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RESEARCH ARTICLE

INHIBITION OF TOXIC POLLUTANTS FROM TANNERY EFFLUENT BY USING AM FUNGI AND ITS RESPONSE ON GREEN GRAM (*Vigna radiata* L.)

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ABSTRACT

Mycorrhizal fungi intimately associate with plant root forming a symbiotic relationship. The mycorrhizal symbiosis in effluent polluted soils was documented and the effect of dual inoculation with AM fungus on the host plant greengram (*Vigna radiata* L.) in pot culture experiments were investigated at six concentrations of tannery effluent *viz.,* control, AM only. 50% effluent, 50% + AM, 100% effluent, 100%+AM. AM inoculated plants significantly increased in all morphological parameters. When compared with uninoculated plants the morphological parameters such as root length, shoot length, fresh weight and dry weight, root nodules and phosphorous content of greengram were increased in AM fungi inoculation soil. This study provides evidence for benefits of AM fungi protection of host plants and symbiosis could be a new approach increase in the effluent tolerance to legumes plants under effluent stress.

INTRODUCTION

Industrialization has brought in water pollution, which is one of the major hazards facing environment today. Since many industries discharge their effluent on to open lards because of high cost of dilution and inadequate treatment facilities, effective and profitable utilization of the effluent of the industries needs greater attention. Phytoremidation (such asphytoextraction, phytostablization and rhizofiltration) of soils contaminated by effluents has been widely accepted as a cost-effective and environmental-friendly cleanup technology (Saleh, 2006). However, the progress in this field is hindered by lack of understanding of complex interactions in the rhizosphere and plant–based mechanisms which allow metal translocation and accumulation in plant (Yu *et al.,* 2004).

Interactions between roots and microorganism in the rhizosphere, they are a fundamental effect on effluent, nutrient uptake and plant growth. The *Arbuscular mycorrhiza* (AM) fungi are important rhizospheric soil microorganism. The obligate biotrops, lead a symbiotic life which is characterized by the transfer of nutrients, especially phosphorus, which have been taken up from the soil by the fungi and in turn they obtain carbohydrates provided by the host plants (Smith and Read 1997) and consequently, they increase root and shoot biomass and improve the plant growth. Thus the benefits of mycorrhizae may be associated with effluent tolerance and also with effluent plant nutrition.

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Therefore in contaminated soils, that is often poor in nutrients and with low water holding capacities. The agriculturally important symbiotic microorganisms play a remarkable role in nutrient (nitrogen, phosphorus, potassium and micro elements) acquisition for plants. In pursuit of that goal, various workers (Cairney and Meharg 2000; Rabie *et al.,* 2005) have used AM fungi as inoculants various plants of the presence or the absence of anthropogenic stresses. These symbiotic organisms have high ability to increase N, P and K as well as other nutrients in inoculated plants (Al-Karaki *et al.,* 2001). The present study indicates AM inoculation increased the concentration of N, P and K, Mg in greengram plants tissue compared with uninoculated. These results agree with previous works suggest that (Johansson *et al.,* 2004; Rabie and Almadini 2005). The inoculated treatment can support both, needs for N, P, K, Mg and increase the growth of host plants.

Mycorrhizal formation would be a great importance inoculation of AM fungi to minimize toxic effect of pollutants and to maximize the plant growth, nutrition, improve plant development and tolerance to polluted soil. Therefore this article considered a good attempt to increase the effluent tolerance of legume crop greengram (*Vigna radiata*) by using inoculation of the AM fungi under effluent stress condition.

MATERIALS AND METHODS

Collection of tannery effluent and greengram

The tannery effluent was collected in pre-cleaned containers from the tannery effluent was collected from the outlet of a tannery industry in Vaniyampadi, Vellore District, Tamil Nadu. Its various physico-chemical characteristics were analysed by using standard method (APHA, 1995). The effluent was stored at 4°C during storage period to avoid changes in its characteristics. Greengram variety KM 2 (Kudimiyanmalai 2) was collected form Tamil Nadu Agricultural University, Coimbatore, India.

