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UTILITY OF CITY WASTEWATER AS A SOURCE OF IRRIGATION WATER FOR MUSTARD

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ABSTRACT

A pot experiment was conducted during rabi season of 2003-2004, to study the effect of two concentrations of city waste water i.e. 50% WW and 100% WW over ground water on the performance of *Brassica juncea* cv. Varuna. In addition to this the crop was also supplied with different doses of potassium i.e. K0, K10, K20 and K30 kg ha 1 with a uniform basal dose of 80 kg N ha 1 and 30 kg P ha 1. Since city wastewater contained sufficient amount of nutrients when compared to groundwater, thus gave better response for leaf area, photosynthetic rate, stomatal conductance, photosynthetic water use efficiency, leaf NPK contents and seed yield of mustard where an increase of 13.23% was recorded by 100% wastewater over ground water. Physic-chemical characteristics of wastewater met the irrigation quality requirements and most of them were within the permissible limits of FAO 1994. Among various doses of potassium K20 proved optimum K10 deficient & K30 proved as luxury.

INTRODUCTION

The pollution of fresh water is increasing at an alarming rate due to steady increase in industrialization and urbanization. Disposal of industrial waste, human waste, including sewage in fresh water bodies causes serious health hazards. Land application of wastewater, though old age practice is diverted towards source of irrigation, as recycling of wastewater supplies the nutrients of fertilizing value (Soumare, 2003) in addition to reducing the burden on groundwater in crop cultivation at various places. Several studies have already been conducted at Aligarh (Khan *et al*. 2003; Javid *et al*. 2006) and one such study was undertaken on mustard so as to minimize the use of inorganic fertilizer and to save fresh water from degradation, because Indian mustard (*Brassica juncea*) is the second most popular edible oil seed crop next to groundnut and country has about 25% of world acreage and 14% of production, ranking 4th in the world (Bojaria, 2000).

MATERIALS AND METHODS

A pot experiment conducted in the net house of the Department of Botany during the rabi season of 2003-2004. Earthen pots of 12" diameter were filled with the mixture of sandy loam soil and organic manure (3:1 ratio) @ 7kg soil pot 1. Five seeds were sown in each pot, after the establishment of seedlings, thinning was done and only one healthy looking plant of more or less uniform size was retained in each pot. Pots were watered on alternate days with 250 mL of water. City wastewater which was a mixture of sewage water, industrial wastewater and household wastewater was collected from a drain commonly in use for the cultivation of various crops located at Aligarh Mathura road, tap water was used as groundwater, whereas for 50% wastewater both the waters were mixed in the ratio of 1:1. All the irrigants were analysed for various physico-chemical properties APHA (2000), whereas the procedures of Ghosh et al. (1983) were followed for soil analysis. For physiological parameters like photosynthetic rate, photosynthetic water use efficiency, stomatal conductance, leaf area and leaf NPK contents, plants were observed at 50, 70 and 90 DAS (i.e. vegetative, flowering and fruiting stages) in three replicates. Portable photosynthetic system LiCOR 6100 was used for the measurement of photosynthetic rate and stomatal conductance. Photosynthetic water use efficiency was calculated by dividing photosynthetic rate by stomatal conductance. Leaf area was calculated with the help of leaf area meter (LA 211, Systronics, New Delhi). For estimating the total N content the method of Lindner (1944) were followed, for phosphorus estimation the method of Fiske and Subba Row (1925) was used whereas potassium was studied spectrophotometrically. Since Aligarh is famous for electroplating industries so the water was tested for a few metals i.e. Cd, Cr, Ni and Pb. Heavy metals were estimated with the double beam atomic absorption spectrophotometer. Seed yield was taken at the time of harvest. All the data was analysed statistically Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Waste water proved a good source of nutrients (Table 1) especially NPK. Higher BOD and COD was found in wastewater determining its pollution strength. Soil also showed favourable pH and presence of some essential nutrients. In the present study city wastewater proved superior to ground water and in general 100% wastewater gave better results over groundwater in comparison to 50% wastewater. Since 100% wastewater prove better which may be because of the reason that the drain is far away from the source and gets diluted at several places. The former recorded an increase of 13.21%, 9.45%, 12.42% in photosynthetic rate, 5.87%, 3.13%, 3.57% in stomatal conductance, 6.73%, 6.00%, 8.10% in photosynthetic water use efficiency, 8.26%, 10.74%, 13.85% in leaf area, 3.86%, 9.32%, 6.98% in total leaf nitrogen content

