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Effect of treated wastewater irrigation and graded fertilizer levels on quality parameters of fodder maize (*Zea mays* L.)

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Abstract
A field experiment was conducted during the summer seasons of 2021 and 2022 at the Agroforestry unit, Zonal Agricultural Research Station, GKVK, UAS, Bangalore to study the effect of different irrigation water sources and variable fertilizer doses on quality parameters of fodder maize (*Zea mays* L.). The experiment consisted of three irrigation water sources (Borewell water (BW), secondary treated wastewater (STW), and tertiary treated wastewater (TTW)) and four fertilizer levels (0, 25, 50, and 100 per cent of the recommended dose of fertilizers - RDF) in split plot design. The results indicated that irrigation with treated wastewater, particularly STW, significantly enhanced the crude protein (8.91%), ether extract (3.24%) and ash content (8.44%) compared to borewell water (8.23%, 2.90%, and 7.71%, respectively), with TTW (8.76%, 3.23%, and 8.34%, respectively) being statistically on par with STW for all three parameters. Similarly, the application of 100% RDF resulted in the highest crude protein (9.69%), ether extract (3.55%), and ash content (9.50%), and a significantly lower crude fibre content (29.62%) compared to the control (30.80%). The findings underscore the potential of utilizing treated wastewater in conjunction with optimal fertilizer management to improve the nutritional quality of fodder maize, offering a sustainable solution for water and nutrient resource management in agriculture.

Keywords: Treated wastewater irrigation, fodder maize

Introduction
The escalating global demand for livestock products necessitates a consistent supply of high-quality animal feed, with fodder maize (*Zea mays* L.) being a crucial component due to its high biomass production and nutritional value. It is a staple food and feed crop particularly in developing economies where the dairy sector is a primary engine of rural growth. Due to its quick growth, versatile growth habit, lower pest and diseases and also high fodder value it is popularly cultivated as source of green fodder in most of the tropical world. Specifically, maize variety ‘African Tall,’ has become an indispensable component of forage production systems of peri-urban agriculture in Peninsular India. Agronomically, it is known for its quick growth, high succulence, exceptional palatability, and freedom from anti-nutritional factors (Kumar *et al.*, 2024) [11], Unlike other fodders, maize produces high biomass in a relatively short duration, providing a critical solution to the chronic fodder scarcity that affects dairy productivity during lean periods (Iqbal and ahmad, 2015) [7]. However, agricultural production, particularly in semi-arid and arid regions, is increasingly constrained by water scarcity, prompting the exploration of alternative irrigation sources. 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. As a result, water reclamation and reuse of treated municipal wastewater (TWW) in agriculture has emerged as a viable and sustainable strategy to conserve freshwater resources (Ungureanu *et al.*, 2020) [17]. Rapid and uncontrolled urbanization and exodus of human population from rural areas into cities is often associated with several anthropogenic problems. Sewage is one of the important by product of such urbanization. The quantum of sewage water is also so enormous that it cannot be ignored, but put to use for some purpose.

Treated wastewater is not merely a source of water but also a rich source of essential plant nutrients, including nitrogen (N), phosphorus (P), and potassium (K), which can partially or fully substitute for conventional inorganic fertilizers (Castro *et al.*, 2015) [4]. The nutrient content in wastewater, however, varies significantly depending on the treatment level (secondary vs. tertiary), which can differentially impact crop growth and quality. While the benefits of TWW on crop yield are well-documented, its influence on the nutritional quality of fodder crops, specifically the proximate composition, requires detailed investigation to ensure the safety and efficacy of the feed for livestock (Amerasinghe *et al*., 2013) [3]. Therefore, the reuse of treated wastewater in agriculture for fodder crops appears viable in this changing water demand scenario. Simultaneously, the optimization of mineral fertilizer application remains critical for maximizing crop quality. The recommended dose of fertilizers (RDF) provides a benchmark, but the interaction between nutrient-rich irrigation water and variable fertilizer levels needs to be understood to develop integrated nutrient management strategies. Based on this background, the current study was carried out with the objective of assessing the individual and interactive effects of three different irrigation water sources (Borewell water, Secondary Treated Wastewater, and Tertiary Treated Wastewater) and four graded levels of fertilizer application (0, 25, 50, and 100% RDF) on the key quality parameters of fodder maize, namely crude protein, ether extract, ash content, and crude fibre.

