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Effect of salt stress and AM fungi on the growth performance of pea plant

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ABSTRACT

The study was conducted to determine the effect of arbuscular mycorrhizal (AM) fungi inoculation on growth of pea grown under salt stressed pot culture conditions. The pots were placed under shade net and watered with normal water for 1 month at the interval of 2 or 3 days depending on the requirement. For each treatment, ten replicates were maintained. The various AM fungi used for pot culture were Acaulospora appendicula, Acaulospora gerdemannii, Glomus fasciculatum, Glomus intraradices and Scutellospora heterogama. The fresh and dry weight of root and shoot of both control and experimental plants decreased with the increase in salt stress. The fresh and dry weight of the root and shoot of mycorrhizal plants were comparatively more than those of control plants. The number of leaves was decreased with the increase in salt concentration. The number of leaves produced in mycorrhizal plants was more as compared to control plants during salt stress.

Keywords: AM fungi; salt stress; *Acaulospora appendicula; Acaulospora gerdemannii;* control and mycorrhizal plants

INTRODUCTION

Green peas are one of the main crops grown by farmers in Maharashtra during the Rabi season. The pea seeds are purchased mostly from dealers and not from other farmers or government agencies. This crop, being highly labour-intensive, will help provide employment to the family members on the farm itself, particularly in the case of small and marginal farmers. It will provide impetus to the diversification programme of the state government, besides improving the soil health, being a leguminous crop. Dita *et al*., 2006 found that field pea, like other pulses, is comparatively sensitive to a number of abiotic stress factors, particularly involving soil nutrition such as salinity and alkaline-induced boron toxicity, reproductive frost damage, heat stress and water deficit During their growth crop plants are usually exposed to different environmental stresses which may limit their growth and productivity (Moud and Magshoudi, 2008; Vujakovic *et al*., 2011).

It has been also found that salinity and drought are major environmental factors limiting plant growth and productivity, causing great economic losses (Jovicic *et al*., 2014). Salinization of soil is a serious problem and is increasing steadily in many parts of the world, in particular in arid and semi-arid areas (Al-Karaki, 2000). To enhance plant growth in saline conditions, the role of arbuscular mycorrhizal (AM) fungi has been well established. Most native plants and crops of arid and semi-arid areas are mycorrhizal and it has been suggested that AM fungal colonization might enhance salt tolerance of some plants (Tain *et al*., 2004). Enhancement in growth and salt tolerance observed in mycorrhizal peanuts may be due to the better nutritional status of the plants (Zandavalli *et al.,* 2004). The present investigation includes effect of AM fungi on growth and productivity of pea and also effect of salt stress on growth and productivity of pea.

MATERIALS AND METHODS

Effect of salinity stress and AM fungi on growth of Pea:

To study the impact AM fungi on salt tolerance an experiment was conducted on both mycorrhizal and non mycorrhizal plants. The rhizosphere soil of pea plant was collected from the three selected localities. Jowar is the monocotyledonous plant used for the pure culture of AMF multiplication. Number of mixture of spores and roots for pure culture of various species of *Acaulospora, Glomus* and *Scutellospora* were used for the treatment.

Plant Material and Salt Treatment

An experiment was carried out where the seeds of Pea (*Pisum sativum* L.) were grown in the pots with and without mycorrhiza. The pots were placed under shade net and watered with normal water for 1 month at the interval of 2 or 3 days depending on the requirement. For each treatment, ten replicates were maintained. The various AM fungi used for pot culture were *Acaulospora appendicula, Acaulospora gerdemannii, Glomus fasciculatum, Glomus intraradices* and *Scutellospora heterogama* .The NaCl treatment of 50 mM, 75 mM and 100mM was started after one month i.e., on the 31st day after germination of all the plants from pot and the subsequent treatment was given at the interval of five days for next one and half month. At the beginning of experiment, Salt stress was not given to avoid osmotic attack. Every time 500 ml of NaCl solution of desired concentration was added in each pot. The NaCl of AR grade was used for salt stress treatment. The plants were harvested after two and half month of salinity stress. The effect of salinity stress and mycorrhiza on the growth parameters and the biochemical analysis was carried out after two and a half months. The parameters are like number of leaves, length of shoot and root, fresh and dry weight of shoot and root were studied during salt stress. Since the pea plant is small in size and it got dried in the field itself, the dry weight was recorded without using any oven by bringing the plant directly from the field.

