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Management of Tannery Waste: Its Use as Planting Medium for *Chrysanthemum* Plants

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ABSTRACT

An experiment was conducted to evaluate the effect of tannery waste on growth and flower yield of *Chrysanthemum* plants. The planting media were prepared by mixing garden soil, sand and tannery waste in the ratio of 3:3:1, 3:3:2, 3:3:3, 3:3:4 and 3:3:5. The pots were planted with *Chrysanthemum* @ 1 cuttings/pot. In control pots, sand and soil were used as planting media mixed in the ratio of 1:1. The growth and yield data obtained showed that there was a significant ($p<0.01$) increase in the number (88%) and weight (59%) of flowers in *Chrysanthemum* plants planted in pots having planting medium in the ratio of 3:3:2. Maximum increase in plant height, shoot dry weight, root dry weight and number of branches were recorded in *Chrysanthemum* cuttings grown in planting medium having ratio of 3:3:1. However, there was a decrease in growth and yield of plants when they were planted in media containing garden soil: sand: tannery waste in the ratio of 3:3:3, 3:3:4 and 3:3:5. The present study clearly showed that tannery waste at lower concentration promotes vegetative growth and yield of *Chrysanthemum* cuttings and behaves as growth inhibitor at higher concentration. Therefore, tannery waste can be successfully utilized in planting medium for production of *Chrysanthemum* flowers. There is also a need to screen the effect of tannery waste based planting medium on other non edible floricultural crops.

Key words: Tannery waste, planting medium, growth and yield promotion, *Chrysanthemum*

INTRODUCTION

Tannery waste is generated in huge amounts by leather industries during the process of leather tanning throughout the world. Tannery wastes are of serious consequence since it has a role in pollution of fresh water bodies, streams and land. It is one of the most polluted industrial wastes and contains high amounts of metals which are very toxic to plants, animals and soil. Reduction in the quality of the crop and its harmful effects on consumers is reported by Gill and Saggoo (2010). Various studies have been conducted earlier to evaluate the effect of tannery waste on physiological, biochemical, growth and yield parameters of crop plants. Tannery wastes are known to reduce germination, growth and yield of gram, wheat, mustard, wheat and lettuce crops when they are applied at higher ratio (Rao and Kumar, 1983; Castilhos *et al*., 2002; Malik *et al*., 2003). Durai and Rajasimman (2011) reported use of biological organisms for the treatment of tannery waste and microbial effectiveness increased when they were used in combination with physical and chemical parameters. However, tannery wastes with high amounts of chromium also

inhibits and reduce the growth of nitrifying bacteria and other microbes (Fargo and Fleming, 1977; Onweremadu and Nwufo, 2009). There are also reports which showed that tannery wastes are beneficial for vegetative growth and yield of crop plants when applied at lower ratio. An increase in root length growth and number of leaves at lower ratio and a decrease in these parameters was recorded at higher ratio. However, growth of shoot and leaves were directly proportional to the ratio of tannery sludge for initial period of 60 days (Singh and Sinha, 2004). An increase in growth and yield of tomato plants has been recorded when they were grown at lower ratio of the tannery waste amendments (Singh *et al*., 2004). Gupta and Sinha (2009) reported that sesame white plants grown in potting medium amended with higher ratio of tannery waste contains higher concentration of metals and toxic compounds. In white sesame plants concentration of accumulated toxic metals were found above the limits and they suggested not to use tannery waste for crop plants.

Plants uptake metals from tannery wastes and it is available in roots, shoots, leaves, flowers and fruits with minimum in fruits. Plants are widely being used for a long time to remove contaminants from soil and water throughout the world (Shimp *et al*., 1993; Raskin *et al*., 1994; Kumar *et al*., 1995; Cunningham *et al*., 1995; Smith *et al*., 1995; Salt *et al*., 1995; Chaney *et al*., 1997). Firdaus and Nazir (2010) used *Tagetes paluta* in association with saprobic and mycorrhizal fungi for metal decontamination of tannery solid waste. There was an increased absorption of metals.

Many edible crop plants grow and perform well on tannery waste amended medium but using the produce of these edible crop plants are very harmful for human and animal health. The present research study was undertaken to investigate the effects of tannery waste on growth and flower production of *Chrysanthemum*. The objective was to develop and utilize tannery waste amended growth media for non edible floriculture crops and thereby reduce the pollutants.

