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REGULAR ARTICLE

DISTILLERY SPENTWASH IRRIGATION ON THE NUTRIENTS OF BANANA (*MUSA PARAISICA*) AND PAPAYA (*CARCIA PAPAYA*) FRUITS

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SUMMARY

Cultivation of Banana (*Musa paradisiaca*) and Papaya (*Carcia papaya*) plants was made by irrigation with distillery spentwash of different proportions. The distillery spentwash i.e., primary treated spentwash (PTSW), 50%, 33% and 20% distillery spentwash were analyzed for plant nutrients such as nitrogen, phosphorous, potassium(NPK) and other physical and chemical parameters. The plants were cultivated by irrigation with raw water (RW), 50%, 33% and 20% distillery spentwash in the prepared land. The impact of distillery spentwash on proximate principles (moisture, protein, fat, fibre, carbohydrate, energy, calcium, phosphorous, and iron), Vitamin content (carotene and vitamin-c), mineral and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) i.e., nutritive value of ripened fruits were analyzed. It was observed that good nutrients uptake in fruits in the case of 20% spentwash than compared with 33%, 50% spentwash and raw water irrigations. This could be due to the maximum absorption of NPK by plants at more diluted condition of spentwash. This concludes that the diluted spentwash can be conveniently used for the effective cultivation without using any external fertilizers. Hence, spentwash serves as a liquid fertilizer, eco-friendly irrigation medium and without adverse effect on environment and soil.

Key words: Distillery spentwash, Fruits, Nutrients, Proximate principles, Minerals

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1. Introduction

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries. About eight liters of wastewater is generated for every liter of ethanol production, known as raw spentwash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000mg/L) and chemical oxygen demand (COD: 25000-30000mg/L) (Joshi et al.,1994) undesirable color and foul smell. Raw spentwash is generally discharged into open land or near by water bodies resulting number of environmental hazards including threat to plant and animal lives. The RSW is highly acidic and contains easily oxidisable organic matter with very high BOD and COD (Patil et al., 1987) and highest content of organic nitrogen and nutrients (Ramadurai and Gearard, 1994). By adopting biomethenation plant in distilleries, reduces the oxygen demand of RSW, it is called primary treated spentwash (PTSW) and is rich in nitrogen (N), potassium (K), and phosphorous (P) and decrease in calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mahmed Haroon and Subhash Chandra Bose,2004). Also it contains easily biodegradable organic matter and its application to soil has been reported to be beneficial to increase the yield of sugar cane Zalawadia et al., 1997), rice (Devarajan and

Oblisami, 1995), wheat Pathak et al., 1998) and quality of groundnut (Amar et al., 2003). Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility (Ramana et al., 2000; Kaushik et al., 2005), seed germination and crop productivity (Kuntal et al., 2004). The diluted spentwash irrigation improved the physico- chemical properties of the soil and further increased soil microflora (Revarkar et al., 2000). Twelve pre sowing irrigations with diluted spentwash had no adverse effect on germination of maize, also improved the growth and yield (Ramana et al., 2001). Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content in peas (Devarajan et al., 2004). Higher concentration of spentwash causes decreased seed germination, seedling growth, chlorophyll content in sunflowers (Helianthus annuus) and the spentwash could be safely used for irrigation purpose at lower concentration (Singh and Rajbahadur, 1998). The spentwash consists of excess of various forms of cations and anions, which are injurious to plant growth. The concentration of these constituents should be reduced to beneficial level by diluting the spentwash, which can be used as a substitute for chemical fertilizer (Rani and Srivastava, 1990). The spentwash could be used as a complement to mineral fertilizer to sugarcane (Rajendran, 1990), it consists N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation (Sahai et al., 1983). Application of diluted spentwash increased the uptake of Zinc (Zn), Copper (Cu), Iron (Fe) and Manganese (Mn) in maize and wheat, the highest total uptake of these were found at lower dilution levels than at higher dilution (Chares, 1985). Mineralization of organic material as well as nutrients present in the spentwash was responsible for increased availability of plant nutrients (Samuel, 1986). The diluted spentwash increase the uptake of nutrients, height, growth, yield and nutrients of leaves vegetables (Pujar, 1995; Chandraju and Basavaraju, 2007; Basavaraju and Chandraju, 2007), top vegetables (Chandraju and Basavaraju, 2008), pulses (Chandraju et al., 2007), condiments and root vegetables (Chandraju et. al., 2008), nutrients of pulses in treated and untreated soil (Chidankumar and Chandraju, 2008) However, there is no information about the irrigation of spentwash on the nutrients of Banana (Musa paradisiaca) and Papaya (Carcia papaya) fruits, therefore the present investigation was carried out to investigate the impact of irrigation of different concentration of spentwash on the nutrients of these fruits.

