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Residual effect of treated sugar mill effluent irrigation with nutrient management approaches on productivity of cowpea in maize-cowpea cropping system

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Abstract
A field experiment was conducted during *Rabi* 2016 to study the "Residual effect of treated sugar mill effluent irrigation with nutrient management approaches on productivity of cowpea in maize-cowpea cropping system" at M/s Chamundeshwari Sugars Limited, Maddur Taluk, Mandya district which is located in southern dry zone of Karnataka. The experiment was laid out in RCBD having twelve treatments and replicated thrice. The treatments consisting (preceeding maize crop) of T_1: Fresh water+ RDF (150: 75: 40 kg ha^{-1}), T_2: Fresh water+ STCR approach for targeted maize yield of 120 q ha^{-1}, T_3: Fresh water + Soil test based NPK recommendation, T_4: Fresh water + SSNM for targeted yield of 120 q ha^{-1}, T_5: TSME + RDF, T_6: TSME + STCR approach for targeted maize yield of 120 q ha^{-1}), T_7: TSME + Soil test based NPK recommendation, T_8: TSME + SSNM for targeted yield of 120 q ha^{-1}, T_9: TSME with amendment (Gypsum) + RDF, T10: TSME with amendment (Gypsum) + STCR approach for targeted yield of 120 q ha^{-1}, T_{11}: TSME with amendment (Gypsum) + Soil test based NPK recommendation, T_{12}: TSME with amendment (Gypsum) + SSNM for targeted yield of 120 q ha^{-1}. The results revealed that higher seed and haulm yields were noticed with residual effect of TSME irrigation with fertilizer application based on SSNM concept (955 seed yield and 3459 kg ha^{-1} haulm yield, respectively) along with RDF compared to other residual treatments.

Keywords: Cowpea, SSNM, STCR, treated sugar mill effluent

1. Introduction
Cowpea (*Vigna unguiculata*) is most widely grown as a pulse and vegetable crop in India. It contains 24.6 per cent protein. It plays an key role in maintaining the soil fertility. Worldwide cowpea is cultivated in an area of 8 million hectares. Area under cowpea in India is 3.9 m h with a production of 2.21 m t with the national productivity of 683 kg ha^{-1} (Mandal *et al.*, 2009) [11]. It is cultivated in an area of 1 lakh ha with a production of 0.4 lakh tonnes and productivity of 470 kg ha^{-1} in Karnataka (Anon. 2014) [1]. The important cropping systems practiced in India is maize-pulses system. The productivity of the system depends on proper nutrient management practices. Low organic matter content in soil coupled with low and imbalanced application of macro nutrients to the crop limits the full potential of yield (Ghosh *et al.*, 2003) [7]. Among the several approaches of soil test based fertilizer recommendation, Site Specific Nutrient Management (SSNM) and Soil Test Crop Response (STCR) approaches provide principles and tools for supplying crop nutrients as and when needed to achieve higher yield and are cost effective and plant need based approaches with specific yield target. Besides, these approaches increase the nutrient use efficiency, thus resulting in more net returns per unit of fertilizer applied. The present study was undertaken to study the use of waste water (treated sugar mill effluent water) in agricultural fieldsthat may be a viable method of disposal and would sustain agriculture in non-irrigated areas where the availability of fresh water is scarce (Kumar and Chopra, 2010) [9]. It reduces fertilizer and irrigation water cost as it is available without paying any cost and rich in various plant nutrients (Kumar and Chopra, 2012) [10].

2. Material and Methods
A field experiment was conducted at M/s Chamundeshwari Sugars Limited, Maddur Taluk, Mandya district during *rabi* 2016.

The pH of the soil was saline (8.25) and medium in available nitrogen (306 kg ha^{-1}), high in available phosphorous (61 kg ha^{-1}) and high in available potassium (325 kg ha^{-1}). The experiment was laid out in RCBD having twelve treatments and replicated thrice. The treatments of preceeding maize crop are T_1: Fresh water + RDF, T_2: Fresh water +STCR approach for targeted maize yield of 120 q ha^{-1}, T_3: Fresh water + Soil test based NPK recommendation, T_4: Fresh water + SSNM for targeted yield of 120 q ha^{-1}, T_5: TSME + RDF, T_6: TSME+ STCR approach for targeted maize yield of 120 q ha^{-1}, T_7: TSME + Soil test based NPK recommendation, T_8: TSME + SSNM for targeted yield of 120 q ha^{-1}, T_9: TSME with amendment (Gypsum) + RDF, T_{10}: TSME with amendment (Gypsum) + STCR approach for targeted maize yield of 120 q ha^{-1}, T_{11}: TSME with amendment (Gypsum) + Soil test based NPK recommendation and T_{12}: TSME with amendment (Gypsum) + SSNM for targeted yield of 120 q ha^{-1}. Cowpea C-152 variety was used for the study. Representative treated sugar mill effluent samples were collected from M/s Chamundeshwari Sugars Limited, Maddur Taluk, Mandya district. The samples were analyzed for various chemical properties.

