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Effect of sewage water irrigation on soil health in peri-urban areas of Guntur, Andhra Pradesh

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Abstract
An investigation entitled "Effect of sewage water irrigation on soil health in peri-urban areas of Guntur, Andhra Pradesh" was carried out in Guntur during 2018-19. The soils irrigated with sewage water was collected twice (pre-monsoon and post-monsoon) from four villages viz., Narakoduru, Vejendla, Chebrolu and Selapadu in Guntur district and analysed for pH, Electrical Conductivity, Macronutrients, DTPA extractable micronutrients and heavy metals. The soils were slightly alkaline in nature. The parameters studied in this work varied among the villages and a significant increase in macronutrients was reported in almost all the samples. Accumulation of micronutrients and heavy metals was reported in the soil samples studied.

Keywords: Sewage water irrigation, macronutrients, micronutrients and heavy metals

Introduction

Water is a finite and vital resource which is limiting now-a-days. In some areas where the sources of fresh water irrigation are unavailable, farmers use sewage contaminated water for irrigating their fields. In fact, 20 million hectares of land is being irrigated with waste water in the world and waste water irrigated areas account for about 10% of total food production (Raychaudhuri *et al*., 2017) [7]. India produce more than 62,000 mld (million litres per day) waste water from various cities and towns having treatment capacity of about 27% leaving more than 70% of waste water untreated (CPCB, 2009) [3].

Sewage from municipal origin contains both major essential plant nutrients and micronutrients. Waste water irrigation shows a significant increase in fertility of the soil (Jayadev and Puttaih, 2012) [4]. Though sewage water irrigation acts as a rich source of nutrients to soil, increasing its fertility, there is a major risk of heavy metal contamination in the environment. Heavy metals cannot be removed completely from sewage water even after treatment, causing a risk of heavy metal contamination in soils, plant and water sources. Sharma *et al.* (2006) [9] reported that prolonged use of sewage waste water for irrigation caused an excessive accumulation of heavy metals in agricultural soils that contaminates soil profile. This in turn affects food chain causing its contamination due to potential accumulation of these heavy metals. Crops grown on contaminated soils of peri-urban areas become saturated with heavy metals as they act as bio-sinks and accumulate these metals in their tissues (Bhatia *et al.,* 2015) [2]. Bioaccumulation of heavy metals in vegetables, fruits may cause health risks on consumption. In this context, the present study was undertaken to access the effect of sewage water irrigation on soil health in peri-urban areas of Guntur, Andhra Pradesh.

Materials and methods

The soil samples were collected twice (in the month of August, 2018 during pre-monsoon season and in the month of January, 2019 during post-monsoon) from four peri-urban villages *viz.,* Narakoduru, Vejendla, Chebrolu and Selapadu where sewage water was used for irrigation and a freshwater irrigated area (check) in Guntur district at a depth of 15 cm. Soil samples were processed and analysed for pH; Electrical Conductivity; macronutrients (Available Nitrogen, Available Phosphorus, Available Potassium, Sulphur, Calcium, Magnesium); DTPA extractable micronutrients (Zinc, Iron, Copper, Manganese) and heavy metals (Cadmium, Chromium, Nickel and Lead).

The soil pH was determined in 1:2.5 soil-water extract (20 g soil in 50 ml of distilled water) using a combined glass electrode and a digital pH meter (model. Systronics μ pH System 362). The Electrical Conductivity of soil was measured in the supernatant collected from 1:2.5 ratio

soil-water suspension with an EC bridge (model Elico, CM 180). Organic Carbon (OC) content of the soil was estimated by wet digestion method given by Walkey and Black (1934) [14]. Available Nitrogen content of the soil was estimated by alkaline permanganate method (Subbaiah and Asija, 1956) using Kelplus automatic nitrogen distillation unit (KELVAC-VA). Available phosphorus in the soil was determined by ascorbic acid method (Watanabe and Olsen, 1965) [15].
Available Potassium was estimated in soil extract prepared by using neutral normal ammonium acetate in 1:5 ratio by shaking and filtration (Schollenberger and Simon, 1945) [8]. The readings were recorded using flame photometer (model. Systronics flame photometer 128). Available sulphur in the soil was determined by turbidometry method at 340 nm using spectrophotometer (model. LABINDIA® UV 3000) (Williams and Steinbergs, 1959) [16]. Calcium and Magnesium in soil were determined by versanate titration method (Tandon, 2017) [12]. Micronutrients and heavy metals were determined in soil extract prepared with DTPA (Diethylene Triamine Penta Acetic acid) extracting solution using Atomic Absorption Spectrophotometer (model. LABINDIA® AA 8000) (Lindsay and Norvell, 1978) [8].

