International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 8, Issue 52, 2016, pp.-2500-2503.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

IMPACT OF FOOD INDUSTRY EFFLUENT ON SOIL AND CROPS OF GUMTHALA VILLAGE IN NAGPUR DISTRICT

RAUT MAYA[1], MHASKE A.R.[2*], BALPANDE S.S.[3] AND GAWANDE S.N.[4]

[1,3]College of Agriculture, Nagpur, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
[2]Agricultural Engineering Section, College of Agriculture, Nagpur, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
[4]Shri Shivaji College of Agriculture, Amravati, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
*Corresponding Author: Email-mhaskear@gmail.com

Received: August 03 2016; Revised: September 02, 2016; Accepted: September 04, 2016; Published: October 30, 2016

Abstract- The study was conducted to estimate the characteristics food industrial effluents, well and canal water for irrigation and to assess the possible impacts on soil and crop during the year of 2011-12. Mixture of treated and untreated effluents of *namkin*, milk and *rasgulla* industries, water quality class comes under C2S1 to C3S1, which is moderately high salinity to low sodium hazards. The RSC of the effluent except milk industry and lake effluent was higher in range *i.e.* 2.63 to 3.54 indicating unsuitable for irrigation, due to as it may develop sodicity in soil by its continuous use. The RSC of milk industry, canal, lake and well water was observed in the range of 1.11 to 2.31 me L^{-1}, which comes under marginally suitable class for irrigation. The micronutrients (Fe, Mn, Cu and Zn) in effluent were within the permissible limit of NEQS. Soils receiving effluent irrigation and crops grown were containing higher proportion of micronutrients as compared to soils and crops receiving well water and canal water irrigation. The soils receiving mixed industrial effluent irrigation were found rich in available N, P, K and organic carbon as compared to soils receiving well water and canal water irrigation.

Keywords- Effluents, Fertility status, Irrigation quality, Micronutrients content.

Citation: Raut Maya, et al., (2016) Impact of Food Industry Effluent on Soil and Crops of Gumthala Village in Nagpur District. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 8, Issue 52, pp.-2500-2503.

Academic Editor / Reviewer: Dr Deepak Kumar Kashyap

Introduction

Water is becoming an increasingly scarce resource for agriculture. Wherever good quality water is limited, water of marginal quality like sewage and other waste water are used to supplement irrigation needs, particularly in the peri-urban areas. About 3000 M L of wastewater is generated every day in India [2] and its economic utilization is emerging as an important dimension in soil and water resource planning. Although wastewater is an important source of plant nutrients [12] and helps in improving crop yields, its likely adverse impact on soil and human health warrants constant monitoring [11].

Use of wastewater in agriculture is gaining importance now a day, because of its value as a potential irrigant and a nutrient donor. Use of wastewater for irrigation makes it possible to conserve the limited water resources for crop production and also prevent pollution of water bodies, as soil is a very good sink. Also application of wastewaters to agricultural land may promote the growth of crops and conserve water and nutrients. But the indiscriminate use of the industrial effluents for irrigation to agricultural crops may cause soil and groundwater pollution problems in the long run when they are not properly handled before and after their application to land. The present investigations comprised of the study of effluent characteristics during pre-monsoon and post-monsoon period, the impact of effluent irrigation on soil and crop quality at Gumthala Village.

