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RESEARCH ARTICLE

EFFECT OF COFFEE PULP EFFLUENT ON QUALITY, NUTRIENT UPTAKE AND ECONOMICS OF HYBRID NAPIER GRASS

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ABSTRACT

The field experiment was conducted during summer season in farmer's field at kollybyle village, Mudigere taluk, Chikamagalore district. In hybrid napier grass raw effluent irrigation (10.69 % and 9.86 %) and raw effluent irrigation along with soil inoculation of *pleurotus* (9.11 % and 9.09%) recorded significantly higher crude protein content as compared to fresh water irrigation (5.57 % and 4.85 %), lower fibre content was recorded in raw effluent (24.7 % and 23.8 %) and fresh water irrigation treatments (29.4 5 and 30.4 %) recorded highest fibre content both in first cut and second cut. Higher chlorophyll content was recorded in fresh water irrigation treatment (2.87 mg g^{-1} and 2.91 m g g^{-1}) and lowest chlorophyll content was observed in raw effluent irrigation treatment (2.08 mg g^{-1} and 2.15 mg g^{-1}) both in first cut and second cut.

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INTRODUCTION

Land application of waste water is one of the most economically and ecologically viable methods (Thomas and Law, 1968). Use of waste water in agriculture is gaining importance now-adays, because of its value as a potential irrigant and nutrient donor. Use of waste water for irrigation makes it possible to conserve the limited water resources after subjecting the waste water to some preliminary treatment to remove the toxic substances present in them. Coffee is being cultivated in an area of 3.55 lakh hectares in India out of which 2.04 lakh hectares in Karnataka. In agro-based coffee processing industry, coffee is processed either by wet method or by dry method to produced washed coffee and unwashed coffee respectively. In wet method coffee berries retain mucilage after pulping and later mucilage is removed by subjecting coffee fruits to fermentation. During fermentation of the mucilage only little amount of water is absorbed by raw fruits and thus the wet process discharges large quantities of the effluent. These effluents are known to contain both organic and inorganic compounds and some of them are toxic in nature. Most of the farmer's usually discharge the effluent with or without treatment into water courses and on to the agricultural lands. In some places, coffee pulp effluent is also stored in small ponds called lagoons. Utilization of these treated effluents would enable to grow crops during summer seasons.

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MATERIALS AND METHODS

The field experiment was conducted during summer seasons in the farmer's field at Mudigere taluk, 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 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., T1 : fresh water irrigation T2:Raw coffee pulp effluent irrigation T3: 1:1 ratio of fresh water irrigation and raw effluent irrigation T4: coffee pulp effluent irrigation + soil inoculation of *pleurotus* T5: Lime treated coffee pulp effluent irrigation T6: : 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).

RESULTS AND DISCUSSION

Quality parameters in hybrid napier grass

Crude protein content

The crude protein content of hybrid napier grass differed significantly due to nature of irrigation. Raw effluent irrigation recorded higher crude protein both in first (10.69 %) and second cut (9.86 %) in hybrid napier grass. Other treatments with effluent irrigation recorded moderate protein contents. Whereas, fresh water irrigation (5.57 % and 4.85 %, respectively) recorded lowest crude protein content both in first cut and second cut. The increased protein content in effluent treated plots might be due to higher content of nitrogen observed in hybrid napier grass which received effluent irrigation (1.50 % and 1.47 %). This is mainly attributed to additional supply of nitrogen through effluent irrigation which encouraged the crop to take up more nitrogen. Nitrogen is major components of amino acids which are fundamental building units of protein and significantly lower yield in effluent irrigation treatments resulting in higher nitrogen accumulation and eventually higher protein distribution. Concentration of nitrogen in both soil and plant was significantly lower in fresh water irrigation which might have been resulted in lower protein yield improvement in quality of grass in terms of protein content it found beneficial to produce higher productivity of protein per unit area, although the biomass yields are found to reduced by effluent irrigation. These results are in conformity with the findings of Salakinkop (1991) Nagaraj (1981) and Pujar (1995). Crude fibre content The lowest crude fibre content was recorded in raw effluent irrigation both in first cut (24.7 %) and second cut (23.8%) followed by other effluent irrigation and highest crude fibre content was recorded in fresh water irrigation both in first cut as well as well as second cut (29.2 %, 30.4 %, respectively). The lower crude fibre content in babies with effluent irrigation was mainly attributed to higher crude protein content in hybrid napier grass that had decreased the deposition of lignin ans cellulose. The protein and fibre contents in plants are normally inversely related. Thus increasing one content might have resulted in decrease of the other quality (Basavalingaiah, 2004). The decrease in crude fibre is desirable in crops like fodder grass as it improves the palatability of the grass to the cattle.

