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Research Article

MICROBIAL AND ENZYME ACTIVITY IN SOIL AFTER BANANA RATOON CROP AS INFLUENCED BY COFFEE PULP EFFLUENT IRRIGATION AND MICROBIAL CULTURE

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Abstract- To study the effect of coffee pulp effluent irrigation on yield and yield attributing characters of banana, a field investigation was carried out during 2006 and 2007 at Kollibylu, Mudigere, Chikmagalur District. Application of raw coffee pulp effluent without microbial culture recorded higher fungi population (7.03 CFU x $104g^{-1}$) followed by all the other effluent irrigated treatments. Alternate irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded higher bacterial population (9.00 CFU x $107g^{-1}$). Lime treated coffee pulp effluent irrigation with microbial culture recorded higher actinomycetes population (6.43 CFU x $103g^{-1}$). Lime treated coffee pulp effluent irrigation with microbial culture recorded higher dehydrogenase activity (336.9 µg TPF $g^{-1}d^{-1}$), raw coffee pulp effluent irrigation without microbial culture recorded higher urease activity (141.4 µg $NH4\text{-}Ng^{-1}h^{-1}$) and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded higher phosphatase activity (65.00 µ mol $p\text{-}NPg^{-1}h^{-1}$) as compare to the other treatments.

Keywords- *Pulp, Effluent, BOD, COD, Microbial, Culture, Alternate*

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Introduction

Water is one of the most valuable natural resource available to man for his domestic, agricultural and industrial uses. Growth of population, massive urbanization, rapid rate of industrialization and availability of modern technology in agriculture have accelerated water pollution and led to the gradual deterioration of its quality. India is the seventh largest nation in terms of industries. Majority of the industries are agro-based and utilize large volumes of good quality water and other raw materials and generate almost entire quantity of water as effluent and appreciable quantities of solid wastes. Demand by these industries for water is expected to increase from 5 percent in 2000 to 11.5 percent by 2010 and 23 percent by 2025. Generation of large volume of effluent due to the phenomenal growth of industries and huge quantities of sewage effluent due to population explosion pose a serious threat to environment and water resources [1]. The changing scenario of both issues had researchers to develop strategies for effective utilization of water resources in food production. One among them is recycling of industrial and sewage effluent for crop production, which is having dual advantage of waste recycling with minimizing environmental pollution.

Coffee is being cultivated on an area of 3 lakh hectares in India, out of which 2 lakh hectares is in Karnataka. Coffee requires large quantities of water for post harvesting processing, which inturn discharged as effluent to natural water bodies posing serious environmental problems. The consumption of water varies from 9-13 cubic meters and from 17-20 cubic meters per ton of coffee processed with or without recycling. Hence there is a great need to conduct studies to overcome the problems of pollution and to suggest the ways of waste water disposal for better purpose like irrigation and manuring.

There is a great potential in trapping nutritive values these effluents, which is known to have considerable quantities of major and minor plant nutrients. In this context the present study was conducted to utilize the coffee pulp effluent for production of baby corn.

Material and Methods

The experiment was carried out during 2006 and 2007 on farmer's field at Kollibylu, Mudigere, Chikmagalur District, Karnataka, India. The experiment was laid out in RCBD design with 3 replications includes 9 treatments. T1 - Fresh water irrigation, T2 - Raw effluent irrigation without microbial culture, T3- Raw effluent irrigation with microbial culture, T4 - Lime treated effluent irrigation without microbial culture, T5 - Lime treated effluent irrigation with microbial culture, T6 - Alternate irrigation with lime treated effluent and fresh water without microbial culture,T7 - Alternate irrigation with lime treated effluent and fresh water with microbial culture, T8- 1:1 ratio irrigation with lime treated effluent and fresh water without microbial culture, T9- 1:1 ratio irrigation with lime treated effluent and fresh water with microbial culture. *Pleurotus florida* and *Trichoderma viride* used as a microbial culture for treating coffee pulp effluent. Banana tissue culture variety Grand naine was used as test crop and was planted in first week of September 2006 at a spacing of 2 m X 2 m. A fertilizer dose of 200:100:300 g N: P_2O_5:K_2O per plant were applied to the crop at different growth stages. FYM (10 kg pit^{-1}) was supplied and mixed thoroughly in to the top soil 15 days prior to planting. The coffee pulp effluent was used as source of irrigation and it was applied as per the crop water requirement during pulping season (December to April).

