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RESPONSE OF WHEAT (*TRITICUM AESTIVUM* L. VAR. GALAXY-2013) TO PRE-SOWING SEED TREATMENT WITH THIOUREA UNDER DROUGHT STRESS

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Abstract

A pot experiment was performed to assess the effect of thiourea (TU) as pre-sowing seed treatment to wheat (*Triticum aestivum* L.) under drought stressed conditions. Seeds of wheat variety named Galaxy-2013 were soaked in various TU levels such as non-soaking (control), water-soaking, 0.1 mM and 1.0 mM thiourea for 12 hours. Drought stress treatments i.e., non stress (100 % field capacity), moderate drought stress (70% FC) and severe drought stress (50% FC) were applied to one week old wheat seedlings. Data of different growth and physicochemical parameters was taken of seven-week-old wheat plants whereas yield was taken at the maturity stage. Drought stress considerably reduced shoot fresh weight, dry weight of shoot, fresh weight of root, shoot length, root length, grain yield plant^{-1}, 100-grain weight, number of grains plant^{-1}, total phenolics and total flavonoid contents, while increased hydrogen peroxide (H_2O_2), proline and glycinebetaine contents. Pre-sowing seed treatment with varying levels of thiourea showed differential effect under drought stress or non stress conditions e.g., under moderate drought stress (70% FC) both 0.1 mM and 1.0 mM TU increased shoot dry weight and decreased total phenolic contents. Furthermore, 0.1 mM TU enhanced root dry weight, while 1.0 mM TU increased proline contents. In conclusion, hydro-priming proved more effective in increasing shoot and root fresh and dry weights, shoot length, total leaf area plant^{-1}, grain yield and number of grains plant^{-1} in wheat var. Galaxy-2013 plants under drought stress or non stress conditions.

Key words: Proline, Total phenolics, Grain yield plant^{-1}, Hydrogen peroxide, Hydro-priming.

Introduction

Drought stress is one of the major abiotic factors that reduces plant water status, obstructs photosynthesis, brings oxidative stress, limits growth and finally leads to the reduction of crops yield (Wang *et al*., 2018; Feng *et al*., 2021). Water scarcity seems to be accelerated under the present changing climatic conditions globally (Noman *et al.,* 2018). Drought is predictable to be more recurrent, lengthier, and occurring prior to exert adverse effects on the yield of cool-season crops such as wheat (*Triticum* spp.) worldwide (ElBasyoni *et al.,* 2017). Wheat (*Triticum aestivum* L.) is being grown in almost all around the world and it signifies a major source of staple food crop (Strugnell, 2018). It has been reported that drought stress decreased more than 50% of mean yield of important food crops globally (Zlative and Lidon, 2012). In emerging countries, nearly 32% wheat varieties suffer various kinds of drought stress at different growth stages (Morris *et al.,* 1991).

Water stress leads to change in membrane permeability, cellular osmotic imbalance and cause oxidative stress (Kumar *et al.,* 2017). Antioxidant defense system protects plants from harmful effects of reactive oxygen species (ROS) (Klein *et al.,* 2018). Plants minimize the effects of ROS by synthesizing enzymatic and non-enzymatic antioxidant species; non-enzymatic contents include phenolics, ascorbic acid, flavonoids, and carotenoids etc. (Akram *et al.,* 2017; Ashraf *et al.,* 2018).

Seed soaking with numerous priming agents (organic and inorganic compounds) has developed as a promising strategy to persuade tolerance in plants under abiotic stresses (Ashraf *et al.,* 2018; Akram *et al*., 2018; Aziz *et al*., 2018; Kaya *et al*., 2018). Seed soaking is a measured hydration practice that break seed dormancy and allows synchronized germination of seed with lessened emergence period of sprout and accretion of key metabolites for osmotic up regulation (Burgass & Powell, 1984; Bray *et al.,* 1989; Naresh *et al.,* 2018). It has been reported that pre-soaking seed treatment with thiols enhanced the antioxidant defense system and photosystem activities in wheat under water deficit conditions (Nathawat *et al.,* 2007).

