irrigation with GW alone without nutrients (222.6 t ha^{-1} yr^{-1}). The amount of N, P and K deposited in the soil was proportional to the amount of wastewater used in irrigation and the quantity of inorganic nutrients applied. As a result, it promoted more extensive crop growth and increased forage yield. The wastewater contains essential nutrients for plant growth, such as N, P and K, as well as micronutrients like iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu), as well as a significant amount of organic matter [16]. Furthermore, N is an essential constituent of amino acids and chloroplasts, which directly influence plant leaf area, growth and development through greater photosynthates, resulting in higher green fodder yield, which may be attributed to the addition of irrigation at optimum soil moisture and nutrients. These findings align with what has previously been published by [17,18,19].

A similar trend was seen in dry fodder yield also. The total dry fodder yields (total of all crop harvests from main and six ratoons) expressed significant ($P<0.05$) differences by using treated wastewater for irrigation along with manure and inorganic nutrients (Table 4). Among the different irrigation treatments, irrigation with treated wastewater alone (I_5) produced a significantly higher total dry fodder yield of 69.12 t ha^{-1} yr^{-1} and the lowest total dry fodder yield was registered in control (I_1) which irrigated with groundwater alone (54.62 t ha^{-1} yr^{-1}). The optimal soil-water, macro and micronutrient availability increase nutrient uptake resulting in increased growth parameters that influence dry fodder output. The results were on par with previous research works [17,20,21,22]. In the manure and inorganic nutrient treatments, the plot applied with 100% inorganic nutrients (N_1) showed significantly higher total dry fodder yield (72.45 t ha^{-1} yr^{-1}) compared to all other nutrient treatments. Applying inorganic nutrients, especially nitrogen, increases the plant's leaf area. Under optimum nutrient level, with adequate sunlight, increased leaf area would increase the photosynthates and finally produces more dry fodder yield of the bajra napier hybrid grass. The application of manure that releases more nutrients slowly throughout the crop growth period also improves the higher dry fodder yield. Similar research findings were also reported earlier [23,24,25].

On interaction effect, treatment with treated wastewater alone and 100% inorganic nutrients (I_5N_1) recorded significantly were total dry fodder yield (76.72 t ha^{-1} yr^{-1}) compared with all other treatment combinations and control (47.68 t ha^{-1} yr^{-1}). The increase might be due to nutrients available in TWW, the decomposition of organic manure being accompanied by a release of appreciable quantity of nutrients and higher mineralization of full dose of fertilizers, which contribute to higher total dry fodder yield. The results of green fodder yield are reflected in dry fodder yield too. Therefore, dry fodder yields under-treated wastewater with manure and fertilizer that matches the previous results [26,27,28].

3.2 Fodder Quality Parameters

The plant samples were collected during the harvest of main and six ratoon crops and from all the treatment plots and used for proximate compound analysis. The important fodder quality parameters viz., crude protein and crude fibre contents were analyzed and the average content of all harvests was presented.

Table 3. Effect of treated wastewater and nutrients on total green fodder yield (t $ha^{-1}yr^{-1}$) of Bajra Napier hybrid grass

Treatments	I_1	I_2	I_3	I_4	I_5	Mean
N_1	378.6	408.2	406.5	417.0	431.1	408.3
N_2	268.5	346.8	342.0	354.6	374.4	337.2
N_3	242.2	288.2	283.1	391.1	411.4	323.2
N_4	222.6	267.1	253.1	276.2	318.3	267.5
Mean	**278.0**	**327.6**	**321.2**	**359.7**	**383.8**	
	I	**N**	**I x N**	**N x I**		
SEd	12.9	9.3	4.8	3.9		
CD (P=0.05)	28.0	21.00	10.6	7.8		

Horizontal factor
I_1 - Irrigation with groundwater (GW) alone
I_2 - Alternate irrigation with GW and Treated wastewater (TWW)
I_3 - Two irrigations with GW + One irrigation with TWW
I_4 - One irrigation with GW + Two irrigations with TWW
I_5 - Irrigation with TWW alone

Vertical factor
N_1 - 100% Inorganic nutrients (IN)
N_2 - 100% Organic nutrients (ON) on N basis
N_3 - 50% Organic + 50% Inorganic nutrients
N_4 - Control (without nutrients)

Table 4. Effect of treated wastewater and nutrients on total dry fodder yield (t ha^{-1} $year^{-1}$) of Bajra Napier hybrid grass

