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Original Research Paper

Studies on the Impact of Irrigation of Distillery Spent Wash on the Yield of Cotton (*Gossipium hirsutum*) and Groundnut (*Arachis hypogaea*) Oil Seed Plants

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ABSTRACT

Cultivation of Cotton and groundnut seeds was made by irrigation with distillery spent wash of different concentrations. The spent wash i.e., primary treated spent wash [PTSW] 1:1, 1:2 and 1:3 spent wash were analyzed for their plant nutrients such as nitrogen, phosphorus, potassium and other physico-chemical characteristics. Experimental soil was tested for its chemical and physical parameters. Cotton and groundnut seeds were sown in the prepared land and irrigated with raw water (RW), 1:1, 1:2 and 1:3 spent wash. The influence of spent wash irrigation on the yield of oil seed plants at maturity was investigated. It was found that the yield of oil seed plants was high in 1:3 spent wash irrigation than raw water and other dilutions.

INTRODUCTION

Ethanol is produced by the fermentation of molasses in distilleries. Since the demand of ethanol is increasing in recent days due to its usages as fuel blended with petrol, a large number of distilleries are coming up. About eight litres of wastewater is generated for every litre of ethanol production in distilleries, known as raw spent wash (RSW) which is characterized by high biochemical oxygen demand (BOD: 5000-8000 mg/L) and chemical oxygen demand (COD: 25000-30000 mg/L), undesirable colour and foul odour (Joshi 1994). Discharge of raw spent wash into open land or nearby water bodies is dangerous, since it results in number of environmental, water and soil pollution problems 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 1987). Also, spent wash contains high organic nitrogen and nutrients (Ramadurai & Gearard 1994). By installing biomethanation plant in distilleries, the oxygen demand of RSW can be reduced, and the resulting spent wash is called primary treated spent wash (PTSW). Primary treated RSW increases the nitrogen (N), phosphorus (P) and potassium (K) and decreases calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mahamod Haroon & Bose 2004). The PTSW is rich in potassium (K), sulphur (S), nitrogen (N), phosphorus (P), as well as easily biodegradable organic matter and its application to soil has been reported to increase the yield of sugarcane (Zalawadia et al. 1997), rice (Devarajan & Oblisami 1995) wheat, rice (Pathak et al. 1998), quality of groundnut (Singh 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. 2000, Raverkar et al. 2000). The diluted spent wash irrigation improved the physical and chemical properties of soil and further increased soil microflora (Devarajan 1994, Kaushik et al. 2005, Kuntal et al. 2004) and the spent wash could safely used for irrigation purpose at lower concentration (Rajendra 1990, Ramana et al. 2001). The spent wash could be used as a compliment to mineral fertilizer to sugarcane. The spent wash contains 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), 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 spent wash were responsible for increased availability of plant nutrients. Diluted spent wash increases the uptake of and yield of leafy vegetables (Chandraju et al. 2007, Basavaraju & Chandraju 2008), root vegetables, yield of condiments (Chandraju and Chidan kumar 2009), and yield of radish (Chandraju et al. 2011).

However, no information is available on the studies on influence of distillery spent wash irrigation on the yield of oil seed plants. Therefore, the present investigation was carried out to study the influence of different proportions of spent wash on the yield of cotton and groundnut oil seed plants.

MATERIALS AND METHODS

Field work was conducted at own land in Halebudanur village near Mandya, Karnataka. Before cultivation, a composite soil sample was collected from experimental site at 25 cm depth at different sites, mixed and dried under sunlight. The sample was analyzed by standard methods (Manivasakam 1987) (Table 1). The PTSW was used for irrigation with dilution of 1:1, 1:2 and 1:3 ratios. The physical and chemical characteristics and amount of nitrogen (N) potassium (K), phosphorus (P) and sulphur (S) present in the PTSW, 1:1, 1:2 and 1:3 distillery spent wash were analyzed (Lindsay & Narvel 1978) using standard procedures (Tables 2 and 3).

The seeds were sown and irrigated by applying 5-10 mm^3/cm^2 depending upon the climatic condition, with raw water (RW), 1:1,1:2 and 1:3 SW at the dosage of twice a week and rest of the period with raw water depending upon the climatic condition. Trials were conducted for three times and average yields were recorded **(**Table 5).

Table 1: Physico-chemical properties of soil.

Parameters	Values
Coarse sand [c]	9.85
Fine sand [c]	40.72
Silt [c]	25.77
Clay [c]	23.66
pH (1:2 soil solution)	8.41
Electrical Conductivity [a]	540
Organic Carbon [c]	1.77
Available Nitrogen [b]	402
Available Phosphorus [b]	202
Available Potassium [b]	113
Exchangable Calcium [b]	185
Exchangable Magnesium [b]	276
Exchangable 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 - ppm, c - %

Table 2: Chemical characteristics of distillery spent wash at different dilution.

