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Impact of Coffee Pulp Effluent on Biological and Chemical Properties of the Soil

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Abstract: ***The field experiment was conducted to study the impact of coffee pulp effluent on biological and chemical properties of the soil. Among the different effluent treatment, raw coffee pulp effluent along with soil inoculation of pleurotus and raw coffee pulp effluent irrigation treatment recorded significantly higher organic carbon content (0.57 % and 0.56 % respectively) in soil as compare to fresh water irrigation treatment (0.46 %). Soil available nitrogen, phosphorous and potassium were also significantly increased (314.0, 77.5 and 416.1 kg ha^{-1}, respectively) with application of raw effluent irrigation as compared to fresh water irrigation. However, fungi population was higher with lime treated effluent irrigation (9.5 x10^{4} cfu g^{-1}). Whereas, coffee pulp effluent irrigation + soil inoculation of pleurotus recorded higher actinomycetes population (7.2 x10^{3} cfu g^{-1}) over other treatment. Nitrogen fixer, p-solubilizer and Dehydrogenase activity were higher in raw coffee pulp effluent treatment and was on par with lime treated coffee pulp effluent irrigation + soil inoculation of pleurotus***

Keywords: Coffee pulp effluent, enzyme activity and Microorganisms

1. Introduction

Current agricultural water use accounts for 83 per cent of total water use. The modern agriculture is also responsible for development of large number of industries specially the agro-based industries through supply of wide variety of raw materials to these industries. Demand by these industries for water is expected to increase from five per cent in 2000 to 11.5 per cent by 2010 and 23 per cent by 2025. Generation of large volume of effluents due to phenomenal growth of industries pose a serious threat to environment and water resources (Rani Perumal and Singaram, 1996)

It has been estimated that about 75,000 to 80,000 litres of waste water is generated for curing one ton coffee beans (Damodaran, 1998) and to process 2.23 lakh tons of coffee through wet processing, 8.4 million cubic metres of waste water is generated (Anand Alwar, 1998). The issue of water pollution became very serious when the Karnataka State Pollution Control Board passed strictures to close the pulping units in Chikmagalur district during 1995-96. The by-products of coffee processing are mainly coffee pulp, pulp effluent, parchment husks and coffee husk. Due to contribution of these byproducts to environmental pollution, effective environmentally friendly disposal methods are very essential (Mburu and Mwaura, 1996). Presently, neutralization of effluent with lime and storing in pits is being adopted for treatment of wastewater, which may not effectively protect the water environment (Anand Alwar, 1998). Hence, there is a great need to conduct studies to suggest safe ways of waste disposal for better purposes like irrigation in agriculture in the locales where the effluent is generated. Therefore the study was conducted to find out the impact of coffee pulp effluent irrigation irrigation on biological and chemical properties of the soil.

2. Materials and Methods

The field experiment was conducted during summer seasons in the farmer's field at Chikmangalore district. The soil of the experimental site was clay loam in texture with coarse sand (32.95%), fine sand (14.35%), silt (10.15%) and clay (26.80 %). The soil was slightly acidic in nature (pH-5.98), low in EC (0.043 dSm-1) and medium in organic carbon content (0.52 %). The soil was low in available nitrogen (211.6 kg ha^{-1}) medium in available phosphorus (49.2 kg ha^{-1}) and medium in available potassium and nutrient composition of the applied effluent is presented in Table 1.

The normal average rainfall of the location is 2431.5 mm. minimum and maximum temperature ranges from 29.47 to 31.56 and 15.38 to 18.63 ^{o}C respectively. The mean relative humidity ranged from 83.8% to 88.8% and experimental plot was laid out in randomized block design with 4 replication. The treatment comprised of 6 with 4 replication *viz.*, T_1 : fresh water irrigation T_2:Raw coffee pulp effluent irrigation T_3: 1:1 ratio of fresh water irrigation and raw effluent irrigation T_4: coffee pulp effluent irrigation + soil inoculation of *pleurotus* T_5: Lime treated coffee pulp effluent irrigation T_6: : Lime treated coffee pulp effluent irrigation + soil inoculation of *pleurotus*. The hybrid napir grass with a variety CO-3 was planted with a spacing of 60 cm X 45 cm and apply 5 kg of Pleurotus and 30 kg of lime as per the treatment. Data collected from the experimental plot was subjected to statistical analysis as given by Panse and Sukhatme (1953)

