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Influence of distillery spentwash irrigation on the nutrients of fruits in untreated and spentwash treated soil

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ABSTRACT

Cultivation of some fruits plants was made by irrigation with distillery spentwash of different proportions. The spent wash *i.e.*, primary treated spent wash (PTSW) and 33% spentwash were analyzed for their plant nutrients such as nitrogen, phosphorous, potassium and other physical and chemical parameters. Experimental soils *i.e.*, untreated (plot-1) and spentwash treated (plot-2) soils were tested for their chemical and physical parameters. The fruits seeds/sets (Namadhari and Mayhco) were sown in the prepared land and irrigated with raw water (RW) and 33% spentwash. Influence of spent wash in untreated and spentwash treated soils on proximate principles (moisture, protein, fat, fiber, carbohydrate, energy, calcium, phosphorous, and iron), Vitamin content (carotene and vitamin-c), minerals and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) of fruits were investigated at their respective maturity. It was found that the nutrients of all fruits were high in 33% than raw water irrigation. Further, the nutritive values were very high in spentwash treated soil (plot-2) 33% irrigation than untreated (plot-1) and raw water irrigations.

Key words : Distillery spent wash, Fruits, Nutrients, Proximate principles, Untreated soil, Spentwash treated soil

INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries by fermentation method. About eight (08) liters of waste water is discharged for every lifer of ethanol production in distilleries, known as raw spent wash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000mg/l) and chemical oxygen demand (COD: 25000-30000mg/l) (Joshi,1994) , undesirable color and foul smell. Discharge of raw spentwash into open land or near by water bodies resulting in a number of environmental, water and soil pollution including threat to plant and animal lives. Hence, discharge of spentwash is a serious problem. The RSW is highly acidic and contains easily oxidizable organic matter with very high BOD and COD (Patil *et al.*, 1987). Also, spentwash contains highest content of organic nitrogen and nutrients (Ramadurai and Gearard, 1994). By installing biomethenation plant in distilleries, reduces the oxygen demand of RSW, the resulting spentwash is called primary treated spent wash (PTSW) and primary treatment to RSW increases the nitrogen (N), potassium (K), and phosphorous (P) contents and decreases the calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mahamod Haron and Subhash Chandra Bose,2004). The PTSW is rich in potassium (K), sulphur (S), nitrogen (N), phosphorous (P) as well as easily biodegradable organic matter and its application to soil has been reported to be beneficial to increase Sugar cane (Zalawadia *et al.*,1997), Rice (Devarajan and Oblisami, 1995), Wheat and Rice yield (Pathak *et al.*, 1998), quality of Groundnut (Amar *et al.*, 2003) and physiological response of Soybean (Ramana *et al.*, 2000). Diluted spent wash could be used for irrigation purpose without adversely affecting soil fertility (Kaushik *et al.*,2005; Kuntal *et al.*,2004; Raverkar *et al.*,2000), seed germination and crop productivity (Ramana *et al.*,2001). The diluted spent wash irrigation improved the physical and chemical properties of the soil and further increased soil microflora (Devarajan *et al.*, 1994; Kaushik *et al.*, 2005; Kuntal *et al.*, 2004). Twelve pre sowing irrigations with the diluted spent wash had no adverse effect on the germination of Maize but improved the growth and yield (Singh and Raj Bahadur, 1998). Diluted spent wash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of Peas (Rani and Srivastava, 1990). Increased concentration of spentwash causes decreased seed germination, seedling growth and chlorophyll content in Sunflowers (Helianthus annuus) and the spent wash could safely used for irrigation purpose at lower concentration (Rajendran,1990; Ramana *et al.*,2001). The spentwash contained an excess of various forms of cations and anions, which are injurious to plant growth and these constituents should be reduced to beneficial level by diluting the spentwash, which can be used as a substitute for chemical fertilizer (Sahai *et*