Chemical parameters	PTSW	1:1 PTSW	1:2 PTSW	1:3PTSW
pH	7.57	7.63	7.65	7.66
Electrical conductivity	26400	17260	7620	5330
Total solids	47200	27230	21930	15625
Total dissolved solids [b]	37100	18000	12080	64520
Total suspended solids [b]	10240	5830	2820	1250
Settleable solids [b]	9880	4150	4700	3240
COD [b]	41250	19036	4700	2140
BOD [b]	16100	7718	4700	2430
Carbonate [b]	Nil	Nil	Nil	Nil
Bicarbonate [b]	12200	6500	3300	1250
Total phosphorus [b]	40.5	22.44	17.03	10.80
Total potassium [b]	7500	4000	2700	1620
Calcium [b]	900	590	370	190
Magnesium [b]	1244.16	476.16	134.22	85
Sulphur [b]	70	30.2	17.8	8.4
Sodium [b]	520	300	280	140
Chlorides [b]	6204	3512	3404	2960
Iron [b]	7.5	4.7	3.5	2.1
Manganese [b]	980	495	288	160
Zinc [b]	1.5	0.94	0.63	0.56
Copper [b]	0.25	0.108	0.048	0.026
Cadmium [b]	0.005	0.003	0.002	0.001
Lead [b]	0.16	0.09	0.06	0.003
Chromium [b]	0.05	0.026	0.012	0.008
Nickel [b]	0.09	0.045	0.025	0.012
Ammonical nitrogen [b]	750.8	352.36	283.76	178
Carbohydrates [c]	22.80	11.56	8.12	6.20

Units: a - µS, b - mg/L, c - %, PTSW - Primary treated spent wash

Table 3: Amount of N, P, K and S (Nutrients) in spent wash.

Chemical Parameters	PTSW	1:1 PTSW	1:2 PTSW	1:3 PTSW
Ammonical nitrogen[a]	750.8	352.36	283.76	160.5
Total phosphorus[a]	40.5	22.44	17.03	11.2
Total potassium[a]	7500	4000	2700	1800
Sulphur[a]	70	30.2	17.8	8.6

Unit: a - mg/L, PTSW**:** Primary treated spent wash

Table 4: Characteristics of experimental soil (After harvest).

Parameters	Values
Coarse sand [c]	9.69
Fine sand [c]	41.13
Slit [c]	25.95
Clay [c]	24.26
pH (1:2 soil solution)	8.27
Electrical Conductivity [a]	544
Organic Carbon [c]	1.98
Available Nitrogen [b]	434
Available Phosphorus [b]	218
Available Potassium [b]	125
Exchangable Calcium [b]	185
Exchangable Magnesium [b]	276
Exchangable 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 - ppm, c - %

Table 5: Average weight (kg) of oil seed plants (Average of 25 plants).

Name of oil seed plants	RW	1:1 PTSW	1.2PTSW	1:3PTSW
Cotton (*Gossipium hirsutum*)	0.3750	0.238	0.350	0.474
Groundnut (*Arachis hypogaea*)	0.576	0.380	0.455	0.6005

RESULTS AND DISCUSSION

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 (Table 1). It was found that the soil composition is fit for the cultivation of plants, because it fulfils all the requirements for the yields of plants. Chemical composition of PTSW, 1:1,1:2 and 1:3 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 (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 (Manivasakam 1987, Piper 1996) (Table 2). Amount of N, P, K and S contents are presented in Table 3.

In both the cases, the yield was 100% in 1:3 SW, 25% in 1:1 SW, 80% in 1:2 SW and 95% in RW irrigations. Yield was very poor in 1:1 SW irrigation compared with RW, 1:2 SW and 1:3 SW irrigations. Maximum yield was observed in 1:3 SW compared to RW, 1:1 SW and 1:2 SW irrigations.

CONCLUSION

It was found that the yield of the oil seed plants was good (100%) in 1:3 SW irrigation, while very poor in 1:1 SW (25%), moderate in 1:2 SW (80%) and 95% in RW irrigations. In 1:3 SW irrigation, the plants are able to absorb maximum amount of nutrients, both from the soil and the spent wash, resulting in high yield. This concludes that the spent wash can be conveniently used for the cultivation of oil seed plants without external (either organic or inorganic) fertilizers. This minimizes the cost of cultivation and hence elevates the economy of the farmers.

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