Table-1 *Chemical composition of raw and treated coffee pulp effluent*

Parameters	Raw effluent	Microbial treated effluent	Lime treated effluent	Microbial and lime treated effluent
pH	3.94	4.27	7.16	7.59
EC (dSm^{-1})	1.366	1.091	1.343	1.112
Suspended solids (g l^{-1})	7.843	4.512	5.766	3.614
Dissolved solids (g l^{-1})	8.265	4.954	6.572	4.789
Total solids (g l^{-1})	16.108	9.466	12.338	8.403
BOD (mg l^{-1})	16500	10200	13600	7800
COD (mg l^{-1})	27700	20400	24200	14900
Chlorides (meq l^{-1})	5.84	5.21	4.63	5.42
Bicarbonates (meq l^{-1})	6.72	7.04	6.37	6.82
Total nitrogen (%)	0.105	0.094	0.099	0.112
Total phosphorus (%)	0.0023	0.0028	0.0037	0.0032
Total potassium (%)	0.058	0.0583	0.0613	0.0501
Iron (ppm)	24.49	25.02	23.17	23.33
Zinc (ppm)	0.696	0.762	0.667	0.621
Copper (ppm)	1.793	1.833	2.162	1.810
Manganese (ppm)	0.586	0.531	0.494	0.511

Table-2 *Microbial population and enzyme activity in soil after banana ratoon crop as influenced by coffee pulp effluent irrigation and microbial culture*

Treatments	Fungi ($CFUx10^4\ g^{-1}$)	Bacteria ($CFUx10^7\ g^{-1}$)	Actinomycetes ($CFUx10^3\ g^{-1}$)	Dehydrogenase (µg TPF $g^{-1}\ d^{-1}$)	Urease (µg NH_4-N $g^{-1}\ h^{-1}$)	Phosphatase (µ mol p-NP $g^{-1}\ h^{-1}$)
T_1	3.60	6.83	3.53	137.1	88.8	34.47
T_2	6.83	4.70	4.70	334.6	124.3	42.37
T_3	7.03	5.10	4.67	302.5	117.9	46.17
T_4	6.97	7.33	5.73	318.6	157.5	40.17
T_5	6.63	7.03	7.17	361.6	141.1	37.93
T_6	5.17	8.13	6.27	344.2	127.8	54.30
T_7	5.23	9.00	6.73	317.5	127.7	64.07
T_8	5.20	7.60	6.20	328.1	123.5	49.50
T_9	5.00	8.43	6.03	325.0	136.6	56.80
S.Em±	0.35	0.48	0.30	15.13	7.21	3.41
CD at 5%	1.05	1.44	0.91	45.37	21.63	10.23

T1 - Fresh water irrigation T2 - Raw CPE irrigation without microbial culture T3- Raw CPE irrigation with microbial culture T4 - Lime treated CPE irrigation without microbial culture T5 - Lime treated CPE irrigation with microbial culture T6 - Alternate irrigation with lime treated CPE and fresh water without microbial culture T7 - Alternate irrigation with lime treated CPE and fresh water with microbial culture T8- 1:1 ratio irrigation with lime treated CPE and fresh water without microbial culture T9- 1:1 ratio irrigation with lime treated CPE and fresh water with microbial culture Note: Recommended dose of fertilizer and FYM is common for all the treatments.

The preliminary analysis of raw and treated coffee pulp effluents was given in the [Table-1]. The pH of raw effluent (3.94) and microbial treated effluent (4.27) was acidic in nature, whereas lime treated effluent (7.16) and microbial and lime treated effluent (7.59) are near to neutral in range. The electrical conductivity ranged from 1.091 to1.366 dSm^{-1}. Higher total solids (suspended solids and dissolved solids) were recorded in raw effluent (16.108 g l^{-1}) followed by lime treated effluent (12.338 g l^{-1}), microbial treated effluent (9.466 g l^{-1}) and microbial and lime treated effluent (8.403 g l^{-1}). The concentration of BOD and COD varied with the treatment of effluent. Raw effluent recorded maximum values (16500 and 27700 mg l^{-1}, respectively) and microbial and lime treated effluent (7800 and 14900 mg l^{-1}, respectively) recorded minimum values. The samples were also analyzed for major and micronutrient contents. There is no much difference with respect to the major and micronutrient contents of treated and raw effluent. Growth and yield observation were recorded and statistically analyzed [2].

