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Genetic divergence in duram wheat cultivars

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ABSTRACT

To identify the parents for crossing, three way crosses [(GW 1160 x Raj 6550) x PWD 274, (GW 1163 x WH 924) x DW 1001 and (GW 1163 x DW 1001) x AKDW 3085)] and double crosses *viz.*, [(HI 8381 x Raj 6550) x (Raj 1555 x WH 924)] and [(PWD 233 x Raj 6552) x (GW 1163 x DW 1001)] were suggested for breeding durum wheat cultivars. The genetic diversity was studied using the multivariate analysis among 47 durum wheat elite cultivars, using 11 quantitative traits. The grouping of material into 16 clusters indicated that presence of wide range genetic diversity. The maximum inter cluster distance was 20.51 in cluster XII and XVI. The study indicated no definite relationship between geographical and genetic diversity and genetic diversity cannot be used as an index of genetic diversity. The days to maturity, days to 50 per cent flowering, plant height and number of spikelets per ear contributed maximum towards the genetic diversity.

Key words : Durum wheat, Genetic divergencem, Cultivars.

INTRODUCTION

The earlier work for the improvement of durum wheat was taken up in the beginning of this century along with the work on the *aestivum* wheat through pure line selection. As a result of this work, a number of varieties were selected in several parts of the durum growing areas (Gill, 1979). However, the durum wheat went out of cultivation on account of their low yield, susceptibly to lodging and yellow rust. In view of a substantial quality of wheat in the world market, there is need to concentrate the durum wheat improvement work. In any crop improvement programme, the choice of potential parents for hybridization decides the success of varietal breeding programme. The choice of parents based on *per se* performance; ecogeographic diversity has a limited success in the past. The choice of parents for hybridization programme based on multivariate analysis will provide a greater likelihood of promising transgrates. As D^2 statistic seems to be a powerful tool in discerning divergence among based on multiple character and such information is limited for durum wheat, hence attempt has been made to study the genetic diversity in 47 durum wheat cultivars.

MATERIALS AND METHODS

The present stiudy was conducted at wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in *rabi* season in 1997-98. Forty-seven durum wheat cultivars were grown in simple lattice design with two replications. Each variety was sown in six rows of 6 metre length, with 30 cm row distance. Recommended cultural practices were followed to raise a good crop. One metre row was randomly selected and the observation were recorded on 11 traits *viz*., days to flowering, flag leaf area, days to maturity, plant height, number of earheads per meter, number of spikelets per ear, number of grains per ear, seed index, biological yield per meter row length, grain yield per meter row length and harvest index. The data is given in Table 1.

Analysis of variance of plots means for different characters were calculated as per standard procedure. To study the genetic diversity in the above characters, the data were processed further by using Mahalanobis D^2-statistic described by Rao (1952). The simultaneous test of difference between mean values of the character studied, was done by using Wilk's criterion (Rao, 1952). For 47 genotypes, a total of 1081 D^2 values were calculated. The genotypes were grouped into different clusters according to Tocher's method (Rao, 1952).

RESULTS AND DISCUSSION

The mean performance of the genotypes for eleven characters have been presented in Table 1 the days to 50% flowering ranged from 69 to 96 days. The genotype GW 1161 and PBND 527 (69 days) was earliest among 47 genotypes. Flag leaf area ranged from 16.36 (Raj 6550) to 31.84 cm^2 (UPD 67). The mean values for days to maturity ranged from 107.5 to 135.5 days. The genotype GW 1160 matured in 107.5 days followed by WH 924 (108 days). The plant height ranged from 61.4 to 90.9 cm. The genotype GW 1161 recorded 61.4 cm plant height followed by DWR 1011 (62.40 cm) and HD 4679 (62.70 cm). Genotype Raj 6550 had shown maximum number of earheads per metre (90.0) followed by AKDW 3085

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Table 1 : Mean performance of 47 genotypes for eleven characters