MaterialsandMethods

The study area Gumthala village, food industry area is located at 21013'58.71" N latitude and. 79038'03.82"E longitude in Nagpur District of Maharashtra. The total agricultural area in which the effluent was applied is about 100 acres (40.4685 ha). The sites selected for sampling were food industry, Gumthala and its surrounding area. A total 10 irrigation water samples, out of which 5 effluent mixed (lake) water samples, one canal water sample and 4 well water samples were collected during pre-monsoon and post-monsoon season. These samples were analyzed for pH, EC, cations, anions and micronutrient content *viz.,* Fe, Mn, Zn and Cu were determined as per the procedure given by [1]. The quality of irrigation water was assessed as per the guide lines of [9]. Soil and plant samples were also collected from this area. A total of 12 soil samples (0-20 cm depth) and 12 plant samples of vegetable and cereal crops were collected from the same sites. Recently matured leaves just before the onset of reproductive stage were taken and processed for analysis using standard methods. Micronutrient content in plant samples were determined from di-acid extracts using AAS. Soil samples were analyzed for pH, EC, organic carbon and were determined as per the procedure given by [3], the major nutrients i.e. available nitrogen was determined by alkaline permanganate method as described by [13] ,available P and K were determined as per the method given by [3] & avail-able micronutrients (Fe, Mn, Zn, Cu) were determined as per the procedure outlined by [6] using AAS.

Results and Discussion

Quality of irrigation water: The data on the characteristics of irrigation water collected from various sources during pre-monsoon and post-monsoon period of 2011-12 is presented in [Table-1]. The data revealed that, pH of the untreated and treated effluents from *namkin*, milk product industry was in the range of 7.42 to 7.98 whereas the treated effluent of milk product industry have the pH in the range of 6.67 to 6.97. The pH of canal and well water in the area was in the range of 7.01 to 7.10, this indicates that pH of the effluent was higher than the canal and well water except effluent of the milk industry water. The pH values for effluent water, well water and canal water were found within the permissible limits compared with CPCB standards. The EC values of effluent water ranged from 0.62 to 0.81 dS m^{-1} and well water and canal water, the EC values were ranged from 0.14 to 0.52 dS m^{-1} during pre-monsoon season. EC was slightly lower

Table-1 *Seasonal variation in chemical characteristics of effluents and well water in food industry area*

Location	Season	pH 1:2.5	EC	Na+	K+	Ca++	Mg++	CO3--	HCO3-	Cl-	SAR	RSC	Water Class
			dS m-1	----------------m mol c L-1 ------------									
Untreated effluent - namkin, milk and rasgulla industries	Pre monsoon	7.96	0.87	6.1	0.265	0.68	1.66	0.55	5.20	2.38	18.51	3.54	C3S1
	Post monsoon	7.88	0.76	5.6	0.244	0.62	1.61	0.51	5.14	2.27	18.36	3.42	C3S1
Untreated effluent- rasgulla industry	Pre monsoon	6.97	0.64	5.00	0.258	0.52	1.43	0.45	4.50	2.22	5.11	3.00	C2S1
	Post monsoon	6.72	0.61	5.26	0.238	0.48	1.37	0.38	4.20	2.20	5.40	2.63	C2S1
Treated effluent - namkin, milk and rasgulla industries	Pre monsoon	7.68	0.78	6.50	0.220	0.60	1.60	0.48	4.87	2.32	6.19	3.15	C2S1
	Post monsoon	7.42	0.72	5.86	0.210	0.56	1.53	0.42	4.64	2.24	5.73	2.97	C2S1
Untreated effluent - Milk industry	Pre monsoon	6.90	0.62	11.85	0.192	0.54	1.48	0.44	3.42	2.21	11.85	1.84	C2S1
	Post monsoon	6.67	0.58	11.36	0.184	0.49	1.41	0.32	3.28	2.17	11.71	1.70	C2S1
Treated effluent discharge at lake	Pre monsoon	7.24	0.65	9.85	0.110	0.47	1.27	0.40	3.35	1.28	10.59	2.01	C2S1
	Post monsoon	7.21	0.58	9.56	0.100	0.45	1.23	0.31	3.24	1.22	10.50	1.87	C2S1
Canal Water in industrial area	Pre monsoon	7.10	0.52	4.00	0.040	0.42	1.15	0.37	3.31	1.19	4.54	2.11	C2S1
	Post monsoon	7.08	0.47	3.72	0.030	0.37	0.83	0.29	3.22	1.12	4.83	2.31	C2S1
Well water 0.5 km away from industrial area	Pre monsoon	7.09	0.51	3.20	0.029	0.36	1.07	0.30	2.35	1.16	3.81	1.22	C2S1
	Post monsoon	7.07	0.49	3.15	0.018	0.34	0.96	0.28	2.32	1.09	3.93	1.30	C2S1
Well water 1 km away from industrial area	Pre monsoon	7.05	0.47	1.10	0.032	0.13	0.67	0.31	2.28	1.13	1.74	1.84	C1S1
	Post monsoon	7.03	0.43	0.98	0.017	0.12	0.63	0.26	2.19	1.05	1.60	1.70	C1S1
Well water 2 km away from industrial area	Pre monsoon	7.04	0.44	1.01	0.028	0.07	0.81	0.33	2.30	1.09	1.53	1.75	C1S1
	Post monsoon	7.01	0.41	0.79	0.023	0.06	0.32	0.27	2.22	1.02	1.83	1.11	C1S1
Well water 3 km away from industrial area	Pre monsoon	7.02	0.42	0.37	0.025	0.09	0.53	0.29	2.24	1.15	0.67	1.91	C1S1
	Post monsoon	7.01	0.40	0.31	0.021	0.08	0.47	0.22	2.12	1.10	0.59	1.79	C1S1

