THINK INDIA JOURNAL

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Title

The Effect of Drought Stress on The Activity of Monoamine Oxidase in Different Wheat Cultivars

Authors

Gurmeen rakhra[1*], Arun dev sharma[2], Rajwinder kaur[2]

Addresses of the authors

[1]Department Of Biochemistry, School of Bioengineering and Biosciences, Lovely Professional University, Phagwara, India

[2]*P.G Department of Biotechnology, Lyallpur Khalsa College, G.T Road, Jalandhar-144001, Punjab, India*

***Corresponding author**:

[1]Department of Biochemistry, School of Bioengineering and Biosciences, Lovely Professional University, Phagwara, India

Email id: gurmeen.25169@lpu.co.in

Abstract

Drought is a major stress factor for plants leading to detrimental effects on the growth and yield of plants. As a consequence of drought stress, plants normal equilibrium get disturbed thereby leading to the host of changes at physiological and biochemical level. Monoamine oxidases (MAOs) are known to limit ROS under different stress perturbations, but research showing how boiling stable MAOs is regulated under drought is still a matter of conjuncture. Through this work, the changes in lipid peroxidation and boiling soluble MAOs were studied in the four wheat cultivars. Concomitant analysis of MDA contents and boiling soluble MAOs enzymes provided a view of the detoxifying potential under conditions of stress. Markers of oxidative stress viz. MDA content decreased under drought treatment depending upon the genotype. Based upon the results, it can be inferred that HD 2932 has more ability to combat the oxidative stress by increasing the biological anti-oxidative boiling stable monoamine oxidase activity.

Key Words: Antioxidants, Boiling soluble proteins(BSPs), Moanoamine oxidase

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Introduction

The big paradoxical question of: How do we adapt to and plan for uncertainty in the environment is becoming a nightmare for the farmers as well as agricultural biotechnologists throughout the world. Growth and yield of different crops is dramatically affected by plethora of environmental constraints due to regular changes in the weather pattern, with drought being the most devastating environmental cue decreasing crop yield greater than other abiotic stress factors [1]. It is anticipated that due to global warming, water deficit conditions would intensify,with rise from one to thirty percent in an intense drought prone land till the end of 21^{st} century[2].

ROS are unavoidable products of the metabolic pathways and electron transport systems linked to the cell membrane[3]. However, under the effect of stress conditions, the altered redox equilibrium results in the aggravated production of ROS ($O_2^{\cdot -}$, H_2O_2,$OH^{\cdot}$) [4]. The elevated levels of ROS oxidize proteins, damage nucleic acids, peroxides lipids, activate the apoptotic pathway ultimately leading to the cell death [5]. MDA (Malondialdehyde), being the most prominent lipid breakdown product, is regarded as a significant marker for oxidation of the lipids present in cell membranes [6]. To tackle the detrimental effects of ROS, plants have antioxidative machinery consisting of various enzymatic and non-enzymatic antioxidant molecules. Amine oxidases (AOs) including Monoamine oxidase (FAD dependent) are also considered to be a part of anti-oxidative machinery implicated in defense response besides stiffening of the cell wall [7]. Monoamine oxidase catalyzes the amines oxidation using O_2 as an electron acceptor resulting in the formation to the corresponding aldehyde and ammonia.

Few stress-induced antioxidant proteins are highly hydrophilic and have the tendency to remain stable and soluble even after the treatment of boiling, henceforth these are termed as “boiling soluble proteins” (BSPs), a term coined initially by [8]. Previous research findings have suggested that these BSPs epitomize less than one percent of the total protein content. Nevertheless, it signifies one of the prominent proteome part involved in imparting tolerance against abiotic and biotic constraints [9]. There have been several reports that authenticate the role of amine oxidases under stress but the role played by MAOs under oxidative stress conditions is still in its infancy. [10,11] documented the potential role of various amine oxidases in plants during biotic or abiotic conditions. Keeping this in mind, the study was

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

undertaken so as to have an insight into the role of boiling soluble MAO under different stress conditions followed by recovery in wheat cultivars. In present study, endosperms and embryos were extracted from four wheat cultivars at various drought intensities (2 h, 6 h, 24 h, and 48 h) followed by relieval of stress after post stress stage.

Materials and methods

Seedlings growth

Seeds of four wheat (*Triticum aestivum* L.) cultivars (HD2851, HD2932, HD2967 and HD3086) were selected for experimental purposes. The surface sterilization of the seeds was done using chemical disinfectants (mercuric chloride and 70% ethanol [12]. After this, the seeds were imbibed for 6 hr and then placed in Petri plates for germination at 25 ± 1°C for 24 hr. Stress was imposed by withholding water supply for 2hr(D2), 6hr(D6), 24hr(D24), 48hr(D48). After 48hr of drought stress treatment, stress was relieved by rewatering the seeds for 4hr (4PS). After different treatments, tissues were separated into embryo and endosperm and then kept for further experimental analysis. The Water content (WC) was calculated from the equation: **WC = fresh weight-dry weight/dry weight**

Boiling stable proteins extraction

Plant tissues were ground to fine slurry using 50 mM Tris- HCl buffer (pH-7.0). After centrifugation, some part of supernatant was collected and was labelled as untreated samples. The remaining supernatant was boiled for 10 minutes in boiling water bath, immediately kept in ice for 5 minutes and again centrifuged, then supernatant was collected which was labelled as the treated samples and stored at -20^{0}C for further analysis. The protein concentration was measured spectrophotometrically according to the method of [13] utilizing BSA as a standard.

Lipid peroxidation

Trichloroacetic acid (TCA)	10%
Thiobarbituric acid (TBA)	0.25%

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Lipid peroxidation was estimated by the level of malondialdehyde (MDA) produced by the thiobarbituric acid reaction [14].

***Monoamine oxidase activity**:*

The level of MAO activity in plant tissues was determined spectrophotometrically by the conversion of benzylamine to benzaldehyde following the method of [15] with some modifications. 1 ml reaction mixture contains (800- X)µl H2O, 5 mM benzylamine (100 µl), 100 mM phosphate buffer (100 µl) pH 7.2 and 120 µg protein sample (X). The formation of 0.15 µmol benzaldehyde results in an increase in absorbance at 250 mM of 1 unit. Therefore, specific activity was expressed as the mmol of benzaldehyde formed min^{-1} mg protein^{-1}(ε= 13800 M^{-1} cm^{-1}).

RESULTS

Variation in water content (Wc):

Water Content was determined in four cultivars of wheat (HD 2932, HD 2967, HD 2851, HD 3086). In embryo (Figure: 2-A) as compared with control, In cultivar HD 2851, a tremendous reduction in water content was observed at all drought stress stages of 2 hr, 6 hr, 24 hr, 48 hr. However, In cv HD 2932 and HD 3086 a significant decrease in drought stress stages was observed at 24 h and 48 hr of drought stress stages. Contrary to this, in cv HD 2967 a significant decrease in water content was observed at 6 hr and 48 hr of drought stress stages. upon relieving stress after 48 hr of drought stress marked increase in water content was observed in all cultivars.