Sr. No.	Genotype	Days to 50% flowering	Flag leaf area (cm^2)	Days to maturity	Plant height (cm)	No.of ear heads/m	No.of spikelets/ ear	No. grains / ear	100 seed weight (g)	Biological yield	Grain yield /m	Harvest index (%)
1.	MACS-3049	81.00	19.11	121.50	75.70	50.50	14.40	31.50	3.62	157.50	29.26	18.76
2.	MACS-3061	94.00	21.56	129.00	75.20	63.00	14.50	31.80	4.83	250.00	58.83	24.30
3.	MACS-3121	83.50	22.30	119.50	75.50	62.50	16.70	42.90	4.09	150.00	69.07	45.44
4.	MACS-3125	76.00	22.03	112.50	77.40	71.50	15.40	40.50	4.70	188.50	61.15	32.44
5.	HD-4677	85.50	21.96	131.50	72.20	60.00	16.70	38.70	4.96	189.00	53.83	28.30
6.	HD-4678	83.50	20.79	124.00	72.60	63.00	15.30	42.90	4.91	202.50	54.00	26.55
7.	HD-4679	83.50	25.79	119.50	62.70	45.00	14.80	26.40	5.52	116.00	32.71	27.21
8.	HD-4680	70.50	21.97	115.00	70.20	56.50	16.00	42.90	4.43	157.50	53.74	38.09
9.	HD-4681	86.00	23.05	128.50	80.60	67.50	15.50	40.90	4.41	210.00	60.06	28.62
10.	PDW-274	78.00	24.35	121.50	71.80	65.00	17.00	41.50	4.93	241.00	72.93	31.07
11.	PDW-275	88.50	21.09	127.50	80.30	70.50	15.50	29.90	4.63	219.00	70.18	32.16
12.	PDW-276	89.00	23.87	125.00	72.90	62.00	14.80	34.10	4.65	240.00	56.61	23.59
13.	PDW-277	83.50	19.77	123.50	70.60	71.00	15.60	32.40	4.74	207.50	76.93	37.33
14.	PDW-278	96.00	17.85	126.50	87.70	64.50	17.80	42.50	3.94	217.50	54.06	25.35
15.	DWR-1011	72.00	20.39	117.50	62.40	59.00	14.20	37.00	3.35	163.50	32.94	20.07
16.	DWR-1012	74.50	26.64	125.00	69.30	60.50	14.20	32.20	4.33	185.00	37.20	20.10
17.	DWR-1013	70.50	22.43	116.50	75.10	67.50	15.70	38.30	4.55	207.50	69.55	33.60
18.	DWR-1014	81.00	18.30	125.50	71.60	50.00	18.90	44.10	4.26	153.50	54.88	34.21
19.	Raj-6550	95.50	16.36	135.50	85.10	90.00	13.00	26.90	4.01	320.00	62.43	19.44
20.	Raj-6551	86.50	26.25	120.50	85.60	63.50	14.50	36.20	4.38	150.00	57.03	38.36
21.	Raj-6552	90.00	25.71	135.50	80.60	55.00	14.50	32.75	3.78	240.00	39.94	16.16
22.	Raj-6553	86.00	23.84	123.50	74.60	70.50	16.40	42.30	3.90	217.50	79.12	37.85
23.	NIDW-75	78.50	20.68	121.00	65.80	47.50	14.90	28.10	3.03	147.50	15.31	11.26
