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# Irrigational impact of distillery spentwash on the nutrients of *S-30, S-36 and Vishwa (DD)* mulberry (*Morus alba)* leaves

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**Some varieties of Mulberry plants were irrigated 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 Mulberry Plants were sowed in the prepared land and irrigated with raw water (RW), 50% and 33% spentwash. The impact of distillery spentwash on proximate composition, Vitamin content (carotene and Vitamin-C), mineral and trace elements of different varieties of Mulberry Plant leaves were investigated. It was found that the uptake of nutrients of all varieties of mulberry plants (*Morus alba*) –*S-30, S-36 and Vishwa (DD)*, were more in 33% spentwash irrigation than raw water and 50% spentwash irrigations.**

**Key words**: Distillery spentwash, nutrients, Mulberry plants, Seed sets, Soil.

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, 2,82244ha. 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 percent. Area under mulberry in Karnataka is 1,66000ha. (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. Nearly 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 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 ($SO_4^{2-}$) (Mahamod Haroon and Subhash Chandra Bose, 2004). 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), rice (Devarajan and Oblisami, 1995), wheat and rice (Pathak et al., 1998), Quality of groundnut (Amar BS et al.) and physiological response of soybean (Ramana et al., 2000). Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility (Kaushik et al., 2005; Kuntal et al., 2004;Raverkar et al., 2000), seed germination and crop productivity (Ramana et al., 2001). The diluted spentwash irrigation improved the physical and chemical properties of the soil and further increased soil micro flora (Devarajan, 1994; Kaushik et al, 2005; Kuntal et al., 2004). Twelve pre-sowing irrigations with the diluted spentwash had no adverse effect on the germination of maize but improved the growth and yield (Singh and Raj Bahadur, 1998). Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Rani and Srivastava, 1990). 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 concentration (Rajendra, 1990; Ramana et al., 2001). 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 (Sahai et al., 1983). The spentwash could be used as a complement to mineral fertilizer to sugarcane (Chares, 1985). The spentwash contained 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 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 (Pujar, 1995). 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 (Chandraju et al., 2007; Basvaraju and Chandraju, 2008), nutrients of cabbage and mint leaf (Chandraju et al., 2008), nutrients of top vegetable (Basvaraju and Chandraju, 2008), pulses, condiments, root vegetables (Chandraju et al., 2008), and yields of condiments (Chandraju and Chidankumar, 2009), yields of some root vegetables in untreated and spentwash treated soil (Chidankumar et al., 2009), yields of top vegetables (creepers) (Chidankumar et al.,2009), yields of tuber/root medicinal plants(Nagendraswamy et al., 2010), yields of leafy medicinal plants (Nagendraswamy et al., 2010) nutrients of creeper medicinal plants (Chandraju et al., 2010), yields of leafy medicinal plants in normal and spentwash treated soil (Chandraju et al., 2010), nutrients uptake of herbal medicinal plants in normal and spentwash treated soil (Chandraju et al., 2010), nutrients of leafy medicinal plants(Chandraju et al., 2010), nutrients of ginger and turmeric in normal and spentwash treated soil (Chandraju et al., 2010), nutrients of tubers/roots medicinal plants (Chandraju et al., 2010). However, no information is available on the irrigation of distillery spentwash on the nutrients of mulberry plants leaves. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on the nutrients of *–S-30, S-36 and Vishwa (DD)*, variety mulberry plants leaves.

**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 solids[b] | 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

**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 (Manivasakam, 1987). 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 (Piper, 1996: Jackson, 1973: Walkeley and Black, 1934: Subbaiah and Asija, 1956: Black, 1965: Lindsay and Norvel, 1978). Varieties of mulberry Plants selected for the present investigation were *S-30.Vishwa(DD) and S-36-* 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 are collected and proximate composition, vitamins, minerals and trace elements were analyzed (Table 4 & 5).

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

| Chemical parameters | PTSW | 50% PTSW | 33%PTSW |
|---|---|---|---|
| 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

**Results**

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 (Table-2).