Materials and Methods

A field experiment was conducted during two consecutive summer seasons of 2021 and 2022 at the Agronomy Field Unit, Zonal Agricultural Research Station, Gandhi Krishi Vignyana Kendra (GKVK), University of Agricultural Sciences, Bengaluru, India. The experimental site falls under the Eastern Dry Zone (Zone-V) of Karnataka and is located at 12°51′ N latitude and 77°35′ E longitude, at an altitude of 930 m above mean sea level. The region is characterized by a semi-arid climate. The soil of the experimental site was red sandy loam in texture, with a soil reaction of pH 6.13, electrical conductivity of 0.13 dS m^{-1} and organic carbon content of 0.49 per cent. The soil was low in available nitrogen (280.03 kg ha^{-1}), medium in available phosphorus (35.14 kg ha^{-1}) and medium in available potassium (290.86 kg ha^{-1}).

The experiment was laid out in a split plot design with three replications, comprising irrigation water sources and graded fertilizer levels as treatment factors. The irrigation treatments consisted of borewell water, secondary treated wastewater and tertiary treated wastewater, while fertilizer treatments comprised 0, 25, 50 and 100 per cent recommended dose of fertilizer (RDF). Thus, a total of 12 treatment combinations were evaluated. The fodder maize variety African Tall was sown at a seed rate of 100 kg ha^{-1}, maintaining a spacing of 30 cm × 10 cm with a sowing depth of 4-5 cm. The recommended dose of fertilizer was 150:75:50 kg $N:P_2O_5:K_2O$ ha^{-1}, applied through urea, single superphosphate and muriate of potash. Entire phosphorus and potassium along with 50 per cent nitrogen were applied as basal at sowing, while the remaining nitrogen was top dressed in two equal splits at 30 and 45 days after sowing, as per the treatment schedule. Irrigation was applied through drip with 0.8 IW/CPE irrigation scheduling throughout the cropping season.

Secondary treated wastewater was obtained through the extended aeration process, wherein prolonged biological oxidation reduced the organic load of sewage, while tertiary treated wastewater was produced through activated sludge process followed by filtration and chlorination to improve physical and microbiological quality. Representative samples of irrigation water were collected periodically and analysed for pH, electrical conductivity, biological oxygen demand, chemical oxygen demand, macro and secondary nutrients were analysed using the standard analytical procedures. The pH and electrical conductivity were measured using a digital pH meter and conductivity meter, respectively. Biological oxygen demand (BOD) and chemical oxygen demand (COD) were estimated following standard APHA procedures.

At harvest, representative plant samples were collected and oven dried for quality analysis. Crude protein content was estimated by the Kjeldahl method and expressed as N × 6.25. Ether extract was determined using petroleum ether in a Soxhlet extraction apparatus. Ash content was estimated by incinerating the samples in a muffle furnace at 550°C until constant weight was attained. Crude fibre content was determined by sequential digestion of the fat-free sample with dilute acid and alkali. All quality parameters were analysed following standard procedures described by AOAC (2005). The data recorded for both seasons were subjected to analysis of variance using Fisher's method appropriate for split plot design. The significance of main effects and their interaction was tested using the F-test, and critical difference values were worked out at 5 per cent level of significance. Pooled analysis over the two years was performed to draw valid conclusions.

Results and Discussion

Composition of borewell water, secondary treated wastewater and teritery treated wastewater such as pH, electrical conductivity, carbonates, bicarbonates, total phosphorous(P), total potassium (K), total nitrogen (N), calcium (Ca), magnesium (Mg), sulphates were analyzed and the results are tabulated in Table-1. Secondary and tertiary treated wastewater showed slightly alkaline pH (7.60 and 7.67) compared to borewell water (7.08). Electrical conductivity was higher in STWW (1.39 dS m^{-1}) and TTWW (1.28 dS m^{-1}) than in borewell water (0.93 dS m^{-1}), but remained within safe limits. Organic load was higher in STWW (BOD 11.87 mg L^{-1} and COD 29.56 mg L^{-1}) and lower in borewell water (0.54 and 5.13 mg L^{-1}, respectively). Tertiary treatment reduced these values to 5.18 mg L^{-1} BOD and 20.17 mg L^{-1} COD, indicating improved water quality. Treated wastewater sources were significantly richer in essential plant nutrients compared to groundwater. STWW contained the higher concentration of nitrogen (18.01 mg L^{-1}), phosphorus (1.56 mg L^{-1}), and potassium (18.15 mg L^{-1}), whereas borewell water contained only 5.54, 0.14, and 4.92 mg L^{-1} of N, P, and K, respectively. The nutrient loading to the field was substantial under wastewater irrigation

