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CHANGES IN THE ANTIOXIDANT ENZYMES ACTIVITY OF WHEAT SEEDLINGS UNDER ABSCISIC ACID (ABA) AND WATER STRESS

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ABSTRACT

The plant hormone abscisic acid (ABA), as a stress signal, plays important roles in the regulation of plant responses to water stress. Increasing evidence indicates that ABA-enhanced water stress tolerance is related to the induction of antioxidant defense systems by ABA. Current research was conducted to compare the effect of ABA and water stress on wheat seedlings of two genotypes ('Sarsabz' and 'Inqilab-91'). Seeds were allowed to grow under normal irrigation for 7 days. Water Stress was imposed by withholding water for a period of one week and also ABA induction was given for the same period of time. Seedlings were collected from stress and non-stress condition and antioxidant enzymes were estimated. Water stress resulted in a significant enhancement in the activity of peroxidase and reduced levels of catalase compared to ABA treated seedlings in 'Sarsabz'. Furthermore, 'Inqilab-91' showed reversed results and highest reduction was noticed of both the enzymes as compared to control and ABA treated seedlings. These results indicated that the antioxidant activities in two wheat genotypes were greatly affected at water stress. In conclusion, 'Sarsabz' reflected more tolerance with respect to antioxidant activities under ABA and water stress condition as compared to 'Inqilab-91'.

Keywords: ABA, antioxidant enzymes, water stress, wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important staple food crop of many countries including Pakistan. It is grown under diversified environments. However, the lack of adequate moisture is common to wheat in rain fed and poorly irrigated areas and results in a significant reduction of yield. Understanding the biochemical and physiological basis of water stress tolerance in plants is vital to select and breed plants for improving crop water stress tolerance (Chaves *et al*., 2003).

Water stress is one of the most important environmental factors that regulate plant growth and development, and limit plant production. Plants can respond and adapt to water stress by perceiving the stimulus, generating and transmitting the signals, and initiating various defense mechanisms (Bohnert and Jensen, 1996). One important regulator of plant responses to abiotic stresses is the phytohormones abscisic acid (ABA). The plant hormone abscisic acid (ABA), act as a stress signal with increase level in response to water stress and plays important roles in the regulation of plant responses from the whole plant level (Davies and Zhang, 1991) to the cellular level (Shinozaki and Yamaguchi-Shinozaki, 1997). Under drought, cold or salt stress conditions, plants accumulate increased amounts of ABA, with drought stress having the most prominent effect. ABA plays important roles in the induction of plant tolerance to these stress conditions (Shinozaki and Yamaguchi-Shinozaki, 1997; Zhu, 2002). Increasing evidence indicates that one mode of ABA action is related to oxidative stress in plant cells. ABA increases the activities of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), and glutathione reductase (GR) in plant tissues (Anderson *et al*., 1994; Bellaire *et al*., 2000; Jiang and Zhang, 2001; Agarwal *et al*., 2005; Sabeva and Nedeva, 2008). Chandrasekar *et al.*, (2000) have reported a higher accumulation of ABA in drought tolerant wheat cultivar than susceptible ones in response to water stress. Exogenous application of ABA has been reported to significantly increase the activities of SOD, CAT, APX and GR and the contents of ascorbate, reduced glutathione, α-tocopherol and carotenoids (Jiang and Zhang, 2001). Current research was focused on effect of antioxidant activities under water stress and ABA in wheat seedlings.

MATERIALS AND METHODS

Experiment was carried out in factorial design. It was conducted *in vitro*, briefly seeds of two varieties i.e. 'Sarsabz' and 'Inqilab-91' were grown in petri dishes. Seeds were treated with 0.1% bleach for the sterilization. Seeds were irrigated for 7 days under normal condition. 10µM ABA solution was given to both varieties, however, water stress was induced at same period of time. Control seedlings were never allowed to dry out. Protein content of seedlings was determined by Lowry *et al*., (1951). Peroxidase (POD) was estimated by the method of Everse *et al*., (1994) and Catalase (CAT) was determined by Aebi, (1984.) Statistical analysis was done by statistical software SPSS Version 11.