Chlorophyll content

Fresh water irrigation recorded higher chlorophyll content in both the cuts (2.87 mg g-1 and 2.91, respectively). Lowest chlorophyll content was observed in raw effluent irrigation (2.08 mg g^{-1} and 2.51 mg g^{-1}). This is attributed to higher magnesium content (0.35 % and 0.36 %) in fresh water irrigation treatment as compared to other treatment. Magnesium is an important constituent of chlorophyll, thus increase magnesium content has resulted in increasing chlorophyll content of leaves.

Nitrogen content of hybrid napier grass

Raw effluent irrigation recorded significantly higher nitrogen content both in first cut (1.50 %) and second cut (1.47 %) followed by raw effluent irrigation along with soil inoculation of *Pleurotus* (1.45 % and 1.46 % respectively), lime treated effluent irrigation along with soil inoculation of *Pleurotus* (1.18 %, 1.19%) and other effluent application treatments as compared to fresh water irrigation (1.09 % and 1.01 %, respectively). Higher absorption and translocation of nitrogen in effluent application treatment might be due to addition of large quantities of nitrogen through effluent which had resulted in higher availability of nitrogen in soil after mineralization in soil. Since the nitrogen added through effluent was in organic form which might have released nitrogen through out the crop growth thus, contributing for higher concentration by accumulated in hybrid napier grass even at the time of harvest.

Phosphorus content of hybrid napier grass

Concentration of P in the plant tissue differed significantly due to the application of effluent. The raw effluent irrigation recorded higher P content both in first (0.22%) and second cut (0.24 %) followed by other applied treatments. Fresh water irrigation recorded lowest P concentration in the hybrid napier grass (0.14 % and 0.16 %, respectively). Higher P concentration in the hybrid napier grass with effluent irrigation treatment was mainly due to additional supply of these nutrients through effluent that lead to higher concentration of P in the soil encouraging more uptake and also reduced biomass production was mainly responsible for higher phosphorous concentration in crops. These results are in corroborate with the findings of Sukanya and Meli (2003) and Babu *et al*. (1996)

Potassium content of hybrid napier grass

Among the effluent treatments, lime treated effluent irrigation along with soil inoculation of *Pleurotus* recorded potassium in the plant tissue both in first (1.37 %) and second cut (1.32 %) followed by lime treated effluent irrigation (1.30 % and 1.30 %, respectively) and lowest in case of fresh water irrigation (1.15 %, 1.18 %). Higher concentration of potassium in the hybrid napier grass under effluent irrigation could be attributed to application of additional quantities of potassium through effluent over fresh water irrigation. This study could be strongly supported by findings of Babu *et al*., (1996) and Sukanya and Meli (2003).

Calcium content of hybrid napier grass

Lime treated effluent irrigation along with soil inoculation of *Pleurotus* recorded higher calcium content both in first cut (0.27 %) and second cut (0.28 %) followed by lime treated effluent irrigation (0.26 %, 0.27% respectively). Lowest calcium per cent was observed in fresh water irrigation. This is attributed to addition of extra amount of calcium through lime is mainly responsible for increase in calcium content in treated effluent compared to fresh water irrigation.