Treatments	I_1	I_2	I_3	I_4	I_5	Mean
N_1	67.88	71.53	71.09	75.01	76.72	72.45
N_2	53.30	62.98	61.74	64.65	66.38	61.81
N_3	49.63	58.52	57.08	68.67	73.53	61.49
N_4	47.68	53.72	51.27	55.71	59.86	53.65
Mean	**54.62**	**61.69**	**60.30**	**66.01**	**69.12**	
	I	**N**		**I x N**	**N x I**	
SEd	0.31	0.35		0.20	0.19	
CD(P=0.05)	0.68	0.79		0.45	0.38	

Horizontal factor
I_1 - Irrigation with groundwater (GW) alone
I_2 - Alternate irrigation with GW and Treated wastewater (TWW)
I_3 - Two irrigations with GW + One irrigation with TWW
I_4 - One irrigation with GW + Two irrigations with TWW
I_5 - Irrigation with TWW alone

Vertical factor
N_1 - 100% Inorganic nutrients (IN)
N_2 - 100% Organic nutrients (ON) on N basis
N_3 - 50% Organic + 50% Inorganic nutrients
N_4 - Control (without nutrients)

Table 5. Effect of treated wastewater and nutrients on average crude protein (%) of Bajra Napier hybrid grass

Treatments	I_1	I_2	I_3	I_4	I_5	Mean
N_1	12.78	13.02	12.99	13.46	13.53	13.16
N_2	10.50	11.70	11.58	12.15	12.38	11.66
N_3	9.92	11.17	11.02	12.82	13.33	11.65
N_4	9.58	10.49	10.24	10.82	11.31	10.49
Mean	10.70	11.59	11.46	12.31	12.64	
	I	**N**		**I x N**	**N x I**	
SEd	0.04	0.03		0.02	0.02	
CD(P=0.05)	0.09	0.08		0.05	0.04	

Horizontal factor
I_1 - Irrigation with groundwater (GW) alone
I_2 - Alternate irrigation with GW and Treated wastewater (TWW)
I_3 - Two irrigations with GW + One irrigation with TWW
I_4 - One irrigation with GW + Two irrigations with TWW
I_5 - Irrigation with TWW alone

Vertical factor
N_1 - 100% Inorganic nutrients (IN)
N_2 - 100% Organic nutrients (ON) on N basis
N_3 - 50% Organic + 50% Inorganic nutrients
N_4 - Control (without nutrients)

3.2.1 Crude protein content

The protein content of forage crops is an important quality factor from the animal nutrition point of view. The crude protein content is directly related to the nitrogen percentage of the plant tissue. Adopting irrigation with treated wastewater combined with organic and inorganic nutrients has shown a significantly increase in the crude protein content of Bajra Napier hybrid grass (Table 5). It ranges from 9.58 - 13.53 per cent. Among the treatments, irrigation with treated wastewater alone (I_5) registered significantly higher average crude protein content (12.64%) than all other treatments. Control (irrigated with groundwater alone - I_1) registered the lowest crude protein content (10.70 %). The increased crude protein content with treated wastewater might be due to a partial supply of nitrogen throughout the lifecycle of forage crop growth. The rise in crude protein content in corn fodder could be linked to sufficient nitrogen in wastewater [29]. Several studies have reported a significant increase in crude protein content of sorghum, maize and tomatoes through the application of treated wastewater as an irrigation source [30,31,32].

In a year, mean data (Table 5) of all seven crop harvests (from the main crop to the sixth ratoon harvest) significantly influenced manure and inorganic nutrient application. The treatment with 100% inorganic nutrients (N_1) registered significantly greater crude protein content (13.16%) than all other treatments and the control. This could be due to adequate nitrogen application through manure and inorganic nutrients increased the vegetative growth, N concentration, amino acids and protein content in forage, ultimately increasing the total crude protein yield. In addition, the slow release of nitrogen in organic manure had an added advantage to uptake and increased the crude protein content in the bajra napier forage crop. The findings corroborate the earlier results [33,34], which reported increasing the crude protein content with manure and inorganic nutrients.

