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Effect of Foliar application of Indole-3-Acetic Acid on Growth and Yield Attributes of Spring Wheat (*Triticum aestivum* L.) Under Salt Stress

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ABSTRACT

A pot experiment was carried out to examine the effect of foliar application of Indole-3-Acetic Acid (IAA, 25 mg L^{-1}) on growth and yield of two lines of spring wheat, Kohistan-97 and Parwaz-94 under different levels (8, 12 and 16 dS m^{-1}) of NaCl salinity. The results revealed that all the growth and yield parameters such as plant height, root length, number of leaves $plant^{-1}$, flag leaf area, number of fertile tillers, spike length, number of spikelets $spike^{-1}$, number of grains $spike^{-1}$, 100-grain weight and grain yield $plant^{-1}$ decreased progressively with increasing salinity. The more adverse affect of salinity was found on Kohistan-97 as compared to Parwaz-94. Application of growth regulator either at the time of salinization or 15 days after salt treatment proved beneficial in alleviating the adverse effect of salinity on all these parameters compared to control (no growth regulator) but more pronounced effect was of the treatment of the growth regulator which was applied at the time of salinization.

Key Words: Wheat; Growth regulator; NaCl salinity

INTRODUCTION

Saline soils are widespread in many parts of the world. In Pakistan, about 6.3 million hectares of agricultural land is affected to various degrees by soil salinity which may be due to an inadequate drainage, low rainfall, poor irrigation management and irrigation with brackish ground water. The major plant response to salt stress is a general reduction in growth and yield (Malibari *et al.,* 1993; Khan *et al.*, 1999). The inhibitory effect of salinity on plant growth and yield has been ascribed to osmotic effect on water availability, ion toxicity, nutritional imbalance, reduction in enzymatic and photosynthetic efficiency and other physiological disorders (Ashraf *et al.,* 1991; Ashraf & Khan, 1993; Khan *et al.,* 1995).

Although wheat is classified as moderately salt-tolerant crop (Maas & Hoffman, 1997), yield at global level is greatly reduced by salinity. Yield losses on moderately salt affected soils of Pakistan are about 64% in comparison with that of normal soils (Quayyum & Malik, 1985). As growth regulators are involved in altering growth processes in plants, it is possible that they might even reduce the detrimental effects of salinity by stimulating growth. Keeping this in mind, the present project was undertaken to find out whether the foliar application of indole-3-acetic acid (1AA) on wheat can alleviate the harmful effect of salinity on plant growth.

MATERIALS AND METHODS

A pot experiment was conducted in the Botanical Garden, University of Agriculture, Faisalabad, during winter 1998-99. The earthen pots of 30 cm diameter lined with polythene bags were filled with 10 kg of sandy loam soil, having ECe, 2.12 dS m^{-1}; pH, 7.5 and saturation percentage 28. Seeds of both the wheat varieties, Kohistan-97 and Parwaz-94 were obtained from the Ayub Agricultural Research Institute (AARI), Faisalabad. The sowing was done on December 2, 1998 and eight seeds were sown 2 cm deep in each pot. One hundred and eight pots in total were used, allocating 54 pots to each variety. Tap water was used for irrigation whenever needed. After germination, five plants were maintained in each pot. Three salinity levels (S1=8, S2=12 and S3=16 dS m^{-1}) were developed using NaCl solution while normal soil having ECe 2.12 dS m^{-1} was considered as control. The salinity treatment was imposed when seedlings were at four-leaf stage. A single dose of 25 mg L^{-1} of IAA was sprayed using a hand spray pump at two different time intervals. First spray was done at the time of salinization and the second 15 days after the salt treatment. The experiment was laid out in a completely randomized design with three factors (variety, salinity, growth regulator), having nine treatments for each variety. Each treatment was replicated thrice. The growth and yield parameters recorded at maturity were: plant height, root length, number of leaves $plant^{-1}$, flag leaf area, number of fertile tillers, spike length, number of spikelets $spike^{-1}$, number of grains $spike^{-1}$, 100-grain weight and grain yield $plant^{-1}$. The data so collected was analyzed statistically and mean values were compared using Duncan New Multiple Range (DMR) test according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Analysis of variance of data for different growth attributes presented in Table I shows that salinity stress had adverse effect on all the attributes. Plant height decreased

Table I. Analysis of variance summaries (mean squares) of data for plant height, root length, number of leaves/plant and flag leaf area