RESULTS

Effect of salt stress and AM fungi on growth performance of pea plant:

The NaCl treatment was given to the thirty days old pea seedlings and the subsequent treatment was given at the interval of five days for next one and half month. The different concentrations of NaCl used include 50 mM, 75 mM and 100mM NaCl. The subsequent NaCl treatment was given at the interval of 5 days for next one and a half month. Different parameters studied include fresh and dry weight of root and shoot and the number of leaves were studied

Effect of salt concentration and AM fungi on fresh weight of shoot and root of pea plant:

The presence of NaCl is accompanied with a significant reduction in root and shoots fresh weight in all control and experimental plants. The fresh weight of root in control plants decreased from 0.113±0.03 g (50 mM NaCl), 0.107±0.80 g (at 75mM NaCl) to 0.075±0.15 g (100 mM NaCl).In mycorrhizal plants, the fresh weight of root decreased from 0.246±0.10 g (50 mM NaCl), 0.202±0.21 g (at 75 mM NaCl) to 0.185±0.05 g (100 mM NaCl).The fresh weight of shoot has been decreesed from 1.012±0.21 g (at 50 mM NaCl), 0.968±0.18 g (at 75 mM NaCl) to 0.629±0.07 g (at 100 mM NaCl) in control plants and in experimental plants, the fresh weight of shoot has been decreased from 2.673±0.12 (50 mM NaCl), 2.52±0.09 g (at 75 mM NaCl) to 1.865± 0.06 (100 mM NaCl).(Table 1). At the higher concentration of 100 mM, there was a significant decrease in the fresh weight of both control and mycorrhizal plants but it has been shown that the weight of mycorrhizal plants was more than those of control plants. The same decrease was observed for dry weight of shoot and roots. All results were significant at P≤ 0.05 level) where the decrease compared to mycorrhizal plants was more in control plants.

Table 1: Effect of different concentration of salt stress and AM fungi on the fresh weight (in grams) of shoot and root

Salt treatment	Control (Fresh Wt.)		Experimental (Fresh Wt.)	
Plant Part	**Shoot**	**Root**	**Shoot**	**Root**
50 mM	1.012±0.21	0.113±0.03	2.673±0.12	0.246±0.10
75 mM	0.968±0.18	0.107±0.80	2.52±0.09	0.202±0.21
100 mM	0.629±0.07	0.075±0.15	1.865±0.06	0.185±0.05

Results differ significantly at P≤0.05 level.

Table 2: Effect of Different Concentration of Salt Stress and AM fungi on the Dry Weight (Grams) of Root and Shoot

Salt treatment	Control(Dry Wt.in g)		Experimental (Dry wt. in g)	
Plant Part	**Shoot**	**Root**	**Shoot**	**Root**
50 mM	0.217±0.54	0.010±0.23	0.261±0.08	0.013±0.12
75 mM	0.188±0.13	0.008±0.31	0.218±0.09	0.010±0.15
100 mM	0.148±0.76	0.003±0.81	0.191±0.05	0.006±0.07

Results differ significantly at P≤0.05 level.

Table 3: Effect of salt stress and AM fungi on the number of leaves of pea plant

Salt treatment	Control leaves	Experimental leaves
50 mM	51.14±3.40	58.67±4.85
75 mM	45.98±2.89	52.89±2.21
100 mM	34.36±2.53	45.10±4.47

Results differ significantly at P≤0.05

Effect of different concentration of salt stress and AM fungi on the dry weight (grams) of root and shoot

The dry weight of root in control plants decreased from 0.010±0.23 g (50 mM NaCl), 0.008±0.31 g (75 mM NaCl) to 0.003±0.81 g (100 mM NaCl). In experimental plants, the dry weight of roots decreased from 0.013±0.12 g (50 mM NaCl), 0.010±0.15 g (75 mM NaCl) to 0.006±0.07 g (100 mM NaCl).The dry weight of shoot has been decreased from 0.217±0.54 g (at 50 mM NaCl), 0.188±0.13 g (at 75 mM NaCl) to 0.148±0.76 g (at 100 mM NaCl) in control plants and in experimental plants, the dry weight of shoot has been decreased from 0.261±0.08 g (50 mM NaCl), 0.218±0.09 g (at 75 mM NaCl) to 0.191±0.05 g (100 mM NaCl) (Table 2).

