ijcrr
Vol 04 issue 01
Category: Research
Received on:21/11/11
Revised on:30/11/11
Accepted on:15/12/11

Impact of Distillery Spentwash Irrigation on Sprouting and Growth of Himalayan Balsam *(Balsaminaceae)* and Crossandra *(Acanthaceae)* Flowering plants

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ABSTRACT

Germination of Himalayan Balsam *(Balsaminaceae)* and Crossandra *(Acanthaceae)* seeds was made by irrigated with distillery spentwash of different concentrations. The spentwash i.e., primary treated spentwash (PTSW), 1:1, 1:2, and 1:3 spent wash were analyzed for their plant nutrients such as nitrogen, phosphorous, potassium and other physical and chemical characteristics. Experimental soil was tested for its 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 germination of seeds was studied. It was found that, the germination 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 , Germination, Growth, 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. 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 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 (resulting in its colloquial name of Kiss-me-on-the-mountain[1] 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. Which is a method of controlling the plant's spread[2-4]. However, a recent study it may cause more harm than good. Destroying riparian stands of Himalayan Balsam can open up the habitat for more aggressive invasive plants. The Bionic Control of Invasive Weeds in Wiesbaden, Germany is trying to establish a self sufficient project to conserve their local biodiversity by developing several food products made from the Impatiens flowers. Eventually, if all goes well, this project will have the Himalayan Balsam financing its own eradication.

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[5,6], are cultivated for their brightly colored flowers. It is known as Kanakambara in Karnataka, southern states in India. Crossandra from the Greek, meaning fringed anthers. The male portion of the flower, the anthers, is distinctly fringed in this genus of plants. The firecracker flower, while relatively unknown to the general public as a houseplant, is just about the most prolifilic indoor flowering plant. A well tended specimen will bloom continuously for years. It is growing from four sided stalked spikes; the asymmetrical petals arise as a slender tube and then split in to their ends. 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[7]. 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 [8]. Also, spentwash contains high organic nitrogen and nutrients [9]. 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-})[10]. 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, wheat and rice [11], Quality of groundnut [12] and physiological response of soybean[13]. Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility[14], seed germination and crop productivity [15]. The diluted spent wash irrigation improved the physical and chemical properties of the soil and further increased soil micro flora[16, 17, 18]. Twelve pre-sowing irrigations with the diluted spent wash had no adverse effect on the germination of maize but improved the growth[19]. Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas[20]. Increased concentration of spent wash causes decreased seed germination, seedling growth and chlorophyll content in Sunflowers *(Helianthus annuus)* and the spentwash could safely used for irrigation purpose at lower concentration[21]. 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 spentwash, which can be used as a substitute for chemical fertilizer[22]. The spent wash could be used as a complement to mineral fertilizer to sugarcane[23]. The spentwash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water[24]. 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. 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[25], nutrients of cabbage and mint leaf[26], nutrients of top vegetable[27], pulses, condiments, root vegetables, of some root vegetables in untreated and spentwash treated soil, yields of top vegetables (creepers). However, no information is available on sprouting and growth of Himalayan Balsam and Crossandra flowering plant irrigated by distillery spentwash. Therefore, the present investigation was carried out to study the influence of different proportions of spent wash on the sprouting and growth[35, 36, 37, 38] 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[28]. 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[29, 30, 31, 32, 33, 34]. 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 sprouting, growth were recorded.

RESULTS AND DISCUSSION

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 and tabulated (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. Sprouting and growth 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 spent wash 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).

Crossandra *(Acanthaceae)*

Balsam *(Balsaminaceae)*

This is due to the more absorption of plant nutrients present in spentwash 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 Himalayan Balsam and Crossandra plant. 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 germination of both Himalayan Balsam *(Balsaminaceae)* and Crossandra *(Acanthaceae)* 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. This concludes that, the maximum absorption of nutrients by plants at more diluted spentwash irrigation. At higher concentrations, spentwash made the mask on the surface of soil and hence, decreases the sprouting of seeds. Growth of plants is also maximum in 1:3 SW irrigation than 1:1 SW, 1:2 SW and RW irrigations. This might be due to the maximum absorption of nutrients by plants at higher dilution compare to 1:1 SW and 1:2 SW irrigations.

After harvest, soil was tested; it was found that, there was no adverse effect on soil characteristics. Hence the spentwash can be conveniently used as irrigation medium with required dilution without affecting environment and soil without external fertilizers (either Organic or Inorganic), which minimizes the cost of cultivation of flowering plants and elevates the economy of growers.

ACKNOWLEDGEMENT

Authors are grateful to The General Manager, N. S. L. Koppa, Maddur Tq., Karnataka, India, for providing spentwash.

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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 Growth of Himalayan Balsam and Crossandra plants at different irrigations (cm)

Name of the plants	RW 15th 22nd 29th (Day)	1:1SW 15th 22nd 29th (Day)	1:2 SW 15th 22nd 29th (Day)	1:3 SW 15th 22nd 29th (Day)
Himalayan Balsam(Balsaminaceae)	22, 25, 27	08, 09, 10	23, 24, 26	23, 27, 31
Crossandra(Acanthaceae)	23, 24, 26	06, 08, 09	22, 25, 26	24, 26 30