Int.J.Curr.Microbiol.App.Sci (2026) *15*(8): 66-76

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 15 Number 8 (2026)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2026.1508.008

Generation Mean Analysis for Seed Yield and Its Components in Durum Wheat (*Triticum durum* Desf.)

Priti[1*], Mukesh Vyas[1] and Deep Singh Rajpurohit[2]

[1]Department of Plant Breeding and Genetics, RCA, MPUAT, Udaipur – 31 3001, India
[2]Department of Agronomy N. M. College of Agriculture, Navsari Agricultural University, Navsari-396450, India

**Corresponding author*

ABSTRACT

The present investigation entitled "Generation Mean Analysis for Seed Yield and its Components in Durum Wheat [Triticum durum Desf.]" was undertaken to elicit information on heterosis and nature and magnitude of gene action thirteen characters in six generation of four crosses involving six parents viz., HI 8737, HI 8498, HI 8663, Raj 1555, PDW 274 and PDW 233. In present study experimental material comprising six generation (P_1, P_2, F_1, F_2, BC_1 and BC_2) of wheat crosses was planted during rabi 2017-18 in randomized block design of three replications under irrigated condition at Institutional Farm of Agronomy Rajasthan College of Agriculture, Udaipur. Significant variability among genotypes was found for almost all the characters except days to maturity in cross HI 8498 x Raj 1555, plant height in crosses HI 8498 x Raj 1555 and HI 8663 x PDW 274 and harvest index in cross HI 8498 x Raj 1555. Raj 1555 and PDW 233 were identify as the most productive on the basis of their higher mean value for grain yield and its important component traits. Among hybrids HI 8663 x PDW 233 and HI 8737 x Raj1555 were spotted as superior for grain yield and its component. Heterosis over mid parent ranged -59.69 (HI 8663 x PDW 274) to 10.60 (HI 8737 x Raj 1555) and inbreeding depression ranged -157.12 (HI 8663 x PDW 274) to -39.22 (HI 8663 x PWD 233) for grain yield per plant but none of cross showed positively significant heterosis for grain yield.

Keywords

Durum wheat, heterosis, grain yield and its components.

Article Info

Received: 18 June 2026
Accepted: 28 July 2026
Available Online: 10 August 2026

Introduction

Durum wheat (*Triticum durum* Desf.) is the most important tetraploid species of wheat having with two diploid genomes AA and BB with chromosome number 2n=4x=28. Wheat belongs to the genus *Triticum* of *Poaceae* family and believes to be originated from South West Asia. Wheat is grown under diverse environment from 11^0 to 30^0 N, from sea level to 4000 m elevation as rain fed to an irrigated crop, with soil pH of 5.5-9.0 and having a growth period of 150-170 days. It is grown during November to April and the seeding time depends on annual crop cycle followed by the farmers under timely sown conditions. Wheat is a unique gift of nature to main kind as it can be molded into innumerable products like chapattis, breads, cakes, biscuits, pasta and many hot and ready-to-eat breakfast foods. Wheat grain contains crude protein (13.3 %), fat (2.0 %), minerals (1.7 %), fiber (2.3%), other carbohydrates (68.7 %) and water (12 %). Macaroni wheat also known as hard wheat. The uniqueness of wheat in contrast to other cereals is that wheat contains gluten protein, which enables leavened dough to rise by forming minute gas cells and this property enables bakers to produce light breads. In India, wheat is the second most important cereal after rice and finds a substantial contributing share about 30% to the food basket of Indians and it ensures food and nutrition security to a majority of the population. It is agronomically and nutritionally most important cereal essential for the food security, poverty alleviation and improved livelihoods (Sharma *et al.,* 2013). Macaroni wheat (*Triticum durum* Desf.) is grown on about 30 million hectares and accounts for almost 10 % of total world wheat production. In India, wheat occupies about 30.72 million hectare with a production of 97.44 million tones and productivity of 31.72 $qt.ha^{-1}$ annually (MoA FW, 2016-17). The major durum wheat growing states are Karnataka, Madhya Pradesh, Maharashtra, Gujarat, Punjab and Western Uttar Pradesh. Heterosis breeding has proved to be potential method of increasing yield in most of the cross pollinated crops. The commercial exploitation of heterosis in self-pollinated crop like wheat has been limited application owing to technical difficulties involved in hybrid seed production. The nature and magnitude of heterosis also helps in identifying superior cross combinations and their exploitation to get desirable transgressive segregants. The theory of dominant linked gene hypothesis put forward by Jones (1917) and advocated and discussed by Singh and Singh (1984) appears to be most acceptable, both in concept and utilization of heterosis in self-pollinated crops. According to them, one can select a pure breeding line equally good or even better than F_1 hybrid. Therefore, the knowledge of heterosis together with inbreeding depression would help in determination of the parents which produce the best cross combinations having maximum heterosis and minimum inbreeding depression.

