Nature Environment and Pollution Technology An International Quarterly Scientific Journal	Vol. 9	No. 4	pp. 743-748	2010

Original Research Paper

Studies on the Impact of Irrigation of Distillery Spentwash on the Yield of Leafy Medicinal Plants

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Nat. Env. Poll. Tech.
ISSN: 0972-6268
www.neptjournal.com

Key Words:
Leafy medicinal plants
Distillery spentwash
Spentwash irrigation

ABSTRACT

Cultivation of some leafy medicinal plants was made by irrigation with distillery spentwash of different dilutions. The spentwash, i.e., primary treated spentwash (PTSW), 50% and 33% spentwash were analyzed for their plant nutrients such as nitrogen, phosphorus, potassium and other physical and chemical characteristics. Experimental soil was tested for its chemical and physical parameters. Seeds of leafy medicinal plants were sown in the prepared land and irrigated with raw water (RW) and 50% and 33% spentwash. The influence of spentwash on the yield of leafy medicinal plants at their respective maturity was investigated. It was found that the yields of all leafy medicinal plants were more in 33% spentwash irrigation than raw water and 50% spentwash irrigations.

INTRODUCTION

Molasses is the chief source for production of ethanol in distilleries by fermentation. About eight litres of wastewater is discharged for every litre of ethanol production in distilleries, known as raw spentwash (RSW), which is characterized by high biochemical oxygen demand, undesirable color and foul smell (Joshi et al. 1994). Discharge of raw spentwash into open land or nearby water bodies is a serious problem since it results in a number of environmental, water and soil pollution problems including threat to plant and animal life. The RSW is highly acidic and contains easily oxidisable organic matter with very high BOD and COD (Patil 1987). Also, spentwash contains high organic nitrogen and nutrients (Ramadurai & Gearard 1994). Biomethanation of spentwash reduces oxygen demand of RSW, and the resulting spentwash is called primary treated spent wash (PTSW). Primary treatment to RSW increases nitrogen, potassium and phosphorus contents, and decreases calcium, magnesium, sodium, chloride, and sulphate (Mahamod Haroon & Subhash Chandra Bose 2004). The PTSW is rich in potassium , sulphur, nitrogen, phosphorus and easily biodegradable organic matter, and its application to soil increases yield of sugar cane (Zalawadia et al. 1997), rice (Devarajan & Oblisami 1995), wheat and rice (Pathak et al. 1998), quality of groundnut (Singh et al. 2003) and physiological response of soybean (Ramana et al. 2000). Diluted spentwash 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 spentwash 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 spentwash had no adverse effect on the germination of maize but improved the growth and yield (Singh & Raj Bahadur 1998). Diluted spentwash increases shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Rani & Srivastava 1990). Increased concentration of spentwash causes decreased seed germination, seedling growth and chlorophyll content in sunflower (*Helianthus annuus*) and the spentwash could safely be used for irrigation purpose at lower concentration (Rajendra 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 al. 1983). The spent wash 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 spentwash 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 were responsible for increased availability of plant nutrients. Diluted spentwash increase the uptake of nutrients, height, growth and yield of leafy vegetables (Chandraju & Basvaraju 2007, Basvaraju & Chandraju 2008), nutrients of cabbage and mint leaf (Chandraju et al. 2008), nutrients of top vegetable (Basvaraju & Chandraju 2008), pulses, condiments, root vegetables (Chandraju et al. 2008), and yields of condiments (Chandraju & Chidankumar 2009). However, not much information is available on the influence of distillery spentwash irrigation on the yield of leafy medicinal plants. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on the yield of leafy medicinal plants.