**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,

**Table: 5 Nutritive Values of *S-30, S-36 and Vishwa (DD)*, mulberry leaves in different Irrigation System**

| Parameters | *S-30* | | | *S-36* | | | *Vishwa (DD)* | | |
|---|---|---|---|---|---|---|---|---|---|
| | RW | 50% SW | 33% SW | RW | 50% SW | 33% SW | RW | 50% SW | 33% SW |
| **Proximate composition** | | | | | | | | | |
| Moisture [a] | 72.0 | 74.0 | 74.5 | 78.0 | 78.0 | 79.83 | 76.0 | 77.5 | 79.0 |
| Fat [a] | 0.90 | 0.92 | 0.93 | 0.80 | 0.82 | 0.82 | 0.80 | 0.89 | 0.95 |
| Acid insoluble ash [a] | 0.60 | 0.63 | 0.65 | 0.60 | 0.62 | 0.66 | 0.70 | 0.76 | 0.79 |
| Protein [a] | 3.20 | 3.52 | 3.69 | 3.20 | 3.45 | 3.60 | 3.00 | 3.30 | 3.45 |
| Fibre [a] | 1.50 | 1.60 | 1.75 | 1.40 | 1.48 | 1.55 | 1.20 | 1.32 | 1.36 |
| Carbohydrate [a] | 6.20 | 6.35 | 6.46 | 5.80 | 6.0 | 6.3 | 6.0 | 6.5 | 6.8 |
| Energy [b] | 40.0 | 45.0 | 48.0 | 50.0 | 52.0 | 52.6 | 60.0 | 62.0 | 63.5 |
| **Macro nutrients** | | | | | | | | | |
| Calcium [c] | 160.0 | 168.0 | 175.0 | 180.0 | 186.0 | 188.0 | 190.0 | 196.0 | 198.0 |
| Magnesium [c] | 48.0 | 49.5 | 54.0 | 46.0 | 49.0 | 53.5 | 52.0 | 53.5 | 54.2 |
| Sodium [c] | 25.0 | 26.0 | 28.5 | 24.0 | 25.2 | 25.8 | 28.0 | 30.0 | 32.6 |
| Potassium [c] | 15.0 | 16.0 | 17.25 | 15.0 | 17.0 | 17.30 | 12.0 | 14.5 | 16.0 |
| Phosphorous [c] | 25.0 | 26.0 | 29.0 | 24.0 | 26.2 | 29.5 | 29.0 | 30.0 | 31.5 |
| Sulphur [c] | 60.0 | 62.0 | 65.0 | 65.0 | 66.0 | 67.5 | 75.0 | 76.5 | 77.0 |
| **Micro nutrients** | | | | | | | | | |
| Iron [c] | 8.50 | 8.50 | 8.8 | 9.0 | 9.2 | 9.5 | 9.50 | 9.65 | 9.74 |
| Zinc [c] | 0.20 | 0.23 | 0.25 | 0.20 | 0.24 | 0.26 | 0.20 | 0.23 | 0.26 |
| Manganese [c] | 0.30 | 0.32 | 0.33 | 0.20 | 0.28 | 0.32 | 0.10 | 0.18 | 0.20 |
| Copper [c] | 0.06 | 0.06 | 0.07 | 0.05 | 0.06 | 0.065 | 0.05 | 0.06 | 0.07 |
| Chlorides [c] | 25.0 | 25.0 | 28.0 | 28.0 | 28.5 | 29.0 | 30.0 | 32.0 | 33.5 |
| Nickel [c] | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| **other elements** | | | | | | | | | |
| Lead [c] | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Cadmium [c] | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Chromium [c] | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| **Vitamins** | | | | | | | | | |
| Carotene [d] | 750 | 759 | 768 | 800 | 825 | 832 | 650 | 660 | 675 |
| Vitamin C [c] | 25 | 28 | 30.0 | 30.0 | 31.0 | 32.5 | 30.0 | 33.0 | 33.0 |

Units: a- g; b- kCal; c- mg; d- µg; RW=Raw water; SW = spentwash; BDL: Below detection limit

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.

**Discussion**

In the case of all varieties of 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 –*S-30, S-36 and Vishwa (DD)*,variety mulberry plants.

**Conclusion**

It is found that the nutrients uptake in all 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 all variety mulberry plants. This could be due to the maximum absorption of nutrients by plants at more diluted spentwash.

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