In Endosperm (Figure: 2-B) Water Content value variable in a cultivar and drought stress dependent manner. As compared with control, In cv 2851 and HD 3086 significant decrease in water content was observed at 24 hr and 48 hr of drought stress stage contrary to this , in cultivars HD 2932 and HD 2967 significant decline in water content was observed at all drought stress stages. Upon relieving stress after 48 hr of drought stress, a significant increase in water content was observed in all cultivars.

Variation in protein content : TPC was determined in four cultivars of wheat (HD 2932, HD 2967, HD 2851, HD 3086). In embryo (Figure 3-A), as compared with control, in cv HD 2851 substantial increase in TPC was observed at 2 h, 6 h, 24 h, of drought stress. However as the severity of stress increased to 48 h, a marked significant decline in TPC was detected but it was still higher than control. In cultivar HD 2932 a significant increase was observed at

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ISSN: 0971-1260
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one day and two days of drought stress. On the other hand, in cultivar HD 3086 a significant increase was observed in TPC value at all stages of drought stress except at 2 h of drought stress. Contray to this in cv HD 2967 a significant decrease in TPC value was observed at 6 h, 24 h, of drought stress. Upon relieving stress after two days of stress treatment, a significant decline in TPC value was observed in the cvs HD 2851, HD 2967, HD 3086. Conversely, in the cv HD 2932 substantial enhancement was observed in TPC at 4 h of post stress.

In endosperm (Figure 3-B) TPC values were variable in a cultivars and drought stress stage dependent manner. In cv HD 2851 TPC decreased at all the stages with maximum decrease at 48h. In cv HD 2932, in comparison to the control, a significant decrease in TPC was observed only at 6 h of drought stress. Contrary to this, in cv HD 2967 marked significant increase in TPC was observed at 6 h of drought stress. However, in cv HD 3086 significant increase in TPC was observed at 2h and 6h stage of stress imposition. However, as the stress intensity increased at two days of drought stress, tremendous decrease in TPC was noticed. Upon relieving stress after two days of drought stress treatment, a significant decrease in TPC was observed in cultivar HD 3086. While in the remaining cultivars, it remained unchanged.

Change in MDA : MDA was determined in four cultivars of wheat (HD 2932, HD 2967, HD 2851, HD 3086). In Embryo (Figure 4-A) MDA values were variable in cultivar and drought stress stage dependent manner. In cv HD 2851, as compared to control, a marked decline in MDA was observed at 2 h of drought stress. However, as the severity of drought stress increased a marked significant increase in MDA content was observed at one day, two days of drought stress. In cv HD 2932 MDA content increased significantly at two days of drought stress stage. On the other hand in cv HD 2967, significant decline in MDA content was observed at low (6 h) and (medium) 24 h of drought stress stages. However in cv HD 3086 MDA content declined significantly at 24 h of drought stress stage. Upon relieving stress after 48 h of drought stress a significant decrease in MDA content was found in all cultivars.

In endosperm, MDA (Figure- 4 B) values were observed in four different cultivars of wheat. In cv HD 2851 and cv HD 2932, as compared to control, an increase in MDA content was found at 48 h of drought stress stage. However in cv HD 3086, decrease was observed in MDA value at all stages of drought stress, except at 6 h of drought stress stage. Contrary to this in cv HD 2967, as compared to control, an increase in MDA value was observed at 48 h of the drought stress stage. Upon relieving stress after 48 h of stress stages, in cultivars HD 2851, HD 2932 and HD 3086 MDA content increased significantly.

Change in MAO activity :

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ISSN: 0971-1260
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BsMAO activity was determined in four cultivars of wheat HD 2932, HD 2967, HD 2851 and HD 3086. In embryo (Figure 5-A), as compared with control, in cultivars HD 2851, decrease in BsMAO activity was recorded at 6 h, 24 h, 48 h drought stress stages, while in cv HD 3086 , a tremendous decline in BsMAO activity was observed at 6 h of drought stress stage. Contrary to this, in cv. HD 2932 a significant decrease in BsMAO activity was observed at 6 h of drought stress stage, Contrary to this in cv HD 2967 significant increase in BsMAO activity was observed at 24h and 48 h of drought stress stages, But BsMAO activity decreased significantly at 6 h and 24 h of drought stress stages in this cultivar. Upon relieving stress after 48 h of drought stress,in cv HD 2851 a significant decrease in BsMAO was observed. Contrary to this, in cv HD 2967 as compared with control, BsMAO activity increased significantly.

In endosperm (Figure 5-B) , as compared with control, in cv HD 2851 BsMAO value increased significantly at one day and two days of drought stress stages, while in cv HD 2932 BsMAO value, increased tremendously at 2 h and 6 h of drought stress stages. contrary to this, in cv HD 3086 a significant decrease in BsMAO was observed at 2 h of drought stress stage. On the other hand, in cv HD 2967, nil value of BsMAO was observed at all drought stress stages. Upon relieving stress after 48 h of drought stress, in cultivar HD 2851, marked decline in BsMAO activity was observed. Contrary to this, in cv HD 3086, we observed a significant increase in BsMAO activity.

Discussion

***Variation in water content*:** Water Content was determined in four cultivars of wheat HD 2932, HD 2967, HD 2851, HD 3086. In the present study, in embryo and endosperm (figure 2- A and B) as compared with control, water content decreased significantly under drought in a stress stage dependent manner in all cultivars. Previous research findings also indicated that in response to drought, WC reduced in different crop species ([16,17]. Upon relieving stress after 48 h, a significant increase in water content was observed.

***Variation in TPC*:**

A study by [18] has reported that stress conditions affect expression of genes and synthesis of proteins. In the present study it is observed that change in TPC were variable in cultivar, tissue dependant manner. TPC was observed in both embryo and endosperm of four different cultivars under drought stress. In embryo (Figure 3-A) of wheat cultivars as compared with

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

control, a significant increase in TPC was observed in cultivars HD 2932, HD 2851, HD 3086 at the drought stress stages. Consistent with these finding, [19] also reported that the leaf proteins increased during severe drought. Contrary to this in cv.HD 2967 TPC content decreased significantly at 6h, 24 h of drought stress stage. The heightened proteolytic and catabolic activity along with lethal ROS levels result in the degradation of protein. The variations in total soluble proteins under drought stress were consistent with the findings of [20] in maize. During post stress period as compared with control TPC content decreased considerably in all cultivars except 2932 . The reduction in TPC has been previously reported in other species like mulberry[21].

In Endosperm, as compared with control a significant decrease in TPC content was found in HD 2851 and HD 2932 cultivars at all drought stress stages. In agreement with the results [22] also reported decline in total protein content under water deficits. Contrary to this, in cultivar HD 3086 increase in TPC was observed at drought stress stages of 2 h and 6 h. [23] study reported augmentation in soluble protein content following water stress. The elevated TPC under drought conditions can be the result of activation of some genes coding for BSPs under drought stress conditions. Upon relieving stress, as compared with control, in cv 3086 TPC content decreased significantly.

