Mysore J. Agric. Sci., 56 (4) : 304-312 (2022)

# Effect of Treated Wastewater Irrigation with Variable Doses of Fertilizer on Growth and Yield of Fodder Maize (*Zea mays* L.)

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*Received :* August 2022
*Accepted :* November 2022

**ABSTRACT**

A field experiment on the effect of different type of treated wastewater with variable doses of fertilizer in fodder maize was carried out during *summer* 2021 at agroforestry unit, GKVK, Bengaluru, consisting of twelve treatments replicated thrice, assigning three sources of irrigation (Borewell water, secondary and tertiary treated wastewater) as the main plot treatment with four subplots of variable doses of fertilizer (0, 25, 50 and 100% of RDF) was laid out in a split-plot design. The results revealed that irrigation by secondary treated wastewater with 100 per cent RDF application recorded significantly higher plant height (255.7 cm), leaf area (5961 $cm^2$ $plant^{-1}$), SPAD reading (42.13), green seeker values (0.72), stem girth (19.36 mm) and green fodder yield (623.1 q $ha^{-1}$) at harvest as compared to borewell water irrigation with 100 per cent RDF (240.6 cm, 5432 $cm^2$ $plant^{-1}$, 39.80, 0.71, 18.22 mm and 573.3 q $ha^{-1}$, respectively) and was on par with tertiary treated wastewater irrigation along with 100 per cent RDF application (249.6 cm, 5831 $cm^2$ $plant^{-1}$, 39.98, 0.72, 19.07 mm, 605.0 q $ha^{-1}$, respectively). Irrigation with borewell water without fertilizer application recorded significantly lower plant height (153.3 cm), leaf area (2553 $cm^2$ $plant^{-1}$) and green fodder yield (320.9 q $ha^{-1}$) as compared to other treatments. The higher growth and yield in treated wastewater irrigation were primarily attributed to higher nutrient content as compared to borewell water irrigation.

*Keywords* : Secondary treated water, Tertiary treated wastewater, Borewell water, Fodder maize, RDF, Yield

WATER is a vital for food production and climate change threatens this most precious resource. Water scarcity problems are well known in the arid and semiarid regions of the world which may be due to rapid growth populations, surface water and groundwater depletions, droughts and climate changes. This is applicable to other rapid population growth areas across the global where increases in per capita water consumption, coupled in part with global climate change have resulted in increased demands on available freshwater resources. The current freshwater use in arid and semiarid lands is not sustainable, as use exceeds replenishment and demand for water continue to increase. The primary use of fresh water in arid and semiarid regions is for irrigation, approximately 70 per cent of water use is for agriculture (Ungureanu *et al*., 2020).

India with 2.4 per cent of the world's total area has 16 per cent of world's population but has only 4 per cent of the total available fresh water. The total water available from precipitation in the country in a year is about 4000 $km^3$. The availability of surface water and replenishable ground water is 1869 $km^3$. Out of this only 60 per cent can be put to beneficial uses. Thus, the total utilizable water resource in the country is only 1,122$km^3$ (Anonymous, 2012). Changing scenario with the economic development of the society towards large-scale urbanization and industrialization is leading to production of huge quantities of wastewater in India. Industrial and domestic effluents are either used or disposed on land for irrigation purposes that create both opportunities and problems. This clearly indicates the need for water resource development, conservation and optimum use. In the context of scientific development and confronted by an increasing water crisis, wastewater reuse merits consideration because the practice helps decrease fresh water use pressure and moderates water pollution. Wastewater use for agriculture is an important management strategy in areas with limited freshwater resources, yielding potential economic and environmental benefits (Mhaske and Nikam *et al*., 2017). The benefits of using recycled water include saving water resources, preventing natural water resources from being contaminated, recovering nutrients for agriculture, augmentation of river flow, saving in wastewater treatment, ground water recharge and sustainable management of water resources (Farahat and Linderholm, 2015).