MATERIALS AND METHODS

Collection of tannery waste: The present study was carried out between October 2007 to December 2009 and experiments were conducted for two seasons. Tannery waste was collected from leather tannery of Jajmau, Kanpur, U.P., India and was dried under shade conditions for one week till complete removal of moisture. After complete drying, tannery waste was finely grounded with the help of laboratory grinder to obtain fine particles of homogenous size.

Preparation of planting media: Garden soil and sand was dried under shade conditions to remove the moisture content. Garden soil, sand and tannery waste were mixed properly in the ratio of 3:3:1, 3:3:2, 3:3:3, 3:3:4 and 3:3:5 to prepare planting medium for pot trials. Garden soil and sand was mixed at the ratio of 1:1 for control plants. The potting soil prepared by the above mentioned method was filled in earthen pots @ 6 kg pot^{-1}.

Pots trials: Six inch cuttings of *Chrysanthemum* were prepared from mother plants and planted in sand medium in earthen pots for the process of rooting. The earthen pots were filled with potting medium at the ratio of 3:3:1, 3:3:2, 3:3:3, 3:3:4 and 3:3:5. The pots were planted with 35 days old rooted *Chrysanthemum* cuttings @ 1/pot and watered properly and kept in the net house for observation.

Growth and yield parameters: *Chrysanthemum* cuttings planted in pots were observed regularly and data on plant height, shoot and root dry weight, number of branches and flowers and weight

of flowers were collected at regular intervals. Plant height was recorded 45 days after plantation. Numbers of flowers were counted periodically and tagged starting from flowering to uprooting of plants. Root and shoot weight were recorded by uprooting the plants after full maturity 65 DAP. The roots were separated from shoots, dried at 50-55°C in an oven and their weight were recorded. The experiments were conducted for two successive seasons following the same procedures.

Statistical analysis: Standard deviation and Standard error was calculated for plant height, number of branches, dry root weight, dry shoot weight, flower number and flower weight. Analysis of variance (ANNOVA) was carried out for all the above data, followed by Duncans test.

RESULTS

Effect of tannery waste on plant height of Chrysanthemum: The results obtained shows that there was a significant ($p<0.01$) increase of 62, 48 and 25% in the height of *Chrysanthemum* plants grown on potting soil having ratio of 3:3:1, 3:3:2 and 3:3:3. However, at higher concentrations (3:3:4 and 3:3:5) of tannery waste amendments a decrease in plant height was reported as compared to control plants. Plants grown at higher ratio had stunted growth and leaves were small and yellowish. *Chrysanthemum* plants grown using lower concentrations of tannery waste showed more vigorous growth than the control (Fig. 1).

Effect of tannery waste on number of branches of chrysanthemum: *Chrysanthemum* plants grown using tannery waste amendments at the ratio of 3:3:1, 3:3:2 and 3:3:3 recorded significantly ($p<0.01$) 48, 32 and 20% more branches than the plants grown in normal potting media. *Chrysanthemum* plants showed stunted growth when grown in tannery waste amendments with ratio of 3:3:4 and 3:3:5. The lower concentration of tannery waste amendments showed inducing effects and was found to be supportive in increasing branching of *Chrysanthemum* plants (Fig. 2).

Effect of tannery waste on root dry weight of chrysanthemum: The root dry weight of *Chrysanthemum* plants grown in potting soil mixture containing tannery waste amendments in the ratio of 3:3:1, 3:3:2 and 3:3:3 showed an significant ($p<0.01$) increase of 232, 166 and 88%, respectively over control (Fig. 3). The plants had more longer, branched and thick rooting system

