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Effect of Sources and Methods of Irrigation on Soil Enzymatic Activity

M. Pooja Nayak, S. S. Angadi

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Abstract A field trial was conducted at the Main Agricultural Research station, Dharwad during summer 2014 to study the effect of sources and methods of irrigation on soil enzymatic activity. The trial was laid out in split plot design with four main plot treatments viz., treated wastewater (I_1) ,sewage water alternated with fresh water (I_2), fresh water (I_3), untreated sewge water (I_4) and four subplot treatments viz., ridge and furrow irrigation (M_1), alternatively alternate furrow irrigation (M_2), ridge and furrow irrigation at 50% depletion (M_3) and basin irrigation (M_4). The treatments M_1, M_2 and M_4 were irrigated at 30% depletion. Results revealed that untreated swage water irrigation recorded significantly higher dehydrogenase and phosphatase activity which were on par with treated wastewater application. Whereas the urease activity was significantly higher under untreated sewage water irrigation over other sources. Basin irrigation recorded significantly higher dehydrogenase and phosphatase activity which was on par with ridge and furrow irrigation at 30% depletion. Whereas, urease activity was found significantly higher under basin irrigation over the other methods of irrigation.

Keywords Dehydrogenase, Phosphatase, Urease, Sources, Methods.

M. Pooja Nayak*, S. S. Angadi
Department of Agronomy, College of Agriculture,
Dharwad University of Agricultural Sciences,
Dharwad 580005, Karnataka, India
e-mail : poojanayakm37@gmail.com
*Correspondence

Introduction

The enzyme activity in soil results from the activity of proliferating microorganisms. They are usually associated with viable proliferating cells, but enzymes can be excreted from a living cell or released into soil solution from dead cells. Study of soil enzymes give information about the release of nutrients in soil by means of organic matter degradation and microbial activity as well as indicators of ecological change. Soil enzyme analysis helps to establish correlation with soil fertility, microbial activity, biochemical cycling of various elements in soil, degree of pollution and to assess the succession stage of an ecosystem. Hence the measurements of enzyme activities in soils were useful in examining impact of environmental change or management on soil enzymatic activities. Several workers have re-

Table 1. Quality characteristics of water used for irrigation at monthly interval. Fresh water—Borewell; Untreated sewage-Raw domestic; Treated wastewater-Horizontal flow constructed wetland method.

Sl. No.	Water quality parameter	6/2/2014 Fresh water	6/2/2014 Untreated sewage water	6/2/2014 Treated waste water	9/3/2014 Fresh water	9/3/2014 Untreated sewage water	9/3/2014 Treated waste water	7/4/2014 Fresh water	7/4/2014 Untreated sewage water	7/4/2014 Treated waste water
1	pH	7.91	7.45	7.56	7.62	7.10	7.34	7.56	6.96	7.21
2	EC (dS/m)	0.56	0.75	0.72	0.52	0.76	0.72	0.48	0.64	0.58
3	TSS (mg/1)	–	406.00	285.60	–	632.00	398.61	–	478.90	298.64
4	TDS (mg/l)	–	543.10	376.57	–	674.34	423.45	–	534.67	345.34
5	COD (mg/l)	–	265.00	212.00	–	276.00	231.89	–	243.67	198.67
6	BOD (mg/l)	–	132.00	98.76	–	121.98	95.56	–	152.00	125.65
7	Total N (ppm)	0.31	19.00	16.00	0.38	17.00	14.00	0.29	18.00	16.00
8	Total P (ppm)	0.21	12.25	8.34	0.14	13.23	9.34	0.12	13.78	8.93
9	K (ppm)	0.51	56.26	48.45	0.38	54.36	46.36	0.29	51.87	47.37
10	Sulfate (ppm)	1.82	7.80	4.70	1.67	6.89	4.76	1.54	7.90	4.54
11	Ca (meq/l)	3.00	9.23	8.76	2.67	8.97	6.56	2.78	8.34	7.89
12	Mg (meq/l)	2.07	5.68	5.23	1.83	6.21	5.67	2.10	5.72	5.35
13	Fe (ppm)	0.10	1.09	0.96	0.06	1.12	1.08	0.87	1.09	0.83
14	Zn (ppm)	0.11	0.23	0.18	0.09	0.25	0.14	0.06	0.21	0.19
15	Bicarbonates (me/l)	2.50	10.67	9.34	2.34	11.23	9.23	2.42	10.34	8.93
Microbial analysis										
1	Bacteria (cfu's/ml × 10^6)	2.50	45.00	38.00	1.80	38.00	32.00	3.20	44.00	36.00
2	Fungi (cfu's/ml × 10^4)	0.50	3.20	3.00	1.20	3.60	2.97	0.84	3.20	2.30
3	Actinomycetes (cfu's/ml × 10^4)	0.8	2.70	2.5	2.40	2.30	1.68	1.20	2.20	1.95
4	*E. Coli* (cfu's/ml × 10^4)	0.0	6.00	3.0	0.00	6.40	3.20	0.00	7.10	4.00

ported the potential use of enzyme activity as an index of productivity or microbial activity. One of the general criteria used to determine microbial activity and biomass is quantifying soil dehydrogenase, urease and phosphatase activity. Present investigation was carried out in view of assessment of effect of different sources and methods of irrigation on soil microbial life in terms of enzyme activity.