Crude protein

Crude protein is one of the most important quality parameters of fodder maize, as it directly determines the nutritional value and digestibility of fodder for livestock. Pooled analysis of data presented in table 2 revealed that irrigation with secondary treated wastewater (I_2) recorded significantly higher crude protein content (8.91%) and crude protein yield (9.41 q ha^{-1}) compared to borewell irrigation. These values were statistically on par with tertiary treated wastewater (I_3), which recorded 8.76% crude protein content and 9.02 q ha^{-1} crude protein yield, whereas borewell irrigation (I_1) registered significantly lower values (8.23% and 7.46 q ha^{-1}, respectively). The higher crude protein content under treated wastewater irrigation might be attributed to the continuous supply of nitrogen throughout the crop growth period, which enhanced nitrogen uptake and assimilation into amino acids and protein fractions. Nitrogen is a primary constituent of amino acids, and its readily available form in treated wastewater enhances protein synthesis in forage crops. Several studies have reported a significant increase in crude protein content of sorghum, wheat and bajra napier through the application of treated wastewater (Ghanbari *et al*., 2007, Galavi *et al*., 2010, Senthilkumar, *et al*., 2022) [5, 15].

Graded fertilizer levels also exerted a significant influence on crude protein content and crude protein yield. Application of 100 per cent RDF (F_4) resulted in significantly higher crude protein content (9.69%) and crude protein yield (12.32 q ha^{-1}) on a pooled basis, followed by 50 per cent RDF (F_3) which recorded 9.09% crude protein content and 9.39 q ha^{-1} crude protein yield. The lowest crude protein content (7.49%) and yield (5.44 q ha^{-1}) were observed in the control (F_1). The higher crude protein content with higher dose of fertilizer may be due to the fact that optimum levels of nitrogen and phosphorus in the plants are known to enhance nitrogen uptake thus nitrogen plays a critical role in protein synthesis, nitrogen concentration in plant tissues, amino acid synthesis and ultimately protein accumulation. These results are in conformity with earlier findings in maize (Patil *et al*., 2019) [13] and Bajra Napier (Vennila & Ananthi, 2019) [18], where higher nitrogen application significantly improved crude protein content. Similar responses have also been reported in forage maize under higher nitrogen levels (KUMAR *et al*.). The interaction between irrigation sources and fertilizer levels was found to be non-significant, indicating that the response of crude protein content and crude protein yield to fertilizer levels remained consistent across irrigation sources. However, numerically higher crude protein content (9.85%) and crude protein yield (12.97 q ha^{-1}) were recorded under the interaction of secondary treated wastewater with 100 per cent RDF (I_2F_4), whereas the lowest values (7.16% and 4.35 q ha^{-1}) were observed under borewell irrigation without fertilizer application (I_1F_1).

Ether extract

Ether extract represents the crude fat content of fodder maize and is an important quality parameter, as it contributes to the energy value of the fodder. The data pertaining to ether extract content are presented in Table 3, Pooled data revealed that irrigation with STW (I_2) recorded significantly higher ether extract content (3.24%), which was statistically on par with TTW (I_3) (3.23%). In contrast, BW**(I_1)** resulted in significantly lower ether extract content (2.90%). The higher ether extract content under treated wastewater irrigation may be attributed to the presence of additional nutrients, particularly nitrogen and organic matter, which enhance photosynthetic efficiency and promote lipid synthesis in plants. Treated wastewater supplies a continuous and balanced source of nutrients, thereby facilitating greater accumulation of crude fat in fodder maize. Similar improvements in ether extract content under treated wastewater irrigation have been reported earlier in Bajra Napier (Senthilkumar, 2025) [14] and Sorghum (Galavi *et al*., 2009) [5]

Graded fertilizer levels also exerted a significant influence on ether extract content. Application of 100 per cent RDF (F_4) resulted in significantly higher ether extract content (3.55%) on a pooled basis, followed by 50 per cent RDF (F_3) (3.33%), whereas the lowest ether extract content was recorded under the control treatment (F_1) (2.63%). The increase in ether extract with higher fertilizer levels could be attributed to enhanced availability of essential nutrients, particularly nitrogen, phosphorus and potassium, which stimulate metabolic activities associated with lipid biosynthesis and energy storage within plant tissues. Adequate nutrient supply improves assimilate production and translocation, leading to higher crude fat accumulation in fodder crops. These findings agree with earlier reports, wherein improved fertilization significantly enhanced ether extract content in fodder crops (Khanduri *et al*.,2016 and Kumar *et al*., 2019). The interaction between irrigation water sources and fertilizer levels was found to be non-significant, However, numerically higher ether extract content was observed under the combination of secondary treated wastewater with 100 per cent RDF (I_2F_4) (3.60%), while the lowest values were recorded under borewell irrigation without fertilizer application (I_1F_1) (2.33%).