***Changes in MDA content* :**

In the present study, MDA content in embryo and endosperm is detected (Figure 4- A and B). In embryo of four wheat cultivars (HD 2932, HD 2967, HD 2851, HD 3086), In cultivars 2851 and 2932, in comparison to control, a remarkable decline in MDA content was observed. These results were in agreement with previous studies by [24],[25],[26], who found that low MDA levels are a result of tolerance towards drought in artichoke plans, common beans, and wheat, respectively. In cultivars HD 2851 and HD 2932, as the severity of drought increased , MDA content increased with increase in intensity of drought. It has been reported that water stress increased the lipid peroxidase productions in leaves of stressed *Phaseolus vulgarism* plants [27]. During post stress stage, as compared with control decrease in MDA content was observed in all cultivars.

In endosperm (Figure 4- B) of wheat cultivars as compared with control, in cultivars HD 2851, HD 2932 and HD 2967 MDA content increased significantly drought stress stage of 48 h. [28] reported that in Marigold, lipid peroxidation in both the leaves and petals increased in drought stress response. At post stress stages MDA content increased significantly in

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ISSN: 0971-1260
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cultivars HD 2851, HD 2932, HD 3086 and these findings corroborate the previous findings by [29] who also reported an increase in MDA content upon stress relieval.

***Change in MAO acitivity*:** In spite of the fact that different stress conditions induce the expression of different antioxidative enzymes, nevertheless the functional delinearity of boiling soluble MAOs under water stress and recovery has not been much highlighted. So in order to gain further insight into the biochemical role of boiling stable MAO (BsMAOs), we studied the effect of drought on the expression of BsMAO in different cultivars of wheat (HD 2932, HD 2967, HD 2851, HD 3086). In present study, in embryo (Figure 5-A) in cultivar HD 2967, a significant increase in BsMAO activity was observed at 24 h of drought stress. It is noteworthy here that the MDA level decreased in the cultivar 2967 at 24 h of drought stress so there was a negative correlation between MDA content and BsMAO activity. Based upon our findings, it is hypothesized that BsMAO might be acting as antioxidants to decrease the MDA content resulting from increased ROS under stress. On removal of drought stress after 48 h, in cv. HD 3086 BsMAO activity increased significantly. Previous study have also depicted that the activity of different antioxidants might be greater for the recovery period as compared to stress as observed in pea [30]. Contrary to this in cv. HD 2851, BsMAO activity decreased significantly.

In endosperms (Figure 5-B), a significant increase in BsMAO activity was observed in cultivars HD 2851, HD 2932, HD 3086 in a stage dependent manner. Previous findings have indicated that plant amine oxidases, including monoamine oxidases are involved in various defense mechanisms by the synthesis of different secondary metabolic compounds [31]. A major function of amine oxidases in plants has been proposed to be H_2O_2 production, which has a role in wound healing through lignification of the cell wall matrix by a restructuring phenomenon during normal growth as well as under stress n removal of stress after 48 h of drought stress in cv. HD 2967, BsMAO activity increased significantly. This throws light on the basic mechanisms that preserves the protein integrity besides enabling repair upon relieval of stress. This emphasizes that stress induces the expression of various antioxidative enzymes which ‘strengthens’ the crops for future stress conditions and this seems to be fundamental for the recovery phase.

Conclusions

The findings of the study depicted that water stress induces the oxidative stress in different wheat cultivars. The damage to the wheat cultivars was there as seen by decreased WC, variable MDA levels (i.e., lipid peroxidation) and heightened BsMAO enzyme activities. Higher BsMAO activity confirmed their role for survival under drought-induced oxidative

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

stress. Findings of the study established enhanced BsMAO activities during oxidative stress in a plant genotype dependent manner. Among the four cultivars, under drought stress, HD 2932 displayed a much more pronounced antioxidative mechanisms and therefore, they were sheltered from the harmful effects of water stress even at an increased stress severity. Therefore, these findings could be utilized as biochemical marker while breeding oxidative stress tolerant high yielding crops in arid regions.

References

[1] Gilliham M, Able JA and Roy SJ (2017).Translating knowledge about abiotic stress tolerance to breeding programmes. The Plant Journal 90: 898-917.

[2] Schlaepfer DR, Bradford JB, Lauenroth WK, Munson SM, Tietjen B, Hall SA, Wilson SD, Duniway MC, Jia G, Pyke DA, Lkhagva A and Jamiyansharav K (2017). Climate change reduces extent of temperate drylands and intensifies drought in deep soils. Nature Communications 31: 14196-204

[3] Bi YH, Chen WL, Zhang WN, Zhou Q, Yun LJ and Xing D (2009). Production of reactive oxygen species, impairment of photosynthetic function and dynamic changes in mitochondria are early events in cadmium induced cell death in Arabidopsis thaliana. Biology of Cell 101: 629-643.

[4] Gao CJ, Xing D, LI L, Zhang LR (2008): Implication of reactive oxygen species and mitochondrial dysfunction in the early stages of plant programmed cell death induced by ultraviolet-C overexposure. Planta 227: 755-767.

[5] Sharma AD, Rakhra G, Singh J (2012). Expression analysis of BsAPase14 acid phosphatase, a stress responsive boiling-stable protein from *Triticum aestivum*. Journal of Crop Science and Biotechnology 15: 41-45.

[6] Goel A, Sheoran IS (2003). Lipid peroxidation and peroxide scavenging enzymes in cotton seeds under natural ageing. Biologia Plantarum 46: 429-434**.**

[7] Cona A, Cencif F, Cervelli M, Federico R, Mariottini P, Mareno S and Angelini R (2003). Polyamine oxidase, a hydrogen peroxide-producing enzyme, is up-regulated by light and down-regulated by auxin in the outer tissues of the maize mesocotyl. Plant physiology 131: 803-813.

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ISSN: 0971-1260
Vol-22-Issue-17-September-2019

[8] Jacobsen JV and Shaw DC (1989). Heat stable proteins and Abscisic acid action in barley aleurone cells. Plant Physiology 91: 1520-1526.

[9] Battaglia M, Olvera-carrillo Y, Garciarrubio A, Campos F and Covarrubias A (2008). The Enigmatic LEA Proteins and Other Hydrophilins. Plant Physiology 148: 6-24

[10] Ghuge SA, Tisi A, Carucci A, Pousada RAR, Franchi S, Tavladoraki P, Angelini R and Cona A (2015). Cell wall amine oxidases new player in root xylem differentiation under stress conditions. Plants 4: 489-504.

[11] Lim TS, Chitra TR, Han P, Pua EC and Yu H (2006): Cloning and characterization of Arabidopsis and Brassica juncea flavin-containing amine oxidases. Journal of experimental Botany 57: 4155-4169.

[12] Rakhra G, Sharma AD, Singh J(2015). Drought-induced changes in the accumulation of boiling-soluble proteins (p40, GST, HSP90) in the grains of drought-tolerant and drought-sensitive cultivars of *Triticum aestivum*. Crop and Pasture Science 66: 904-911.

[13] Lowry OH, Rosebrough NJ, Farr AL and Randall RJ (1951). Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry 193: 265-75.

[14] Dhindsa RS, Plumb-Dhindsa P, Thorpe T(1981). Leaf senescence: correlated with increased levels of membrane permeability and lipid peroxidation, and decreased levels of superoxide dismutase and catalase. Journal of Experimental Botany 32, 93–101.