The pH of treated sugar mill effluent was slightly alkaline in reaction (8.2). Electrical conductivity of 894µS/cm. The total N, P and K content was 3.88, 1.83 and 37.4 ppm, respectively. The Na and SO_4 concentration was 28 and 52 mg/l, respectively. The total suspended and dissolved solids (mg/l) were 30 and 650 mg/l, respectively. The chloride content of effluent was 92 mg/l. The values indicate that the parameters are well within the Karnatak State Polution Control Board (KSPCB) norms.

3. Results and Discussion

Significantly higher plant height of cowpea was recorded at 60 and 90 DAS with different nutrient management approaches under treated sugar mill effluent irrigation compared to RDF irrigated with fresh water. Treatment receiving fertilizer based on SSNM approach for targeted yield of 12 t ha^{-1} amended with gypsum under TSME recorded significantly higher plant height (35.53 and 34.68 cm, respectively) and it was on par with fertilizer application through STCR for targeted yield of 12 t ha^{-1} amended with gypsum under TSME over rest of the treatment combinations (34.64 and 33.43 cm, respectively). Significantly lower plant height of cowpea was noticed in RDF with fresh water (26.28 and 23.85 cm) (Table 1).

The plant height improved with increase in the rate of nitrogen, phosphorus and potassium application under treated sugar mill effluent water. This could be attributed to the relatively higher amount of nitrogen, phosphorus and potassium in the soil before sowing of cowpea crop. Further, the residual effect of the different nutrient approaches (SSNM and STCR) applied to the previous crop showed a favorable effect on plant height of succeeding cowpea compared to RDF with freshwater (Gabriel, 2010) [6].

It is clearly evident from the data that residual effect of treated sugar mill effluent with different nutrient approaches for a targeted yield had significant influence on number of branches per plant of cowpea at all the crop growth stages except at 60 and 90 DAS (Table 1). Fertilizer recommendation for a targeted yield of 12 t ha^{-1} based on SSNM approach amended with gypsum under TSME recorded significantly higher number of branches per plant (6.45 and 6.88, respectively) and it was on par with STCR fertilizer application for targeted yield of 12 t ha^{-1} amended with gypsum under TSME (6.62 and 6.45, respectively) over rest of the treatments. Significantly lower number of branches per plant of cowpea at harvest was recorded in RDF with fresh water (3.76 and 4.21, respectively). The superiority could be due to greater availability of major and micro nutrients added from treated sugar mill effluent water which in turn have led to acceleration of various metabolic activity. The improvement of above growth parameters in cowpea is associated with increase in nitrogen, phosphorus and potassium in the soil due to residual effect of different nutrient approaches (SSNM and STCR) and treated sugar mill effluent water application. Better crop growth recorded might be the result of adequate nutrients released by both inorganics and organics source as earlier reported by Babaji *et al.* (2011) [3].

Treatment receiving fertilizer based on SSNM approach for targeted yield of 12 t ha^{-1} amended with gypsum under TSME recorded significantly higher leaf area of cowpea at 60 and 90 DAS (1390 and 639 cm^2 $plant^{-1}$, respectively) (Table 1) and it was on par with fertilizer application through STCR for targeted yield of 12 t ha^{-1} amended with gypsum under TSME over rest of the treatment combinations (1385 and 623 cm^2 $plant^{-1}$, respectively). Significantly lower leaf area was noticed in RDF with fresh water (844 and 364 cm^2 $plant^{-1}$ respectively). The increased plant height and dry matter production under nitrogen, phosphorus and potassium fertilization due to greater meristermatic activity which have promoted better interception, greater canopy development, absorption and utilization of radiant energy with greater CO_2 fixation, leading to enhanced photosynthetic efficiency resulting in increased leaf area and dry matter production as observed by Abayomi *et al*. (2008) [2] and Stephen and Christopher (2014) [16].

