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Short Research Article

Physiological and Biochemical Characterization for Drought Stress at Seedling Stage in Wheat Genotypes

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Abstract

A laboratory experiment was conducted to evaluate the cultivated wheat genotypes of middle Gujarat region for tolerance to drought, artificially created by the application of 0, 5, and 10% polyethylene glycol (PEG). During screening, data were recorded for various physiological and biochemical parameters of the wheat genotypes. Decrease in percent germination was observed with the increase in the level of PEG at 5% and 10% in all the genotypes. However, percent germination was significantly higher in the genotypes LOK 1, HW-2004, AR-06-1, AR-07-33, AR-07-30 and GW-1 reflecting the drought tolerance characteristics. Overall, with increased concentration of artificial drought stress inducer, PEG, reduction in germination percentage, root length, shoot length and seedling vigor index was observed. Proline content increased during stress condition induced by 5% and 10% PEG. Isozymes study of peroxidase, catalase under normal and drought stress conditions showed specific banding pattern which appeared only after PEG induce stress where as esterase showed unaltered banding pattern. The study of protein banding pattern through SDS-PAGE identified induced proteins involved in drought stress response. The protein bands of 158 kDa and 196 kDa were induced under the 5% and 10% PEG concentrations, respectively. From this primary screening, the wheat genotypes were characterized on the basis of response to PEG induced drought. Among all the irrigated aestivum genotypes, LOK-1, HW-2004 were found to be highly tolerant while the genotypes, GW-496, GW-173 and GW-322 were moderately susceptible and the genotypes, GW-273, GW-366 were found to be highly drought susceptible. Among the durum genotypes, rainfed genotypes A-206, DR-08-07, AR-06-1, A-9-30-1, AR-07-7, AR-07-30, AR-07-33and DR-08-06 were highly tolerant. Among the irrigated genotypes of durum wheat, GW-1245, GW-1255, GW-1260, GW-1265 and HI-8498 were moderately susceptible whereas GW-1139 was found to be highly drought susceptible.

1. Introduction

Wheat (*Triticum aestivum* and *Triticum durum*) belonging to the family Poaceae is one of the most important staple food grain crops cultivated all over India. It is widely grown as a rain-fed crop in semi-arid areas, where large fluctuations occur in the amount and frequency of rainfall events (Monneveux et al., 2012). Large part of the north-west India including Gujarat falls under arid and semi-region. Most of the wheat production areas are distributed in North Gujarat and North Saurashtra regions of the state and about 30% of wheat area of these regions is under rainfed ecosystem. The main dry wheat areas of Gujarat comprise of Bhal tract of Dholka and Dhandhuka talukas of Ahmedabad district, Khambat and Matar talukas of Anand district, Wagra taluka of Bharuch district and Olpad taluka of Surat district. Irrigated wheat is grown in all the districts of the state except Dangs (Chakraborty, 1992).

Abiotic stresses such as drought, high or low temperatures and salinity cause adverse effects on plant growth that reduces crop productivity (Bray et al., 2000). Abiotic stresses are location-specific, vary in frequency, intensity, duration and can occur at any stage of plant growth and development (Sorrells et al., 1998). Drought is the primary abiotic stress causing differences between the mean yield and the potential yield and is highly heterogeneous in time and space.

Drought stress leads to changes in expression of a large number of genes in plants (Way et al., 2005). Protein variation is an

essential part of plant response to environmental stress as well as for adaptation to environmental conditions. Study of isozyme pattern offers the most reliable single gene markers which are often co-dominant in inheritance (Bakalova et al., 2003). The antioxidant defenses appear to provide crucial protection against oxidative damage in cellular membranes and organelles in plants grown under unfavorable conditions (Kocsy et al., 1996). Proline is an important osmolyte which accumulates during moisture stress condition and helps to maintain turgor and promotes continued growth in low water potential soils (Mullet and Whitsitt, 1996). Thus, it is used as a biochemical marker for increased stress tolerance in conventional crop breeding program and could lead to development of varieties with heritable stress resistance.

The productive approaches to establishing the basic responses of plants to drought involve studying candidate genes and differential screening. At least 60 mha of wheat is grown in marginal rainfed environments in developing countries. For improving yields under dry land conditions, the development of new wheat genotypes with high grain yield potential is of great significance (Rajaram and Ginkel, 1996). Generally, there is a low level of polymorphism in wheat relative to other cereal crops which implies that a larger number of biochemical and molecular markers must be screened for wheat genotypes. Keeping in view these aspects, the present study was framed to evaluate the effect of artificial drought stress inducer, PEG on 22 wheat genotypes cultivated in middle Gujarat in seedling stage.

