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Effect of Dairy Factory Effluent on Soil Enzymes in Greengram and Pearlmillet Crops

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ABSTRACT

A pot culture experiment was conducted during *rabi,* 2009 at S.V.Agricultural college, Tirupati (Andhra Pradesh) to characterize Dairy factory effluent (DFE) with respect to soil enzymes and also to study the effect of Dairy factory effluent on soil enzymes activities in greengram and pearlmillet crops. The urease, dehydrogenase, acid and alkaline phosphatase and arylsulfatase activities were increased with increase in Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ irrespective of crops studied. Soil enzymes activities such as urease, dehydrogenase and arylsulfatase were higher in greengram crop while acid and alkaline phophatase activities were higher in pearlmillet crop. The interaction effect between crops and levels of Dairy factory effluent was significant on urease and dehydrogenase activities at all stages of crop growth.

Key words : Dairy factory effluent, Greengram, Pearlmillet, Soil enzymes.

Dairy production plants are one of the most important agro-based industries producing different dairy products like homogenized or pasteurized milk, ghee, butter milk, flavoured milk, kova, doodhpeda *etc*. The dairy industry is an important contributor to the economy of India. In the preparation of various dairy products and cleaning of the equipment, lot of waste water is generated which is known as Dairy factory effluent (DFE). Dairy factory effluent is either disposed on land or surface water bodies resulting in pollution of soil, water and atmosphere. The farmers in the vicinity of dairy production plants are using effluent as source of plant nutrients without knowing beneficial or adverse effects on crop as well as on soil. Keeping this in view, the present investigation was undertaken to study the effect of different levels of Dairy factory effluent on soil enzymes activities, which are the indicators of biological activity of soil in pearlmillet and greengram crops.

MATERIAL AND METHODS

A pot culture experiment was carried out at S.V Agricultural college, Tirupati, Andhra Pradesh during *rabi*, 2009. The experimental soil was sandy clay loam (Typic Haplustalfs) in texture, neutral in reaction (pH 7.4) and non-saline (0.61 dSm^{-1}), low in available N (225 kg ha^{-1}) and P (8.64 kg ha^{-1}) and medium in available K (204 kg ha^{-1}) and S (10.62 kg ha^{-1}). The experiment was conducted in a complete randomized block design with factorial concept, comprising of five levels of Dairy factory effluent and two crops with three replications. The five levels of Dairy factory effluent were DFE_0 (soil alone), $DFE_{1.0}$ (soil + 1,00,000 L ha^{-1}), $DFE_{1.5}$ (Soil + 1,50,000 L ha^{-1}), $DFE_{3.0}$ (soil + 3,00,000 L ha^{-1}) and $DFE_{4.5}$ (soil + 4,50,000 L ha^{-1}). The crops grown were greengram (LGG - 460) and pearl millet (PBS -1). All the levels of Dairy factory effluent envisaged in the study were applied to a pot containing 40 kg soil one month before sowing of the crop. FYM @ 5 t ha^{-1} was applied uniformly to all the pots to enhance mineralization of Dairy factory effluent. The Dairy factory effluent required for experiment was collected from Dairy plant, College of Dairy Technology, S.V. Veterinary University, Tirupati, Chittoor district, Andhra Pradesh. Soil samples were collected at 25 days, 50 days and at harvest. All the soil samples were analysed for urease, dehydrogenase, acid and alkaline phosphatase and arylsulfatases.

Dehydrogenase activity of soil and Dairy factory effluent was determined by TTC reduction (Casida *et al*., 1964). Urease (urea amido hydrolase EC 3.5.1.5) activity of soil and effluent was estimated by the method of Tabatabai (1982), acid phosphatase (ortho phosphoric monoester phosphohydrolase EC 3.1.3.2) and alkaline phosphatase (orthophosphoric monoester phosphohydrolase EC 3.1.3.1) of soil and effluent

were determined by the method as described by Tabatabai and Bremner (1969) and arylsulfatase (arylsulfate sulfohydrate EC 3.1.6.1) activity of soil and effluent was determined by the procedure outlined by Tabatabai and Bremner (1970).