during post monsoon season, which might be due to dilution effect. The cations (Na^+, K^+, Ca^{2+}, $Mg^{2+)}$ in effluent water were ranged from 4.92 to 6.10, 0.110 to 0.265, 0.47 to 0.68 and 1.27 to 1.66 me L^{-1}, respectively while in well water and canal water cations were ranged from 0.67 to 3.42, 0.025 to 0.040, 0.09 to 0.42 and 0.53 to 1.15 me L^{-1}, respectively. Carbonates and bicarbonate content in effluent water were ranged from 0.40 to 0.55 and 3. 35 to 5.20 me L^{-1}, respectively and in well water and canal water samples ranged from 0.29 to 0.37 and 2. 24 to 3.31 me L^{-1}, respectively during pre-monsoon and which were also lowered during post-monsoon season. Sodium adsorption ratio (SAR) in effluent ranged from 4.71 to 5.65 during pre-monsoon season which was slightly decreased in post-monsoon season. Chloride content in well water and canal water were lower as compared to effluent. According to the water class, mixture of treated and untreated effluents of *namkin*, milk and *rasgulla* industries, water quality class comes under C2 S1, which is moderately high salinity to low sodium hazards. However, the well and canal water SAR ranged from 1.20 to 4.05. The RSC of the effluent except milk industry and lake effluent was higher in range *i.e.* 2.63 to 3.54 indicating unsuitable for irrigation, due to as it may develop sodicity in soil by its continuous use. The RSC of milk industry, canal, lake and well water was observed in the range of 1.11 to 2.31 me L^{-1}, which comes under marginally suitable class for irrigation. The data presented in [Table-2] indicated that, the micronutrient content (Fe, Mn, Zn and Cu) in effluents water during pre-monsoon ranged from 0.97 to 1.51, 0.09 to 0.25, 0.12 to 0.19 and 0.015 to 0.037 mg L^{-1} respectively. These results were within permissible limits of NEQS (National environmental quality standards) [6].Similarly the micronutrients *viz.,* Fe, Mn, Zn and Cu in well and canal water during pre-monsoon were ranged from 0.42 to 0.78, 0.04 to 0.07, 0.03 to 0.09 and 0.010 to 0.018 mg L-1. The conc. of micronutrients observed higher during pre-monsoon than post-monsoon season. It was two fold higher in effluents water than in the canal and well water. The cation content in effluent water was higher than the well water and canal water. Micronutrient content in well water and canal water were found within permissible limit for irrigation and may not pose any serious hazard [2].

