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Impact of sewage water irrigation on nutrient contents, heavy metal accumulation and yield of chickpea in peri urban areas of Nagpur district

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Abstract
The experiment was conducted on farmers field in the villages who are in close vicinity of Nag River of Nagpur district in relation to study on "Impact of sewage water irrigation on nutrient contents, heavy metal accumulation and yield of chickpea" in Rabi season during 2022-2023. The N, P, K contents and yield of chickpea found higher in sewage water irrigated chickpea as compared to well water irrigated one. In sewage water irrigated chickpea heavy metals (Cd, Cr, Pb and Co) accumulation was higher than that of well water irrigation.

Keywords: Sewage water, nutrient status, yield and heavy metals accumulation

Introduction
Gram is most important pulse crop. Gram is king of pulses as it has highest genetic yield potential among all the pulses. In India, Gram is grown over an area of 114.95 lakh ha with total production 112.29 lakh tonnes with an average productivity of 1399 kg ha^{-1}. In Maharashtra, gram is grown over an area of 25.25 lakh ha with production of 27.97 lakh tonnes with an average productivity of 1074 kg ha^{-1} (Anonymous 2023) [2]. In Nagpur, Gram is grown over an area of 4.4 thousand-hectare with production of 57.6 thousand tonnes and the productivity is 481 kg ha^{-1} (www.agricoop.nic.in 2022-23). Sewage water may have high concentration of heavy metal such as Cd, Ni, Pb and Cr. The benefits of sewage water use in irrigation are numerous, but precautions should be taken to avoid short and long-term environmental risks. Domestic wastewater contains essential plant nutrients such as N, P, K and micronutrient which are beneficial for plant growth. (Kharche *et al.* 2011) [6].

Materials and Methods
The study was conducted in Nagpur district of Maharashtra (India) during the years 2022-23. Farmers were selected from different villages in the vicinity of Nag River, who are cultivating crop continuously with raw sewage irrigation since 25-30 years. Accordingly, the farmer's field was demarcated. Each treatment is replicated for the 5 farmers in the villages of Narsara, Vihirgaon, and Bahadura. Total twenty plant samples each were collected from the different locations of three villages. The experiment was laid out in Randomized Block Design with four treatments and five replications. The treatment consists of T_1 (Sewage water irrigation through drain with natural vegetative barrier 0-200 m distance from source), T_2 (Sewage water irrigation through drain with natural vegetative barrier 200-400 m distance from source), T_3 (Sewage water irrigation through direct pipeline), T_4 (Well water irrigation in the vicinity of Nag River).
The result was tabulated and subjected to statistical analysis by Gomez and Gomez (1984) [3]. Total nitrogen was estimated by Kjeldahl's method as described by Piper (1966) [11]. Total phosphorus was determined by Vanado-molybdate yellow colour method as described by Jackson, (1967) [4]. Total potassium was estimated by Di-acid extract on flame photometer method as described by Jackson, (1967) [4]. Micronutrients and heavy metals Fe, Mn, Zn, Cu, Pb, Cr, Cd, and Co were determined using Atomic Absorption Spectrophotometer from the above digested solution (Page *et al.*, 1982) [9].

The initial status of sewage water pH was found in the range between (6.83-7.27), EC (0.89-0.98 dS m^{-1}), CO_3^- and HCO_3^- (0.30-0.34 and 2.90-3.15 me L^{-1}), Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+, and K^+ were ranged from (5.13-6.27, 4.20-5.99, 3.35-3.95, 1.19-1.58, 3.16-3.61 and 0.31-0.63 me L^{-1}), micronutrients *Viz*., Fe, Mn, Zn and Cu (1.47-2.42, 0.28-0.41, 0.41-1.31 and 0.21-0.35 mg L^{-1}) and heavy metals *viz*., Cd, Cr, Pb and Co were ranged from (0.017-0.026, 0.11-0.21, 0.016-0.024 and 0.054-0.061 mg L^{-1}).

