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COMBINING ABILITY ANALYSIS OF GRAIN YIELD AND ITS CONTRIBUTING TRAITS IN F_1's AND F_2' s GENERATIONS OF WHEAT (*TRITICUM AESTVUM* L. EM THELL)

S.C. Gaur and L.B. Gaur

Department of Genetics and Plant Breeding, B.R.D.P.G. College, Deoria -274 001 (UP), INDIA.

E-mail: scgaur101@gmail.com

ABSTRACT

***Triticum aestivum* is an important cereal crop, grown throughout the world as staple food for most of the people of world. It is very important to improve grain yield of wheat to nourish rapid growing population of world. Various conventional and non-conventional breeding methods and biometrical approaches have been used to achieve the goal of production. Combining ability analysis was under taken in a 10 x 10 half diallel progenies (F_1 and F_2) for grain yield and its component characters. The mean squares due to gca and sca showed highly significant differences for all the characters in F_1 and F_2 generations. The estimated value of sca effects for number of tillers per plant in PBW 343x K9107, PBW 343 x K816, K88 x K95933, K8962 x K 9533, K8962 x K7903, K8962 x KRL 1-4, K9533 x K7903, K7903 x KRL 1-4 and HUW 234 x K816 in F_1 and K7903 x K816 and HUW 234 x K816 crosses of F_2 generation were most considerable. Out of 45 combination, significant sca effects in cross combinations like, PBW 343 x K7903, PBW 343 x K816, K9107 x HUW 234, K88 x HP1633, K9533 x K7903, K9533x KRL 1-4, K7903x HUW 234, K7903 x KRL 1-4 and KRL 1-4 x K816 for plant height in both generations were positive whereas, eight combinations in F_1 and mine combination F_2 generation for plant height pronounced positive existence.**

Key words : *Triticum aestivum, Combining ability, diallel, GCA, SCA and Yield.*

Wheat is one of the oldest cereals and most important food crops in the world. Wheat is the second most importance crop offer rice both in terms of area end production in India. India produced a record 93.90 million tons of wheat from 29.90 million hectors with a productivity of 31.40 q/ha in the year 2012-2013. India is probably one of the few countries in the world where three types are grown. The major area i.e. 86 percent, is under breed wheat (*Triticum aestivum* L.), about 12 percent under dwum wheat (*Triticum thrgidum* L.) and the third is dicoccum wheat (*Tritcum Monococcum* L.). The global wheat demand by year 2020 would be between 840 and 1050 million tones and India would require 109 million to meet the demand of wheat. Due to low chance the production and productivity of wheat, this received great attention of breeders for its genetic improvement as it has exhibited greater production potential under varying environment. Enhance the present yield level and overcome yield stagnation, it is essential to reshuffle the gene through hybridization in suitable parent. For this it is necessary to identify the gene action involve in the expression of various yield contributing characters and also the combining ability of the parent and resulting crosses. The present study was, therefore, undertaken to estimate combining ability effects for grain yield and its related traits in breed wheat.

MATERIALS AND METHODS

The materials of the present investigation were carried out during rabi season of research from of C. S. A. University of Agriculture & Technology, Kanpur during 3 rabi season. Forty five f1s and Forty five F2s derived from ten high yielding and pure breeding genotypes of wheat, namely, PBW 343, K9107, K88, K8962, K9533, K7903, HUW 234, KRL 1-4, HP 1633 and K816 were tested in a randomized block design with three replications. The Observation were recorded on randomly taken plants for various characters viz, days to 50% following, numbers of tillers per plant, Plant height flag leaf area, days to maturity, length of spike per plant, peduncle length per plant, Biological yield per plant, number of grains per spike, 1000 grain weight, grain yield per plant, seed hardness, protein content and gluten content. Pooled data was used for statistical and biometrical analysis. In each replication parents and F1s were sown in single row while F2s were sown in two row plots by dibbling method. Non experimental rows were also kept to check bar der effects. The length of each row was 1.5 m with inter and intra row distance of 30cm. and 15cm, respectively. The usual cultural practices were applied to raise a good crop. The combining analysis was worked out by the procedure suffused by Griffirg's (M 56 b) Method 2 model repeatedly for F_1 generations.

RESULT AND DISCUSSION

The analysis of variance for combining ability revealed that general combining ability (gca) and specific combining ability (Sca) variances were significant for all the characters in both F_1s and F_2s generations (Table 1). The significant variance due to gca and sca showed involvement of both additive and non additive gene action in controlling the traits. The genetic variance of F_1 generation was higher than F_2s for all the traits ascept in few cases under study.

Similar performance was observed due to gca/Sca ratio as indicated that F_1 values were higher than the F2 values in respect of all the attributing traits except plant height, peduncle length per plant flag leaf area of main shoot, number of grains per spike and 1000 grain weight per plant (Table 1) for these traits were hearted by katheria and Shasma (1996), singh and chatrath (1997),

This estimates of general combining ability effects and corresponding mean performance of the parents along with succeeding generations (Table 2) for days to 50 per cent flowering were most effective due to parent K953, K7903, HUW 234 and K816 ; for high productive tillers due to K88, K7903, HUW 234 and K RL 1-4 having medium short stature characteristics ; K9107 and HP 1633 for length of spike per plant ; K9107 for pedicle length per plant ; K8962, HUW 234 and HP 1633 for increased flag leaf area of main short ; K8962, K933 and K7903 for decrease in maturity days. The biological yield per plant and number of grains per spike were most considerable due to high value of K88 whereas, K9107, K8962 and K9533 contributed increased 1000 grain weight. The grain yield due to KRL 1-4 and PBW 343 were most considerable due to their high productive nature. The significant and desirable gca effects on seed hardness due to the parent K9533, K88 and HP 1633 were most considerable according to their results whereas, K9107 and K8962 were responsible for high protein and gluten content. Thus, the result on quality traits for gca effects were highly significant in both the generations. High gca values for seed hardness, protein content and gluten content were desirable due to KRL 1-4, K 7903 and K 9533 parents. It indicated that these parent in future breeding programme height to be most effective in improvement of quality traits.

The estimates of specific combining ability (sca) effects in F_1 and F_2 generations of 14 characters in 45 cross combinations as given in Table 3. The estimated value of sea effects for desirable trait like days to 50 per cent flowering in both generations involving combination K 9107 x K 7903 was favorable. Out of 45 combinations, 11 F_1s and 17 F_2s resulted significant sca effects in respect of early flowering.