2. Material and Methods

2.1. Germplasm collection and screening for drought stress using PEG 6000 in laboratory conditions

The 22 genotypes comprising of 7 *Triticum aestivum* accessions viz. LOK-1, HW-2004 (Rainfed), GW-173, GW-273, GW-322, GW-366 and GW-496 (Irrigated) and 15 accessions of *Triticum durum* including A-206, A-9-30-1, AR-06-1, AR-07-7, AR-07-30, AR-07-33, DR-08-06, DR-08-07, GW-1 (Rainfed), GW-1139, GW-1245, GW-1255, GW-1260, GW-1265 and HI-8498 (Irrigated), used in the present study were procured from the Regional Research Station, Anand Agricultural University, Anand and Main Wheat Research Station, Vijapur, Sardarkrishinagar Dantiwada Agricultural University, Dantiwada.

Seeds of 22 wheat genotypes were surface sterilized in 0.1% (w/v) $HgCl_2$ solution. Solutions of PEG 6000 were prepared according to weight by volume i.e. for 5% and 10% PEG solution, 50 g and 100 g PEG were dissolved in one liter distilled water respectively. Twenty five seeds of each genotype were germinated in sterilized glass petri dishes on filter paper under controlled condition (water), 5% and 10% PEG 6000 with respective treatment in three replications. Seeds were considered as germinated when the emergent radicals reached two mm length and accordingly, germination percentage was recorded (ISTA, 1987). Shoot length and root length were recorded on tenth day after germination. The seedlings of each genotype were examined for biochemical parameters as mentioned in the following sections.

2.2. Physiological characterization

Germination percentage, root length, shoot length and seedling vigor index (SVI, calculated by multiplying germination percentage and seedling length) were measured at ten days after germination. The seed lot showing the higher seed vigour index is considered to be more vigorous (Abdul-Baki and Anderson, 1973).

2.3. Biochemical characterization

2.3.1. Proline content

The proline content of the seedlings was estimated as per the method described by Bates et al., 1973.

2.3.2. Native PAGE and SDS-PAGE

2.3.2.1. Protein extraction

Wheat seedlings (300 mg) of each genotype were homogenized using 1.5 ml of extraction buffer, containing 50 mM sodium phosphate buffer (pH 7.2) with 1mM EDTA and 1% of polyvinyl pyrrodine (PVP). The homogenates were centrifuged at 10,000 rpm for 10 min at 4 ^{0}C and the supernatant was used for isozyme analysis. For SDS-PAGE, protein was extracted from the leaves of wheat seedlings (300 mg) from each genotype (10 DAG) followed by homogenization in extraction buffer, containing 50mM sodium phosphate buffer (pH 7.2) with 10% SDS and β- mercaptoethanol. The homogenates were incubated in boiling water bath for 2-5 min and centrifuged at 10,000 rpm for 20 min. The supernatant was used for SDS-PAGE analysis.

2.3.2.2. Electrophoresis

Electrophoresis was conducted on vertical slab gel PAGE unit (C.B.S. Scientific, U.S.A.) at 60 mA for 60 minutes. Isozymes were resolved on discontinuous gel, stacking gel with 5% acrylamide contained 0.5M Tris-HCL (pH 6.8) and resolving gel with 8% acrylamide contained 1.5M Tris-HCL (pH 8.8). After electrophoresis the gels were washed with distilled water and stained for each isozymes viz. for peroxidase (POX) by O-dianisidine method, esterase (EST) by α-napthyl acetate method and catalase (CAT) by ferric chloride and potassium ferricyanide method described by Guibualt (1976); Davis (1964) and Woodberry et al., (1971) respectively whereas SDS-PAGE were carried out on 5% stacking and 12% resolving acrylamide and stained with 0.1% commassie brilliant blue-R250 (Laemmli et al., 1970).

2.3. Data analysis

The data obtained from physiological and biochemical parameters were analyzed using a completely randomized block design (CRD). The mean value for each of the quality attributes was based on analysis of three replicate samples. Analysis of variance (ANOVA), appropriate for the design, was carried out to determine the significance of differences among the genotypes for each of the parameter under study. Relative mobility (Rm) was calculated by the ratio of distance travelled by the band to distance travelled by tracking dye. The intensity of band was approximately categorized as faint, light and intense by visual observation. The isozymes and SDS-PAGE banding pattern were assessed on basis of presence (+) and absence (-) of bands in each genotype.

3. Results and Discussion

3.1. Physiological characterization

Seeds were considered to have germinated when the white coleoptile became visible through rupture of the seed-coat. This is the earliest stage of germination that can be readily and definitely recognized by ordinary ocular observation (Tang, 1931). The data on germination percentage, root length, shoot length and SVI of 22 rainfed and irrigated wheat genotypes were recorded at 0, 5, and 10% PEG treatment and presented in the Table 1.

Most of the reports regarding drought tolerance and oxidative stress under water deficit condition are undertaken in controlled laboratory conditions on hydroponic cultures with PEG treatment which is one of the commonest experiments in germination of the seeds or on pot soil experiments with some constraints for the development of the root system. The PEG treatment uses shorter experimental duration and imposition of more severe drought than that under natural field conditions (Simova-Stoilova et al., 2009).

