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RESEARCH ARTICLE

Influence of high temperature on ~-amylase and antixoxident enzymes in wheat (*Triticum aestivum* L.) varieties

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SUMMARY

The study was conducted for two winter seasons during 2006-07 and 2007-08 at Student Instructional Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad using 15 wheat (*Triticum aestivum* L.) varieties (Halna, Raj 3765, NW 1014, PBW 343, HD 2643, HP 1744, NW 2036, DBW 14, NW 1076, Sonalika, HD 2285, HD 2307, K 8962, UP 2425, and HP 1633) and three sowing dates 10th December (NS), 25th December (LS_1) and 10th January (LS_2) to assess the relative efficiency of different selection parameters. There was significant increase in the activity of superoxide dismutase (SOD), peroxidase and calatase in the late and very late planting at all stages, however, α-amylase content activity decreased under late and very late planting compared to normal planting.

Key Words : SOD, Peroxidase, Calatase and α-amylase, Wheat

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Heat stress indices significant changes in normal physiological processes, such as photosynthesis dark respiration and mitrochondrial respiration (Ngliyen and Joshi, 1993). One mechanism of injury involves the generation and reaction of reactive oxygen species (ROS) (Liu and Huang, 2000). Plant protect cell and sub-cellular system from the cytotoxic effect of the active oxygen radicles using antioxidant enzymes, such as superoxide dismutase, catalase, paroxidase and α-amylase and metabolite like Glutathion, ascarbic acid, α-tocopherol and carotenoid (Sairam *et al.*, 2000). Under heat stress levels of catalase have been shown to drop in a wide range of species. Activity of SOD also drop in creeping bent gross after two weeks of exposure to 35^{0}C. The present work was conducted to study the effect of high temperature stress on antioxidant enzyme and the role played by the antioxidant enzymes in protecting the plant cell from damage occurring the two high temperature stresses.

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MATERIALS AND METHODS

The experiment was conducted in the field condition with 15 wheat varieties *viz.*, Halna, Raj 3765, NW 1014, PBW 242, HD 2643, HP 1744, NW 2036, PBW 14, NW 1076, Sonalika, HD 2285, HD 2307, K 8962, UP 2425 and HP 1633. Seed were obtained from Department of Genetics and Plant Breeding, field were prepared before sowing mixing sandy loam sowing by Kudali. Planting were done on 10th December (NS), 25th December (LS_1) and 10th January (LS_2) in order to expose the plants to different temperature regime. Normal recommended agronomic practices were performed the temperature under three sowing at three stages were recorded by a field meteorological laboratory fitted microprocessor control data logger, which recorded daily maximum, minimum temperature, sunlight duration, RH, rainfall, wind velocity etc. All enzymatic content like α-amylase (Chance and Maehly, 1955) calatase (Sinha, 1972), peroxidase (Curne and Galston, 1959) and SOD (Asada *et al.*, 1974) were estimated on first fully expended leaf (third from top) at vegetative stage (30, 60 and 90 DAS).

Age as a result all the varieties recorded maximum enzyme activity at 90 DAS under both normal and late sowing condition. Under normal condition, the different varieties did not show any significant difference in enzyme activity, however, under late sowing condition, high significant differences were observed. The NW 1014, HD 2643, NW 1076 and PBW 343 showed higher α-amylase activity under late sowing, however, lower values were observed in Sonalika, K 8962, Raj 3765, HD 2285 and NW 2036 α-amylase is an enzyme which catalyzes the breakdown of starch. Results of present

Table 3 : Effect of late sowing on peroxidase activity (unit g^{-1} fresh wt. $min.^{-1}$) in leaves of wheat varieties at different growth intervals. (2006-07 and 2007-08)