[15] Schnaitman C, Erwin VG, Greenawalt J(1967). The submitochondrial localization of monoamine oxidase. The journal of cell biology 32: 719-735.

[16] Sanchez-Blanco MJ, Rodrgiuez P, Morales MA, Ortuo MF, Torrecillas A (2002). Comparative growth and water relations of *Citrus albidus* and *Citrus monspeliensis* plants during water deficit conditions and recovery. Plant Science, 162:107-113.

[17] Chakraborty U, Pradhan B (2012): Oxidative stress in five wheat varieties (*Triticum aestivum* L.) exposed to water stress and study of their antioxidant enzyme defense system. water stress responsive metabolites and H_2O_2 accumulation. Brazilian Society of Plant Physiology 24:17-130.

[18] Lobato AKS, Santos BG, Costa RCL, Oliveir ACF, Meirelles ACS, Cruz FJR, Alves Gar, Neves HKB, Pita JD, Lopes MJS, Freitas JMN, Monteiro BS, Ferreira RR (2008). Physiological and biochemical changes in soybean (Glycine max) plants under progressive water deficit during the vegetative phase. Journal of Agricultural, 3: 327-333.

[19] Jiang Y, Huang B(2002). Protein Alterations in Tall Fescue in Response to Drought Stress and Abscisic acid. Crop Science 42: 202-207.

Copyright © 2019 Author

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

[20] Nayer M and Reza H(2008). Drought-induced Accumulation of Soluble Sugars and Proline in Two Maize Varieties. World Applied Sciences Journal 3: 448-453

[21] Chaitanya V, Sundar D, Masilamani S(2002).Variation in heat stress-induced antioxidant enzyme activities among three mulberry cultivars. Plant Growth Regulation 36: 175-180.

[22] Salekjalali M, Haddad R and Jafari B(2012). Effects of Soil Water Shortages on the Activity of Antioxidant Enzymes and the Contents of Chlorophylls and Proteins in Barley. American-Eurasian Journal of Agriculture and Environmental Science 12: 57-63

[23] Lee DH, Lee CB (2000): Chilling stress-induced changes of antioxidant enzymes in the leaves of cucumber: in gel enzyme activity assays. Plant Science 159:75-85.

[24] Sairam RK., Saxena DC (2000). Oxidative stress and antioxidants in wheat genotypes: possible mechanism of water stress tolerance. Journal of Agronomy and Crop Science 184:55-61.

[25] Terzi R and Kadioglu A (2006). Drought stress tolerance and the antioxidant enzyme system in *Ctenanthe setosa*. Acta Biologica Cracoviensia 48: 89-96**.**

[26]Zhang MD, Chen Q, Shen SH (2011). Physiological responses of two Jerusalem artichoke cultivars to drought stress induced by polyethylene glycol. Acta Physiologia Plantarum, 33:313-318.

[27] Zlatev ZS,Lidon FC, Ramalho JC and Yordanov IT(2006). Comparison of resistance to drought of three bean cultivars. Biologia plantarum 50: 389-394.

[28]Tian Z, Wang F, Zhang W, Liu C and Zhao X (2012). Antioxidant mechanism and lipid peroxidation patterns in leaves and petals of marigold in response to drought stress. Horticulture, Environment, and Biotechnology 53: 183-92.

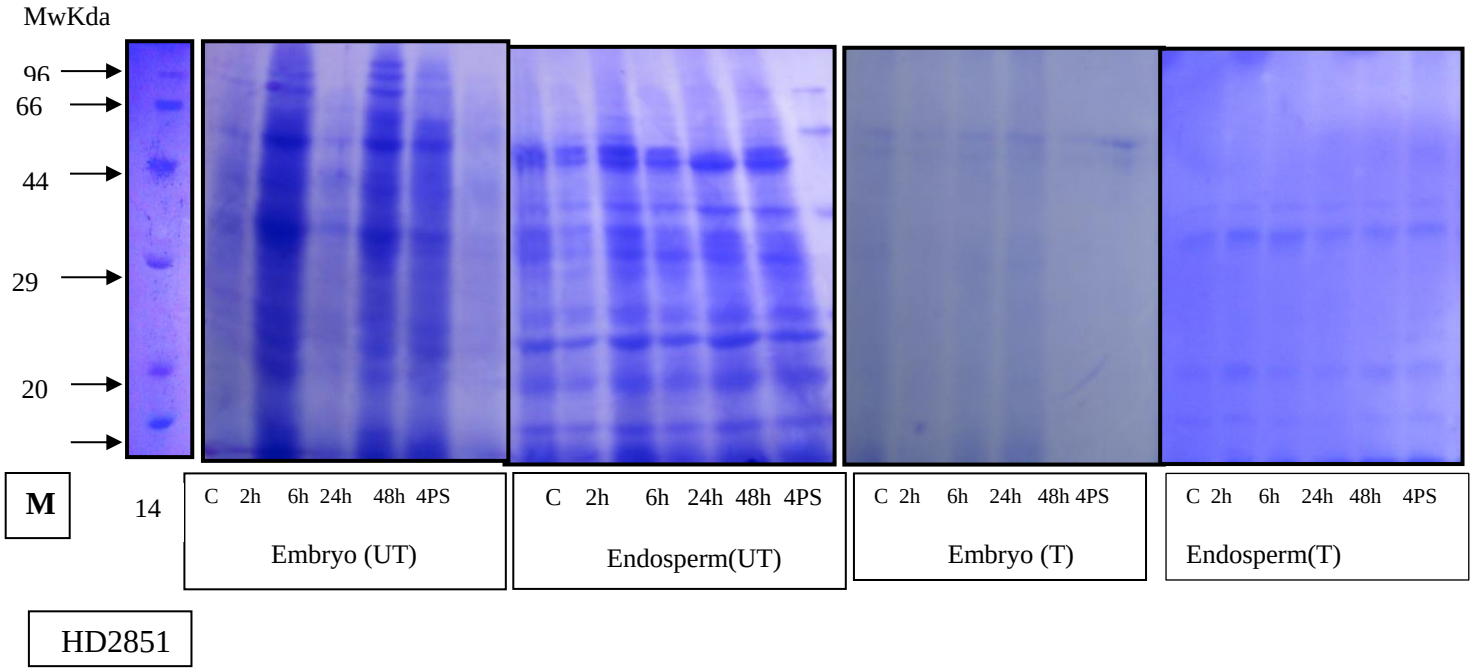
[29]Simova-Stoilova LE, Demirevska K ,Petrova T, Tsenov N, Feller U (2009). Antioxidative protection and proteolytic activity in tolerant and sensitive wheat (*Triticum aestivum* L.) varieties subjected to long-term field drought. Plant Growth Regulation 58:107–117

