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Effect of Tannery Industrial Effluents on Crop Growth and VAM Colonization in *Vigna radiata* (L) Wilczek and *Zea mays* L.

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Abstract: Shoot growth and pod yield was decreased while root growth was stimulated when *Vigna radiata* (L.) Wilczek was grown in Tannery Effluent Contaminated Soil (TECS). Nodulation in *V. radiata* was also adversely affected in TECS. In maize (*Zea mays* L.) root length was increased significantly while shoot length and root/shoot biomass were non significantly affected in TECS. VA mycorrhizal colonization was suppressed in TECS in both the test species. Arbuscular infection was severely arrested in TECS.

Key words: Tannery industrial effluents, crop growth, VAM colonization, nodulation, *Vigna radiata,* maize

Introduction

Tanning industry is one of the oldest in Pakistan. Tanning industrial wastes are of a serious consequence from point of view of pollution of streams, fresh water bodies and land. The wastes from this industry rank among the most polluting of all industrial wastes. Not only the environment external to tannery but also the internal environment namely occupational environment of tanner workers is affected resulting in high incidence of respiratory diseases as well as skin and allergic disorders (Backyavathy, 1986). A great amount of chemicals such as sodium chloride, sodium sulfite, lime and chromium are used at different stages of tanning process. Tannery industrial effluents are known to reduce the germination and growth of *Cicer arietinum* (Rao and Kumar, 1983) and chlorophyll synthesis in sugar beet (Hewit, 1954). Furthermore, chromium present in these effluents causes inhibition of nitrifying bacteria (Fargo and Fleming, 1977). In Pakistan at some places like Kasur near Lahore, tannery industrial effluents are used for irrigation purposes. The present research work was undertaken to study the plant growth and VAM colonization in *Vigna radiata* and maize, in soil collected from fields contaminated with tannery industrial effluent irrigation in Kasur near Lahore.

Materials and Methods

Pots of diameter 20 cm were filled with soil collected from a filed in Kasur, with five-year history of tannery industrial effluent irrigation. Soil collected from field with tube-well water irrigation history was used as control. Seeds of *Vigna radiata* and maize were sown at four seeds per pot, which were thinned to two uniform seedlings after germination. Each treatment was replicated thrice. Pots were kept in open under a wire netting house. Irrigation was done with tap water whenever required. Maize plants were harvested 30 days after sowing and data regarding root and shoot growth was recorded. *V. radiata* plants were harvested 45 and 70 days after sowing and data pertaining to root and shoot growth, pod yield and nodulation was recorded. All the data were analyzed statistically by applying t-test. A part of roots of both the test species was cleared and stained following the procedure of Phillips and Hayman (1970), for VAM infection study. Chemical analysis of tap water and tannery effluents is given in Table 1.

Results

Root and shoot development in *V. radiata* was differently affected in tannery effluent contaminated soil (TECS). At both harvest stages i.e. 45 and 75 Days After Sowing (DAS), there was an insignificant reduction in length and biomass of shoot in TECS as compared to control (Fig.1 A-D).In contrast, the corresponding parameters in root were stimulated in TECS (Fig. 1E, F). Pod yield in terms of fresh and dry biomass was adversely affected in TECS. (Fig. 1G, H). Nodulation in *V. radiata* was severely arrested in TECS. There was a significant ($p = 0.05$) reduction in nodule's number at both the growth stages. Reduction in nodule's fresh and dry biomass was more pronounced and significant at later growth stage (Fig. 2). An increase in root and shoot length in maize was observed in TECS. The increase in root length was significant. Both root and shoot fresh biomass was increased while dry biomass was reduced in TECS. However, the effect was insignificant as compared to control (Fig. 3). VA mycorrhizal colonization was suppressed in TECS in both the test species. Arbuscular infection was severely arrested in TECS (Table 2).