whereas an increase of 10.91%, 11.74%, 10.84% and 8.81%, 13.35% 11.17% was observed in lead phosphorus and leaf potassium content at 50, 70 and 90 DAS respectively. A significant increase of 13.23% was also observed in the seed yield by 100% wastewater over groundwater (Table 3). Further, among various doses of potassium K20 proved to be optimum as its values were at par to K30. The increase in above mentioned parameters by wastewater application may be due to presence of some essential nutrients like N, P, K, Ca, Mg, S, Cl which are essential, for the growth of a crop. Mention may be made of N which has well established role in cell division, elongation, expansion and differentiation and also in biochemical reactions (Gardner *et al*. 1985), leading to increased growth and leaf area and thus allowing the plants to trap maximum solar energy for biomass production. Phosphorus being an essential component of ATP and NADPH, thus strongly affects photosynthesis and carbon partitioning in light dark reactions, it also reduces leaf expansion, leaf surface area, and number of leaves as observed in soybean (Fredeen et al., 1989). While considering potassium, in addition to increasing leaf area, it affects photosynthesis via its regulation in stomatal conductance while Mg

Table 1

Chemical properties of ground water (GW), 50% city waste water (50% CWW), 100% city waste water (100% CWW) and physico-chemical characteristics of soil before sowing in 1: 5 (soil : water extract). All determinations in mg L^{-1} or as specified.

Determinations	Water GW50%	CWW 100%	CWW	Soil Determinations	
EC (µmhos cm 1)	740	870	1020	Texture	Sandy loam
TS	9.88	1451	2480	CEC (meq 100g $^{-1}$ soil)	3.42
TDS	540	858	1410	pH	7.60
TSS	448	593	1070	Organic carbon (%)	8.50
pH	7.8	7.0	6.9	NO3-N (g kg $^{-1}$ soil)	3.22
BOD	17.34	76.18	140.32	Phosphorus (g kg $^{-1}$ soil)	0.115
COD	42.32	157.34	361.12	Potassium	16.00
NO_3-N	0.80	3.61	8.01	Calcium	30.90
PO^-_4	0.76	1.31	1.90	Magnesium	18.81
K	8.39	13.24	19.91	Sodium	13.32
Ca	28.12	85.34	152.48	Carbonate	18.64
Mg	18.32	69.42	132.13	Sulphate	109.76
Cl	71.42	101.18	136.17	Carbonate	16.24
CO^-_3	18.16	48.14	96.84		
HCO_3	64.16	192.43	374.12		
Heavy Metals in waste water					
		0.005			
		0.043			
		0.496			
		0.035			

Table 2

Effect of ground water, 50% waste water and 100% waste water on leaf area, photosynthetic rate, stomatal conductance and photosynthetic water use efficiency of *Brassica juncea* grown under four levels of potassium.

