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Impact of Distillery Spentwash Irrigation on Sprouting and Growth of Gardenia *(Rubiaceae)* Flowering plant

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ABSTRACT
Sprouting and growth of Gardenia (Rubiaceae) flowering plant was made by irrigated 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, phosphorous, potassium and other physical and chemical characteristics. Experimental soil was tested for its chemical and physical parameters. Gardenia (Rubiaceae) sets were planted in different pots and irrigated with raw water (RW), 1:1, 1:2 and 1:3 spent wash. The nature of sprouting and growth was studied. It was found that the sprouting and growth of plant 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 irrigation growth.

Key words: *Distillery spent wash;* Gardenia *(Rubiaceae); Sprouting; Growth; Irrigation; Soil.*

INTRODUCTION

Gardenia (Nandi Battalu) belongs to Rubiaceae family. Gardenia belongs to the Tribe Gardenia [1]. It belongs to the Genus Gardenia. Gardenia is a genus of 142 species [2] of flowering plants in the coffee family, Rubiaceae, native to the tropical and subtropical regions of Africa, southern Asia, Australasia and Oceania. Several species occur on Hawaii, where gardenias are known as nanu. The genus was named by Carl Linnaeus after Dr. Alexander Garden, a Scottish-born American naturalist. They are evergreen shrubs and small trees growing to 1-15 meters tall. The leaves are opposite or in whorls of three or four, 5-50 centimeters long and 3-25 centimeters broad, dark green and glossy with a leathery texture. The flowers are solitary or in small clusters, white, or pale yellow, with a tubular based corolla with 5-12 lobes from 5-12 centimeters in diameter. Flowering is form about mid-spring to mid-summer and many species are strongly scented. Gardenia plants are prized for the strong sweet scent of their flowers, which can be very large in some species [3] potting soils developed especially for gardenias are available. In Japan and China, Gardenia jasminoides is called Kuchinashi (Japanese) and Zhi zi (Chinese) the bloom is used as a yellow die, which is used for clothes and food (including the Korean mung bean jelly called hwangpomuk). In France, decades ago, Gardenia was the traditional flower which men wore sometime as boutonnieres on special occasions. It is the National flower of Pakistan. Jazz singer Billie Holiday was known to wear gardenias in her hair, one of her most noticeable features. She called them her trademark [4]. Crocetin is a chemical compound found in gardenia fruit. In high concentrations, it has protective effects against retinal damage in vitro and vivo [5,6].

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 spent wash (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 oxi disable organic matter with very high BOD and COD [8]. Also, spent wash contains high organic nitrogen and nutrients [9]. By installing biomethenation plant in distilleries, reduces the oxygen demand of RSW, the resulting spent wash is called primary treated spent wash (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 [16-18]. Twelve pre-sowing irrigations with the diluted spent wash had no adverse effect on the germination of maize but improved the growth [19]. Diluted spent wash 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 spent wash could safely used for irrigation purpose at lower concentration [21]. The spent wash 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 spent wash, 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 spent wash 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 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 . Mineralization of organic material as well as nutrients present in the spent wash was responsible for increased availability of plant nutrients. Diluted spent wash 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 Gardenia flowering plant irrigated by distillery spent wash. Therefore, the present investigation was carried out to study the influence of different proportions of spent wash on the sprouting and growth of Gardenia.

EXPERIMENTAL SECTION

physico-chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated diluted spent wash (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 spent wash irrigation was air-dried, powdered and analyzed for physico-chemical properties [29-34]. Flowering plants selected for the present investigation were Gardenia. 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.

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 spent wash*

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

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 spent wash*

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 Gardenia plant at different irrigations (cm)

Name of the plant	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)
Gardenia(Rubiaceae)	**22, 25, 27**	**08, 09, 10**	**23, 24, 26**	**23, 27, 31**

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 Gardenia 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). This could be due to the more absorption of plant nutrients present in spent wash 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 Gardenia plant. The soil was tested after the harvest; found that there was no adverse effect on soil characteristics (Table-4).

CONCLUSION

It is found that the nutrients uptake in the Sprouting and growth of Gardenia *(Rubiaceae)* plant were largely influenced in case of both1:1, 1:2 and 1:3 SW irrigation than with raw water. But 1:3 distillery spent wash shows more uptakes of nutrients when compared to 1:2 SW. This could be due to the maximum absorption of nutrients by plants at more diluted spent wash. After harvest, soil has tested; found that there was no adverse effect on characteristics. Hence the spent wash can be conveniently used for irrigation purpose with required dilution without affecting environment and soil.

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