Thiourea (TU) is a non-physiological thiol which is used for the developments of crop plants and induces stress resistance to plants under stressful environments (Sahu *et al*., 2006). Thiourea acts as a bio-stimulator that is active for decreasing the effects of abiotic factors. Foliar application of thiourea enhances the mechanism of photosynthesis in *Cyamopsis tetragonoloba* plants (Garg *et al*., 2006). Treatments of TU to plants regulate different mechanisms in plants and restrict the adverse influence of salt stress (Srivastava *et al.,* 2010). Thiourea significantly enhanced quality and nutritional significance of grains of wheat plants by enhancing protein, oil % age, total solube sugars and free amino acids (Amin *et al*., 2016). It has been found that foliar application of thiourea increased growth and chlorophyll contents in maize (*Zea mays* L.) (Perveen *et al.,* 2013) and sesame (*Sesame indicum* L.) plants (Kumar *et al*., 2018). Pre-sowing seed treatments with thiourea (1.0%) significantly affected seed germination percentage and growth parameters in custard apple (*Annona squmosa*) plant (Mane *et al.,* 2018) and mango *(Mangifera indica)* stones (Patel *et al.,* 2017). Moreover, positive effect of thiourea has been shown in enhancing photosynthetic rates, chlorophyll and starch in clusterbean (*Cyamopsis tetragonoloba* L.) under rainfed conditions (Garg *et al.,* 2006).

Due to protective functions against abiotic stresses thiourea has been used as seed treatments. Prime objective of current study was to explore the effect of

pre-sowing seed treatment with thiourea on growth, yield, membrane permeability, photosynthetic pigment, activities of enzymatic and non-enzymatic antioxidant enzymes, total phenolics, flavonoids, total soluble sugars, total free amino acids, free proline and glycinebetaine contents of wheat (var. GALAXY-2013) under drought stress and to check the response of wheat to various concentration of thiourea under drought stress or non stress conditions.

Materials and Methods

An experiment was conducted to assess the effect of different concentrations of thiourea (TU) as pre-sowing seed treatment under different levels of drought stress on wheat (*Triticum aestivum* L.). Seeds of wheat variety named Galaxy-2013 were acquired from Ayube Agricultural Research Institute (AARI), Faisalabad, Pakistan. Seeds were soaked in water and 0.1 and 1 mM concentration of TU solutions for 12 hours and dried under shade to bring seeds to original weight. After this, non-primed (control), presoaked seeds in water (hydro-primed), 0.1and 1.0 mM solutions of TU treated seeds were sown in sand filled plastic pots. Thinning was performed to one week old seedling to maintain 6 plants per pot. Three drought stress levels i.e., normal irrigation (100% field capacity), moderate drought stress (70% FC) and severe drought stress (50% FC) were applied to one week old plants. Wheat plants grown under normal irrigation, moderate and severe drought stress condition were nourished by full strength Hoagland's nutrient solution. Data of various growth and physicochemical parameters was collected of 7 week old wheat plants but yield was taken at maturity.

Measurements of growth and physiochemical parameters: Plants were carefully uprooted and washed the roots with distilled water then shoot and root lengths in centimeters and shoot and root fresh weights in gram were measured. The same plants were air-dried under shade for one week and then oven-dried at 72ºC for 48 hours and root and shoot dry weights (g) were measured.

Measurement of total leaf area: Carleton and Foote (1965) protocol was used for the measurement of total leaf area per plant (cm^2) using formulae maximum leaf length × leaf width × correction factor (0.75).

Determination of yield parameters: At maturity stage yield parameters were taken. Two plants were taken from each experimental unit. Note the number of tillers $plant^{-1}$, number of grains $plant^{-1}$ and their weight. Weighed ten seeds then multiplied with 10 to get the 100 grain weight.

Relative water contents (RWC %): Relative water contents were determined by the protocol of Gao (2006). Took Fresh leaves of plants and noted the fresh weight by using the weighing balance. Fresh samples of plants leaves soaked in 10 ml of distilled water for about 24 hours and noted the turgid weight. After it, samples were oven-dried for about 48 hours and measured the oven-dried weight of samples. Relative water contents were determined via subsequent formulation:

$$RWC\ (\%) = [(Wf - Wd) / (Wt - Wd)] \times 100$$

Membrane permeability (MP %): Fresh leaf samples (0.5 g) were cut into pieces and put into 10 ml of distilled H_2O in test tubes. By using electrical conductivity (EC) meter EC_o was measured. The samples kept at the room temperature for over-night then EC_1 was determined. Next day, the samples autoclaved for 1 hour and EC_2 were calculated. Yang *et al*. (1996) formula was used for RMP (%) measurement.

$$RMP\ (\%) = (EC_1\text{-}EC_o / EC_2\text{-}EC_o) \times 100$$

Chlorophyll contents determination: Chlorophyll contents were assayed by the process of Lichtenthaler and Wellurn (1983). Fresh leaf (0.5 g) samples crushed and homogenized in 10 ml of acetone (80%) and then Centrifuged at 3,000 rpm. The supernatant was used for the measurement of chlorophyll contents (*a, b*) on spectrophotometer at 645 and 663 nm respectively. The chlorophyll contents were determined by following formulae:

Chlorophyll *a* contents (µg/ml) =12.21(A663) -2.81(A646)

Chlorophyll *b* contents (µg/ml) = 20.13(A646) -5.03(A663)

Carotenoids (µg/ml) = (1000A470-3.27[chl *a*]-104[chl *b*])/227

Hydrogen peroxide (H_2O_2) assay: The hydrogen peroxide contents were determined by using Loreto and Velikova (2001) protocol. Fresh leaf (0.3 g) was homogenized in 3 ml of trichloroacetic acid (1%). The mixture centrifuged at 10,000 × *g* for 10 minutes at 4°C. Later, 0.75 ml of supernatants mixed into 1.5 ml of 1 M potassium iodide and 0.75 ml of 10 mM Potassium phosphate buffer. Contents of H_2O_2 were measured at 390 nm absorbance on spectrophotometer.

