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EFFECT OF VAM FUNGUS (*GLOMUS INTRARADICES*) ON THE GROWTH OF SORGHUM, MAIZE, COTTON AND PENNISETUM UNDER SALT STRESS

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Abstract

Effect of VAM-fungus *Glomus intraradices* on the growth of sorghum, maize, cotton and *Pennisetum* sp., was studied in soil under salt stress. The VAM-inoculated 20 day old seedlings growing in 1% (16.0m mho cm^{-1}) saline soil showed better growth and increase in fresh and dry weight over the non-inoculated plants.

Introduction

One of the most serious agricultural problems in arid and semi-arid regions is the accumulation of salt on the soil surface which renders the field unproductive. At least 1-10 metric tons of salt per acre might be added in the soil (Kramer, 1983). In Pakistan, out of 75 million acres of land, 12 million acres are affected by salinity and the level of soil salinity ranges from 0.8 cm^{-1} to 18 m mho cm^{-1} (Anon., 1990).

The exact reason of salt tolerance by some species of plants more than by other species is not known with certainity. There is a possibility that soil-borne vesicular arbuscular mycorrhizal (VAM) fungi which are ubiquitous and are well documented for increasing "P" uptake from the soil (Sanders *et al.*, 1975; Rovira *et al.*, 1983) along with some other nutrients (Safir *et al.*, 1971) could play a positive role in salt tolerance. This work deals with the germination and growth of seeds and seedlings of sorghum, maize, cotton and *Pennisetum* sp., at 1 % (16.0 m mho cm^{-1}) soil salinity with and without inoculation of VAM-fungus.

Materials and Methods

Seed samples of sorghum, maize, cotton (*Salmalia malabarica*) and *Pennisetum* were obtained from Gotteningen (Germany) and used for experiment at the Institut fur Pflazenkrankheiten, Universitat Hannover, F.R. Germany.

On blotters: Double layered blotting papers soaked in 0.5, 1.0, 1.5 and 2 % NaCl (Natrium chloride reinst, Merk (M = 58.44g/mol) solutions were placed in 9 cm diam Petri plates on which 5 seeds of a test plant species were placed. The Petri plates were incubated at 25°C in a glass house covered by another metallic tray to avoid light for the germination of seeds. There were 5 replicates of each treatment and the germination of seeds were recorded after 5 days.

In pots: Soil containing organic carbon 1.37%, clay 11.3 %, silt 84.1 %, sand 4.6 %, pH 6.38 collected from North Germany was adjusted to 1.0% (16.0 m mho cm^{-1}) soil salinity by adding 125 ml of 1.0 % NaCl solution in 780 g soil kept in a 12 cm diam., neutral synthetic pot. The basis of adding 125 ml of 1.0 % NaCl solution in 780g soil in a pot was

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Table 1. Percent seed germination of 4 plant species on blotter soaked in different concentrations of NaCl in Petri plates.

DOSAGES (NaCl Conc.)	(Percent seed germination) Sorghum a	Maize ab	Cotton ab	Pennisetum b
0.0 a	98.6 ± 01.6	100.0 ± 0.0	98.0 ± 0.5	99.0 ± 1.2
0.5 a	98.6 ± 01.6	99.2 ± 0.8	98.8 ± 1.7	98.5 ± 2.6
1.0 b	91.2 ± 10.6	91.2 ± 9.3	91.5 ± 7.2	93.3 ± 5.3
1.5 c	52.0 ± 18.0	58.8 ± 8.4	45.4 ± 5.9	51.7 ± 9.8
2.0 d	49.4 ± 15.0	51.2 ± 6.6	39.2 ± 7.8	42.7 ± 3.9

The similar alphabets show non-significant difference whereas the dissimilar alphabets show significant difference. The significant level for crops was P=0.01 whereas for the doses it was P=0.001.

done after deter mining the water holding capacity (WHC) of the soil determined earlier. Replicate series of pots for the 4 test plant species were prepared accordingly.

Expanded clay particles obtained from Denmark already inoculated by a VAM-fungus (*Glomus intraradices* strain # 49 of the institute) was mixed with soil in proportion of 1:5 (v/v) and in a comparable set soil was not inoculated with VAM-fungus (*G. intraradices*). Five seeds of a test plant species were sown per pot and each soil pot was watered by adding 100 ml double distilled water regularly and maintained at 38 % WHC. There were 6 replicates of each plant species and the pots were kept at 25°C in 12 h ADL and darkness of a glass house.