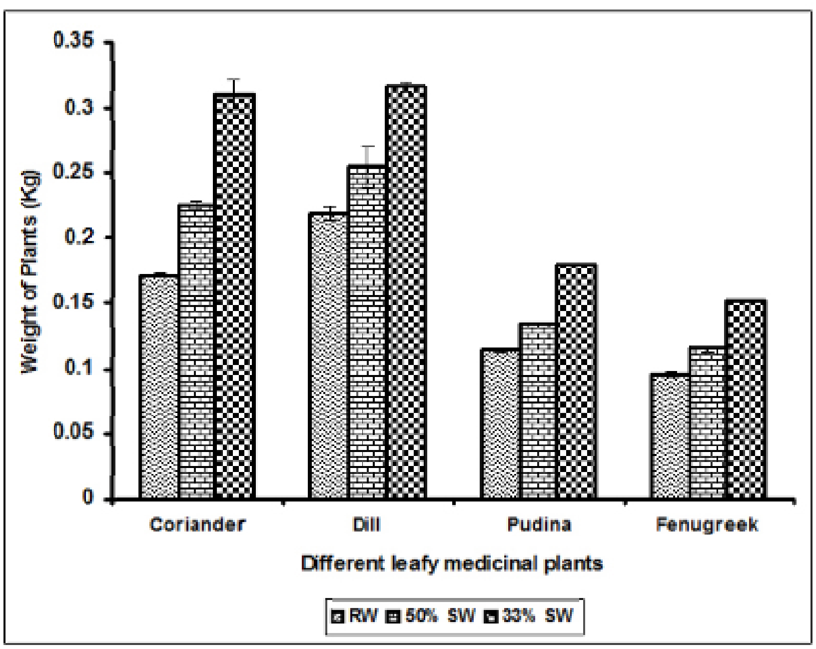

Fig. 1: Yield of leafy medicinal plants in raw water (RW), 50% PTSW, 33% PTSW.

Table 1: Chemical characteristics of distillery spentwash.

Chemical parameters	PTSW	50%PTSW	33% PTSW
pH	7.57	7.63	7.65
Electrical conductivity[a]	26400	17260	7620
Total solids[b]	47200	27230	21930
Total dissolved solids[b]	37100	18000	12080
Total suspended solids[b]	10240	5380	4080
Settleable solids[b]	9880	4150	2820
COD[b]	41250	19036	10948
BOD[b]	16100	7718	4700
Carbonate[b]	Nil	Nil	Nil
Bicarbonate[b]	12200	6500	3300
Total phosphorous[b]	40.5	22.44	17.03
Total potassium[b]	7500	4000	2700
Calcium[b]	900	590	370
Magnesium[b]	1244.16	476.16	134.22
Sulphur[b]	70	30.2	17.8
Sodium[b]	520	300	280
Chlorides[b]	6204	3512	3404
Iron[b]	7.5	4.7	3.5
Manganese[b]	980	495	288
Zinc[b]	1.5	0.94	0.63
Copper[b]	0.25	0.108	0.048
Cadmium[b]	0.005	0.003	0.002
Lead[b]	0.16	0.09	0.06
Chromium[b]	0.05	0.026	0.012
Nickel[b]	0.09	0.045	0.025
Ammonical nitrogen[b]	750.8	352.36	283.76
Charbohydrates[c]	22.80	11.56	8.12

Units: a - µS, b - mg/L, c - %, PTSW - Primary treated distillery spentwash

MATERIALS AND METHODS

Physico-chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated diluted spentwash (50% and 33%) were analyzed by standard methods (Manivasakam 1987**.** The PTSW was used for irrigation with a dilution of 33% and 50%. A composite soil sample collected (at 25 cm depth) prior to spentwash irrigation was air-dried, powdered and analyzed for physico-chemical properties (Piper 1996, Jackson 1973, Subbaiah & Asija 1956, Black 1965, Lindsay & Norvel 1978).

Leafy medicinal plants selected for the present investigation were coriander (*Coriandrum sativum*), dill (*Anethum graveolens*), pudina/spearmint (*Mentha viridis*), fenugreek/methi (*Trigonella foenum-graecum*). The seeds were sown and irrigated with raw water (RW), 50% and 33% SW at the dosage of twice a week and rest of the period with raw water as required by applying 5-10 mm/cm^2 depending upon the climatic condition. Trials were conducted for three times and at the time maturity, plants were harvested and the yields were recorded by taking the average weight.

RESULTS AND DISCUSSION

Chemical composition of PTSW, 50% and 33% SW such as pH, electrical conductivity, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), settleable solids (SS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), carbonates, bicarbonates, total phosphorus, total potassium, ammonical nitrogen, calcium, magnesium, sulphur, sodium, chlorides, iron, manganese, zinc, copper, cadmium, lead, chromium and nickel were analyzed and given in Table 1.

