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Effect of saline-sodic sewage on the growth, yield and quality of cotto

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Abstract: Field experiment was conducted during 1999 to exploit the possibilities of recycling the open drain sewage by an integrated management approach. The sewage used was saline-sodic in nature and six treatments were employed. Apart from well water and raw sewage controls, treatments involving application of gypsum, alternating with well water and raw sewage were also included for the test crop of cotton (MCU 5). The results revealed that the attempt to neutralize the undesirable RSC of sewage by soil incorporation of gypsum was effective. This management practice produced high total dry matter and seed cotton yield of 4687 and 1847 kg ha^{-1} during winter representing 25.2 and 58.6 per cent increase in yield and 4612 and 1748 kg ha^{-1} during summer representing 47.9 and 55.2 per cent increase in yield over the control respectively.

Similar effect was also recorded in the treatment that involved sewage cum well water irrigation supplemented by gypsum. This treatments during both winter and summer, produced the total dry matter yield of 4636 and 4590 kg ha^{-1} and cotton yield of 1934 and 1828 kg ha^{-1} respectively.

Key words : Sewage, Quality, Cotton.

Introduction

Human waste, an abundant and regularly produced resource is recycled for several purposes. Its most common use are in agriculture for irrigation and crop fertilization, in aquaculture for fish production, application in forest lands and in land reclamation (Panicker, 1994).

In many parts of the world treated municipal waste water has been successfully used for the irrigation of various crops including agronomic (Feigin *et al.* 1984), horticultural (Neilsen *et al.* 1991) crops and commercial crops especially cotton (Day *et al.* 1981. However, interest in the use of treated sewage effluent has accelerated significantly in the developing countries from 1980 (Biswas, 1989).

Long term field experiments conducted at the National Environmental Engineering Research Institute (NEERI) with land application of untreate diluted, primary and secondary treated sewag effluent have shown that the use of untreate sewage significantly reduced the yield of crop viz. paddy, wheat, cotton and yield decreas ranged from 14-23 per cent as compared t treated sewage effluent (Juwarkar *et al.* 1990 Tiwari *et al.* (1996) reported that treated sewag application produced yield equal to tube we irrigated rice crop.

Materials and Methods

Field experiments were conducted in th NA 6 Eastern block - TNAU farm Coimbator with cotton MCU 5 as winter crop with si treatment *viz.* T_1 - irrigation with sewage alon (13 irrigations each to 5 cm depth). T_2 - alternat irrigation with sewage and well water (7 sewag irrigation and 6 well water irrigation). T_3 irrigation with sewage as in T_1 and gypsur

Table 1. Effect of sewage irrigation on drymatter production, branching and yield of

Parameters / Treatments	Drymatter production (kg ha^{-1})			No. of monopodia per plant		No. of sympodia per plant		Seed cotton yield (kg ha^{-1})			Seed yield (kg ha^{-1})			Lint yield (kg ha^{-1})		
	Win.	Sum.	Pooled	Win.	Sum.	Win.	Sum.	Win.	Sum.	Pooled	Win.	Sum.	Pooled	Win.	Sum.	Pooled
T_1 - Raw sewage	3745	3695	3720	2.16	2.09	17.51	16.19	1165	1126	1146	751.8	728.0	740.4	413.2	398.0	405.6
T_2 T_1 + Well water (alter.)	4574	4512	4543	2.50	2.38	24.80	23.12	1780	1694	1737	1121	1068	1095	659.1	626.4	642.8
T_3 T_1 + Gypsum	4687	4612	4650	2.74	2.60	26.76	24.64	1847	1748	1798	1136	1076	1106	710.9	671.8	691.4
T_4 Well water + NPK	4032	3976	4004	2.41	2.36	20.11	18.30	1782	1680	1731	1108	1039	1074	674.3	640.8	657.6
T_5 T_4 + Gypsum	3985	3922	3954	2.39	2.36	19.84	18.06	1647	1571	1609	1039	990.8	1015	607.9	580.1	594.0
T_6 T_2 + Gypsum	4636	4590	4613	2.68	2.52	25.61	24.12	1934	1828	1881	1170	1105	1138	764.1	723.2	743.7
SEd	24.32	21.64	18.89	0.124	0.089	1.14	0.953	42.4	45.6	43.8	25.1	32.9	29.2	27.9	31.1	25.6
CD (0.05)	51.83	46.12	40.26	0.264	0.190	2.43	2.03	90.4	97.3	93.3	53.6	70.1	62.3	59.6	66.3	54.6

