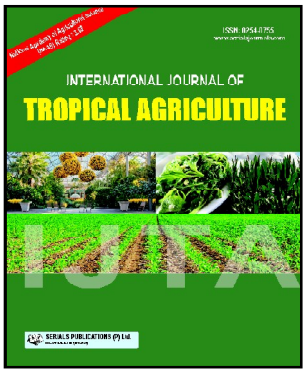

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Fruit Characters and Yield of Banana Main Crop and Ratoon Crop as Influence by Coffee Pulp Effluent Irrigation

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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 to 2009 at Kollibylu, Mudigere, Chikmagalur District. Alternate irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded maximum bunch yield of main crop and ratoon crop (75.1 t ha^{-1} and 69.6 t ha^{-1}, respectively) which was on par with alternate irrigation with lime treated coffee pulp effluent and fresh water without microbial culture (71.0 t ha^{-1} and 67.1 t ha^{-1}, respectively) followed by fresh water irrigation (70.7 t ha^{-1} and 67.4 t ha^{-1}, respectively), 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water with microbial culture (70.5 t ha^{-1} and 66.2 t ha^{-1}, respectively) and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water without microbial culture (70.1 t ha^{-1} and 65.6 t ha^{-1}, respectively). The lowest bunch yield was recorded in raw coffee pulp effluent irrigation without microbial culture (38.6 t ha^{-1} and 37.6 t ha^{-1}, respectively) which was significantly inferior to all the other treatments.

Key words: Effluent, BOD, COD, Ratoon.

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 per cent in 2000 to 11.5 per cent by 2010 and 23 per cent 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 (Rani Perumal and Singram, 1996). The changing scenario of both issues had researchers to develop strategies for effective utilization of waste water resources in food production 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 banana.

MATERIAL AND METHODS

The experiment was carried out during 2006 to 2009 on farmer's field at Kollibylu, Mudigere, Chikmagalur District, Karnataka, India. 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). 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})

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

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. The experiment was laid out in RCBD design with 3 replications includes 9 treatments.

T_1-Fresh water irrigation, T_2-Raw effluent irrigation without microbial culture, T_3-Raw effluent irrigation with microbial culture, T_4-Lime treated effluent irrigation without microbial culture, T_5-Lime treated effluent irrigation with microbial culture, T_6-Alternate irrigation with lime treated effluent and fresh water without microbial culture,T_7-Alternate irrigation with lime treated effluent and fresh water with microbial culture, T_8-1:1 ratio irrigation with lime treated effluent and fresh water without microbial culture, T_9-1:1 ratio irrigation with lime treated effluent and fresh water with microbial culture. 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 × 2 m. A fertilizer dose of 200:100: 300 g N: P_2O_5 :K_2O per plant were was 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. Growth and yield observation were recorded and statistically analyzed by adapting the procedure outlined by Panes and Sukatme (1967).

RESULTS AND DISCUSSION

Bunch yield differed significantly due to coffee pulp effluent irrigation and microbial culture (Table 2). Alternate irrigation with lime treated coffee pulp effluent and fresh water with microbial culture recorded maximum bunch yield of main crop and ratoon crop (75.1 t ha^{-1} and 69.6 t ha^{-1}, respectively) which was on par with alternate irrigation with lime treated coffee pulp effluent and fresh water without microbial culture (71.0 t ha^{-1} and 67.1 t ha^{-1}, respectively) followed by fresh water irrigation (70.7 t ha^{-1} and 67.4 t ha^{-1}, respectively), 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water with microbial culture (70.5 t ha^{-1} and 66.2 t ha^{-1}, respectively) and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water without microbial culture (70.1 t ha^{-1} and 65.6 t ha^{-1}, respectively). The lowest bunch yield was recorded in raw coffee pulp effluent irrigation without microbial culture (38.6 t ha^{-1} and 37.6 t ha^{-1}, respectively) which was significantly inferior to all the other treatments. The reduction in bunch yield of banana main crop and ratoon crop in treatments receiving raw coffee pulp effluent irrigation and lime treated coffee pulp effluent without microbial culture could be due to decreased individual plant performance characters in terms of length of fruits, girth of fruit, fruit weight, number of hands per bunch, number of fingers per bunch (Table 2), fruit length, fruit girth, fruit weight, pulp weight, peel weight and pulp to peel ratio (Table 3) at harvest and at different stages of main crop and ratoon crop growth. The results clearly show that either undiluted coffee pulp effluent or continuous irrigation with only lime treated coffee pulp effluent has deleterious effect on the growth of banana plant and resulted in its stunted growth and lower yields of both main and ratoon crop.

Alternate and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water with and without microbial culture recorded higher yield as compared to the other treatments (Table 2). This might be due to dilution effect in case of alternate and 1:1 ratio irrigation with lime treated coffee pulp effluent and fresh water and also due to greater reduction in BOD and COD load by treating the effluent with lime and microbial culture which resulted in 38 to 26 per cent reduction in microbial treated coffee pulp effluent, 18 to 13 per cent

Table 2

Effect of coffee pulp effluent irrigation and microbial culture on bunch characters and yield of banana main crop and ratoon crop at harvest.