The estimated value of sca effects for number of tillers per plant in PBW 343x K9107, PBW 343 x K816, K88 x K95933, K8962 x K 9533, K8962 x K7903, K8962 x KRL 1-4, K9533 x K7903, K7903 x KRL 1-4 and HUW 234 x K816 in F_1 and K7903 x K816 and HUW 234 x K816 crosses of F2 generation were most considerable. Thus the intra-allelic interaction is a consequence for sca (Spra gue and Tatum, 1942) which indicated that high number of tillers will certainly increase the hybrid and selection procedure on sca basis must be followed for future breeding programme.

Out of 45 combination, significant sca effects in cross combinations like, PBW 343 x K7903, PBW 343 x K816, K9107 x HUW 234, K88 x HP1633, K9533 x K7903, K9533x KRL 1-4, K7903x HUW 234, K7903 x KRL 1-4 and KRL 1-4 x K816 for plant height in both generations were positive whereas, eight combinations in F_1 and mine combination F_2 generation for plant height pronounced positive existence. In confirmation (Kumar, Javd Ahmad, z. 1989) were in the view of our findings.

Over all only one combination HUW 234 x K 816 in this experiment was most prominent for consideration on priority basis to enhance this character in future breeding programme. Fifteen combinations in F_2s and seven combination like, K9107 x K7903, K88 x K7903, K7903 x HP 1633, K7903x K816, HUW 234 x KRL 1-4, HUW 234 x K816 and KRL 1-4 HP 1633 in F2s generation were found most effective for length of spike per plant due to there sca performance. The sca effect on peduncle length per plant was prominent in crosses PBW 343 x K 9533, K9107 x HP 1633 and K 8962 x K816 and their desirability due to its significant parental combination in both generations, which stood parallel to confirm the concept of Griffing (1956 b) in respect of sca.

The positive and significant sca effect for flag leaf area of main shoot was much effective. In this study, the estimated values of ten combinations were considerable which showed best performance in both the generation and noted as best specific combiners i.e. PBW 343x K9107, K9107x KRL 1-4, K88 x K9533,

Table 1 : Analysis of variance for combining ability for 14 attributes in ten parental diallel cross in F_1 and F_2 Generations of Wheat: Mean sum of squire (Griffings method 2 Model 1).

Source of Variation	Generation	D.F.	Days to 50% Flowering	No. Of tillers per plant	Plant Height (cm)	Length of spike per plant (cm)	Peduncle length per plant (cm)	Flag leaf area of main shoot (cm^2)	Days to maturity	Biological yield per plant (g)	No. Of grains per spike	1000 Grain weight (g)	Grain Yield Per Plant (g)	Seed Hardness (Kg/grain)	Protein Content (%)	Gluten content (%)
Gca	F_1	9	66.574**	4.264**	33.257**	1.678**	10.842**	2.190**	387.079**	121.578**	33.943**	35.569**	17.062**	0.479**	3.130**	1.029**
	F_2	9	50.202**	0.741*	130.785**	0.505**	20.587**	1.605**	87.881**	22.444**	24.859**	31.219**	4.369*	0.264**	1.886**	0.843**
Sca	F_1	45	1.612**	2.445**	107.520**	0.858**	9.275**	1.794**	4.828**	55.690**	34.249**	26.102**	7.019**	1.109**	1.738**	1.099**
	F_2	45	10.922**	3.973**	95.235**	0.470**	20.00**	1.060**	29.609**	78.384**	19.509**	20.125**	13.032**	1.487**	2.421**	1.182**
Error	F_1	108	0.470	0.204	.267	0.055	1.314	0.107	0.531	0.895	2.061	0.720	0.867	0.032	0.062	0.043
	F_2	108	1.171	.345	3.499	0.073	2.113	0,129	0.173	5.075	7.066	0.305	2.077	0.029	0.018	0.013
gca var.	F_1		5.508	.338	2.749	0.135	0.794	0.173	32.212	10.056	2.656	2.904	1.349	0.037	0.255	0.082
	F_2		4.085	.033	10.607	0.036	1.539	0.123	7.309	1.447	1.482	2.576	0.191	0.019	0.155	0.069
sca var.	F_1		1.134	2.241	107.253	0.803	7.961	1.687	4.297	54.795	32.188	25.382	6.151	1.077	1.676	1.056
	F_2		9.751	3.628	91.736	0.397	17.887	0.931	29.436	73.309	12.443	19.820	10.955	1.458	2.403	1.169
Gca var./ sca var.	F_1		4.857	.150	0.025	0.168	0.099	0.102	7.496	0.183	0.082	0.114	0.219	0.034	0.152	0.077

K88x K816, K8962x HUW 234, K8962 x HP1633, K9533x HP1633, K7903x K816, HUW 234x K816 and KRL 1-4 x K816 over the part of increased leaf area. The significant effects of sca in F2 was prevalent than F1 for days to maturity as Carnaham et al. (1960) also reported sca effect on growth habit of alfalfa. The positive and significant sca effect for maturity is not much appreciable approach due to its non – additive or epistemic gene action.

Cross combination PBW 343xKRL1-4, K9107xK88, K88xHUW 234 and K88xKRL1-4 exhibited negative and significant performance as desirable in both generations and noted and best specific combination for this trait.

The high biological yield weight may contribute in the enhanced of grain yield. The combination HUW 234 x K816 and KRL1-4 x HP 1633 exhibited significant and positive performance in both the generation treated as best specific combiners for thus trait.

Positive and significant sea effect due to 16 combination of F_1s and 7 crosses like, PBW 343xK816, K8962xKRL1-4, K9533 x RL1-4, K7903x HP1633, K7903x K816, HUW 234x HP1633 and HUW234x K816 in F2 generation exhibited positive and significant sca effects. The common crosses in both the generation like K8962xKRL1-4 and HUW 234x K816 Wight be considerable as best for this trait, as indicated additive gene effects.

Highly significant performance for 100 grain weight at sca level was much appreciable. The cross combination PBW343xK88, PBW 343x HUW234, K9107x HU1633, K9107xK816, K8962x KRL1-4, K8962xHP1633, HUW 234xKRL1-4 and KRL1-4x K816 exhibited significant and positive performance in both the generations for 100 grain weight. Significant and positive sca values for grain yield was fund only one combination HUW 234xK816 common in both the generations in dictated that the base population due to high grain yield will be reliable for consideration in present study (Table 3). Similar approaches were also reported

The variability in sea effects for seed hardness at F2 level in the present study revealed that addition and non-additive gene effects were involved in determining the traits. The positive and significant sca effects assumed to be the semi-hard and positive or negative and significant as hard and negative for soft.

Table 2 : General combinng ability analysis for F_1 and F_2 generations in wheat.