Effect of salt stress and AM fungi on the number of leaves of pea plant

Salt stress showed a decrease in the number of leaves in both control and mycorrhizal plants at different NaCl concentrations i.e. 50 mM NaCl, 75 mM NaCl and 100 mM NaCl. At 50 mM NaCl concentration, the number of leaves was more (51.14±3.40 in control and 58.67±4.85 in mycorrhizal). At 75 mM NaCl concentration, the number started decreasing gradually in both control (45.98±2.89) and mycorrhizal (52.89±2.21). At 100 mM NaCl concentration, it went on decreasing significantly. (34.36±2.53 in control and 45.10±4.47 in mycorrhizal plants). All results differ significantly at P≤0.05. Table 3 showed the exact number of leaves at different concentrations.

DISCUSSION

It has been found that fresh weight of the plant was significantly decreased with the increase in salinity both in control and experimental plants. The fresh weight of shoot and root produced in control plants in all three salt treatments was lower than that of mycorrhizal plants. Mycorrhizal pea plants showed improved fresh weight of shoot and root than control pea plants irrespective of salt treatment. At 50 mM NaCl concentration, the fresh weight of the plant was high and at 100 mM NaCl concentration, fresh weight

kept on decreasing. The results are significant at P≤0.05 level. Depressive effects of NaCl on growth have been reported in legumes, as well as the chick-pea (Dua, 1992), soybean (Singleton and Bohlool, 1984) and faba-bean (Zahran and Sprent, 1986; Cordovilla *et al*., 1996).

The dry weight of the shoot and root was decreased with the increase in the salt concentration. Mycorrhizal plants showed improved dry weight than control plants irrespective of salt treatment. At the low salt concentration (50 mM NaCl), dry weight of the pea plants was high but as the salt concentration increased, there was a significant decrease in the dry weight of root and shoot of pea plant.

Both fresh and dry weights of roots and shoots were reduced with increasing salinity. Fresh and dry weight of root and shoot of experimental plants was more than those of control plants It has been reported that mycorrhizal *Acacia nilotica* seedlings had higher root and shoot dry weight than the non-mycorrhizal seedlings (Giri *et al.,* 2007). Al-Karaki (2000) observed a higher shoot and root dry weight, fresh fruit yield, fruit weight and fruit number in a mycorrhizal tomato plant than in a non mycorrhizal tomato plant.

The number of leaves produced in mycorrhizal plants was more as compared to control plants during salt stress. It has been observed that the number of leaves was decreased with the increase in salt concentration. At low salt concentration, the number was more and as the salt concentration increased, the number kept on decreasing. The results were significant at P≤0.05 level.

CONCLUSION

Fresh weight of shoot and root decreased with the increase in the salt concentration. At low salt concentration, fresh weight of both root and shoot was more but as the salt concentration kept on increasing, fresh weight went on decreasing. Fresh weight of shoot and root was high in mycorrhizal plants as compared to control plants.

Dry weight of root and shoot was improved in mycorrhizal plants in comparison to control plants during salt stress. Dry weight decreased with the increase in salt concentration.

The number of leaves was decreased with the increase in salt concentration. The number of leaves produced in mycorrhizal plants was more as compared to control plants during salt stress. There is a limited research work done on the association of pea and mycorrhiza and there are fewer report of salt stress and AM fungi on pea and careful co-selection of VAM species can enhance pea yield and nutrition. Hence present work was undertaken by selecting pea plant which is one of the important cash crops in India.

Conflict of Interest

The author declares that there is no conflict of interest.

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