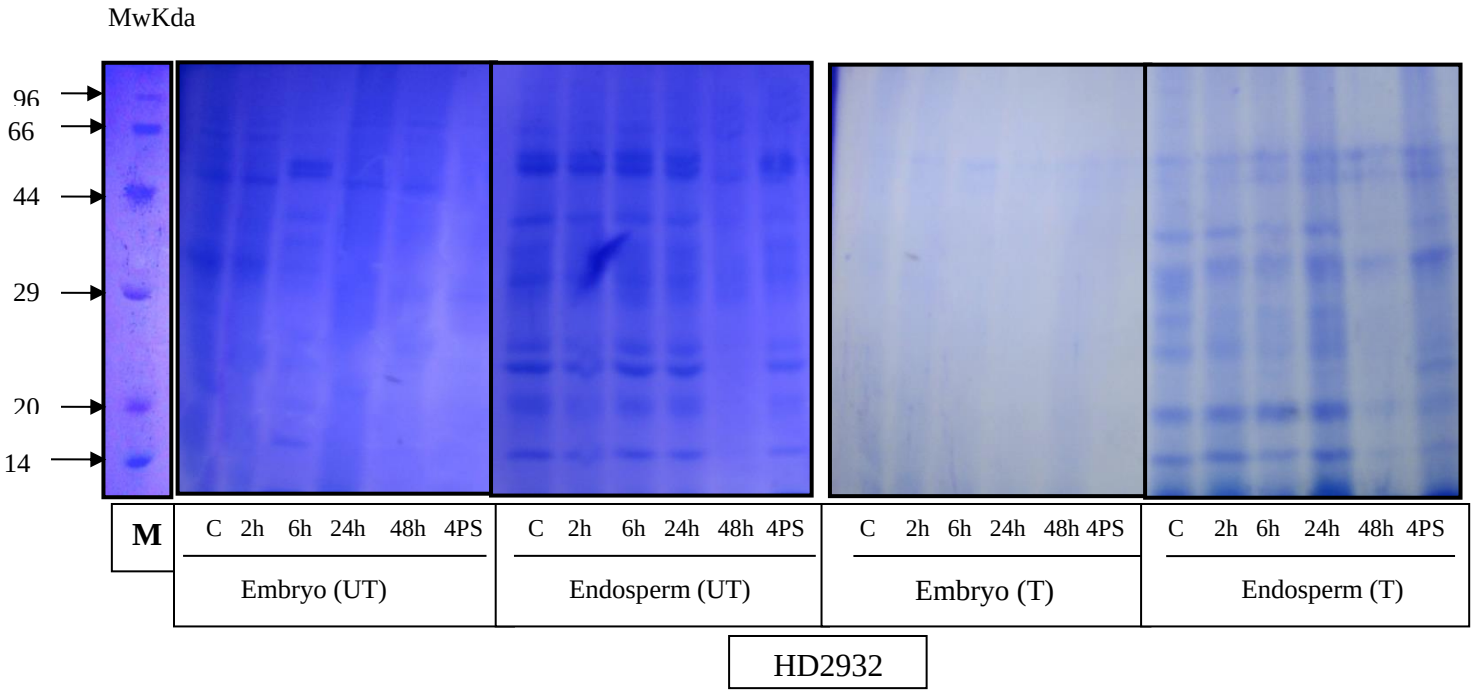
[30]Ratnayaka HH, Molin WT, Sterling TM (2003). Physiological and antioxidant responses of cotton and spurred anoda under interference and mild drought. Journal of Experimental Botany 54: 2293-2305.

Copyright © 2019 Author

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

[31]Verma and Sharma S (2010. Role of H_2O_2 and cell wall monoamine oxidase in germination of *vigna radiata* seeds. Indian journal of biochemistry and biophysics 47:249-253.





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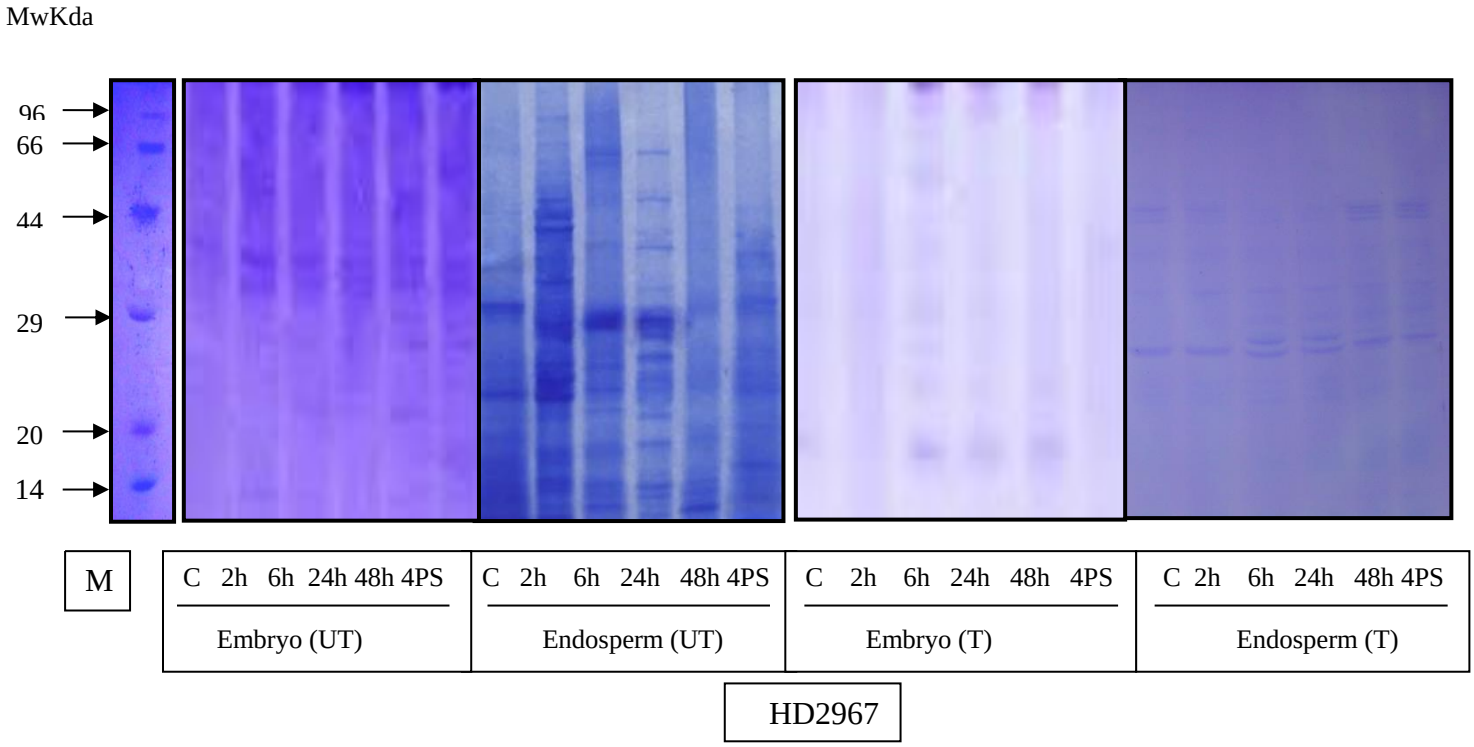