Decrease in per cent germination was observed with the increase in concentration of PEG at 5% and 10% in all the

Table 1: Changes in percent germination, root length, shoot length and seedling vigor index as affected by drought inducer PEG 6000 at 10 DAG

Genotype	Germination %			Root length			Shoot length			Seedling vigor index		
	Con-trol	5% PEG	10% PEG	Con-trol	5% PEG	10% PEG	Con-trol	5% PEG	10% PEG	Con-trol	5% PEG	10% PEG
LOK-1	98	95	94	9.57	6.3	3.53	6.33	4.43	4.87	1.18	1.21	0.88
GW-173	99	94	91	7.6	5.4	2.20	5.6	4.5	2.50	1.23	1.43	0.73
GW-273	99	96	92	7.87	5.47	2.37	7.43	4.93	2.47	1.27	1.02	1.30
GW-322	99	97	93	6.77	5.13	4.17	6.76	5.03	3.17	1	1.02	1.32
GW-366	99	96	93	7.97	6.57	2.33	7.36	5.53	2.20	1.20	1.40	1.36
GW-496	98	98	90	7.4	6.6	3.27	6.8	5.4	3.03	1.03	1.22	1.08
HW-2004	99	95	91	7.2	5.36	5.23	8.76	5.46	4.33	0.46	0.98	1.57
A-206	99	96	93	8.6	5.26	6.7	9.3	7.6	6.5	1.16	1.03	0.93
A-9-30-1	98	97	94	8.33	5.57	8.5	8.1	6.23	5.2	1.05	1.06	1.27
AR-O6-1	100	96	94	8.17	6.13	5.30	6.43	6.03	4.07	1.06	1.11	0.96
AR-07-7	99	96	94	8.7	6.3	6.0	8.0	7.43	6.23	1.02	0.98	1.36
AR-07-30	100	96	93	8.83	6.43	6.17	5.33	4.27	3.67	1.28	1.51	1.68
AR-07-33	100	96	94	8.63	7.47	7.27	7.36	6.03	4.03	1.08	1.19	1.06
DR-08-06	99	96	92	9.43	6.57	6.83	9.7	5.40	4.43	0.97	1.22	1.54
DR-06-07	99	95	93	8.83	6.30	5.87	9.2	6.63	4.83	0.96	0.95	1.21
GW-1	99	97	94	8.37	6.10	6.80	9	7.03	4.30	0.93	0.87	1.58
GW-1139	99	96	93	7.5	5.52	2.45	6.36	4.03	2.30	1.17	1.24	2.20
GW-1245	98	97	94	8.63	7.27	5.37	7.36	5.5	3.56	1.17	1.32	1.50
GW-1255	99	96	93	7.43	6.17	4.83	7.03	5.2	3.17	1.06	1.38	1.4
GW-1260	99	97	94	7.56	6.07	4.07	7.56	6.7	2.47	1.26	0.91	1.6
GW-1265	99	97	93	8.1	5.70	4.47	7.76	4.77	3.63	1.04	1.20	1.2
HI-8498	99	96	94	7.4	5.57	4.20	7.56	5.43	3.43	0.98	1.47	1.4
SEm±	0.236	0.341	0.414	0.464	0.23	0.119	0.39	0.327	0.183	0.187	0.148	0.121
CD (p=0.05)	0.674	0.974	1.184	1.326	0.657	0.347	1.13	0.933	0.524	NS	NS	NS

genotypes. However, percent germination was significantly higher in the genotypes LOK 1, HW 2004, AR-06-1, AR-07-33, AR-07-30 and GW-1 reflecting the drought tolerance characteristics. Out of the total 22 genotypes, at 5% PEG treatment irrigated genotype, GW-496 showed the highest germination percentage (98%) followed by GW-173(94%). There were significant differences among the genotypes and drought levels. Under control condition, the maximum root length was observed in the genotype LOK-1(irrigated) with 9.57 cm and the minimum root length was observed in GW-322 (irrigated) with 6.77 cm. At 5% PEG drought level, rainfed genotype AR-07-33 (7.47 cm) showed the (irrigated) maximum root length while irrigated genotype GW-322 showed minimum root length (5.13 cm). At 10% PEG, rainfed genotype A-9-30-1 (8.5 cm) showed the maximum root length while irrigated genotype GW-173 showed the minimum root length (2.20 cm). PEG induced stress significantly decreased root length in all the genotypes affirming the previous findings in wheat seedlings induced with drought stress (Jajarmi et al., 2009; Kocheva et al., 2010).