AM fungi

Mycorrhizal spores: The spores of AM fungi (*Glomus fasciculatum*) were extracted from their cultivation and propagation pots, planted by *Zea mays* using wet sieving and decanting method (Daniles and Skipper 1982). The spore suspension was diluted with water, so that each ml has 50 spores. For soil inoculation. The surface soil crushed and mixed thoroughly with 10 ml spore suspension.

It was comprised with different concentrations of tannery effluent and inoculation treatments with replicates for each treatment. The healthy and uniform sized greengram seeds were selected and surface-sterilized with 0.1% $HgCl_2$ and 0.2% HCl for 5 min., followed by repeated washes with distilled water to avoid surface contamination. Loaded with 5 kg air dried sterilized sandy loam soil and than 10 seeds were planted showed. The pots were arranged in randomized block method. It was treated with different concentrations of tannery effluent with AM fungi inoculation. The seeds were irrigated with equal volume of different concentrations of AM fungi inoculated effluent.

Greengram (*Vigna radiata* L.) seedlings were allowed to grow under the pot conditions for 15, 30, 45, 60 and 75 days. Plant samples were carefully uprooted, washed thoroughly with tap water. After washing, the root and leaves were separated, thereafter the necessary analysis are carried out periodically. The plant growth parameters such as height (cm), root length (cm), number of leaf and leaf area (cm^2) were measured. The fresh and dry weight (g/plant) of the root and shoot were also measured. The root nodules also calculated for each plant. The plant materials were digested in nitric-perchloric acid mixture (5.3) and analyzed colourimetrically with malachite green reagent to determine phosphorus concentration by atomic absorption spectrophotometry (AAS) (Fernandez *et al.,* 1985).

RESULTS AND DISCUSSION

The AM fungus is an important rhizospheric microorganism. They are the mutualistic symbiosis (non-pathogenic association) between soil borne fungi and the roots of higher plants. It frequently suggested that AM may improve the plant nutrition, enhance the nitrogen (N) uptake, improve disease resistance in their host plants and adaptation to various environmental stresses. The AM symbiosis becomes even more important in sustainable agricultural systems in effluent polluted soil. The present study attempt the inoculation of AM fungi tolerance of greengram plants grown under effluent stress.

The physico-chemical characteristics of tannery effluent are shown in Table 1. The raw effluent was dull white in colour, deficit in dissolved oxygen, rich in total solids high amount of BOD and COD with considerable amounts of sodium, calcium, chloride, sulphate, fluoride, nitrate.

Table 1. Physico-chemical analysis of tannery effluent

Parameters	Raw effluent	Tolerance limits
General parameters		
pH	6.5	5.5 to 9.0
Colour	Dull white	
Odour	Disagreeable smell	
Temperature (°C)	35°C	
Electrical Conductivity	381	
Total solids	491	
Total Dissolved solids	132	2200
Total hardness as $CaCO_3$	428	200
Acidity	1363	
Biological Oxygen Demand	3513	100
Chemical Oxygen Demand	7923	
Chemical parameters		
Bicarbonate alkalinity as $CaCO_3$	190.1	
Calcium	120.6	
Magnesium	20.30	130
Chloride	328	600
Sulphate	450	1000
Fluoride	2.00	
Nitrate	53.15	
Silica	92.0	
Total chromium	14.34	

All parameters except colour, pH, EC, temperature are expressed in

The shoot length increases with the advancement of age of plants. The maximum shoot length, root length, number of leaves, leaf area, fresh weight and dry weight was recorded in AM + 50 per cent effluent treatment on 75th day (Figs. 1-6). Minimum shoot length was recorded in 100% effluent treatment. The AM inoculated plants showed higher shoot length when compared to the effluent treated plants. In this connection (Mosse 1973; Abbott and Robson 1982) says that the AM fungi by means association of roots usually increase the growth of plants by improving the nutrients uptake of phosphorus. The total leaf area increased in AM + 50% effluent, at the same times the total leaf area decreased in raw effluent treatment. In the increasing total leaf area in 50% + AM fungi may be the AM fungi reduce the organic, inorganic chemical. Because AM fungi accumulate the particular amount of elements. So that the 50% + AM promote the plant growth that why the large number of leaves in AM inoculated treatment.