Varieties	30 DAS				60 DAS				90 DAS			
	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean
Halna	142.75	186.37	240.87	190.00	150.41	256.00	266.25	224.22	232.77	310.36	344.20	295.78
Raj 3765	140.37	190.75	243.87	191.66	154.37	265.62	274.37	231.45	231.24	314.31	349.30	298.28
NW 1014	147.25	174.50	216.62	179.46	149.73	236.50	241.00	209.08	236.34	270.33	316.27	274.31
PBW 343	149.12	169.25	210.75	176.37	142.12	229.12	237.12	202.79	232.35	266.35	314.24	270.98
HD 2643	144.10	174.75	213.87	177.57	150.12	232.62	245.62	209.45	229.25	272.32	309.32	270.30
HP 1744	143.25	175.75	205.87	174.96	153.00	238.00	241.50	210.83	229.26	274.35	310.32	271.31
NW 2036	144.37	198.12	239.62	194.04	157.75	269.50	279.37	235.54	230.23	289.25	351.23	290.24
DBW 14	143.25	177.00	217.37	179.21	149.87	236.75	244.12	210.25	230.28	271.26	322.27	274.60
NW 1076	145.12	193.87	221.25	186.75	145.87	239.87	243.87	209.87	229.29	279.31	314.29	274.30
Sonalika	142.00	199.00	231.37	190.79	151.87	271.62	281.30	234.93	229.34	301.29	352.27	294.30
HD 2285	138.00	172.37	221.00	177.12	153.00	260.12	275.12	229.41	229.36	327.27	349.23	301.95
HD 2307	139.25	175.47	217.12	177.28	150.37	239.25	246.12	211.91	233.28	281.37	317.28	277.31
K 8962	144.50	205.87	234.00	194.79	145.37	274.12	284.25	234.58	234.29	322.35	357.81	304.82
UP 2425	142.37	172.87	214.37	176.54	152.50	229.00	240.75	207.42	229.37	268.34	317.33	271.68
HP 1633	147.25	178.62	220.12	182.00	148.50	233.87	243.87	208.75	228.33	279.28	312.25	273.29
Mean	143.53	182.97	223.20		150.32	247.46	256.31		231.00	288.52	329.17	
C.D. at 5%	V = 9.97, S=10.28, V at S = 16.96, S at V = 18.42				V = 13.22, S=16.71, V at S = 22.90, S at V = 25.89				V = 17.38, S=14.66, V at S = 30.11, S at V = 31.59			

Table 4 : Effect of late sowing on SOD activity (unit g^{-1} fresh wt. $min.^{-1}$) in leaves of wheat varieties at different growth intervals (2006-07 and 2007-08)

Varieties	30 DAS				60 DAS				90 DAS			
	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean
Halna	229.30	287.83	345.45	287.53	283.42	387.93	452.72	374.69	353.91	451.02	488.05	430.99
Raj 3765	226.40	285.66	347.39	286.48	288.51	400.58	459.74	382.94	379.58	453.16	497.26	443.33
NW 1014	223.81	264.61	314.37	267.60	277.89	358.66	417.71	351.42	377.98	418.92	433.98	410.29
PBW 343	227.62	267.06	307.41	267.36	273.54	343.54	401.73	339.60	370.27	405.66	423.66	399.86
HD 2643	224.67	260.41	313.44	266.17	253.26	357.57	408.78	339.87	368.54	411.48	435.44	405.15
HP 1744	227.00	268.25	316.43	270.56	279.14	369.59	416.72	355.15	376.66	409.31	432.41	406.13
NW 2036	225.64	276.51	349.45	283.87	282.75	388.15	467.75	379.55	378.25	459.63	490.73	442.87
DBW 14	220.73	269.40	311.47	267.20	279.42	366.59	415.73	353.91	376.58	405.93	430.83	404.45
NW 1076	228.09	261.10	329.46	272.88	270.95	361.29	418.74	350.33	371.17	409.44	437.32	405.98
Sonalika	226.22	285.98	359.45	290.55	278.42	393.63	465.76	379.27	374.05	466.36	488.46	442.96
HD 2285	223.88	293.06	351.44	289.46	297.85	397.81	468.78	388.15	374.03	460.55	497.46	444.01
HD 2307	228.21	268.80	314.41	270.47	282.56	353.72	409.77	348.68	368.16	407.78	435.43	403.79
K 8962	224.77	293.33	353.42	290.51	287.14	390.06	475.75	384.32	379.47	471.29	501.32	450.69
UP 2425	229.52	263.32	317.43	270.09	285.50	355.43	407.73	349.55	367.32	410.15	438.03	405.17
HP 1633	227.51	267.17	314.47	269.72	281.07	357.15	413.70	350.64	366.52	408.70	435.32	403.51
Mean	226.22	274.17	329.70	276.70	280.09	372.11	433.41	361.87	372.17	429.96	457.71	419.95
C.D. at 5%	V = 15.87, S=13.27, V at S = 27.50, S at V = 28.82				V = 20.52, S=17.62, V at S = 35.55, S at V = 37.38				V = 25.25, S=21.54, V at S = 43.74, S at V = 45.96			

