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Evaluating the impact of textile and dye effluent irrigation and amendments on major nutrient nitrogen status of soil under maize crop

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ABSTRACT

To assess the impact of textile and dye industrial effluent on soil and crops, the pot culture experiment carried out with maize crop to determine the effect of dye and textile factory effluent in combination with amendments (poultry manure, green leaf manure, biocompost, vermicompost). This study revealed that application of CETP sludge @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + NPK increased the soil organic carbon, available N, P, K, Ca, Mg and micronutrients (Fe, Cu, Mn, Zn) in soil under treated effluent irrigation compared to river water irrigation. The sodium content and ESP of soil increased under effluent irrigation. However, it did not produce any toxic effects to the crops. This showed that the treated effluent could be safely used for irrigation along with poultry manure @ 5 t ha^{-1} and NPK.

Introduction

Textiles are among the basic needs of human being. The textile industry is one of the most complicated industries among manufacturing industry. Textile industry is one of the many industries that discharge large quantities of wastewater rich in different types of pollutants. Wastewater generated from the textile industries may contain a variety of polluting substances, such as acids, heavy metals, bases, toxic organic and inorganic dissolved solids, and colors. The conventional textile finishing industry requires nearly about 100 l of water to process about 1 kg of textile materials. Dyeing and printing process consume relatively largest amount of water during textile processes. Butani Naresh et al., 2013. The textile and dye industrial sludge is reported to promote crop growth if added to the soil in quantities below the toxicity limits. Moreover, the land application of industrial sludge provides an effective and environmentally acceptable option of waste disposal to recycle valuable nutrients into the soil plant system. The potential utilization of such wastes can be assessed to some extent based on its composition. Most of the sludge have disadvantages like toxic constituents in the form of heavy metals, carcinogen, fluoride, cyanide etc. Proper recycling of this sludge in an integrated ecofriendly and scientific way has become the need of the day. Hence, the present study was proposed to find scientific ways and means of utilizing the liquid and solid waste of the textile and dye industry for agriculture. In this investigation an attempt has been made to assess the impact of textile and dye industrial effluent on soil and crops.

Experimental

Materials

A pot culture experiment was conducted to assess the effect of effluent and sludge on soil quality and productivity of maize was carried out in the Department of Environmental Science, Tamilnadu agricultural University, Coimbatore. The two different concentrations of effluent (1:1 dilution and undilution) were taken for the pot culture experiment and compared with control (river water). Hybrid maize, (COH3) was used as the test crop. The treatment details are given below.

Experimental Details

Factor I: Irrigation Source

I_1 - River water (Control), I_2 – Diluted textile and dye effluent (1:1- Effluent and river water)

I_3 - Undiluted textile and dye effluent

Factor II: Treatments

T_1 - Control (NPK alone), T_2 - Textile and dye sludge @ 5 t ha^{-1} + NPK, T_3 - T_2 + FYM @ 12.5 t ha^{-1} , T_4 - T_2 + Poultry manure @ 5 t ha^{-1} , T_5 - T_2 + Green leaf manure @ 5 t ha^{-1} , T_6 - T_2 + Vermicompost 5 @ t ha^{-1} ,T_7 - T_2 + Bio compost 5 @ t ha^{-1}

Fertilizer dose: 135: 12.5: 50 NPK kg ha^{-1} respectively (100 per cent NPK)

Replication: Three, **Crop** : Maize (COH3), **Design : FRBD**

The experimental data were statistically scrutinized to find out the influence of various treatments on the soil properties and crop growth as suggested by Panes and Sukhatme (1955). The critical difference was worked out at five per cent (0.05) probability

The amendments and fertilizers were mixed thoroughly with seven kg soil as per the treatments given above and placed into plastic pots. Maize seeds were sown at five seeds per pot and thinned to three healthy seedlings per pot on 7th day after germination. Irrigation was given as per the treatments once in a week. The analytical procedures followed for the estimation of chemical constituent of the plant samples.

The analytical methods followed for all these studies are presented here under.

Results and Discussions

This study was carried out to investigate the integrated management aspects of solid and liquid wastes, which are

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generated from textile and dye industry. The results obtained from the pot culture experiments are presented hereunder.