Free proline contents assay: Free proline contents were analyzed by the protocol of Bates *et al*., (1973). Fresh leaf samples (0.5 g) chopped and homogenized with sulfosalicyclic acid (10 ml) and centrifuged at 10,000 rpm. Then 2 ml of acid ninhydrine and 2 ml of glacial acetic acid were added into supernatant in a test tube. The mixture was kept in water bath at 100°C for 1 h. Extract blend by 4 ml toluene. Aspirated the chromophore film with toluene and cooled at the room temperature. Absorbance obtained at 520 nm by using the spectrophotometer.

Total free amino acids: Hamilton and Van-slyke (1973) protocol performed to assay total free amino acid contents. Fresh leaf (0.1 g) mixed in 2 ml of buffer. 1 ml leaf extract added in all test tubes and then added 1 ml of 10% pyridine solution plus 1 ml of ninhydrine solution in every test tube. Test tubes were kept into the hot water bath for 30 minutes. All test tube volume rose up to 25 ml and the reading took at 570 nm on the spectrophotometer.

Glycinebetaine contents: Grieve and Gratan (1983) protocol was used to analyze the glycinebetaine contents. For glycinebetaine, 0.25 ml leaf extract was taken and mixed 0.25 ml of 2N HCl, added 2 ml of potassium tri iodide. Shake the mix and cooled it for 90 min. After that Added 2.5 ml of cool distilled H_2O and 20 ml of 1-2 dichloro-methane. In test tube, 2 films formed in solution, upper layer was discarded and analyzed at 365 nm on spectrophotometer.

Total soluble sugars: Anthrone method (Irigoyen *et al*., 1992) was used for the analysis of total soluble sugar. Fresh leaf (0.5 g) was crushed and added 5 ml of 80% alcohol to leaf samples. The mixture was centrifuged at 6000 rpm for 15 minutes. Supernatant was taken in test tube and added 12.5 ml of 80% alcohol to samples. To this mixture, added 1 ml of 0.2% anthrone solution. Then mixture was heated in a water bath at 100°C for 10 minutes and incubated the samples on ice bath for 5 minutes to stop the reaction. Absorbance was measured on spectrophotometer at 620 nm.

Total phenolic contents: Total phenolic contents assayed by using procedure of Julkenen-Titto (1985). Fresh leaf sample (0.1 g) chopped in 2 ml of 80% acetone and centrifuged at 15,000 × *g* at 4ºC for 15 minutes. To 0.1 ml of supernatant, 2 ml of distilled H_2O, and 0.5 ml folin-ciocalteaus phenol reagent was added. After that, 2.5 ml of 20% sodium carbonate added to mixture and final volume was made up to 5 ml and vortexed for 5 sec. Then samples were incubated at room temperature (20ºC) for 15 minutes and absorbance of samples was measured at 750 nm with a spectrophotometer.

Flavonoids: Flavonoids were assayed as the protocol of Zhishen et al. (1999). Fresh leaf (0.1 g) extracted in 80% acetone. To 0.5 ml of supernatant, distilled water (2 ml), 0.5 ml of $AlCl_3$ (10 %), 0.6 ml of 5% $NaNO_2$ then 2 ml of NaOH (1 M) was added. Optical density of the samples was measured at 510 nm with a spectrophotometer.

Assay of antioxidant enzymes activities: Catalase and peroxidase activities were assayed by following the protocol defined as Fu and Huang (2001). For catalase determination, 3 ml reaction mixture contains 50 mM buffer (pH 7), 5.9 mM H_2O_2 and then 100 µl of leaf extract. The alteration in absorbance of sample solution at 240 nm stands owing to disintegrated H_2O_2 analysis for each 20 seconds. One unit activity of catalase was important by means of an absorbance variation of 0.01 units min^{-1}. The peroxidase activity was measured by the guaicol oxidation process; to 3 ml reaction mixture added 50 mM phosphat buffer (pH 7), 20 mM guiacol, and 40 mM H_2O_2, and 0.1 ml enzyme extract. The modification in absorbance of mixture at 470 nm checked at every 20 sec. One unit activity of peroxidase was well-defined as change of 0.01 absorbance units min^{-1}.