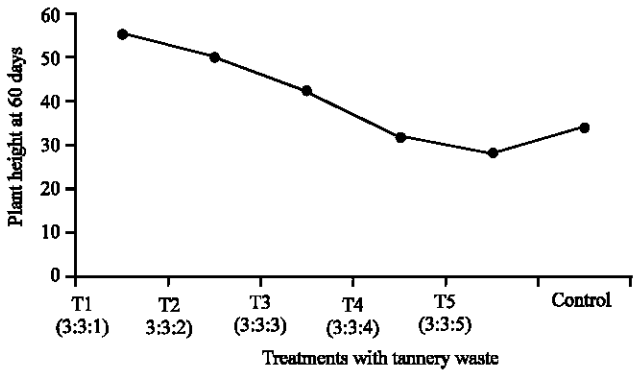

Fig. 1: The effect of tannery waste amendments on the height of the *Chrysanthemum* cuttings

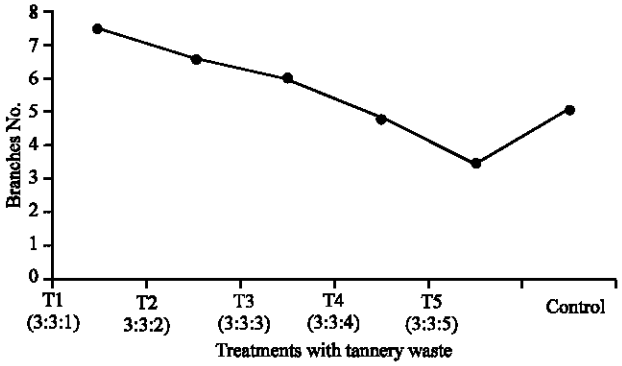

Fig. 2: The effect of tannery waste amendments on the branching of the *Chrysanthemum* cuttings

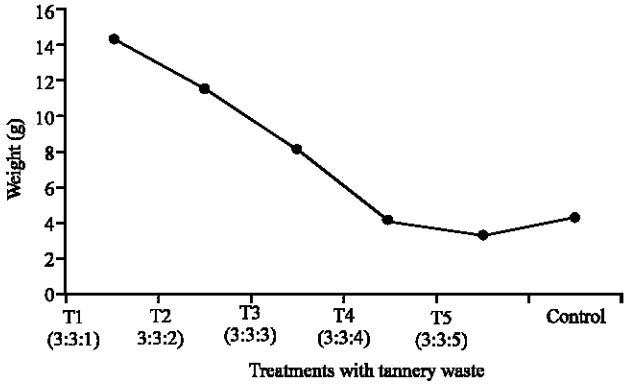

Fig. 3: The effect of tannery waste amendments on the dry root weight of the *Chrysanthemum* cuttings

as compared to control. Data collected on root dry weight showed that at higher concentration of tannery waste amendments the growths of roots were suppressed.

Effect of tannery waste on shoot dry weight of chrysanthemum: Results on shoot dry weight clearly indicated that *Chrysanthemum* plants grow very well in the potting soil amended with tannery waste in ratio of 3:3:1, 3:3:2 and 3:3:3. It showed a significant ($p<0.01$) increase of 131, 84 and 33% in shoot dry weight over control plants. A decrease of 14 and 22% was found in shoot dry weight of *Chrysanthemum* plants when planted in potting soil amendments with ratio of 3:3:4 and 3:3:5. The plants grown at 3:3:4 and 3:3:5 ratios showed stunted growth as compared to control plants (Fig. 4).

Effect of tannery waste on flower production by chrysanthemum: Amendment of potting soil mixture with tannery waste at 3:3:2 ratio showed a positive effect on flower production of *Chrysanthemum* and increased significantly ($p<0.01$) the number of flowers by 88% compared control plants. Potting soil mixture with ratio of 3:3:1 showed a slight increase in number of flowers only with 4%. However, there was a reduction in flower production by 15, 40 and 65% in *Chrysanthemum* plants grown on potting medium with ratio of 3:3:3, 3:3:4 and 3:3:5, respectively as compared to control plants. Flower production was promoted at 3:3:2 ratio in the *Chrysanthemum* plants (Fig. 5).

