Study of heat tolerance in *durum* wheat through timely and late sown condition

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ABSTRACT

The genotype having inbuilt tolerance to drought and high temperature must be characterized for their further use in breeding programme. Accordingly the present investigation was planned to study the tolerance to high temperature by planting the genotype in normal date of sowing (second week of November) and late date of sowing (second week of December) to expose the crop to high temperature during February and March in north Gujarat condition of central zone. Estimated heat tolerance for grain yield per plant by the 'heat susceptibility index (S) which scales the reduction in parental genotype performance from cool to hot condition related to the respective mean reduction over all genotypes. The parental line BAWAJI was found tolerant to heat as it registered minimum heat susceptibility index. The cross combination GW 1239 x GW 1189 was promising for both the sowing conditions for generating heat tolerant segregants in durum wheat. For late sown condition only, the crosses GW 1139 x GW 1240 and GW- 02-51 x VDW- 99-176 found having potential to throw good segregants for tolerance to heat.

Gami, R.A., Tank, C.J., Thakor, D.M., Patel, S.S. and Patel, C.G. (2011). Study of heat tolerance in *durum* wheat through timely and late sown condition. *Internat. J. agric. Sci.*, **7**(1): 13-16.

Key words : Tolerance, Drought, Heat susceptibility index, Segregants

INTRODUCTION

Triticum durum Desf, the macaroni wheat is the second most important species of wheat in India. Its cultivation is confined to central and penisular zones. The best quality *durum* wheat is produced in central zone under rainfed condition. The best quality *durum* wheat is produced in central zone under rainfed condition. Considering the global climate changes, wheat research in India has been now directed with breeding objective of tolerance to high temperature and drought. The genotype having inbuilt tolerance to drought and high temperature must be characterized for their further use in breeding programme. Temperature is critical factor affecting plant growth and development. Normal plant growth and subsequent grain yield are realised under optimum environment conditions. High temperature above 28^0C during grain development is the single most important factor that limits productivity of wheat in India (Singh *et al.*, 2005). The present study was undertaken with two planting dates so as to expose the late sown crop to raised temperature during grain filling stage.

MATERIALS AND METHODS

The present investigation consisted of eight diverse parental lines of durum wheat (*Triticum durum* Desf.) and their twenty-eight F1s (excluding reciprocals). The parental lines *viz.*, GW-02-51, VDW-99-176, RD-1009, GW1139, GW1239, GW1189, BAWAJI and GW 1240 were selected from germplasm maintained at Wheat Research Station, Vijapur, (North Gujarat), during winter, 2007-08 and these lines were crossed in diallel mating design. The complete set of 36 genotypes comprising eight parental genotypes and 28 F1's were evaluated in Randomized Block Design with three replications during winter 2008-09 under two date of sowing (2nd week of November and 2nd week of December). The 'heat susceptibility index' was calculated for each experimental genotype according to Fisher and Maurer (1978). It is calculated by formula S= (1-Y/Yp) / (1-X/Xp), where, Y= Yield under stress condition, Yp = Yield under without stress condition, X = Mean yield over stress condition, Xp= Mean yield over without stress condition.

RESULTS AND DISCUSSION

The comparison of different growth stages the crop against weekly minimum and maximum temperature is presented in Table 1. The timely sown crop was expected to raised minimum temperatures (5^0 C more than average) during initial growth and tillering stage. The crop again exposed to raised maximum temperature (>28^0 C) during grain filling stage during standard week 5 to 6.

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Table 1 : Comparison of the ambient air temperature (Min. and Max.) with different growth stages of *durum* wheat at Vijapur (North Gujarat)

Month	Standard week	Temperature (^oC)				Crop stages	
		Mean of 2003-08		2008-09			
		Max.	Min.	Max.	Min.	Timely sown condition	Late sown condition
	45	33.86	18.64	35.1#	24.4*		
November	46	34.4	17.6	34.1#	24.3*	Sowing	
	47	33.64	15.92	32.0#	25.3*		
	48	32.52	14.52	31.4#	25.0*	Adventitious rooting	
	49	30.84	13.88	35.3#	23.9*		
December	50	27.76	12.4	36.3#	23.1*	Tillering	Sowing
	51	27.28	12.16	33.0#	19.4*		
	52	27.18	13.98	35.4#	15.6		Adventitious rooting
	01	25.84	10.76	28.9#	9.6	Flowering/ Days to heading	
January	02	26.22	11.1	26.5	12.6		Tillering
	03	27.32	10.64	29.5#	16.5*		
	04	25.44	9.36	28.3#	11	Grain filling period	Flowering/ Days to heading
	05	27.58	10.48	29.5#	10.3		
February	06	28.12	10.98	29.3#	10.7		
	07	30.1	12.34	30.4#	18.5	Physiological maturity	Grain filling period
	08	31.36	12.86	33.7#	14.7		
	09	33.86	14.8	36.1	18.1	Maturity	Physiological maturity
March	10	33.58	15.42	35.6	14.7		
	11	34.68	16.46	36.1	17.1		Maturity
	12	37.12	18.38	35.7	19.2		