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al., 1983). The spentwash could be used as a complement to mineral fertilizer to Sugarcane (Chares, 1985). The spentwash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water (Samuel, 1986). The application of diluted spent wash increased the uptake of Zinc (Zn), Copper (Cu), Iron (Fe) and manganese (Mn) in Maize and Wheat as compared to control and the highest total uptake of these were found at lower dilution levels than at higher dilution levels(Pujar,1995). Mineralization of organic material as well as nutrients present in the spentwash was responsible for increased availability of plant nutrients. Diluted spentwash increase the uptake of nutrients, height, growth and yield of Leaves vegetables (Chandraju and Basvaraju, 2007; Basvaraju and Chandraju, 2008), nutrients of cabbage and mint leaf (Chandraju *et al.*, 2008), nutrients of top vegetable (Basvaraju and Chandraju, 2008), pulses, condiments and root vegetables (Chandraju *et al.*, 2008), nutrients of pulses in untreated and treated soil (Chidankumar and Chandraju, 2008). However, not much information is available on the influence of distillery spent wash on the nutrients of fruits in untreated and spentwash treated soil. Therefore, the present investigation was carried out to investigate the influence of different concentration of spentwash on the nutrients of fruits in untreated and spentwash treated soils.

MATERIALS AND METHODS

Physico-chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated spentwash and 33% spentwash were analyzed by standard methods (Table 1 and 2). The PTSW was used for irrigation with a dilution of 33% in plot-1 and plot-2. Before initiation, plot-2 soil was treated with diluted spentwash for four times with an intervals of one week, each time land was ploughed and exposed to sunlight. A composite soil samples from both plots were collected at 25 cm depth, air-dried, powdered and analyzed for physico-chemical properties (Table 3).

The fruits plants selected for the present investigation were, Banana (*Musa paradisiaca*), Papaya *(Carcia papaya),* Musk melon (*Cucumis melo*), Water melon (*Citrullus vulgaris*) and Tomato (*Lycopersicon esculentum*). The seeds/sets were sown and irrigated with raw water (RW) and 33% spentwash in both plots at the dosage of twice a week and rest of the period with raw water. At the maturity time, fruits were harvested and proximate principles, vitamins, minerals and trace elements were analyzed (Table 4, 5, 6, 7 and 8).

RESULTS AND DISCUSSION

Chemical composition of PTSW and 33% spentwash such as pH, 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), ammonical nitrogen (N), calcium (Ca), magnesium (Mg), sulphur (S), sodium (Na), chlorides (Cl), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), chromium (Cr) and nickel (Ni) were analyzed and tabulated (Table 1). Amount of N, P, K and S contents are presented in Table 2.

Table 1: Chemical composition of distillery spent wash

Chemical parameters	PTSW	33% PTSW
pH	7.65	7.75
Electrical conductivity[a]	28800	10020
Total solids[b]	46140	20870
Total dissolved solids[b]	35160	10140
Total suspended solids[b]	10540	4380
Settleable solids[b]	10070	3010
COD[b]	40530	10228
BOD[b]	16200	4800
Carbonate[b]	Nil	Nil
Bicarbonate[b]	13100	4200
Total Phosphorous[b]	30.26	6.79
Total Potassium[b]	7200	2400
Calcium[b]	940	380.0
Magnesium[b]	1652.16	542.22
Sulphur[b]	74.8	22.6
Sodium[b]	480	240
Chlorides[b]	5964	3164
Iron[b]	9.2	5.20
Manganese[b]	1424	368
Zinc[b]	1.28	0.41
Copper[b]	0.276	0.074
Cadmium[b]	0.039	0.010
Lead[b]	0.16	0.06
Chromium[b]	0.066	0.014
Nickel[b]		
Ammonical Nitrogen[b]	743.68	276.64

PTSW - Primary treated spentwash Units: a- µS: b- mg/l

Table 2 : Amount of N, P, K and S in distillery spent wash

Chemical parameters	PTSW	33% PTSW
Ammonical Nitrogen[a]	743.68	276.64
Total Phosphorous[a]	30.26	6.79
Total Potassium[a]	7200	2400
Sulphur[a]	74.8	22.6

PTSW- Primary treated spentwash Units: a- µS: b- mg/l

Table 3: Characteristics of experimental soils

Parameters	Plot-1	Plot-2
Coarse sand[a]	9.72	10.94
Fine sand[a]	40.80	42.86
Slit[a]	25.28	26.32
Clay[a]	24.2	19.88
pH (1:2 soln) [a]	8.16	8.15
Organic carbon[a]	526	451
Electrical conductivityb[b]	0.61	0.93
Available Nitrogen[c]	340	460
Available Phosphorous[c]	130	180
Available Potassium[c]	80	95
Exchangeable Calcium[c]	140	150
Exchangeable Magnesium[c]	220	190
Exchangeable Sodium[c]	90	180
Available Sulphur[c]	240	230
DTPA Iron[c]	200	240
DTPA Manganese[c]	220	260
DTPA Copper[c]	5.0	8.0
DTPA Zinc[c]	50	65

