Research Article

Impact of Distillery Spentwash Irrigation on the yields of Himalayan Balsam *(Balsaminaceae)* and Crossandra *(Acanthaceae)* Flowering Plants

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ABSTRACT
The yields of Himalayan Balsam (Balsaminaceae) and Crossandra (Acanthaceae) seeds was made by irrigated with distillery spentwash of different concentrations. Primary treated spentwash (100%, 1:1, 1:2, and 1:3) was analyzed for plant nutrients such as nitrogen, phosphorous, potassium and other physical and chemical characteristics. Soil was tested for chemical and physical parameters. Himalayan Balsam and crossandra seeds were sowed in different pots and irrigated with raw water (RW), 1:1, 1:2 and 1:3 spentwash. The nature of yields was studied. It was found that, the yields was very good (100%) in 1:3 SW irrigation, while very poor (25%) in 1:1 SW, moderate (80%) in 1:2 SW and 95% in RW irrigations.

Keywords: Distillery spentwash, Himalayan Balsam , Crossandra, Yield , Irrigation, Soil.

INTRODUCTION

Himalayan Balsam belongs to the family *Balsaminaceae*. It typically grows to 1 to 2 m high, with a soft green or red-tinged stem, and lanceolate leaves 5 to 23 cm long. The crushed foliage has a strong musty smell (A National History). The flowers are pink, with a hooded shape, 3 to 4 cm broad the flower shape has been compared to a policeman's helmet, giving rise to the alternative common name Policeman's Helmet. Although it does not range all over India and is by no means the only Impatiens native to that country, it is also known as Indian Balsam (Himalayan Balsam) in countries where it is introduced. In India it is commonly called as Karnakundala. Himalayan Balsam, Impatiens glandulifera, is a large annual plant, native to the Himalayans (Impatiens) resulting in its colloquial name of Kiss-me-on-the-mountain in the UK. After flowering between June and October, the plant forms seed pods 2 to 3 cm long and 8mm broad. Which explode when disturbed, scattering the seeds up to 7 meters. The green seed pods and seeds can be eaten, and also the young leaves and shoots.

Crossandra is belongs to the family *Acanthaceae*, comprising 52 species that occur in Africa, Madagascar, Arabia and the Indian subcontinent. Some species, especially Crossandra infundibuliformis, are cultivated for their brightly colored flowers. It is known as Kanakambara in Karnataka, southern states in India. A well tended specimen will bloom continuously for years. Plant breeders, especially in Europe, have been hybridizing Crossandras. Cultivars with yellow and even red flowers are available. Crossandra is a sturdy, productive ornamental that should be more popular with indoor gardens.

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries by fermentation method. About 08 (eight) liters of wastewater is generated for every liter of ethanol production in distilleries, known as raw spentwash (RSW), which is known for high biological oxygen demand (BOD: 5000-8000mg/L) and chemical oxygen demand (COD: 25000-30000mg/L), undesirable color and foul odor (Joshi, 1994). Discharge of RSW into open field or nearby water bodies' results in environmental, water and soil pollution 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, spentwash contains high 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 spentwash (PTSW) and primary treatment to RSW increases the nitrogen (N), potassium (K), and phosphorous (P) contents and decreases calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}). 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 increase yield of sugar cane (Zalawadia, 1997), wheat (Pathak, 1998) and rice (Devarajan and Obiliswamy, 1995). Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility (Kaushik, Nisha.R, andJagjeeta. K and Kaushik. C.P, 2005) (Kuntal, Ashish. K, and Mishra.K, 2004) (Revarkar. K.P, Biswas.A.K, and Kundu.S, 2000) . The diluted spent wash irrigation improved the physical and chemical properties of the soil and further increased soil micro flora (Devarajan, 1994; Kaushik, 2005; Kuntal, 2004). Twelve pre-sowing irrigations with the diluted spent wash had no adverse effect on the germination of maize but improved the growth. Increased concentration of spent wash causes decreased seed germination, seedling growth and yield (Singh and Raj Bahadur,, 1998). Increased concentration of SW causes decreased seed germination, seedling growth and chlorophyll content in Sunflowers *(Helianthus annuus)* and the SW could safely used for irrigation purpose at lower concentration (Rajendra, 1990). The SW 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 SW , which can be used as a substitute for chemical fertilizer (Sahai,R, Jabeen.S, and Saxena,P.K, 1983). The SW could be used as a complement to mineral fertilizer to sugarcane (Chares, 1985). The SW contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water (Samuel, 1986). Diluted SW increase the uptake of nutrients, height, growth and leaves vegetables, and yields of some root vegetables (Chandraju,s and Basavaraju, 2007; Chidan Kumar, S, Chandraju, S, and Nagendra Swamy,R, 2009), in untreated and SW treated soil, top vegetables (creepers) tuber\root medicinal plants, leafy medicinal plants in normal and SW treated soil. However, no information is available on Himalayan Balsam and Crossandra flowering plant irrigated by distillery SW. Therefore, the present investigation was carried out to study the influence of different proportions of SW on the yields of Himalayan Balsam and Crossandra.