Table 2. Effect of sewage irrigation on quality attributes of cotton

Parameters / Treatments	Seed index (g)		Lint index (g)		Ginning per cent		Fibre length (cm)		Seed oil content (%)	
	Win.	Sum.	Win.	Sum.	Win.	Sum.	Win.	Sum.	Win.	Sum.
T_1 - Raw sewage	6.22	6.20	3.42	3.39	35.47	35.35	30.64	30.51	22.60	22.50
T_2 T_1 + Well water (alter.)	6.80	6.85	4.00	4.02	37.03	36.98	33.85	33.86	21.80	21.62
T_3 T_1 + Gypsum	7.00	7.05	4.38	4.40	38.49	38.43	31.20	31.15	22.86	22.90
T_4 Well water + NPK	6.90	6.86	4.20	4.23	37.84	38.14	34.06	34.02	20.10	20.14
T_5 T_4 + Gypsum	6.70	6.74	3.92	3.95	36.91	36.95	33.96	33.96	21.94	21.90
T_6 T_2 + Gypsum	7.12	7.06	4.65	4.62	39.51	39.56	32.30	32.26	22.46	22.60
SEd	0.117	0.009	0.239	0.211	0.831	0.737	0.158	0.146	0.779	0.826
CD (0.05)	0.249	0.211	0.509	0.450	1.77	1.57	0.337	0.311	1.66	1.76

as amendment (amount of gypsum was arrived based on RSC of sewage and depth of irrigation water). T_4 - well water irrigation supplemented with recom-mended blanket N,P and K of 80-40-40 kg ha^{-1} and 12.5 t ha^{-1} of FYM. T_5 - treatment T_4 plus gypsum amendment. T_6 - treatment T_2 supplemented with gypsum. The experiment was laid out in randomized block design in four replication. Calculated quantity of gypsum was incorporated into soil at 30, 60 and 90 DAS for the relevant treatments. FYM, P and K were applied as basal and N in two splits, for T_4 and T_5 treatments. A total of 304 mm of rain was received during the crop period in 22 rainy days.

The same field experiment was repeated in the adjacent plot during summer season (Feb.96 to Aug.96). A total of 250 mm rain was received in 29 rainy days during the crop period.

The soil of the winter experimental site was clay loam in texture with pH and EC of 7.4 and 0.33 dSm^{-1} respectively with CEC of 29.06 cmol (P^+) kg^{-1}. The ESP was 12.60. The organic carbon content was low (0.83%) and the available N,P and K levels observed were 410, 15.2 and 360 kg ha^{-1} respectively. The DTPA extractable micronutrients and heavy metals were Zn (4.32), Cu (2.14), Fe (9.37), Mn (6.51), Pb (1.00), Cd (0.04), Cr (0.23), Co (1.14), Ni (0.88) and B (0.04) mg l^{-1}. The soil of the summer experimental site was clay loam in texture. The pH and EC values were 7.4 and 0.33 dSm^{-1} respectively. The soil contained CEC and RSC values of 29.33 cmol (p+) kg^{-1} and 12.55. The organic carbon was low (0.83 per cent) and the available N, P and K status recorded were 412, 15.2 and 362 kg ha^{-1} respectively.

The sewage used for irrigation during winter analysed at two stages of crop growth (sowing and flowering) and was saline-sodic with EC 3.41 and 3.44 dSm^{-1} and RSC valu of 3.74 and 3.40 m.e.L^{-1}, SAR observed w 11.49 and 11.21 and SSP was 69.93 and 69.1 respectively. The sewage used for irrigatio during summer analyzed at sowing and floweri also found to be saline-sodic. The pH w 8.47 and 8.40, EC was 3.70 and 3.6 dSm^{-1} and RSC values was 3.52 and 3.41 m. L^{-1} respectively. The other parameters such a SAR and SSP recorded as 11.42 and 11.7 and 69.75 and 70.73 respectively.

The well water used for irrigation fo the winter crop tested at sowing and floweri was found to contain pH values of 7.6 and 7.60 and EC values of 0.17 and 0.1 dSm^{-1} and RSC values of -5.93 and -6.1 m.e.L^{-1}. The SAR was 3.03 and 3.13, S was 44.57 and 43.12 at initial and floweri stages. The pH and EC value of the wel water employed for summer cotton was 7.6 and 7.68 and 0.156 and 0.146 dSm^{-1} initia and flowering stages. The RSC was -5.87 an -6.16 m.e.l^{-1}, SAR was 2.86 and 2.94 an SSP was 43.12 and 43.34.

Results and Discussion

1. Monopodial and sympodial branches

The monopodial and sympodial branche were found to be significantly influenced b differential treatments. The raw sewage irrigatio was found to significantly depress the plan monopodial and sympodial branches. The gypsun amended sewage irrigation treatment was associate with better soil environment for betterment o the above parameters. This finds support wit work of Ayers and Westcott (1977), Gupt (1977) and Ali *et al.* (1986).

2. Dry matter production and seed cotton yiel

The dry matter production which signifie the overall growth potential of the crop wa found to be significantly influenced by th

reatment differences. While the raw sewage aused significant growth depression, neutralizing he undesirable RSC through gypsum brought bout significant positive influence and this vas observed at all stages of crop growth. The dry matter recorded were 620, 1218, 2194 nd 3745 kg ha^{-1} for the former and 621, 1416, 2465 and 4687 kg ha^{-1} at 30, 60, 90 DAS and harvest stage for the winter crop whereas, this treatment recorded drymatter production of 605, 1389, 2410 and 4612 kg ha^{-1} for the progressively increasing growth stages for the summer crop. It may also be noted that alternative irrigation with sewage nd well water with gypsum also proved efficient n producing drymatter yields on par with wholly ewage irrigation with gypsum amendment.