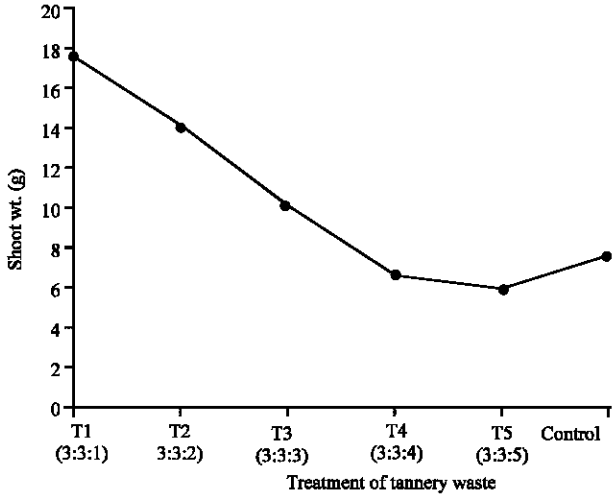

Fig. 4: The effect of tannery waste amendments on the dry shoot weight of the *Chrysanthemum* cuttings

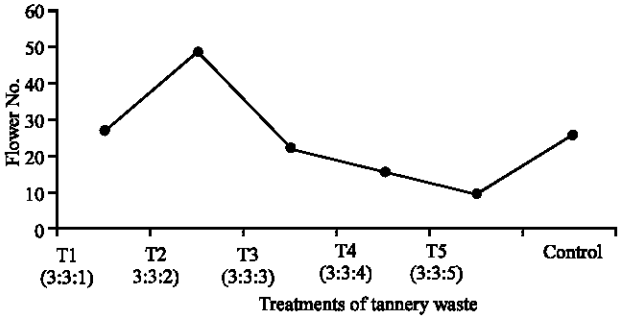

Fig. 5: The effect of tannery waste amendments on the number of flowers production in the *Chrysanthemum* cuttings

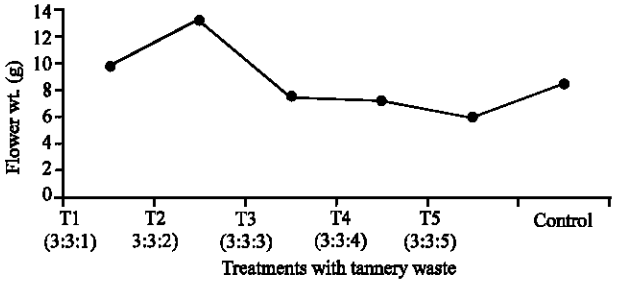

Fig. 6: The effect of tannery waste amendments on the fresh weight of flowers production in the *Chrysanthemum* cuttings

Effect of tannery waste on weight of flower produced by chrysanthemum: Fresh flower weight of *Chrysanthemum* plants significantly ($p<0.01$) increased by 19 and 59% when amendments were used at 3:3:1 and 3:3:2 ratios, respectively. Fresh weight of flowers were reduced drastically when tannery wastes with higher ratios were used in the potting medium. The size of

the flowers were found to be maximum at 3:3:2 ratio while smaller sized flowers were recorded at 3:3:5 ratio (Fig. 6). The tannery wastes had a negative effect on size and weight of *Chrysanthemum* flowers when used at higher ratios.

DISCUSSION

There was an increase in the plant height of *Chrysanthemum* when grown on potting soil having lower ratio of tannery waste (3:3:1, 3:3:2 and 3:3:3). At higher concentrations (3:3:4 and 3:3:5) of tannery waste amendments a decrease in plant height suggests the negative effects of tannery on growth and physiology. Plants grown at higher ratio had stunted growth and leaves were small and yellowish. Similar were the findings of Singh *et al.* (2004). They reported an increase in vegetative growth and flowering of tomato plants when it was grown at lower ratio of tannery waste amendments. An increase in germination, leaf area, chlorophyll and protein content have been recorded in *Oryza sativa, Acacia holosericea, Leucaena leucocephala, Gossypium hirsutum, Vigna mungo, Vigna uniquiclata* and *Lycopersicon esculentum* at lower concentration of tannery waste (Karunyal *et al.*, 1994).

Chrysanthemum plants grown on lower concentrations of tannery waste amendments recorded more branches than the plants grown in normal potting media. *Chrysanthemum* plants showed stunted growth when grown in tannery waste amendments with higher ratio. Lower concentration of tannery waste amendments induced the growth and was found to be supportive in increasing branching of *Chrysanthemum* plants. At higher concentration of tannery waste growth and yield parameters of sunflower are suppressed (Davies and Linsey, 2001).