Parent	Days to 50% Flowering			No. Of tillers per plant			Plant Height (cm)			Length of spike per plant (cm)			Peduncle length per plant (cm)			Flag leaf area of main shoot (cm^2)			Days to maturity		
	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men
PBW 343	2.65**	1.19**	75.55	0.01	-0.22	11.07	0.58**	-5.22**	83.87	0.17**	-035**	10.51	1.46**	-173**	26.37	0.24**	-0.01	12.32	4.45**	2.56**	129.33
K 9107	3.63**	2.36**	77.31	0.53**	-0.04	12.11	1.73**	4.24**	99.25	0.35**	0.24**	11.34	0.83**	2.38**	29.47	-0.02	-0.14	12.03	6.14**	2.08**	128.67
K88	2.45**	1.10**	75.28	0.18	0.32*	10.68	-1.28**	-1.68**	82.37	-0.49**	-0.37**	9.54	-0.38	0.92*	22.60	-0.19*	0.00	10.73	4.76**	0.94**	124.33
K 8962	-1.22**	1.82**	65.35	-0.08	-0.19	9,21	-1.96**	5.99**	113.16	-0.44**	0.04	1083	-0.75*	1.45**	30.63	0.52**	0.50**	12.65	-2.61**	-0.42**	110.33
K9533	-1.38**	-1.00**	65.50	1.03**	0.24	12.24	2.40**	0.92	90.64	-0.09	0.16*	11.53	0.94**	0.40	29.20	-0.20*	-0.10	11.28	-1.05**	-0.36**	112.33
K 7903	-3.68**	-4.08**	60.30	-0.86**	-0.48**	7.30	-0.70**	-2.12**	71.51	-0.29**	0.02	8.88	-0.65*	-0.60	22.97	-0.62**	-0.55**	10.35	-13.83**	-7.19**	85.33
HUW 234	-1.75**	-1.21**	65.27	0.27*	0.15	11.17	-1.06**	-2.01**	88.47	0.01	-0.01	10.12	-1.66**	-1.50**	20.61	0.45**	0.42**	12.87	-1.47**	0.36**	112.00
KRL 1-4	1.22**	1.63**	70.63	0.26*	-0.02	10.11	-0.14	-1.61**	81.34	0.38**	0.00	9.37	075*	-1.10**	22.80	-0.10	0.08	11.44	2.84**	0.89**	122.67
HP 1633	-0.05	0.26	67.97	-0.87**	-0.01	9.15	2.29**	1.48**	106.37	0.63**	0.16*	10.79	-0.22	-0.38	27.22	0.52**	0.35**	12.78	-0.13	1.06**	115.33
K 816	-1.40**	-2.07**	65.49	0.53**	0.25	9.25	-1.86**	0.01	80.81	-0.28**	0.04	9.80	-0.38	-0.28	23.93	-0.61**	-0.56**	10.64	0.89**	0.08	116.33
SE(gi) +-	0.189	0.296		0.123	0.158		0.141	0.511		0.064	0.047		0.314	0.397		0.089	0.098		0.199	0.114	
SE (gi-gj) +-	0.283	0.441		0.184	0.238		0.210	0.763		0.096	0.110		0.467	0.593		0.133	0.146		0.297	0.170	

Table 2 ; Contd,.

Variety	Biological yield per plant (g)			No. of grains per spike			1000 Grain weight (g)			Grain Yield Per Plant (g)			Seed Hardness (kg/grain)			Protein Content (%)			Gluten content (%)		
	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men	F_1	F_2	Men
PBW 343	1.86**	0.99	52.25	1.00*	1.28	52.82	2.88**	-0.67**	42.58	1.69**	-0.05	22.50	0.13**	-0.01	9.70	-0.19**	0.17**	11.73	-0.13*	0.20**	9.13
K 9107	3.26**	0.46	48.50	0.34	1.20	45.01	1.66**	3.63**	44.32	0.88**	-1.02**	21.19	0.01	0.09	9.73	0.44**	0.80**	12.77	0.30**	0.38**	9.47
K88	1.68**	2.89**	54.84	2.69**	1.54*	53.31	0.43	0.30*	43.72	0.63*	0.24	20.70	-0.41**	0.28**	9.63	-0.170*	-0.46**	10.73	-0.03	-0.34**	8.82
K 8962	-1.35**	-1.47*	35.36	-1.06**	-2.29*	36.64	1,07**	1.87**	45.42	-0.27	-0.33	19.04	0.21**	0.00	8.67	0.83**	0.04	12.30	0.44**	-0.16**	8.82
K9533	4.76**	0.02	45.84	2.20**	0.56	46.87	1.07**	-0.16	44.43	1.05**	-0.32	20.72	-0.26**	-0.10*	9.00	0.57**	-0.18**	12.67	0.38**	-0.14**	9.60
K 7903	-3.84**	-1.50*	32.96	-0.82*	-2.21*	39.44	-2.22**	-0.46**	41.11	-0.90**	-0.15	19.19	-0.04	0.14**	10.00	0.38**	-0.05	12.90	0.05	0.00	9.56
HUW 234	-0.15	-1.40*	37.80	-1.42**	0.46	42.22	-0.42	-1.23**	39.27	-0.04	-0.21	20.58	0.21**	-0.08	10.37	-0.41**	0.15**	11.27	-0.44**	0.06*	7.99
KRL 1-4	1.72**	-0.23	40.97	0.97*	1.02	44.43	-1.87**	-1.40**	37.40	0.52*	0.51	22.55	-0.02	0.06	9.01	-0.28**	-0.47**	10.37	-0.10*	-0.34**	8.00
HP 1633	-4.45**	-0.52	35.88	-1.92**	-0.42	34.43	-2.06**	-0.34*	38.51	-2.09**	0.06	18.99	0.13**	-0.20**	8.76	-0.63**	0.35**	10.33	-0.23**	0.40**	8.87
lparK 816	-3.49**	0.78	34.43	-1.97**	-1.15	34.36	-0.54*	-1.54**	33.54	-1.47**	1.27**	20.93	0.05	-0.18**		-0.54**	-0.36**	8.79	-0.25**	-0.07	7.47
SE(gi) +-	0.259	0.616		0.392	0.728		0.232	0.151		0.254	0.394*		0.48	0.046		0.068	0.037		0.056	0.031	
SE (gi-gj) +-	0.386	0.919		0.585	0.108		0.346	0.225		0.379	0.588		0.073	0.069		0.101	0.055		0.084	0.046	

Table-3 : Estimates SCA effect and corresponding mean performance for 14 attributes in the 45 crosses of F_1 and F_2 generations of wheat.