Materials and Methods

The present investigation entitled "Generation mean analysis for seed yield and its components in durum wheat (*Triticum durum* Desf.)" was carried out at the Instructional Farm of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur during *rabi* 2017-18. On the basis of parental characteristics and performance of field grown F_1 plants, four crosses were selected. Backcrosses as well as fresh crosses were attempted in the same season during *rabi* 2016-17. For making backcross and fresh crosses sufficient number of F_1 and parental plants were emasculated and to generate F_1, F_2 and backcross generation. Final experiment trail comprising six parents along with their 4 F_1s, 4 F_2s and 8 back cross generations were evaluated during *rabi,* 2017-18 in randomized block design with three replications. Parents, F_1s and back cross generations were grown in single row while F_2s in three row. Sowing was done by dibbling the seeds at a distance of 10 cm in the rows of 2 m length with row to row spacing of 22.5 cm.

Name and pedigree of the parents

No.	Parents	Pedigree	Developed From
1	HI-8737	HI8177/HI8158/HI8498	IARI, RS Indore
2	HI-8498	RAJ6070/RAJ911	IARI, RS, Indore (MP)
3	HI-8663	HI8177/HI8185	IARI RS, Indore (MP)
4	RAJ-1555	COCORIT'S/RAJ911	Durgapura, Jaipur
5	PDW-274	DWL-6018/KARPASIA	SRVC, PAU, Ludhiana
6	PDW-233	YAV "S"/ TEZ "S"	PAU, Ludhiana

Name of crosses in different generations

SN.	Crosses	Generations
1	HI-8737 X RAJ-1555	F_1's, F_2, BC_1 and BC_2
2	HI-8498 X RAJ-1555	F_1's, F_2, BC_1 and BC_2
3	HI-8663 X PDW-274	F_1's, F_2, BC_1 and BC_2
4	HI-8663 X PDW-233	F_1's, F_2, BC_1 and BC_2

Characters studied

i. Days to heading
ii. Days to maturity
iii. Plant height
iv. Number of effective tillers per plant
v. Flag leaf area
vi. Grain yield per plant

Results and Discussion

1. Analysis of variance and mean performance
2. Heterosis, heterobeltiosis and inbreeding depression

Analysis Of Variance and Mean Performance

The analysis of variance for the experimental design for all the thirteen characters studied in four crosses of durum wheat (*Triticum durum* Desf.) is presented.

ANOVA revealed highly significant difference among all the genotypes indicating sufficient amount of variation present in the material for aforesaid characters except days to maturity in cross HI-8498 x Raj-1555, plant height in crosses HI-8498 x Raj-1555 and HI-8663 x PDW-274 and harvest index in cross HI-8498 x Raj-1555 in Table 4.1. Similar work done by Kumar *et al.,* (2017a) studied analysis of variance revealed that the all components of variances showed significant differences for almost the traits. Similar work done by Sadeghi *et al.,* 2013.

A perusal mean values (Table 4.1.2 and Appendix I) showed that among parent PDW 233 and HI 8737 exhibited early heading and early maturity. Among the F_1 hybrids, early heading was observed in HI 8498 x Raj 1555 followed by HI 8663 x PDW 233 while, early maturity was observed in HI 8663 x PDW 233 followed by HI 8737 x Raj 1555.

Lower mean value for plant height were observed in HI 8737 and PDW 233 where as higher mean value for no. of effective tillers per plant was observed in Raj 1555 and PDW 274.