Ash content

Ash content is an important quality parameter of fodder maize as it represents the total mineral composition of the fodder, which plays a vital role in animal nutrition. The data presented in Table 3 revealed that ash content of fodder maize was significantly influenced by irrigation water sources and graded fertilizer levels, whereas their interaction effect was found to be non-significant. Pooled analysis indicated that irrigation with secondary treated wastewater (I_2) recorded significantly higher ash content (8.44%), which was statistically on par with tertiary treated wastewater (I_3) (8.34%). In contrast, borewell irrigation (I_1) resulted in significantly lower ash content (7.71%). The higher ash content under treated wastewater irrigation could be attributed to the increased availability of dissolved minerals and nutrients present in wastewater. These nutrients enhance mineral uptake and accumulation within plant tissues, thereby increasing the ash content of the fodder. Treated wastewater thus acts as a supplemental source of macro- and micronutrients, improving the mineral composition of fodder maize. Similar observations have been reported earlier, where wastewater irrigation significantly enhanced mineral content in fodder crops (Kaur *et al*., 2017 and Senthil Kumar, 2025) [9].

Graded fertilizer levels also exerted a significant effect on ash content of fodder maize. Application of 100 per cent RDF (F_4) resulted in significantly higher ash content (9.50%) on a pooled basis, followed by 50 per cent RDF (F_3) (8.70%), whereas the lowest ash content was observed under the control treatment (F_1) (6.96%). The increase in ash content with higher fertilizer application could be attributed to improved availability and uptake of essential nutrients such as nitrogen, phosphorus and potassium, which promoted greater mineral accumulation in plant tissues. Adequate nutrient supply enhances metabolic activity and nutrient translocation, leading to improved mineral content in fodder crops (Mahmud *et al*., 2003 and Yadav *et al*., 2019) [10, 19]. The interaction between irrigation water sources and fertilizer levels was found to be non-significant, However, numerically higher ash content was recorded under the combination of secondary treated wastewater with 100 per cent RDF (I_2F_4) (9.68%), whereas the lowest values were observed under borewell irrigation without fertilizer application (I_1F_1) (6.64%)

Crude fibre

Crude fibre content is an important quality parameter of fodder maize, as it is inversely related to fodder digestibility; higher fibre content generally results in reduced digestibility. The data presented in Table 3 indicated that crude fibre content of fodder maize was not significantly influenced by irrigation water sources in the pooled analysis, with values ranging from 30.14

to 30.79 per cent. However, numerically lower crude fibre content was observed under STW (30.14%) and TTW (30.18) irrigation compared to borewell irrigation (30.80). This reduction in crude fibre under treated wastewater irrigation may be attributed to improved nutrient availability and enhanced organic matter decomposition, which promoted rapid vegetative growth and protein synthesis. Such conditions favor the development of more succulent plant tissues with reduced accumulation of structural carbohydrates, thereby improving fodder digestibility. Earlier studies also proved that using tertiary treated sewage water for irrigating barley did not affect the crude fiber (Ajmi *et al*., 2009) [1].

Graded fertilizer levels had a significant effect on crude fibre content. Pooled data revealed that the control (F_1) and 25 per cent RDF (F_2) recorded relatively higher crude fibre content (30.80% and 30.60%, respectively), whereas application of 100 per cent RDF (F_4) resulted in significantly lower crude fibre content (29.62%). Increased nitrogen availability under higher fertilizer levels enhances protein synthesis and vegetative growth, thereby reducing the allocation of assimilates towards structural components such as cellulose and lignin. Consequently, fodder produced under higher nitrogen levels is more succulent and digestible. It was confirmed by Srinivas *et al*.,2014 [16] in forage crops.