24.	NIDW-78	75.50	27.70	119.00	73.60	57.00	16.30	39.20	4.36	207.50	55.53	26.80
25.	NIDW-80	73.50	21.13	116.00	68.90	64.00	16.50	34.30	3.60	187.50	44.23	23.54
26.	HI-8563	78.00	27.65	118.00	68.00	66.00	15.90	32.20	4.53	190.50	42.03	21.97
27.	HI-8570	73.50	22.00	117.00	74.80	69.00	14.40	37.10	4.12	191.00	49.94	25.88
28.	HI-8572	74.00	25.98	122.00	74.30	75.50	15.10	38.90	4.11	225.00	53.51	23.86
29.	GW-1160	72.00	28.57	107.50	69.69	45.00	16.50	28.90	2.61	145.00	19.66	13.19
30.	GW-1161	69.00	17.62	115.50	61.40	61.50	14.00	28.30	3.80	137.50	32.51	23.51
31.	GW-1162	73.50	16.86	117.00	68.40	55.00	16.70	44.20	4.07	110.00	35.74	32.18
32.	GW-1163	85.00	27.88	124.00	83.20	70.00	16.70	41.40	4.41	277.50	95.92	34.47
33.	UPD-66	91.00	22.99	126.00	54.60	37.50	13.50	28.20	3.01	105.00	21.05	19.31
34.	UPD-67	90.00	31.85	123.00	74.40	65.50	17.80	39.40	4.69	247.50	43.73	19.24
35.	WH-924	71.00	26.94	108.00	67.20	38.00	17.20	37.60	3.94	175.00	36.74	21.14
36.	Raj-6546	85.50	25.60	121.00	70.70	64.00	13.90	38.80	4.33	190.00	59.33	31.70
37.	Raj-6547	74.00	19.36	116.00	69.20	62.50	14.10	32.00	4.23	175.00	57.63	31.68
38.	MP-1105	83.00	25.96	116.50	73.90	57.50	15.70	39.10	3.76	92.50	32.51	35.82
39.	MP-1106	72.50	19.85	117.00	69.70	59.50	16.50	33.10	4.37	162.50	42.09	25.83
40.	PBND-527	69.00	21.07	115.00	88.20	64.50	16.00	39.10	5.32	257.00	87.91	35.65
41.	AKDW-3085	91.50	21.70	126.00	86.50	81.50	14.80	35.20	3.99	265.00	64.92	23.61
42.	DW-1001	85.50	21.89	131.00	90.90	72.50	16.80	43.80	4.37	280.00	77.47	27.63
43.	DW-1002	83.50	21.23	123.00	76.40	72.50	14.10	35.00	4.65	235.00	79.71	33.32
44.	HD-4502	71.50	23.42	125.00	72.90	35.00	15.30	33.60	3.95	147.00	25.59	17.48
45.	PDW-233	83.00	24.27	124.00	74.20	55.50	15.20	37.70	3.98	220.00	36.40	16.71
46.	Raj-1555	83.00	22.26	125.50	81.60	79.00	16.90	34.35	4.50	245.00	52.11	20.50
47.	HI-8381	90.00	2.24	128.50	78.20	77.50	14.70	39.70	4.52	210.00	70.45	34.15
	S.E. (±)	2.42	2.24	1.51	2.63	7.70	0.71	3.04	0.28	28.76	12.56	5.78
	Range	69 to 96	16.36 to 31.84	107.5 to 135.5	61.4 to 90.9	35.0 to 90.0	13.0 to 18.9	26.4 to 42.2	2.61 to 5.52	92.5 to 320.0	15.31 to 95.92	11.26 to 45.44