Results and discussion

The overall pH of the soils irrigated with sewage water was higher than that of fresh water irrigated soils. The pH of sewage irrigated soils in Narakoduru, Vejendla, Chebrolu and Selapadu during pre-monsoon season were 7.75, 7.84, 7.90 and 7.77 respectively whereas, during post-monsoon season it was 8.06, 8.12, 8.25 and 8.10 respectively. The soils of four villages are slightly alkaline in nature. The pH of soils in check area during pre and post-monsoon season were 7.47 and 7.48 respectively. Highest Electrical Conductivity was recorded in soils of Chebrolu (1.25 and 1.37 dSm^{-1}) during both the seasons whereas lowest EC of 0.93 and 1.22 dSm^{-1} was recorded in Selapadu. The soils are non- saline in nature. The EC of the soils in check area during pre and post-monsoon season was less (0.33). Highest Organic Carbon was recorded in Vejendla and Narakoduru (0.67 and 0.82%) during pre and post-monsoon seasons respectively whereas, lowest was recorded in Selapadu (0.58 and 0.65%). The high organic carbon of sewage irrigated soils could be ascribed to a very high load of organic compounds of domestic origin present in sewage effluent that are rapidly decomposed in the soil (Singh *et al*., 2012 and Pankaj *et al*., 2015) [10, 6]. The available nitrogen content in sewage irrigated soils during pre-monsoon season in Narakoduru, Vejendla, Chebrolu and Selapadu was 282, 288, 278 and 309 kg ha^{-1} and 331, 318, 306 and 327 kg ha^{-1} during post-monsoon season respectively. The potassium content in the check area in pre and post-monsoon were 482 and 476 kg ha^{-1} respectively. The increase in available nitrogen and phosphorus content in sewage irrigated soils was due to continuous addition of sewage water having high amounts of organic matter, phosphate accumulates (Usha Rani *et al*., 2015) [13]. During pre-monsoon, highest phosphorus content was recorded in Selapadu (20.19 kg ha^{-1}) followed by Chebrolu (19.62 kg ha^{-1}), Vejendla (19.47 kg ha^{-1}) and Narakoduru (19.42 kg ha^{-1}) whereas during post-monsoon, highest was recorded in Narakoduru (23.54 kg ha^{-1}) and lowest in Chebrolu (20.96 kg ha^{-1}). The potassium content in four villages were in the order Chebrolu > Narakoduru > Vejendla > Selapadu (Table 1). The sulphur content in the sewage irrigated soils during pre-monsoon was 10.6, 7.9, 10.1 and 11.2 mg kg^{-1} in Narakoduru, Vejendla, Chebrolu and Selapadu respectively whereas 12.4, 9.4, 11.3 and 11.7 mg kg^{-1} during post-monsoon respectively. The sulphur content in the check area was comparatively low. Calcium and Magnesium content were higher in the sewage irrigated soils compared to fresh water irrigated soils in check area. During pre-monsoon, highest Zinc concentration was recorded in Vejendla (0.85 ppm) and lowest in Selapadu (0.53 ppm) whereas during post-monsoon highest zinc concentration was observed in Chebrolu (1.44 ppm) and lowest in Narakoduru (0.67 ppm). The iron content in the sewage irrigated soils was in the order Narakoduru, Selapadu>Vejendla>Chebrolu during pre-monsoon season and Narakoduru>Selapadu>Vejendla>Chebrolu during post-monsoon. During pre-monsoon, highest copper content was recorded in Chebrolu (4.2 ppm) and lowest in Narakoduru (2.5 ppm) whereas during post-monsoon season, highest copper content was recorded in Chebrolu (6.19 ppm) and lowest in Narakoduru (3.63 ppm). Highest manganese content was recorded in Narakoduru (3.75 and 4.89 ppm) and lowest was recorded in Chebrolu (2.45 and 2.97 ppm) during both the seasons. The micronutrients viz., zinc, iron, copper and manganese were comparatively lower in the soils irrigated with fresh water. The cadmium content in Narakoduru, Vejendla, Chebrolu and Selapadu during pre-monsoon was 0.16, 0.19, 0.14 and 0.12 ppm whereas the cadmium content during post-monsoon was 0.23, 0.26, 0.18 and 0.20 ppm respectively. During pre and post-monsoon, highest chromium content was recorded in sewage irrigated soils in Vejendla (0.84 and 0.59 ppm) and lowest in Selapadu (0.59 and 0.65 ppm). Highest and lowest nickel and lead concentrations were recorded in Selapadu and Vejendla during pre and post-monsoon respectively. Heavy metal content in the fresh water irrigated soils was relatively lower than that of sewage irrigated soils.
Micronutrients and heavy metals in the sewage irrigated soils were higher than the permissible limits (APAU, 1967-95). The accumulation of micronutrients and heavy metals in the sewage irrigated soils could be attributed to the continuous usage of sewage water containing high amount of these metals that were included through various sources *viz.*, industrial and domestic discharges.