Maize (*Zea mays*) is an important cereal crop in world. It plays a significant role in nutrition and food security in India after rice and wheat. The seeds and cobs are used as raw material in various industries. Maize is having a special significance due to its addition to staple food for human beings, also as quality feed for animals. Maize is called as 'miracle crop' or 'Queen of Cereals' because of its superior yield potential as compared to other cereals. Maize is used as a fodder crop since several decades, due to its higher green fodder yield, short duration, free from anti nutritional elements highly succulent and vast suitable for silage making (Iqbal and Ahmad, 2015). Livestock sector comprises of 25.4 per cent of agricultural Gross Domestic Product (GDP) and about 4.11 per cent of total GDP. However, fodder crops cultivated to an area of 4.6 per cent of the gross cultivated area with an annual production of 899.3 million tonnes (411.3 mt green and 488 mt dry fodder). On the contrary the annual forage requirement is 1820 mt (1170 mt green and 650 mt dry) to feed the existing livestock population in the country. The nation can only meet green fodder resource requirement of 49.41 per cent and facing shortfall of 50.59 per cent (Anonymous, 2019). Due to shortfall of green and dry forage production in the country, drastic reduction in milk production of livestock breeds has been widely observed. So, there is more research needed on different practices of fodder production by utilizing available resources to feed the existing livestock population. Among all the varieties of maize, African tall proved to be the best for forage and have high forage yielding capacity. however, very less or practically no research work has been so far reported on the aspects of treated wastewater irrigation with varying application of RDF for fodder production in fodder maize. In view of the above considerations, the present study was conducted on, "Effect of treated wastewater irrigation with variable doses of fertilizer on growth and yield of fodder maize *(Zea mays* L.)"

## Material and Methods

A field experiment on effect of treated wastewater irrigation with variable doses of fertilizer on growth and yield of fodder maize *(Zea mays* L.) was carried out during *summer* 2021 at Agro-forestry unit of Zonal Agricultural Research Station, Gandhi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore. The site of experimentation is in Region III of Agro Climatic Zone V (Eastern Dry Zone) of Karnataka. The soil analysis data indicated that soil was found to be neutral in reaction (6.90) with electrical conductivity of 0.27 ds $m^{-1}$ and low in organic carbon (0.39 %). Further, the soil was low in available nitrogen (240.3 kg $ha^{-1}$), medium in available phosphorous (27.80 kg $ha^{-1}$) and medium in available potassium (261.4 kg $ha^{-1}$). The experiment was laid out in split plot design. There were twelve treatments combinations consists of three main factors and four sub factors. The experiment will be laid out in split-plot design with three sources of irrigation ($I_1$-Bore well water, $I_2$ -Secondary treated wastewater and $I_3$ -Tertiary treated wastewater) in main plots with four levels of fertilizers ($F_1$ – 0 % of RDF, $F_2$ - 25 % of RDF, $F_3$ -50 % of RDF, $F_4$ - 100 % of RDF) in sub plots and are replicated thrice.

Three different types of water were applied for plots using variable chemical fertilizers. Three types of irrigation water include borewell water, secondary treated wastewater (Extended Aeration) and tertiary treated wastewater (Activated sludge process+ filtration + chlorination). Borewell water was provided by the agroforestry unit UAS, Bengaluru. Tertiary treated water was supplied by Yelahanka tertiary treatment plant and secondary treated wastewater from Raj canal STP of Bengaluru. Four different chemical fertilizer ratios were applied includes 0, 25, 50 and 100 per cent of recommended dose of fertilizer (150 : 75 : 50 NPK per ha) as per package of practice of UAS, Bangalore. Nitrogen was applied as urea, 50 per cent at the time of sowing and remaining 50 per cent was top dressed at 30 DAS. Application of full dose of potassium and phosphorous was made through single super phosphate and Muriate of potash, respectively at sowing. Recommended FYM of 10 t ha$^{-1}$ applied before sowing the crop to all the treatments. Before sowing, the land was prepared to a fine tilth and sowing was taken during march end of 2021. The furrows were opened with row spacing of 30 cm x 10 cm. The calculated amounts of nutrients were applied to the respective treatments. Irrigation scheduling was done based on IW/CPE ratio of 0.8 with drip irrigation. The variety of fodder maize used was African tall and harvested at 50 per cent flowering. Fisher's method of analysis of variance (ANOVA) was used in the analysis. Significance between the treatments mean were tested by critical difference (CD) at 5 per cent level of significance.

## Results and Discussion

The mean values of selected parameters of borewell water, secondary treated wastewater and tertiary treated wastewater during the experiment is given in Table 1.