RESULTS AND DISCUSSION

Data were subjected to factorial ANOVA by using SPSS version 11. The data indicated significant ($P \leq 0.05$) effects on treatments of seedlings in wheat genotypes. Under drought, cold or salt stress condition, plants accumulate increased amounts of ABA, with drought stress having the most prominent effect. ABA plays important roles in the induction of plant tolerance to these stress conditions (Shinozaki and Yamaguchi-Shinozaki, 1997; Xiong *et al.*, 2002; Zhu, 2002). Increasing evidence indicates that one mode of ABA action is related to oxidative stress in plant cells (Ming-Yi and Jian-Hua, 2004).

Table 1. Mean squares for peroxidase activity (O.D at 470nm/mg protein/8 minute) in wheat under irrigated, ABA and waters stress condition

Sources of variation	df	MS Value
Replications	1	19.07
Treatments (T)	2	60.12**
Varieties (V)	1	38.98*
T × V	2	87.82**
Error	2	0.25

* and **: significant at 5% and 1% level of probability, respectively

Table 2. Mean squares for catalase activity (O.D at 240 nm/mg protein/1minute) in wheat under irrigated, ABA and water stress condition

Sources of variation	df	MS Value
Replications	1	0.13
Treatments (T)	2	2.76**
Varieties (V)	1	8.26**
T × V	2	0.29
Error	2	6.76

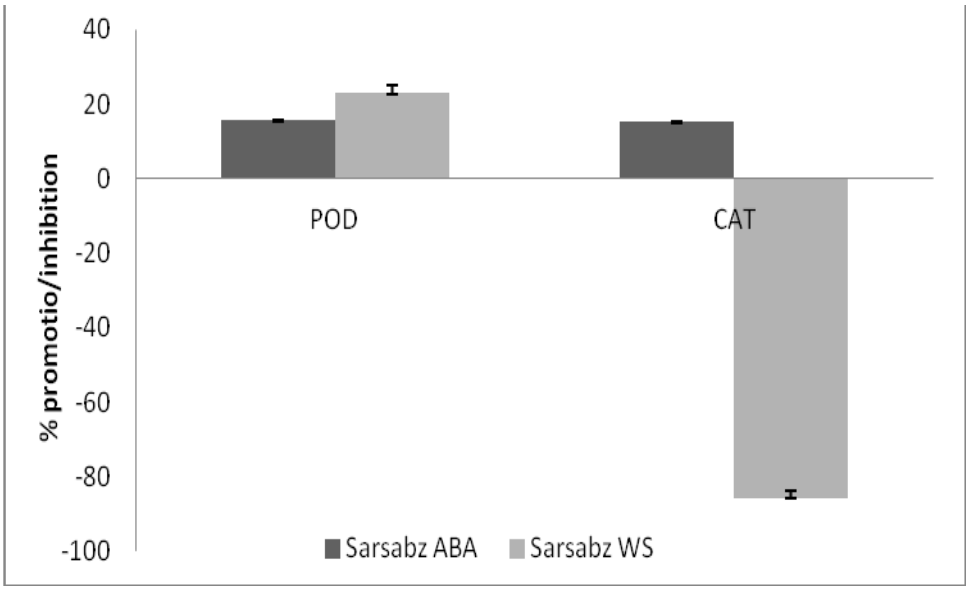

Fig.1. Percent promotion / inhibition in POD and CAT activity of 'Sarsabz' under ABA and water stress condition against control.