	Number of hands per bunch		*Number of fingers per hand*		*Number of fingers per bunch*		*Mean bunch weight (kg)*		*Bunch yield (t ha^{-1})*	
Treatments	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*
T_1	10.6	10.3	12.9	12.7	134.9	130.5	28.27	26.96	70.7	67.4
T_2	6.2	6.2	12.8	10.9	78.2	68.4	15.45	15.04	38.6	37.6
T_3	8.1	7.8	11.1	10.3	89.7	79.2	20.17	19.50	51.3	48.8
T_4	8.9	8.9	10.2	10.7	91.0	89.7	24.70	23.57	61.8	58.9
T_5	9.7	9.4	11.3	12.0	109.3	113.6	26.64	25.05	66.6	62.6
T_6	10.5	10.2	13.0	12.7	135.1	129.0	28.38	26.85	71.0	67.1
T_7	11.0	10.9	12.7	12.6	139.1	135.2	30.03	27.82	75.1	69.6
T_8	10.6	9.9	12.6	12.7	127.1	126.6	28.05	26.25	70.1	65.6
T_9	10.5	10.3	12.6	13.0	132.3	129.9	28.21	26.49	70.5	66.2
S.Em±	0.37	0.42	0.71	0.55	4.8	4.48	1.09	1.06	2.44	2.65
CD at 5%	1.11	1.26	NS	1.64	14.25	13.44	3.28	3.18	7.30	7.94

T_1-Fresh water irrigation

T_2 - Raw CPE irrigation without microbial culture

T_3- Raw CPE irrigation with microbial culture

T_4 - Lime treated CPE irrigation without microbial culture

T_5 - Lime treated CPE irrigation with microbial culture

T_6 - Alternate irrigation with lime treated CPE and fresh water without microbial culture

T_7 - Alternate irrigation with lime treated CPE and fresh water with microbial culture

T_8 - 1:1 ratio irrigation with lime treated CPE and fresh water without microbial culture

T_9 - 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.

Table 3

Effect of coffee pulp effluent irrigation and microbial culture on fruit characters of banana main and ratoon crop.

	Fruitlength (cm)		*Fruit girth (cm)*		*Fruit weight (g)*		*Pulp weight (g)*		*Peel weight (g)*		*Pulp to peel ratio*	
Treatments	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*	*Main crop*	*Ratoon crop*
T_1	21.47	19.80	15.30	14.21	204.6	199.1	154.0	149.0	50.6	50.1	3.05	3.00
T_2	12.40	11.35	12.07	10.34	135.3	125.9	96.2	88.9	39.2	37.0	2.46	2.42
T_3	14.03	13.22	12.53	11.49	149.7	142.9	109.6	104.2	40.1	38.7	2.74	2.71
T_4	15.23	15.25	13.37	12.67	169.1	170.9	137.7	125.6	44.4	45.3	2.81	2.76
T_5	17.20	17.05	14.20	13.85	185.8	182.5	137.8	134.8	48.0	47.7	2.88	2.83
T_6	21.67	19.17	15.37	14.19	206.2	199.5	155.4	149.3	50.7	50.2	3.07	2.98
T_7	22.27	21.01	15.57	14.63	211.3	204.3	160.4	154.5	50.9	49.8	3.16	3.10
T_8	21.13	20.17	15.17	14.03	200.2	197.5	149.8	147.6	50.4	49.2	2.97	3.02
T_9	21.23	20.40	15.30	14.41	202.3	201.7	152.1	152.0	50.2	49.7	3.03	3.06
S.Em±	0.57	0.90	0.44	0.58	5.9	7.16	4.79	5.32	1.89	2.38	0.09	0.11
CD at 5%	1.70	2.69	1.32	1.75	17.79	21.47	14.37	15.95	5.67	7.13	0.26	0.33

T_1-Fresh water irrigation

T_2-Raw CPE irrigation without microbial culture

T_3-Raw CPE irrigation with microbial culture

T_4-Lime treated CPE irrigation without microbial culture

T_5-Lime treated CPE irrigation with microbial culture

T_6-Alternate irrigation with lime treated CPE and fresh water without microbial culture

T_7-Alternate irrigation with lime treated CPE and fresh water with microbial culture

T_8-1:1 ratio irrigation with lime treated CPE and fresh water without microbial culture

T_9-1:1 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.

reduction in lime treated coffee pulp effluent and 53 to 46 per cent reduction in lime treated coffee pulp effluent with microbial culture (BOD and COD, respectively). The lime treatment enables to raise the soil pH to neutrality and under neutral pH conditions, the inoculated microbial culture grows optimally and then contributing for further reduction of BOD and COD. Similar results have been obtained by Singh and Raj Bahadur (1997), Sukanya and Meli (2004) and even though coffee pulp effluent is rich in organic matter and high BOD and COD, it will undergo mineralization at faster rate releasing plant nutrients over it is added to soil. Application of coffee pulp effluent was known to increase the nutrient status of soil indicating better mineralization.

This might be attributed to the presence of high humic substances which facilitate the timely availability of NPK to the plants through gradual release of nutrients in to the soil and thus contributing for higher yield parameters. Greater absorption of nutrients in turn aids in conversion of vegetative phase in to reproductive phase of the plant. Rapid differentiation of the meristem into various floral primordial structures that determine the future bunch size and also contribute for earlier completion of flower primordial differentiation in the span of four and eight months. Yield attributing characters like fruit length, fruit girth, fruit weight pulp to peel ratio (Table 3), number of fingers per hand, number of hands per bunch and number of finger per bunch contributed for final yield of banana main crop and ratoon crop. The entire processes of fruit growth and development in banana which are mediated by the interplay of endogenous growth substances and particularly, fruit length and girth have been associated with endogenous levels of IAA and gibberellins in development parthenocarpic fruit like banana. Vaughan and Linehan (1976) found that humic acids released from organic matter have stimulatory effect on cell elongation in both roots and shoots indicating the possibility of triggering the endogenous production of growth hormones. Similar results were observed by several workers (Ushakamari *et al.*, 1997 and Tirkey *et al.*, 2002).

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