The borewell water, secondary treated wastewater and tertiary treated wastewater were ranged from neutral to slightly alkaline in nature having pH of 7.01, 7.71 and 7.64, respectively, with electrical conductivity of 1.27, 1.85 and 1.69 dSm$^{-1}$ in borewell water, secondary treated and tertiary treated wastewater, respectively. The concentration of total nitrogen (except nitrite nitrogen) in borewell water, secondary and tertiary treated wastewater was 2.10, 28.45 and 21.57 mg L$^{-1}$, respectively. Phosphorus content of borewell water, secondary and tertiary treated wastewater was 0.05,

Table 1

Mean value of selected parameters of borewell water, secondary and tertiary treated wastewater (n=4)

| Parameters | Borewell water | Treated wastewater | |
|---|---|---|---|
| | | Secondary | Tertiary |
| pH | 7.01 | 7.71 | 7.64 |
| EC (dS m$^{-1}$) | 1.27 | 1.85 | 1.69 |
| Total nitrogen (mg L$^{-1}$) | 2.10 | 28.45 | 21.57 |
| Total phosphorous (mg L$^{-1}$) | 0.05 | 4.98 | 4.01 |
| Potassium (mg L$^{-1}$) | 4.22 | 21.38 | 16.69 |

4.98 and 4.01 mg L$^{-1}$, respectively. Potassium content of borewell water, secondary treated wastewater and tertiary treated wastewater recorded to an extent of 4.22, 21.38 and 16.69 mg L$^{-1}$, respectively. It was observed that higher nutrient contents were obtained in both type of treated wastewater than borewell water.

The data on plant height (cm) of fodder maize at different stages of growth as influenced by different source of irrigation and variable doses of fertilizer application are presented in Table 2.

Irrigation with secondary treated wastewater recorded the significantly higher plant height at 20, 40, 60 DAS and at harvest (17.25, 60.88, 143.4 and 231.2 cm, respectively) as compared to borewell water irrigation (15.33, 52.88, 126.4 and 205.9 cm, respectively) and was on par with tertiary treated wastewater irrigation (16.87, 57.91, 139.0 and 226.2 cm, respectively). Significantly higher plant height at 20, 40, 60 DAS and at harvest was observed with application of 100 per cent of RDF (19.70, 72.92, 168.8 and 248.6 cm, respectively) as compared to control (13.01, 39.84, 95.6 and 185.5 cm, respectively). This shows that addition of fertilizer caused the increase of increasing availability of essential elements (NPK) for plant growth.

Secondary treated wastewater irrigation along with application of 100 per cent of RDF recorded significantly higher plant height at 20, 40, 60 DAS and at harvest (20.65, 74.94, 172.5 and 255.7 cm,

TABLE 2

Plant height (cm) at different growth stages in fodder maize as influenced by different source of irrigation and variable doses of fertilizer (RDF)

| Treatments | 20 DAS | 40 DAS | 60 DAS | At harvest |
|---|---|---|---|---|
| Mainplot | | | | |
| $I_1$ : Borewell water | 15.33 | 52.88 | 126.4 | 205.9 |
| $I_2$ : Secondary treated wastewater | 17.25 | 60.88 | 143.4 | 231.2 |
| $I_3$ : Tertiary treated wastewater | 16.87 | 57.91 | 139.0 | 226.2 |
| Ftest | * | * | * | * |
| S.Em.± | 0.16 | 0.76 | 1.3 | 1.8 |
| CD @ 5% | 0.64 | 2.99 | 5.1 | 7.2 |
| Subplot | | | | |
| $F_1$ : 0 % RDF | 13.01 | 39.84 | 95.60 | 185.5 |
| $F_2$ : 25 % RDF | 15.29 | 50.04 | 130.6 | 217.0 |
| $F_3$ : 50 % RDF | 17.95 | 66.09 | 150.0 | 233.2 |
| $F_4$ : 100 % RDF | 19.70 | 72.92 | 168.8 | 248.6 |
| Ftest | * | * | * | * |
| S.Em.± | 0.21 | 0.63 | 1.0 | 2.6 |
| CD @ 5% | 0.62 | 1.88 | 3.1 | 7.7 |
| Interaction | | | | |
| $I_1F_1$ | 11.13 | 33.68 | 81.88 | 153.3 |
| $I_1F_2$ | 14.31 | 45.14 | 119.7 | 206.1 |
| $I_1F_3$ | 17.59 | 62.40 | 140.1 | 223.4 |
| $I_1F_4$ | 18.30 | 70.28 | 163.9 | 240.6 |
| $I_2F_1$ | 13.85 | 44.93 | 105.7 | 204.0 |
| $I_2F_2$ | 15.63 | 55.47 | 139.1 | 224.2 |
| $I_2F_3$ | 18.88 | 68.18 | 156.3 | 241.0 |
| $I_2F_4$ | 20.65 | 74.94 | 172.5 | 255.7 |
| $I_3F_1$ | 14.05 | 40.90 | 99.3 | 199.1 |
| $I_3F_2$ | 15.91 | 49.50 | 133.1 | 220.8 |
| $I_3F_3$ | 17.37 | 67.68 | 153.7 | 235.2 |
| $I_3F_4$ | 20.15 | 73.53 | 170.1 | 249.6 |
| Ftest | * | * | * | * |
| S.Em.± | 0.36 | 1.10 | 1.8 | 4.5 |
| CD@ 5% | 1.07 | 3.26 | 5.4 | 13.3 |