ANOVA of peroxidase (Table 1) reflected significant effect between the varieties and treatments. Similar results were found for catalase (Table 2). The relationship between ABA accumulation and antioxidant defense in plants under stress conditions has been also investigated by Ming-Yi and Jian-Hua, (2004) and Iqbal and Bano,

(2009). The increase in antioxidant defense systems is closely related to the stress tolerance. An earlier study has provided genetic evidence for the involvement of ABA in the protection against oxidative damage in *Arabidopsis* exposed to heat stress (Larkindale and Knight, 2002). Under ABA and water stress condition, 'Sarsabz' showed increased POD activity as compared to control and ABA (Fig 1). Whereas 'Inqilab-91' showed decline POD activity in both conditions but maximum decline was seen under water stress condition (Fig 2). ABA helped in mediating drought tolerance in plants (Zeevart, 1999) and its exogenous application to sunflower under drought converted tolerant cultivars to more tolerant and sensitive cultivars to tolerant cultivars (Quarrie, 1980; Cellier *et al*., 1998; Hussain *et al*., 2010).

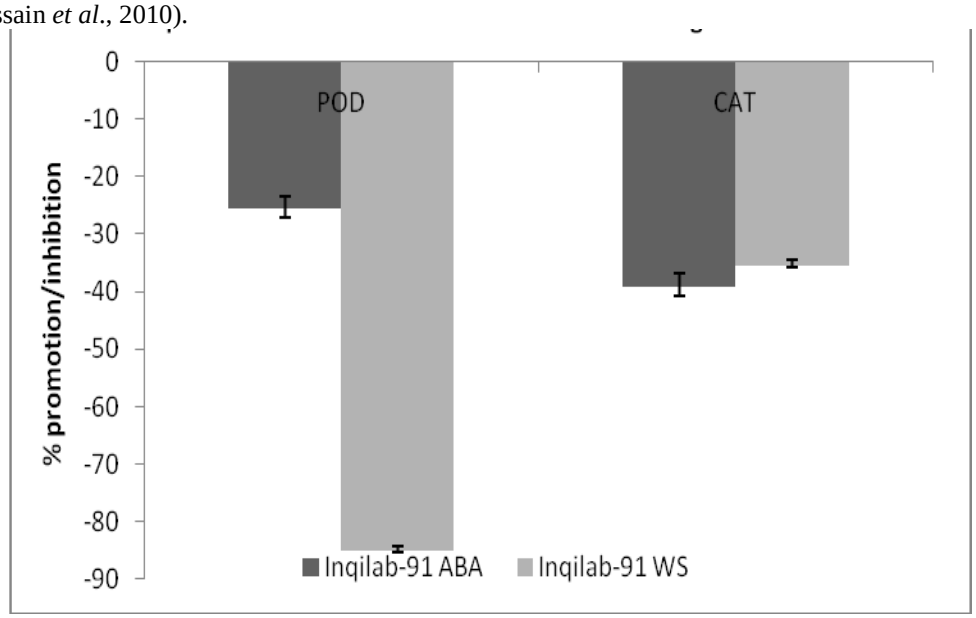

Fig.2. Percent promotion / inhibition in POD and CAT activity of 'Inqilab-91' under ABA and water stress condition against control.

ABA stress depicted increased CAT activity in 'Sarsabz' whereas decline activity was observed under water stress against control. Genotype 'Inqilab-91' showed decline activities of catalase under both stresses but maximum decline was noticed under water stress. ABA also promotes plant growth under non stressful condition and has shown to be essential for vegetative growth in several organs (Sharp *et al*., 2000; Cheng *et al*., 2002). Exogenous application of ABA enhances the tolerance of plants or plant cells to drought (Lu *et al*., 2009). Progressive water stress in wheat was induced by withholding irrigation for seven days at a fully expanded first leaf developmental stage. The comparison of antioxidant enzymes from control, ABA and water-stress revealed prominent effect in wheat seedlings. It is concluded that 'Sarsabz' reflected more tolerance with respect to antioxidant activities under ABA and water stress condition as compared to 'Inqilab-91'.

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