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Physiological and biochemical studies on drought tolerance of wheat plants by application of amino acids and yeast extract



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Abstract Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the world. Drought is a worldwide problem, constraining global crop production seriously and recent global climate change has made this situation more serious. Two experiments (pots and field) were performed to investigate the effect of foliar spray with some biostimulants (amino acids 1.5 and 3 ml/L or yeast 3 and 6 g/L) to reduce hazards of drought stress (irrigation after the depletion of 65% and 80% of available soil water) on bread wheat (Sakha 94 cv.). The obtained results revealed that all studied characters of growth, relative water content (RWC), photosynthetic pigments, total soluble sugars (TSS), total carbohydrates (TC), total free amino acids (TAA), enzymes activities, minerals (NPK% and uptakes), yield and its attributes and grain quality were negatively affected by lower water supplies, meanwhile a significant increase was obtained in leaf water deficit (LWD), osmotic potential (OP), total phenols (TP) and proline content. The maximum decrease was recorded under high level of water stress (W2) compared to optimum level of water supply (W0). Application of amino acids and yeast extract significantly increased all measurement studied with exception of leaf water deficit, osmotic potential and proline content characters in favor of yeast application at a rate of 6 g/L compared to untreated plants in the two seasons. The interaction between the tested water stress and biostimulants was found to be significant for most characters of physiological traits and yield and its components. Also it was noticed that application of yeast (6 g/L) under normal water supply gave the best results of all studied characters. Also, it could be recommended that application of natural substances led to overcome the deleterious effect of drought and consequently resulted in improved the productivity of wheat and its grain quality.

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Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the world which plays a key role in the

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economic activity. It is used as a stable food grain for urban and rural societies and as a major source of straw for animal feeding. In Egypt, the cultivated area was around 3 million fed-dan yearly. Increasing the cultivated area of wheat should be done in the reclaimed land due to the limited areas of the Nile Valley and the competition of the main crops. Therefore, improving both quantitative and qualitative characteristics of wheat was still the aim of many investigators. Water stress (drought) is the most important factor that affecting the productivity of wheat. Exposing plants to water stress adversely affect plant growth and productivity (Namich, 2007). Drought is a worldwide problem, constraining global crop production seriously and recent global climate change has made this situation more serious. Wheat should be irrigated when 50–55% of the available soil water is depleted in the root zone (Doorenbos and Pruitt, 1992; Mahmood and Ahmad, 2005). Water deficiency is generally considered as one of the limiting factors for crop productivity which affects physiological and biochemical processes in plants (Osborne et al., 2002). Egypt presents a typical example of the drought problem faced in some arid districts. There is a critical need to balance water availability, water requirements and water consumption. Thus, water conserving is becoming a decisive consideration for agriculture. Exploiting and increasing production in these areas are necessary to bridge the gap between production and consumption of wheat.

The application of biostimulants, i.e. amino acids and yeast extract was found to extent positive effect of plant growth which overcomes the harmful effect of some environmental stress such as drought. The importance of amino acids came from their widely use for the biosynthesis of a large variety of nonproteinic nitrogenous materials, i.e. pigments, vitamins, coenzymes, purine and pyrimidine bases. Studies have proved that amino acids can directly or indirectly influence the physiological activities in plant growth and yield (Mohamed, 2006). Yeast extract is a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine and vitamins B1, B2, B3 and B12), cytokinins and many of the nutrient elements as well as organic compounds i.e., protein, carbohydrates, nucleic acid and lipids (Barnett et al., 1990; Nagodawithana, 1991). The positive effect of yeast extract in alleviation the deleterious effect of drought stress was observed by Hammad (2008). In this connection, Mohamed (2005) found that active dry yeast as foliar application had a beneficial effect on growth, yield and chemical constituents of plants. Therefore, the aim of this study was suggested the possibility of using some natural substances (amino acids or yeast extract) to reduce the harmful effect of water stress with studying the physiological mechanism or changes under these situation, photosynthetic pigments, water relations, chemical constituents, yield and its quality of wheat.

Materials and methods

Experimental site

Two experiments (pots and field) were carried out during the two winter seasons of 2010/2011 and 2011/2012 at the Experimental Farm, Faculty of Agriculture, Minufiya University, in Shebin El-Kom, Egypt, to investigate the performance of spring wheat cultivar Sakha 94 in relation to foliar spray with

some natural substances (amino acids “commercial name Delfan” and yeast extract) under drought conditions. Wheat cultivar was identified and obtained from Wheat Researches Institute, Agriculture Researches Center, Egypt.

Treatments

The experiments included 15 treatments which were all possible combinations of water stress and natural substances application. The plants under study were irrigation after depletion of 50% (W0), 65% (W1) and 80% (W2) of available soil water. These treatments reflecting conditions achieved as optimum level of water supply, moderate and severe water stress, respectively. The water stress treatments were applied after first irrigation until plant maturity. For the natural biostimulants, the plants were treated with delfan at 1.5 ml/L (D1), 3 ml/L (D2) and yeast extract at 3 g/L (Y1), 6 g/L (Y2) as well as untreated plants were taken as control. The treatments were sprayed three times, and the first one was 25 days after sowing and repeated each 15 days. Tween 20 was added to spraying solution at 0.5% as a surfactant. All cultural practices, other than treatment variables, were performed as recommended for the area.

Amino acids

Spanish compound known as Delfan 10% L- α -free amino acids was used as simulative compound source for amino acids mixture. Delfan is a brown liquid with pH of 5–5.5 and containing amino acids mixture as follows (mg/100 ml): Aspartic (2.3), Glycine (4.6), Threonine (1.2), Tyrosine (0.9), Glutamic (4.2), Histidine (0.3), Alanine (2.5), Cystine (0.2), Valine (1.8), Methionine (0.2), Isoleucine (1.1), Leucine (2.1), Phenylalanine (1.1), Hydroxyproline (2.7), Serine (2.8), Arginine (2.6), Proline (2.8) and Lysine (1.1). Also, contains amino nitrogen (1.4%) and organic matter (18.4%). Delfan is produced by Trade Corporation International Company Madrid and imported by TECNOGREEN Co., Egypt.

Yeast extract

The dry pure yeast powder was activated by using sources of carbon and nitrogen at a rate of 6:1 (Barnett et al., 1990) to obtain higher reactive yeast cells (1200 yeast cell/1 ml yeast extract). Then the media were frozen and thawed directly before usage.

Soil analysis

Soil samples of experimental site were randomly collected from depths of 0 to 30 cm and 30 to 60 cm using an auger before sowing to analyze for the determination of some physical and chemical properties of the soil according to Jackson (1973), Chapman and Pratt (1978) and Klute (1986) as shown in Tables 1a and 1b.

Pots experiments

Wheat grains were sowing on 15th November in the two seasons at a rate of 10 grains per pot. Pot was 25 cm inner diameter and 30 cm depth, and each holding 6 kg air-dry clay

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