Discussion

Shoot biomass and pod yield were reduced when *V. radiata* was grown in TECS. Earlier Rao and Kumar (1983) have reported a reduction in shoot growth of *Cicer aretinum* when seeds received pr treatment of tannery effluents, and decreased paddy yield when rice crop was irrigated with tannery effluents. The reduction in crop growth and yield may be attributed to the stress caused by high salinity, which is a characteristic of tannery effluents (Rao and Kumar, 1981). Chlorophyll contents of plants are also known to be reduced due to tannery effluent irrigation (Rao and Kumar, 1983) possibly because of Cr in the effluents (Bharati *et al.,* 1979). The reduced chlorophyll contents reduce the rate of photosynthesis resulting in reduced crop growth and yield. The effect of TECS on shoot growth of maize was less pronounced as compared to *V. radiata.* It seems probable that growth and yield in *V. radiata* was affected more because of reduction in nodulation in TECS. Root length in both the test species was invariably and significantly increased in TECS. In contrast, Rao and Kumar (1983) observed a decline in root length in *Cicer aretinum* due to tannery effluents. Chromium, a principal constituent of tannery effluents is known to inhibit soil microorganisms such as nitrifying bacteria (Fargo and Fleming, 1977) and ectomycorrhizal fungi (Aggangan *et al.*,1998). The reduced nodulation in *V. radiata* in TECS may be due to decrease in *Rhizobium* population in the soil due to Cr and high salinity. The reduction in VAM colonization in both the