S.O.V.	D.F.	Plant height	Root length	Number of leaves plant^{-1}	Flag leaf area
Salinity (S)	2	83.26**	55.90**	10.16**	71.22**
Growth Regulator (GR)	2	9.08**	7.37^{NS}	0.222*	4.85**
Varieties (V)	1	352.92**	52.12**	3.13**	94.40**
V x S	2	1.26^{NS}	0.387**	0.241^{NS}	0.250^{NS}
V x GR	2	0.029^{NS}	0.817**	2.74**	0.126^{NS}
S x GR	4	0.669^{NS}	0.038^{NS}	0.556**	0.074^{NS}
V x S x GR	4	0.338^{NS}	0.502^{NS}	0.685*	0.022^{NS}
Error	36	0.444	0.184	0.074	0.533
Total	53				

*= Significant; **=Highly significant; NS=Non-significant at 5% and 1% level of probability

progressively with increasing salinity in both wheat varieties (Fig.1a). The more adverse affect of salinity was found on Kohistan-97 than Parwaz-94. Application of growth regulator either at the time of salinization or 15 days after salt treatment

Fig. 1. (a) Plant height (b) Root length (c) Number of leaves plant^{-1} and (d) Flag leaf area of two varieties of spring wheat grown at varying salt treatments and IAA at maturity

presented in Table II shows that salinity stress had adverse effect on all the attributes. Yield and yield components were also negatively affected by salinity. It is clear from Fig. 2 that number of fertile tillers, spike length, number of spikelets spike^{-1}, number of grains spike^{-1} and 100-grain weight decreased gradually with increase in salinity level. The foliar application of IAA proved beneficial in

Fig. 2. (a) Number of fertile tillers plant^{-1} (b) Spike length (c) Number of spikelets spike^{-1} (d) Number of grains spike^{-1} (e) 100-grain weight and (f) Grain yield plant^{-1} of two varieties of spring wheat grown at varying salt treatments and IAA at maturity

days of salinization because grain yield plant^{-1} in this growth regulator treatment was relatively greater at all salinity levels compared with the latter growth regulator treatment.

The most common plant response to salt stress is a general reduction in growth and yield. As salt concentration increases above threshold level, both the growth rate and ultimate yield decreases progressively. However, the threshold level and the rate of growth reduction vary widely among different crop species and even cultivars (Maas & Hoffman, 1996).

In the present study plant height, root length plant^{-1}, number of leaves plant^{-1} and flag leaf area were decreased with increasing salinity in both wheat varieties and application of growth regulator (IAA) proved effective in reducing the adverse effect of salinity on all these parameters. These results are in accordance with the findings of Dogra and Thukrl (1991), Liand Liu (1993), Sharma *et al*. (1994), Maliwal (1997), Ashraf *et al*. (1998), and Sharif *et al*. (1999). They also found that increasing salinity in the growth medium reduced the plant growth in terns of all the earlier mentioned parameters, in wheat, barley, rice and maize. However, growth regulator treatment mitigated the adverse effect of salinity on all these parameters.

Yield and yield attributing characters are the most important criteria to judge the merit of a particular treatment. In the present study, most adverse effect of salt stress was found on number of fertile tillers since they decreased significantly with increase in salinity levels of the growth medium. Growth regulator application did not prove effective in alleviating the effect of salinity on number of fertile tillers. Production of less number of tillers under saline environment may have been be due to the large accumulation of toxic ions in the shoot thereby causing poor growth (Akbar *et al*., 1972). These results are in agreement with those of Raghav and Pal (1994) who also reported that increasing salinity decreased the number of tillers in wheat but contradict the earlier findings of Bastianpillai *et al*. (1982) and Singh and Saxon (1991) in which they found that IAA treatment under salt stress increased tillering in wheat. From the results it is evident that salinity had a significant effect on spike length, number of spikelets spike^{-1}, number of grains spike^{-1}, 100-grain weight and grain yield plant^{-1}. However, growth regulator proved beneficial in reducing the effect of salinity on all the yield and yield components. The decrease in yield and yield components under saline conditions may have been due to the retarded growth of plants as a result of low uptake of water and nutrients as well as due to the specific ion effects. These results support the earlier findings in which it was reported that increasing salinity decreased all the earlier mentioned parameters but growth regulator treatment ameliorated the adverse effect of salinity on all these parameters in wheat (Raghav & Pal, 1994; Hegazi *et al*., 1995; Khan *et al*., 1999), rice (Rudnikas *et al.,* 1992; Anjum *et al.,* 1993; Maliwal, 1997), and maize (Sharif *et al*., 1999).

In conclusion, both the treatments of growth regulator (IAA) were effective in alleviating the adverse effect of salinity on both wheat lines. However, growth regulator treatment applied along with the salt treatment proved to be more effective than that incepted 15 days after salt treatment.

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