(81.5). The number of spikelets per ear ranged from 13.0 to 18.9 and highest number was recorded by DWR 1014. The highest number of grains per ear was observed in case of genotype GW 1162 (44.20). The highest 100 seed weight was recorded by genotype HD 4679 (5.52 g) and the maximum biological yield was recorded by genotype Raj 6550 (320 g). The grain yield per metre ranged from 15.31 to 95.92 g. The genotype GW 1163 (95.92 g) recorded highest grain yield per metre. This was followed by PBND 527 (81.91 g), DW 1002 (79.71 g) and Raj 6553 (79.12 g). The highest harvest index was recorded by genotype MACS 3121 (45.44 %).

The analysis of genetic diversity indicated considerable genetic diversity among 47 genotypes. Canonical analysis indicated that the overall contribution of first four canonical roots was 81.87 per cent, suggesting completion of major portion of differentiation in the first four phases.

The grouping of genotypes was done by Tocher's method and is presented in Table 2. The 47 genotypes were grouped into sixteen clusters. Cluster I was the largest involving twenty six genotypes from different geographical origin. In this cluster three check varieties *viz.*, HI 8381,Raj 1555 and PDW 233 were included. Four genotypes were grouped into cluster II (HD 4680, GW 1162, DWK 1011, GW 1161). Cluster IV have three genotypes and two genotypes were grouped in cluster XII. Remaining clusters contained only one genotype. It

Table 2 : Grouping of genotypes into different clusters

Cluster number	Number of genotypes	Genotypes
I	26	MACS 3061, PDW 276, PDW 275, DW 1002, PDW 277, HI 8381, HD 4678, HD 4681, Raj 1555, PDW 233, Raj 6553, MACS 3049, GW 1163, PWD 274, HI 8570, NIDW 78, HI 8572, DWR 1013, Raj 6545, Raj 6547, HI 8563, MACS 3121, NIDW 75, MP 1106, NIDW 80, DWR 1012
II	4	HD 4680, GW 1162, DWR 1011, GW 1161
III	1	HD 4502
IV	3	PDD 278, AKDW 3085, Raj 6551
V	1	MP 1105
VI	1	DW 1001
VII	1	Raj 6552
VIII	1	MACS 3125
IX	1	HD 4679
X	1	DWR 1014
XI	1	UPD 67
XII	2	GW 1160, WH 924
XIII	1	HD 4677
XIV	1	UPD 66
XV	1	PBND 527
XVI	1	Raj 6550

Table 3 : Intra and inter-cluster distances for 16 clusters

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	V	XVI
I	5.65	7.08	7.62	7.96	8.31	8.69	8.80	7.24	7.70	7.60	6.92	11.54	7.70	8.03	7.82	11.58
II		4.23	7.25	11.17	8.01	11.67	11.79	7.26	8.56	6.71	9.10	10.32	9.18	8.48	9.09	15.12
III			___	11.25	11.50	7.83	7.56	11.13	11.31	5.90	10.79	13.83	6.59	10.29	8.83	12.37
IV				5.80	8.51	8.68	9.21	7.82	10.18	11.51	7.91	12.86	11.10	10.39	8.68	10.71
V					___	13.36	13.13	5.31	8.33	11.19	7.30	7.44	13.05	8.13	10.30	16.33
VI						___	4.46	12.23	13.49	8.82	10.80	17.14	6.82	12.91	9.13	7.14
VII							___	13.13	13.16	9.53	10.47	17.06	6.95	11.18	11.16	6.44
VIII								___	6.58	10.95	7.38	8.35	12.11	9.76	6.72	15.18
IX									___	10.75	7.11	10.56	10.62	8.01	9.75	15.13
X										___	9.45	13.79	5.35	9.76	10.22	13.31
XI											___	10.30	9.71	8.04	10.26	13.28
XII												4.90	16.59	10.73	12.24	20.51
XIII													___	10.50	10.68	9.80
XIV														___	12.90	14.60
XV															___	12.94
XVI																___

can also be seen from the Table 3 that the genotypes from same geographical region were grouped in different cluster and vice versa. The maximum inter-cluster distance was 20.51 in cluster XII and XVI followed by cluster VI and XII (17.14), VII and XII (17.06) and XII and XVI (16.33).

The days to maturity, days to 50 per cent flowering, plant height and number of spikelets per ear, contributed towards genetic divergence. Overall study of cluster mean for all the character indicated that cluster XVI showed maximum mean for four characters *viz.*, days to 50 per cent flowering, days to maturity, number of earheads per metre and biological yield. Cluster X possessed the highest cluster mean for four character *viz.*, number of spikelets per ear and number of grains per ear. The cluster XI exhibited the highest cluster mean for flag leaf area. Cluster VI possessed the highest cluster mean for plant height, cluster IX recorded highest cluster mean for 100 seed weight. Cluster XV possessed highest cluster mean for grain yield per meter and cluster V exhibited the highest mean for harvest index. (Table 4)

The same clusters contained durum wheat cultivars coming from different region of the country. This indicates lack of parallelism between genetic and geographical diversity. Murty and Arunachalam (1966) have shown that genetic drift and selection in different environment could cause greater diversity among genotypes than their geographical distances. Therefore, selection of parental material for hybridization simply based on geographical diversity, may not be rewarding. The hybridization involving genetically diverse parents belonging to different clusters separated by high inter-cluster values is suggested for achieving desirable recombination. Similar results were reported in durum wheat by Raut *et al*. (1985) and Singh (1994).