Statistical analysis of experimental data: Analysis of variance (ANOVA) was performed by using computer software (Co-STAT).

Results and Discussion

Plants under normal conditions often face numerous environmental constraints in relation of submergence, temperature immoderations, salinity, and drought. Drought stress is one of the major environmental factors that reduce the growth and ultimate yield of crops (Geng *et al.,* 2016; Daryanto *et al.,* 2017). Water scarcity badly damages the growth and germination of plants (Almaghrabi, 2012). However, usage of plant growth regulators through priming, significantly improve crop performance under unpredictable climatic conditions (Ashraf *et al.,* 2018) particularly under water stressed conditions in wheat (Tabbasum *et al.,* 2018). Thiourea used as seed soaking or foliar application increase plants improvements and physicochemical characteristics under model (Jagetiya & Kaur, 2006; Garg *et al.,* 2006) and challenging environment (Srivastava *et al.,* 2009). Pre-soaking seed treatments with thiourea has significant effect on growth of maize cultivars under salt stress (Kaya *et al.,* 2015).

In this study, drought stress significantly reduced growth parameters such as shoot and root fresh and dry weight. Pre-sowing seed treatment significantly increased shoot fresh and dry weights and root dry weight under drought stress. Hydro-priming showed more positive effect in increasing shoot fresh and dry weights and root dry weight under control and stressed condition. Under moderate drought stress (70% FC), both 0.1 and 1.0 mM thiourea (TU) proved effective in increasing shoot fresh and dry weight, while root dry weight was significantly increased by 0.1 mM TU treatment (Table 1; Fig. 1).

Plants under water stress conditions decrease the leaf area reduce the stomatal conductance to decrease the water transpiration, and enhance the root spreading in the soil to increase the uptake of water (Farooq *et al.,* 2009; Fang *et al.,* 2017). In the current study, drought stress significantly reduced shoot and root lengths and total leaf area $plant^{-1}$ (Table 1; Fig. 1). Water-soaking (hydro-priming) and 0.1 mM TU treatment enhanced the shoot length as well as total leaf area $plant^{-1}$ under moderate drought stress (70% FC) or non-stressed regimes (Table 1; Fig. 1). Seed treatments with thiourea stimulate the growth and antioxidant defense system in wheat (Sahu *et al.,* 2006).

In the present investigation, drought stress negatively affected yield parameters such as grain yield $plant^{-1}$, number of grains $plant^{-1}$ and 100-grain weight of wheat (var. Galaxy-2013) plants (Table 1; Fig. 1). However, hydro-priming increased grains yield $plant^{-1}$ under non stressed conditions (Table 1; Fig. 1).

It has been reported that exogenous application of thiourea enhance growth through reducing H_2O_2 contents, membrane permeability, altering the anti-oxidant enzymes actions and improving the contents of photosynthesis in maize cultivars under salt stress (Kaya *et al.,* 2015). Water deficiencies cause greater change in relative membrane permeability of plants (Vardharajula *et al.,* 2011; Sandhya *et al.,* 2010) (Fig. 2). In this study, drought stress and pre-sowing seed treatment of different TU levels did change photosynthetic pigments (chlorophyll *a, b*), relative water contents (%) and membrane permeability (%) of wheat plants (Table 1; Fig. 1). It has been found that foliar application of thiourea increased growth and chlorophyll contents in maize (*Zea mays* L.) (Perveen *et al.,* 2013) and sesame (*Sesame indicum* L.) plants (Kumar *et al*., 2018). In another study, thiourea application augmented photosynthetic activity of Basmati-515 rice via refining the chlorophyll contents (Zahra *et al.,* 2018).

Table 1. Mean squares from analysis of variance of data for various growth and physicochemical parameters of 7-week-old wheat plants raised from seeds treated with thiourea under drought stress and non-stress conditions.