Hybrid/cross combination	Days to 50 per cent flowering				No. of tillers per plant			
	F_1		F_1		F_1		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	1.20	77.17	0.28	75.31	2.83**	12.45	-0.46	6.20
00PBW 343 x K88	-0.91	73.87	0.16	73.93	-0.81	8.47	-0.59	6.43
PBW 343 x K8962	-0.48	70.63	-3.16**	71.34	-1.86**	7.15	-0.31	6.21
PBW 343 x K9533	-0.02	70.94	-0.16	71.51	-0.62	9.50	-0.60	6.34
PBW 343 x K7903	-1.10	67.56	-2.09*	66.50	-0.78	7.51	-1.31*	4.91
PBW 343 x HUW234	1.36*	71.94	1.12	72.58	-1.90**	7.46	-1.51**	5.34
PBW 343 x KRL 1-4	-0.12	73.43	1.14	73.16	-0.53	8.82	-1.32*	5.36
PBW 343 x HP 1633	-0.65	71.18	0.61	73.54	-1.13**	7.10	-1.61**	5.08
PBW 343 x K816	-0.42	70.52	1.00	71.59	0.87*	9.44	-1.46**	5.50
K 9107 x K 88	-0.05	75.81	-0.31	74.63	0.36	10.16	-1.17*	6.03
K 9107 x K 8962	-1.09	71.00	-4.16**	71.50	0.24	9.77	-0.67	6.02
K 9107 x K 9533	2.22**	74.15	0.06	72.89	-1.20**	9.45	-1.73*	5.39
K 9107 x K 7903	-1.33*	68.30	-2.11*	67.65	-1.47**	7.35	-1.16*	5.24
K 9107 x HUW 234	-0.05	71.50	-0.74	71.89	-0.50	9.38	-1.79**	5.24
K 9107 x KRL 1-4	-0.83	73.70	3.86**	79.33	-1.40**	8.47	-1.8-**	5.05
K 9107 x HP 1633	0.67	73.78	0.92	75.02	-0.14	8.61	-0.57	6.30
K 9107 x K 816	-1.60*	70.31	-0.03	71.73	-2.64**	6.45	-1.21*	5.92
K 88 x K 8962	-0.59	70.32	-2.30*	72.11	-1.89**	7.30	-1.14*	5.51
K 88 x K 9533	0.09	70.84	0.45	72.03	2.91**	13.21	-1.40*	6.07
K 88 x K 7903	-1.66**	66.79	-1.08	67.42	-2.52	7.95	-0.39	6.36
K 88 x HUW 234	0.87	71.24	1.23	72.61	-0.09	9.45	-0.15	7.54
K 88 x KRL 1-4	0.55	73.90	-0.93	73.28	-0.68	8.85	-0.61	6.60
K 88 x HP 1633	-0.36	71.27	-0.80	72.05	0.34	8.74	-0.76	6.47
K 88 x K 816	0.56	71.29	0.38	70.88	-2.10**	6.64	-0.36	7.13
K 8962 x K 9533	-0.32	66.76	4.32**	76.62	1.72**	11.76	-0.21	6.76
K 8962 x K 7903	0.26	65.04	1.52	70.74	1.54**	9.74	-0.16	6.10
K 8962 x HUW 234	1.99	66.89	7.83**	79.93	-1.47**	7.80	-1.64**	5.25
K 8962 x KRL 1-4	1.00	70.68	3.47**	78.40	1.86**	11.12	-0.19	6.52
K 8962 x HP 1633	0.96	68.91	6.79**	80.36	-0.55	7.59	-0.36	6.36
K 8962 x K 816	2.83**	69.89	5.24**	76.47	-0.14	8.33	-0.66	6.33
K 9533 x K 7903	2.41**	67.03	1.13	67.53	1.06*	10.37	-0.49	6.19
K 9533 x HUW 234	-1.88**	64.67	-1.61	67.66	-2.04**	8.34	-1.75**	5.56
K 9533 x KRL 1-4	-0.44	69.08	2.98**	75.09	-0.97*	9.40	-0.98	6.16
K 9533 x HP 1633	0.51	68.31	0.79	71.53	0.13	9.38	-1.80**	5.36
K 9533 x K 816	0.28	67.18	0.01	68.42	-3.15**	6.43	-0.73	6.68
K 7903 x HUW 234	1.47*	65.72	0.56	66.67	0.38	8.91	-1.24*	5.35
K 7903 x KRL 1-4	0.91	68.13	1.13	70.16	0.93*	9.47	0.36	6.78
K 7903 x HP 1633	0.99	66.49	3.47**	71.14	-1.23**	6.19	0.59	7.02
K 7903 x K 816	2.07**	66.67	3.51**	68.83	0.46	8.21	1.13*	7.82
HUW 234 x KRL 1-4	0.29	69.43	2.98**	74.88	-0.21	9.40	-0.60	6.45
HUW 234 x HP 1633	-1.22	66.20	-2.94**	67.59	-0.63	7.86	-0.98	6.08
HUW 234 x K 816	-0.20	66.33	-0.83	67.37	3.36**	12.19	1.46**	8.78
KRL 1-4 x HP 1633	1.42*	71.82	0.34	73.72	-0.64	7.84	0.76	7.65
KRL 1-4 x K 816	0.19	69.69	-4.49**	66.55	0.63	9.44	-2.07**	5.08
HP 1633 x K 816	-0.92	66.85	-1.11	68.56	0.25	7.94	0.23	7.39
SE (Sij)	0.636		0.996		0.415		0.540	
SE (Sij–Sjk)	0.935		1.465		0.612		0.794	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	Plant Height in cm				Length of spike per plant in cm			
	F_1		F_1		F_2		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	-4.97**	78.68	-20.02**	73.80	-1.01**	9.75	-0.61*	9.04
PBW 343 x K88	0.70	81.33	10.17**	98.07	-0.07	9.86	-0.05	8.99
PBW 343 x K8962	-10.56**	69.40	7.84**	103.40	-1.19**	8.78	0.04	9.50
PBW 343 x K9533	1.83**	86.15	-5.16**	85.34	-0.87**	9.45	-0.51*	9.00
PBW 343 x K7903	12.31**	93.52	4.08*	91.54	1.61**	11.80	-0.43	9.00
PBW 343 x HUW234	-3.99**	76.87	-5.33**	82.24	-0.21	10.21	-0.16	9.25
PBW 343 x KRL 1-4	-7.06**	74.71	-3.62*	84.35	-0.10	10.70	-0.30	9.19
PBW 343 x HP 1633	1.65**	85.85	2.46	93.52	0.77**	11.81	-0.35	9.23
