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PERFORMANCE FOR GRAIN YIELD AND QUALITY TRAITS OF DURUM WHEAT (*Triticum turgidum* var. Durum) UNDER LATE SOWN CONDITIONS

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ABSTRACT

A study was conducted to assess the potential of durum wheat genotypes for grain yield and quality traits under late sown conditions, in comparison with popular bread wheat cultivars. Under late sown conditions, durum wheat genotypes had high 1000 grain weight and hectoliter weight compared to bread wheat check varieties, Lok-1 and DL 788-2. Their grain appearance was normal with minimum incidence of yellow berry (grain mottling). Mean grain yield pooled over locations indicated that genotypes HI 8627, HI 8662, HI 8670, HI 8672, HI 8673, and Raj 1555 were superior or on par with bread wheat checks. Hectoliter weight and protein content of the durum wheat genotypes was comparable to the bread wheat check varieties; whereas, yellow pigment content and hardness of the durum wheat genotypes were not affected due to late sown conditions. Over the years, grain yield and quality characteristics viz., grain appearance, test weight, protein content and sedimentation value were not affected much due to late sowing in comparison with bread wheat varieties. Hence, early maturing durum wheat genotypes can be successfully grown under late sown conditions with bread wheat varieties without any adverse effect on grain yield and quality traits. Growing durum wheat varieties under late sown conditions can diversify the wheat cultivation thereby minimizing the chances of any rust epidemics build-up. The area and production can be increased by recommending to the farmers of these zones to grow durum wheat varieties to improve their overall economy of their farms by exploiting its demand in upcoming fast food industry and export potential.

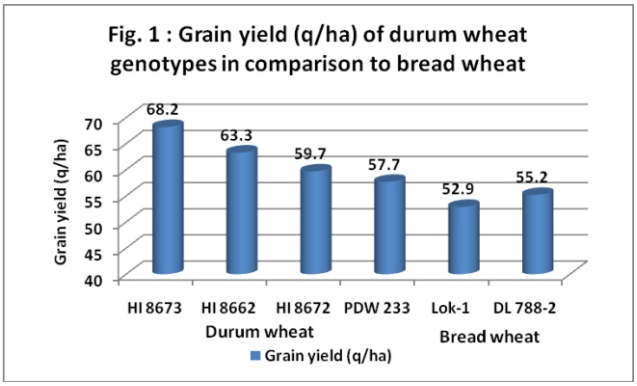
Key words : *Durum wheat, export potential, grain yield, late sown and quality traits.*

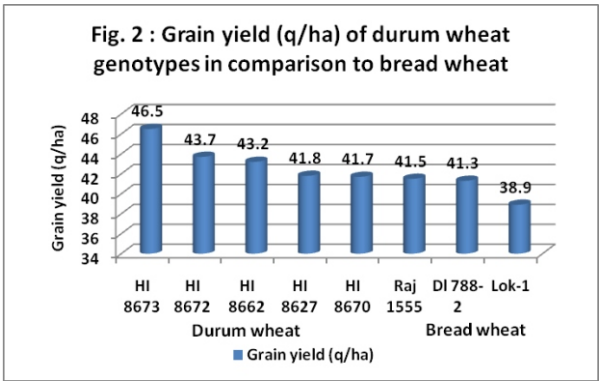
Wheat is one of the most durable and dependable cereal crops after rice, grown under diverse agro-climatic conditions, and which provides 20% of the total food calories of human requirement. The diverse environmental conditions and food habits support the cultivation of three species of wheat viz., *Triticum aestivum, T. turgidum* var. durum, and *T. turgidum* var. dicoccum in our country. Durum wheat is the hardest of all wheat species and is usually bold, translucent with golden colour and higher gluten strength; and is consumed mainly in the form of semolina (suji) and fast food products (pasta products). India is a major durum wheat producer with 2.5 million tones of annual production. It has tremendous export potential due to increasing global demand, value addition potential, better price in international market and resistance to Karnal bunt. The best quality durum is produced in regions having a relatively dry climate, with hot days and cool nights during the growing season. Central India comprising of Madhya Pradesh, Gujarat, Maharashtra, Karnataka and Southern Rajasthan produces high quality durum grain with good hectolitre value, high protein and less yellow berry incidence.