respectively) as compared to borewell water irrigation with 100 per cent RDF (18.30, 70.28, 163.9 and 240.6 cm, respectively) and it was found statistically on par with tertiary treated wastewater irrigation along with application of 100 per cent of RDF (20.15, 73.53, 170.1, 249.6 cm, respectively). Significantly lower plant height at 20, 40, 60 DAS and at harvest (11.13, 33.68, 81.88 and 153.3 cm, respectively) was recorded with the borewell water irrigation without application of recommended dose of fertilizers as compared to other treatments. The increased plant height in treated wastewater irrigation with variable fertilizer applications was due to continuous availability of NPK nutrients with proper scheduling and method of irrigation helped in more leaf area as a consequence more assimilates were produced and increased the plant height (Tavassoli *et al*., 2010). It was also confirmed by Mousavi and Shahsavari, 2014, who stated that increase of plant height with use of treated wastewater applications due to high nutrient absorption.

The data on leaf area ($cm^2$ $plant^{-1}$) of fodder maize at different stages of growth as influenced by different source of irrigation and variable doses of fertilizer application recordedare presented in Table 3.

Secondary treated wastewater irrigation recorded the significantly higher leaf area at 20, 40, 60 DAS and at harvest (251.0, 3212, 4258 and 4717 $cm^2$ $plant^{-1}$, respectively) as compared to borewell water irrigation (187.6, 2817, 3655, 4126 $cm^2$ $plant^{-1}$, respectively) and it was found to be on par with tertiary treated wastewater irrigation (231.3, 3092, 4112 and 4546 $cm^2$ $plant^{-1}$). Significantly higher leaf area at 20, 40, 60 DAS and at harvest was observed with application of 100 per cent of RDF (309.8, 3567, 5218 and 5742 $cm^2$ $plant^{-1}$) as compared to without application of fertilizer (133.3, 2333, 2487, 2895 $cm^2$ $plant^{-1}$, respectively).

Among different source of irrigation and different doses of fertilizers, Secondary treated wastewater irrigation along with application of 100 per cent of RDF recorded significantly higher leaf area at 60 DAS and at harvest (5459 and 5961 $cm^2$ $plant^{-1}$, respectively) as compared to borewell water irrigation with 100 per cent RDF (4866 and 5432 $cm^2$ $plant^{-1}$, respectively) and it was statistically on par with tertiary treated wastewater irrigation along with the application of 100 per cent of RDF (5330 and 5831 $cm^2$ $plant^{-1}$, respectively). Significantly lower leaf area at 60 DAS and at harvest (2369 and 2553 $cm^2$ $plant^{-1}$, respectively) was recorded with the borewell water irrigation without application of recommended dose of fertilizers as compared to other treatments. The higher leaf area was due to the increased plant height resulted into more number of nodes per plant leading to more number of leaves per plant. These results are line with Galavi *et al.* (2009) who reported that the existence of higher nitrogen and potassium in treated wastewater improved the plant growth, cell reproduction and leaf area in sorghum.

The data on SPAD values of fodder maize at different stages of growth as influenced by different source of irrigation and variable doses of fertilizer application are presented in Table 4.

At 20, 40, 60 DAS and at harvest (32.68, 40.27, 41.88 and 35.42, respectively) recorded significantly higher SPAD values with irrigation of secondary treated wastewater as compared to borewell water irrigation (28.55, 35.95, 37.19 and 31.53 at 20, 40, 60 DAS and at harvest, respectively) and showed statistically on par to tertiary treated wastewater irrigation (31.78, 39.00, 40.56 and 34.28 at 20, 40, 60 DAS and at harvest, respectively). Out of different dose of recommended fertilizer, application of 100 per cent of RDF recorded higher SPAD values (37.04, 45.73, 46.84 and 40.64 at 20, 40, 60 DAS and at harvest, respectively) as compared to control (25.10, 30.78, 31.69 and 26.52 at 20, 40, 60 DAS and at harvest, respectively).