Characteristics of textile and dye factory effluent and river water

The treated effluent used for the study had a pH of 8.38 with of dull blue colour and EC of 2.16 dS m^{-1}. The organic carbon content of the effluent was 0.60 per cent. The nitrogen, phosphorus and potassium contents of the effluent were 37.0, 24.0 and 16.8 mg L^{-1}, respectively. The calcium and magnesium contents of the effluent were 28.0 and 20.0 mg L^{-1}, respectively. The chloride, sulphate, carbonate, bicarbonate and sodium content of the effluent were 120.0, 42.0, 21.0, 85.0 and 150.0 mg L^{-1} respectively. Ramachandran (1994) reported that low concentrations of carbonate and bicarbonate compared to sulphate and chloride. Kothandaraman *et al.* (1976) reported a range from 300-570 mg L^{-1} for chloride and from 660-1600 mg L^{-1} for sulphate and very low content (less than 0.2 mg L^{-1}) of micronutrients and heavy metals. The river water had a pH of 6.95 and EC of 0.12 dS m^{-1}. The calcium content of the river water was 11.5 mg L^{-1} and sodium 6.5 mg L^{-1}.

Analysis method of textile and dye industry solidwaste and soil sample

S. No.	Parameters	Methods followed
Analysis of textile and dye solid waste		
1.	pH and EC	Dye sludge and distilled water @ 1:10 and measured in pH meter and conductivity meter Falcon *et al.* (1987)
2.	Preparation of triacid extract	Nitric acid: sulphuric acid: perchloric acid @ 9:2:1 ratio Biswas *et al*. (1977)
3.	Preparation of diacid extract	Sulphuric acid and perchloric acid @ 5:2 ratio Biswas *et al.* (1977)
4.	Total nitrogen	Diacid extract - semiautomatic Kjeldahl apparatus Bremner (1965)
5.	Total phosphorus	Triacid extract - vanadomolybdate yellow colour method Jackson (1973)
6.	Total potassium	Triacid extract - flame photometer Jackson (1973)
Analysis of soil sample		
1.	pH	Soil: Water suspension of 1: 2.5 Jackson (1973)
2.	Available N	Alkaline permanganate method Subbiah and Asija (1956)
3.	Available P	Photoelectric colourimeter at 660 nm Olsen *et al*. (1954)
4.	Available K	Neutral Normal Ammonium acetate extract (Flame photometer) Stanford and English (1948)

Characteristics of the initial soil and amendments

From the initial analysis, it was observed that the soil was low in available NPK status. The organic carbon content of the soil was low with appreciable quantities of exchangeable cations. Among the amendments, poultry manure was alkaline in nature with a pH of 8.50 with high NPK (1.33, 0.98 and 1.16 per cent, respectively) followed by biocompost. Among the materials, the organic carbon content was more or less same in all amendments except ETP sludge.

The poultry manure, farmyard manure, green leaf manure and biocompost used as amendments in this study were analysed. Among the amendments, poultry manure was alkaline in nature with a pH of 8.50 along with high N, P and K (1.33, 0.98 and 1.16 per cent, respectively) followed by biocompost. Among the amendments, poultry manure had the highest Ca and Mg content of 1.18 and 0.56 per cent, respectively. The lowest Ca (0.31 per cent) and Mg (0.21 per cent) content were observed in green leaf manure.

Initial characteristics of the sludge used for pot culture experiment

The sludge was alkaline in pH (8.50) and with EC of 4.53 dS m^{-1}. The sludge had small amount of total N and total P, but appreciable amount of total K. The sludge had very high amount of calcium (18.25 per cent) and magnesium (1.79 per cent). The sodium and sulphate contents of the sludge were 0.76 and 19.56 per cent, respectively. It had an appreciable amount of micronutrients and also microbial load.