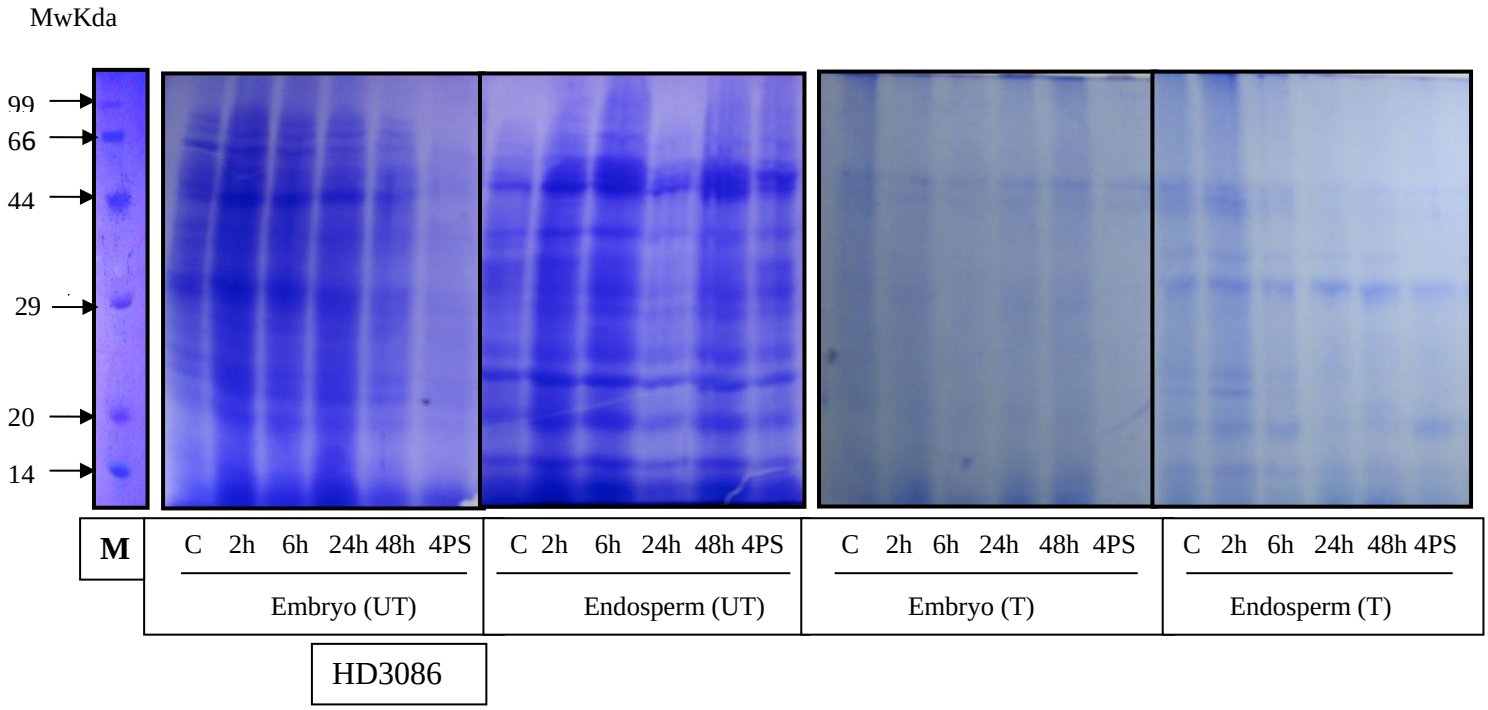

Fig. 1: An **SDS PAGE** profile of proteins in embryo and endosperm of four different cultivars (HD2851, HD2932, HD2967 and HD3086) of *T. aestivum* harvested at different stages (C, 2h, 6h, 24h, 48h) followed by recovery at 4PS repectively under drought stress conditions. Each lane loaded with 120µg of protein sample. Symbols used: M: marker, C: control, 2h: 2hours, 6h, 6hours, 24h: 24hours, 48h: 48hours of drought stress treatment, 4PS: 4 hours of post stress , UT: untreated protein samples, T: treated protein samples.

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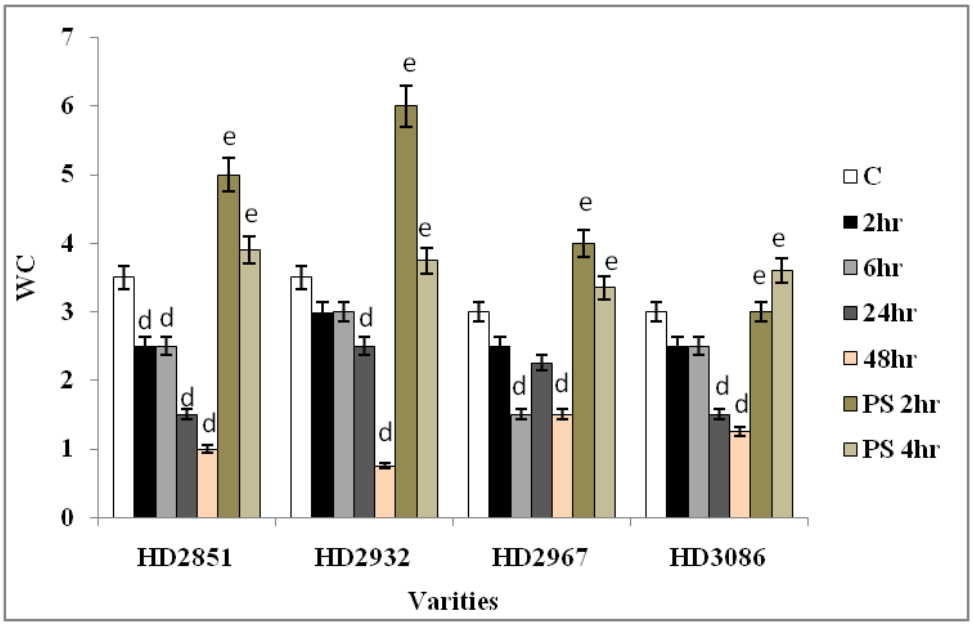
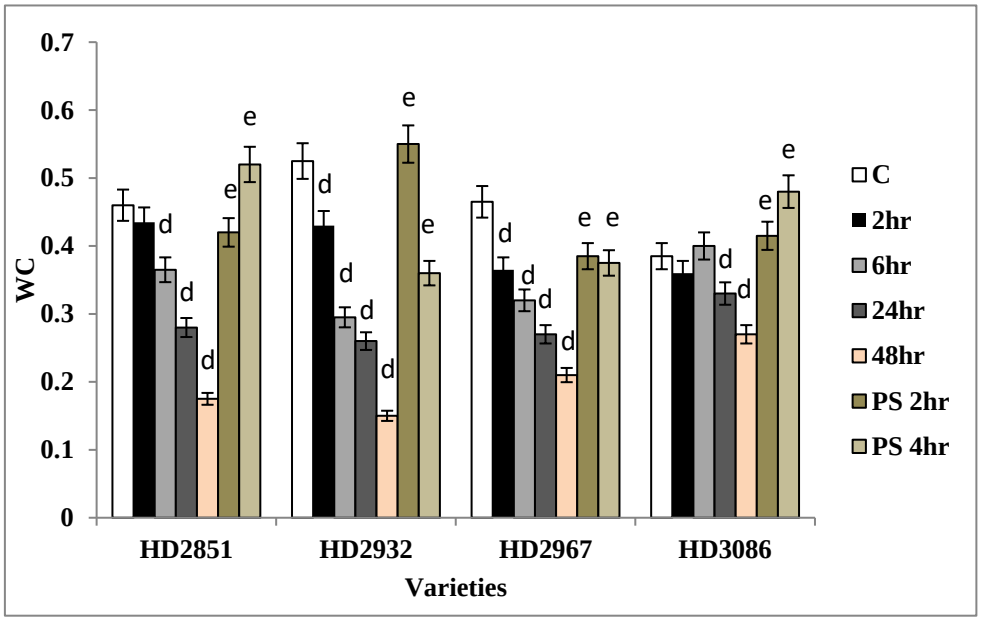


A.