Results and Discussion

Soil beneficial microorganisms differed significantly due to coffee pulp effluent irrigation and microbial culture [Table-2]. Application of raw coffee pulp effluent without microbial culture recorded higher fungi population (7.03 CFU x $104g^{-1}$) followed by all the other effluent irrigated treatments. Alternate irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded higher bacterial population (9.00 CFU x $107g^{-1}$). Lime treated coffee pulp effluent irrigation with microbial culture recorded higher actinomycetes population (6.43 CFU x $103g^{-1}$). Significantly lower fungi and actinomycetes population were recorded in fresh water irrigation (3.83 CFU x $104g^{-1}$ and 3.83 CFU x $103g^{-1}$, respectively), whereas lower bacterial population was recorded in raw coffee pulp effluent without microbial culture (5.63 CFU x 107 g^{-1}). Application of lime treated coffee pulp effluent recorded higher fungi and actinomycetes population (5.60 CFU x 104 g^{-1} and 5.47 CFU x 103 g^{-1}, 6.69 CFU x 104 g^{-1} and 5.91 CFU x 103 g^{-1}, respectively). 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water recorded higher bacterial population (8.28 CFU x $107g^{-1}$ and 7.84 CFU x $107g^{-1}$, respectively). This enhancement in soil fungi, bacteria and actinomycetes could be attributed to addition of organic matter through coffee pulp effluent. However, soil bacterial population was lower in raw coffee pulp effluent irrigation without microbial culture. Reduced soil pH towards acidic range favours the growth of fungal population and hence decreased the multiplication of bacteria. However, soil bacterial population was higher in 1:1 ratio irrigation with lime treated coffee pulp effluent irrigation. This is due to slightly increased soil pH towards neutral range favouring the growth of bacterial population [3]. Addition of sewage increased the bacterial and fungal population [4]. The soil fungi, bacterial and actinomycetes population were increased due to application of coffee pulp effluent [5,6]. Soil enzymes activity differed significantly due to coffee pulp effluent irrigation and microbial culture [Table-2]. Lime treated coffee pulp effluent irrigation with microbial culture recorded higher dehydrogenase activity (336.9 µgTPF$g^{-1}d^{-1}$), raw coffee pulp effluent irrigation without microbial culture recorded higher urease activity (141.4 µg NH4-N$g^{-1}h^{-1}$) and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded higher phosphatase activity (65.00 µ mol p-NP$g^{-1}h^{-1}$)followed by other effluent treatments. Significantly lower dehydrogenase (116.5 µ g TPF $g^{-1}d^{-1}$), urease (80.5 µg NH4-N$g^{-1}h^{-1}$ and phosphatase (µ mol p-NP $g^{-1}h^{-1}$) activity was noticed in fresh water irrigation. Lime treated coffee pulp effluent irrigation recorded higher dehydrogenase and urease activity (314.7 µg TPF $g^{-1}d^{-1}$ and 140.8 µgNH4-N$g^{-1}h^{-1}$, respectively) and alternate irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded higher phosphatase activity (61.1 µ mol p-NP$g^{-1}h^{-1}$ and 60.8 µ mol p-NP$g^{-1}h^{-1}$, respectively) in soil after harvest of banana plant and ratoon crop. Decomposition of organic matter led to production of more humic substances in the soil thereby enhancing the enzymatic activity in the soil. Biological properties of soil were significantly influenced by coffee pulp effluent irrigation. Treated effluent irrigation recorded significantly higher alkaline phosphatase, acid phosphatase and urease activities in soil except

dehydrogenase activity, which was found to be significantly higher in soil irrigated with 1: 1 ratio of raw effluent and fresh water [7]. The soil fungi, bacteria, actinomycetes population and enzymes activities were significantly higher in coffee pulp effluent irrigation as compared to fresh irrigation [6].

Application of research: Normally, the effluent is discharged indiscriminately in to paddy lands without growing any crop. Under such situations coffee pulp effluent can serve as source of both water and nutrients, besides it contains a higher amount of organic matter, which is helpful in the build up of organic carbon content and serves as a source of microorganisms in the soil and which, solves the pollution problem.

Research Category: Agronomy.

Abbreviations: BOD- Biological Oxygen Demand, COD- Chemical Oxygen Demand, ha- hactare, l- liter, g- gram, mg- milligram, ppm- parts per million, %- percent, dSm^{-1}- desi simons per meter, pH- power of Hydrogen, EC- Electric Conductivity, meq- milli equivalent, cm- centimeter, m- meter, SEm- Standard Error mean, CD- critical Difference, NS- Non Significant, FYM- Farm Yard Mannure, CPE- Coffee Pulp Effluent, CFU- Colony Forming Unit, TPF- triphenylformazan.

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Study area / Sample Collection: Mudigere

Cultivar / Variety / Breed name: G-nine Banana

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References

[1] Rani Perumal and Singaram P. (1996) *Indian J. Agric. Chem*., XXIX (1&2), 1-8.
[2] Panse V.G. and Sukhatme P.V. (1961) *Indian Council of Agricultural Research, New Delhi*, 347.
[3] Ekar T. and Bhattacharya A.K. (1982) *Pergamon Press Ltd., Oxford, United Kingdom*, 447-460.
[4] Sukanya T.S. and Meli S.S. (2004) *Karnataka J. Agric. Sci*., 17 (3), 405-409.
[5] Janeesh A.C. (2008) *M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore, India.*
[6] Singh Y. and Raj Bahadur (1997) *Indian J. Ecology*, 24, 53-59.
[7] Dhananjaya B.N. (2005) *Ph.D. Thesis, University of Agricultural Sciences, Bangalore, India.*