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Active yeast extract counteracts the harmful effects of salinity stress on the growth of leucaena plant

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ABSTRACT

The current investigation was carried out at the Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt during the two successive growing seasons of 2014 and 2015 in order to ameliorate the growth of leucaena plants grown under different levels of salinity in irrigation water (2000, 4000 and 8000 ppm) by foliar spray with active yeast extract (100 ml AYE/L.).

The obtained results indicated that increasing salt concentration significantly decreased all investigated growth parameters (plant height, stem diameter, number of compound leaves developed/plant, fresh weight of stems/plant, fresh weight of leaves/plant and plant biomass). Likewise, concentration of chloroplast pigments and percentage of crude protein in leaves were decreased especially those plants grown under 4000 and 8000 ppm salinity. By contrast, increased salinity level more than 200 ppm induced significant increase in proline concentration in leucaena leaves. At the same time, the decrease in stem diameter which was observed due to salinity stress could be attributed mainly to the prominent decrease in all included tissues (periderm, cortex, phloem, xylem and pith). Data also revealed that leucaena plants grown under stress of different levels of salinity and sprayed with active yeast extract (AYE) had better growth behavior than those unsprayed. It was found that yeast extract treatment had the ability to induce significant recovery for the reduction occurred in vegetative growth of leucaena plants which exposed to salinity stress.

1. Introduction

Leucaena is one of the most important genera of the family Mimosaceae. It includes 13 species which *Leucaena leucocephala* (Lam.) de Wit. is one of them. It has excellent agroforestry potential (Anonymous, 1977; Fayez et al., 1996; Reda, 2002). Leucaena is one of the fast growing tropical tree capable of producing large biomass (Giller and Wilson, 1991). It is a promising candidate for sandy soils as it is a nitrogen-fixing tree which is characterized by longer tap root and high rate of annual leaflet drop amounting to 1.2 ton dry matter and 30 kg N/ha. The strong deep root system allows leucaena to combat erosion and tolerate drought. All parts of the plant are edible to animals, including leaves, young stems, flowers, young and mature pods and seeds (Dhamothiran et al., 1991). Leucaena can adapt to a wide variety of environmental conditions (Schroder, 1986). It is a nitrogen-fixing tree which has been recently introduced in subtropical regions. Although it is not widely known in Egypt, its importance increases as a fodder plant (Suliman et al., 2003) and for sand-dune fixation. Hence, it could be cultivated in newly reclaimed areas of Egypt to support animal production and fix sand-dunes. It offers a wide assortment of uses, produce firewood, timber, nitrogenous and rich organic fertilizers. Its diverse uses include providing wind breaks, shade, soil improvement and ornamentation (Ayensu, 1981). Therefore, it is considered one of the ideal multipurpose tree species and being the subject of the present study.

Most of the newly reclaimed Egyptian soils are sandy, calcareous and some of them are salty. The local area which is considered salt-affected to different degrees is approximately two million feddans (840,000 ha)(El-Gabaly, 1975). Most of this area is located in the northern part of Nile Delta and newly reclaimed lands at Noubaria, Fayoum and Sinai. Such area could be devoted for crops and woody trees that are tolerant to salts. Moreover, expansion of the agricultural area requires an enormous amount of irrigation water, which is not sufficient to meet all the expected demand.

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Therefore, the possibility of using saline water for irrigation especially from underground or drainage water is expected. The application of saline water for irrigation is dependent upon the concentration, composition of dissolved salts and the degree to which the plant species are salt tolerant. It is well established that salinity inhibits growth and reduces yield in many crop plants. The damage of salinity differs in different plant species, depending on the organ of the plant being harvested, and in many cases the shoot is affected more than the root. One of the new strategies in facing salinity problem in Egypt is the use of salt-tolerant species, especially woody plants, for cultivation in newly reclaimed soils. *L. leucocephala* is one of the most promising trees in this respect. Hyder et al. (1984) indicated that seedling dry weight of leucaena decreased linearly with increasing NaCl concentration in irrigation water. Also, Niazi et al. (1985) stated that increasing salt concentration adversely affected leucaena growth represented by plant height and shoot fresh weight. A reduction of 50% in plant growth occurred at salinity level of 8000 ppm NaCl. Likewise, Hansen and Munns (1988) found that NaCl at concentrations of 3000 and 6000 ppm reduced plant height, leaf number and biomass of leucaena seedlings. In this concern, Reda et al. (2000) indicated that leucaena plants can grow well under salinity level of 2000 ppm with no significant effect on their morphological characters of vegetative growth (plant height, stem diameter, fresh and dry weights of stem, number of compound leaves per plant and fresh and dry weights of leaves per plant). At the same time, increasing salt concentration in irrigation water decreased significantly all investigated morphological characters and the rate of reduction increased steadily as the salinity level increased and expressed its maximum with salinity level of 8000 ppm.