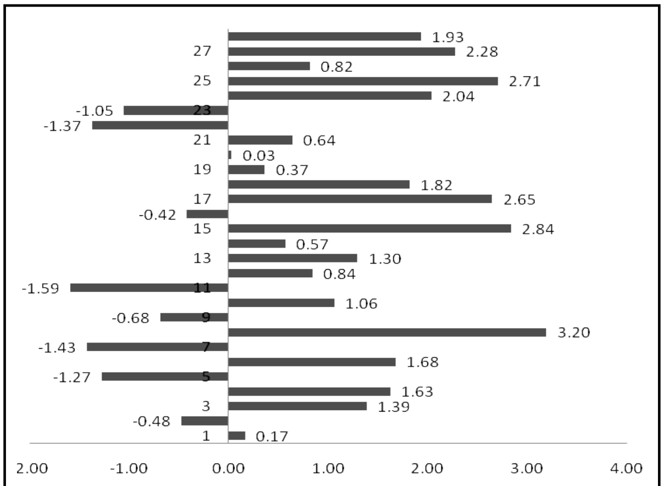
* indicates increased minimum air temperature (5^0C more than average), # increased maximum air temperature (> 28^0C)

The late sown crop experienced raised minimum temperatures at tillering stage during standard week 03. The crop again experienced raised maximum temperature at flowering and grain filling stage during standard week 5 to 9. Thus both the sowing conditions, crop experienced raised temperatures during the one or more stages. The Table 1 revealed that the crops planted in both the dates experienced temperature rise during tillering, and grain filling stages.

The heat susceptibility index estimated for a genotype, the reduction on grain yield from normal to stress environment related to the respective mean reduction for all genotype was worked out. The variation among parent and hybrids in heat susceptibility was greatest for grain yield per plant which presented in Fig.1 and Fig.2.

The population mean was sharply decreased in late sown crop as against normal sown crop for grain yield per plant (11.06 g against 13.50 g), 1000-grain weight (45.78 g against 55.87 g) harvest index (28.82 % against 43.52 %), number of effective tillers (5.30 against 7.57), days to maturity (95.83 days against 106.58days) and flag leaf duration (37.56 days against 61.15 days). Number of studies revealed reduction in either grain yield or yield components when crop experienced higher air temperature frequently during tillering, flowering and grain filling stages, (Macas *et al*., 2000 and Gibson and Paulsen, 1999). Shpiler and Blum (1986) reported number of grain per spikelets, duration of grain filling and spikelets per spikes as heat sensitive traits and these traits as criteria for selection for heat-tolerance in bread wheat. These characters are sensitive to heat and therefore, can be used as parameters for indirect selection for heat tolerance. Indirect selection for heat tolerance through yield and yield components can be a rational strategy (Clarke and Tounley Smith, 1984). The yield selection in stresses environment is advocated on the basis of the premise that above average yield under stress conditions must be a result of tolerance to the stresses. Therefore, as in present study grain yield per plant, 1000-grain weight, harvest index, number of effective tillers, duration of flag leaf and days to maturity were found sensitive to heat under late sown condition. They can be used in screening germplasm for indirect selection for tolerance to heat in durum wheat.

A comparison of superior genotype with respect to heat susceptibility index and other parameter is presented in Table 2. The parental line BAWAJI found tolerant to heat as it registered minimum heat susceptibility index, it



1 =	GW-02-51 X RD-1009	15=	VDW-99-176 X GW 1239
2 =	GW-02-51 X VDW-99-176	16=	VDW-99-176 X GW 1189
3 =	GW-02-51 X GW 1139	17=	VDW-99-176 X BAWAJI
4 =	GW-02-51 X GW 1239	18=	VDW-99-176 X GW 1240
5 =	GW-02-51 X GW 1189	19=	GW 1139 X GW 1239
6 =	GW-02-51 X BAWAJI	20=	GW 1139 X GW 1189
7 =	GW-02-51 X GW 1240	21=	GW 1139 X BAWAJI
8 =	RD-1009 X VDW-99-176	22=	GW 1139 X GW 1240
9 =	RD-1009 X GW 1139	23=	GW 1239 X GW 1189
10=	RD-1009 X GW 1239	24=	GW 1239 X BAWAJI
11=	RD-1009 X GW 1189	25=	GW 1239 X GW 1240
12=	RD-1009 X BAWAJI	26=	GW 1189 X BAWAJI
13=	RD-1009 X GW 1240	27=	GW 1189 X GW1240
14=	VDW-99-176 X GW 1139	28=	BAWAJI X GW1240

Fig. 1 : Heat susceptibility index (S) graph of hybrids for grain yield per plant