B.

Figure 2 : Water Content in Embryo(A) and Water Content in Endosperm(B) in four different wheat cultivars under control and different drought stress treatment. Symbol used: C-Control, 2hrs- 2hrs drought, 6hrs-6hrs drought, 24hrs-24hrs drought, 48hrs-48hrs drought, PS-Post Stress. Data shown are average ± SE. [d.]indicates significant difference between C v/s 2hrs-48hrs at P≤0.05. [e.]indicates significant difference between 48hrs v/s PS 2hrs-PS 4hrs at P≤ 0.05

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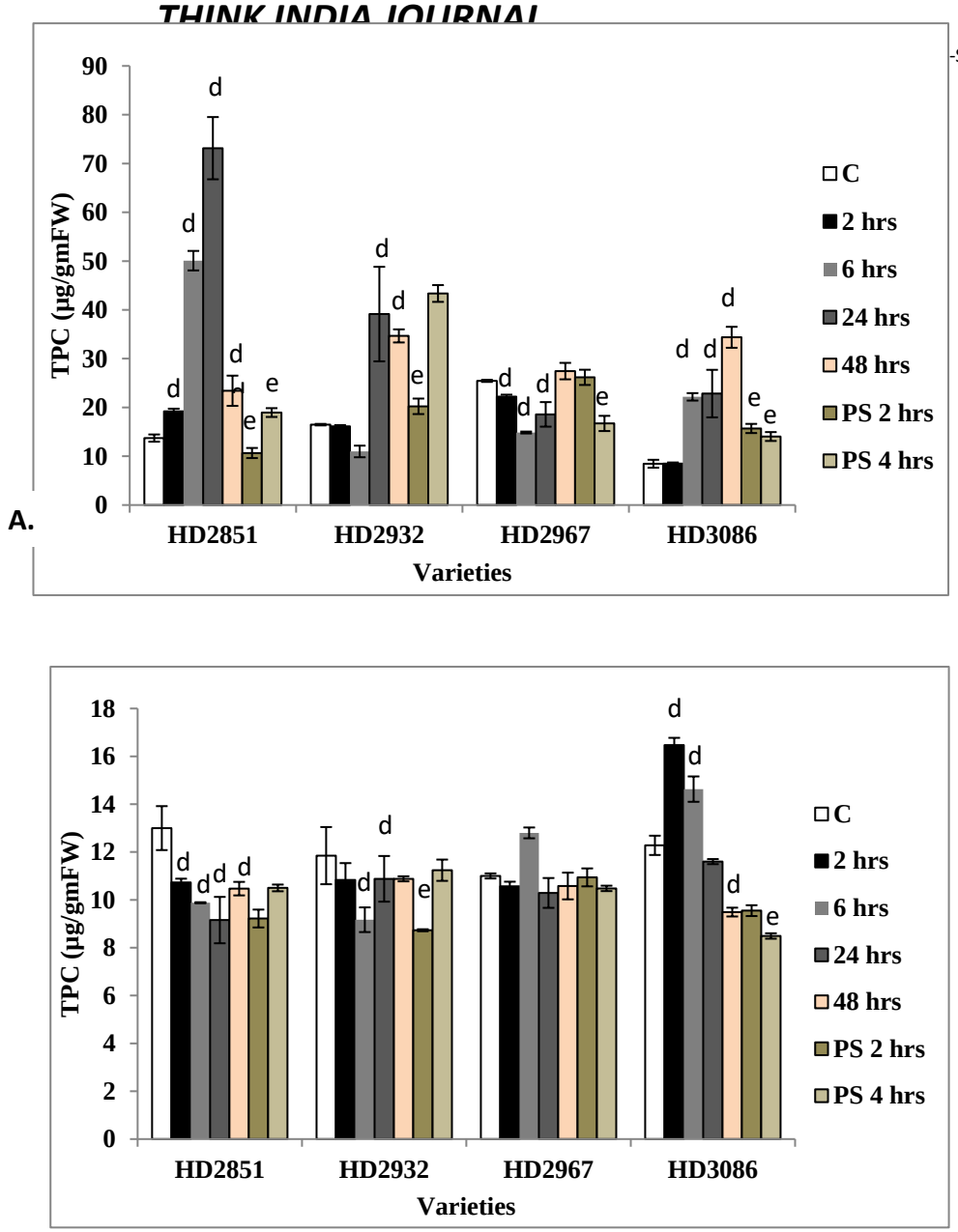

Figure 3 : TPC in Embryo(A) and TPC in Endosperm(B) in four different wheat cultivars under control and different drought stress treatment. Symbol used: C-Control, 2hrs- 2hrs drought, 6hrs-6hrs drought, 24hrs-24hrs drought, 48hrs-48hrs drought, PS-Post Stress. Data shown are average ± SE. [d.]indicates significant difference between C v/s 2hrs-48hrs at P≤0.05. [e.]indicates significant difference between 48hrs v/s PS 2hrs-PS 4hrs at P≤ 0.05.