The shoot length ranged from 2.2 cm to 9.7 cm for all the treatments. The maximum shoot length of 9.7 cm was observed in rainfed genotype DR-08-06 and minimum shoot length was recorded in AR-07-30 (5.33) under control condition. Genotype, A-206 showed the maximum shoot length (7.6 cm) while genotype GW-1139 showed the minimum shoot length (4.03 cm) at 5% PEG treatment. At 10% PEG the maximum shoot length (6.5 cm) was observed in genotype A-206 while shoot length (2.2 cm) was observed in GW-366. PEG induced stress significantly decreased shoot length in all the genotypes.

The Seedling Vigor Index (SVI) ratio of all the genotypes ranged from 0.46 to 2.2. PEG induced stress significantly reduced the SVI. The SVI ranged from 0.46 to 1.28 in control, 0.87 to 1.47 in 5% PEG and 0.73 to 2.2 in 10% PEG. The minimum SVI was recorded in *Triticum aestivum* genotype LOK 1 (0.88); HW-2004 (1.57) at 10% PEG and HW-2004 (0.98); GW-173 (1.43) at 5% PEG. The maximum SVI was observed in *T. durum* irrigated genotype GW-1139 (2.2) and minimum in rainfed genotype A-206 (0.93) at 10% PEG and GW-1 (0.87), GW-1255 (1.38) respectively at 5% PEG. With increase in concentration of artificial drought inducer PEG, overall reduction in germination percentage, root length, shoot length and seedling vigor index was observed. Characteristics of rainfed and irrigated genotypes varied with particular genotypes. Germination percentage, shoot and root length at PEG levels display significant differences among cultivars, and drought stress levels (Jajarmi, 2009). In the present investigation, negative and variable response was observed in wheat genotypes to PEG concentrations for shoot length, root length, seedling vigor index. The results are in agreement with earlier reports where a similar trend in drought tolerant and susceptible wheat varieties against PEG6000 (Moayedi et al., 2009; Raziuddin et al., 2010; Gorji et al., 2010).

3.2. Biochemical characterization

3.2.1. Proline content

Accumulation of proline has been advocated for use as a parameter of selection for stress tolerance (Yancy et al., 1982). Proline content of 22 wheat genotypes (rainfed and irrigated) analyzed under control and stress conditions at 5% PEG and 10% PEG treatments were presented in Table 2. The proline content in control seedlings ranged from 31.80 μg g^{-1} to 89.80 μg g^{-1} with the highest accumulation of proline observed in the rainfed genotype AR-06-1 and the lowest in rainfed genotype A-9-30-1. PEG (5%) treated seedlings showed proline in the range of 47.00 μg g^{-1} to 104.47μg g^{-1}. The highest proline content was observed in rainfed genotype GW-1 while the lowest was observed in irrigated genotype GW-1260. PEG (10%) treated seedlings showed proline in the range of 48.20 μg g^{-1} to 108.40 μg g^{-1}. The highest proline content was observed

Table 2: Changes in proline content (μg g^{-1}) as affected by drought inducer PEG 6000 at 10 DAG

Genotypes	Control	5% PEG	10% PEG
LOK-1	47.87	101.13	108.40
GW-173	58.00	84.13	72.67
GW-273	71.40	73.93	71.67
GW-322	71.20	70.40	70.47
GW-366	86.13	75.47	81.67
GW-496	73.67	76.67	70.00
HW-2004	85.80	95.47	91.87
A-206	89.80	97.00	93.47
A-9-30-1	31.80	83.33	88.27
AR-06-1	102.93	102.87	105.27
AR-07-7	62.87	91.60	97.60
AR-O7-30	74.53	86.47	90.00
AR-07-33	50.33	104.67	105.73
DR-08-06	84.13	82.00	87.20
DR-08-07	70.33	92.53	95.00
GW-1	59.73	59.33	85.47
GW-1139	65.40	51.27	65.67
GW-1245	60.33	61.60	61.60
GW-1255	85.47	83.07	60.13
GW-1260	46.40	47.00	50.20
GW-1265	70.60	71.93	72.27
HI-8498	49.80	66.93	48.20
SEm±	0.016	0.021	0.013
CD (*p*=0.05)	0.046	0.060	0.037

in rainfed genotype, GW-1 while the lowest was observed in irrigated genotype HI-8498 at 10% PEG treatment. Significant differences were observed between control and PEG treated genotypes. Among all the genotypes, *Triticum aestivum* genotype LOK-1 showed the highest proline (108.40 μg g^{-1}) content at 10% PEG treatment. Among the durum genotypes, the rainfed genotype AR-07-33 (105.73 μg g^{-1}) showed the highest proline content while the irrigated genotype, HI-8498 (48.2 μg g^{-1}) showed the lowest proline content at 10% PEG. Results showed that proline content was increased during stress condition at 5% and 10% PEG than control condition in all the rainfed genotypes. Proline accumulation was seen in wheat genotypes due to the imposition of osmotic stress PEG6000 (Mujtaba et al., 2007). A positive impact of PEG induced drought stress on proline content is well demonstrated in wheat genotypes wherein production of more proline was recognized as drought tolerance indicator (Raziuddin et al., 2010; Bayoumi et al., 2008). The proline level increased in the rainfed genotypes showing its drought tolerance characteristics, thus confirming the effects of artificial drought inducer PEG and confirming it as an adaptation to overcome stress condition. High levels of proline enable a plant to maintain low water potentials, allowing additional water to be taken up from the environment, thus buffering the immediate effect of water shortages within the organism (Kumar et al., 2003). This helps plants supply energy for growth and survival, thereby helping the plant to tolerate stress (Sankar et al., 2007).