Treatments	Leaf area (cm2 plant $^{-1}$)			Photosynthetic rate (µ mL (CO_2) m $^{-2}$ s $^{-1}$)			Stomatal conductance (mol m $^{-2}$ s $^{-1}$)			Photosynthetic water use efficiency (µ mol mol $^{-1}$)		
	GW	50%WW	100%WW	GW	50%WW	100%WW	GW	50%WW	100%WW	GW	50%WW	100%WW
						50 DAS						
K0	284.16	298.34	304.90	14.86	15.83	16.18	0.318	0.326	0.341	46.73	47.11	47.44
K10	316.57	352.26	359.17	16.93	18.16	19.04	0.350	0.365	0.372	48.37	51.12	51.18
K20	367.72	389.41	400.13	19.85	22.01	23.17	0.378	0.385	0.400	52.51	57.17	57.93
K30	382.89	396.62	398.8	20.73	22.45	23.51	0.386	0.386	0.403	53.70	58.16	58.34
CD at 5%	NS			0.45			0.005			1.12		
						70 DAS						
K0	371.44	388.23	401.53	19.31	20.64	21.10	0.347	0.358	0.361	55.65	57.65	58.45
K10	428.77	479.06	493.51	21.73	23.11	23.64	0.370	0.382	0.389	58.73	60.49	60.77
K20	506.81	557.24	562.12	24.19	25.64	26.88	0.406	0.413	0.418	59.58	62.09	64.31
K30	518.21	564.28	564.00	24.89	26.04	27.01	0.411	0.415	0.415	60.56	62.75	65.08
CD at 5%	11.5			0.98			0.006			1.74		
						90 DAS						
K0	321.37	348.16	357.40	16.13	17.01	17.92	0.340	0.347	0.350	47.44	49.02	51.20
K10	375.46	418.04	436.25	18.44	19.68	20.06	0.354	0.363	0.369	52.09	54.21	53.36
K20	442.42	494.31	508.38	21.38	23.81	24.68	0.378	0.386	0.392	56.56	61.68	62.96
K30	461.28	510.23	520.08	22.00	24.26	24.68	0.385	0.390	0.369	57.14	62.21	63.01
CD at 5%	10.16			0.81			0.009			1.65		

Table 3

Effect of ground water, 50% waste water and 100% waste water on leaf nitrogen, phosphorus, potassium contents and seed yield of Brassica juncea grown under four levels of potassium.

Treatments	Total leaf N content (%)			Total leaf P content (%)			Total leaf K content (%)			Seed yield (g plant $^{-1}$) Harvest		
	GW	50%WW	100%WW	GW	50%WW	100%WW	GW	50%WW	100%WW	GW	50%WW	100%WW
				50 DAS								
K0	3.25	3.34	3.46	0.458	0.480	0.496	3.22	3.42	3.50	6.98	7.13	7.52
K10	3.60	3.80	4.03	0.513	0.564	0.584	3.65	3.80	4.08	7.83	8.21	8.56
K20	4.80	4.44	4.51	0.604	0.677	0.680	4.20	4.36	4.58	7.83	9.82	10.25
K30	4.26	4.56	4.56	0.623	0.680	0.680	4.36	4.50	4.64	8.50	9.90	10.30
CD at 5%	0.195			0.012			0.084			0.24		
						70 DAS						
K0	2.91	3.05	3.15	0.420	0.440	0.457	2.95	3.13	3.36			
K10	3.21	3.48	3.61	0.483	0.536	0.550	3.25	3.62	3.75			
K20	3.75	4.00	4.17	0.564	0.620	0.635	3.89	4.29	4.41			
K30	3.83	4.04	4.06	0.578	0.629	0.641	4.00	4.36	4.42			
CD at 5%	NS			NS			0.078					
						90 DAS						
K0	2.78	2.92	3.03	0.401	0.420	0.432	2.89	3.08	3.17			
K10	3.29	3.56	3.70	0.465	0.506	0.524	3.25	3.51	3.67			
K20	3.77	3.91	3.98	0.537	0.582	0.609	3.84	4.19	4.32			
K30	3.90	3.99	4.01	0.554	0.598	0.603	3.96	4.24	4.36			
CD at 5%	0.095			0.013			0.067					

is the central atom of chlorophyll molecule.

Since yield is the final manifestation of morphological, physiological and biochemical traits of a crop, improved photosynthesis and favourable partitioning of photosynthates would have contributed to higher seed yield. These findings are in accordance with the findings of Shah *et al.* (2005). It is significant to note that wastewater application reduced the dosage of potassium by 10 kg ha 1 as 20 kg ha 1 proved adequate in comparison to 30 kg ha 1 which was commonly observed at Aligarh. It may because of presence of sufficient K which was slightly more than the double of groundwater and thus benefited the crop not only due to its own physiological role (Wolf et al., 1976) but also by enhancing the effect of N.

CONCLUSION

Overall, waste water proved beneficial for enhancing the yield of mustard. Among two different concentrations 100% wastewater proved better which indicates that this wastewater is suitable for crops without any dilution, thus fulfilling the objective of saving inorganic fertilizers and fresh water. All the heavy metals tested except Ni were within the permissible limits.

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