Fertility status of soil: The data presented in the [Table-3] showed that, the effluent mixed lake water irrigated soils in the study area are slightly alkaline in reaction with pH ranging from 7.74 to 7.97 The EC values of effluents mixed lake water irrigated soils ranged from 0.51 to 0.85 dS m^{-1} and found to be higher than the well and canal water irrigated soils. This can be attributed to addition of soluble salts in soil by way of effluent irrigation. It was observed that the organic carbon content of effluents mixed lake water irrigated soils were found in higher range *i.e* 4.80 to 7.35 g kg^{-1} than that of well and canal water irrigated soils *i.e* 3.45 to 4.20 g kg^{-1}. These findings are in conformity with the work of [5] reported that organic carbon status of surface soil samples of effluent irrigated area increased as compared to that which received well water for irrigation. Available N, P and K in effluents mixed lake water irrigated soils ranged from 201.95 to 280.98, 22.84 to 27.78 and 315.80 to 370.19 kg ha^{-1} respectively. In well and canal water irrigated soils available N, P and K ranged from 166.83 to 193.17, 18.59 to 22.17 and 291.20 to 313.60 kg ha^{-1} respectively. Data indicates that, the usefulness of food industrial effluent as a source of providing the major nutrients. [7] reported that there was an increase in available N and K content of soil receiving effluent irrigation. The data depicted in [Table-4], the results indicates that the DTPA extractable micronutrients Fe, Mn, Zn and Cu in effluent irrigated soil ranged between 5.45 to 7.97, 10.86 to 16.66, 2.33 to 2.67 and 1.94 to 3.04 mg kg^{-1}, respectively. Whereas the corresponding values for the soils irrigated with the well and Cu content in effluent mixed lake water irrigated crops were ranged from 0.50 to 170.10, 16.18 to 111.80, 15.73 to 40.18 and 1.19 to 19.60 mg kg^{-1} respectively whereas the micronutrients content Fe, Mn, Zn and Cu in well water and canal water irrigated crops were ranged from 8.00 to 45.87, 11.00 to 41.52, 15.18 to 26.01 and 3.50 to 5.68 mg kg^{-1} respectively. [10] Reported that, waste water mixed with industrial effluent used for irrigation in vegetable growing area, the plant sample had greater concentration of heavy metals than the recommended values. However, area irrigated with well water was safer and heavy metals quantities were within the limits in soil and plant. However, in spinach crop the similar results were observed canal water were ranged from 2.15 to 4.41, 9.04 to 14.58, 1.38 to 1.62 and 1.40 to 1.97 mg kg^{-1}, respectively. The

Table-2 *Seasonal variation in micronutrient content in effluent and well water as Influenced by food industrial effluents*

Sr. No.	Location	Seasons	Fe	Mn	Zn	Cu
			(mg L-1)			
1	Mixture of untreated effluents of namkin, milk and rasgulla industries	Pre monsoon	1.51	0.25	0.19	0.037
		Post monsoon	1.01	0.20	0.13	0.033
2	Regular industry effluents	Pre monsoon	1.22	0.12	0.15	0.022
		Post monsoon	1.18	0.10	0.13	0.018
3	Mixture of treated effluents of namkin, milk and rasgulla industries	Pre monsoon	1.35	0.18	0.17	0.031
		Post monsoon	1.29	0.15	0.13	0.026
4	Milk industry effluents	Pre monsoon	1.20	0.13	0.14	0.023
		Post monsoon	1.17	0.11	0.11	0.017
5	Treated effluents discharge at lake	Pre monsoon	0.97	0.09	0.12	0.015
		Post monsoon	0.92	0.08	0.10	0.012
6	Canal flowing near industrial area	Pre monsoon	0.78	0.07	0.09	0.018
		Post monsoon	0.73	0.06	0.07	0.015
7	Well water sample 0.5km away from industrial area	Pre monsoon	0.65	0.05	0.09	0.017
		Post monsoon	0.58	0.04	0.05	0.012
8	Well water sample 1 km away from industrial area	Pre monsoon	0.56	0.06	0.06	0.014
		Post monsoon	0.48	0.04	0.05	0.011
9	Well water sample 2 km away from industrial area	Pre monsoon	0.44	0.05	0.05	0.012
		Post monsoon	0.39	0.04	0.04	0.007
10	Well water sample 3-4 km away from industrial area	Pre monsoon	0.42	0.04	0.03	0.010
		Post monsoon	0.38	0.02	0.02	0.005
NEQS			2.0	1.5	5.0	1.0

