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PLANT GROWTH REGULATORS AND ASCORBIC ACID EFFECTS ON PHYSIOLOGICAL QUALITY OF WHEAT SEEDLINGS OBTAINED FROM DETERIORATED SEEDS

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Abstract

This study attempted to examine the effect of seed priming using plant growth regulators and vitamin C on the physiological traits of non-aged and aged seeds of wheat and their obtained seedlings. Accelerated aging (AA) method (40°C, RH=100% for 72h) was used for aging seeds. The seeds were pre-treated by gibberellin (GA), salicylic acid (SA), brassinosteroid (BR), and ascorbic acid (AS). Some seed traits such as germination and electric conductivity (EC) and seedling traits such as malondialdehyde (MDA) content, activity of some antioxidant enzymes, soluble protein content (SP), soluble sugar (SS), and proline were measured seven days after germination. The results showed that accelerated aging of seeds reduces the germination percentage and speed, increases soluble sugar, and reduces soluble protein, activity of catalase (CAT), peroxidase (POD) and superoxide dismutase (SOD) in the seedling. Pre-treatment of the aged seed by GA had the maximum positive impact on seed germination and seedling growth. Priming improved germination indices, quality of seedling, and seedling resistance against the oxidative stress caused by AA. It also improved cell membrane integrity and thus reduced seeds' EC. Priming increased the activity of CAT, POD and SOD enzymes in both aged and non-aged seeds. When the deteriorated seeds were primed, proline and SS contents of the seedling increased significantly, but SP and MDA decreased. In general, pre-treatment of the non-aged and aged seeds by gibberellin improved the physiological quality of the seed and seedling.

Key words: Seed aging, PGRs, Physiological characteristics, Priming, Wheat, Vitamin C.

Abbreviations: AAS, accelerated aging seed; CAT, catalase; EC, Electrical conductivity; MDA, malondialdehyde; POD, peroxidase; ROS, reactive oxygen species; SOD, super-oxide dismutase; GA, gibberllin; BR, brassinosteroid; AS, ascorbic acid; SA, salicylic acid; SS, soluble sugar; SP, soluble protein; VI, vigour index; HP, hydro-primed; NP, non-primed; NAS, non-aged seed.

Introduction

Seed aging leads to its deterioration. Seed deterioration leads to genetic and economic losses in agricultural products (McDonald, 1999; Walters, 1998). Due to the disorders in cell organelles such as mitochondria and glyoxysomes, reactive oxygen species (ROS) including H_2O_2, OH-, and O_2^- increase in the deteriorated seeds (Bailly, 2004). A good understanding of seed deterioration mechanism would reveal new methods for preservation and longevity of seeds (Bailly *et al.*, 2008).

If ROS production exceeds their removal, seeds will suffer from oxidative stress and their germination power will reduce. Several tests have proven the adverse effects of accelerated aging on antioxidative factors associated with seed viability and its germination in some crops (Bailly *et al.*, 1998; Chiu *et al.*, 1995; Sung & Jeng, 1994). Several studies showed induction of various species of ROS in different tissues, which were exposed to oxidative stresses (Anderson *et al.*, 1995; Bailly, 2004; Bailly *et al.*, 1998).

Release of active species of oxygen increases lipid and membrane proteins peroxidation and accelerates seed deterioration by destroying membrane structure (Goel *et al.*, 2003). Radicals of (O_2^-) and hydrogen peroxide (H_2O_2), which may cause ROS accumulation, are the major factors of seed aging and deterioration, thus reducing power and vitality of seed (Bailly *et al.*, 2008; Hu *et al.*, 2012; Oracz *et al.*, 2009; Rajjou & Debeaujon, 2008). Antioxidant systems prevent ROS accumulation, which leads to seed deterioration (Bailly, 2004; Pukacka & Ratajczak, 2005).

Accelerated aging has been widely recognized as a suitable test for predicting storage time of seeds and as a criterion for estimating vigor of cereal seeds. The mechanisms involved in seed deterioration vary in different conditions. The share of peroxidation of lipids, hydrolysis of sugars, and the Maillard reaction in seed deterioration is highly dependent on water and temperature content; therefore, seed aging, in the first place, is highly dependent on seed moisture and temperature during storage (Kibinza *et al.*, 2006; Walters, 1998). Seed aging may reduce viability and germination power of seeds (Eisvand *et al.*, 2010a; McDonald, 1999).

Seed priming is one of the applied techniques for improving performance of crop products (Murungu *et al.*, 2004). Seed priming treatments mainly have certain effects on metabolism, biochemistry and enzymatic activities of seed; therefore, they may result in better performance of seed's biological processes such as germination and seed establishment (Demir & Mavi, 2004). So far, some studies have discussed the effects of priming on germination and resistance to adverse conditions such as oxidative stress (Espanany *et al.*, 2015; Goel *et al.*, 2003; Shinwari *et al.*, 2015).

This study discusses the effect of priming of aged seeds of wheat with plant growth regulators and ascorbic acid on germination performance and activity of several enzymes capable of removing free radicals in wheat