PBW 343 x K816	7.34**	87.39	10.55**	100.14	1.20**	11.34	-0.46	9.00
K 9107 x K 88	6.24**	88.03	-14.94**	82.43	0.47*	10.58	-0.37	9.27
K 9107 x K 8962	-9.41**	71.69	9.31**	114.34	-0.28	9.88	0.21	10.26
K 9107 x K 9533	-2.45**	83.02	0.05	100.01	-0.72**	9.78	-0.19	9.97
K 9107 x K 7903	-6.44**	75.93	12.75**	109.67	-0.34	10.03	0.64**	10.66
K 9107 x HUW 234	9.19**	91.20	11.46**	108.50	-0.58**	10.02	0.35	10.35
K 9107 x KRL 1-4	-12.21**	70.71	8.81**	106.25	1.10**	12.08	-0.21	9.88
K 9107 x HP 1633	=7.64**	77.71	-7.12**	93.41	0.51*	11.73	-0.99**	9.18
K 9107 x K 816	-1.19*	80.01	7.77**	106.83	0.05	10.37	-0.99**	9.05
K 88 x K 8962	-13.06**	65.03	14.32**	113.43	-0.86**	8.46	-0.30	9.15
K 88 x K 9533	-1.28**	81.18	-4.40	93.64	-0.09	9.57	-0.50	9.06
K 88 x K 7903	-0.28	79.06	0.57	91.57	0.00	9.53	0.77**	10.18
K 88 x HUW 234	6.05**	85.04	-8.07**	83.04	1.09**	10.86	-0.07	9.32
K 88 x KRL 1-4	3.29**	83.20	0.76	92.28	1.51**	11.06	-0.20	9.28
K 88 x HP 1633	3.70**	86.04	8.09**	102.70	0.13	10.51	-0.32	9.25
K 88 x K 816	-12.56**	65.63	7.64**	100.78	-2.72**	6.76	-0.03	9.48
K 8962 x K 9533	-2.67**	79.11	-5.96**	95.74	-0.30	9.42	-0.04	9.93
K 8962 x K 7903	-3.62**	75.04	-1.70	96.96	0.20	9.78	-0.38	9.45
K 8962 x HUW 234	-18.03**	60.28	-9.04**	89.74	0.54*	10.36	-0.80**	9.00
K 8962 x KRL 1-4	0.99*	80.22	-4.55**	94.63	-0.78**	9.42	0.03	9.92
K 8962 x HP 1633	-6.23**	75.43	-12.96**	89.31	0.61**	11.05	-0.37	9.61
K 8962 x K 816	-8.91**	68.60	-10.03**	90.77	-0.85**	8.68	-0.34	9.51
K 9533 x K 7903	11.27**	94.30	9.71**	98.30	0.45*	10.37	-0.06	9.88
K 9533 x HUW 234	-1.17*	81.51	7.50**	101.21	-0.15	10.01	-0.74**	9.18
K 9533 x KRL 1-4	5.84**	89.43	4.51**	98.62	0.15	10.69	0.27	10.27
K 9533 x HP 1633	-13.51**	72.52	2.94	100.14	-0.74**	10.04	-0.61**	9.48
K 9533 x K 816	-6.86**	75.02	3.81**	99.54	-0.68**	9.20	-0.44	9.52
K 7903 x HUW 234	4.73**	84.30	17.50**	108.17	-0.08	9.95	-0.48	9.30
K 7903 x KRL 1-4	8.68**	89.17	4.00*	95.07	0.64**	11.04	-0.35	9.52
K 7903 x HP 1633	-10.83**	72.09	-1.35	92.81	-0.38	10.27	0.59*	10.53
K 7903 x K 816	1.00*	79.77	-2.48	90.21	-0.31	9.43	1.54**	11.37
HUW 234 x KRL 1-4	0.03	80.17	-3.64*	87.55	-0.33	10.30	0.58**	10.42
HUW 234 x HP 1633	-15.30**	67.24	0.86	95.14	-0.61**	10.27	-0.08	9.85
HUW 234 x K 816	0.02	78.44	-6.60**	86.21	0.80**	10.78	0.87**	10.67
KRL 1-4 x HP 1633	-3.81**	79.67	-6.63**	88.04	-0.04	11.22	1.06**	11.07
KRL 1-4 x K 816	3.67**	83.00	20.86**	114.07	1.11**	11.46	0.23	10.11
HP 1633 x K 816	11.08**	92.83	-3.51*	92.79	1.17**	11.77	-0.34	9.63
SE (Sij)	0.475		1.723		0.216		0.248	
SE (Sij – Sjk)	0.70		2.532		0.319		0.367	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	Peduncle length per plant in cm				Flag leaf area of main shoot in cm^2			
	F_1		F_2		F_1		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	1.95	31.50	-6.15**	24.95	1.05**	15.40	0.91**	14.19
PBW 343 x K88	3.95**	32.30	4.72**	34.36	0.67*	14.86	0.21	13.64
PBW 343 x K8962	3.91**	31.88	3.78**	33.95	0.49	15.38	0.38	14.30
PBW 343 x K9533	-3.87**	25.79	-3.81**	25.30	0.27	14.45	-0.11	13.21
PBW 343 x K7903	3.24**	31.32	-2.72*	25.83	0.63*	14.39	0.17	13.04
PBW 343 x HUW234	-1.91	25.22	0.73	27.95	0.53	15.35	0.27	14.11
PBW 343 x KRL 1-4	-0.66	28.81	0.13	27.75	0.29	14.56	0.42	13.92
PBW 343 x HP 1633	-1.10	27.40	1.58	29.91	0.46	15.35	0.06	13.83
PBW 343 x K816	2.13**	30.47	2.98*	31.42	0.20	13.96	-0.14	12.71
K 9107 x K 88	2.87**	30.58	1.30	35.04	0.73*	14.66	-0.19	13.11
K 9107 x K 8962	-0.97	26.37	0.15	34.42	-0.02	14.61	-0.24	13.56
K 9107 x K 9533	-0.74	28.30	3.03*	36.24	0.74*	14.66	0.27	13.47
K 9107 x K 7903	-1.22	26.23	8.02**	40.67	0.86**	14.35	0.22	12.96
K 9107 x HUW 234	1.03	27.53	6.54**	37.87	-0.16	14.41	0.40	14.11
K 9107 x KRL 1-4	-1.33	27.51	1.51	33.24	1.58**	15.59	1.18**	14.56
K 9107 x HP 1633	-2.37*	25.50	-4.40**	28.04	-0.57	14.06	-0.69*	12.95
K 9107 x K 816	-0.31	27.40	1.46	34.00	-0.10	13.41	0.37	13.10