Root dry weight of *Chrysanthemum* plants showed an increase of 232, 166 and 88%, respectively over control, when grown at lower ratio of tannery waste. Root growth of the plants were increased at lower ratio while as at higher ratio root proliferation was suppressed. Results on shoot dry weight clearly indicated that *Chrysanthemum* plants grow very well in the potting soil amended with tannery waste in ratio of 3:3:1, 3:3:2 and 3:3:3. A decrease was found in shoot dry weight of *Chrysanthemum* plants when planted in potting soil amendments with ratio of 3:3:4 and 3:3:5. Similar were the findings of Azmat and Khanum (2005). Tannery waste amendments were found to be supportive in improving the growth of root, shoot and leaves of *Chrysanthemum* plants when they were applied at lower ratio in the potting medium. Our results are in confirmation with the findings of Singh and Sinha (2004) and Karunyal *et al.* (1994).

Amendment of potting soil mixture with tannery waste at 3:3:2 ratio showed a positive effect on flower production of *Chrysanthemum*. A dose dependent response was observed in our experiments which shows that all the concentration of the tannery waste are not effective in promoting the growth and flower production. Potting soil mixture with ratio of 3:3:1 showed a slight increase in number of flowers. However, there was a reduction in flower production of *Chrysanthemum* plants grown on potting medium with higher ratio of tannery waste. Higher flower production in *Chrysanthemum* plants at lower- medium (3:3:2) ratio are in confirmation with the findings of Babyshakila and Usha (2009). They reported that use of tannery waste amendments at lower ratio increased growth and yield of *Vigna radiata* plants. Reduction of in physiological parameters of plants following treatments with higher dose of tannery waste has been reported by several workers. At higher concentration of tannery waste growth and yield parameters of sunflower and wheat are suppressed (Davies and Linsey, 2001; Hussain *et al.*, 2010).

Increase in the fresh flower weight is directly linked with the growth promotory effects of the tannery waste at lower ratio. Fresh flower weight of *Chrysanthemum* plants increased at 3:3:1 and

3:3:2 ratios respectively while it reduced drastically when tannery wastes with higher ratios were used in the potting medium. The size of the flowers were found to be maximum at 3:3:2 ratio while flower size were suppressed at higher tannery ratio. The tannery wastes had a negative effect on size and weight of *Chrysanthemum* flowers when used at higher ratios. Tannery wastes are known to reduce germination, growth and yield of gram, wheat and lettuce crops when they are applied at higher ratio (Rao and Kumar, 1983; Castilhos *et al*., 2002).

CONCLUSIONS

The present study clearly indicated that vegetative growth (plant height, branching, root dry weight and shoot dry weight) of *Chrysanthemum* plants is promoted by tannery waste at lower ratio (3:3:1, 3:3:2 and 3:3:3). However, at higher ratios (3:3:4 and 3:3:5) tannery waste caused a suppression in the vegetative growth of *Chrysanthemum* plants. Tannery waste when mixed at more or less in equal ratio (3:3:2) with garden soil and sand it increased the production of *Chrysanthemum* flowers. However, at higher ratios (3:3:3, 3:3:4 and 3:3:5) it suppressed the flower production. The potting medium containing tannery waste amended with soil and sand at 3:3:2 ratios can be successfully employed in floriculture industry for increased production of *Chrysanthemum* flowers. It is suggested that future studies are necessary to test the effect of tannery waste amended medium on other floricultural crops.

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REFERENCES

Azmat, R. and R. Khanum, 2005. Effect of chromium metal on the uptakes of mineral atoms in seedlings of bean plant *Vigna radiata* (L.) wilckzek. Pak. J. Biol. Sci., 8: 281-283.

Babyshakila, P. and K. Usha, 2009. Effect of diluted effluent on soil properties and plant growth. Adv. Stud. Biol., 1: 391-398.

Castilhos, D.D., M.J. Tedesco and C. Vidor, 2002. Crop yields and chemical alterations in soil treated with tannery waste and hexavalent chromium. R. Bras. Ci. Solo, 26: 1083-1092.

Chaney, R.L., M. Malik, Y.M. Li, S.L. Brown, E.P. Brewer, J.S. Angel and A.J. Baker, 1997. Phytoremediation of soil metals. Curr. Opin. Biotech., 8: 279-283.