Cross HI 8498 x Raj 1555 and HI 8663 x PDW 274 had higher mean effective tiller per plant. It is obvious that parent Raj 1555 and PDW 274 contributing higher number of effective tillers per plant in aforesaid F_1s. F_2 population for cross HI 8498 x Raj 1555 had less no. of effective tillers per plant than F_1 and back cross generations.

Parent PDW 274 and HI 8737 exhibited higher mean value for flag leaf area. In F_1 generation HI 8737 x Raj 1555 had higher flag leaf area.

Among parents biological yield per plant and grain yield per plant was reported higher in PDW 233 and PDW 274 with higher harvest index. While highest 1000- grain weight were reported in HI 8663 with highest number of grain per spike, no. of spikelets per spike and spike length. Among hybrids HI 8663 x PDW 274 showed higher mean value for 1000- grain weight and harvest index. Cross HI 8737 x Raj 1555 showed higher man value for biological yield per plant and grain yield per plant. F_2 generation performed better mean value for biological yield per plant, grain yield per plant and harvest index than F_1 and BC_1 generation performed better mean value for 1000- grain weight and harvest index than F_1.

Parent PDW 233 performed better than all other parents. For grain yield per plant as well as possessed higher biomass per plant.

To sum up, parent Raj 1555 and PDW 233 appeared to be most productive parent for grain yield and its important component traits. Among crosses HI 8663 x PDW 233 and HI 8737 x Raj1555 were found superior for grain yield and its components as they involved at least one of the parents with high per se performance.

Heterosis and Inbreeding Depression

The phenomenon of heterosis has provided the most important genetic tool improving yield potential of crop plants. Heterosis breeding is primary based to the identification of parents and their cross combinations capable of producing the highest level of transgressive segregates. The magnitude of heterosis depends on the extent of genetic diversity between parents and helps in choosing the parents for superior F_1 hybrids.

In the present investigation, two types of heterosis *viz*., relative heterosis and heterobeltiosis and inbreeding depression were estimated. The magnitude of heterosis have been expressed as per cent increase or decrease of F_1 value over mid parent/ relative heterosis (MP) and over better parent/ heterobeltiosis (BP). Inbreeding depression was calculated as per cent reduction in the mean values of F_2 over F_1.

The character wise results of relative heterosis, heterobeltiosis and inbreeding depression are presented in Table 4.2.1. For all the characters, positive values were considered desirable whereas, for days to heading, days to maturity and plant height negative values were considered desirable for calculating relative heterosis (MP), heterobeltiosis (BP) and inbreeding depression. The trait wise results are summarized as under:

Table.1 Analysis of Variance for RBD for Different Character in Durum Wheat

Characters	Cross	Replication	Genotype	Error
1. Days to heading	1	4.22**	3.66**	0.28
	2	6.91*	25.12**	1.54
	3	4.72**	3.06**	0.38
	4	3.06**	8.48**	0.36
2. Days to maturity	1	3.84*	10.66**	0.91
	2	12.85	55.38	15.46
	3	24.76**	28.65**	2.21
	4	28.12**	17.08**	2.84
3. Plant Height	1	4.22	148.98**	11.52
	2	1.260	35.10	6.54
	3	1.84	52.817	10.17
	4	10.71	136.78**	10.95
4. Flag leaf area	1	0.08	189.09**	6.02
	2	5.69*	221.75**	0.81
	3	2.73	70.84**	2.81
	4	1.89	47.96**	2.18
5. Awn length	1	2.46	7.60**	0.66
	2	4.23**	7.13**	0.16
	3	2.72*	10.19**	0.39
	4	2.39*	1.23*	0.43
6. Number of tillers per Plant	1	1.59	55.38**	1.08
	2	1.26	42.68**	1.11
	3	1.08	17.33**	1.05
	4	1.51	24.36**	1.19
7. Spike length	1	0.35	5.01**	0.12
	2	0.04	1.55**	0.13
	3	0.31*	4.29**	0.07
	4	0.56**	2.740**	0.03
8. Number of spiklets per spike	1	0.75**	8.56**	0.08
	2	0.33**	6.08**	0.02
	3	0.33	7.62**	0.73
	4	0.29	11.90**	0.48
9. Number of grain per spike	1	3.45	721.65**	2.27
	2	0.21	380.23**	0.75
	3	0.66	444.11**	0.55
	4	0.97	442.08**	0.24
10. 1000 grains weight	1	1.21	229.87**	5.65
	2	2.70	69.39**	2.17
	3	0.71	121.25**	0.98
	4	2.54	66.64**	0.88
11. Biological yield per	1	150.8	3271.40**	75.69