Table-3 *Fertility status of soil as influenced by irrigation water*

Sources of Irrigation Water	PH (1:2.5)	E C (d S m^{-1})	O C (g kg^{-1})	Avail. N (kg ha^{-1})	Avail. P (kg ha^{-1})	Avail. K (kg ha^{-1})
Soil irrigated with effluents mixed lake water						
Sample -1	7.87	0.82	6.00	245.86	27.33	358.40
Sample -2	7.97	0.58	5.10	228.30	26.43	324.80
Sample -3	7.82	0.85	7.35	280.98	22.84	370.19
Sample -4	7.92	0.56	5.04	219.52	27.78	336.12
Sample -5	7.74	0.69	7.05	263.42	26.21	315.80
Sample -6	7.91	0.53	4.95	210.73	25.76	348.18
Sample -7	7.89	0.51	4.80	201.95	24.64	369.60
Sample -8	7.76	0.75	5.85	237.08	23.07	347.24
Soil irrigated with canal water						
Sample -9	7.60	0.45	4.20	193.17	22.17	313.60
Soil irrigated with well water						
Sample -10	7.57	0.41	3.60	175.61	18.59	302.40
Sample -11	7.58	0.42	3.75	184.39	20.16	291.20
Sample -12	7.54	0.37	3.45	166.83	20.61	312.16

DTPA extractable micronutrients were higher in effluent mixed lake irrigated soils as compared to well and canal water irrigated soil. Therefore, the continuous irrigation with metal contaminated effluent might have resulted in the build-up of these metals in surface soil due to higher adsorption and low permeability of the soils. [4].

Table-4 *Available micronutrients content in soil as influenced by irrigation water*

Soil sample(0 -15 cm depth)	DTPA Extractable , mg kg^{-1}			
	Fe	Mn	Zn	Cu
Soils irrigated with effluents mixed lake water				
Sample -1	7.29	2.88	2.46	1.04
Sample -2	7.61	2.84	2.62	0.80
Sample -3	5.71	1.86	2.33	0.94
Sample -4	6.20	1.40	2.51	1.07
Sample -5	7.38	1.37	2.49	1.20
Sample -6	7.97	1.20	2.67	1.00
Sample -7	6.74	1.66	2.34	0.86
Sample -8	5.45	1.52	2.57	0.88
Soils irrigated with canal water				
Sample -9	4.41	1.08	1.62	0.97
Soil irrigated with well water				
Sample -10	2.35	0.88	1.57	0.50
Sample -11	2.28	0..84	1.42	0.47
Sample -12	2.15	0.86	1.38	0.40

The data presented in [Table-5]. indicates that, the micronutrients *viz.,* Fe , Mn, Zn and Cu content in effluent mixed lake irrigated spinach crop were 170.10, 111.80, 31.00 and 19.60 mg kg^{-1} ,respectively where as the micronutrients content Fe, Mn, Zn and Cu in well water irrigated spinach crop were 40.29, 41.52, 26.01 and 4.45 mg kg^{-1} respectively. Effluent mixed lake water irrigated spinach had higher micronutrient content than that of well water irrigated spinach. The micronutrients Fe, Mn, Zn and Cu content in effluent mixed lake water irrigated crops were ranged from 0.50 to 170.10, 16.18 to 111.80, 15.73 to 40.18 and 1.19 to 19.60 mg kg^{-1} respectively whereas the micronutrients content Fe, Mn, Zn and Cu in well water and canal water irrigated crops were ranged from 8.00 to 45.87, 11.00 to 41.52, 15.18 to 26.01 and 3.50 to 5.68 mg kg^{-1} respectively. [10] reported that, waste water mixed with industrial effluent used for irrigation in vegetable growing area, the plant sample had greater concentration of heavy metals than the recommended values. However, area irrigated with well water was safer and heavy metals quantities were within the limits in soil and plant. However, in spinach crop the similar results were observed.