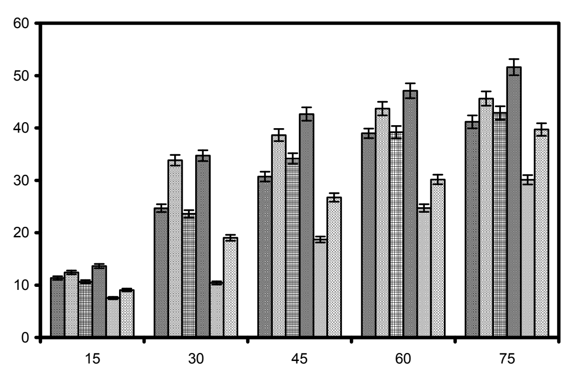


Fig. 1. Effect of AM fungi and tannery effluent on plant shoot length (cm) of greengram.

Mycorrhizal inoculations to many plants increase their essential metal uptake of P, N, Mg, K, Na and Ca (Quilambo 2003; Price *et al.,* 1989). It was indicated that VAM colonization increased photosynthetic activity (Koide 1985; Dell-Amico *et al.,* 2002) it was found that

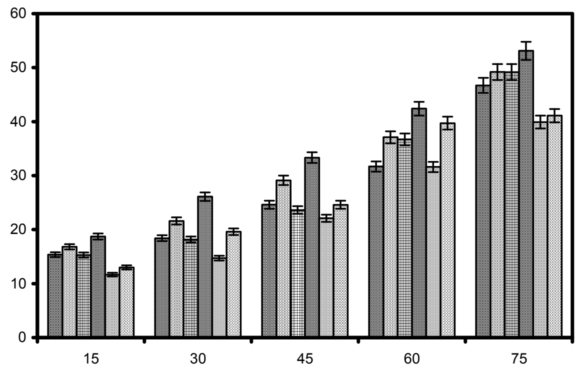


Fig. 2. Effect of AM fungi and tannery effluent on plant root length (cm) of greengram.

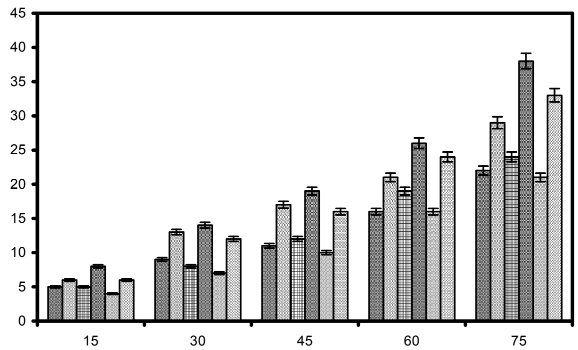


Fig. 3. Effect of AM fungi and tannery effluent on plant total numbers of leaves of greengram.

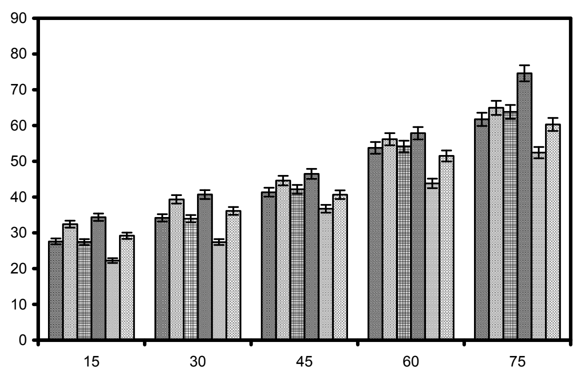
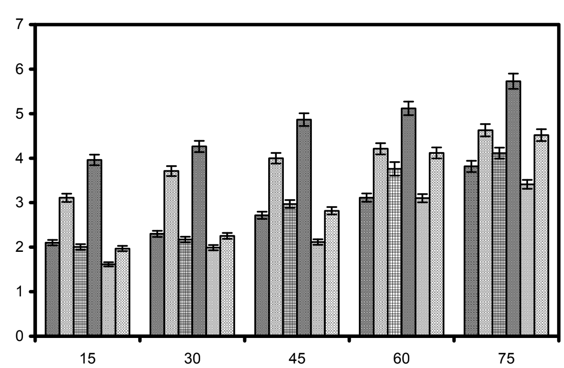