K 88 x K 8962	-1.43	24.70	5.93**	38.74	0.80	14.76	0.24	14.18
K 88 x K 9533	-1.83	26.00	-3.05*	28.71	0.66*	14.41	0.99**	14.33
K 88 x K 7903	-1.04	25.20	0.23	31.43	0.43	13.76	1.23**	14.12
K 88 x HUW 234	1.81	27.10	-3.12*	26.74	0.72*	15.11	0.34	14.19
K 88 x KRL 1-4	5.40**	33.03	3.05*	33.42	0.27	14.11	1.02**	14.54
K 88 x HP 1633	2.40*	29.07	6.02**	37.00	1.01**	15.48	0.66	14.45
K 88 x K 816	-4.31**	22.20	4.29**	35.38	1.26**	14.59	0.90**	13.77
K 8962 x K 9533	-3.94**	23.51	3.16*	35.44	0.09	14.54	0.16	14.00
K 8962 x K 7903	-3.41**	22.46	-0.55	31.18	0.92**	14.94	0.58	13.96
K 8962 x HUW 234	-1.32	23.60	0.12	30.52	1.01**	16.11	0.76*	15.11
K 8962 x KRL 1-4	1.24	28.50	1.19	31.98	0.51	15.05	0.32	14.34
K 8962 x HP 1633	-0.17	26.12	-0.64	30.87	1.39**	16.55	1.11**	15.39
K 8962 x K 816	-3.66**	22.47	-7.73**	23.88	0.35	14.39	0.24	13.61
K 9533 x K 7903	2.94**	30.50	1.49	32.16	0.38	13.69	0.24	13.03
K 9533 x HUW 234	-1.28	25.33	1.76	31.10	0.48	14.87	0.60	14.35
K 9533 x KRL 1-4	3.52**	32.47	-0.93	28.81	0.57	14.40	0.31	13.73
K 9533 x HP 1633	2.78**	30.77	0.88	31.33	1.27**	15.73	1.45**	15.13
K 9533 x K 816	2.34*	30.17	1.55	32.11	0.45	13.77	0.00	12.77
K 7903 x HUW 234	3.64**	28.67	6.84**	35.62	0.43	14.40	-0.14	13.16
K 7903 x KRL 1-4	-0.43	26.93	-0.83	28.80	0.09	13.49	0.41	13.37
K 7903 x HP 1633	-1.37	25.03	0.47	30.37	0.69*	14.72	0.54	13.78
K 7903 x K 816	3.66**	29.90	0.89	30.87	0.64*	13.54	0.71*	13.03
HUW 234 x KRL 1-4	4.42**	30.83	-2.11	25.74	0.20	14.68	-0.03	13.91
HUW 234 x HP 1633	-0.15	25.30	2.61	31.17	0.44	15.55	-0.07	14.31
HUW 234 x K 816	0.68	25.97	0.30	28.96	0.69*	14.66	0.67*	13.96
KRL 1-4 x HP 1633	-2.82**	24.97	-0.66	28.30	0.29	14.79	-0.11	13.76
KRL 1-4 x K 816	2.61*	30.24	9.09**	38.16	1.22**	14.64	0.81*	13.76
HP 1633 x K 816	2.00	28.66	-0.92	28.86	-0.61	13.88	-0.23	12.99
SE (Sij)	1.055		1.339		0.30		0.331	
SE (Sij – Sjk)	1.552		1.968		0.442		0.486	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	Days to maturity				Biological Yield per plant (g)			
	F_1		F_1		F_1		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	-0.01	126.33	-2.97**	122.67	8.62**	52.70	-1.46	27.47
PBW 343 x K88	0.38	125.33	-3.83**	120.67	-5.77**	36.73	-5.25**	26.11
PBW 343 x K8962	0.74	118.33	2.53**	125.67	-4.25**	35.22	-1.26	25.74
PBW 343 x K9533	1.85**	121.30	0.81*	124.00	-2.42**	43.17	-2.44	26.05
PBW 343 x K7903	-6.71**	99.67	0.64	117.00	-5.59**	31.99	-6.24**	20.73
PBW 343 x HUW234	1.61*	120.33	0.42	124.33	-7.77**	32.90	-8.64**	18.43
PBW 343 x KRL 1-4	-1.37*	121.67	-3.44**	121.00	-2.40**	40.15	-7.02**	21.22
PBW 343 x HP 1633	-4.73**	115.33	0.72	125.33	-4.16**	32.20	-5.13*	22.82
PBW 343 x K816	-1.10	120.00	-1.31*	122.33	4.61**	41.95	-8.14**	21.11
K 9107 x K 88	-1.65*	125.00	-5.36**	118.68	8.71**	52.62	-6.00**	24.83
K 9107 x K 8962	0.38	119.67	3.33**	126.00	-0.06	40.82	-2.73	23.74
K 9107 x K 9533	-0.51	120.33	-1.72**	121.00	3.13**	50.13	-3.55	24.40
K 9107 x K 7903	-0.73	107.33	1.11**	117.00	-9.03**	29.35	-3.34	23.10
K 9107 x HUW 234	0.90	121.33	0.22	123.67	-0.64	41.44	-6.04**	20.50
K 9107 x KRL 1-4	-0.73	124.00	-2.64**	121.33	-8.52**	35.43	-8.46**	19.25
K 9107 x HP 1633	0.90	122.37	0.86*s	125.00	-3.96**	33.82	-4.76*	22.66
K 9107 x K 816	0.21	123.00	0.17	123.33	-4.25**	34.49	-3.84	24.88
K 88 x K 8962	0.10	118.00	3.47**	125.00	-12.20**	27.09	-7.80**	21.10
K 88 x K 9533	-1.12	118.33	5.08**	126.67	7.34**	52.75	-8.97**	21.42
K 88 x K 7903	4.32**	111.00	2.58**	117.33	-11.01**	25.80	-4.20*	24.68
K 88 x HUW 234	-0.37	118.67	-2.97**	119.33	-0.22	40.28	-0.86	28.11
K 88 x KRL 1-4	-1.35*	122.00	-1.83**	121.00	2.88**	45.25	-5.04*	25.10
K 88 x HP 1633	1.96**	122.30	-0.33	122.67	-1.03	35.16	-2.70	27.15
K 88 x K 816	-0.40	121.00	0.31	122.33	-13.73**	23.43	-2.34	28.80
K 8962 x K 9533	-1.10	111.00	0.78*	121.00	13.77**	56.15	1.10	27.12