Table-5 *Micronutrient content in crop leaves as influenced by irrigation water*

Crop leaves	Fe	Mn	Zn	Cu
	(mg kg-1)			
Irrigated with effluent mixed lake water				
Cabbage	40.00	35.00	20.00	6.00
Cauliflower	35.00	30.00	25.00	4.00
Brinjal	55.00	42.00	30.00	9.00
Tomato	50.00	40.00	20.00	5.00
Spinach	170.10	111.80	31.00	19.60
Mustard	80.26	30.52	40.18	8.47
Gram	33.95	16.18	15.73	1.19
Fenugreek	31.95	23.90	27.68	1.22
Irrigated with canal water				
Wheat	15.00	19.86	24.58	5.68
Irrigated with well water				
Maize	45.87	15.08	17.48	4.20
Spinach	40.29	41.52	26.01	4.45
Wheat	8.00	11.00	15.18	3.50

Conclusion

If land with suitable topography, soil characteristics and drainage available, treated effluent of food industries can put good use as a source of both irrigation water and plant nutrients. Use of treated effluent of food industries for irrigation increased fertily of the soil and yield of crops. There may be possibility of developing sodicity in soil for long term. In India, encountering the problems of water scarcity and high cost of fertilizers, treated effluent of food industries could be successfully used for irrigation. Findings indicate that, treated effluent of food industries can be a good water resource for irrigation if the quality of water is monitored properly in sustainable environment.

Acknowledgment / Funding resource: Author is thankful to Associate Dean, College of Agriculture, Nagpur for Providing facilities during research work.

Conflict of Interest: None declared

References

[1] APHA-AWWA-WPCF. (1975) Standard methods for the examination of water and waste water. American Public Health Association, Washington, USA.
[2] Balakrishnan M., Arul Antony S., Gunasekaran S. and Natarajan R.K. (2008) *Indian Journal of Science and Technology*, 1 (7), 1-8.
[3] Jackson M.L. (1973) Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, India. pp. 38-82
[4] Jeyabaskaran K.J. and Sreeramulu U.S. (1996) *J. Indian Soc. Soil Sci.,* 44 (4), 401-404.
[5] Kumar Ashok, Yadav B.R., Singh S.K. and Pathak H. (1998) *J of Indian Soc. of Soil Sci.,* 46 (3), 427-429.
[6] Lindsay W.L. and Norvell W.A. (1978) *Soil Science Society of America Journal,* 42, 421-428.
[7] Maiti, Shriniwashchari, Dakshinamoorthy M. and Arunachalam G. (1998) *Madras Agric. J.,* 85 (10-12), 564-566.
[8] NEQS. (2000) National Environmental Quality Standards (NEQS) for municipal and liquid industrial effluents.
[9] Richards L.A. (1954) Diagnosis and improvements of saline and alkali soils. Agricultural Handbook No.60, USDA, Washigton, D.C. pp.160.
[10] Saif M., Saleem, Midrar-ul-Haq and Kazi Suleman Memon (2005) *Int. J. Agri. Biol.,* 7 (4), 646-648.
[11] Sen T.K., Dubey P.N., Gaikwad S.T. and Murali S. (1997) *Agropedology*, 7, 65-70.
[12] Sreeramulu U.S. (1994) *J. Indian Soc. Soil Sci*., 42, 525– 532.
[13] Subbiah B.V. and Asija G.L. (1956) *Current Science,* 25, 259-260.