3.2.2. Isozyme studies

The wheat genotypes were analyzed for study of three isozymes (peroxidase, catalase and esterase) under normal and drought stress conditions.

Wheat genotypes generated total five isoforms of peroxidase pattern under control and PEG induced drought stress with Rm value ranging from 0.05 to 0.92 (Figure 1). The specification on banding pattern of isozymes is presented in the Table 3. Isoforms, POX 3 with Rm value 0.39 and POX 4 with Rm value 0.79 appeared only after PEG induced stress in most of the rainfed genotypes which reveals its function in drought tolerance. Rest of the isoforms remained same for control and PEG induced stress. Catalase banding pattern revealed total five isoforms with Rm value ranging from 0.11 to 0.70 (Figure 2). Isoform, CAT 4 with Rm value 0.59 was present only in 5% PEG induced stress in most of the genotypes with high intensity and disappeared in 10% PEG induced stress which indicates induction of CAT 4 in all genotypes for normalized reactive oxygen species generation during drought stress. Esterase showed a total 10 isoforms with Rm value ranging from 0.27 to 0.96 (Figure 3). Esterase banding pattern was unable to distinguish between drought tolerance and susceptible genotypes.

3.2.3. Protein electrophoresis by SDS-PAGE

SDS-PAGE was analyzed to identify protein patterns involved in drought stress response in the 22 wheat genotypes (Figure 4). The proteins were separated into ten bands, which showed heterogeneity among the rainfed and irrigated genotypes. The maximum number of bands was observed in *Triticum aestivum* genotype, LOK-1 and rainfed durum genotype A-9-30-1 and AR-06-1. The intensity of bands increased with the increase in concentration of PEG at 5 and 10%. The protein bands of 158 kDa and 196 kDa were induced under the two PEG concentrations. The characterization of proteins by SDS-PAGE indicated the drought tolerance and revealed considerable variations among the genotypes. In the present study, SDS-PAGE displayed two newly induced proteins expressed in response to drought stress in the 22 wheat genotypes. These results affirmed with the reports of Abdelsamad et al., (2007), where SDS-PAGE analysis displayed some newly induced proteins expressed in response to drought stress in the four wheat genotypes. Abdel et al., (2001) also found some newly induced protein markers for drought tolerance in wheat cultivars under different PEG concentration. Diana et al., (2002) showed that the band intensity is directly related to protein concentration in the wheat seedlings. The results were found to be in agreement with previous studies of Bayoumi et al., (2008) and concluded that leaf protein profiles could be useful marker in the studies of genetic variation along with the classification of adapted cultivars under control and stress conditions. These specific proteins could be predicted to be induced by drought stress and needs further confirmation on two-dimensional electrophoresis or sequencing.

Table 3: Specific isozymes banding pattern recognized during PEG induced drought stress.

Isozyme	Band	Intensity	Remarks
Peroxidase	0.39 [POX3]	Medium	Appeared only after PEG induced stress at 5% in most rainfed genotypes.
	0.79 [POX4]	Faint	Appeared only after PEG induced stress in LOK-1, GW-366, DR-08-06, DR-08-07 and GW-1245.
Catalase	0.59 [CAT 4]	Dark	Appeared in 5% PEG stress in most of the genotypes and disappeared in 10% PEG stress with higher intensity at 5% PEG stress than the control.
	0.70 [CAT 5]	Faint	Appearance in control of some genotypes which disappeared after PEG induced stress