plant				
	2	138.85	1278.67**	67.04
	3	54.58	3419.69**	32.86
	4	37.11	2585.10**	55.69
12. Grain yield per plant	1	0.10	509.79**	4.03
	2	0.19	351.43**	2.32
	3	0.059	403.07**	2.76
	4	0.32	396.13**	1.85
13. Harvest Index	1	1.47	42.82**	4.34
	2	6.03	35.25	8.80
	3	0.86	19.23**	2.30
	4	2.09	95.70**	2.37

* and ** Significant at 5 and 1 per cent levels, respectively.

Table.2 Mean and range of different characters for various generations in wheat.

Characters	Parents	F_1	F_2	BC_1	BC_2
1. Days to heading	72.76 (70.00-76.27)	72.43 (69.47-74.00)	74.69 (74.12-75.25)	73.40 (72.12-75.07)	74.55 (72.23-78.00)
2. Days to maturity	114.55 (111.80-118.13)	117.14 (115.47-118.80)	115.78 (113.83-118.78)	112.98 (108.77-115.63)	115.97 (108.00-122.40)
3. Plant height	87.60 (83.79-90.49)	86.75 (78.88-93.59)	82.21 (73.68-88.06)	80.08 (76.46-83.28)	83.77 (69.72-92.76)
4. Flag leaf area	19.84 (14.71-25.99)	23.51 (16.25-36.04)	25.70 (20.39-34.15)	18.46 (14.59-25.15)	24.40 (20.77-39.12)
5. Awn length	11.92 (8.99-13.62)	12.57 (11.77-13.54)	10.96 (8.47-12.74)	11.53 (11.29-11.90)	12.00 (11.26-12.84)
6. Number of tillers per plant	13.64 (6.95-16.58)	10.43 (5.88-15.05)	10.18 (8.80-12.10)	9.64 (5.55-12.32)	10.35 (8.48-14.32)
7. Spike length	8.20 (6.33-10.41)	7.59 (6.35-9.77)	8.68 (7.91-10.25)	7.42 (6.38-8.94)	8.24 (7.53-8.58)
8. Number of spikelets per spike	20.50 (19.15-22.59)	19.39 (17.79-21.22)	20.69 (19.43-23.15)	19.01 (16.75-20.70)	19.28 (16.75-21.32)
9. Number of grain per spike	66.83 (51.56-79.07)	59.33 (38.49-81.02)	66.13 (56.91-80.68)	49.13 (35.86-55.01)	56.68 (53.36-64.24)
10. 1000-grains weight	61.04 (53.44-65.61)	61.92 (57.79-66.27)	57.04 (47.55-64.57)	69.68 (65.18-74.39)	65.36 (58.77-74.39)
11. Biological yield per plant	115.78 (85.18-178.74)	88.53 (58.06-121.50)	112.76 (80.46-149.12)	99.64 (58.53-126.16)	92.20 (62.61-122.43)
12. Grain yield per plant	36.30 (23.95-54.30)	23.05 (16.54-34.78)	39.75 (26.41-57.46)	32.03 (21.40-43.60)	32.94 (23.79-46.98)
13. Harvest index	32.04 (31.33-32.81)	28.35 (22.78-31.11)	34.29 (31.05-38.57)	32.51 (22.23-36.78)	35.44 (29.39-38.27)