The durum wheat improvement programme has been largely confined to use of conventional breeding methods such as pedigree, bulk and back cross method. The varieties which came out of the early breeding programme were mostly the progenies of single crosses. The recombination obtained from single crosses are too restrictive to permit rapid improvement in durum wheat. The pedigree method has been the mainstay of most breeding programmes and desirable traits have been fixed either by selfing of backcrossing. These conventional methods have several limitations such as limited use of available genetic variability resulting in the development of varieties with very narrow genetic base, the restriction of genetic variability and recombination potential through intensive inbreeding and the absence of intercrossing among the progenies (Jenson, 1970). Thus, the breeding programme in durum wheat should be modified so as to overcome limitations pointed out by Jenson (1970). Therefore, more emphasis need to laid on future programmes on multiple crosses to combine genes with high level of grain yield. From this material 5 multiple crosses were suggested for further breeding programme such as three way crosses *viz.*, [(GW 1160 x Raj 6550)

Table 4 : Cluster mean for eleven characters

Vector	Days to 50% flowering	Flag leaf area (cm^2)	Days to maturity	Plant height (cm)	No. of ear heads/m	No. of spikelets/ ear	No. of grains/ ear	100 seed weight (g)	Biological yield (g)	Grain yield/m (g)	Harvest index (%)
I	81.10	23.14	122.19	73.84	65.11	15.41	36.29	4.32	205.83	57.23	27.73
II	71.25	19.21	116.25	65.60	58.00	15.22	38.35	4.00	142.12	38.74	28.47
III	71.50	23.42	125.00	72.90	35.00	15.30	33.60	3.95	147.50	25.59	17.48
IV	91.33	21.94	124.33	86.60	69.83	15.70	37.97	4.10	210.83	58.67	29.11
V	83.00	25.96	116.50	73.90	57.50	15.70	39.10	3.76	92.50	32.51	35.82
VI	85.50	21.89	131.00	90.90	72.50	16.80	43.80	4.37	280.00	77.47	27.63
VII	90.00	25.71	135.00	80.60	55.00	14.50	32.75	3.78	240.00	39.94	16.16
VIII	76.00	22.03	112.30	77.40	71.50	15.40	40.50	4.70	188.50	61.15	32.44
IX	83.50	25.79	119.50	62.70	45.00	14.80	26.40	5.52	116.00	32.71	27.21
X	81.00	18.30	125.50	71.60	50.00	18.90	44.10	4.26	153.50	54.88	34.21
XI	90.00	31.84	123.00	74.40	65.50	17.80	39.40	4.69	247.50	43.73	19.24
XII	71.50	27.75	107.75	68.45	41.50	16.85	33.25	3.27	160.00	28.20	17.17
XIII	85.50	21.90	131.50	72.20	60.00	16.70	38.70	4.96	189.00	53.83	28.30
XIV	91.00	22.99	126.00	54.60	37.50	13.50	28.20	3.01	105.00	21.05	19.31
XV	69.00	21.07	115.00	88.20	64.50	16.00	39.10	5.32	257.50	87.91	35.65
XVI	95.50	16.36	135.50	85.10	90.00	13.00	26.90	4.01	320.00	62.43	19.44
S.D.	8.35	3.77	8.02	9.75	14.52	1.48	5.49	0.67	65.61	18.94	6.86
Variance	69.84	14.23	64.45	95.07	211.09	2.21	30.23	0.45	4304.89	358.79	47.16

x PWD 274, (GW 1163 x WH 924) x DW 1001 and (GW 1163 x DW 1001) x AKDW 3085)] and double crosses viz., [(HI 8381 x Raj 6550) x (Raj 1555 x WH 924)] and [(PWD 233 x Raj 6552) x (GW 1163 x DW 1001)] were suggested for breeding durum wheat cultivars. Further, in the resulting F_2 generation intermating should be followed and segregating material should be carried further by single seed descent method to obtain potential transgrates for yield and quality attributes.

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