experiment show strong correlation between starch disappearance and enhancement of α-amylase activity. Under temperature stress, current photosynthets are limited which leads to degradation of starch in to soluble sugar to meet the plant energy requirement. This increases the activity of α-amylase. It is also evident from the result that varieties which showed higher α-amylase activity under late sowing had lower starch content and *vice-versa*.

The activities of antioxidant enzymes *viz*., catalase, peroxidase and super oxide dismutase increased gradually in all varieties with increase in the age of the crop up to 90 DAS under both normal and late sown condition. Late sowing induced higher activity of all above enzymes and all the varieties exhibited higher activity under both 15 and 30 days late sowing than normal sowing. Highest activity of all these enzymes were recorded under 30 days late sowing at 90 DAS.

The oxidative damage to cellular components is limited under normal growing condition due to efficient processing of reactive oxygen species (ROS) through a well coordinated and rapidly responsive antioxidant system consisting of several enzymes and redox metabolites. However, under various abiotic stresses the extent of ROS production exceeds the antioxidant defense capability of the cell, resulting in cellular damages. It is clear from the data that there was a significant increase in the antioxidant enzymes activity in response to late sowing. Tolerance to high temperature stress in crop plants has been reported to be associated with an increase in antioxidant enzyme activity (Sairam *et al.*, 2000; Zhau *et al.*, 1995; Badiani *et al.*, 1994). As far as, varietal response was concerned, under normal sowing, the different varieties showed non significant difference activity of all above enzymes at various growth intervals, however, under late sowing and particularly under 30 days late sowing a great variation existed among the varieties. K 8962, HD 2285, NW 2036, Raj 3765 and Sonalika showed greater increase in activities of catalase, peroxidase and SOD than other varieties under 30 day late sowing. This indicates that these varieties have better scavenging capacity and higher tolerance to heat stress than other varieties. Whereas, UP 2425, HP 1744, PBW 343, HP 1633, NW 1014 and NW 1076 showed lower expression of above enzyme under 30 days late sowing, which shows that these varieties have little or in adequate H_2O_2 scavenging mechanism and hence, poor temperature tolerance.

Catalase and peroxidase activity is associated with scavenging of H_2O_2. An increase in its activities is related with increase in stress tolerance (Foyer *et al.*, 1997; Olmos *et al.*, 1994). Involvement of SOD in temperature stress tolerance has been also advocated by Alscher *et al.*, 2002. A perusal of the data showed that varieties, superoxide dismutase converts one form of ROS (O_2) to another equally toxic one (H_2O_2). A tolerant varieties thus preferably should have greater expression of most of the antioxidant enzymes such as SOD and Halliwell-Asada Pathway enzymes (APX, DHAR, MDHAR, GR) as well as catalase.The present study conclude that activity of enzyme α-amylase and antioxidant enzymes *viz*., catalase, peroxidase and super oxide dismutase (SOD) in leaves increased gradually in all the varieties up to 90 DAS under both normal and late sown condition. Late sowing caused a tremendous increase in activity of above enzymes in all varieties and magnitude of increase was more under 30 days late sowing than 15 days late sowing. As far as, varietal response is concerned, under late sowing, activity of all antioxidant enzymes were higher in Raj 3765, HD 2285, Sonalika, NW 2036, Halna and K 8962 but in case of α-amylase these varieties showed lower activity than other varieties.

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