3. Results and Discussion

Organic carbon content of soil

Organic carbon content of soil differed significantly due to application of coffee pulp effluent as compared to fresh water irrigation (0.46 %). Raw effluent irrigation recorded highest organic carbon (0.57 %). This may be because of the fact that the organic carbon content of the soil was enhanced due to effluent irrigation as large quantities of organic material was added to the soil through effluent. Similar results have been reported by Arora *et al*. (1995). These results are in corroborate with the findings of Raj and Bahadur (1998) and Pathak *et al* (1999).

Available nitrogen content of soil

There was an increase in the nitrogen content of the soil treated with the effluent. The raw effluent irrigation along with soil inoculation of Pleurotus (315.2 kg ha-1) and raw effluent irrigation (314.0 kg ha-1) and lime treated effluent irrigation along with soil inoculation (312.5 kg ha-1) recorded maximum values, the least was found in fresh water irrigation (249.4 kg ha-1) with respect to available nitrogen in the soil. This may be attributed to the addition of nitrogen through organic materials present in the effluent. The nitrogen content in the effluent was to the extent of 0.13 % and due to application of effluent through various treatments., the addition of nitrogen was 2246.4 kg ha-1. The enormous quantity of nitrogen addition had definitely contributed for increased availability of nitrogen in soil at harvest of the crop.. similar results are also observed by Salakinkop et al. (2000), Sukhanya and Meli (2003).

Available phosphorus content of soil

Application of coffee pulp effluent irrigation increased the available phosphorus in the soil. Availability in effluent applied soil dependent on the release of inorganic phosphorus after mineralization, another reason for low availability of phosphorus at low pH can be attributed to higher iron content of effluent which have formed insoluble iron phosphate. These results are in corroborate with the findings of Pawankumar (1977), Srinivasamurthy (1983), anil kumar (1995) and Joshi et al (1996).

Available potassium content of soil

Rate of mineralization of coffee pulp effluent is directly related to the release of potassium in soil. Effluent treatments increased the available potassium in the soil. Although potassium content of the effluent was to the extent of 0.056 %, a large quantity of potassium 967.68 kg ha-1 in various treatments was added. This positively would have contributed for higher potassium at the time of harvest of crop . in addition, effluent irrigation had increased the available potassium content of the soil probably because of the higher calcium content of the effluent, which might have replaced potassium fro soil exchange complex. These results are in conformity with the findings of Mitra and Gupta (1999) and Pathak *et al* (1998)

Beneficial microorganisms and Dehydrogenase activity of soil as influenced by coffee pulp effluent irrigation

Bacteria, Fungi, Actinomycetes and nitrogen fixer

Bacterial population in soil differed significantly due to effluent irrigation. Among the effluent irrigation, raw effluent irrigation along with soil inoculation of Pleurotus recorded higher bacterial population (9 x 105 cfu g-1) followed by other effluent irrigation applied treatments. Fresh water irrigation recorded lowest bacterial population (6 x 105 cfu g-1), which could be attributed to presence of bacteria in the treated water. This enhancement may also be attributed to the increase in nutrient status of the soil as result may also be attributed to the increased nutrient status of the soil as a result of addition of organic matter content through effluent. These results are in conformity with the findings of Bhattacharya (1982)

Fungal population in the soil differed significantly due to effluent irrigation. Lime treated effluent irrigation recorded higher fungal population (9.5 x 104 cfu g-1). Fresh water irrigation recorded lower fungal population (4.0 x 104 cfu g-1), which attributed to increased nutrient status of the soil as a result of addition of organic matter through effluent irrigation and also might be due to increase in pH to slightly neutral which favours the growth and multiplication of fumgi. Similar results have also observed by Ramanathan et al (1971).