Results and Discussion

Table 1: Effect of sewage water irrigation on heavy metals content in chickpea

Treatments	N (%)		P (%)		K (%)		Yield (q ha^{-1})	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
T_1: Sewage irrigation through drain with natural vegetative barrier (0-200 m distance from source)	3.27	0.83	0.51	0.28	1.22	1.57	16.31	32.16
T_2: Sewage irrigation through drain with natural vegetative barrier (200-400 m distance from source)	3.25	0.82	0.45	0.23	1.16	1.49	16.26	32.07
T_3: Sewage water irrigation through direct pipeline	3.43	0.83	0.56	0.34	1.29	1.65	17.82	33.38
T_4: Well water irrigation in the vicinity of Nag river	3.21	0.81	0.39	0.17	1.10	1.45	15.86	31.94
SE (m) ±	0.023	0.020	0.016	0.014	0.017	0.020	1.35	1.55
CD at 5%	0.72	-	0.049	0.042	0.051	0.060	-	-

Table 2: Effect of sewage water irrigation on heavy metals content in chickpea

Treatments	Cd (mg kg^{-1})		Cr (mg kg^{-1})		Pb (mg kg^{-1})		Co (mg kg^{-1})	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
T_1: Sewage irrigation through drain with natural vegetative barrier (0-200 m distance from source)	0.30	0.05	1.37	0.050	0.28	0.06	0.35	0.07
T_2: Sewage irrigation through drain with natural vegetative barrier (200-400 m distance from source)	0.26	0.03	1.20	0.023	0.24	0.03	0.33	0.06
T_3: Sewage water irrigation through direct pipeline	0.34	0.07	1.49	0.062	0.32	0.09	0.36	0.09
T_4: Well water irrigation in the vicinity of Nag river	0.17	0.02	0.64	0.018	0.20	0.02	0.28	0.05
SE (m) ±	0.011	0.001	0.014	0.001	0.010	0.002	0.014	0.002
CD at 5%	0.030	0.003	0.035	0.003	0.030	0.005	0.044	0.006

Results and Discussion

The result was presented in Table 1 and Table 2. revealed that, the N, P and K contents in chickpea seed was found significantly more with sewage water irrigation through direct pipeline *viz*. 3.43, 0.56 and 1.29 (%) respectively followed by other irrigation treatments and found lower in well water irrigated chickpea which was 3.27, 0.51 and 1.22 respectively and in straw of chickpea P and K contents was obtained significantly higher in sewage water irrigation through direct pipeline *viz.* 0.34 and 1.65 (%) respectively and nitrogen content of straw was found non- significant which is 0.83% and in well water N, P and K content was obtained comparatively lower i.e. 0.81 0.17 and1.45% respectively. Similar results were noted by Paul *et al.* 2006 [10]. Effect of different treatments of irrigation has non-significant influenced over yield of chickpea. Higher seed yield (17.82 q ha^{-1}) was recorded in treatment with sewage irrigation through direct pipeline. Whereas, Lower seed yield (15.86 q ha^{-1}) was found in well water irrigated chickpea. These results are also similar with Singh *et al.* 2012 [12], Kiran *et al.* 2012 [5] and Nischita Gowda *et al*. 2020 [8]. In seeds of chickpea the heavy metals (Cd, Cr, Pb and Co) were found higher in treatment with sewage water irrigation through direct pipeline i.e. (0.34, 1.49, 0.33 and 0.36 mg kg^{-1}) respectively and in straw heavy metals (Cd, Cr, Pb and Co) were found maximum in treatment with sewage water irrigation through direct pipeline i.e. (0.07, 0.062, 0.09 and 0.09 mg kg^{-1}) respectively. These similar results were observed in Mhaske *et al.* 2021 [7] and Singh *et al* 2012 [12].

Conclusion

Sewage water irrigation improves the nutrients status in crop but increases the heavy metal accumulation in plants due to long term use of sewage irrigation. This warrants the potential hazard to soil and plants health. Sewage water irrigation has no influenced on yield of chickpea.

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