Research Article

Irrigational Impact of Distillery Spentwash on the Nutrients of V-1 Mulberry (Morus *Alba)* Plants

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ABSTRACT

Cultivation of V-1 Mulberry plants was made by irrigation with distillery spentwash of different concentrations. The spentwash i.e., primary treated spentwash (PTSW), 50% and 33% spentwash 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. Sets of V-1Mulberry Plants were planted in the prepared land and irrigated with raw water (RW) 50% and 33% spentwash. . The impact of distillery spentwash on proximate composition (moisture, protein, fat, fiber, carbohydrate, energy, calcium, phosphorous and iron), Vitamin content (carotene and Vitamin-C), mineral and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) of Mulberry Plant leaves was investigated. It was found that the uptake of nutrients of mulberry plants *Morus alba*) V-1 were more in 33% spentwash irrigation than raw water and 50% spentwash irrigations. This concludes that the diluted spentwash is an effective irrigation medium for the cultivation of V-1 mulberry plants.

Keywords: Distillery spentwash, nutrients, Mulberry plants, Seed sets, Soil.

1.INTRODUCTION

Sericulture, or silk farming, is the rearing of silkworms *Bombyx mori* for the production of raw silk. Mulberry leaves, particularly those of the white mulberry, are ecologically important as the sole food source of the silkworm (*Bombyx mori*, named after the mulberry genus *Morus*), the pupa/cocoon of which is used to make silk. Silk is a way of life in India. Over thousands of years, it has become an inseparable part of Indian culture and tradition. No ritual is complete without silk being used as a wear in some form or the other. Silk is the undisputed queen of textiles over the centuries. Silk provides much needed work in several developing and labor rich countries. Sericulture is a cottage industry par excellence. It is one of the most labor intensive sectors of the Indian economy combining both agriculture and industry, which provides for means of livelihood to a large section of the population i.e. mulberry cultivator, co-operative rarer, silkworm seed producer, farmer-cum rarer, realer, twister, weaver, hand spinners of silk waste, traders etc. It is the only one cash crop in agriculture sector that gives returns within 30 days. This industry provides employment nearly to three five million people in our country. India is the second largest silk producer in the World after China. Germany is the largest consumer of Indian silk. The sericulture industry is land based as silk worm rearing involves over 700,000 farm families and is concentrated in Karnataka, Tamilnadu and Andhra Pradesh (Southern states of India). Assam and West Bengal states are also involved to certain extent. (http://www.seri.ap.gov.in Retrieved on 03/02/2011)

Mulberry foliage is the only food for the silkworm (*Bombyx mori*) and is grown under varied climatic conditions ranging from temperate to tropical. Favorable soils for mulberry cultivation are sandy loam and clayey loam. Slightly acidic are ideally suitable. Mulberry leaf is a major economic component in sericulture, since the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest. In India, most states have taken up sericulture as an important agro-industry with excellent results. The total area of mulberry in the country is around 2,82,244 ha Though mulberry cultivation is practiced in various climates, the major area is in the tropical zone covering Karnataka, Andhra Pradesh and Tamil Nadu states, with about 90 %. Area under mulberry in Karnataka is 166 000ha. (R. K. Datta, CSRTI, Mysore).