Appendix-I: Generation mean values of different characters in durum wheat

Generations	Days to heading	Days to maturity	Plant height (cm)	Flag leaf area(cm^2)	Awn length (cm)	Number of effective tillers/plant
Parents						
HI-8737	71.33	111.80	83.79	24.85	13.47	13.01
HI-8498	73.80	114.80	86.00	14.71	12.33	6.95
HI-8663	72.73	113.80	88.60	15.99	12.43	15.75
Raj-1555	72.73	15.80	90.49	22.87	8.99	16.58
PDW-274	72.53	118.13	88.52	25.99	13.62	16.53
PDW-233	70.00	112.47	84.49	15.75	13.13	7.97
F_1s						
HI-8737 X Raj-1555	74.00	116.47	78.88	36.04	36.04	11.80
HI-8498 X Raj-1555	69.47	118.80	87.34	20.80	20.80	13.54
HI-8663 X PDW-274	73.87	117.80	87.18	16.25	16.25	13.16
HI-8663 X PDW-233	72.40	115.47	93.59	20.94	20.94	11.77
F_2s						
HI-8737 X Raj-1555	74.12	113.83	82.20	34.15	12.74	10.96
HI-8498 X Raj-1555	75.18	115.67	88.06	27.62	10.72	8.80
HI-8663 X PDW-274	74.20	114.85	84.90	20.64	8.47	12.10
HI-8663 X PDW-233	75.25	118.78	73.68	20.39	11.92	8.86
BC_1s						
HI-8737 X Raj-1555	72.12	112.75	76.46	15.51	11.50	5.55
HI-8498 X Raj-1555	75.07	108.77	80.32	18.57	11.44	12.32
HI-8663 X PDW-274	73.18	115.63	80.25	14.59	11.29	10.41
HI-8663 X PDW-233	73.22	114.77	83.28	25.15	11.90	10.29
BC_2s						
HI-8737 X Raj-1555	72.23	115.72	69.72	20.77	12.84	8.48
HI-8498 X Raj-1555	78.00	108.00	84.45	39.12	11.86	9.49
HI-8663 X PDW-274	75.22	122.40	92.76	24.79	12.05	14.32
HI-8663 X PDW-233	72.73	117.75	88.13	24.40	11.26	9.10

Generations	Spike length (cm)	Number of spikelet' per spike	Number of grain per spike	1000-grain weight (g)	Biological yield per plant (g)	Grain yield per plant	Harvest index (%)
Parents							
HI-8737	8.40	19.15	75.48	58.58	117.86	34.98	31.42
HI-8498	6.33	21.22	58.58	58.01	85.18	23.95	31.33
HI-8663	10.41	22.59	79.07	65.61	119.30	39.28	32.51
Raj-1555	7.26	19.19	63.18	63.58	85.62	27.91	32.00
PDW-274	7.40	20.70	51.56	53.44	134.62	42.78	32.81
PDW-233	8.17	19.41	64.54	59.90	178.74	54.30	31.73
F_1s							
HI-8737 X Raj-1555	7.06	19.41	38.49	57.79	121.50	34.78	29.58
HI-8498 X Raj-1555	6.35	19.13	68.88	58.56	64.25	17.46	29.94

HI-8663 X PDW-274	7.18	17.79	48.92	66.27	58.06	16.54	31.11
HI-8663 X PDW-233	9.77	21.22	81.02	65.06	110.32	23.43	22.78
F_2s							
HI-8737 X Raj-1555	10.25	23.15	80.68	47.55	149.12	57.46	38.57
HI-8498 X Raj-1555	7.99	19.43	56.91	61.71	80.46	26.41	31.05
HI-8663 X PDW-274	8.55	20.70	69.89	54.32	118.71	42.52	35.83
HI-8663 X PDW-233	7.91	19.49	57.05	64.57	102.73	32.61	31.72
BC_1s							
HI-8737 X Raj-1555	6.82	18.96	55.01	74.39	58.53	21.40	36.49
HI-8498 X Raj-1555	6.38	16.75	35.86	71.02	106.93	39.32	36.78
HI-8663 X PDW-274	7.52	19.63	51.55	68.14	126.16	43.60	34.53
HI-8663 X PDW-233	8.94	20.70	54.09	65.18	106.93	23.79	22.23
BC_2s							
HI-8737 X Raj-1555	8.58	21.32	53.36	58.77	80.95	23.79	29.39
HI-8498 X Raj-1555	7.53	19.42	54.09	65.18	122.43	46.98	38.27
HI-8663 X PDW-274	8.15	19.62	64.24	63.11	62.61	23.96	38.07
HI-8663 X PDW-233	8.71	16.75	55.01	74.39	102.81	37.03	36.02

Table.3 Analysis of Heterosis (MP), Heterobeltiosin (BP) and Inbreeding Depression (ID) for Different Character in Durum Wheat

