Studies on the impact of irrigation of distillery spentwash on the yields of tuber/root medicinal plants

R. NAGENDRASWAMY[1], S. CHANDRAJU*, GIRIJANAGENRDASWAMY[2] and C.S. CHIDANKUMAR[3]

Department of Studies in Sugar Technology, Sir M.Visweswaraya Postgraduate Center, University of Mysore, Tubinakere, Mandya - 571 402 (India).
[1]Department of Chemistry, Government First Grade College, Hanagodu - 571 105 (India).
[2]GirijaNagenrdaswamy, Department of Chemistry, Maharani's Science College for Women, JLB Road, Mysore - 570 005 (India).
[3]C.S.Chidankumar, Department of Chemistry, Bharathi College, Bharathi Nagar-571 422 (India).

(Received: March 10, 2010; Accepted: April 14, 2010)

ABSTRACT

Cultivation of some tuber/root medicinal 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. Seeds of tuber/root medicinal plants (Namadhari and Mayhco) were sowed in the prepared land and irrigated with raw water (RW), 50% and 33% spentwash. The influence of spentwash on the yields of tuber/root medicinal plants at their respective maturity was investigated. It was found that the yields of all tuber/root medicinal plants were more in 33% spentwash irrigation than raw water and 50% spentwash irrigations.

Key words: Distillery spent wash, Yields, Tuber, root, medicinal plants, Seeds, Soil.

INTRODUCTION

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 smell (Joshi,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 (N), potassium (K), and phosphorous (P) contents and decreases the calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mahamod Haroon and Subhash Chandra Bose, 2004). 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 cane (Zalawadia, 1997), rice (Devarajan and Oblisami, 1995), wheat and rice (Pathak *et al.,* 1998), quality of groundnut (Singh *et al.,* 2003) 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, 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 use for irrigation purpose at lower concentration (Rajendra, 1990; Ramana *et al.,* 2001). 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 (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). 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 (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). However, not much information is available on the influence of distillery spentwash irrigation on the yields of tuber/root medicinal plants. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on the yields of tuber/root medicinal plants.

MATERIAL 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).

Tuber/root medicinal plants selected for the present investigations were, Ginger (*Zingiber officinale*) Radish (*Raphanus sativus*) Turmeric (Curcuma longa) Onion (*Allium cepa*) Garlic (*Allium sativum).* 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 maturity, plants were harvested and the yields were recorded by taking the average weight (Table- 4).

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.

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). It was found that the soil composition is fit for the cultivation of

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
Charbohydrates[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 plants, because it fulfils all the requirements for the cultivation of plants.

The yields were very high in the case of 33% SW irrigation for all types of tuber/root medicinal plants, and moderate in 50%, while comparatively poor in RW (Table-5). In our previous studies we 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 higher dilution (33%). In the case of 50% SW irrigation the yields were less, this could be due to more acidic nature than 33% SW. However, the percentage yield is maximum in the case of Radish (*Raphanus sativus*) (81.77%) and minimum in case of Turmeric (Curcuma longa) (56.53%). [Garlic (*Allium sativum)* (70.0%), Onion (*Allium cepa*) (64%) and Ginger (*Zingiber officinale*) (60.29%)]. The soil was tested after the harvest of roots and tubers, shows there is enrich in the plant nutrients (N.P.K)

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: Average weight of tuber/root medicinal plants at different irrigation (Average weight is taken from 25 plants)

Name of tuber/root medicinal plants	Average weight (kg)		
	RW	50% PTSW	33%PTSW
Ginger (*Zingiber officinale*)	0.753 ± 0.006	0.935 ± 0.002	1.207 ± 0.043
Radish (*Raphanus sativus*)	0.192 ± 0.005	0.239 ± 0.008	0.349 ± 0.001
Turmeric (Curcuma longa)	0.589 ± 0.016	0.712 ± 0.003	0.922 ± 0.028
Onion (*Allium cepa*)	0.106 ± 0.002	0.136 ± 0.001	0.174 ± 0.002
Garlic (*Allium sativum*)	0.070 ± 0.001	0.085 ± 0.002	0.119 ± 0.002