Soil characteristics as influenced by effluent irrigation and amendments

Soil reaction

The soil reaction increased progressively till at the end of harvest stage. The pH varied significantly among the treatments at all the stages. At harvest stages, the highest mean pH (8.24) was recorded in T_2, which was followed by T_4 and T_3. The lowest mean was recorded in T_1 (7.91) at vegetative stage, which was on par with T_4. Treated undiluted effluent (I_3) irrigation significantly increased the soil pH over diluted effluent (1:1 ratio) and river water irrigation. Similar increase in soil pH due to effluent irrigation was reported by Vasconcelos and Cabrel (1993). The increase in soil pH due to amendment addition, in the present study corroborates with the findings of Olaniya *et al*. (1991). Soil pH increased with advancement of crop growth in the effluent irrigated treatments while under river water the change was not at a considerable level. Similar viewpoints were also expressed by Malathi (2001)

Electrical conductivity (EC)

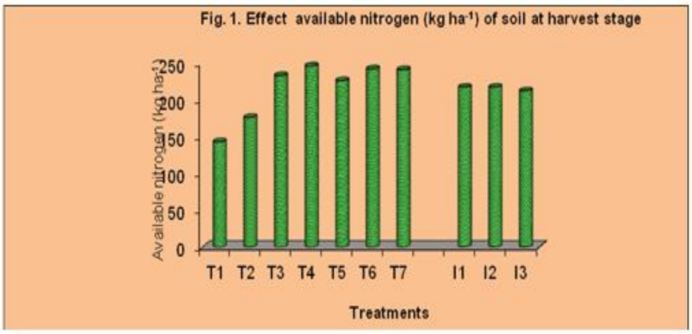
The soil EC ranged from 0.35 to 0.60 dS m^{-1}, 0.35 to 0.82 dS m^{-1} and 0.35 to 1.25 dS m^{-1} at vegetative, flowering and at harvest stages, respectively. Drastic increase in soil EC was observed up to flowering stage and the increase was marginal at harvest stage. Treated undiluted effluent irrigation significantly increased the soil EC over diluted effluent (1:1 ratio) and river water irrigation. Among the treatments, T_2 (sludge + NPK) registered higher mean soil EC during vegetative stage (0.52 dS m^{-1}), flowering stage (0.69 dS m^{-1}) and harvest stage (0.88 dS m^{-1}), followed by T_4, T_3 and T_6, which differed significantly among themselves. The higher EC in effluent receiving treatments might be due to salt accumulation because of continuous effluent irrigation. The increase in EC might be due to higher Ca and Mg content of sludge. These findings were in line with that of Hameed and Udayasoorian (1999). Significant interaction between irrigation and amendment was observed at all the stages of crop growth. The treatment combination I_3T_2 (effluent irrigation + CETP sludge) recorded the highest EC (1.25 dS m^{-1}) at harvest stage and the lowest value in I_1T_1 (0.35 dS m^{-1}) at vegetative stage. The results revealed that application of sludge alone without any amendments increased the EC value significantly. Hameed and Udayasoorian (1999) assessed increased EC in surface and subsurface soils due to constant drenching of dye effluent.

Available nitrogen

The effluent irrigation along with amendments significantly influenced the available N content of soil cultivated with maize. The mean available nitrogen content of soil ranged from 175 to 272 kg ha^{-1} at vegetative stage and a declining trend on available N content was noticed as the crop growth advanced. The mean soil available N was the highest in T_4 (272 kg ha^{-1}) followed by T_7 and T_6, which were on par with each other at vegetative stage. The lowest value of 175 kg ha^{-1} was observed in control

(T_1). Similar trends were observed at flowering and harvest stages of crop growth. This might be due to their higher nutrient status and mineralization rate. Significant increase in available NPK was observed up to flowering stage and decreased at harvest stage. The increase in availability of nutrients in soil might be due to high nutrient status of different amendments and subsequent transformations from existing solid phase to a soluble metal complex as reported by Madhumita *et al*. (1991).

The interaction effect between irrigation and treatment was significant at all stages of crop growth. In general, all the treatments invariably increased the soil available N with effluent irrigation over river water irrigation. Among them, the increase was more visible with poultry manure combinations at all stages of crop growth.



Reduction in nutrient availability towards the maturity of crop might be due to higher uptake by plant. The result clearly indicated that addition of organic manures had a strong influence on the availability of major nutrients *viz*., N, P and K. The buildup of the available N could be due to the release of mineralisable N from organic manures.

Conclusions

In this study the soil pH and EC was increased under undiluted effluent irrigation along with amendments, when compared to diluted effluent irrigation. Addition of amendments had a strong influence in enhancing the soil quality parameters *viz.*, Organic carbon, available. The yield attributes and grain yield of maize was higher in effluent irrigated soil amended with CETP sludge @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + NPK.