RESULTS AND DISCUSSION

Characterisation of initial soil and Dairy factory effluent

Urease activity of soil and Dairy factory effluent was 356 (µg urea hydrolyzed g^{-1} soil h^{-1}) and 100 (µg of urea hydrolyzed ml^{-1} effluent h^{-1}) whereas the dehydrogenase activity of soil and effluent was 125 (µg TPF g^{-1} soil h^{-1}) and 54 (µg of TPF ml^{-1} effluent h^{-1}), respectively. Further, the acid phosphatase activity in soil and effluent was 61.20 (µg of *p*-nitrophenol g^{-1} soil h^{-1}) and 25.10 (µg of *p*-nitrophenol ml^{-1} effluent h^{-1}) and alkaline phosphatase activity of soil and effluent were 68.39 (µg of *p*-nitrophenol g^{-1} soil h^{-1}) and 30.10 (µg of *p*-nitrophenol ml^{-1} effluent h^{-1}), respectively. The arylsulfatase activity of soil and effluent was 58.39 (µg of *p*-nitrophenol g^{-1} soil h^{-1}) and 20.50, (µg of *p*-nitrophenol ml^{-1} effluent h^{-1}), respectively.

Urease activity

Urease activity significantly increased with increase in the levels of Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ (Table 1) at 25 days, 50 days and at harvest. The higher value was reported with $DFE_{3.0}$ at all the stages of crop growth. Increase in microbial growth due to addition of nutrients through Dairy factory effluent might be the reason for increased urease activity. Similar findings were reported by Jezierska and Frac (2009). The soils collected from pearlmillet crop recorded higher urease activity than soils collected from greengram crop. The interaction effect between crops and levels of Dairy factory effluent on urease activity was found to be significant at all stages of crop growth. The highest enzyme activity was noticed in pearlmillet crop treated with $DFE_{3.0}$. This might be due to positive interaction between pearlmillet crop and Dairy factory effluent.

Dehydrogenase activity

Dehydrogenase activity in soil significantly increased with increased levels of Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ (Table 2) at all the stages of crop growth. The higher value was reported with $DFE_{3.0}$ at all the stages of crop growth. The increase in dehydrogenase activity night be due to supply of organic matter through effluent which might be responsible for increased microbial population consequently more enzyme activity. These results were in accordance with the findings of Saliha *et al*., (2005). The soils sown with pearlmillet crop showed significantly higher dehydrogenase activity than the soils sown with greengram crop at 25 days and 50 days of crop growth. The highest activity of dehydrogenase enzyme in pearlmillet crop may be due to positive influence of pearlmillet root on rhizosphere microbes.

Acid and alkaline phosphatase activity

The acid and alkaline phosphatase activities were significantly increased with increased levels of Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ (Table 3 & 4). The higher activity of both the enzymes was recorded with $DFE_{3.0,}$ irrespective of the crops. The increase in enzyme activities may be ascribed to increased microbial population due to increased availability of organic carbon through effluent which inturn released the enzymes. The results were in agreement with the findings of Dinesh *et al*., (2000). The soils of greengram crop showed higher acid and alkaline phosphatase activities than soils of pearlmillet crop. Legumes require higher amount of phosphorus and the microbes in the rhizosphere of greengram crop might have secreted more phosphatase enzyme leading to greater solubilisation of phosphorus resulting in higher phosphatases activities. These results were in line with findings of Makoi *et al.,* (2008).

Arylsulfatase activity

Arylsulfatase activity in soil increased significantly with increase in levels of Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ (Table 5). The higher arylsulfatase activity was reported in $DFE_{3.0}$ treatment at all the stages of crop growth. Pearlmillet crop showed higher arylsulfatase activity than greengram crop at 25 days and 50 days. This might be due to favourable rhizosphere effect of pearlmillet crop on microbes which led to higher secretion of arylsulfatase enzyme by microbes.

Soil enzymes activities were increased with increase in the levels of Dairy factory effluent application from DFE_0 to $DFE_{3.0}$ and the treatment $DFE_{3.0}$ recorded the higher enzymes activities. The organic matter present in Dairy factory effluent enhanced the microbial activity, there by favouring the synthesis of various enzymes in soils under greengram and pearlmillet crops.

Table 1. Urease activity (µg urea hydrolyzed g^{-1} soil h^{-1}) of soil at different stages of crop growth in pearmillet and greengram

Treatments	Growth Stages								
	25 Days			50 Days			Harvest		
	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean
DFE_0	155	151	153	148	146	147	135	138	136
$DFE_{1.0}$	187	175	181	174	168	171	162	154	158
$DFE_{1.5}$	202	200	201	195	184	189	183	180	181
$DFE_{3.0}$	214	211	212	209	205	207	207	201	204
$DFE_{4.5}$	200	198	199	190	186	188	185	178	181
Mean	191	187		183	177		174	170	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Crops	0.5164	1.5234	0.5164	1.5234	0.5164	1.5234
Treatments	0.8165	2.4087	0.8165	2.4087	0.8165	2.4087
Interaction	1.1547	3.4064	1.1547	3.4064	1.1547	3.4064