Actinomycetes population differed significantly due to effluent irrigation. Raw effluent irrigation along with soil inoculation of Pleurotus recorded higher actinimycetes population (7.2 x 103 cfu g^{-1}). Fresh water irrigation recorded lower actinimycetes population (3.5 x 103 cfu g^{-1}). Similar results have been observed by Ramanathan *et al* (1971)

Fresh water irrigation and lime treated effluent irrigation along with soil inoculation of pleurotus recorded (2.5 x 10^3 cfu g^{-1}) higher nitrogen fixer in soil and lower nitrogen fixer is observed in raw effluent irrigation (0.75 x 10^3 cfu g^{-1}). This attributed to toxic nature of raw effluent. Phosphorus solubilizers in soil differed significantly due to effluent irrigation. Fresh water irrigation recorded higher P-solubilizer (4.9 x 10^3 cfu g^{-1}) and raw effluent irrigation recorded lower P- solubilizers this might be due to toxic nature of effluent. Similar results were also observed by Rao *et al* (1993)

Dehydrogenase activity

Dehydrogenase activity in soil differed significantly due to effluent irrigation. Fresh water irrigation recorded higher Dehydrogenase activity (1.22 µg TPF g^{-1} h^{-1}) and raw effluent irrigation recorded lower Dehydrogenase activity (0.84 µg TPF g^{-1} h^{-1}) . Similar results were also observed by Sukhanya and Meli (1993). Finally concluded that fresh water irrigation recorded significantly higher microbial activity and enzymatic activity compared to rest of the treatment and was followed by lime treated effluent irrigation along with soil inoculation of Pleurotus.

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Table 1: Organic carbon (%), Available N, P and K content (kg ha^{-1}) of soil at harvest of hybrid napier grass at harvest as influenced by coffee pulp effluent irrigation

Treatments	Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
T_1	0.46	249.4	58.0	337.0
T_2	0.56	314.0	77.5	416.1
T_3	0.48	275.2	63.3	360.5
T_4	0.57	315.2	78.6	414.7
T_5	0.54	312.5	76.2	400.5
T_6	0.54	313.2	77.1	405.0
S.Em±	0.008	2.007	0.473	2.722
C.D at 5%	0.025	6.048	1.426	8.203

T_1:Fresh water irrigation
T_2:Raw coffee pulp effluent irrigation
T_3:1:1 ratio fresh water and raw effluent irrigation
T_4: Coffee pulp effluent irrigation + soil inoculation of *pleurotus*
T_5: Lime treated coffee pulp effluent irrigation
T_6: Lime treated coffee pulp effluent irrigation + soil inoculation of *pleurotus*

Table 2: Effect of coffee pulp effluent irrigation on soil microbial population and Dehydrogenase activity under hybrid napier grass

Treatments	Bacteria ($x10^5$ cfu g^{-1})	Fungi ($x10^4$ cfu g^{-1})	Actinomycetes ($x10^3$cfu g^{-1})	Nitrogen fixer ($x10^3$cfu g^{-1})	P solubilizers ($x10^3$ cfu g^{-1})	Dehydrogenase activity (µg TPF^{-1} $g^{-1}h^{-1}$)
T_1	6.0	4.0	3.5	2.5	4.9	1.22
T_2	7.5	6.2	5.2	0.8	3.5	0.84
T_3	7.7	5.0	4.5	1.8	3.9	1.01
T_4	9.0	7.5	7.2	1.6	4.0	0.92
T_5	7.0	7.0	6.2	1.5	3.8	0.85
T_6	8.5	9.5	6.0	2.5	4.8	1.19
S.Em±	2.22	0.44	0.39	0.24	0.35	0.053
C.D at 5%	NS	1.34	1.19	0.72	1.05	0.179

T_1:Fresh water irrigation
T_2:Raw coffee pulp effluent irrigation
T_3:1:1 ratio fresh water and raw effluent irrigation
T_4: Coffee pulp effluent irrigation + soil inoculation of *pleurotus*
T_5: Lime treated coffee pulp effluent irrigation
T_6: Lime treated coffee pulp effluent irrigation + soil inoculation of *pleurotus*