In recent years, intensified research has led to the development of distinctly superior varieties of durum wheat yielding on par or superior than the improved bread wheat varieties; which helped in increasing the area and production under durum wheat in the country, particularly in central India. However, efforts are being focused on developing durum wheat varieties suitable for early sown rainfed and timely sown irrigated conditions; ignoring their potential for late sown cultivation due to a myth that yield and quality of durum wheat deteriorate under late sown conditions. This study was conducted to assess the potential of durum wheat genotypes for grain yield and quality traits under late sown conditions in comparison to popular bread wheat varieties.

MATERIALS AND METHODS

An experiment was conducted involving eighteen durum genotypes viz., HI 8381, HI 8498, HI 8591, HI 8627, HI 8638, HI 8662, HI 8663, HI 8664, HI 8668, HI 8670, HI 8671, HI 8672, HI 8673, HD 4672, WH 896, PDW 233 and NIDW 295 along with two bread wheat checks Lok-1 and DL 788-2 at Indian Agricultural Research Station, Regional Station, Indore, Madhya Pradesh during two rabi seasons (2006-08). The experiment was sown in RBD design with three replications on 10th December during both the years. Each entry was raised in a plot of 6 rows of 6 m length with spacing of 18 cm between row-to-row. The recommended agronomic practices were followed for raising the crop. The same set of lines was evaluated at ZARS, Powarkheda, Madhya Pradesh during rabi, 2007-08. The grain yield and some quality parameters were estimated. Also, grain yield and quality parameters of advanced durum breeding lines were evaluated during 2009 to 2014 from the All India Co-ordinated Wheat Trials conducted in NWPZ, NEPZ, CZ and PZ were compared with the corresponding bread wheat checks of that





particular zone. The statistical analysis was done with the help of suitable statistical procedures [1].

RESULTS AND DISCUSSION

The grain yield data over two years (2006-08) from the experiment conducted under late sown conditions at IARI-RS, Indore showed that HI 8673 (68.2 q/ha), HI 8662 (63.3 q/ha), HI 8672 (59.7 q/ha) and PDW 233 (57.7 q/ha) gave higher grain yield than both the bread wheat checks Lok-1 (52.9 q/ha) and DL 788-2 (55.2 q/ha) (Fig 1). Durum wheat genotypes had high 1000 grain weight and hectoliter weight compared to bread wheat check varieties, and grain appearance was normal with minimum incidence of yellow berry under late sown conditions.

From the trials conducted at IARI-Regional Station, Indore and ZARS, Powarkheda during rabi 2007-08, it was observed that durum wheat genotypes HI 8673 (62.7 q/ha) and HI 8662 (59.4 /ha) showed significantly superior grain yield at Indore centre compared to the bread wheat check varieties DL 788-2 (51.7 q/ha) and Lok-1 (52.3 q/ha). Whereas, at Powarkheda, genotypes HI 8627 and HI 8670 yielded superior than DL 788-2; and HI 8498, HI 8627 and HI 8670 showed significantly higher grain yield than Lok-1. Mean grain yield pooled over locations indicated that, among 18 durum wheat entries, HI 8627 (41.8 q/ha), HI 8662 (43.2 q/ha), HI 8670 (41.7 q/ha), HI 8672 (43.7 q/ha), HI 8673 (46.5 q/ha), and Raj 1555 (41.5 q/ha) were superior or on par with bread wheat checks Lok-1 (38.9 q/ha) and DL 788-2 (41.3 q/ha) (Fig. 2).

The grain samples from both the locations were analysed in the quality lab of Directorate of Wheat Research (IIWBR), Karnal (Table 1). The 1000 grain weight of all the durum wheat genotypes was more than that of Lok-1; and seven lines showed higher test weight than that of DL-788-2. HI 8664 (54.3 g) and HI 8498 (53.6 g) showed higher 1000 grain weight compared to other durum wheat genotypes and significantly superior than the bread wheat check varieties. Grain appearance of a number of durum wheat genotypes viz., HI 8664 (7.1), PDW 233 (7.1), HI 8672 (6.8), HI 8663 (6.8) and HI 8498 (6.7) was found superior compared to bread wheat check varieties Lok-1 (6.1) and DL 788-2 (5.8). Hectoliter weight and protein content of the durum wheat genotypes was comparable to the bread wheat check varieties; whereas, yellow pigment content and hardness of the durum wheat genotypes were not affected due to late sown conditions as reported earlier [2]. Minimum incidence of yellow berry was noticed in most of the durum wheat genotypes, and which was comparable to the bread wheat varieties. Thus, these results break the myth that durum wheat lines do not yield well and their quality parameters are adversely affected under late sown conditions [3]. Per-se performance of some genotypes under late sown

Table 1 : Quality traits of selected durum wheat genotypes in comparison to bread wheat varieties under late sown conditions.