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ISSN: 0971-1260
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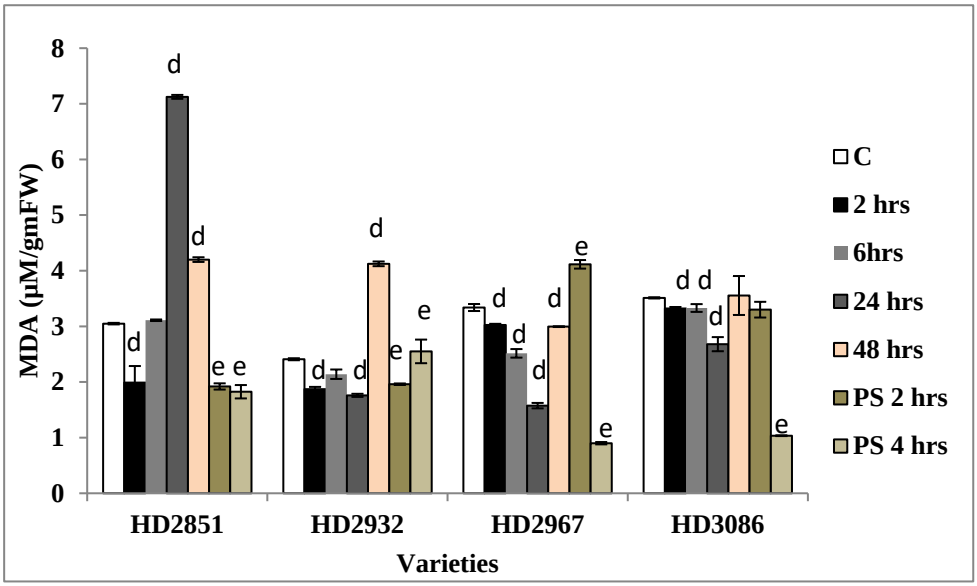
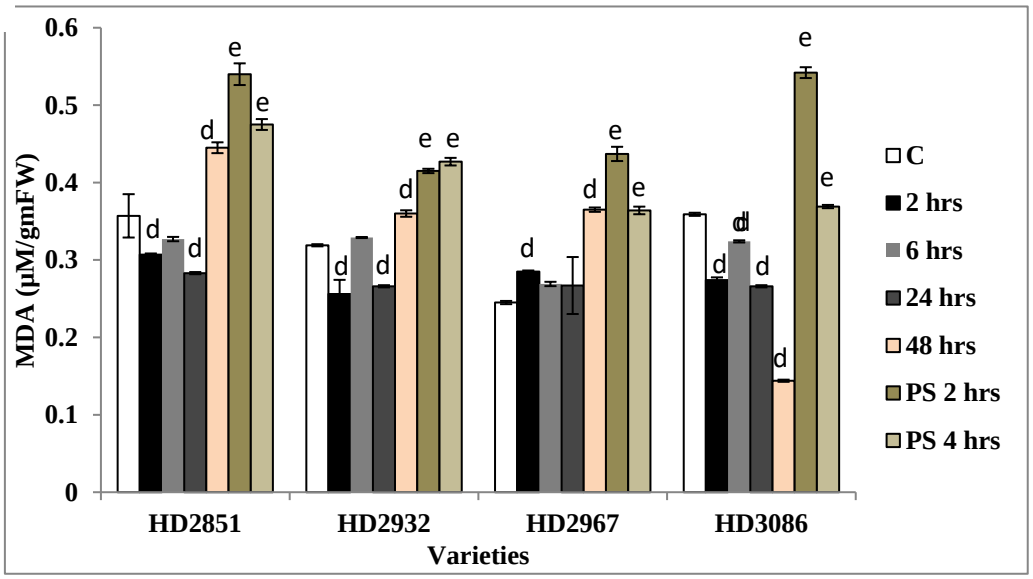


A.



B.

Figure 4 : MDA Content in Embryo(A) and MDA Content in Endosperm(B) in four different wheat cultivars under control and different drought stress treatment. Symbol used: C-Control, 2hrs- 2hrs drought, 6hrs-6hrs drought, 24hrs-24hrs drought, 48hrs-48hrs drought, PS-Post Stress. Data shown are average ± SE. $^{d.}$indicates significant difference between C v/s 2hrs-48hrs at $P \leq 0.05$. $^{e.}$indicates significant difference between 48hrs v/s PS 2hrs-PS 4hrs at $P \leq 0.05$.

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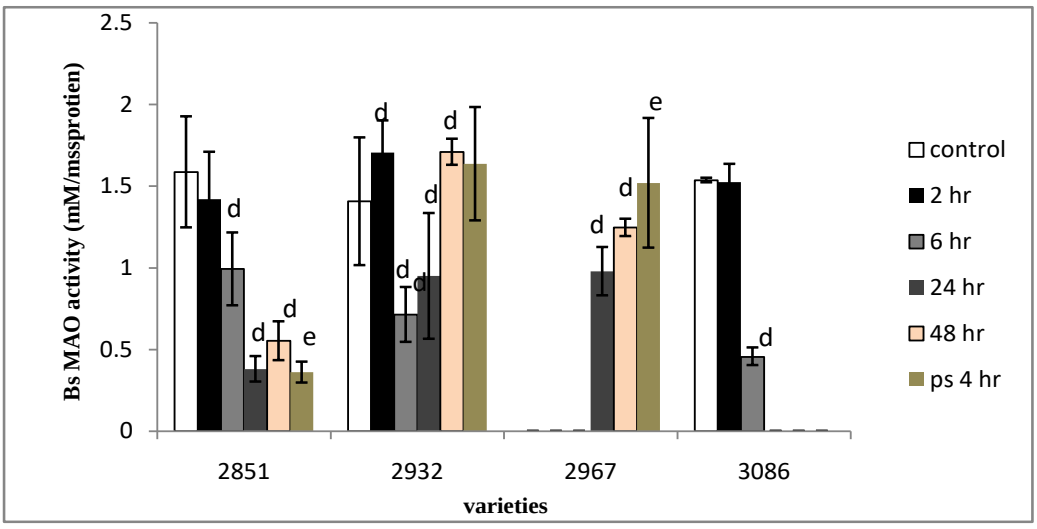
A.



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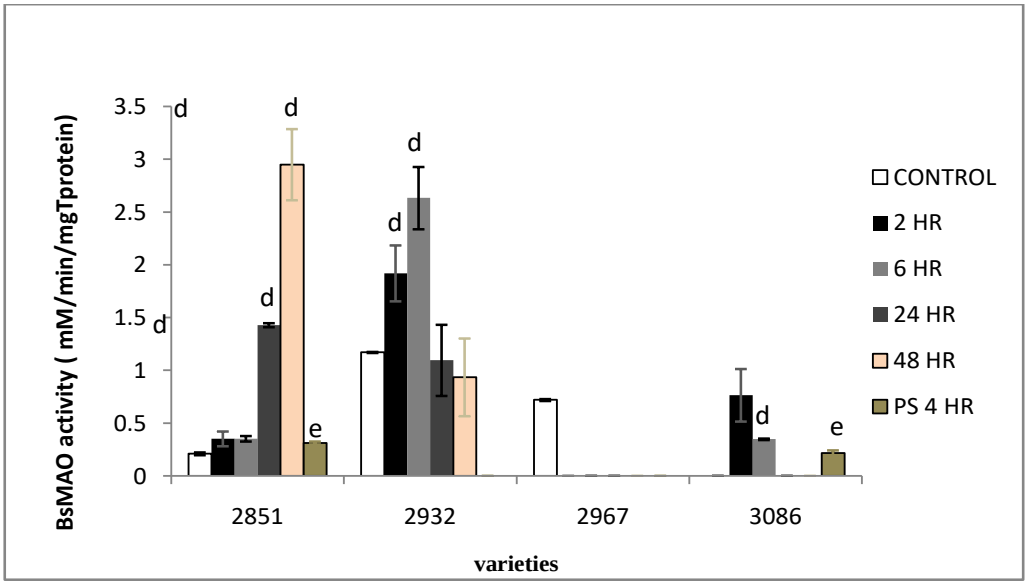

Figure 5 : MAO activity in Embryo (A) and Endosperm (B) in four diff cultivars under control and different drought stress treatment. symbol used : c- control, 2 hr- 2 hr drought stress, 6 hr- 6 hr drought stress, 24hr- 24 hr drought stress , 48 hr- 48 hr drought stress, PS – post stress. . Data shown are average ± SE. ^{d} indicates significant difference between C v/s 2hrs-48hrs at P≤0.05. ^{e} indicates significant difference between 48hrs v/s PS 2hrs-PS 4hrs at P≤ 0.05.

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