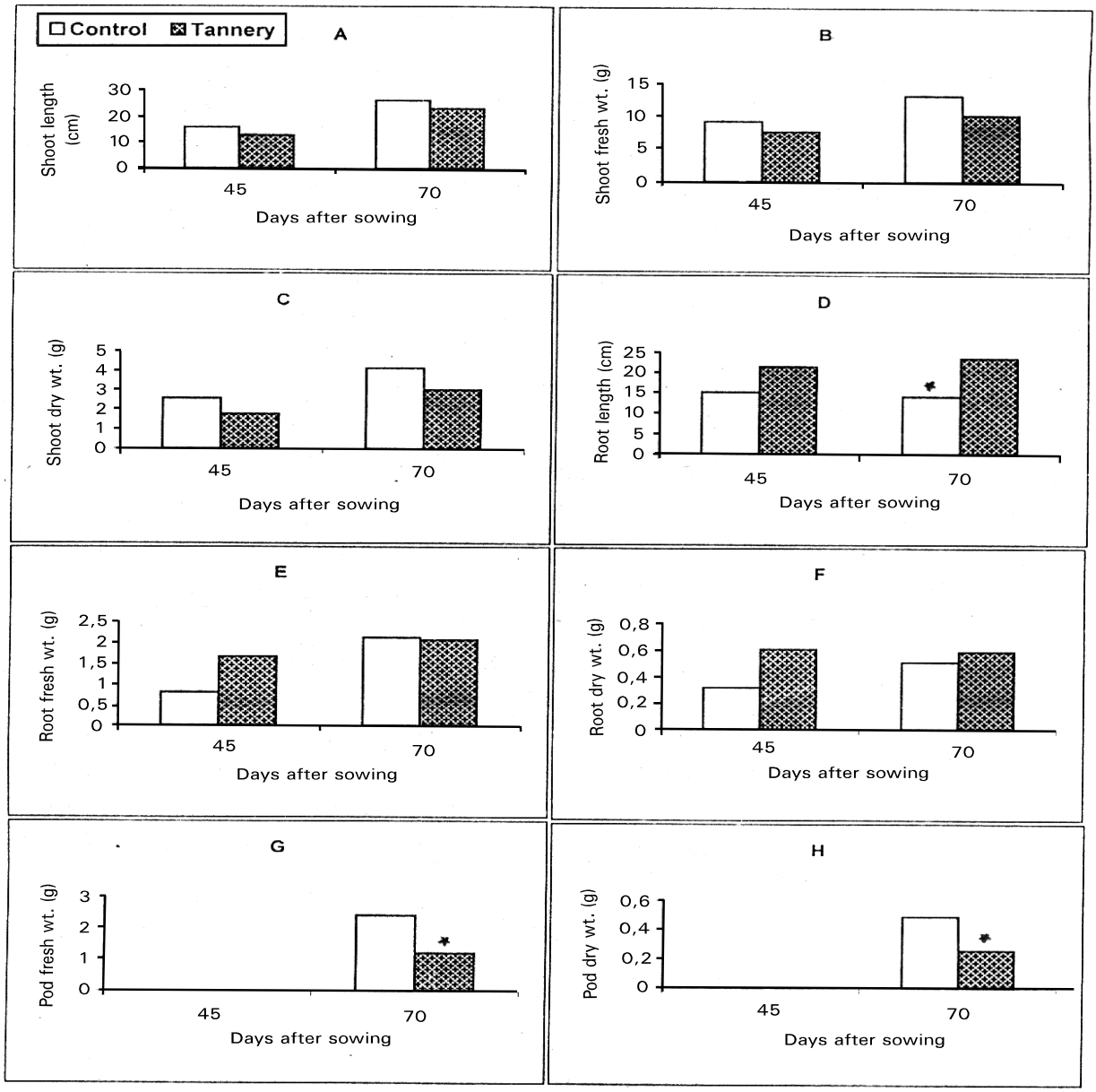

Fig. 1(A-H): Effect of tannery industrial effluents on growth and yield of *Vigna radiata*

Table 1: Chemical analysis of tap water and tannery effluents

	EC		TDS	COD	BOD	N^+	Mg^{+2}	Ca^{+2}	HCO_3^{-1}	Cl^-	Cr
	μ mhos /cm	PH	mg/l			meq/l					
Tap water	595	8.2	598	8.9	1.51	25	14	35	4.91	0.13	0
Tannery effluent	3483	7.8	2438	223	165	391	90	150	12.5	14	0.25

EC: Electrical Conductivity
TDS: Total Dissolved Solids
COD: Chemical Oxygen Demand
BOD: Biological Oxygen Demand

Table 2: Effect of tannery effluent contaminated soil on VAM colonization in maize and *Vigna radiata*

Species	Treatments	Harvest I				Harvest II			
		% VAM infection				% VAM infection			
		myce-lium	arbus-cules	vesic-les	Extent of cm/100 cm	myce-lium	arbus-cules	Vesic-les	Extent of Vam cm/100 cm
Vigna radiata	NFS	87	57	93	56	80	40	80	48
	TECS	100	33	87	42	90	0	77	37
Maize	NFS	100	80	63	69	-	-	-	-
	TECS	97	37	47	54	-	-	-	-

Harvest I: 30 and 45 days after sowing in maize and *V. radiata,* respectively
Harvest II: 70 days after sowing in *V. radiata*
NFS: Normal field soil
TECS: Tannery effluent contaminated soil