Among different source of irrigation and different doses of fertilizers, Secondary treated wastewater irrigation along with application of 100 per cent of RDF recorded significantly higher SPAD values at harvest (42.13) as compared to borewell water irrigation with 100 per cent RDF (39.80) and it was statistically on par with tertiary treated wastewater irrigation along with application of 100 per cent of RDF (39.98). Significantly lower SPAD values (22.32) recorded with the borewell water irrigation without application of recommended dose of fertilizers as compared to other treatments. The higher SPAD values were reflection of more chlorophyll content in fodder maize. The effect of NPK doses enhanced the total chlorophyll. The full dose of the recommended NPK fertilizer significantly recorded higher SPAD value compared to others. Similarly, the interactive effect

TABLE 3

Leaf area ($cm^2$ $plant^{-1}$) at different growth stages in fodder maize as influenced by different source of irrigation and variable doses of fertilizer (RDF)

| Treatments | 20 DAS | 40 DAS | 60 DAS | At harvest |
|---|---|---|---|---|
| Mainplot | | | | |
| $I_1$ : Borewell water | 187.6 | 2817 | 3655 | 4126 |
| $I_2$ : Secondary treated wastewater | 251.0 | 3212 | 4258 | 4717 |
| $I_3$ : Tertiary treated wastewater | 231.3 | 3092 | 4112 | 4546 |
| Ftest | * | * | * | * |
| S.Em.± | 7.3 | 59.55 | 38.26 | 53.35 |
| CD @ 5% | 28.5 | 233.8 | 150.2 | 209.5 |
| Subplot | | | | |
| $F_1$ : 0 % RDF | 133.3 | 2333 | 2487 | 2895 |
| $F_2$ : 25 % RDF | 191.5 | 2970 | 3806 | 4201 |
| $F_3$ : 50 % RDF | 258.6 | 3292 | 4523 | 5013 |
| $F_4$ : 100 % RDF | 309.8 | 3567 | 5218 | 5742 |
| Ftest | * | * | * | * |
| S.Em.± | 9.2 | 63.38 | 52.45 | 61.27 |
| CD @ 5% | 27.4 | 188.3 | 155.8 | 182.0 |
| Interaction | | | | |
| $I_1F_1$ | 98.8 | 1995 | 2369 | 2553 |
| $I_1F_2$ | 131.4 | 2754 | 3226 | 3559 |
| $I_1F_3$ | 228.4 | 3077 | 4158 | 4961 |
| $I_1F_4$ | 291.6 | 3443 | 4866 | 5432 |
| $I_2F_1$ | 165.5 | 2560 | 2628 | 3161 |
| $I_2F_2$ | 225.7 | 3096 | 4146 | 4643 |
| $I_2F_3$ | 284.6 | 3483 | 4800 | 5101 |
| $I_2F_4$ | 328.3 | 3709 | 5459 | 5961 |
| $I_3F_1$ | 135.8 | 2444 | 2465 | 2972 |
| $I_3F_2$ | 217.5 | 3060 | 4045 | 4401 |
| $I_3F_3$ | 262.8 | 3316 | 4610 | 4977 |
| $I_3F_4$ | 309.3 | 3549 | 5330 | 5831 |
| Ftest | NS | NS | * | * |
| S.Em.± | 16.0 | 109.8 | 90.85 | 106.1 |
| CD @ 5% | 47.5 | 326.1 | 269.9 | 315.3 |

of NPK doses with irrigation treatments enhanced recorded higher SPAD values due to availability of additional nutrients by treated wastewater irrigation throughout the growing season. These results are line with Suhaibani *et al*., 2021.

The data on green seeker reading, stem girth (mm) and green fodder yield (q $ha^{-1}$) of fodder maize as influenced by different source of irrigation and variable doses of fertilizer application are presented in Table 5.