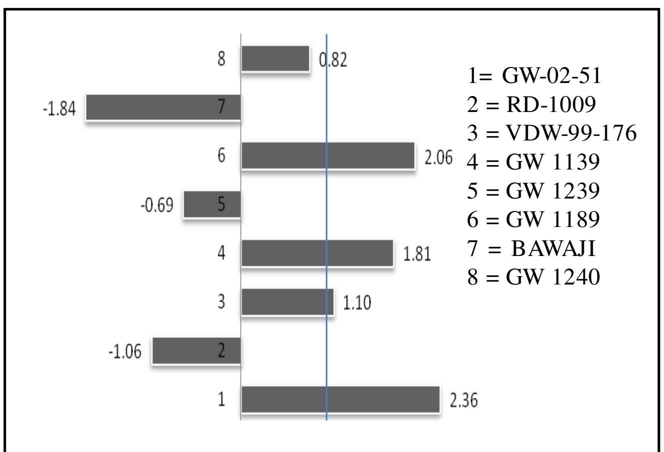


Fig. 2 : Heat susceptibility index (S) graph of parents for grain yield per plant

was above average for grain yield per plant under late sown condition and having good general combining ability for grain yield per plant, 1000 grain weight, harvest index,

Table 2: Comparison of superior genotype with respect to heat susceptibility index and other parameters

Sr. No.	Genotypes	Heat Susceptibility index (S)	Grain yield per plant (g) *per se* performance and (GCA effects)		*Per se* performance											
					Effective tillers per plant		1000 grains weight (g)		Harvest index (%)		Grains per spike		Grain protein (%)		Duration of flag leaf	
			Timely sown	Late sown	Timely sown	Late sown	Timely sown	Late sown	Timely sown	Late sown	Timely sown	Late sown	Timely sown	Late sown	Timely sown	Late sown
Parents																
1.	BAWAJI	1.84	11.60 (G)	15.46 (G)	6.39	6.79	54.82	41.97	60.90	35.71	44.33	44.86	18.77	18.51	60.78	37.33
2.	RD 1009	1.06	8.13 (P)	9.69 (P)	7.02	4.50	59.54	38.41	27.88	19.06	42.11	43.45	18.80	18.15	62.67	34.00
3.	GW 1239	0.69	8.06 (G)	9.06 (A)	5.33	5.22	46.76	51.11	42.83	15.55	47.11	45.14	19.07	18.20	57.90	35.00
Hybrids																
1.	RD 1009 x GW 1189	1.59	9.45 (P x P)	12.17 (P x A)	7.78	4.89	53.60	58.71	35.25	29.45	44.11	42.83	18.47	18.26	58.85	37.00
2.	GW 1139 x GW 1240	1.37	11.81 (A x G)	14.74 (A x A)	7.52	4.63	49.40	52.45	36.58	35.21	42.89	43.62	16.80	19.34	62.88	38.67
3.	GW 1239 x GW 1189	1.05	13.50 (G x P)	16.06 (A x A)	11.08	5.69	64.18	55.30	52.76	35.91	42.56	44.02	16.17	17.70	59.86	35.00
4.	RD 1009 x GW 1139	0.68	11.27 (P x A)	12.66 (P x A)	8.00	5.67	63.54	61.90	26.75	34.02	49.56	47.83	17.80	19.90	63.67	39.67
5.	GW 02 51xVDW 99 176	0.48	14.06 (A x A)	15.27 (G x P)	5.72	6.11	54.64	53.18	50.55	34.25	50.56	49.71	16.53	18.81	58.09	37.67
6.	GW 1139 x GW 1189	0.03	12.14 (A x P)	12.07 (A x A)	9.11	4.88	45.21	52.77	43.73	50.07	43.11	42.42	16.23	18.73	62.67	36.33
7.	GW 02 51 x RD 1009	0.17	13.83 (A x P)	13.41 (G x P)	9.44	6.06	72.47	31.48	36.69	28.99	47.00	46.12	19.73	18.70	58.40	39.00
8.	GW 1139 x BAWAJI	0.64	16.53 (A x G)	14.61 (A x G)	7.00	5.00	59.13	51.27	50.60	25.92	50.78	50.51	17.77	18.20	63.33	37.00
	General Mean		13.50	11.06	7.57	5.30	55.87	45.78	43.52	28.82	45.60	45.65	17.73	18.39	61.15	37.56
	S.E.	0.003	0.71	0.59	0.36	0.30	0.75	0.67	1.69	1.43	1.69	0.96	0.29	0.41	1.42	0.88

* and ** indicates significance of values at P 0.05 and P 0.01 levels, respectively

grain protein, length of main spike and grain per spike for both the conditions. It was also good general combiner under late sown condition for effective tillers and flag leaf duration.

The superior crosses having minimum heat susceptibility index in Table 2 expressed sca effects irrespective of their susceptible index. The cross combinations GW 1239 x GW 1189 and GW 1139 x BAWAJI under both the conditions were above average with respect to grain yield per plant, effective tillers per plant, 1000-grain weight and harvest index. Under late sown condition these crosses involved average to good general combiner parents for most of important trait like effective tillers per plant, 1000-grain weight and harvest index. This cross was promising for generating heat tolerant segregants for the improvement of durum wheat.

For late sown conditions the crosses GW 1139 x GW 1240 and GW-02-51 x VDW-99-176 involved averages to good general combiner parents for grain yield per plant, effective tillers per plant, 1000-grain weight, harvest index and duration of flag leaf. These two crosses were found having potential to throw good segregants for tolerance to heat.

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Received : May, 2010; Accepted : July, 2010