Table 1: Physico-chemical and chemical characteristics of soils irrigated with sewage water

Soil parameters	Pre-monsoon					Post-monsoon				
	1	2	3	4	Check	1	2	3	4	Check
pH	7.75	7.84	7.9	7.77	7.47	8.06	8.12	8.25	8.1	7.48
Electrical Conductivity (dSm^{-1})	0.97	1.06	1.25	0.93	0.33	1.24	1.27	1.37	1.22	0.33
Organic Carbon (%)	0.63	0.67	0.61	0.58	0.37	0.82	0.79	0.68	0.65	0.41
Available Nitrogen (kg ha^{-1})	282	288	278	309	219	331	318	306	327	216
Available Phosphorus (kg ha^{-1})	19.42	19.47	19.62	20.19	12.77	23.54	21.73	20.96	22.61	15.33
Available Potassium (kg ha^{-1})	591	542	661	522	482	682	671	711	703	476
Available Sulphur (mg ka^{-1})	10.6	7.9	10.1	11.2	6.8	12.4	9.4	11.3	11.7	6.9
Available Calcium (meq/100 g)	6.08	6.56	6.82	5.24	2.67	7.01	7.61	7.49	6.57	2.75

Available Magnesium (meq/100 g)	3.16	3.03	3.52	2.86	1.78	3.55	3.8	4.13	3.25	1.96
Zinc (ppm)	0.58	0.85	0.73	0.53	0.29	0.67	1.27	1.41	0.82	0.29
Iron (ppm)	7.88	5.54	4.93	6.54	4.37	9.01	6.33	5.36	7.24	4.19
Copper (ppm)	2.55	3.28	4.2	3.81	0.93	3.63	4.36	6.19	5.05	0.89
Manganese (ppm)	3.75	2.59	2.45	2.95	1.03	4.89	3.27	2.97	4.73	1.21
Cadmium (ppm)	0.16	0.19	0.14	0.12	0.02	0.23	0.26	0.18	0.2	0.01
Chromium (ppm)	0.63	0.84	0.76	0.59	0.32	0.68	0.91	0.83	0.65	0.33
Nickel (ppm)	10.9	9.87	10.64	12.75	1.2	11.2	10.13	10.86	12.83	0.83
Lead (ppm)	4.03	2.78	4.04	5.47	0.4	4.12	2.84	4.09	5.57	0.37

1,2,3 and 4- Narakoduru, Vejendla, Chebrolu and Selapadu villages respectively

Conclusion

The pH, Electrical Conductivity, macronutrients, DTPA extractable micronutrients and heavy metals were higher in the sewage irrigated soils than that of the fresh water irrigated soils. There was an increase in all the parameters in the sewage irrigated soils from pre to post-monsoon respectively. From the study, it can be concluded that sewage water irrigation proved to incorporate organic matter and plant nutrients to the soil. The accumulation of micronutrients and heavy metals in the soil is a major concern. Frequent monitoring of these metals in sewage water and soils is necessary to prevent excess build-up of the metals in food chain.

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