RW - Raw water: PTSW- Primary treated distillery spentwash

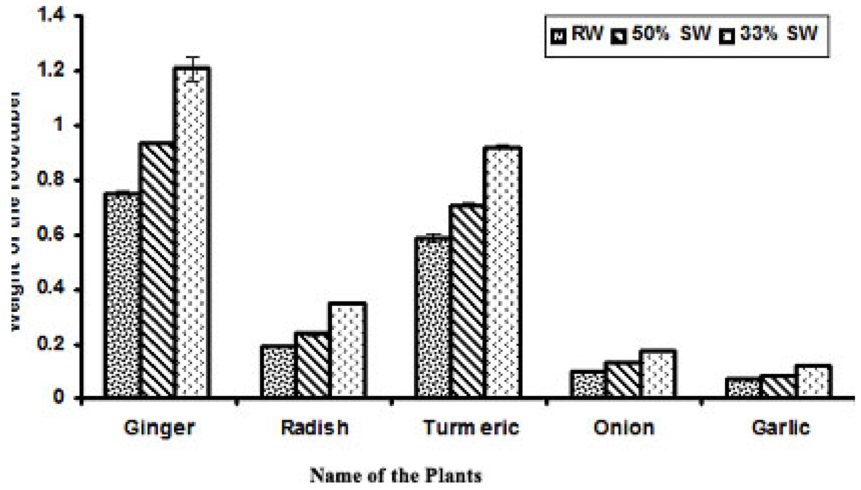

Fig. 1: Yield of tuber/root medicinal plants in raw water (RW), 50% PTSW, 33% PTSW

in the soil and no adverse effect on other parameters (Table-4).

CONCLUSIONS

It was noticed that the yields of all the tuber/root medicinal plants were maximum in the case of 33% and moderate in 50% SW and minimum in RW irrigations. In 33% SW irrigation the plants are able to absorb maximum 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 tuber/ root medicinal plants without external (either organic or inorganic) fertilizers. This minimizes the cost of cultivation and hence elevates the economy of the farmers.

ACKNOWLEDGEMENTS

The authors R.N.S and G.N.S are thankful to The commissioner of collegiate education in Karnataka, India, for permission to carryout research and N.S.L.Koppa, Maddur Tq.Karnataka, for providing spentwash.

REFERENCES

1. Amar, B. S, Ashish, K.B. and Sivakoti Ramana., Effect of distillery effluent on plant and Soil enzymatic activities and ground nut quality. *J. Plant Nutri. Soil Sci.* **166**: 345-347 (2003).
2. Basavaraju, H.C. and Chandraju S., Impact of distillery spentwash on the nutrients of Leaves vegetables: An Investigation. *Asian J. Chem.* **20**(7): 5301-5310 (2008).
3. Black, C.A., Methods of soil analysis part 2, Agronomy monograph No.9, *Am. Soc. Agron. Madison.* Wisconsin USA PP 15-72 (1965).
4. Basavaraju, H.C. and Chandraju, S., An Investigation of Impact of distillery spentwash on the nutrients of Top Vegetables. *Int. J. Agri. Sci.* **4**(2): 691-696 (2008)
5. Chares, S., Vinasse in the fertilization of sugarcane. Sugarcane, **1**: 20 (1985).
6. Chandraju, S. and Basavaraju, H.C., Impact of distillery spentwash on seed germination and growth of leaves Vegetables: An investigation. *Sugar Journal* (SISSTA). **38**: 20-50 (2007).
7. Chandraju, S. Basavaraju, H.C. and Chidankumar, C.S., Investigation of impact of Irrigation of distillery spent wash on the

growth, yield and nutrients of tuber/root vegetable. *Chem. Env. Res*. **17**(1&2) (2008).