K 8962 x K 7903	-1.65*	97.67	3.28**	116.67	9.99**	42.96	-2.73	21.78
K 8962 x HUW 234	0.65	112.33	2.72**	123.67	-1.91	35.86	-2.51	22.10
K 8962 x KRL 1-4	1.02	117.00	1.53**	123.00	5.86**	45.20	-2.96	22.82
K 8962 x HP 1633	-0.68	112.33	4.69**	126.33	-0.65	32.51	-3.06	22.43
K 8962 x K 816	0.96	115.00	-2.67**	118.00	-8.26**	25.87	0.31	27.10
K 9533 x K 7903	-0.54	101.33	3.22**	116.67	8.22**	48.11	-0.07	25.93
K 9533 x HUW 234	1.77**	115.00	2.67**	123.67	-3.78**	39.81	-6.34**	19.76
K 9533 x KRL 1-4	0.79	118.33	1.14*	122.67	-3.48**	41.48	-3.15	24.12
K 9533 x HP 1633	1.10	115.67	1.97**	123.67	-4.51**	34.76	-9.77**	17.21
K 9533 x K 816	0.40	116.00	1.94**	122.67	-12.97**	27.28	-3.97	24.80
K 7903 x HUW 234	0.21	100.67	10.83**	125.00	4.69**	39.67	-6.45**	18.13
K 7903 x KRL 1-4	2.90**	107.67	6.64**	121.33	2.72**	39.56	-0.72	25.04
K 7903 x HP 1633	1.88**	103.67	5.81**	120.67	-4.06**	26.61	1.33	26.80
K 7903 x K 816	5.85**	108.67	8.44**	122.33	1.51	33.15	5.47**	32.23
HUW 234 x KRL 1-4	-1.12	116.00	0.42	122.67	-0.51	40.03	-0.81	25.04
HUW 234 x HP 1633	-1.15	113.00	1.25**	123.67	-5.63**	28.73	-2.26	23.30
HUW 234 x K 816	-0.85	114.33	3.89**	125.33	17.22**	52.55	7.66**	34.52
KRL 1-4 x HP 1633	0.54	119.00	0.06	123.00	3.85**	40.08	7.07**	33.80
KRL 1-4 x K 816	-3.15**	116.33	-1.64**	120.33	2.49**	39.69	-6.82**	21.21
HP 1633 x K 816	0.49	117.00	0.53	122.67	8.51**	39.54	0.39	28.30
SE (Sij)	0.670		0.383		0.871		2.075	
SE (Sij – Sjk)	0.986		0.563		1.281		3.050	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	No. of grains per spike				1000 grain weight (g)			
	F_1		F_2		F_1		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	-4.07**	44.36	3.62	49.88	0.98	51.50	2.63**	50.37
PBW 343 x K88	-9.05**	41.74	-9.41**	57.20	3.16**	52.47	3.26**	49.67
PBW 343 x K8962	-2.06	44.98	-3.61	39.17	0.11	50.05	4.03**	50.00
PBW 343 x K9533	2.08	52.37	-5.15*	40.12	2.45**	52.39	-3.39**	40.55
PBW 343 x K7903	-2.51*	44.38	-0.36	42.50	8.08**	54.73	-2.64**	41.00
PBW 343 x HUW234	3.29*	49.97	-1.92	43.61	4.05**	52.51	3.17**	46.04
PBW 343 x KRL 1-4	4.85**	53.92	0.70	46.79	-2.63**	44.37	-5.00**	37.71
PBW 343 x HP 1633	2.22	48.51	-1.48	43.16	-5.05**	41.75	-2.85**	50.90
PBW 343 x K816	-1.78	44.35	4.99*	48.90	7.18**	55.50	0.48	43.04
K 9107 x K 88	1.22	51.34	-0.38	46.14	3.29**	51.37	-12.69**	36.01
K 9107 x K 8962	3.37*	49.74	-3.09	39.61	-2.00*	46.71	0.88	51.15
K 9107 x K 9533	6.62**	56.25	1.82	47.36	-6.17**	42.55	2.32**	50.56
K 9107 x K 7903	-2.10	44.52	1.09	43.87	-0.25	45.18	4.35**	52.29
K 9107 x HUW 234	-1.63	44.38	0.15	45.59	-4.70**	42.53	6.58**	53.75
K 9107 x KRL 1-4	3.00*	51.41	-0.40	45.61	-0.07	45.70	6.01**	53.01
K 9107 x HP 1633	-1.58	43.94	0.95	45.52	10.45**	56.03	1.54**	49.60
K 9107 x K 816	0.70	46.16	-1.41	42.42	8.43**	55.53	3.82**	50.68
K 88 x K 8962	-5.45**	43.26	1.48	44.51	-1.12	46.37	4.84**	51.78
K 88 x K 9533	1.93	53.91	-1.65	44.23	7.88**	55.37	-2.05**	42.68
K 88 x K 7903	4.96**	53.92	-2.45	40.66	1.12	45.32	7.08**	51.69
K 88 x HUW 234	-6.58**	41.78	-2.43	43.35	-3.47**	42.53	-2.54**	41.30
K 88 x KRL 1-4	11.03**	61.78	-5.73*	40.62	-4.84**	39.71	-2.39**	41.29
K 88 x HP 1633	-6.04**	53.90	4.09	49.00	-0.10	44.25	5.62**	50.35
K 88 x K 816	-5.78**	42.04	3.58	47.76	0.32	46.19	0.16	43.69
K 8962 x K 9533	-2.54	45.69	3.21	45.26	-2.97**	45.15	-0.44	46.03
K 8962 x K 7903	2.42	47.64	-0.80	38.49	1.03	45.87	-3.97**	42.20
K 8962 x HUW 234	-3.06*	41.55	-1.42	40.54	-1.32	45.31	-3.71**	41.69
K 8962 x KRL 1-4	6.20**	53.21	5.50*	48.02	7.34**	52.52	2.53**	47.77
K 8962 x HP 1633	10.13**	54.25	0.70	41.78	5.39**	50.38	4.44**	50.73
K 8962 x K 816	7.68**	51.75	3.15	43.49	-1.06	45.45	-2.43**	42.67
K 9533 x K 7903	8.50**	57.03	-0.63	41.50	-2.01*	42.82	-2.26**	41.88
K 9533 x HUW 234	2.74*	50.61	-3.63	41.18	5.81**	52.44	-0.34	43.03
K 9533 x KRL 1-4	-9.34**	40.92	5.69*	51.06	5.19**	50.38	-2.53**	40.68