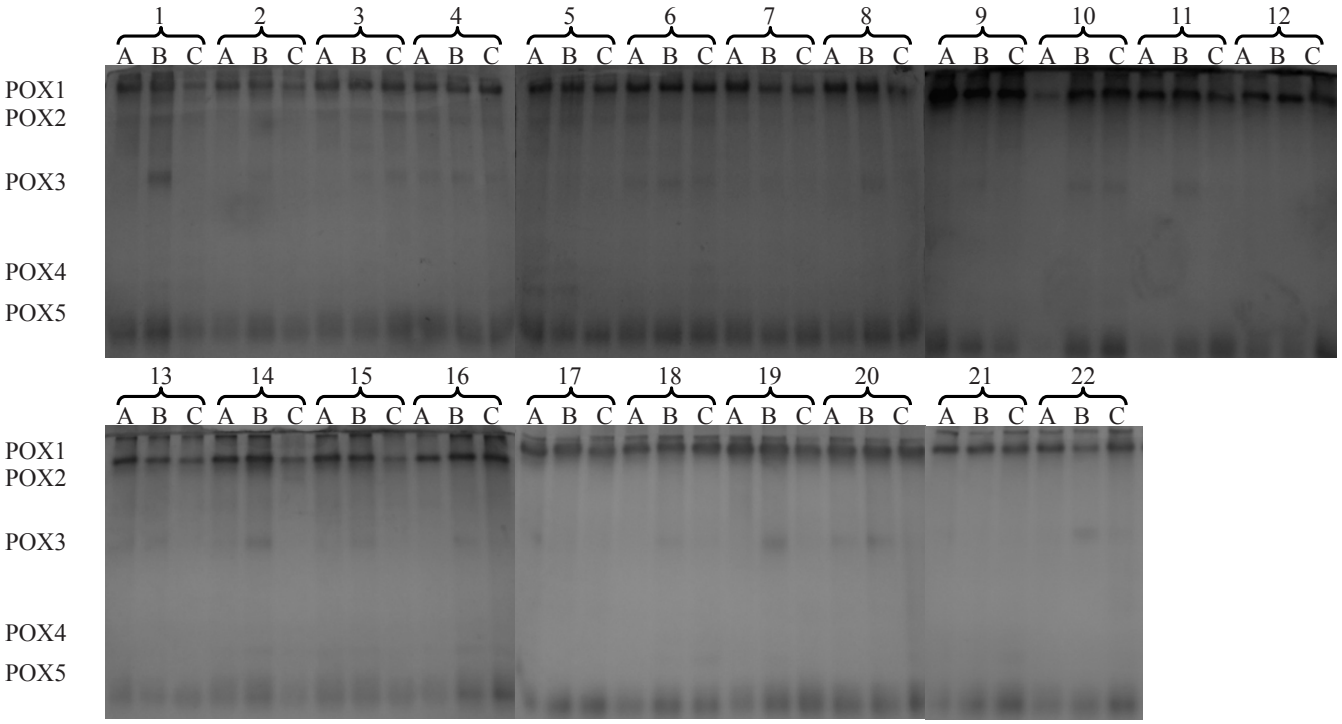

Figure 1: Isozyme pattern of Peroxidase in wheat seedlings (10DAG) with PEG treatment

A: Control; B: 5% PEG; C: 10% PEG; 1.LOK-1; 2.GW-173; 3.GW-273; 4.GW-322; 5.GW-366; 6.GW-496; 7.HW-2004; 8.A-206; 9.A-9-30-1; 10.AR-06-1; 11.AR-07-7; 12.AR-07-30; 13.AR-07-33; 14.DR-08-06; 15.DR-08-07; 16.GW-1; 17.GW-1139; 18.GW-1245; 19.GW-1255; 20.GW-1260; 21.GW-1265; 22.HI-8498