Source of variation	df	Shoot f. wt.	Shoot dry wt.	Root f. wt.	Root dry wt.	Shoot length
Drought (D)	2	42.02***	0.135*	1.33*	0.005ns	144.9***
Thiourea (TU)	3	31.11***	0.286***	0.229ns	0.012*	192.9***
D × TU	6	12.7**	0.065ns	0.93*	0.009*	24.47ns
Error	24	2.93	0.031	0.366	0.003	12.66
Source of variation	**df**	**Root length (cm)**	**leaf area/plant(cm^2)**	**Grain yield (g $plant^{-1}$)**	**Number of grains $plant^{-1}$**	**100-grain weight**
Drought (D)	2	91.48***	377.5*	0.156***	151.0***	1.610**
Thiourea (TU)	3	0.441ns	505.6*	0.033*	32.18ns	0.419ns
D × TU	6	8.849*	231.9ns	0.031**	9.046ns	0.117ns
Error	24	3.48	109.6	0.008	13.83	0.234
Source of variation	**df**	**Chl. *a***	**Chlorophyll *b***	**Total Chl.**	**RWC (%)**	**RMP (%)**
Drought (D)	2	0.000ns	0.0136ns	0.008ns	94.3ns	150.3ns
Thiourea (TU)	3	0.006ns	0.0125ns	0.012ns	8.21ns	25.53ns
D × TU	6	0.002ns	0.007ns	0.008ns	59.4ns	13.14ns
Error	24	0.006	0.021	0.020	49.3	44.57
Source of variation	**df**	**H_2O_2**	**Proline**	**Glycinebetaine**	CAT	**POD**
Drought (D)	2	10.11***	104.6**	63.049***	2.02ns	15.7ns
Thiourea (TU)	3	0.579ns	45.38*	3.227ns	1.013ns	8.884ns
D × TU	6	1.09ns	17.65ns	4.402ns	0.645ns	1.94ns
Error	24	0.742	14.59	5.04	0.777	6.117
Source of variation	**df**	**Total free amino acid contents**	**Total phenolic contents**	**Total soluble sugars**	**Flavonoid contents**	
Drought (D)	2	0.045ns	23.20*	121.7ns	0.429***	
Thiourea (TU)	3	0.059ns	22.88*	116.5ns	0.117*	
D × TU	6	0.121ns	4.787ns	103.9ns	0.054ns	
Error	24	0.103	6.31	43.9	0.031	

*, **, *** significant at 0.05, 0.01 and 0.001 levels respectively; df= degrees of freedom; D = drought; TU = thiourea; Chl. *a* = chlorophyll *a*; CAT = catalase; POD = peroxidase; H_2O_2 = hydrogenperoxide; RMP (%) = relative membrane permeability; RWC % = relative water content

Plants produced highly reactive oxygen species under water strained environments which cause disruptions in chloroplasts apparatus and mitochondrial systems (Apel & Hirt, 2004). Water stress raises superoxide and H_2O_2 contents by quick oxygen photo-reduction in plants chloroplast (Robinsins & Bunce, 2000). In this study, drought stress significantly increased hydrogen peroxide H_2O_2 contents (Table 1; Fig. 1). Exogenous application of thiourea enhanced growth through reducing H_2O_2 contents, membrane permeability and altering the anti-oxidant enzymes actions and improving the contents of photosynthesis in maize cultivars under salt stress (Kaya *et al.*, 2015).

In this study, different levels of drought stress and TU treatments significantly decreased total phenolic contents in wheat plants (Table 1; Fig. 3). Of different TU levels, 1.0 mM thiourea treated plants showed greater number of phenolic contents (Table 1; Fig. 3). A good correlation was found among decrease in growth and chlorophyll contents and enhanced melondialdehyde and phenolics in barlay (Dbira *et al.*, 2018).

It has been reported that exogenous application of thiourea increase growth via altering the anti-oxidant enzymes activities in maize cultivars under salt stress (Kaya *et al.*, 2015). Thiourea has been used for the enhancement of antioxidant defense system under water scarcity or normal irrigation in plants (Ge *et al.*, 2006). Anti-oxidant enzymes action has been thought to be the most active to combat reactive oxygen species (Sharifi *et al.*, 2012). In the current study, application of different drought stress and TU levels did not change catalase and peroxidase activities significantly (Table 1; Fig. 3).

Drought stress significantly decreased flavonoid contents (Table 1; Fig. 3). Pre-sowing seed treatment with different TU levels (0.1 and 1 mM) showed greater flavonoids contents under controlled conditions. Hydro-priming proved more effective in increasing flavonoid contents (Table 1; Fig. 3). It has been reported that total flavonoid contents increased by treatment with thiourea (Ge *et al.*, 2006).

Total free amino acids and total soluble sugar did not show alteration under different levels of drought stress and TU treatment in wheat (var. Galaxy-2013) (Table 1; Fig. 3). In the current study, drought stress exerted significant effect on the proline and glycinebetaine (GB) contents of wheat plants (Table 1; Fig. 3). Proline and GB contents significantly increased under different levels of drought stress. Under moderate stress, pre-sowing seed treatment with 1.0 mM increased proline contents (Table 1; Fig. 3). It has been reported that proline and glycinebetaine accumulation leads to drought stress tolerance in primed plants (Wang *et al.*, 2018).