TABLE 4

SPAD readings of fodder maize as influenced by different source of irrigation and variable doses of fertilizer (RDF)

| Treatments | 20 DAS | 40 DAS | 60 DAS | At harvest |
|---|---|---|---|---|
| Mainplot | | | | |
| $I_1$ : Borewell water | 28.55 | 35.95 | 37.19 | 31.53 |
| $I_2$ : Secondary treated wastewater | 32.68 | 40.27 | 41.88 | 35.42 |
| $I_3$ : Tertiary treated wastewater | 31.78 | 39.00 | 40.56 | 34.28 |
| Ftest | * | * | * | * |
| S.Em.± | 0.70 | 0.81 | 0.87 | 0.39 |
| CD @ 5% | 2.75 | 3.18 | 3.40 | 1.53 |
| Subplot | | | | |
| $F_1$ : 0 % RDF | 25.10 | 30.78 | 31.69 | 26.52 |
| $F_2$ : 25 % RDF | 28.49 | 35.85 | 38.07 | 32.53 |
| $F_3$ : 50 % RDF | 33.38 | 41.25 | 42.90 | 35.28 |
| $F_4$ : 100 % RDF | 37.04 | 45.73 | 46.84 | 40.64 |
| Ftest | * | * | * | * |
| S.Em.± | 0.46 | 0.73 | 0.83 | 0.46 |
| CD @ 5% | 1.37 | 2.16 | 2.47 | 1.37 |
| Interaction | | | | |
| $I_1F_1$ | 22.67 | 27.30 | 27.63 | 22.32 |
| $I_1F_2$ | 25.40 | 33.37 | 36.03 | 30.50 |
| $I_1F_3$ | 31.90 | 39.15 | 40.80 | 33.50 |
| $I_1F_4$ | 34.23 | 43.96 | 44.28 | 39.80 |
| $I_2F_1$ | 27.07 | 33.25 | 34.33 | 29.29 |
| $I_2F_2$ | 29.20 | 37.37 | 39.37 | 33.23 |
| $I_2F_3$ | 35.13 | 43.27 | 44.93 | 37.03 |
| $I_2F_4$ | 39.33 | 47.20 | 48.87 | 42.13 |
| $I_3F_1$ | 25.57 | 31.80 | 33.10 | 27.97 |
| $I_3F_2$ | 30.87 | 36.81 | 38.81 | 33.87 |
| $I_3F_3$ | 33.10 | 41.34 | 42.98 | 35.30 |
| $I_3F_4$ | 37.57 | 46.03 | 47.37 | 39.98 |
| Ftest | NS | NS | NS | * |
| S.Em.± | 0.80 | 1.26 | 1.44 | 0.80 |
| CD @ 5% | 2.37 | 3.74 | 4.28 | 2.37 |

Irrigation with secondary treated wastewater recorded the significantly higher green seeker values (0.69) and stem girth (16.82 mm) at harvest as compared to borewell water irrigation (0.65 and 15.55 mm, respectively) and was on par with tertiary treated wastewater irrigation (0.68 and 16.48 mm, respectively). Significantly higher green seeker values (0.71) and stem girth (18.88 mm) observed at harvest with application of 100 per cent of RDF as compared to control (0.62 and 14.09 mm, respectively). Among different source of irrigation and different doses of fertilizers, secondary treated wastewater irrigation

TABLE 5

Green seeker readings, stem girth (mm) and green fodder yield (q $ha^{-1}$) at harvest of fodder maize as influenced by different source of irrigation and variable doses of fertilizer (RDF)