Table 2. Dehydrogenase activity (µg TPF g^{-1}soil h^{-1}) of soil at different stages of crop growth in pearmillet and greengram

Treatments	Growth Stages								
	25 Days			50 Days			Harvest		
	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean
DFE_0	5.88	5.70	5.79	5.22	5.18	5.20	4.15	4.30	4.22
$DFE_{1.0}$	6.71	6.48	6.59	6.03	5.93	5.98	5.50	5.33	5.41
$DFE_{1.5}$	8.07	7.39	7.73	7.44	7.23	7.33	5.81	5.53	5.61
$DFE_{3.0}$	11.24	10.58	10.91	10.21	9.83	10.02	8.76	8.56	8.66
$DFE_{4.5}$	6.37	6.13	6.25	5.88	5.67	5.77	4.99	5.07	5.03
Mean	7.65	7.26		6.96	6.77		5.84	5.76	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Crops	0.0516	0.1524	0.0525	0.1547	0.0506	NS
Treatments	0.0817	0.2409	0.0829	0.2447	0.0799	0.2358
Interaction	0.1155	NS	0.1173	NS	0.1130	NS

Table 3. Acid phosphatase activity (µg of *p*-nitrophenol g^{-1} soil h^{-1}) of soil at different stages of crop growth in pearmillet and greengram

Treatments	Growth Stages								
	25 Days			50 Days			Harvest		
	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean
DFE_0	43.10	45.26	44.18	41.16	43.21	42.19	40.60	41.64	41.12
$DFE_{1.0}$	48.42	50.30	49.36	43.67	46.70	45.18	41.20	42.34	41.17
$DFE_{1.5}$	50.21	54.41	52.31	47.78	55.67	51.72	45.34	46.27	45.80
$DFE_{3.0}$	54.95	56.40	55.68	53.24	56.34	54.79	51.64	52.17	51.91
$DFE_{4.5}$	49.34	53.61	51.48	46.27	54.29	50.38	43.22	44.62	43.92
Mean	49.20	52.00		46.46	51.24		44.40	45.41	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Crops	0.5663	1.6706	0.5617	1.6570	0.5664	NS
Treatments	0.8954	2.6415	0.8881	2.6200	0.8955	2.6418
Interaction	1.2663	NS	1.2560	NS	1.2664	NS

Table 4. Alkaline phosphatase activity (µg *p*-nitrophenol g^{-1} soil h^{-1}) of soil at different stages of crop growth in pearmillet and greengram

Treatments	Growth Stages								
	25 Days			50 Days			Harvest		
	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean
DFE_0	47.30	48.30	47.80	43.43	44.20	43.82	37.50	38.23	37.83
$DFE_{1.0}$	53.27	52.28	52.77	49.28	48.38	48.83	40.61	42.63	41.62
$DFE_{1.5}$	58.26	59.19	58.78	54.26	55.19	54.73	42.29	48.30	45.30
$DFE_{3.0}$	63.41	64.71	64.06	59.42	60.71	60.07	58.00	59.72	58.86
$DFE_{4.5}$	54.28	55.71	54.99	50.29	51.74	51.02	39.61	41.61	40.61
Mean	55.32	56.04		51.34	52.04		43.60	46.10	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Crops	0.5636	NS	0.5557	NS	0.5543	1.6281
Treatments	0.8911	2.6288	0.8786	2.5920	0.873	2.5743
Interaction	1.2602	NS	1.2426	NS	1.2307	NS

Table 5. Arylsulfatase activity (µg of *p*-nitrophenol g^{-1} soil h^{-1}) of soil at different stages of crop growth in pearmillet and greengram

Treatments	Growth Stages								
	25 Days			50 Days			Harvest		
	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean	Pearlmillet	Greengram	Mean
DFE_0	46.70	45.00	45.85	43.10	41.08	42.09	36.21	32.00	34.10
$DFE_{1.0}$	56.60	53.00	54.80	50.61	48.36	49.49	41.26	43.26	42.26
$DFE_{1.5}$	60.00	61.27	60.63	57.00	55.28	56.14	50.33	52.61	51.47
$DFE_{3.0}$	65.71	63.28	64.50	62.80	60.37	61.58	57.80	57.34	57.57
$DFE_{4.5}$	52.80	50.68	51.74	48.67	45.89	47.28	39.88	39.16	39.52
Mean	56.36	54.65		52.44	50.20		45.10	44.87	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Crops	0.5194	1.5322	0.5164	0.15235	0.5170	NS
Treatments	0.8212	2.4226	0.8165	2.4089	0.8175	2.4117
Interaction	1.1614	NS	1.1548	NS	1.1561	NS

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