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 discharged for every liter of ethanol production in distilleries, known as raw spentwash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000mg/L) and chemical oxygen demand (COD: 25000-30000mg/L), undesirable color and foul smell1. Discharge of raw spentwash into open land or near by water bodies is a serious problem since it results in a number of 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 COD2. Also, spentwash contains high organic nitrogen and nutrients3. By installing biomethenation plant in distilleries, reduces the oxygen demand of RSW, the resulting spentwash is called primary treated spent wash (PTSW) and primary treatment to RSW increases the nitrogen (N), potassium (K), and phosphorous (P) contents and decreases the calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-})4,5. The 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 cane6, rice7, wheat and rice8, quality of groundnut9 and physiological response of soybean10. Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility11,12,13, seed germination and crop productivity. The diluted spentwash irrigation improved the physical and chemical properties of the soil and further increased soil microflora14,10,11. Twelve pre-sowing irrigations with the diluted spentwash had no adverse effect on the germination of maize but improved the growth and yield15. Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas 16. Increased concentration of spentwash 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 concentration14,15. 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 the spentwash, which can be used as a substitute for chemical fertilizer16. The spent wash could be used as a complement to mineral fertilizer to sugarcane17. The spentwash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water18. 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 levels19,. Mineralizations 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 leaves vegetables 20,21, nutrients of cabbage and mint leaf22, nutrients of top vegetable23, pulses, condiments, root vegetables 24, and yields of condiments25, yields of some root vegetables in untreated and spentwash treated soil26, yields of top vegetables (creepers) 27, yields of tuber/root medicinal plants28, yields of leafy medicinal plants29 nutrients of creeper medicinal plants30, yields of leafy medicinal plants in normal and spentwash treated soil31, nutrients uptake of herbal medicinal plants in normal and spentwash treated soil32, nutrients of leafy medicinal plants33, nutrients of ginger and turmeric in normal and spent wash treated soil, 34, nutrients of tubers/roots medicinal plants35. However, not much information is available on the influence of distillery spentwash irrigation on the yields of mulberry plants. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on nutrients of V-1 variety mulberry plant.

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 36**.** 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 37,38,39,40,41,42.

Mulberry plants selected for the present investigation was *V-1.* The seeds/ sets were sowed and irrigated (by applying 5-10mm/cm^2 depends upon the climatic condition) 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. Trials were conducted for three times and at the time of maturity, fresh leaves of plants were collected and proximate composition, vitamins, minerals and trace elements were analyzed (Table-5).

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 solidsb	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
Carbohydrates[c]	22.80	11.56	8.12

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	50% PTSW	33%PT SW
Ammonical Nitrogen[b]	750.8	352.36	283.76
Total Phosphorous[b]	40.5	22.44	17.03
Total Potassium[b]	7500	4000	2700
Sulphur[b]	70	30.2	17.8

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

Table 3: 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 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, c- %

Table 5: Effect of spentwash irrigation on the Nutritive values of V-1 mulberry plants

Parameters	RW	50%PTSW	33% PTSW
Proximate composition			
Moisture [a]	71.96	72.84	74.86
Fat [a]	0.80	0.82	0.85
Acid insoluble ash [a]	0.31	0.36	0.39
Protein [a]	4.65	4.70	4.78
Fiber [a]	1.6	1.7	1.9
Carbohydrate [a]	7.98	8.31	8.45
Energy [b]	55.0	58.0	59.5
Macro nutrients			
Calcium [c]	282.0	287.0	290.0
Magnesium [c]	495.0	498.0	499.0
Sodium [c]	25.0	26.2	27.9
Potassium [c]	249.0	253.0	265.0
Phosphorous [c]	26.0	27.2	30.0
Sulphur[c]	66.2	66.78	68.0
Micro nutrients			
Iron [c]	7.2	7.4	8.3
Zinc [c]	0.26	0.28	0.33
Manganese [c]	0.33	0.35	0.36
Copper [c]	0.27	0.28	0.28
Chlorides [c]	27.3	27.65	28.34
Nickel [c]	BDL	BDL	BDL
other elements			
Lead [c]	BDL	BDL	BDL
Cadmium [c]	BDL	BDL	BDL
Chromium [c]	0.002	0.002	0.002
Vitamins			
Carotene [d]	990.0	1050.0	1380.0
Vitamin C [c]	95.0	106.0	138.0

Units: a- g; b- kCal; c- mg; d- μg; BDL-below detection level

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), 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 in Table-2. In 33% Spentwash the various constituents are in lower concentrations compared to primary treated spentwash and in 50% Spentwash the concentrations of various constituents are moderate.

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 cultivation of plants.

In the case of V-1 mulberry plant leaves, uptakes of all the parameters were very good in both 50% and 33% spentwash as compared to raw water. In both 33% and 50% spentwash 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 33% spentwash irrigation than 50% and raw water irrigations (Table-5). This could be 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. V-1 mulberry plants.

CONCLUSION

It is found that the nutrients uptake in V-1 variety mulberry plants were largely influenced in case of both 33 and 50% SW irrigation than with raw water. But 33% distillery spentwash shows more uptakes of nutrients when compared to 50% SW in V-1 variety mulberry plant. This could be due to the maximum absorption of nutrients by plants at more diluted spentwash.

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