The percentage germination of seeds and performance in growth of the seedlings were observed for 20 days. The plants dried at 70°C for 72 h were weighed on an electrical balance.

The infection by the VAM-fungus in the cortical tissue of host plant roots was determined by the method of Phillips & Hayman (1970) and percentage of infection by the method of Giovannetti & Mosse (1980). Factorial analysis of variance (FANOVA) was performed on percentage germination data after arcsine transformation (Zar, 1974).

Results and Discussion

On the basis of percent seed germination of sorghum, maize, cotton and Pennisetum on blotters soaked in different concentrations of NaCl in Petri plates (Table 1), the seeds were sown in 1% NaCl soil salinity with and without inoculation of VAM fungus in soil pots. Twenty day old seedlings of sorghum, maize, cotton and *Pennisetum* showed better growth response and higher fresh and dry weights as compared to the control ($P < 0.05$) (Table 2). After 20 days the soil salinity level in soil pots was 0.8 % (12.9 m mho cm^{-1}). The lowering of salinity level in soil pot by 0.2 % may be ascribed to the leaching of the salt from soil through the perforated bottom of the pots. Singh & Tilak (1990) reported a change in the distribution of carbohydrate mediated by VAM development to the benefit of the plant roots in sorghum. Sengupta & Chaudhri (1990) observed decrease in VAM colonization by flooding of sorghum fields with salt water which is similar to the

Table 2. Fresh and dry weight of 4 plant species with and without VAM-inoculation at 1.0 % soil salinity.

CROPS	UNINOCULATED			INOCULATED		
	VAM-infection (%)	Fresh wt. (g)	Dry wt. (g)	VAM-infection (%)	Fresh wt. (g)	Dry wt (g)
Sorghum	00 a	2.12 ± 1.2 ab	0.41 ± 0.1 a	28 ± 2.5 b	2.23 ± 1.2 ab	0.43 ± 0.1 a
Maize	00 a	6.52 ± 1.6 c	0.39 ± 0.5 a	82 ± 3.4 c	7.31 ± 1.5 b	1.90 ± 0.2 c
Cotton	00 a	1.88 ± 1.1 b	0.28 ± 0.1 a	46 ± 4.4 b	1.93 ± 0.2 b	0.24 ± 0.1 a
Pennisetum	00 a	1.48 ± 0.1 b	0.21 ± 0.1 a	20 ± 3.2 d	1.68 ± 0.1 b	0.23 ± 0.0 a

The similar alphabets show non-significant difference whereas the dissimilar alphabets show significant difference. The significance level was P=0.05.

decrease in seed germination percentage with the increasing salinity as observed here. It is to be noted that VAM-colonization of the root of a host plant in saline soil has a direct bearing on further growth and development of a plant since VAM-infection takes place soon after root formation. Levy *et al.*, (1983) found that accumulation of salinity in soil layers were within the limit of tolerance of sour orange roots which apparently did not affect VAM-fungi much. Graham & Syvertson (1989) found that VA-mycorrhiza did not alleviate salinity stress to the citrus plants. Levy & Krikun (1980) in another experiment noticed that VA-mycorrhiza affected stomatal conduction, photosynthesis and proline accumulation in lemon seedlings but not leaf water potential suggesting that most of the effect of mycorrhizal association is on stomatal regulation. Pfiffer & Bloss (1988) found that growth and nutrition of guayule (*Parthenium argentatum*) in saline soil was influenced by VA-mycorrhiza. Sieverding (1991) described the diversity of VAM-fungi and plant interactions in arid soils and emphasised the need to introduce VAM-fungi to disturbed tropical soil and agrosystem due to the impoverishment of soil, soil erosion, flooding, water logging and salinity. Kiran & Rao (1989) have shown VAM-fungi to be the major factor in increasing soil fertility in arid and semi-arid soils. The foregoing account is suggestive that VAM-fungi showed positive effect in the nutrition and growth by the mycorrhizal plants in stressed agricultural soils. There thus exists a great potential for exploiting VAM-fungi in agricultural soils affected by salinity to alleviate the salinity stress at least in the range of 0.5 to 0.8% (8.2 to 12.9 m mho cm^{-1}) soil salinity.

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