Recently, a great attention has been focused on the possibility of using natural, cheap and safety substances in order to improve plant growth and counteracting or at least alleviate the harmful effects of stresses on plant growth. In this connection, yeasts have been reported to be a rich source of phytohormones, vitamins, enzymes, amino acids and minerals (Barnett et al., 1990; Mahmoud, 2001). It was reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Kraig and Haber, 1980 Castelfranco and Beale, 1983). It participate a beneficial role during stress due to its cytokinins content (Barnett et al., 1990). Improving growth and fruiting of horticultural plants by application of active yeast extract (**AYE**) were recorded by Bowe et al. (1989), Ahmed et al. (1997), Atawia and Desouky (1997), Hegab et al. (1997), El-Mogy et al. (1998), Abd El-Ghany et al. (2001) and Ismaeil et al. (2003). Likewise, Reda and Ismail (2008) stated that foliar application with 100 or 200 ml active yeast extract/L. induced significant enhancement in vegetative growth of river red gum plant (*Eucalyptus camaldulensis* Dehn.). In this respect, Darwesh Rasmia (2013) found that foliar application with 50 ml yeast extract/L. ameliorated the harmful effect of salinity (18000 ppm) on vegetative growth of data palm plantlets.

Thus, it is aimed in this study to bring to light more information about the effect of salinity stress on morphological characters of vegetative growth, chlorophyll pigments and proline concentrations as well as protein percent in leaves and stem anatomy of leucaena plant. Moreover, the use of active yeast extract, as natural source of phytohormones, in counteracting or at least alleviating the harmful effects of salinity stress on vegetative growth, physiological aspects and anatomical structure of stem of leucaena plant was also investigated.

2. Materials and methods

The research work presented in this paper was carried out at the Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt during the two growing seasons of 2014 and 2015 in order to ameliorate the growth of leucaena plants grown under salinity stress by foliar spray with active yeast extract.

2.1. Preparation of yeast extract (YE)

The pure dry yeast powder was activated by using sources of carbon and nitrogen at the rate of 6:1 (Barnett et al., 1990). This ratio was suitable to obtain the highest vegetative production of yeast, each ml of activated yeast contain about 12000 yeast cells. Such technique allowed yeast cells to be grown and multiplied efficiently during conductive aerobic and nutritional conditions. To produce *de novo* beneficial bioconstituents; *i.e.,* phytohormones, carbohydrates, proteins, amino acids, fatty acids, vitamins, enzymes, minerals . . ..etc, hence allowed such constituents to release out of yeast cells in readily form. Such technique for yeast preparation based on: 1-Nutritional media of glucose and casein as favorable sources of C, N and other essential elements (P, K, Ca, Mg, Fe, Mn, Cu, B and Mo as well as Na and Cl) in suitable balance (Barnett et al., 1990). 2-Air pumping and adjusting incubation temperature. The media then subjected to two cycles of freezing and thawing for disruption of yeast cells and releasing their bioconstituents directly before usage. The conditions for yeast activation are nutrients (glucose and casein (6:1)), temperature (25 °C) and pH (6)

2.2. Source of seeds and procedure of the experiment

Seeds of *L. leucocephala* (Lam.) de Wit. were collected from authentic mother trees grown in Experimental Farm of Faculty of Agriculture at Giza. To promote germination, seeds were treated by boiling water and then soaked in tap water for 48 h before sowing. Seeds were sown on nineteenth February, 2014 in the first season and replicated on seventeenth February, 2015 in the second one to provide the experimental plant materials. Seeds were sown in plastic trays, 40 × 60 cm, filled with peat moss and clean sand at the ratio of 1:1 by volume. One month from sowing date, the emerged uniform seedlings were transplanted to plastic pots; one seedling per pot (25 cm diameter) filled with about 8 kg of clay and clean sand at the ratio of 1:1 by weight. Mineral fertilizer of NPK was added at the rates of 40 kg N/fedd., 15 kg P_2O_5/fedd. and 24 kg K_2O/fedd. It means each pot received 2 g ammonium sulphate (20.6% N), 1 g calcium superphosphate (15.5% P_2O_5) and 0.5 g potassium sulphate (48% K_2O).

The experiment was made in a randomized complete block design with four replicates. The replicate contained 42 pots, each 6 pots were assigned for one treatment. The treatments were seven as follows:

1. Control (plants were irrigated with tap water).
2. Threelevels of salinity in irrigation water, namely, 2000, 4000 and 8000 ppm of salt mixture (NaCl: $CaCl_2$, 1:1 w/w).
3. One level of active yeast extract (100 ml/L) was applied on each of the tested three levels of salinity.

Each level of salinity in irrigation water was added regularly (500 ml/pot/week) during whole period of the experiment (six months from transplanting; *i.e.,* the age of seven months from sowing date). Irrigation treatments were applied four times with salt-water followed by one time with tap-water (for leaching the accumulated salts) and then repeated in the same manner till the end of the experiment.

In order to ameliorate the vegetative growth of leucaena plants grown under salinity stress, the previously prepared active yeast extract was applied twice at the rate of 100 ml/L. The first spray