Character	Cross	(MP)		(HB)		(ID)
1. Days to heading	1	2.73		-		-0.16
	2	-7.42		-5.87		-8.23*
	3	1.70		-		-0.45
	4	1.45		-		-3.94
2. Days to maturity	1	2.34		-		2.26
	2	3.04		-		2.64
	3	1.58		-		2.50
	4	2.06		-		-2.87
3. Plant Height	1	-9.48		-5.86		-4.21
	2	-0.87		-		-0.82
	3	-1.56		-1.51		2.62
	4	8.10*		-		21.28**
4. Flag leaf area	1	51.05**		45.02**		5.23
	2	11.69		-		-32.77**
	3	-22.59**		-		-27.03**
	4	31.95**		30.93*		2.62
5. Awn length	1	5.05		-		-8.01
	2	27.05*		9.87		20.85**
	3	1.06		-		35.69**
	4	-7.93		-		-1.26
6. Number of tillers per Plant	1	-60.23**		-		-86.23**

	2	27.91**		-		41.51**
	3	-25.95**		-		-1.19
	4	-25.37*		-		-0.05
7. Spike length	1	-9.80		-		-45.14**
	2	-6.63		-		-25.94
	3	-19.37		-		-19.13
	4	5.18		-		19.09
8. Number of spiklets per spike	1	1.26		1.15		-19.28*
	2	-5.33		-		-1.57
	3	-17.84		-		-16.37
	4	1.02		-		8.15
9. Number of grain per spike	1	-44.49**		-		-109.64**
	2	13.14		9.02		17.37**
	3	-25.09**		-		-42.86**
	4	12.84		2.47		29.59**
10. 1000 grains weight	1	-5.39		-		17.71**
	2	-3.66		-		-5.38*
	3	11.33*		1.01		18.03**
	4	3.67		-		0.76
11. Biological yield per plant	1	19.42		3.09		-22.74
	2	-24.77		-		-25.23
	3	-54.27*		-		-104.46*
	4	-25.97		-		6.88
12. Grain yield per plant	1	10.60		-		-65.22**
	2	-32.65*		-		-51.23**
	3	-59.69**		-		-157.12**
	4	-49.94**		-		-39.22**
13. Harvest Index	1	-6.73		-		-30.40
	2	-5.46		-		-3.72
	3	-4.74		-		-15.18
	4	-29.09		-		-39.27**

* and ** Significant at 5 and 1 percent levels, respectively.

Table.4 Mean of Heterosis, Heterobeltiosis and Inbreeding depression with range for different characters in durum wheat

Characters	Heterosis	Heterobeltiosis	Inbreeding Depression
1. Days to heading	-1.54 (-7.42 to 2.73)	-5.87 (- to -5.87)	-3.19 (-7-8.23 to-0.16)
2. Days to maturity	2.25 (1.58 to 3.04)	-	1.13 (-2.87 to 2.64)
3. Plant height	-0.95 (-9.48 to 8.10)	-3.66 (-5.86 to -1.51)	4.71 (-4.21 to 21.28))

4. Flag leaf area	18.02 (-22.59 to 51.05)	34.97 (30.93 to 45.02)	3.3 (-32.77 to 5.23)
5. Awn length	6.30 (-7.93 to 27.05)	9.87 (- to 9.87)	11.81 (-8.01 to 35.69)
6. Number of tillers per plant	-20.91 (-60.23 to 27.91)	-	-11.49 (-86.23 to 41.51)
7. Spike length	-7.65 (-19.37 to 5.18)	-	-17.78 (-45.14 to 19.09)
8. Number of spikelets per spike	-5.22 (-17.87 to 1.26)	1.15 (- to 1.15)	-7.26 (-19.28 to 8.15)
9. Number of grain per spike	-10.9 (-44.49 to 13.14)	5.74 (2.47 to 9.02)	-26.36 (-109.64 to 29.59)
10. 1000-grains weight	1.48 (-5.39 to 11.33)	1.01 (- to 1.01)	7.78 (-5.38 to 18.03)
11. Biological yield per plant	-21.39 (-54.27 to 19.42)	3.09 (- to 3.09)	-36.38 (-104.46 to6.88)
12. Grain yield per plant	-32.92 (-59.69 to 10.60)	-	-78.79 (-157.12 to -39.22)
13. Harvest index	-11.50 (29.09 to -4.74)	-	-22.14 (-39.27 to 30.40)