In conclusion, drought stress considerably reduced shoot fresh weight, dry weight of shoot, fresh weight of root, shoot length, root length , grain yield $plant^{-1}$, 100-grain weight, number of grains $plant^{-1}$, total phenolics and total flavonoid contents, while increased hydrogen peroxide (H_2O_2), proline and glycinebetaine contents. Pre-sowing seed treatment with varying levels of thiourea showed differential effects under drought stress or non stress conditions e.g., under moderate drought stress (70% FC) both 0.1 mM and 1.0 mM TU increased shoot dry weight and decreased total phenolic contents. Furthermore, 0.1 mM TU enhanced root dry weight, while 1.0 mM TU increased proline contents. In conclusion, hydro-priming proved more effective in increasing shoot and root fresh and dry weights, shoot length, total leaf area $plant^{-1}$, grain yield and number of grains $plant^{-1}$ in wheat var. Galaxy-2013 plants under water stressed or non stressed conditions. It has been established that hydro-priming of Malaysian *Indica* rice (MR219) seed is linked with the accretion of proline and controlling the activity of catalase and ascorbate peroxidase under water stress. Hydro-priming to seeds can ameliorate the adverse impacts of water stress (Kalhori *et al.*, 2018). Hydro-primed maize seeds exhibited quick sprout rise and better field stand (Nagar *et al.*, 1998).