Varieties	Grain wt. (g)	Grain appearance	Hectoliter weight (kg/l)	Protein (%)	SDS value (ml)	-carotene (ppm)	Hardness	Yellow berry (%)
Durum wheat								
HI 8673	43.0	6.2	81.5	10.5	41	5.4	88	5.7
HI 8672	49.3	6.8	83.1	10.7	26	6.2	82	8.6
HI 8662	51.7	6.6	83.8	11.0	32	5.3	83	5.6
HI 8627	47.9	6.4	83.5	10.8	30	5.7	84	9.6
Raj 1555	51.6	6.4	83.0	10.6	34	4.1	78	5.7
HI 8498	53.6	6.7	83.7	10.6	35	4.3	84	7.9
HI 8638	50.6	6.5	83.7	10.8	33	5.5	89	8.3
HI 8663	45.2	6.8	83.7	10.9	32	5.7	90	6.2
HI 8664	54.3	7.1	83.3	11.5	38	5.5	80	0.2
PDW 233	47.9	7.1	83.7	10.8	34	7.8	92	2.5
Bread wheat								
Lok-1	42.8	6.1	81.8	11.0	44	2.3	68	3.6

Table-2 : Grain yield (q/ha) and quality traits of durum wheat genotypes in comparison to bread wheat check varieties under late sown and timely sown conditions of All India Wheat Co-ordinated Trials (NIVT-3 & 4).

Varieties		Grain yield (q/ha)			Grain appearance (0-10)			Test weight (kg/l)			Protein (%)			SDS (ml)		
		NWPZ	CZ	PZ	NWPZ	CZ	PZ	NWPZ	CZ	PZ	NWPZ	CZ	PZ	NWPZ	CZ	PZ
Rabi 2009-10																
NIVT-3 (Late sown)	HI 8710 (d)	33.9	43.4	36.2	6.0	5.5	6.0	77.4	78.0	80.0	12.9	14.1	13.6	40	46	46
	HI 8711 (d)	34.2	41.6	29.7	5.4	5.5	5.7	76.8	82.8	80.8	12.9	13.8	13.5	36	44	41
	PBW 373 (Aes)	35.5	38.6	35.6	5.4	6.0	5.3	74.2	76.7	76.7	12.4	13.6	12.6	36	46	39
	MP 4010 (Aes)	36.6	43.9	28.5	5.8	6.5	6.0	77.6	83.2	85.2	12.6	12.6	13.1	37	40	40
	HD 2932 (Aes)	37.2	45.8	38.1	5.8	6.3	6.0	76.3	81.8	80.4	11.8	13.3	13.4	37	41	44
	CD	2.9	4.2	7.2												
NIVT-4 (Timely sown)	HI 8498 (d)				5.4	5.8	4.9	78.9	82.9	82.9	12.0	12.1	12.4	32	38	33
	NIDW 295 (d)				4.7	6.0	5.5	74.3	79.9	78.5	11.8	12.2	12.4	34	37	34
	PDW 291 (d)				5.2	5.6	6.0	76.9	81.0	82.3	11.9	12.1	12.1	33	35	35
Rabi 2010-11																
NIVT-3 (Late sown)	HI 8723 (d)	38.6	40.9	40.8	5.0	5.8	6.7	75.9	80.4	80.3	12.5	12.9	12.0	38	40	38
	PBW 590 (Aes)	38.6	41.7	42.1	5.4	6.3	5.7	75.8	77.9	78.8	13.2	13.1	13.0	45	44	45
	MP 4010 (Aes)	34.1	42.8	40.6	5.6	6.8	6.7	75.5	79.7	81.0	12.6	12.8	11.6	40	39	34
	HD 2932 (Aes)	39.8	44.0	40.6	5.0	6.0	6.3	73.7	77.9	78.1	12.0	12.4	12.7	36	38	42
	CD	2.7	4.2	5.2												
NIVT-4 (Timely sown)	HI 8498 (d)				5.9	5.8	5.3	80.4	83.2	83.1	12.0	12.1	12.4	41	43	38
	NIDW 295 (d)				5.7	5.8	5.4	75.7	79.3	81.0	12.3	12.2	12.3	43	37	39
	PDW 291 (d)				6.1	5.8	5.5	79.7	81.4	74.3	12.1	12.3	12.1	32	33	30
Rabi 2011-12																
NIVT-3 (Late sown)	HI 8734 (d)	43.8	43.8	38.6	4.7	6.4	5.1	77.1	79.5	80.0	10.8	12.6	11.1	37	37	38
	PBW 590 (Aes)	42.8	43.4	40.2	5.1	5.2	6.0	77.2	78.9	77.3	11.1	13.2	13.4	38	43	46
	MP 4010 (Aes)	41.6	44.1	41.3	5.3	6.4	6.0	77.1	80.9	79.7	10.8	12.8	12.0	36	38	42
	HD 2932 (Aes)	43.0	42.3	40.5	4.7	6.0	5.4	76.0	78.1	76.5	10.7	12.9	13.8	35	38	46
	CD	2.8	3.8	4.8												
NIVT-4 (Timely sown)	HI 8498 (d)				5.4	6.6	5.7	79.2	82.4	81.9	11.3	11.7	12.2	39	40	46
	NIDW 295 (d)				5.5	6.1	5.8	77.5	80.3	79.3	11.6	11.8	12.1	46	42	39
	PDW 291 (d)				5.2	6.0	6.1	79.4	81.1	80.9	11.9	11.9	12.1	48	38	30