At 60 and 90 DAS, fertilizer recommendation for a targeted yield of 12 t ha^{-1} based on SSNM approach amended with gypsum under TSME recorded significantly higher dry matter production of cowpea (36.20 and 45.61 g, respectively) and it was on par with STCR fertilizer application for targeted yield of 12 t ha^{-1} amended with gypsum under TSME over rest of the treatment combinations (34.28 and 43.28 g, respectively). Significantly lower dry matter production of cowpea was recorded in RDF with fresh water (17.58 and 27.26 g, respectively) (Table 2). Total dry matter production increased with residual effect of different nutrient approaches and treated sugar mill effluent irrigation due to increase in the plant size and cumulative effect of all the other growth parameters. This could be attributed to positive response of cowpea to the residues of applied fertilizers through inorganic (SSNM and STCR) and organic manures to preceding crop hybrid maize. The increased uptake of nutrients promoted growth along with dry matter production of succeeding crop cowpea, probably by promoting greater meristematic (increase in cell number and their elongation) and photosynthetic activities (Kalaiyarasan, 2011) [8].

At 60 and 90 DAS, fertilizer recommendation for a targeted yield of 12 t ha^{-1} based on SSNM approach amended with gypsum under TSME recorded significantly higher number of nodules per plant in cowpea (18.22 and 12.48, respectively) and it was on par with STCR fertilizer application for targeted yield of 12 t ha^{-1} amended with gypsum under TSME over rest of the treatment combinations (17.56 and 12.33, respectively). Significantly lower number of nodules per plant was recorded in RDF with fresh water (11.99 and 8.85, respectively) (Table 2).

Significantly higher number of pods $plant^{-1}$ (13.79) and seeds pod^{-1} (9.05) were recorded with residual effect of TSME with

SSNM approaches to previous maize crop than the other residual treatments combinations. However, lower values were observed with residual effect of RDF with fresh water (8.41 and 6.80, respectively) (Table 2 & 3). Higher plant height, leaf area and total dry matter production have contributed for significantly higher yield components like number of pods per plant and higher number of seeds per pod than other treatments due to higher nutrient availability in treatment receiving treated sugar mill effluent water and fertilizer application based on SSNM and STCR concepts. Perhaps, high uptake of nutrients viz. N, P, K, S and Zn promotes the growth as well as yield components. Further improvement in yield might be due to adequate supply of nutrients with fertilizers coupled with added nutrients from sugar mill effluent.

Higher seed and haulm yields were noticed with residual effect of TSME irrigation with fertilizer application based on SSNM concept (923 and 3116 kg ha^{-1}, respectively) of continuous treated SME irrigation along with RDF compared to other residual treatments (Table 3). This might be due to slow and steady nutrient releasing capacity of organics which had only 45 to 50 per cent impact on first crop but a good residual effect on the second crop. Narayana Reddy and Krishnaiah (1999) [12] reported that one ton of organic manure on an average supplied about 5-8 kg of N and K and 2 kg of P. Further, they stated that about one third of total N, half of total P were available to first crop and rest of N and P are available to the succeeding crop as residual effect. The positive response recorded on both seed and haulm yield of succeeding crop cowpea could be due to mineralization of nutrients, as a result of which better growth was achieved. Higher vegetative production in crop means higher interception of light and, therefore, more assimilate production that increase yield (Babaji *et al*., 2011) [3].

Significantly higher total nutrient uptake (N, P and K) by cowpea was noticed due to the residual effect of treatment receiving fertilizers recommendations based on SSNM (88.28, 15.01 and 64.90 kg ha^{-1}, respectively) for targeted yield of 12 t ha^{-1} amended with gypsum under TSME and it was found to be on par with fertilizer application through STCR targeted yield of 12 t ha^{-1} amended with gypsum under TSME (86.63, 14.44 kg ha^{-1} and 60.60 kg ha^{-1}, respectively) (Table 4). Whereas lower total uptake of N, P, K was noticed with RDF + fresh water (65.30, 18.15 and 44.60 kg ha^{-1}, respectively). Similar trend were noticed in seed and haulm uptake. The increase in nitrogen uptake in seed residual cowpea and haulm was higher due to increased availability of soil nutrients under SSNM and STCR approach to the previous maize crop and release of N from the treated sugar mill effluent water which is mediated by the increased microbial activity in organically amended soils. Thus, it resulted in increase in the nitrogen uptake by seed and haulm of cowpea. This finding was also confirmed by Dinesha (2014) [5] who reported that with the application of organic manure about one third of total N, half of total P are available to first crop and rest of N and P are available to the succeeding crop as residual effect.