| Treatments | Green seeker readings | Stem girth (mm) | Green fodder yield (q $ha^{-1}$) |
|---|---|---|---|
| Mainplot | | | |
| $I_1$ : Borewell water | 0.65 | 15.55 | 442.7 |
| $I_2$ : Secondary treated wastewater | 0.69 | 16.82 | 497.0 |
| $I_3$ : Tertiary treated waste water | 0.68 | 16.48 | 480.7 |
| Ftest | * | * | * |
| S.Em.± | 0.01 | 0.15 | 5.71 |
| CD @ 5% | 0.02 | 0.57 | 22.42 |
| Subplot | | | |
| $F_1$ : 0 % RDF | 0.62 | 14.09 | 369.8 |
| $F_2$ : 25 % RDF | 0.65 | 15.08 | 430.4 |
| $F_3$ : 50 % RDF | 0.70 | 17.08 | 493.3 |
| $F_4$ : 100 % RDF | 0.71 | 18.88 | 600.5 |
| Ftest | * | * | * |
| S.Em.± | 0.01 | 0.16 | 4.68 |
| CD @ 5% | 0.02 | 0.48 | 13.91 |
| Interaction | | | |
| $I_1F_1$ | 0.58 | 13.01 | 320.9 |
| $I_1F_2$ | 0.62 | 14.28 | 417.1 |
| $I_1F_3$ | 0.69 | 16.69 | 459.6 |
| $I_1F_4$ | 0.71 | 18.22 | 573.3 |
| $I_2F_1$ | 0.66 | 14.66 | 397.8 |
| $I_2F_2$ | 0.67 | 15.26 | 445.4 |
| $I_2F_3$ | 0.70 | 18.00 | 521.8 |
| $I_2F_4$ | 0.72 | 19.36 | 623.1 |
| $I_3F_1$ | 0.63 | 14.60 | 390.8 |
| $I_3F_2$ | 0.65 | 15.69 | 428.7 |
| $I_3F_3$ | 0.70 | 16.56 | 498.4 |
| $I_3F_4$ | 0.72 | 19.07 | 605.0 |
| Ftest | * | * | * |
| S.Em.± | 0.01 | 0.28 | 8.11 |
| CD @ 5% | 0.03 | 0.83 | 24.09 |

with application of 100 per cent of RDF recorded significantly higher green seeker values (0.72) and stem girth (19.36 mm) at harvest as compared to borewell water irrigation with 100 per cent RDF (0.71 and 18.22 mm, respectively) and it was statistically on par with tertiary treated wastewater irrigation along with application of 100 per cent of RDF (0.72 and 19.07 mm, respectively). The increase in plant vigor in terms of height, number of functional leaves and their expansion application of full dose of NPK fertilizer along with the different treated wastewater irrigation found to be useful in utilizing the radiant energy more effectively thereby increased synthesis of carbohydrates, eventually increased the greenness and stem girth of plant (Galavi *et al.,* 2009 and Mousavi & Shahsavari, 2014).

Irrigation with secondary treated wastewater recorded the significantly green fodder yield (497.0 q $ha^{-1}$) and was on par with tertiary treated wastewater irrigation (480.7 q $ha^{-1)}$ as compared to borewell water irrigation (442.7 q $ha^{-1}$). Among the main treatments, significantly higher green forage yield recorded with secondary and tertiary wastewater mainly due to availability of additional nutrients, it was conformity with (Alghobar and Suresha, 2016 and Alkhamisi *et al*., 2011). Significantly higher green fodder yield was observed with application of 100 per cent of RDF (600.5 q $ha^{-1}$) as compared to control (369.8 q $ha^{-1}$). The fertilizer dose decreased, the rate of green fodder yields also decreased to the lowest, its amount in $F_1$ (without fertilizer application) treatment. It shows that fertilizer caused the increase of green fodder yield of fodder maize because of increasing availability of essential elements (NPK) for plant growth (Nanjudappa *et al*., 2000; Tavassoli *et al*., 2010 and Kumar *et al*., 2021).

Among the interaction of sources of irrigation and doses of fertilizers, Secondary treated wastewater irrigation along with application of 100 per cent of RDF recorded significantly higher green fodder yield (623.1 q $ha^{-1}$) as compared to borewell water irrigation with 100 per cent RDF (573.3 q $ha^{-1}$) and it was statistically on par with tertiary treated wastewater irrigation along with application of 100 per cent of RDF (605.0 q $ha^{-1}$). Green forage yield was affected significantly due to different fertilizer treatment. Significantly lower green fodder yield (320.9 q $ha^{-1}$) was recorded with the borewell water irrigation without application of recommended dose of fertilizers as compared to other treatments. The amount of N, P and K deposited in the soil was proportional to the amount of treated 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 treated wastewater contains essential nutrients for plant growth, such as N, P and K as well as micronutrients and also significant amount of organic matter. Furthermore, N is an essential constituent of amino acids and chloroplasts, which directly influence plant growth, leaf area and development through greater photosynthates, resulting in higher green fodder yield. It also attributed to the addition of nutrients with optimum soil moisture throughout the crop growth period (Suhaiban *et al.,* 2021 and Senthilkumar *et al*., 2021). Thus, treated wastewater is an important source of irrigation and nutrients for plants and protects the environment by reducing the leaching of excessive fertilizers into groundwater. But long-term study on pollutants and nutrients addition through use of different type of treated wastewater for production of crops needed.

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