NWPZ = North Western Plains Zone, CZ = Central Zone, PZ = Peninsular Zone, (Aes) = bread wheat and (d) = durum

Table 2a: Grain yield (q/ha) and quality traits of durum wheat genotypes in comparison to bread wheat check varieties under late sown and timely sown conditions of All India Wheat Co-ordinated Trials (NIVT-3 & 4).

Varieties		Grain yield (q/ha)				Grain appearance (0-10)				Test weight (kg/l)				Protein (%)				SDS (ml)			
		NWPZ	NEPZ	CZ	PZ	NWPZ	NEPZ	CZ	PZ	NWPZ	NEPZ	CZ	PZ	NWPZ	NEPZ	CZ	PZ	NW PZ	NEPZ	CZ	PZ
Rabi 2012-13																					
NIVT-3 (Late sown)	HI 8746(d)	42.1	39.5	44.8	33.8	5.4	4.6	7.0	6.2	78.9	77.3	82.3	80.2	12.3	12.7	12.9	11.9	43	40	43	39
	Checks																				
	WH 1021	40.0	38.6	41.5	33.9	5.7	4.4	5.8	6.4	75.5	73.3	78.1	79.6	12.2	133	13.2	12.6	40	44	44	42
	MP 4010	40.7	36.0	40.0	33.4	5.8	5.0	6.3	6.2	77.4	77.3	81.2	81.3	11.5	11.3	12.3	12.1	38	38	43	42
	HD 2932	41.6	41.2	46.6	37.8	5.0	4.6	7.0	6.1	76.6	74.3	79.8	78.4	12.3	11.7	12.6	11.9	41	38	44	44
	HI 1563	42.3	40.8	43.1	36.2	5.9	5.0	7.2	6.4	78.7	74.2	81.8	80.8	11.5	11.7	11.8	12.0	39	39	42	45
	CD	2.9	4.2	3.6	4.7																
NIVT-4 (Timely sown) Checks	HD 2967					5.6		5.7	6.2	79.7		80.7	80.8	11.7		11.9	11.8	38		48	46
	NIDW 295					5.9		6.6	6.4	78.3		82.3	80.5	11.2		11.6	12.4	44		42	41
	HI 8498					5.8		6.5	6.1	81.1		83.9	81.7	11.5		12.0	12.0	36		45	41
	PDW 314					5.5		6.2	5.9	79.1		81.2	82.8	11.6		11.4	11.6	43		45	37
Rabi 2013-14																					
NIVT-3 (Late sown	HI8756 (d)	47.5	46.5	47.0	45.8	6.0	5.5	7.3	6.4	77.1	76.6	80.0	80.2	11.7	12.1	12.1	11.1	36	38	40	37
	Checks																				
	HI 1563	40.0	42.0	46.1	40.0	5.6	5.5	7.1	7.2	78.2	77.1	79.5	80.7	11.5	10.9	11.9	12.9	37	36	43	50
	MP 3336	39.0	40.6	45.5	42.3	5.7	6.0	6.6	7.4	77.0	79.0	79.7	80.9	11.9	11.5	11.3	12.4	39	39	35	45
	WH 1021	38.7	39.8	46.7	37.6	5.8	5.6	7.1	7.7	76.5	77.1	79.5	80.3	12.0	12.5	12.2	13.1	37	41	41	50
	HD 2932	38.1	44.5	50.9	44.5	4.9	5.5	7.6	7.5	74.3	76.5	78.5	80.2	11.4	10.8	11.6	13.1	34	33	36	47
	CD	2.1	2.3	2.7	4.0																
NIVT-4 (Timely sown) Checks	HI 8498					5.6		6.0	5.8	78.3		83.1	81.0	12.1		12.2	12.4	39		37	42
	HD 2967					5.8		5.6	5.6	80.0		82.3	81.6	12.1		12.3	12.5	39		39	42
	NIDW 295					5.7		5.9	5.9	78.6		82.4	82.3	12.0		12.3	12.1	40		38	39
	PDW 314					5.7		5.6	5.4	78.7		83.2	82.7	12.2		12.4	12.3	39		32	39