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 (1:1, 1:2 and 1:3 SW) were analyzed by standard methods. The PTSW was used for irrigation with a dilution of 1:1, 1:2 and1:3. A composite soil sample collected prior to spentwash irrigation was air-dried, powdered and analyzed for physico-chemical properties (Piper, 1996; Jackson, 1973; Walkeley and Black, 1934; Subbaiah and Asija, 1956; Black, 1965; Lindsey and Norvel, 1978). Flowering plants selected for the present investigation were Himalayan Balsam and Crossandra. The sets were planted in different pots 30(h), 25(dia)] and irrigated (by applying 5-10mm/cm^2 depends upon the climatic condition) with raw water (RW), 1:1 SW, 1:2 SW and 1:3 SW at the dosage of twice a week and rest of the period with raw water as required. Cultivation was conducted in triplicate, in each case yields were recorded.

Table 1: Chemical characteristics of distillery Spentwash

Chemical parameters	PTSW	1:1 PTSW	1:2 PTSW	1:3 PTSW
pH	7.57	7.63	7.65	7.66
Electrical conductivity[a]	26400	17260	7620	5330
Total solids[b]	47200	27230	21930	15625
Total dissolved solids[b]	37100	18000	12080	64520
Total suspended solids[b]	10240	5380	4080	1250
Settleable solids[b]	9880	4150	2820	3240
COD[b]	41250	19036	10948	2140
BOD[b]	16100	7718	4700	2430
Carbonate[b]	Nil	Nil	Nil	Nil
Bicarbonate[b]	12200	6500	3300	1250
Total Phosphorous[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 distillery spentwash

Table 2: Amount of N, P, K and S (Nutrients) in distillery Spentwash

Chemical parameters	PTSW	1:1 PTSW	1:2 PT SW	1:3 PTSW
Ammonical Nitrogen[b]	750.8	352.36	283.76	160.5
Total Phosphorous[b]	40.5	22.44	17.03	11.2
Total Potassium[b]	7500	4000	2700	1800
Sulphur[b]	70	30.2	17.8	8.6

Unit: b – mg/L, PTSW - Primary treated distillery spentwash

Table 3: Characteristics of experimental soil

Parameters	Values
Coarse sand[c]	9.24
Fine sand[c]	40.14
Slit[c]	25.64
Clay[c]	20.60
pH (1:2 soln)	8.12
Electrical conductivity[a]	530
Organic carbon[c]	1.64
Available Nitrogen[b]	412
Available Phosphorous[b]	210
Available Potassium[b]	110
Exchangeable Calcium[b]	180
Exchangeable Magnesium[b]	272
Exchangeable Sodium[b]	113
Available Sulphur[b]	330
DTPA Iron[b]	204
DTPA Manganese[b]	206
DTPA Copper[b]	10
DTPA Zinc[b]	55

Units: **a** – µS, **b** – mg/L , **c**- %

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 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,

Table 5: Yields of *Himalayan Balsam (Balsaminaceae) and Crossandra (Acanthaceae)* Flowers at different irrigations. (Average number is taken from the five plants)

Name of the Plants	RW		1:1 SW		1:2 SW		1:3 SW	
	No.of Flowers	Size of Flowers	No. of Flowers	Size of Flowers	No.of Flowers	Size of Flowers	No. of Flowers	Size of Flowers
Himalayan Balsam *(Balsaminaceae species)*	15	4cm	--	--	25	6cm	40	7cm
Crossandra *(Malvaceae species)*	35	3cm	--	--	40	4cm	50	5cm

RESULTS AND DISCUSSIONS

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), 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 (Table-2). 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 (Table-3 & 4). It was found that the soil composition is fit for the cultivation of plants, because it fulfils all the requirements for the growth of plants. Yields of Himalayan Balsam and Crossandra plant leaves, uptakes of all the parameters were very good in both 1:2 and 1:3 spent wash as compared to1:1, SW and raw water. In both 1:1, 1:2 and 1:3 SW irrigation, the uptake of the nutrients such as fat, calcium, zinc, copper and vitamins carotene and vitamin c were almost similar but the uptake of the nutrients and parameters such as protein, fiber, carbohydrate, energy, magnesium and phosphorous were much more in the case of 1:1, 1:2, spent wash irrigation than 1:3, and raw water irrigations (Table-5). This could be due to the more absorption of plant nutrients present in SW by plants at higher dilutions. It was also found that no negative impact of heavy metals like lead, cadmium and nickel on the leaves of both plants. The soil was tested after the harvest; found that there was no adverse effect on soil characteristics (Table-4).

CONCLUSION

It was found that the nutrients uptake in both plants were largely influenced in case of 1:1, 1:2 and 1:3 SW irrigation than with raw water. But 1:3 SW shows more uptakes of nutrients like N, P, K, when compared to 1:2 SW. This could be due to the maximum absorption of nutrients like N.P.K, by plants at more diluted SW in 1:3. After harvest, soil has tested; found that there was no adverse effect on characteristics. Hence the SW can be conveniently used for irrigation purpose with required dilution without affecting environment and soil.

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