The earliness in days to heading and days to maturity and dwarfness in plant height has been considered as desirable trait in wheat crop. Evidence from Table 4.2.1 significant positive heterosis as well as inbreeding depression were observed for plant height in hybrid HI 8663 x PDW 274. For days to maturity none of cross expressed significant heterosis and inbreeding depression. Whereas, significant negative inbreeding depression was recorded for days to heading in cross HI-8498 x Raj-1555. Similar result were reputed by Jaiswal *et al.,* (2018) revealed negative estimates of heterotic effects were observed in some traits may be attributed to inter-allelic interactions.

Among the agronomical yield component plant height out of four crosses, HI 8663 x PDW 233 showed positive significant heterosis as well as inbreeding depression. Mean value for heterosis and heterobeltiosis were -0.96 per cent and -3.68 per cent respectively, whereas heterosis ranged for this trait from -0.87 to 8.10 per cent as evident from Table 4.2.2, for plant height none of crosses showed significant heterobeltiosis. Similar work reported by Lal *et al.,* (2013) and Gul *et al.,* (2015).

Effective tiller and grains per spike are among the important yield contributing traits in wheat. As evident from Table 4.2.1 significant negative heterosis and inbreeding depression was recorded for cross HI 8737 x Raj 1555 and positive heterosis and inbreeding depression for cross HI 8498 x Raj 1555 and significant negative heterosis were recorded for crosses HI 8663 PDW 274 and HI 8663 x PDW 233 for number of effective tillers. For number of grains per spike crosses HI 8737 x Raj 1555 and HI 8498 x Raj 1555 were heterotic for mid-parent with negative significant inbreeding depression and positive significant inbreeding depression was recorded in cross HI 8663 x PDW 233 for grains per spike. Whereas, hybrids HI 8737 x Raj 1555 heterotic for mid-parent with negative significant inbreeding depression thereby it indicates involvement of non-additive gene action for aforesaid trait. These finding also supported by Yadav *et al.,* (2017).

For flag leaf area crosses HI 8737 x Raj 1555 and HI 8663 x PDW 233 showed positive significant heterosis as well as heterobeltiosis. While negative significant inbreeding depression reported in crosses HI 8498 x Raj 1555 and HI 8663 x PDW 274 for this trait. Mean value for heterosis and heterobeltiosis were18.02 per cent and 37.97 per cent respectively, whereas heterosis ranged for this trait from -22.59 to 51.05 per cent. Similar work done by Zaazaa *et al.,* (2012).

For awn length out of four crosses positive significant heteosis in cross HI 8498 x Raj 1555 and inbreeding depression in cross HI 8498 x Raj 1555 and HI 8663 x

PDW 274 were reported. None of the hybrid showed significant heterobeltiosis.

The mean heterosis for spike length, number of spikelets per spike and harvest index was -7.65, -5.22 and -11.50 per cent, respectively. While heterobeltiosis reported 1.15 per cent for no. of spikelets per spike. Heterosis for spike length and harvest index ranged from -6.63 to 5.18 per cent (one cross positive) and -29.09 to -6.73 per cent, respectively. Similarly for number of spikelets per spike heterosis ranged from -5.33 to 1.26 per cent (two crosses positive) however inbreeding depression observed negative significant in cross HI 8737 x Raj 1555 for spike length and number of spikelets per spike and in cross HI 8663 x PDW 233 for harvest index. None of cross expressed significance heterosis and heterobeltiosis for aforesaid trait as evident from Table 4.2.1. Similar work reported by Sharma and Sain (2005) suggested that the gene effects, heterosis and inbreeding depression for harvest index and grain yield under normal planting and significant heterosis by Kushwah and Kandalkar (2016).

For 1000-grain weight positive significant heterosis as well as inbreeding depression was reported in cross HI 8663 x PDW 274, while negative and positive significant inbreeding depression observed in cross HI 8498 x Raj 1555 and cross HI 8663 x PDW 274 respectively. Similarly, for biological yield per plant negative significant heterosis and inbreeding depression reported in cross HI 8663 x PDW 274, however none of cross expressed superior heterobeltiosis for 1000-grain weight and biological yield per plant as evident from Table 4.2.1. Similar results were reported by Lal *et al.,* (2013) and Kant *et al.,* (2011).