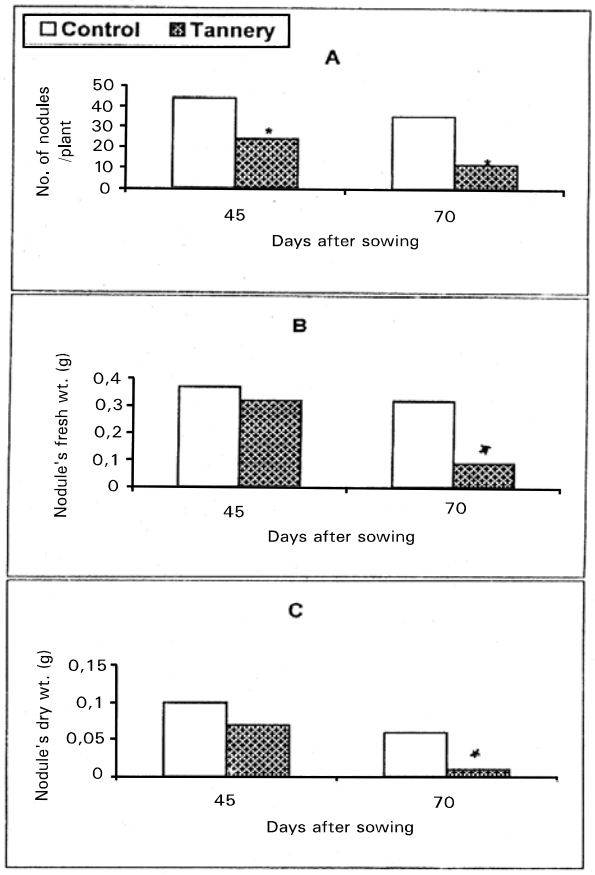

Fig. 2(A-C): Effect of tannery industrial effluents on nodulation in *Vigna radiata*

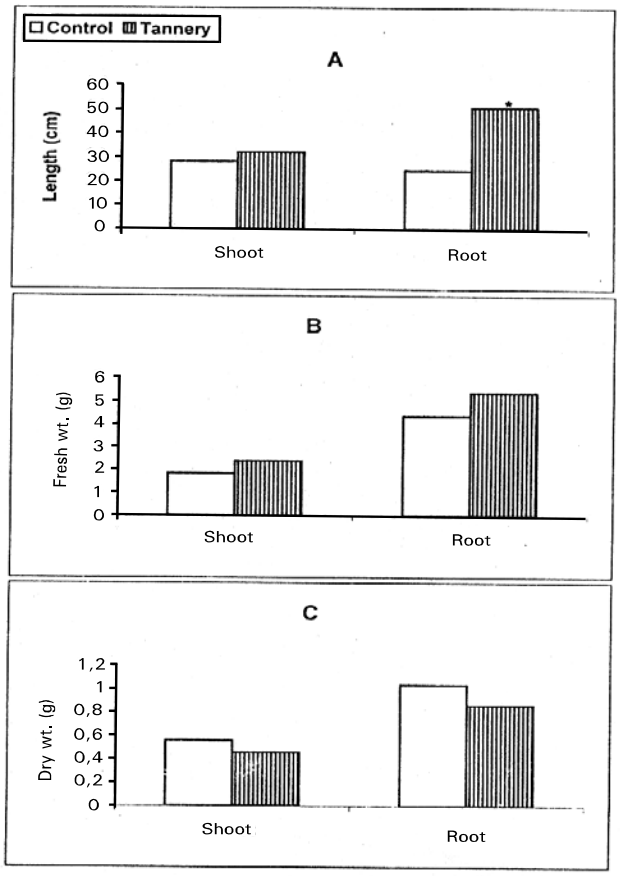

Fig. 3(A-C): Effect of tannery industrial effluents on root and shootgrowth in maize

test species grown in TECS furthers confirms the inhibitory impact of tannery effluents on soil microorganisms. Thus the plants grown in TECS could be less benefited by symbiotic association of N_2-fixing *Rhizobium* and VAM fungi resulting in poor crop growth. Apart from adverse impact on crop growth and soil microorganisms, constituents of tannery effluents particularly Cr is also dangerous for animal's health. Chromium is generally moves from soil and water to plants (Khasim,

1988). The milk from cattle which fed on such Cr contaminated fodder show Cr contents ranging from 0.079-0.390 ppm (Khasim, 1988). Similarly Ajmal *et al*. (1985) showed 0.8-1.66 ppm Cr in fishes from tannery effluent contaminated reservoirs. This movement of Cr from soil and water to plants and animals and its accumulation in various components of food chains and food products warranting cautious surveillance and safety measures. Though man is polluting the soil and water with toxic chemicals harmful to plants and animals, a sort of natural protection seems to operate in plants for the benefits of consumers of food chain. Earlier workers (Lyon *et al*., 1969; Turner and Rust, 1971) observed that accumulation and translocation of Cr is more in root system followed by leaves, shoot and less in seeds. Thus the plant seeds which are edible has least accumulation of Cr. Therefore, it is recommended that if in any region, tannery effluent irrigation is unavoidable, cultivation of fodder crops for cattle in general and crops like turnip, radish and carrot etc. whose roots are edible should particularly be avoided.

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