8. Chandraju, S. Basavaraju, H.C. and Chidankumar, C.S., Investigation of impact of Irrigation of distillery spentwash on the nutrients of cabbage and mint leaf. *Indian Sugar*. **39**: 19-28 (2008).
9. Chandraju, S. Basavaraju, H.C. and Chidankumar, C.S., Investigation of impact of Irrigation of distillery spentwash on the nutrients of pulses. *Asian J. Chem.* **20**(8): 6342- 6348 (2008).
10. Chandraju, S. Basavaraju, H. C. and Chidankumar, C.S., Investigation of impact of Irrigation of distillery spentwash on the nutrients of some condiments and root vegetables. *Chem. Env. Res*. 17(1&2) (2008).
11. Chidankumar, C.S. and Chandraju, S, Impact of distillery spentwash Irrigation on the yields of some condiments: An investigation, *Sugar Tech,* **11**(3): 303-306 (2009).
12. Deverajan, L. and Oblisami, G., Effect of distillery effluent on soil fertility status, yield and quality of rice. *Madras Agri. J*. **82**: 664-665 (1995).
13. Devarajan, L. Rajanan, G. Ramanathan, G. and Oblisami, G., Performance of field crops under distillery effluent irrigations, Kisan world, 21: 48-50 (1994).
14. Joshi, H.C. Kalra, N. Chaudhary, A. and Deb, D.L., Environmental issues related with distillery effluent utilization in agriculture in India, *Asia Pac J Environ. Develop*, **1**: 92-103 (1994).
15. Jackson, M.L., Soil Chemical analysis practice Hall of India Pvt.Ltd. New Delhi P 485 (1973).
16. Kaushik, K. Nisha, R. Jagjeeta, K. and Kaushik, C.P., Impact of long and short term irrigation of a sodic soil with distillery effluent in combination with bio-amendments. *Bioresource Technology*, **96**(17): 1860-1866 (2005).
17. Kuntal, M.H. Ashish, K.B. Kalikinkar, B. and Misra, K, Effect of post-methanation effluent on soil physical properties under a soybean-wheat system in a vertisol. *J. Plant Nutri. Soil Sci*. **167**(5): 584-590 (2004).
18. Lindsay, W.L. and Norvel, W.A., Development of DTPA soil test for Zn, Fe, Mn & Cu, Soil Sci. Soc. AM.J, **42**: 421-428 (1978).
19. Mohamed Haroon, A.R. and Subash Chandra Bose, M., Use of distillery spentwash for alkali soil reclamation, treated distillery effluent for ferti irrigation of crops. *Indian Farm,* 48-51 (2004).
20. Manivasakam, N. 1987. Physico chemical examination of water sewage and industrial effluent, Pragathi prakashan, Merut.
21. Patil, J.D. Arabatti, S.V. and Hapse, D.G., A review of some aspects of distillery spentwash (vinase) utilization in sugar cane, Bartiya sugar 9-15 (1987).
22. Pathak, H. Joshi, H.C. Chaudhary, A. Chaudhary, R. Kalra, N. and Dwivedi, M.K. Distillery effluent as soil amendment for wheat and rice. *J. Indian Soc.Soil Sci.* **46**: 155-157 (1998).
23. Pujar, S.S, Effect of distillery effluent irrigation on growth, yield and quality of crops. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad (1995).
24. Piper, C.S., Soil and plant analysis, Han's publication, Bombay (1966).
25. Ramadurai, R. and Gerard, E.J., Distillery effluent and downstream products, SISSTA, *Sugar Journal*. **20**: 129-131 (1994).
26. Ramana, S. Biswas, A.K., Kundu, S. Saha, J.K. and Yadava, R.B.R., Physiological response of Soybean (Glycine max L.) to foliar application of distillery effluent. *Ann. Plant Soil Res*. **2**: 1-6 (2000).
27. Raverkar, K.P. Ramana, S. Singh, A.B. Biswas, A.K. and Kundu, S, Impact of post methanated spentwash (PMS) on the nursery raising, biological parameters of Glyricidia sepum and biological activity of soil. *Ann. Plant Res*. **2**(2): 161-168 (2000).
28. Ramana, S. Biswas, A.K., Kundu, S. Saha, J.K. and Yadava, R.B.R., Effect of distillery effluent on seed germination in some vegetable crops. *Bio-resource Technology*, **82**(3): 273-275 (2001).
29. Rani, R. Sri Vastava, M.M., Eco-siological response of Pisum sativum and citrus maxima to distillery effluents. *Intl.J. Eco. Environ. Sci*., 16-23 (1990).
30. Rajendran, K., Effect of distillery effluent on the seed germination, seedling growth, Chlorophyll content and mitosis in Helianthus

Annuus-Indian Botanical Contactor, 7: 139-44 (1990).

31. Sahai, R. Jabeen, S. and Saxena, P.K., Effect of distillery waste on seed germination, seedling growth and pigment content of rice. *Indian J.Eco.* 10:7-10 (1983).
32. Samuel, G., The use of alcohol distillery waste as a fertilizer, *Proceedings of International American Sugarcane Seminar.* 245-252 (1986).
33. Singh, Y. and Raj Bahadur., Effect of application of distillery effluent on maize crop and soil properties. *Indian. J. Agri. Sci.*, **68**: 70-74 (1998).
34. Subbaiah, B.V. and Asija, G.L., A rapid procedure for the estimation of available nitrogen in soils, *Curr.Sci*. **25**: 259-260 (1956).
35. Zalawadia, N.M. Raman, S. and Patil, R.G., Influence of diluted spentwash of Sugar industries application on yield and nutrient uptake by sugarcane and changes in soil properties. *J. Indian Soc. Soil. Sci*. **45**: 767-769 (1997).