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# Studies on the impact of irrigation of distillery spentwash on the yields of S-30, S-36 and Vishwa (DD) mulberry plants

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## ABSTRACT

**Cultivation of some 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, phosphorus, 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 influence of spentwash on the yields of different varieties of mulberry plants at their respective maturity was investigated. It was found that the yields of Mysore local, M-5 and MR-2 were high in 33% spentwash [the percentage yield was maximum in S-30 (74.79%) and minimum in Vishwa(DD) (52.0%) and moderate in S-36 (68.03%)] irrigation than raw water and 50% spentwash irrigations.**

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**Key words :** Distillery spentwash, Yields, Mulberry plants, Seeds sets, Soil

## 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 labour rich countries. Sericulture is a cottage industry par excellence. It is one of the most labour 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. Favourable 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 per cent. Area under mulberry in Karnataka is 166000ha.

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) litres of wastewater is generatd for every litre 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

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(COD: 25000-30000mg/l), undesirable color and foul odor (Joshi *et al.*,1994). 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 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, potassium, and phosphorus contents and decreases the calcium, magnesium, sodium, chloride and sulphate (Mahamod Haroon and Subhash Chandra Bose, 2004). The PTSW is rich in potassium, sulphur, nitrogen, phosphorus as well as easily biodegradable organic matter and its application to soil has been reported to increase yield of sugar cane (Zalawadia *et al.*, 1997), rice (Devarajan and Oblisami, 1995), wheat and rice (Pathak *et al.,* 1998) 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 microflora (Devarajan *et al.*, 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 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.,* 2000). 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 fertilizer (Sahai *et al.*, 1983). The spent wash 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, copper, iron and manganese 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 and Basavaraju, 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), 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 of ginger and turmeric in normal and spent wash 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 yields of mulberry plants. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on the yields of different varieties mulberry plants.

## MATERIALS AND METHODS

Physico-chemical parameters and amount of nitrogen, potassium, phosphorus and sulphur 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).

Mulberry Plants selected for the present studies were S-30.Vishwa (DD) and S-36.The land was ploughed repeatedly to loosen the soil and all gravel, stones and weed removed making the soil fine. The ridges and furrows were made at a distance of 0.30 to 0.45 m. Mulberry was planted at a distance of 0.10 to 0.15 m between the plants on either sides of ridges along the row 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, plants were harvested and the yields were recorded by taking the average weight.

## RESULTS AND DISCUSSION

Chemical composition of PTSW, 50% and 33% SW such as pH, electrical conductivity, total solids, total dissolved solids, total suspended solids, settelable solids, chemical oxygen demand, biological oxygen demand, carbonates, bicarbonates, total phosphorus (P), total potassium, ammonical nitrogen, calcium, magnesium, sulphur, sodium, chlorides, iron, manganese, zinc, copper, cadmium, lead, chromium and nickel were analyzed (Table 1). Amount of N, P, K and S were also analyzed (Table 2).

Characteristics of experimental soil such as pH, electrical conductivity, the amount of organic carbon, available nitrogen, phosphorus, potassium, sulphur, exchangeable calcium, magnesium, sodium, DTPA iron, manganese, copper and zinc were analyzed and tabulated (Table 3). It was found that the soil composition was suitable for the cultivation of mulberry plants.

The yields were very high in the case of 33% SW irrigation for all the three types of mulberry plants, and moderate in 50%, while comparatively poor in RW (Table 5 and Fig. 1). In earlier studies the authors also found 33% SW irrigation favors the growth, yield and nutrients in plants. This could be due to the maximum absorption of NPK by the plants at the dilution of 33%. In the case of 50% SW irrigation the yields were less, this could be due to higher concentration of SW. However, the percentage yield was maximum in the case of S-30 (74.79%) and minimum in case of Vishwa (DD) (52.0%) and moderate in S-36 (68.03%). The yields of S-36, S-30 and Vishwa (DD) in 50% SW irrigation were found to be 30.36, 25.0 and 20.0 %, respectively. The soil was tested after the harvest of mulberry plants which that, shows there was enrich in the plant nutrients (N.P.K) in the soil and no adverse effect on other parameters (Table 3 and Table 4).

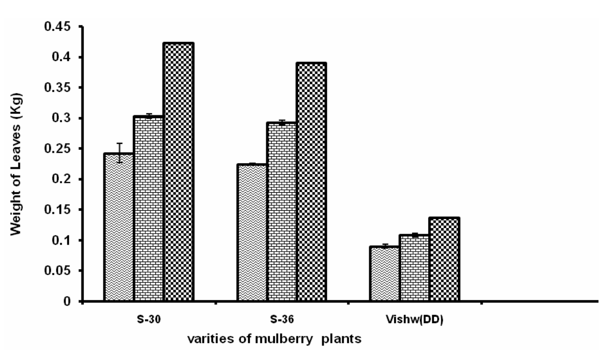


**Fig. 1 : Yields of different varieties of mulberry leaves**

**Table 1: 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 : Nutrients (N, P, K and S) 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

## Conclusion:

It was observed that the yields of all the varieties of mulberry plants were maximum in the case of 33% and moderate in 50% SW and minimum in RW irrigations. In 33% SW irrigation the plants were able to absorb maximum

**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: Weight of mulberry leaves at different irrigation (Average weight is taken from100 leaves)**

| Name of mulberry plants | Average weight (kg) | | |
|---|---|---|---|
| | RW | 50% PTSW | 33%PTSW |
| S-30 | 0.242±0.0014 | 0.303±0.002 | 0.423±0.003 |
| S-36 | 0.224±0.0015 | 0.292±0.002 | 0.390±0.003 |
| Vishwa(DD) | 0.090±0.0028 | 0.108±0.002 | 0.137±0.006 |

RW - Raw water: PTSW- Primary treated distillery spentwash

amounts of nutrients both from the soil and the spent wash resulting good yields. This concludes that, the SW can be conveniently used for the cultivation of mulberry plants without external (either organic or inorganic) fertilizers. Hence, the spentwash can be conveniently used for the irrigation purpose without polluting the environment.This minimizes the cost of cultivation and hence elevates the economy of the farmers.

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