2. Methodology

Before initiation, a composite soil sample was collected from the experimental site at 25 cm depth, air-dried, powdered and analyzed for its physico-chemical properties by standard methods and as shown in Table 1.

The PTSW was used for the irrigation with dilution of 20%, 33% and 50%. The physico- chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the PTSW, 20%, 33% and 50% spentwash were analyzed by standard methods and as shown in Table 2.

Cultivation of fruits plants such as *Banana (Musa paradisiaca)* and *Papaya (Carcia papaya)* were made by irrigation with raw water (RW), 20%, 33% and 50% spentwash at the dosage of twice a week and rest of the period with RW depend upon the climatic condition. The nutrients of matured (ripened) fruits were analyzed and presented in Tables 3&4.

Table 1. Physico- Chemical Properties of the Experimental soil

Parameters	
Coarse sand[a]	10.94
Fine sand[a]	42.86
Slit[a]	26.32
Clay[a]	19.88
pH value (1:2 solution)	8.15
Electrical conductivity[b]	451.0
Organic carbon[a]	0.93
Available Nitrogen[c]	460.0
Available Phosphorous[c]	180.0
Available Potassium[c]	65.0
Exchangeable Calcium[c]	150.0
Exchangeable Magnesium[c]	190.0
Exchangeable Sodium[c]	180.0
Available Sulphur[c]	230.0
DTPA Iron[c]	240.0
DTPA Manganese[c]	260.0
DTPA Copper[c]	8.00
DTPA Zinc[c]	65.0

a -%; b- µS; c- ppm

Table 2. Physico-Chemical Properties of Distillery spentwash

Chemical parameters	PTSW	20% PTSW	33% PTSW	50% PTSW
pH	7.65	7.86	7.75	7.73
Electrical conductivity[a]	28800	8020	10020	19660
Total solids[b]	46140	12030	20870	26170
Total dissolved solids[b]	35160	7034	10140	16060
Total suspended solids[b]	10540	2380	4380	5680
Settleable solids[b]	10070	2600	3010	4340
COD[b]	40530	5515	10228	18316
BOD[b]	16200	1680	4800	7818
Carbonate[b]	Nil	Nil	Nil	Nil
Bicarbonate[b]	13100	3300	4200	7400
Total Phosphorous[b]	30.26	3.89	6.79	12.20
Total Potassium[b]	7200	1400	2400	3700
Calcium[b]	940.0	260.0	380.0	600.0
Magnesium[b]	1652.16	320.20	542.22	884.16
Sulphur[b]	74.80	14.40	22.60	35.00
Sodium[b]	480	140	240	260
Chlorides[b]	5964	2262	3164	3272
Iron[b]	9.20	3.40	5.20	6.40
Manganese[b]	1424	188	368	724
Zinc[b]	1.280	0.240	0.410	0.720
Copper[b]	0.276	0.036	0.074	0.134
Cadmium[b]	0.039	0.004	0.010	0.021
Lead[b]	0.16	0.04	0.06	0.09
Chromium[b]	0.066	0.006	0.014	0.032
Nickel[b]	0.165	0.022	0.040	0.084
Ammonical Nitrogen[b]	743.68	172.48	276.64	345.24

