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Sewage Farming and VA Mycorrhiza III: Effect of Sewage Irrigation on Growth, Yield, Nodulation and VA Mycorrhizal Colonization in Pea (*Pisum sativum* L.)

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Astract: Sewage irrigation enhanced nodulation but adversely affected VA mycorrhizal colonization in pea (*Pisum sativum* L.). Effect of sewage irrigation on root and shoot growth and pod yield was insignificant.

Key words: Sewage irrigation, VA mycorrhiza, *Pisum sativum*, crop growth

Introduction

The sewage is a rich source of plant nutrients and other organic wastes. Average content of N, K_2O and P_2O_5 in raw sewage is shown to be 66.2, 42.1 and 26.6 mg/L respectively. Irrigation of soil with sewage adds 2.5-3.0 Kg of N, 1.0 Kg of P_2O_5 and 1.3-1.6 Kg of K per capita per year (Mishra, 1989). The information already available suggests a highly positive effect of sewage or sludge on the growth of grasses, shrubs and field crops like barley, oat and wheat (Day *et al*., 1963; Kardos, 1987; Clapp *et al*., 1984; Azam *et al*., 1999) but with some reservation due to the some negative effects via pathogens, heavy metals and organic pollutants (Unken, 1987; Benckiser and Simaramata, 1994).

Pea, an important vegetable crop of Pakistan, is grown on an area of 141.4 thousand hectares with annual production of 70.8 thousand metric tones (Anonymous, 1992). Being a legume, pea is symbiotic with both nodule forming *Rhizobium* and VA mycorrhizal fungi (Javaid *et al.,* 1995). Sewage irrigation affects these two types of symbionts differently. It generally supports the population of *Rhizobium* and nodulation (Kulkarni, 1981; Bajwa *et al.,* 1999) while mostly VA mycorrhizal colonization is adversely affected (Bajwa *et al.,* 1999; Javaid *et al*., 1999a, b). The objective of the experiment reported here was to study the effect of sewage irrigation on crop growth and yield, nodulation and VA mycorrhizal colonization in pea (*Pisum sativum* L.).

Materials and Methods

The sewage-affected soil was collected from a field with 10-year history of sewage irrigation. Soil from nearby area with tube well irrigation history was also collected to be used as control. Pots of diameter 20 cm were filled with these soils. Four seeds of pea, surface sterilized with 1% sodium hypochlorite solution, were sown in each pots which were thinned to two uniform seedlings after germination. There were three replicate pots for each of the two treatments. Pots were kept in open under a wire netting house. Pots that contained sewage affected soil also received raw sewage at 500 ml/pot once a week other wise they were irrigated with tap water whenever required. Plants were harvested 40 and 60 days after sowing. At each harvest nodules were counted and weighed. Data regarding the root, shoot and pod biomass was also recorded. All the data were analyzed statistically by t-test. A part of roots of second harvest were cleared and stained following the procedure of Phillips and Hayman (1970) for VAM infection study. The extent of VAM infection was measured by slide length method (Giovannetti and Mosse, 1980). The chemical analysis of the sewage and tap water is presented in Table 1.

Table 1: Chemical analysis of sewage and tap water.

Treatments	Sewage	Tap Water
BOD mg/l	75	4
TDS mg/l	1000	460
SS mg/l	280	0
COD mg/l	154	7
Cl mg/l	80	70
Na meq/l	369	46
Ca meq/l	30	25
Mg meq/l	24	14
SO4 meq/l	8	6
Settle able solids mg/l	2	0

BOD: Biological Oxygen Demand,
TDS: Total Dissolved solids, SS: Suspended Solids,
COD: Chemical Oxygen Demand

Results and Discussion

Shoot and pod biomass was decreased due to sewage irrigation. However, the adverse effect was insignificant as compared to control. The effect of sewage irrigation on root biomass

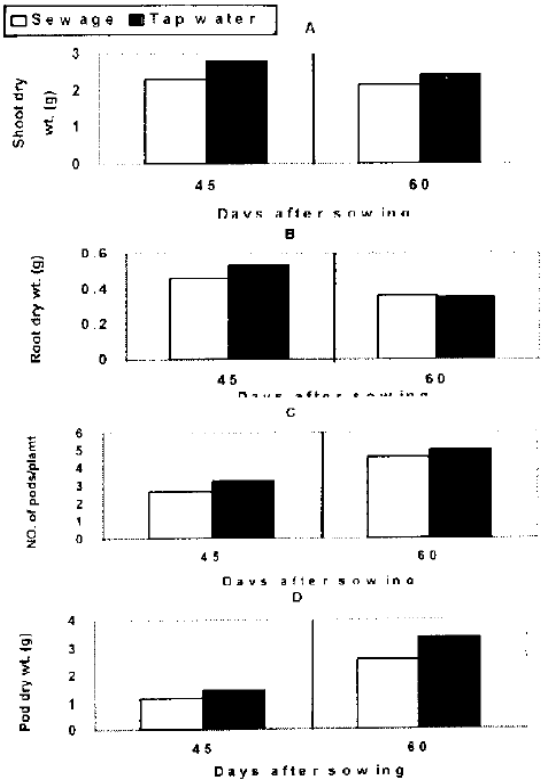

Fig. 1(A-D): Effect of sewage irrigation on plant vegetative and reproductive growth in pea.
*Differ significantly (p = 0.05)