Characteristics of experimental soils such as pH, electrical conductivity, the amount of organic carbon, available nitrogen, phosphorus, potassium, sulphur, exchangeable calcium, magnesium, sodium, DTPA iron, manganese, copper and zinc are given in Table 2. It was found that the soil composition is fit for the cultivation of plants, because it fulfils all the requirements for the cultivation of plants.

The yields were very high in the case of 33% SW irrigation for all types of leafy medicinal plants, and moderate in 50%, while comparatively poor in RW (Table 4, Fig. 1). In previous studies by the authors, it was found that 33% SW irrigation favours the growth, yield and nutrients in plants. This could be due to the maximum absorption of NPK by the plants at higher dilution (33%). In case of 50% SW irrigation the yields were less, this could be due to more acidic nature than 33% SW. However, the percentage yield is maximum in the case of coriander (*Coriandrum sativum*) (77.78%), and minimum in spearmint (*Mentha viridis*) (66.4%).

Table 2: Characteristics of experimental soil.

Parameters	Values
Coarse sand[c]	9.85
Fine sand[c]	40.72
Slit[c]	25.77
Clay[c]	23.66
pH (1:2 soln)	8.41
Electrical conductivity[a]	540
Organic carbon[c]	1.77
Available Nitrogen[b]	402
Available Phosphorous[b]	202
Available Potassium[b]	113
Exchangeable Calcium[b]	185
Exchangeable Magnesium[b]	276
Exchangeable Sodium[b]	115
Available Sulphur[b]	337
DTPA Iron[b]	202
DTPA Manganese[b]	210
DTPA Copper[b]	12
DTPA Zinc[b]	60

Units: a - µS, b - mg/L, c - %

Table 3: Characteristics of experimental soil (After harvest of leafy medicinal plants).

Parameters	Values
Coarse sand[c]	9.69
Fine sand[c]	41.13
Slit[c]	25.95
Clay[c]	24.26
pH (1:2 soln)	8.27
Electrical conductivity[a]	544
Organic carbon[c]	1.98
Available Nitrogen[b]	434
Available Phosphorous[b]	218
Available Potassium[b]	125
Exchangeable Calcium[b]	185
Exchangeable Magnesium[b]	276
Exchangeable Sodium[b]	115
Available Sulphur[b]	337
DTPA Iron[b]	212
DTPA Manganese[b]	210
DTPA Copper[b]	12
DTPA Zinc[b]	60

Units: a - µS, b - mg/L, c - %

The soil was tested after the harvest of vegetables, which shows that there is enrichment of the plant nutrients (N.P.K) in soil and no adverse effect on other parameters (Table 3).

CONCLUSION

It was noticed that the yield of all the leafy medicinal plants was maximum in case of 33% and moderate in 50% SW and minimum in RW irrigations. In 33% SW irrigation the plants were able to absorb maximum amount of nutrients, both from the soil and the spentwash resulting good yield. This concludes that the SW can be conveniently used for the cultivation of leafy medicinal plants without external (either organic or inorganic) fertilizers. This minimizes the cost of cultivation and hence elevates the economy of the farmers.

ACKNOWLEDGEMENT

The authors R. Nagendraswamy and Girija Nagendras-wamy are thankful to Department of Collegiate Education, Government of Karnataka for according permission to carry out this study.

Table 4: Average weight of leafy medicinal plants at different irrigation (Average weight is taken from 25 plants).

Name of leafy medicinal plants	Average weight of leafy medicinal plants (kg)		
	RW	50% PTSW	33%PTSW
Coriander (*Coriandrum sativum*)	0.128 ± 0.002	0.194 ± 0.001	0.225 ± 0.002
Dill (*Anethum graveolens*)	0.533 ± 0.008	0.773 ± 0.009	0.911 ± 0.002
Pudina/Spearmint (*Mentha viridis*)	0.116 ± 0.001	0.145 ± 0.005	0.193 ± 0.001
Fenugreek/Methi (*Trigonella foenum-graecum*)	0.114 ± 0.002	0.156 ± 0.001	0.196 ± 0.001

RW - Raw water: PTSW - Primary treated distillery spentwash

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