PTSW – Primary treated spentwash

Table 3. Nutrients of *Banana ripe (Musa paradisiaca)* at Different Irrigations

Parameters	RW	50%PTSW	33%PTSW	20%PTSW
Moisture[a]	72.4	72.6	73.0	73.0
Fat[a]	0.3	0.35	0.40	0.45
Acid insoluble Ash[a]	0.05	0.06	0.06	0.06
Protein[a]	1.30	1.40	1.45	1.50
Fibre[a]	0.30	0.40	0.45	0.50
Carbohydrate[a]	26.9	27.6	27.8	29.0
Energy[b]	115	117	118	120
Calcium[c]	16.8	18.0	20.0	22.0
Magnesium[c]	44.0	45.0	46.0	48.0
Sodium[c]	36.0	36.5	37.0	38.0
Potassium[c]	87.0	88.0	89.2	90.4
Iron[c]	0.36	0.36	0.4	0.4
Phosphorous[c]	36.0	36.4	37.0	38.0
Zinc[c]	0.15	0.15	0.16	0.16
Manganese[c]	0.20	0.21	0.22	0.22
Copper[c]	0.15	0.16	0.17	0.17
Chlorides[c]	8.00	8.00	8.80	9.00
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.004	0.004	0.004	0.004
Nickel[c]	Nil	Nil	Nil	Nil
Sulphur[c]	7.00	7.00	7.20	7.20
Carotene[d]	77.4	78.2	79.0	80.0
Vitamin-C[c]	6.90	8.00	8.50	9.20

RW - Raw water; PTSW – Primary treated spentwash
a-g; b- k.cal; c- mg; d- µg

Table 4. Nutrients of *Papaya ripe (Carcia papaya)* at Different Irrigations

Parameters	RW	50%PTSW	33%PTSW	20%PTSW
Moisture[a]	91.2	92.5	92.8	93.0
Fat[a]	0.10	0.15	0.20	0.20
Acid insoluble Ash[a]	0.05	0.05	0.05	0.05
Protein[a]	0.50	0.60	0.70	0.75
Fibre[a]	0.72	0.87	0.90	0.95
Carbohydrate[a]	6.50	7.50	8.50	9.00
Energy[b]	29.4	32.0	33.0	34.0
Calcium[c]	18.0	20.0	22.0	25.0
Magnesium[c]	12.0	14.0	16.0	20.0
Sodium[c]	7.0	8.0	10.0	12.0
Potassium[c]	69.2	70.2	72.4	74.6
Iron[c]	0.60	0.70	0.80	0.90
Phosphorous[c]	18.0	20.0	24.0	26.0
Zinc[c]	0.20	0.10	0.20	0.20
Mang[c]anese	0.02	0.01	0.02	0.02
Coppe[c]r	0.15	0.20	0.20	0.25
Chlorides[c]	12.0	11.0	12.0	14.0
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.002	0.002	0.002	0.002
Nickel[c]	Nil	Nil	Nil	Nil
Sulphur[c]	15.0	19.6	20.0	20.0
Carotene[d]	660	667	670	680
Vitamin-C[c]	56.8	57.4	58.9	60.4

RW - Raw water; PTSW – Primary treated spentwash
a-g; b- k.cal; c- mg; d- µg

3. Result

The parameters such as pH, electrical conductivity, amount of organic carbon, available nitrogen (N), phosphorous (P), potassium (K), sulfur (S), exchangeable calcium (Ca), magnesium (Mg), sodium (Na), DTPA iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) of experimental soil were analyzed (Table 1).

Also the parameters such pH value, electrical conductivity, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), settelable solids (SS), chemical oxygen demand (COD), biological oxygen demand (BOD), carbonates, bicarbonates, total phosphorous (P), total potassium (K), ammoniacal nitrogen (N), calcium (Ca), magnesium (Mg), sulfur (S), sodium (Na), chlorides (Cl), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), chromium (Cr) and nickel (Ni) of PTSW, 50%, 33% and 20% spentwash were analyzed (Table 2).

It was found that, the uptake of all the nutrients in both fruits were influenced by diluted spentwash than raw water and are in the order 20% > 33% > 50% > RW. However uptake of calcium, magnesium, sodium, potassium, phosphorous, chlorides, carotene and vitamin-c were influenced to greater extent in 20% irrigation (Tables 3&4). Further, there was no uptake of heavy metals like lead, cadmium and nickel in both fruits.

4. Discussion

It was found that, the uptakes of nutrients in both the fruits were considerably influenced by diluted spentwash than raw water irrigation. However irrigation with 20% spentwash shows more uptakes of nutrients in both fruits compared to 33%, 50% spentwash and raw water. This could be due to the maximum absorption of plant nutrients from the soil and spentwash, in more diluted spentwash irrigation by the plants. This concludes that the diluted spentwash can be conveniently used for the effective cultivation without using any external fertilizers. Hence, spentwash serves as a liquid fertilizer, eco-friendly irrigation medium and without adverse effect on environment and soil.

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