The results are also in conformity with the findings of Yamagata and Otani (1996) [17] from Japan, who found that phosphorus uptake by soybean supplied with organic nitrogen was higher than control. Higher uptake of nitrogen, phosphorus, potassium, sulphur and zinc in cowpea crop might be due to increased addition of these nutrients because of residual effect of sugar mill effluent irrigation and ultimately it might have helped in the formation of more nodules, vigorous root development and better nitrogen fixation and over all development of plants. Similar results were also reported by Senthilraja (2010) [14] who found that increased uptake of N, P, K, Ca, Mg and zinc respectively were observed in irrigation with pure brewery waste water plot with vermicompost at 3.5 t ha^{-1} and recommended dose of NPK over the control.

Residual effect of treatment receiving fertilizer based on SSNM and STCR approach for targeted yield of 12 t ha^{-1} amended with gypsum under TSME recorded significantly higher available nitrogen (T_2: 299, T_4: 301, T_6: 261, T_8: 272, T_{10}: 250 and T_{12}: 255 kg ha^{-1}) compared to RDF with fresh water (223 kg ha^{-1}) (Table 5). The increase in soil available nitrogen content of soil could be ascribed to the increased organic matter and total nitrogen content of the soil. This might also be attributed to greater multiplication of beneficial microbes caused by addition of organic materials through effluent irrigation to convert organically bound nitrogen to inorganic form. Nitrogen in organic form is less prone to leaching and volatilization losses.

Residual effect of treatment (T_{12}) receiving fertilizer based on SSNM and STCR approach for targeted yield of 12 t ha^{-1} amended with gypsum under TSME to preceeding maize crop recorded significantly higher available P_2O_5 (T_2:51, T_4: 45, T_6: 41, T_8: 37, T_{10}: 36 and T_{12}: 33 kg ha^{-1}) compared to all the other treatments. Whereas, soil test based fertilizer recommendation (T_3: 20, T_7: 22, T_{11}: 23) and RDF (T_1: 28, $T_{5:}$ 20 and T_9: 23 kg ha^{-1}) recorded significantly lower available P_2O_5 after harvest of the cowpea crop (Table 5). The magnitude of increase in available P from preceding crop to succeeding crop might be due to the reason that only 45- 50 per cent of applied organic manures becomes available to the immediate crop and rest adds to the soil pool which increased the available P status of soil after the harvest of cowpea. The pooled P was efficiently utilized by the succeeding cowpea.

Sugar mill effluent contains considerably higher proportion of K and S that might have contributed to the soil pool and resulted in higher levels of potassium after harvest of cowpea. Similar results were also reported by Chatterjee *et al.* (2003) [4] and Singh and Roop Singh (2005); who reported that N, P, K and S availability and organic carbon content of soil were enhanced by effluent irrigation, though the EC and pH of the soil increased.

Significantly higher available K_2O was registered in treatment receiving fertilizer recommendation through SSNM approach for targeted yield of 12 t ha^{-1} amended with gypsum under TSME (T_4: 370, T_8: 451 and T_{12}: 441 kg ha^{-1}) compared to rest of the treatments. These results also corroborate the findings of Sajani and Muthukkaruppan (2011) [13] who reported that the soil polluted with sugar mill effluent had high amount of pH, electrical conductivity, nitrogen, phosphorus, potassium, copper, zinc, iron and manganese.

Table 1: Plant height (cm), number of branches per plant and leaf area (cm^2) of cowpea at different growth stages as influenced by residual effect of different nutrient management approaches and treated sugar mill effluent irrigation in maize-cowpea cropping sequence

Treatments	Plant height		Number of branches		Leaf area	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1	26.28	23.85	3.76	4.21	844	364
T_2	28.49	26.66	4.73	5.42	1275	459
T_3	27.04	25.03	4.63	5.10	1208	403
T_4	29.27	27.85	4.93	5.70	1323	500
T_5	30.04	28.87	4.03	5.12	1044	432
T_6	33.01	31.67	5.49	6.00	1314	569
T_7	31.04	29.36	4.80	5.55	1142	549
T_8	34.22	32.34	5.85	6.12	1339	591
T_9	31.41	30.94	5.34	5.90	1226	460
T_{10}	34.64	33.43	6.62	6.45	1385	623
T_{11}	32.05	31.37	5.64	6.10	1290	594
T_{12}	35.53	34.68	6.45	6.88	1390	639
S.Em±	0.95	0.41	0.20	0.17	28	10
CD @ 5%	2.85	1.22	0.60	0.50	84	30