Fig. 4. Effect of AM fungi and tannery effluent on plant leaf area (cm^2) of greengram.



ig. 5. Effect of AM fungi and tannery effluent on plant fresh weight (g) of greengram.

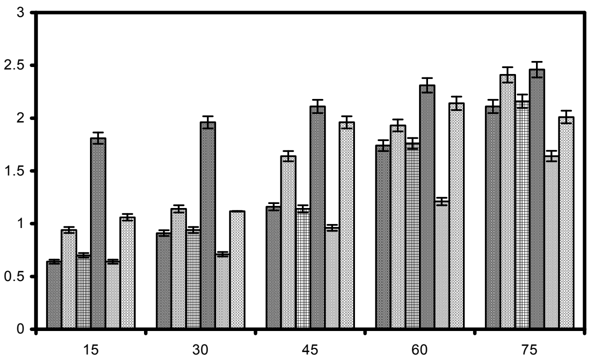


Fig. 6. Effect of AM fungi and tannery effluent on plant dry weight (g) of greengram.

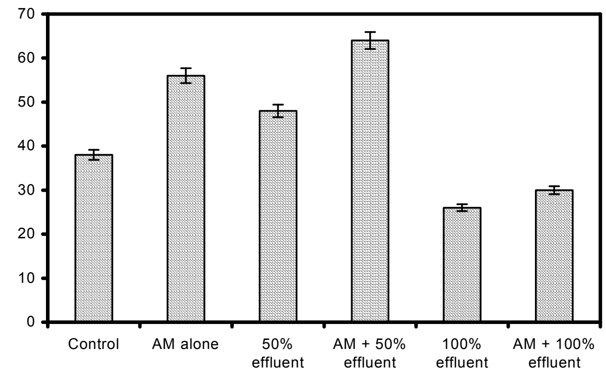


Fig. 7. Effect of AM fungi and tannery effluent on root nodules

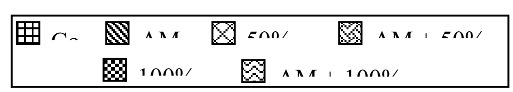


Fig. 8. Effect of AM fungi and tannery effluent on phosphorus content of greengram.

VAM symbiosis in legume plants has been attributed to high P uptake necessary for nodualtion and N_2-fixation and also improve N absorption (Dell-Amico *et al.,* 2002; Liu, 2002).

The maximum number of root nodules counted in 50% effluent inoculated with AM fungi at the same time the reduced root formation observed in lower concentration of effluent (Fig. 7). The maximum number of root nodule formation in AM inoculation, may be due to the symbiotic relationship between root and soil and fix the higher amount of nitrogen in root system. The presence of higher amount of nitrogen enhances the plant growth and also yields (Dell-Amico *et al.,* 2002). AM symbiosis in legume plants for nodulation and N_2-fixation and also improve N absorption (Liu 2002; Johansen *et al.,* 1993).

The activity of phosphorus was maximum in plants inoculated with 50% effluent and AM fungi. The plant accumulated a larger amount of phosphorus in both root and shoot systems (Fig. 8) the accumulation of phosphorus in higher amount may be due to the AM hyphae network which is substantiated by the observed increase in phosphorus content of plants inoculated with AM fungi (Manoharan *et al.,* 2008). Finally the paper concluded that by using AM fungi we can improve the soil fertility and we will get higher yield of crop plants.

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