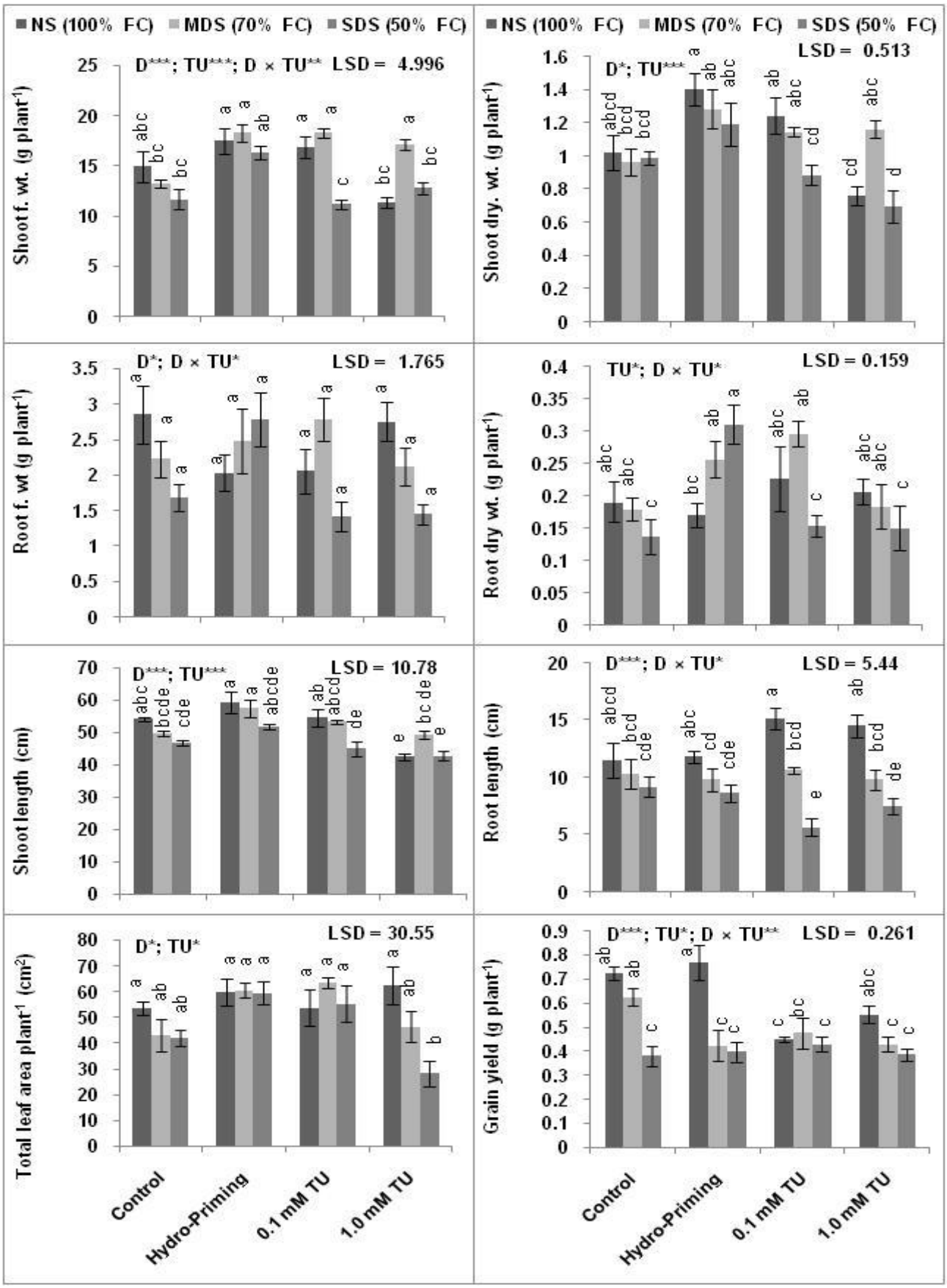

Fig. 1. Growth and yield parameters of 7-week-old wheat plants raised from seeds treated with thiourea under drought stress and non-stress conditions. FC = field capacity; NS = non-stress; MDS = moderate drought stress; SDS = severe drought stress; TU = thiourea; LSD = least significant difference at 0.05 levels of significance; different lettering at columns show significant difference between treatments at $p \leq 0.05$.

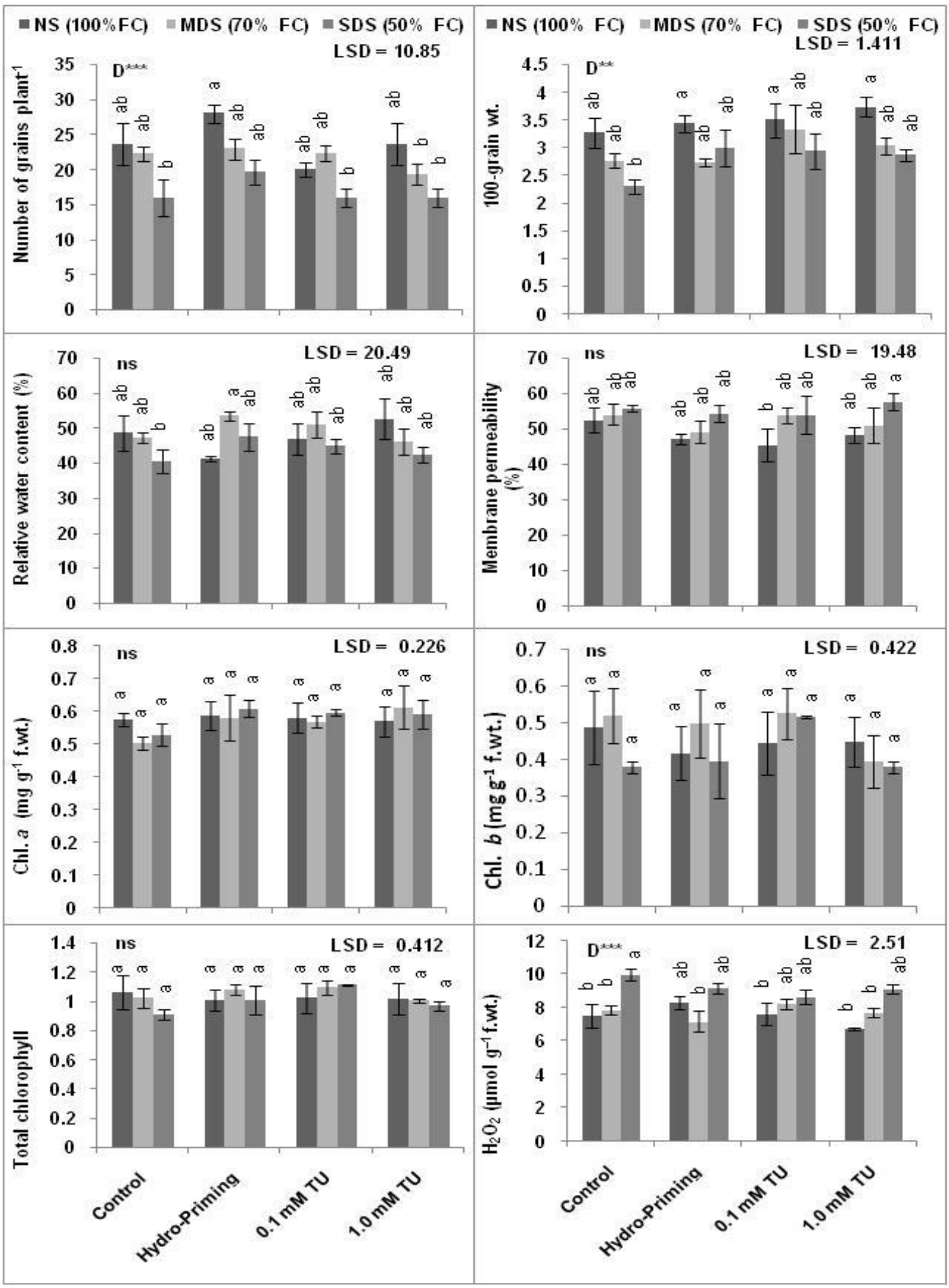

Fig. 2. Yield, water content (%), membrane permeability (%), chlorophyll and hydrogen peroxide contents of 7-week-old wheat plants raised from seeds treated with thiourea under drought stress and non-stress conditions. FC = field capacity; NS = non-stress; MDS = moderate drought stress; SDS = severe drought stress; TU = thiourea; LSD = least significant difference at 0.05 levels of significance; different lettering at columns show significant difference between treatments at $p \leq 0.05$.