Plot-1: Untreated Soil; Plot-2: Spentwash treated Soil
Units: a- %; b- µS; c-ppm

Table 4 : Nutritive values of banana (*Musa paradisiacal)* in plot-1 and 2

Parameters	Plot-1		Plot-2	
	RW	33%SW	RW	33% SW
Fat[a]	0.3	0.3	0.3	0.3
Acid insoluble Ash[a]	0.05	0.06	0.06	0.06
Protein[a]	1.3	1.4	1.4	1.4
Fibre[a]	0.3	0.4	0.4	0.4
Carbohydrate[a]	26.9	27.6	27.8	29.0
Energy[b]	115.0	117.0	117.0	120.0
Calcium[c]	16.8	18.0	20.0	22.0
Magnesium[c]	44.0	45.0	45.0	48.0
Sodium[c]	36.0	36.5	37.0	38.0
Potassium[c]	87.0	88.0	88.2	88.4
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]	8.0	8.0	8.8	9.0
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
Sulfur[c]	7.0	7.0	7.2	7.2
Carotene[d]	77.4	78.2	79.0	80.0
Vitamin C[c]	6.9	8.0	8.0	8.2

a-g; b-k cal; c-mg; d-µg; RW-Raw water
PTSW-Primary treated Spentwash
Plot-1: Untreated soil; Plot-2: Spentwash treated soil

Table 5 : Nutritive values of papaya (*Musa paradisiaca*) in plot-1 and 2

Parameters	Plot-1		Plot-2	
	RW	33%SW	RW	33% SW
Fat[a]	0.1	0.1	0.1	0.1
Acid insoluble Ash[a]	0.05	0.04	0.05	0.05
Protein[a]	0.5	0.6	0.7	0.7
Fibre[a]	0.72	0.87	0.90	0.92
Carbohydrate[a]	6.5	7.5	7.5	8.0
Energy[b]	29.4	32.0	32.0	34.0
Calcium[c]	18.0	20.0	20.0	25.0
Magnesium[c]	12.0	14.0	16.0	20.0
Sodium[c]	7.0	7.0	10.0	12.0
Potassium[c]	69.2	70.2	72.4	74.6
Iron[c]	0.6	0.5	0.8	0.8
Phosphorous[c]	18.0	20.0	24.0	26.0
Zinc[c]	0.2	0.1	0.2	0.2
Manganese[c]	0.02	0.01	0.02	0.02
Copper[c]	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
Sulfur[c]	15.0	19.6	20.0	20.0
Carotene[d]	660.0	667.0	670.0	680.0
Vitamin C[c]	56.8	57.4	58.9	60.4

Table 6 : Nutritive values of musk melon *(Cucumis melo)* in plot-1 and 2

Parameters	Plot-1		Plot-2	
	RW	33%SW	RW	33% SW
Moisture[a]	96.0	95.9	96.5	97.0
Fat[a]	0.18	0.21	0.22	0.26
Acid insoluble Ash[a]	0.05	0.08	0.09	0.9
Protein[a]	0.29	0.29	0.3	0.5
Fibre[a]	0.38	0.4	0.4	0.6
Carbohydrate[a]	3.0	3.6	3.7	4.0
Energy[b]	16.9	18.1	18.4	18.6
Calcium[c]	30.0	34.0	38.0	39.0
Magnesium[c]	32.0	34.0	36.0	36.5
Sodium[c]	104.0	105.2	106.0	107.0
Potassium[c]	360.0	370.0	375.0	380.0
Iron[c]	1.41	1.42	1.46	1.56
Phosphorous[c]	14.0	14.2	15.2	16.1
Zinc[c]	0.27	0.28	0.3	0.35
Manganese[c]	0.01	0.02	0.02	0.25
Copper[c]	0.028	0.03	0.04	0.45
Chlorides[c]	79.0	81.0	83.0	84.0
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.005	0.006	0.006	0.006
Nickel[c]	Nil	Nil	Nil	Nil
Sulfur[c]	32.0	33.2	34.2	34.3
Carotene[d]	168.0	170.0	173.0	175.0
Vitamin C[c]	30.0	30.8	31.0	33,2

a-g; b-k cal; c-mg; d-µg; RW-Raw water
PTSW-Primary treated Spentwash
Plot-1: Untreated soil; Plot-2: Spentwash treated soil