NWPZ = North Western Plains Zone, NEPZ = North Eastern Plains Zone, CZ = Central Zone, PZ = Peninsular Zone, (Aes) = bread wheat and (d) = durum

conditions viz., HI 8673, HI 8672, HI 8662 and PDW 233 clearly suggested that grain yield comparable to bread wheat varieties can be realized from the durum wheat. Stability analysis for grain yield (q/ha) of durum wheat genotypes over locations showed that HI 8662 followed by HI 8672, HI 8591, NIDW 295 and HI 8663 had high yield, exhibiting regression coefficient near unity and deviation from regression almost equivalent to zero[4,5,6]. Hence, these varieties can be evaluated on large scale to estimate the actual performance and identify promising cultivars for late sown conditions.

Mean grain yield (q/ha) and quality traits of durum wheat genotypes evaluated during three years (2009-14) along with respective bread wheat check varieties under late sown conditions (NIVT-3) for various zones are presented in Table 2. During rabi 2009-10, durum genotypes HI 8710 and HI 8711 showed on par performance with their respective bread wheat check varieties of those zones. During rabi 2010-11, durum genotype HI 8723 showed on par performance with the respective bread wheat check varieties of three zones; and HI 8734 (durum wheat genotype) showed on par performance with the respective bread wheat check varieties of those zones during rabi 2011-12 also, indicating that durum wheat can be successfully grown under late sown conditions. During rabi 2011-12, in CVT 3 of IARI Common Varietal trials over locations, ID 1130 (HI 8746) gave higher grain yield (49.6 q/ha) compared to bread wheat check variety HD 2932 (45.0 q/ha). In rabi 2012-13, durum genotype HI 8746 showed numerical superiority with respective zonal check variety and on par performance with respective best yielding check variety in North Western Plains Zone (NWPZ), North Eastern Plains Zone (NEPZ) and Central Zone (CZ). A durum wheat genotype HI 8756 in rabi 2013-14 has shown numerically superior performance than respective zonal check variety in CZ and Peninsular zone (PZ); wheareas significantly superior performance than respective best check variety in NWPZ and NEPZ (Table: 2a). Over the years, quality characteristics viz., grain appearance, test weight, protein content and sedimentation value were not affected much due to late sowing in comparison to bread wheat varieties [7]. Although, durum cultivars are recommended for timely-sown conditions (mid-November), production of good quality durum grains with respect to protein content and reduced percentage of the yellow berry free grains could be realised under late planting [8]. It was observed that the quality traits showed non-significant differences in comparison to the durum wheat check varieties grown under timely sown conditions, suggesting that the durum wheat can be grown under late sown conditions without losing much in grain quality. Reports based on heat tolerance, grain yield, water use efficiency and rust resistance show that durum wheat can be successfully grown under the very late-planting heat stress environment in the Vertisols of central India [9].

Performance of durum wheat genotypes over five years under late sown conditions clearly brings out that durum wheat with early maturity trait can be grown along with bread wheat varieties without having any adverse affect on grain yield and quality traits [10]. The potential of durum wheat entries can be exploited under late sowing by planning a perfect breeding programme; and develop durum wheat varieties for late sowing. Breeding for cultivars that are tolerant to post-anthesis high temperature stress and short growing period is an effective strategy to overcome this problem.

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