For grain yield per plant in three crosses HI 8498 x Raj 1555, HI 8663 x PDW 274 and HI 8663 x PDW 233 showed negative significant heterosis with negative significant inbreeding depression. While negative significant inbreeding depression also reported in hybrid HI 8737 x Raj 1555. Similar work done by Kushwah and Kandalkar (2016), Beche *et al.,* (2013) and Gul *et al.,* (2015).

Author Contributions

Priti: Investigation, formal analysis, writing—original draft. Mukesh Vyas: Validation, methodology, writing—reviewing. Deep Singh Rajpurohit:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

References

Beche, E., Lemes da Silva, C., Pagliosa, E. S., Capelin J. F., Gilvani, M. A. and Benin, G. 2013. Hybrid performance and heterosis in early segregant populations of brazilian spring wheat. *Australian Journal of Crop Science,* 7: 51-57.

Gul, S., Aziz, M. K., Ahamad, R.I., Liaqat, M., Rafiq, M., Hussain, F., Rafiq, M. and Manzoor, A. 2015. Estimation of heterosis and heterobeltiosis in wheat (*Triticum aestivum* L.) crosses. *Basic Research Journals*, 4: 151-157.

Jones, D. F. 1917. Dominance of linked factors as a means of accounting for heterosis. *Genetics,* 2: 466–479.

Kant, L., Mahajan, V. and Gupta, H. S. 2011. Mid-parent advantage and heterobeltiosis in F_1 hybrids from crosses of winter and spring wheat. *SABRAO Journal of Breeding and Genetics*, 43: 91-106.

Kumar, J., Kumar, A., Kumar, M., Singh, S. k., Singh, L. and Singh, G. P. 2017(a). Heterosis and inbreeding depression in relation to heterotic parameters in bread wheat (*Triticum aestivum* L.) under late sown condition. *Journal of Wheat Research,* 9: 32-41.

Kushwah, M. K. and Kandalkar, V. S. 2016. Gene effects through generation means analysis in wheat crop. *Bhartiya Krishi Anuandhan Patrika*, 31: 89-96.

Lal, C., Kumar, V. and Maloo, S. R. 2013. Heterosis and inbreeding depression for somequntitative and heat tolerance characters in bread wheat (*Triticum* *aestivum* L.). *Journal of Wheat Research,* 5: 52-55.

Sadeghi, F., Dehghani, H., Najafian, G., and Sarbarzeh, M. A. 2013. Estimation of gene action and genetic parameters for bread making quality attributes in hexaploid wheat (*Triticum aestivum* L.). *Persian Seed and Plant Improvement Journal.* 29: 443-465.

Sharma, I., Chatrath, R. and Sendhil, R. 2013. Challenges, target and strategies: for sustainable wheat production for food security and nutrition. *Indian Farming,* 63: 3-6.

Sharma, S. N. and Sain, R. S. 2005. Estimation of components of heterosis for harvest index in durum wheat under normal and late plantings. *Crop Improvement,* 32: 137-142.

Singh, M. and Singh, R. K. 1984. Hayman's Graphical Analysis in Segregating Generations of a Diallel Cross. *Biometrical Journal*, 26: 69-74.

Yadav, J., Sharma, S. N. and Shweta 2017. Heterosis and Inbreeding Depression Analysis for Yield and Its Components Traits in Bread Wheat (*Triticum aestivum* L. em. Thell.) ove environments. *International Journal of Pure and Applied Bioscience,* 5: 995-1003.

Zaazaa, E.I., Hager, M.A. and El-Hashash, E.F. 2012. Genetical analysis of some quantitative traits in wheat using six parameters genetic model. *American-Eurasian Journal of Agricultural and Environmental Sciences,* 12(4): 456-462.

How to cite this article:

Priti, Mukesh Vyas and Deep Singh Rajpurohit. 2026. Generation Mean Analysis for Seed Yield and Its Components in Durum Wheat (*Triticum durum* Desf.). *Int.J.Curr.Microbiol.App.Sci.* 15(8): 66-76.
doi: https://doi.org/10.20546/ijcmas.2026.1508.008