References

Butani Naresh, Jobanputra Jaydip, Bhatiya Prabhat, Patel Rajkumar, 2013. Recent Biological Technologies for Textile Effluent Treatment**. International Research Journal of Biological Sciences.** Vol. **2(6),** 77-82.

Biswas, T.D., B.L Jaian and S.C. Maldal. 1977. Cumulative effect of different levels of manures on the physical properties of soil. **J. Indian Soc. Soil Sci., 19:** 31-37.

Bremner, J.M. 1965. Inorganic forms of nitrogen**. In: Methods of Soil Analysis. Part 2.** C.A. Black (Eds.), Am. Soc. Agron. Inc. Wisconsin, USA, pp. 1170-1237.

Falcon, M.A., E. Corominas, M.L. Perez and F. Perestelo. 1987. Aerobic bacterial populations and environmental factors involved in the composting of agricultural and forest wastes of the Conary Islands. **Biol. Wastes., 20:** 89-99.

Gaur, A.C. 1982. Recycling of organic wastes by improved techniques of composting and other methods. **Resources and conservation, 13:** 157-174.

Hameed Sulaiman, S.M. and C. Udayasoorian. 1999. Metals in soil environment and the growth of *Eucalyptus* seedlings as influenced by paper mill wastes. Proc. Environmental Impacts of Metals. International workshop, Department of Environmental Sciences Tamil Nadu Agric.Univ., Coimbatore, March,22-23.pp 41-42.

Jackson, M.L. 1973. **Soil Chemical Analysis**. Prentice Hall of India (Pvt.) Ltd., New Delhi.pp.24-36.

Kothandaraman, V., K.M. Aboo and C.A. Sastry. 1976. Characteristics of waste from a textile mill. ***Indian J. Environ. Hlth.*, 18:** 99-112.

Madhumita, D.B.P., R. Singh, B.S. Munna Ram and R.N. Prasad. 1991. Influence of organic manures on native plant nutritive availability in an acid Alfisol. **J. Indian Soc. Soil Sci., 39:** 286-291.

Malarvizhi, P. and A. Rajamannar. 2001. Efficient utilization of sewage water for improving the forage yield and quality of bajra napier hybrid grass. **Madras Agric. J., 88:** 477-482.

Malathi, G. 2001. Impact of Treated Pulp and Paper Mill Effluent on Vegetables – Soil Ecosystem. M.Sc. (Environmental Science) Thesis, Tamil Nadu Agric. Univ., Coimbatore

Olsen, S.R., L.L. Cole, F.S. Watanabe and D.A. Dean. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A. – Circ. p. 939.

Panse, V.G and P.V. Sukhatme. 1985. Statistical methods for Agricultural workers. I.C.A.R. Publ., New Delhi, P.359.

Prabu, P.C. 2003. Bioremediation of paper mill effect polluted habitat. Ph.D., (Env. Sciences) Thesis, Tamil Nadu Agric. Univ., Coimbatore.

Ramachandran, K.1994. Studies on the effect of dyeing factory effluent on soils and adjoining ground waters. M.Sc. (Agri). Thesis, Tamil Nadu Agric. Univ., Coimbatore

Ramasubramonium. S., A. Chandrasekaran and G. James Pitchi. 2001. Effect of pollutants and industrial wastes on yield of Rice and physical properties of Latritic soils. In: First Post Graduates seminar Abstracts; Tamil Nadu Agric. Univ., Coimbatore, p.23.

Srinivasachari, M., M.Dhakshinamoorthy and G.Arunachalam. 1999. accumulation and availability of Zn, Cu, Mn and Fe in soils polluted with paper mill waste water. **Madras. Agric.J., 87:** 237-24.

Stanford, S. and L. English. 1948. Use of flame photometer in rapid soil tests of K. **Agron. J., 41:** 446-447.

Subbiah, B.V. and G.L. Asija. 1956. A rapid procedure for estimation of available nitrogen in soils. **Curr. Sci., 25:** 259 - 260.

Vasconcelos, E. and F. Cabrel. 1993. Use and environmental implications of pulp mill sludge as organic fertilizer. **Environ. Pollution,** 80: 159-162.