Materials and Methods

A field experiment was undertaken at the Main Agricultural Research Station, Dharwad during summer 2014 to study the effect of sources and methods of irrigation on soil enzymatic activity. The trial was laid out in split design with four main plot treatments viz., treated wastewater (I_1), sewage water alternated with fresh water (I_2) fresh water (I_3), untreated sewage water (I_4) and four subplot treatmnts viz., ridge and furrow irrigation (M_1), alternatively alternate furrow irrigation (M_2), ridge and furrow irrigation at 50% depletion (M_3) and basin irrigation (M_4) . The treatments M_1, M_2 and M_4 were irrigated at 30% depletion. Total number of irrigations given were 16 for 30% depletion treatments and 13 for 50% depletion treatment. The quality parameters of water sources used for irrigation are presented in Table 1. The nutrients analyzed in case of both untreated sewage water and treated wastewater were below the permissible limits. The soil dehydrogenase activity, Phosphatase activity and urease activity were estimated according the procedure.

Results and Discussion

In the present investigation, the untreated sewage water irrigation recorded (Table 2) significantly higher dehydrogenase activity (43.61µg TPF/g of soil/day) at 60 days after sowing over other sources of irrigation. However was found on par with treated wastewater irrigation (43.58 µg TPF/g of soil/day). The soil microbial population basically depends upon

Table 2. Soil dehydogenase activity (µg TPF/g of soil/day) at 60 DAS and at final harvest as influenced by sources and methods of irrigation. Initial soil dehydrogenase activity–13.20 µg TPF/g of soil/day. M_1-Ridge and furrow; M_2-Alternatively alternate furrow; M_3-Ridge and furrow at 50% depletion; M_4-Basin irrigation. (M_1, M_2 and M_4 were irrigated at 30% depletion).

	60 DAS Method (M)					At final harvest Method (M)				
Source (I)	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
I_1 Treated wastewater	44.47	44.00	41.89	43.96	43.58	19.67	20.33	19.22	22.17	18.14
I_2 Sewage water alternated with fresh water	40.63	38.22	37.40	41.11	39.34	16.66	16.08	17.56	18.52	17.21
I_3 Fresh water	24.59	23.19	23.18	24.72	23.92	14.96	12.00	10.67	16.00	13.41
I_4 Farmer's practice (untreated sewage water)	43.24	43.21	43.33	44.66	43.61	21.95	20.70	20.89	22.13	21.42
Mean	38.23	37.16	36.45	38.61	37.61	18.31	17.46	17.09	19.7	18.14

For comparing means of	SEm ±	CD at 5%	SEm ±	CD at 5%
Source of irrigation (I)	0.40	1.38	0.53	1.84
Methods of irrigation (M)	0.30	0.85	0.41	1.19
I at same level of M	0.58	NS	0.81	NS
I at same or different level of M	0.66	NS	0.90	NS

soil nutrition, water supply and aeration. Since the available macro and micronutrients (Table 1) were higher in both untreated and treated wastewater, which acted as a source of building blocks or precursors for the synthesis of new cellular constituents, which might have enhanced the microbial nutrition, growth and resulted in higher dehydrogenase activity. In addition, the organic matter added through wastewater acted as a substrate for microbial growth. The results obtained in present study were in conformity with other workers [1].

Similarly, phosphatases are a broad group of enzymes that are capable of catalyzing hydrolysis of esters and anhydrides of phosphoric acid. In the present study, phosphatase activity was found significantly higher (Table 3) under untreated sewage water irrigated plots (93.93 µg pnp /g of soil/ hour) at 60 DAS over the other sources of irrigation. The result obtained was in conformity with the finding of earlier workers [2]. The increase in phosphatase activity was due the presence of organisms in higher number which mineralized organic form of phosphorus to available form through the activity of phosphatase enzyme. The activity of phosphatases was found to correlate with organic matter in various studies. Since the sewage water provided organic matter as food source for microbes and hence the micro-

Table 3. Soil phosphatase activity (µg pnp /g of soil /hour) at 60 DAS and at final harvest as influenced by sources and methods of irrigation. Initial soil phosphatase activity–28.00 µg pnp/g of soil/hour. M_1-Ridge and furrow; M_2-Alternatively alternate furrow; M_3-Ridge and furrow at 50% depletion; M_4-Basin irrigation. (M_1, M_2 and M_4 were irrigated at 30% depletion).