Cunningham, S.D., W.R. Berti and J.W. Huang, 1995. Phytoremediation of contaminated soils. Trends Biotechnol., 13: 393-497.

Davies, M.A. and E.F. Linsey, 2001. Drastic impacts of polluted waters on the yield of wheat in Europe grown near to the industrial estates. Water Air Soil Pollut., 16: 14-23.

Durai, G. and M. Rajasimman, 2011. Biological treatment of tannery wastewater-A review. J. Environ. Sci. Technol., 4: 1-17.

Fargo, L.L. and R.W. Fleming, 1977. Effects of chromate and cadmium on most probable number estimates of nitrifying bacteria in activated sludge. Bull. Environ. Contam. Toxiciol., 18: 350-354.

Firdaus, B. and A. Nazir, 2010. Metal decontamination of tannery solid waste using *Tagetes paluta* in association with saprobic and mycorrhizal fungi. Environmentalist, 30: 45-53.

Gill, A. and M.I.S. Saggoo, 2010. Mutagenic potential and nutritive quality of turnip plants raised over chromium amended soils. Int. J. Botany, 6: 127-131.

Gupta, A.K. and S. Sinha, 2009. Antioxidant response in sesame plants grown on industrially contaminated soil: Effect on oil yield and tolerance to lipid peroxidation. Bioresour. Technol., 100: 179-185.

Hussain, F., S.A. Malik, M. Athar, N. Bashir, U. Younis, M. Hassan and S. Mahmood, 2010. Effect of tannery effluents on seed germination and growth of two sunflower cultivars. Afr. J. Biotechnol., 9: 5113-5120.

Karunyal, S., G. Renuga and K. Paliwal, 1994. Effects of tannery effluent on seed germination, leaf area, biomass and mineral content of some plants. Bioresour. Technol., 47: 215-218.

Kumar, P.B.A.N., V. Dushenkov, M. Motto and L. Raskin, 1995. Phytoextraction: The use of plants to remove heavy metals from soils. Environ. Sci. Technol., 29: 1232-1238.

Malik, S.A., T.Z. Bokhari, A.A. Dasti and S.Z.N. Abidi, 2003. Effect of waste water effluents from a tannery on the growth of some crop plants. Asian J. Plant Sci., 2: 623-626.

Onweremadu, E.U. and M.I. Nwufo, 2009. Pedogenetic activities of soil microbes as influenced by trivalent cationic chromium. Res. J. Soil Biol., 1: 8-14.

Rao, G.M. and N.M. Kumar, 1983. Impact of tannery effluents on seed germination in *Cicer arientum*. Poll. Res. J., 2: 33-37.

Raskin, I., P.B.A.N. Kumar, S. Dushenkov and D.E. Salt, 1994. Bioconcentration of heavy metals by plants. Curr. Opin. Biotechnol., 5: 285-290.

Salt, D.E., M. Blaylock, N.P.B.A. Kumar, V. Dushenkov, B.D. Ensley, I. Chet and I. Raskin, 1995. Phytoremediation: A novel strategy for the removal of toxic metals from the environment using plants. Nat. Biotechnol., 13: 468-474.

Shimp, J.F., J.C. Tracy, L.C. Davis, E. Lee, W. Huang, L.E. Erickson and J.L. Schnoor, 1993. Beneficial effects of plants in the remediation of soil and groundwater contaminated with organic materials. Crit. Rev. Environ. Sci. Technol., 23: 41-77.

Singh, S. and S. Sinha, 2004. Scanning electron microscopic studies and growth response of the plants of *Helianthus annuus* L. grown on tannery sludge amended soil. Environ. Int., 30: 389-395.

Singh, S., S. Sinha, R. Saxena, K. Pandey and K. Bhatt, 2004. Translocation of metals and its effects in the tomato plants grown on various amendments of tannery waste: Evidence for involvement of antioxidants. Chemosphere, 57: 91-99.

Smith, L.A., J.L. Means, A. Chen, B. Alleman and C.C. Chapman *et al.*, 1995. Remedial Options for Metals-Contaminated Sites. Lewis Publications, New York.