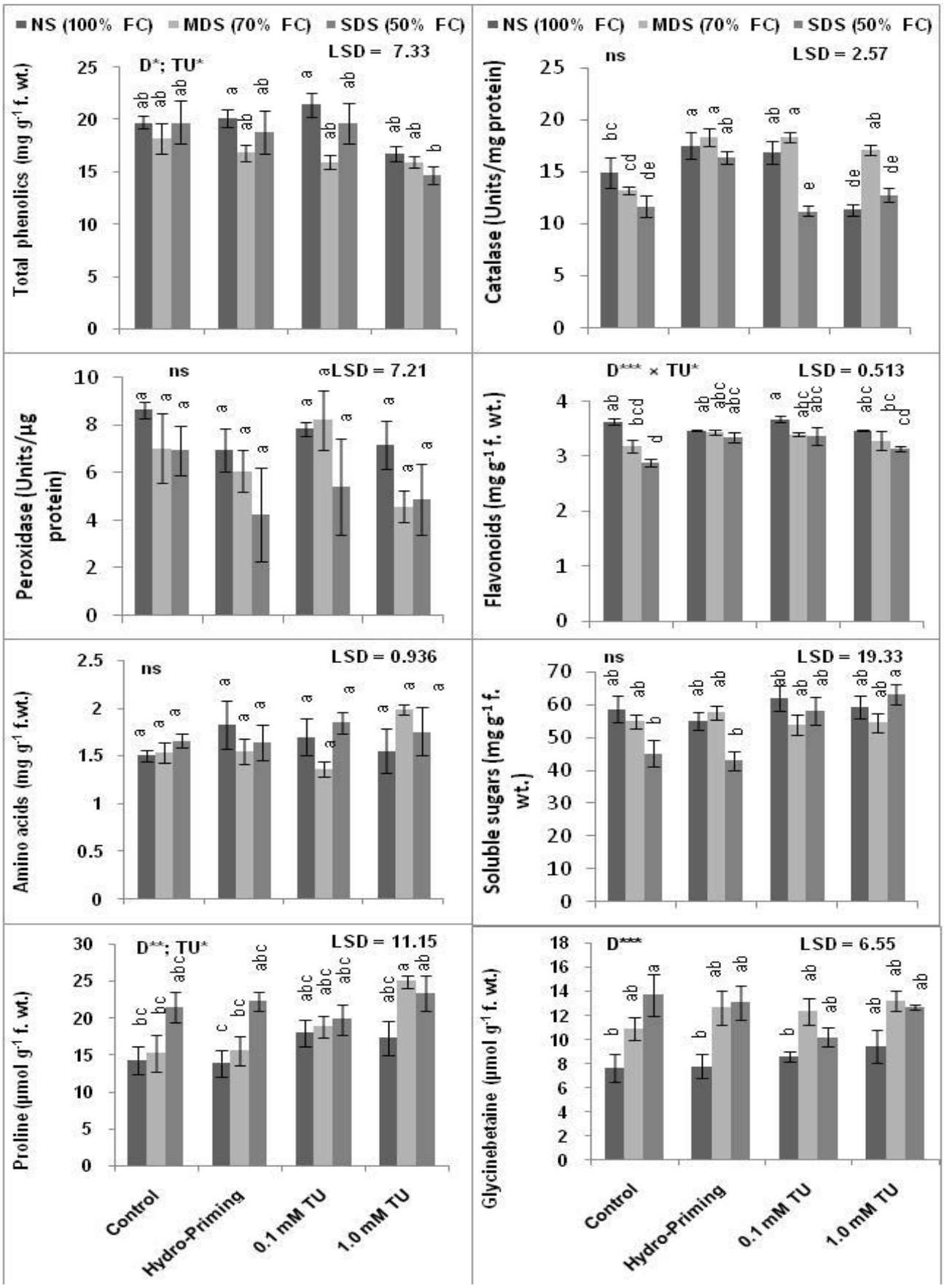

Fig. 3. Physicochemical parameters of 7-week-old wheat plants raised from seeds treated with thiourea under drought stress and non-stress conditions. FC = field capacity; NS = non-stress; MDS = moderate drought stress; SDS = severe drought stress; TU = thiourea; LSD = least significant difference at 0.05 levels of significance; different lettering at columns show significant difference between treatments at $p \leq 0.05$.

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