3. *Seed cotton yield*

The seed cotton yield ranged from 1165 to 1934 kg ha^{-1} and the treatment differences were statistically significant. The sewage irrigation both wholly or partly (alternated with well water) along with gypsum rated better with mean yield values of 1847 and 1934 in relation to 1165 to 1782 kg ha^{-1} in others. The other three treatments remained on par. The use of raw sewage without supplementation either gypsum or well water was associated with the least seed cotton yield of 1165 kg ha^{-1} recorded in winder cotton.

In summer crop, the seed cotton yield ranged from 1126 to 1828 kg ha^{-1} and the treatment differences proved statistically significant. The treatments sewage irrigation with gypsum and also along with alternate well irrigation was best with mean yield values of 1748 and 1828 in comparison to 1126 to 1694 kg ha^{-1} in others. The raw sewage irrigation yielded least seed cotton of 1126 kg ha^{-1}.

4. *Quality parameters*

The important quality attributes namely ginning percentage, seed and lint index, fibre length were found to be significantly depressed with unamended raw sewage irrigaton. However, amending with gypsum and using sewage wholly or party could account for significant improvement in the above quality. The conventioanl blanket method also produced cotton of same quality as that of above focus treatment. Similar observations were also reported by Gupta (1977) and Ray and Khaddar (1991).

5. *Oil content*

All sewage involving treatments with and without gypsum and alternated well water could ensure significantly higher oil content in the seeds. While the conventional blanket recommendation of well water plus, N, P and K registered an oil content value of 20.1 per cent, the above treatment showed a range of 21.8 to 22.6 per cent in winter crop. Where as in summer cotton, oil content in the seeds with range value of 21.6 to 22.9 per cent. While the conventional well water plus blanket method treatment observed an oil content value of 20.1 per cent.

II. Pooled analysis of winter + summer season crops

In the present investigation cotton crop was raised improving six differential treatments and the experiment was carried out for two seasons during winter 1995 and summer 1996. In order to have an idea of more refined effect of the treatment on the seed cotton yield a pooled analysis was performed for total dry matter production, seed cotton yield, seed and lint yields.

1. Seed cotton yield

The yield for the different treatments ranged from 1146 to 1881 kg ha^{-1}. While the raw sewage recorded the least yield of 1146 kg ha^{-1}, amending it by way of gypsum or managing it by way of alternating with well water cum gypsum brought about pronounced improvement in the yield.

The above treatments recorded 1881 and 1798 kg ha^{-1} representing 8.67 and 3.87 per cent increase in yield over blanket recommendation (T_4) and 64.14 and 56.89 per cent increase in seed cotton yield over raw sewage irrigation (T_1). The other three treatments also brought about significant improvement in the yield over raw sewage irrigation with the magnitude of increase being 40.40 to 51.57 per cent. The same trend was observed for lint and seed yields as well.

2. Dry matter production

The dry matter yield of different treatments ranged from 611 to 680, 1207 to 1489, 2163 to 2438 and 3720 and 4650 kg ha^{-1} during 30, 60, 90 DAS and harvest stage of plant respectively. The raw sewage irrigation registered the least yield. The two treatments namely gypsum supplemented sewage cum well water and sewage recorded markedly higher dry matter production. The other treatments also brought about significant improvement in the dry matter production over raw sewage irrigation.

Thus, the trend of results in terms of drymatter as also the seed cotton yields go in favour of alternate irrigation with well-sewage irrigation. Next in rank was the complete sewage irrigation with more gypsum, the only necessary condition in either case was neutralization of the unfavourable RSC by equivalent gypsum addition. Such a beneficial effects may be ascribed to an array of reasons. The foremost and first among these is the enrichment of the soil with partially/fully decomposed organic matter. Setting aside the well known direct and indirect benefits of the above organic matter, the nutritive value adds further to the phenomena. The fact that the sewage is a rich source of various nutrients inclusive of the micronutrients has been well indicated. Considering this indepth what is perhaps happening under sewage irrigation is the detrimental effect of high BOD and COD/RSC operating on one side and beneficial effect of organic matter enrichment/fertility supplementation occurring on the other. Once the ill-effect o RSC is overcome by gypsum the beneficia effect became well manifested and perhaps thi has been well demonstrated in this experiment Moreover cotton is a crop that can withstan salinity but not the sodicity. So the neutralizatio of the sodicity brought aout significant an substantial favourable effect. This is inline wit the findings of Joshi and Dhir (1994) an Minhas *et al.* (1995) who reported gypsu application under sodic water increased cotto yield.

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