Among irrigation and inorganic nutrient combinations, treatment imposed with treated wastewater alone and 100% inorganic nutrients (I_5N_1) recorded significantly higher crude protein content (13.53%) than other treatments. It could be because of the presence of numerous nutrients, particularly nitrogen, in treated wastewater which is required for the growth of bajra napier hybrid grass. In manure, N is present in both organic and inorganic forms and typically decompose slowly, behaving as N's slow-release source over many months. However, most organic N sources require mineralization (conversion to inorganic forms) before plants use them. Therefore, it depends upon environmental factors like soil temperature, pH, moisture etc. The organic N-containing compounds in manure become available for plant uptake following mineralization by soil microorganisms, while the inorganic N fraction is readily available. The sufficient availability of water and adequate nutrients favoured early canopy development, resulting in greater nutrient uptake, which promoted the synthesis of more metabolites and paved the way for higher crude protein yield. Also, higher use of solar radiation due to increased leaf N concentrations resulting from high N availability in the soil after adopting treated wastewater irrigation. As a result, the crude protein content reflected the nutrient concentration, particularly nitrogen. These findings were on par with other researchers [21,29,35].

3.2.2 Crude fibre content

The total crude fibre content of the Bajra Napier hybrid grass is significantly affected by the use of treated wastewater for irrigation, manure and inorganic nutrients (Table 6). Among different irrigation treatments, significantly lower crude fibre (28.80%) was seen in irrigation with treated wastewater alone (I_5) than other treatments. Conversely, the highest crude fibre content (30.36%) was recorded in control (I_1 - irrigated with groundwater alone). This might be due to the partial supplement of nitrogen in treated wastewater increasing the photosynthates, reducing the accumulation of cellulolytic components in plants and decreasing the crude fibre content. On the other hand, there is no nutritional value in groundwater that induces lignin accumulation in the plant cell. These results were supported by other research findings [12, 28].

Table 6. Effect of treated wastewater and nutrients on average crude fibre (%) of Bajra Napier hybrid grass

Treatments	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**Mean**
N_1	28.92	28.57	28.65	28.18	28.03	28.47
N_2	30.43	29.35	29.56	29.20	29.05	29.52
N_3	30.92	30.02	30.16	28.89	28.36	29.67
N_4	31.18	30.51	30.78	30.31	29.78	30.51
Mean	30.36	29.61	29.79	29.15	28.80	

	I	**N**	**I x N**	**N x I**
SEd	0.14	0.09	0.06	0.05
CD(P=0.05)	0.30	0.20	0.13	0.10

Horizontal factor
I_1 - Irrigation with groundwater (GW) alone
I_2 - Alternate irrigation with GW and Treated wastewater (TWW)
I_3 - Two irrigations with GW + One irrigation with TWW
I_4 - One irrigation with GW + Two irrigations with TWW
I_5 - Irrigation with TWW alone

Vertical factor
N_1 - 100% Inorganic nutrients (IN)
N_2 - 100% Organic nutrients (ON) on N basis
N_3 - 50% Organic + 50% Inorganic nutrients
N_4 - Control (without nutrients)

Among the nutrient treatments, the plots that received 100% organic nutrients (N_1) received treatment registered significantly lower average crude fibre content (28.47%) compared to the control (30.51%) and other treatments. The value of crude fibre is an indirect indication of the digestibility of the forage. It is known that higher crude fibre content lowers the digestibility and vice-versa. The availability of nitrogen fraction in the soil through manure and inorganic nutrients might improve the carbohydrates and reduce the formation of lignin, cellulose and hemicellulose material, which are responsible for increasing the crude fibre content. The decrease in nitrogen content increases the crude fibre in observed by other scientific workers in the bajra napier [36,15,23,24].

In interaction effects of irrigation and inorganic nutrients, a combination of treated wastewater along with 100% inorganic nutrients (I_5N_1) recorded significantly lower crude fibre content (28.03%) than all other treatment combinations. The lower fibre content in treated wastewater and inorganic nutrition applied treatment compared to the control could be due to the supply of sufficient essential nutrients and better decomposition of organic matter improved the availability of nutrients resulting in high succulent biomass formation and yield. The same results were reported earlier [11,28,37].

4. CONCLUSION

The effect of treated wastewater irrigation combined with organic and inorganic nutrients on Bajra Napier hybrid grass showed a significant difference in total green and dry fodder yields. The imposed treatments influenced crude protein and crude fibre in the proximate analysis. The treatment irrigation with treated wastewater combined with organic and inorganic nutrients registered the highest total green and dry fodder yields and positively responded to proximate compounds. Based on the study results, it can be concluded that treated wastewater irrigation, either 100% treated wastewater alone or two irrigation with TWW followed by GW with the recommended dose of organic and inorganic nutrients, is a viable option to increase fodder productivity. It will help to utilize nutrients available in treated wastewater effectively, reduce the water dependency of groundwater for fodder cultivation and conserve/ save the groundwater resources in the future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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