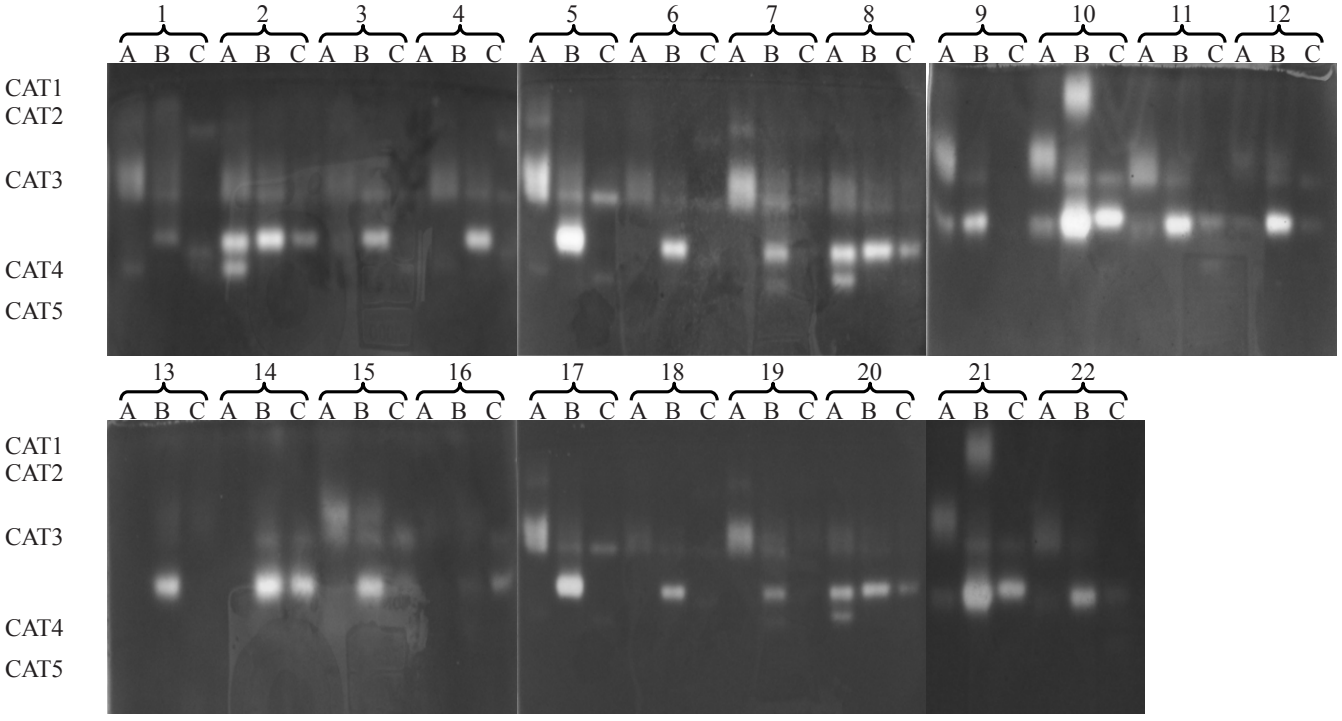

Figure 2: Isozyme pattern of Catalase in wheat seedlings (10 DAG) with PEG treatment

A: Control; B: 5% PEG; C: 10% PEG; 1.LOK-1; 2.GW-173; 3.GW-273; 4.GW-322; 5.GW-366; 6.GW-496; 7.HW-2004; 8.A-206; 9.A-9-30-1; 10.AR-06-1; 11.AR-07-7; 12.AR-07-30; 13.AR-07-33; 14.DR-08-06; 15.DR-08-07; 16.GW-1; 17.GW-1139; 18.GW-1245; 19.GW-1255; 20.GW-1260; 21.GW-1265; 22.HI-8498

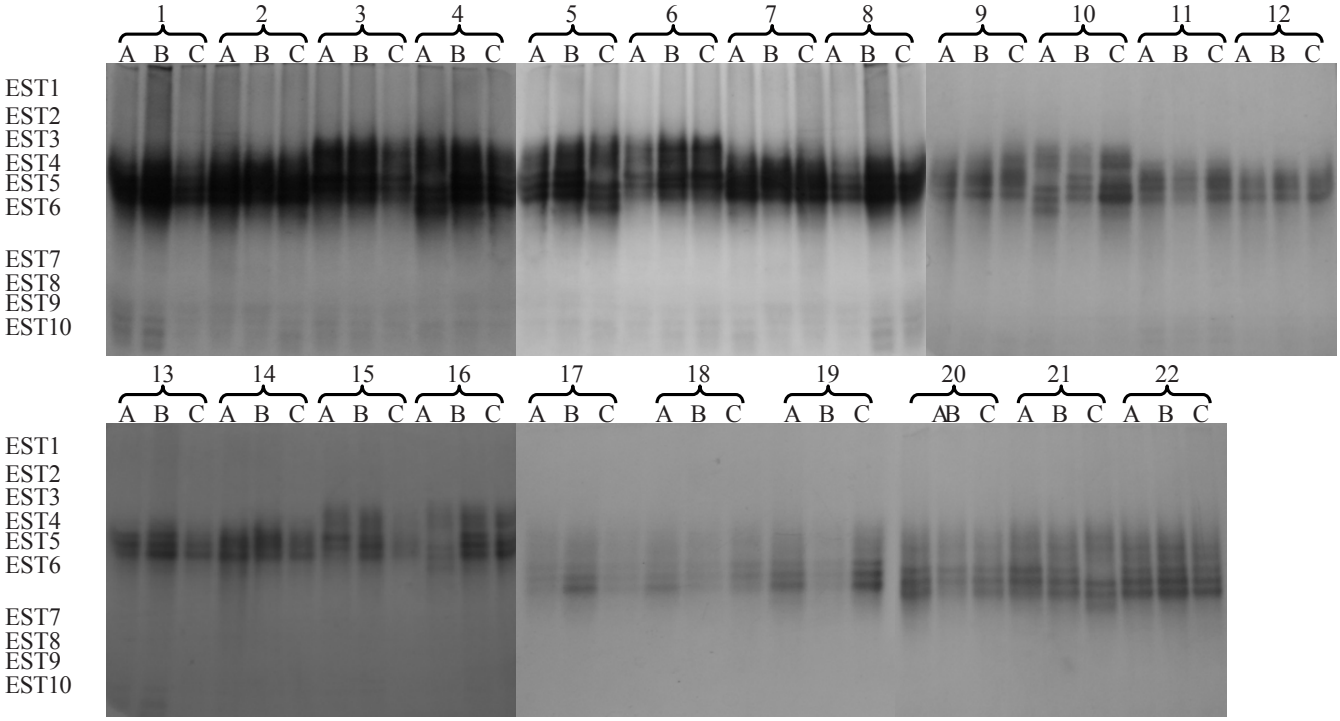

Figure 3: Isozyme pattern of Esterase in wheat seedlings (10DAG) with PEG treatment