	60 DAS Method (M)					At final harvest Method (M)				
Source (I)	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
I_1 Treated wastewater	90.00	89.52	91.07	91.00	90.39	31.33	29.33	30.55	33.19	30.80
I_2 Sewage water alternated with fresh water	88.78	85.67	84.33	89.00	86.95	29.89	30.71	30.33	32.26	30.79
I_3 Fresh water	75.00	74.82	66.67	75.67	73.04	28.11	27.67	27.30	29.82	28.23
I_4 Farmer's practice (untreated sewage water)	93.26	93.78	93.48	95.19	93.93	31.82	30.80	31.22	31.72	31.21
Mean	86.76	85.95	83.89	87.72	86.08	30.29	29.45	29.78	31.45	30.26

For comparing means of	SEm±	CD at 5%	Sem±	CD at 5%
Source of irrigation(I)	0.40	1.37	0.30	1.05
Method of irrigation (M)	0.76	2.20	0.24	0.69
I at same level of M	1.51	NS	0.48	NS
I at same or different level of M	1.31	NS	0.52	NS

Table 4. Soil urease activity (µg NH_4-N/g of soil/day) at 60 DAS and at final harvest as influenced by sources and methods of irrigation. Initial soil urease activity–2.5 µg NH_4-N/g of soil/day. M_1-Ridge and furrow; M_2-Alternatively alternate furrow; M_3-Ridge and furrow at 50% depletion; M_4-Basin irrigation. (M_1, M_2 and M_4 were irrigated at 30 depletion).

	60 DAS Method (M)					At final harvest Method (M)				
Source (I)	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
I_1 Treated wastewater	4.68	4.53	4.48	4.85	4.64	2.75	2.72	2.63	2.95	2.76
I_2 Sewage water altermated with fresh water	4.52	4.30	4.32	5.09	4.56	2.69	2.67	2.69	3.00	2.76
I_3 Fresh water	2.69	2.36	2.25	2.72	2.51	2.13	2.06	1.94	2.25	2.10
I_4 Farmer's practice (untreated sewage water)	4.93	4.77	4.58	5.07	4.84	2.86	2.82	2.71	2.94	2.83
Mean	4.21	3.99	3.91	4.43	4.14	2.61	2.57	2.49	2.79	2.62
For comparing means of		SEm±		CD at 5%			SEm±		CD at 5%	
Source of irrigation		0.025		0.088			0.029		0.100	
Method of irrigation (M)		0.041		0.119			0.019		0.054	
I at same level of M		0.082		NS			0.037		NS	
I at same or different level of M		0.073		NS			0.045		NS	

bial activity was higher under wastewater irrigation. Similarly, significantly higher urease activity was recorded (Table 4) under wastewater irrigated plots (4.84 µg NH_4-N/g of soil/day) at 60 DAS over other sources of irrigation water. Such studies were also reported increased urease activity upon wastewater irrigation [2]. Urease is an enzyme responsible for the hydrolysis of urea fertilizer applied to the soil into NH_3 and CO_2. Urease activity in soils is influenced by organic matter content of the soil, its activity increased with increase in organic matter content [3]. The increased urease activity in the present study was also due to increased organic matter content under wastewater irrigated soils.

Methods of irrigation also had a significant influence on soil biological properties. Basin irrigation recorded (Table 2) significantly higher dehydrogenase (38.61 µg TPF/g of soil/day) activity, which was on par with ridge and furrow irrigation (38.23µg TPF/g of soil/day). With regard to soil-air-water relationship, studies have shown that dehydrogenase enzyme was greater in flooded soil as compared to non-flooded soil. The increase in this enzyme after flooding was also related to decreased redox potential. A study suggested that soil water content and temperature influenced dehydrogenase activity indirectly by affecting the soil redox potential status. In the preent investigation, since the amount of water added through basin and ridge and furrow irrigation at 30% depletion was significantly higher over the other methods and hence there was increase in dehydrogenase activity.

Similarly, basin irrigation also recorded (Table 3) significantly higher phosphatase activity (87.72µg pnp/g of soil/hour) which was on par with ridge and furrow irrigation (86.76µg pnp/g of soil/hour). Whereas, urease activity reported (Table 4) under basin irrigation (2.79 µg NH_4-N/g of soil /day) was significantly higher over the other methods of irrigation. Since the dehydrogenase is a key respiratory enzyme present in all the micro organisms, indicates the overall microbial population in the soil. Higher dehydrogenase activity reported under basin and ridge and furrow irrigation at 30% depletion also supports the higher phosphatase and urease activity under these methods.

It can be concluded from the above investigation that, untreated sewage water and treated wastewater irrigation have a positive influence on soil enzymatic activity. Thus, treated wastewater can be safely used for irrigation. Basin irrigation and ridge and furrow method of irrigation at 30% depletion were found to improve soil biolife and hence the enzymatic activity.

References

1. Kulandaivelu V, Bhat R (2012) Changes in the physico-chemical and biological quality attributes of soil following amend ment with untreated coffee processing wastewater. Eur J soil Biol 50 : 39—43.
2. Kalaiselvi P, Mahimairaja S (2010) Effect of spentwash application on nitrogen dynamics in soil. Int J Environ Sci Develop 1 : 184—189.
3. Yang Z, Liu S, Zheng D, Feng S (2006) Effects of cadium, zinc and lead on soil enzyme activities. J Environ Sci 18 : 1135—1141.