Legend

T_1: Fresh water +RDF	T_7: TSME+ Soil test based (LMH)
T_2: Fresh water +STCR targeted yield 120 q ha^{-1}	T_8: TSME+ SSNM targeted yield 120 q ha^{-1}
T_3: Fresh water + Soil test based (LMH)	T_9: TSME + Gypsum + RDF
T_4: Fresh water + SSNM targeted yield 120 q ha^{-1}	T_{10}: TSME + Gypsum + STCR targeted yield 120 q ha^{-1}
T_5: TSME+ RDF	T_{11}: TSME +Gypsum + Soil test based (LMH)
T_6: TSME+ STCR targeted yield 120 q ha^{-1}	T_{12}: TSME +Gypsum + SSNM targeted yield 120 q ha^{-1}

Table 2: Total dry matter production, number of nodules per plant and number of pods per plant of cowpea at different growth stages as influenced by residual effect of different nutrient management approaches and treated sugar mill effluent irrigation in maize-cowpea cropping sequence

Treatments	Total dry matter production		Number of nodules $plant^{-1}$	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1: Fresh water +RDF	17.58	27.26	11.99	8.85
T_2: Fresh water +STCR targeted yield 120 q ha^{-1}	30.29	31.82	14.14	11.22
T_3: Fresh water + Soil test based (LMH)	22.04	29.63	12.52	9.85
T_4: Fresh water + SSNM targeted yield 120 q ha^{-1}	32.15	33.26	14.25	12.10
T_5: TSME+ RDF	22.45	34.81	12.55	10.02
T_6: TSME+ STCR targeted yield 120 q ha^{-1}	33.39	40.48	16.36	11.30
T_7: TSME+ Soil test based (LMH)	25.22	36.65	15.11	10.55
T_8: TSME+ SSNM targeted yield 120 q ha^{-1}	34.80	41.21	17.22	11.92
T_9: TSME + Gypsum + RDF	24.96	36.29	12.89	11.20
T_{10}: TSME + Gypsum + STCR targeted yield 120 q ha^{-1}	34.28	43.28	17.56	12.33
T_{11}: TSME +Gypsum + Soil test based (LMH)	28.18	38.22	16.97	11.81
T_{12}: TSME +Gypsum + SSNM targeted yield 120 q ha^{-1}	36.20	45.61	18.22	12.48
S.Em±	1.34	1.61	0.33	0.22
CD @ 5%	3.99	4.83	1.00	0.65

Table 3: Seed yield and haulm yield of cowpea as influenced by residual effect of different nutrient management approaches and treated sugar mill effluent irrigation in maize-cowpea cropping sequence

Treatments	Number of pods plant pod^{-1}	Number of seeds $plant^{-1}$	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index
T_1: Fresh water +RDF	8.41	6.80	608	2199	0.22
T_2: Fresh water +STCR targeted yield 120 q ha^{-1}	10.63	8.19	646	2314	0.22
T_3: Fresh water + Soil test based (LMH)	10.08	7.06	622	2224	0.22
T_4: Fresh water + SSNM targeted yield 120 q ha^{-1}	10.73	8.15	674	2416	0.22
T_5: TSME+ RDF	9.90	7.20	807	2853	0.23
T_6: TSME+ STCR targeted yield 120 q ha^{-1}	12.97	8.62	859	2915	0.24
T_7: TSME+ Soil test based (LMH)	11.36	8.27	839	2898	0.24
T_8: TSME+ SSNM targeted yield 120 q ha^{-1}	13.16	8.92	872	3037	0.23
T_9: TSME + Gypsum + RDF	10.60	8.47	838	2907	0.23
T_{10}: TSME + Gypsum + STCR targeted yield 120 q ha^{-1}	13.42	8.86	901	3061	0.23
T_{11}: TSME +Gypsum + Soil test based (LMH)	12.43	8.64	860	2988	0.21
T_{12}: TSME +Gypsum + SSNM targeted yield 120 q ha^{-1}	13.79	9.05	923	3116	0.23
S.Em+	0.30	0.10	15	48	0.01
CD @ 5%	0.89	0.30	45	144	NS