A: Control; B: 5% PEG; C: 10% PEG; 1.LOK-1; 2.GW-173; 3.GW-273; 4.GW-322; 5.GW-366; 6.GW-496; 7.HW-2004; 8.A-206; 9.A-9-30-1; 10.AR-06-1; 11.AR-07-7; 12.AR-07-30; 13.AR-07-33; 14.DR-08-06; 15.DR-08-07; 16.GW-1; 17.GW-1139; 18.GW-1245; 19.GW-1255; 20.GW-1260; 21.GW-1265; 22.HI-8498

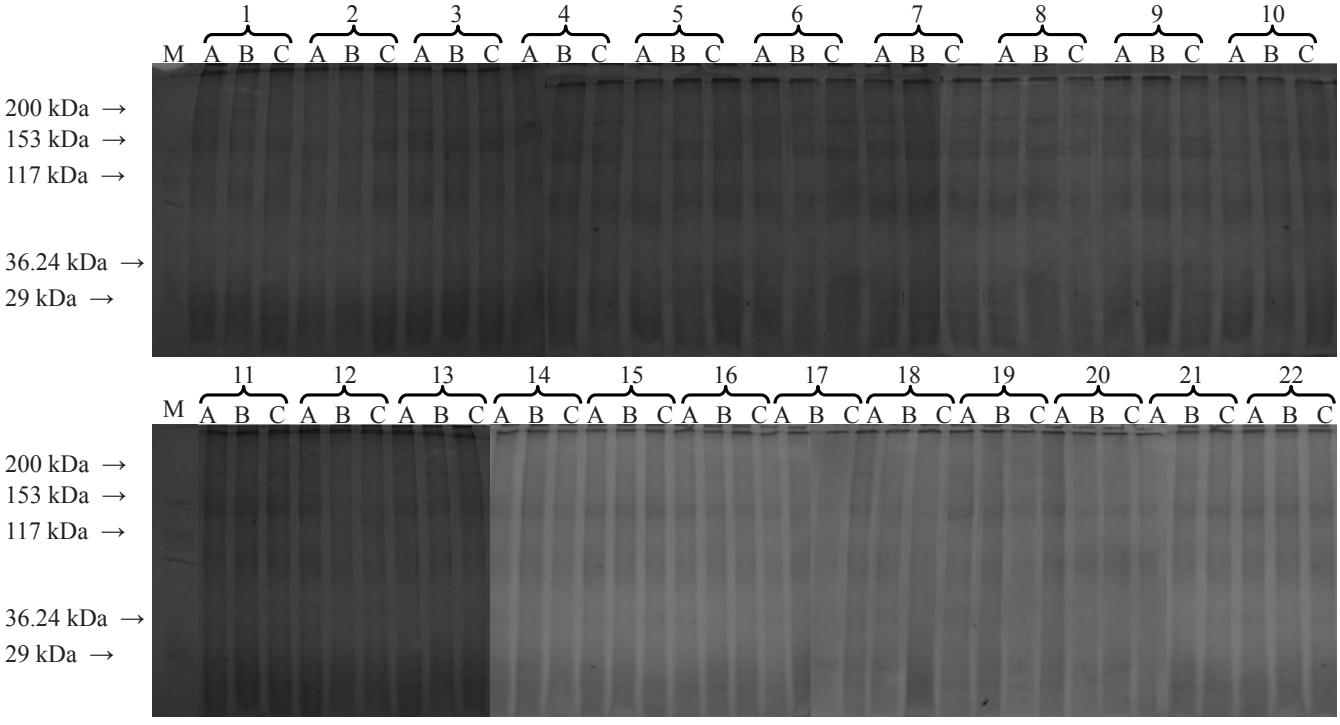

Figure 4: Electrophoretic pattern of protein through SDS-PAGE in wheat seedlings (10DAG) with PEG treatment

A: Control; B: 5% PEG; C: 10% PEG; 1.LOK-1; 2.GW-173; 3.GW-273; 4.GW-322; 5.GW-366; 6.GW-496; 7.HW-2004; 8.A-206; 9.A-9-30-1; 10.AR-06-1; 11.AR-07-7; 12.AR-07-30; 13.AR-07-33; 14.DR-08-06; 15.DR-08-07; 16.GW-1; 17.GW-1139; 18.GW-1245; 19.GW-1255; 20.GW-1260; 21.GW-1265; 22.HI-8498

4. Conclusion

Wheat genotypes, LOK 1, HW-2004, AR-06-1, AR-07-33, AR-07-30, GW-1, A-206, DR-08-07, A-9-30-1, AR-07-7, AR-07-33and DR-08-06 displayed drought tolerance. This information would primarily provide a basis for assorting the genotypes/ newly developed lines for drought trait used as parents in the breeding programme or marker-assisted selection.

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6. Reference

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