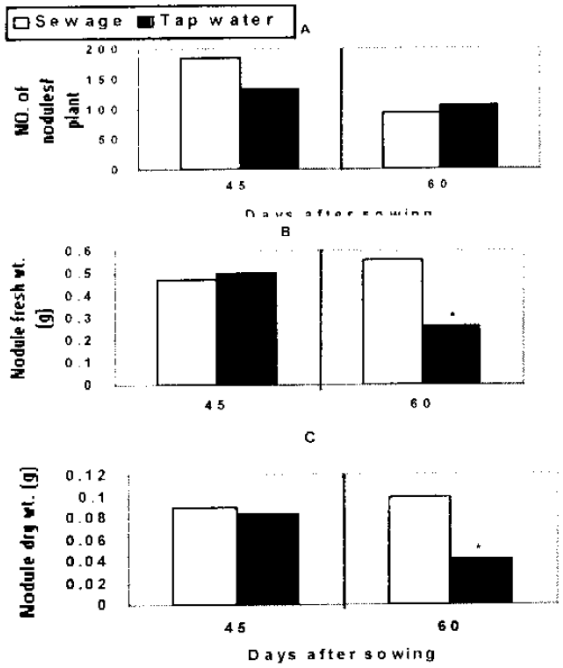

Fig. 2(A-C): Effect of sewage irrigation on nodulation in pea. *Differ significantly (p=0.05)

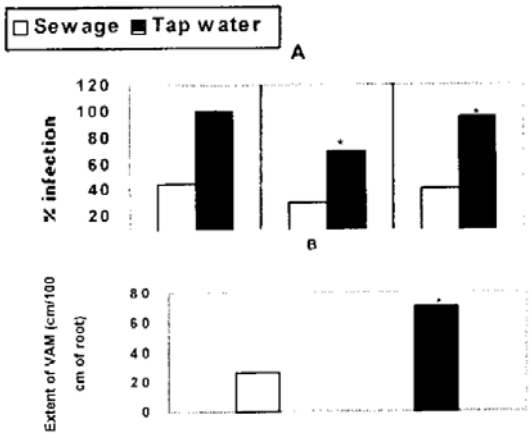

Fig. 3(A-B): Effect of sewage irrigation on VA mycorrhizal colonization in Pea. *Differ significantly (p = 0.05)

productioner was also insignificant (Fig. 1). In contrast to these findings some earlier workers have reported an increase in crop growth and yield in non-leguminous crops such as wheat, rye, corn and maize (Anonymous, 1967; Kardos, 1987; Javaid *et al.*, 1999b).

Nodulation in terms of nodule number was enhanced in sewage irrigated plants 45 Days After Sowing (DAS). This enhanced nodule's number could be attributed to the increased rhizobial population under sewage irrigation system (Kulkarni, 1981). However, no significant effect of sewage was observed on nodule biomass at this growth stage. At 60 days growth stage a significant increase in nodule fresh and dry biomass was recorded in sewage irrigated plants as compared to control irrigated with tap water (Fig. 2). Earlier Bajwa *et al*. (1999) have reported an increase in nodulation due to sewage irrigation in *Vigna radiata*. Since the enhanced nodulation in the present study failed to induce a parallel increase in crop growth and yield, it seems probable that N_2-fixation activity of nodules was suppressed under sewage irrigation system.

Sewage irrigation adversely affected the VAM colonization. All the mycorrhizal structures viz. mycelium, arbuscules and vesicles were significantly suppressed by sewage (Fig. 3). Such similar effects of sewage on VAM development have also been reported in *Vigna radiata,* maize and some wild aquatic plants (Bajwa *et al.*, 1999; Javaid *et al.*, 1999a, b). Since VA mycorrhizal colonization is known to enhance nutrient uptake and supports the process of biological N_2-fixation (Jeffries and Rhodes, 1987), therefore, the insignificant effect of sewage irrigation on crop growth and yield in the present study could be attributed to the reduced VA mycorrhizal colonization under sewage irrigation.

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