The interaction between irrigation water sources and fertilizer levels was found to be non-significant for crude fibre content. However, the highest crude fibre content (31.02%) was recorded under the interaction of borewell irrigation without fertilizer application (I_1F_1). This could be attributed to the absence of supplemental nutrients, particularly nitrogen, in groundwater, which limited protein synthesis and favored the accumulation of structural carbohydrates. In contrast, treated wastewater supplied additional nutrients, especially nitrogen, which enhanced photosynthetic activity and increased the production of soluble photosynthates, thereby reducing lignin and cellulose synthesis and lowering crude fibre content. Similar reductions in crude fibre content with increased nitrogen availability have been reported earlier in forage maize by Almodares *et al.* (2009) [2].

Table 1: characterization of different irrigation water sources used in the experiment

Parameter	Unit	Different sources of irrigation		
		Borewell water	Secondary treated wastewater	Tertiary treated wastewater
pH	-	7.08 ± 0.179	7.60 ± 0.204	7.67 ± 0.267
EC	(dS m^{-1})	0.93 ± 0.244	1.39 ± 0.362	1.28 ± 0.277
BOD	(mg L^{-1})	0.54 ± 0.33	11.87 ± 4.56	5.18 ± 1.78
COD	(mg L^{-1})	5.13 ± 1.10	29.56 ± 8.71	20.17 ± 4.34
Nitrogen	(mg L^{-1})	5.54 ± 3.43	18.01 ± 4.80	15.60± 4.033
P as phosphate	(mg L^{-1})	0.14 ± 0.05	1.56 ± 1.13	1.40 ± 1.14
Potassium	(mg L^{-1})	4.92 ± 2.31	18.15 ± 3.77	19.21 ± 4.62
Calcium	(mg L^{-1})	56.92 ± 7.33	70.09 ± 11.09	63.18 ± 9.12
Magnesium	(mg L^{-1})	17.03 ± 1.95	23.24 ± 4.55	20.53 ± 2.56
S as sulphate	(mg L^{-1})	12.05 ± 6.03	18.78 ± 6.09	14.09 ± 4.91

Table 2: Crude protein content of fodder maize as influenced by irrigation water sources and graded fertilizer levels

Treatments	Crude protein content (%)			Crude protein yield (q ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled
Main plot: Irrigation water sources (I)						
I_1: Borewell irrigation	8.36	8.10	8.23	7.70	7.22	7.46
I_2: Secondary treated WW	8.98	8.84	8.91	9.61	9.21	9.41
I_3: Tertiary treated WW	8.87	8.66	8.76	9.23	8.81	9.02
F test	*	*	*	*	*	*
S.Em.±	0.12	0.11	0.09	0.16	0.24	0.19
CD at 5%	0.47	0.44	0.37	0.64	0.94	0.75
Sub plot: Graded fertilizer levels (F)						
F_1: 0% RDF	7.55	7.43	7.49	5.58	5.29	5.44
F_2: 25% RDF	8.34	8.19	8.27	7.56	7.19	7.38
F_3: 50% RDF	9.25	8.92	9.09	9.68	9.10	9.39
F_4:100% RDF	9.79	9.59	9.69	12.57	12.07	12.32
F test	*	*	*	*	*	*
S.Em.±	0.12	0.13	0.11	0.15	0.18	0.13
CD at 5%	0.36	0.39	0.32	0.44	0.52	0.39
Interaction (I x F)						
I_1F_1	7.37	6.95	7.16	4.60	4.10	4.35
I_1F_2	7.62	7.52	7.57	6.04	5.66	5.85
I_1F_3	8.92	8.53	8.72	8.50	7.88	8.19
I_1F_4	9.53	9.40	9.46	11.67	11.24	11.45
I_2F_1	7.71	7.81	7.76	6.21	6.08	6.15
I_2F_2	8.87	8.66	8.76	8.61	8.17	8.39
I_2F_3	9.40	9.14	9.27	10.42	9.87	10.15
I_2F_4	9.93	9.78	9.85	13.20	12.73	12.97
I_3F_1	7.58	7.54	7.56	5.94	5.69	5.82
I_3F_2	8.53	8.41	8.47	8.03	7.75	7.89
I_3F_3	9.44	9.09	9.27	10.12	9.55	9.84
I_3F_4	9.90	9.61	9.76	12.83	12.24	12.53
F test	NS	NS	NS	NS	NS	NS
S.Em.±	0.21	0.23	0.19	0.25	0.31	0.23
CD at 5%	-	-	-	-	-	-

Table 3: Ether extract, ash content and crude protein content of fodder maize as influenced by irrigation water sources and graded fertilizer levels