Magnesium content of hybrid napier grass

Fresh water irrigation recorded higher magnesium content both in first cut (0.35 %) and second cut (0.36 %) followed by 1 : 1 ratio of fresh water and raw effluent irrigation (0.30 %, 0.31 %, respectively) and lime treated effluent irrigation along with soil inoculation of *Pleurotus* (0.29 % and 0.30 %). Raw effluent irrigation recorded lower magnesium content both in first cut (0.23 %) and second cut (0.24 %), this is attributed to reduction in the pH of the soil when soil was treated with raw effluent and being acidic in nature effluent might have reduced magnesium availability under acidic condition availability is more in the pH range of 5.5 and 6.5. Sulphur content of hybrid napier grass Fresh water irrigation recorded higher sulphur content both in first cut (0.17 %) and second cut (0.17 %)

Table 1. Chlorophyll content (mgg^{-1}) Crude protein (%) and Crude fibre (%) of hybrid napier grass at harvest as influenced by coffee pulp effluent irrigation

Treatments	First cut			Second cut		
	Chlorophyll Content	Crude protein	Crude fibre	Chlorophyll Content	Crude protein	Crude fibre
T_1	2.87	5.57	29.2	2.91	4.85	30.4
T_2	2.08	10.69	24.7	2.15	9.86	23.8
T_3	2.51	7.38	26.2	2.60	6.77	25.1
T_4	2.21	9.11	24.8	2.32	9.09	24.4
T_5	2.62	7.22	27.8	2.64	7.21	27.5
T_6	2.76	6.88	26.2	2.70	7.02	25.6
S.Em±	0.028	0.46	0.26	0.021	0.40	0.52
C.D at 5%	0.085	1.39	0.79	0.064	1.22	1.54

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. Nitrogen (%), Phosphorous (%) and Potassium (%) of hybrid napier grass at harvest as influenced by coffee pulp effluent irrigation

Treatments	First cut			Second cut		
	Nitrogen	Phosphorous	Potassium	Nitrogen	Phosphorous	Potassium
T_1	1.09	0.14	1.15	1.01	0.16	1.18
T_2	1.50	0.22	1.23	1.47	0.24	1.21
T_3	1.13	0.18	1.25	1.08	0.17	1.23
T_4	1.45	0.17	1.23	1.45	0.20	1.24
T_5	1.17	0.18	1.30	1.19	0.18	1.30
T_6	1.18	0.16	1.37	1.18	0.19	1.30
S.Em±	0.15	0.005	0.015	0.097	0.007	0.028
C.D at 5%	0.45	0.016	0.048	0.29	0.020	0.086

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 3. Calcium (%), Magnesium (%) and Sulphur (%) of hybrid napier grass at harvest as influenced by coffee pulp effluent irrigation

Treatments	First cut			Second cut		
	Calcium	Magnesium	Sulphur	Calcium	Magnesium	Sulphur
T_1	1.09	0.14	1.15	1.01	0.16	1.18
T_2	1.50	0.22	1.23	1.47	0.24	1.21
T_3	1.13	0.18	1.25	1.08	0.17	1.23
T_4	1.45	0.17	1.23	1.45	0.20	1.24
T_5	1.17	0.18	1.30	1.19	0.18	1.30
T_6	1.18	0.16	1.37	1.18	0.19	1.30
S.Em±	0.15	0.005	0.015	0.097	0.007	0.028
C.D at 5%	0.45	0.016	0.048	0.29	0.020	0.086

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 4. Effect of coffee pulp effluent irrigation on soil microbial population and Dehydrogenase activity under hybrid napier grass

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha-1)	Net returns (Rs ha-1)	B: C ratio
T_1	11185	22190	11005	1.98
T_2	11185	15625	4440	1.40
T_3	11185	18470	7285	1.65
T_4	11435	17110	5675	1.50
T_5	12085	19090	7005	1.58
T_6	12335	20285	8050	1.64

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*

followed by other effluent treatment. This could be mainly due to acidic nature of the effluent. In acidic pH, sulphur availability will be low as compared to neutral pH or slightly acidic pH.

Economics of hybrid napier grass as influenced by coffee pulp effluent irrigation

Gross income varied due to varied nature of irrigation. Fresh water irrigation recorded higher net returns (Rs -11 1005 ha) as against raw effluent irrigation (Rs 4440 -1h a), which was lowest among other treatments. This was mainly due to higher green forage yield produced under fresh water irrigation. Fresh water irrigation recorded higher B:C ratio (1.98) as compared to raw effluent irrigation (1.40). It was due to higher green forage yield under fresh water irrigation.

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