Table 7: Nutritive values of water melon *(Citrullus vulgaris)* in plot-1 and 2

Parameters	Plot-1		Plot-2	
	RW	33%SW	RW	33% SW
Moisture[a]	94.0	95.9	96.0	96.5
Fat[a]	0.2	0.22	0.28	0.30
Acid insoluble Ash[a]	0.08	0.07	0.07	0.07
Protein[a]	0.4	0.46	0.5	0.58
Fibre[a]	0.22	0.22	0.28	0.32
Carbohydrate[a]	3.1	3.4	3.5	4.5
Energy[b]	20.0	22.0	23.0	24.0
Calcium[c]	10.0	11.4	11.9	12.1
Magnesium[c]	12.6	13.8	14.2	14.3
Sodium[c]	27.0	28.4	29.6	30.0
Potassium[c]	158.0	161.0	163.0	165.0
Iron[c]	7.9	8.0	8.4	8.9
Phosphorous[c]	12.0	13.4	14.8	15.3
Zinc[c]	0.04	0.05	0.05	0.05
Manganese[c]	0.02	0.06	0.06	0.06
Copper[c]	0.05	0.06	0.07	0.07
Chlorides[c]	20.0	22.0	23.4	23.6
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.001	0.001	0.001	0.001
Nickel[c]	Nil	Nil	Nil	Nil
Sulfur[c]	41.0	42.9	43.2	43.3
Carotene[d]	Nil	Nil	Nil	Nil
Vitamin C[c]	2.0	2.4	2.6	3.6

a-g; b-k cal; c-mg; d-µg; RW-Raw water
PTSW-Primary treated Spentwash
Plot-1: Untreated soil; Plot-2: Spentwash treated soil

Table 8 : Nutritive values of tomato *(Lycopersicon esculentum)* in plot-1 and 2

Parameters	Plot-1		Plot-2	
	RW	33%SW	RW	33% SW
Fat[a]	0.21	0.22	0.23	0.26
Acid insoluble Ash[a]	0.02	0.03	0.03	0.03
Protein[a]	1.5	1.6	1.7	1.9
Fibre[a]	0.72	0.8	0.8	0.8
Carbohydrate[a]	3.2	3.7	3.9	4.2
Energy[b]	18.0	20.0	21.2	22.0
Calcium[c]	47.8	48.0	50.4	51.4
Magnesium[c]	12.0	12.5	13.6	14.0
Sodium[c]	11.4	12.9	13.5	14.0
Potassium[c]	140.0	146.0	150.0	155.0
Iron[c]	1.2	1.4	1.4	1.5
Phosphorous[c]	30.0	31.0	32.0	33.0
Zinc[c]	0.4	0.42	0.42	0.43
Manganese[c]	0.25	0.27	0.27	0.28
Copper[c]	0.18	0.19	0.19	0.19
Chlorides[c]	6.0	7.1	7.2	7.3
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.015	0.015	0.015	0.015
Nickel[c]	Nil	Nil	Nil	Nil
Sulfur[c]	20.0	20.5	21.0	21.5
Carotene[d]	349.0	352.0	359.0	362.0
Vitamin C[c]	28.0	30.0	32.0	34.6

a-g; b-k cal; c-mg; d-µg; RW-Raw water
PTSW-Primary treated Spentwash
Plot-1: Untreated soil; Plot-2: Spentwash treated soil

Characteristics of experimental soils such as pH, electrical conductivity, the amount of organic carbon, available nitrogen (N), phosphorous (P), potassium (K), sulphur (S) exchangeable calcium (Ca), magnesium (Mg), sodium (Na), DTPA iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were analyzed and tabulated (Table3).

Uptakes of all the parameters were very good in 33% spentwash as compared to raw water in both fields (plots-1&2) for all fruits. However, considerable uptake of the nutrients was very high in plot-2 than plot-1 in all types of irrigations and there was no negative impact of spentwash on the nutrients (Table 4, 5, 6, 7 and 8).

Conclusion:

It was noticed that the nutrients uptake in all the varieties was largely influenced in case of 33% diluted spent wash irrigation than with raw water in spentwash treated than untreated soil. This concludes that, the treated soil is enriched with the plant nutrients such as nitrogen, potassium and phosphorous. It further concludes that, the subsequent use of diluted spentwash for irrigation enriches the soil fertility and hence the diluted spent wash (33%) is effective eco-friendly irrigation medium for cultivation of fruits without any adverse effect.

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