Treatments	Ether extract (%)			Ash content (%)			Crude fibre content (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Main plot: Irrigation water sources (I)									
I_1: Borewell irrigation	2.90	2.90	2.90	7.66	7.77	7.71	30.68	30.91	30.79
I_2: Secondary treated WW	3.21	3.26	3.24	8.50	8.39	8.44	30.16	30.12	30.14
I_3: Tertiary treated WW	3.17	3.29	3.23	8.40	8.28	8.34	30.22	30.15	30.18
F test	*	*	*	*	*	*	NS	NS	NS
S.Em.±	0.05	0.06	0.05	0.14	0.12	0.10	0.20	0.23	0.20
CD at 5%	0.20	0.25	0.20	0.56	0.49	0.40	-	-	-
Sub plot: Graded fertilizer levels (F)									
F_1: 0% RDF	2.63	2.62	2.63	6.92	7.01	6.96	30.71	30.89	30.80
F_2: 25% RDF	2.95	3.01	2.98	7.54	7.46	7.50	30.64	30.56	30.60
F_3: 50% RDF	3.28	3.39	3.33	8.70	8.70	8.70	30.44	30.52	30.48
F_4:100% RDF	3.53	3.58	3.55	9.59	9.41	9.50	29.63	29.60	29.62
F test	*	*	*	*	*	*	NS	NS	*
S.Em.±	0.14	0.08	0.08	0.11	0.12	0.08	0.37	0.32	0.23
CD at 5%	0.41	0.22	0.23	0.33	0.35	0.24	-	-	0.68
Interaction (I x F)									
I_1F_1	2.39	2.26	2.33	6.49	6.80	6.64	30.91	31.13	31.02
I_1F_2	2.69	2.61	2.65	7.00	7.03	7.01	30.88	30.90	30.89
I_1F_3	3.08	3.20	3.14	7.92	8.09	8.01	30.63	30.87	30.75
I_1F_4	3.45	3.53	3.49	9.22	9.15	9.18	30.31	30.73	30.52
I_2F_1	2.75	2.72	2.73	7.22	7.20	7.21	30.50	30.80	30.65
I_2F_2	3.12	3.25	3.18	7.87	7.76	7.81	30.61	30.05	30.33
I_2F_3	3.39	3.49	3.44	9.12	9.02	9.07	30.40	30.42	30.41
I_2F_4	3.59	3.60	3.60	9.79	9.58	9.68	29.14	29.22	29.18
I_3F_1	2.74	2.90	2.82	7.05	7.02	7.04	30.70	30.75	30.73
I_3F_2	3.03	3.18	3.11	7.75	7.60	7.67	30.44	30.73	30.58
I_3F_3	3.37	3.48	3.43	9.05	8.98	9.01	30.30	30.27	30.28
I_3F_4	3.55	3.59	3.57	9.76	9.52	9.64	29.44	28.86	29.15
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.Em.±	0.24	0.13	0.14	0.20	0.20	0.14	0.64	0.55	0.39
CD at 5%	-	-	-	-	-	-	-	-	-

Conclusion

The two-year field study clearly demonstrated the significant influence of irrigation water source and fertilizer application rate on the nutritional quality of fodder maize. Irrigation with treated wastewater, particularly secondary treated wastewater (STW), proved superior to borewell water in improving key fodder quality parameters, namely crude protein, ether extract and ash content. Fertilizer application rate played an equally critical role in determining fodder quality. Application of 100 per cent recommended dose of fertilizer (RDF) consistently resulted in higher crude protein (9.69%), ether extract (3.55%) and ash content (9.50%), while simultaneously recording the lowest crude fibre content (29.62%). This indicates that optimal nutrient supply is essential for promoting protein and lipid synthesis, reducing structural carbohydrate accumulation, and improving overall fodder digestibility and nutritive value. The interaction between irrigation water source and fertilizer level was found to be non-significant, indicating that the beneficial effects of fertilizer application on fodder quality were consistent across irrigation sources. However, the highest numerical values for all desirable quality parameters were observed under the combined application of secondary treated wastewater with 100 per cent RDF, suggesting a synergistic advantage of nutrient-rich irrigation water and adequate fertilizer supply. In conclusion, the short-term reuse of treated wastewater for fodder maize irrigation combination with the recommended dose of fertilizers, represents an effective and sustainable management strategy. This approach not only conserves freshwater resources but also enhances the nutritional quality of fodder maize, thereby supporting sustainable livestock production.

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