Table 4: Nitrogen, phosphorus and potassium uptake by seed and haulm of cowpea as influenced by residual effect of different nutrient management approaches and treated sugar mill effluent irrigation in maize-cowpea cropping sequence

Treatments	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	Seed	Haulm	Total uptake	Seed	Haulm	Total uptake	Seed	Haulm	Total uptake
T_1	31.34	33.96	65.30	3.75	4.40	8.15	20.50	24.10	44.60
T_2	35.64	38.62	74.26	4.35	5.10	9.45	24.90	29.30	54.20
T_3	33.71	36.51	70.22	3.98	4.68	8.66	23.20	27.20	50.40
T_4	37.76	40.90	78.66	4.53	5.31	9.84	27.10	31.80	58.80
T_5	35.16	38.10	73.26	4.69	5.51	10.20	22.80	26.70	49.50
T_6	39.14	42.41	81.55	5.64	7.62	12.25	26.70	31.30	58.00
T_7	36.03	40.63	76.66	5.19	5.40	10.59	25.20	28.40	53.60
T_8	40.07	45.19	85.26	6.63	6.91	13.54	29.50	33.20	62.70
T_9	36.56	41.22	77.78	5.59	5.81	11.40	24.50	27.60	52.10
T_{10}	40.72	45.91	86.63	7.08	7.36	14.44	28.50	32.10	60.60
T_{11}	37.27	42.02	79.29	5.99	6.23	12.22	26.50	28.90	54.50
T_{12}	41.49	46.79	88.28	7.35	7.66	15.01	30.50	34.40	64.90
S.Em+	0.33	0.36	0.73	0.27	0.12	0.33	0.67	0.80	0.67
CD @ 5%	1.00	1.07	2.20	0.80	0.35	1.00	2.0	2.4	2.00

Legend

T_1: Fresh water +RDF	T_7: TSME+ Soil test based (LMH)
T_2: Fresh water +STCR targeted yield 120 q ha^{-1}	T_8: TSME+ SSNM targeted yield 120 q ha^{-1}
T_3: Fresh water + Soil test based (LMH)	T_9: TSME + Gypsum + RDF
T_4: Fresh water + SSNM targeted yield 120 q ha^{-1}	T_{10}: TSME + Gypsum + STCR targeted yield 120 q ha^{-1}
T_5: TSME+ RDF	T_{11}: TSME +Gypsum + Soil test based (LMH)
T_6: TSME+ STCR targeted yield 120 q ha^{-1}	T_{12}: TSME +Gypsum + SSNM targeted yield 120 q ha^{-1}

Table 5: Available soil nitrogen, phosphorus and potassium after harvest of cowpea as influenced by residual effect of different nutrient management approaches and treated sugar mill effluent irrigation in maize-cowpea cropping sequence

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
	2016	2016	2016
T_1: Fresh water +RDF	223	28	261
T_2: Fresh water +STCR targeted yield 120 q ha^{-1}	299	51	210
T_3: Fresh water + Soil test based (LMH)	181	20	220
T_4: Fresh water + SSNM targeted yield 120 q ha^{-1}	301	45	370
T_5: TSME+ RDF	190	20	236
T_6: TSME+ STCR targeted yield 120 q ha^{-1}	261	41	235
T_7: TSME+ Soil test based (LMH)	161	22	234
T_8: TSME+ SSNM targeted yield 120 q ha^{-1}	272	37	451
T_9: TSME + Gypsum + RDF	182	23	271
T_{10}: TSME + Gypsum + STCR targeted yield 120 q ha^{-1}	250	36	222
T_{11}: TSME +Gypsum + Soil test based (LMH)	151	23	218
T_{12}: TSME +Gypsum + SSNM targeted yield 120 q ha^{-1}	255	33	441
S.Em+	1.9	0.9	2.7
CD @ 5%	5.6	2.6	8.1

4. Conclusion

The study indicated that treated sugar mill effluent irrigation with nutrient management approaches was promising in maintaining higher productivity of residual cowpea. Treatment receiving fertilizer recommendation based on SSNM/STCR for targeted yield of 12 t ha^{-1} amended with gypsum under treated sugar mill effluent irrigation to the preceding maize crop increased the growth, yield and yield components of cowpea. Also, it is noteworthy to mention that treated sugar mill effluent irrigation to the preceeding maize crop did not cause any adverse effect on the succeeding salt sensitive cowpea crop.

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