K 9533 x HP 1633	-2.20	45.18	-1.01	42.92	-1.64*	43.35	1.09**	45.35
K 9533 x K 816	1.42	48.74	-2.24	40.95	-1.14	45.37	7.63**	50.70
K 7903 x HUW 234	9.95**	54.81	-4.41	37.63	3.54**	49.49	0.28	43.35
K 7903 x KRL 1-4	-2.89	44.36	-4.51	38.09	-1.43	40.47	0.09	43.00
K 7903 x HP 1633	-6.67**	37.69	6.16*	47.32	-4.51**	37.19	-0.57	43.39
K 7903 x K 816	0.71	45.02	5.75*	46.17	-4.70**	38.52	3.12**	45.85
HUW 234 x KRL 1-4	-5.22**	41.43	3.61	48.88	3.35**	47.05	3.72**	45.86
HUW 234 x HP 1633	-0.27	43.48	7.35**	51.18	-0.82	42.68	-0.52	42.67
HUW 234 x K 816	4.84**	48.55	7.65**	50.75	5.31**	50.33	-0.60	41.40
KRL 1-4 x HP 1633	0.88	47.03	2.72	47.11	-1.30	40.75	2.50**	45.53
KRL 1-4 x K 816	0.70	46.80	-4.79*	38.87	4.00**	47.67	4.22**	46.05
HP 1633 x K 816	9.13**	52.35	-2.44	39.77	4.29**	47.67	-0.10	42.78
SE (Sij)	1.322		2.448		0.781		0.508	
SE (Sij – Sjk)	1.943		3.599		1.148		0.748	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	Grain yield per plant (g)				Seed hardness (Kg/grain)			
	F_1		F_1		F_1		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	5.53**	27.17	-0.87	12.65	0.54**	9.51	-0.60**	8.02
PBW 343 x K88	-1.67	19.72	-2.62*	12.16	-0.92**	7.63	-0.86**	8.01
PBW 343 x K8962	-0.79	19.69	-2.03	12.18	0.73**	9.89	-0.90**	7.63
PBW 343 x K9533	-0.87	20.94	1.40	13.62	0.00	8.69	0.11	8.54
PBW 343 x K7903	-0.35	19.51	-1.34	13.06	-0.13	8.79	1.27**	9.94
PBW 343 x HUW234	-1.74*	18.98	-2.06	12.27	-1.44**	7.72	-0.49**	7.97
PBW 343 x KRL 1-4	-0.99	20.29	-2.99*	12.07	-0.98**	7.95	0.91**	9.50
PBW 343 x HP 1633	0.38	19.04	-2.33	12.28	-0.39*	8.70	-1.48**	6.85
PBW 343 x K816	0.38	19.67	-3.17*	12.65	1.37**	10.38	-0.37*	7.98
K 9107 x K 88	2.46**	23.04	-1.57	12.24	-1.59**	6.84	0.04	8.95
K 9107 x K 8962	0.26	19.94	-0.40	12.83	1.27**	10.31	0.83**	9.48
K 9107 x K 9533	-1.73*	19.27	-1.77	11.48	0.16	8.73	-1.04**	7.50
K 9107 x K 7903	-1.78*	17.27	-3.38*	10.04	-0.29	8.50	-1.45**	7.33
K 9107 x HUW 234	0.09	20.00	-2.91*	10.44	-0.87**	8.17	-1.88**	6.68
K 9107 x KRL 1-4	-1.46	19.02	-3.15*	10.93	-1.24**	7.57	-1.65**	7.05
K 9107 x HP 1633	0.24	18.10	0.05	13.68	1.58**	10.54	2.45**	10.89
K 9107 x K 816	-4.32**	14.17	-3.37*	11.57	-1.35**	7.54	1.31**	9.77
K 88 x K 8962	-2.79**	16.63	-2.60	11.90	0.68**	9.30	0.69**	9.52
K 88 x K 9533	5.82**	26.56	-5.39**	9.12	0.89**	9.04	1.28**	10.01
K 88 x K 7903	0.04	18.83	0.03	14.71	0.23	8.61	-1.01**	7.95
K 88 x HUW 234	-0.15	19.51	1.59	16.21	-0.67**	7.86	0.98**	9.73
K 88 x KRL 1-4	-1.39	18.83	-0.60	14.75	-0.11	8.29	-1.17**	7.71
K 88 x HP 1633	0.39	17.99	-0.62	14.28	-1.01**	7.54	-0.99**	7.63
K 88 x K 816	-3.44**	14.80	0.52	16.62	-0.75**	7.52	-0.09	8.56
K 8962 x K 9533	3.86**	23.70	1.22	15.16	-0.23**	8.54	-1.27**	7.18
K 8962 x K 7903	0.82	18.71	-0.93	13.18	-1.21**	7.79	0.30	8.99
K 8962 x HUW 234	-2.82**	15.93	-2.58	11.46	-0.96**	8.28	-1.08**	7.40
K 8962 x KRL 1-4	3.15**	22.47	-0.90	13.87	0.93**	9.94	-0.92**	7.68
K 8962 x HP 1633	-1.72*	14.92	-0.44	13.88	0.38*	9.54	0.68**	9.02
K 8962 x K 816	-0.98	16.35	-1.56	13.97	-0.45**	8.64	1.45**	9.82
K 9533 x K 7903	1.60	20.82	-1.01	13.11	-0.39*	8.13	0.42**	9.01
K 9533 x HUW 234	-1.80*	18.20	-1.79	12.26	0.61**	9.38	2.41**	10.79
K 9533 x KRL 1-4	-1.61	19.03	-0.05	12.73	-1.48**	9.06	-1.55**	6.95
K 9533 x HP 1633	0.92	18.94	-2.87*	11.46	0.81**	9.51	-0.84**	7.41
K 9533 x K 816	-5.22**	13.43	-1.28	14.26	-1.75**	6.87	-0.83**	7.43
K 7903 x HUW 234	-0.36	17.77	-3.49**	10.74	0.51**	9.50	-0.90**	7.71
K 7903 x KRL 1-4	0.53	19.23	0.05	15.01	0.20	8.96	0.46**	9.20
K 7903 x HP 1633	-3.23**	12.85	-0.05	14.46	-2.06**	6.86	0.08	8.56
K 7903 x K 816	-1.12	15.59	0.35	16.07	0.62**	9.46	-1.52**	6.99
HUW 234 x KRL 1-4	-0.97	18.58	-1.72	13.18	-0.99**	8.02	-0.59**	7.94
HUW 234 x HP 1633	-1.56	15.38	-2.75*	11.69	0.38*	9.55	-1.10**	7.17
HUW 234 x K 816	6.22**	23.79	2.90*	18.55	1.30**	10.68	-1.70**	7.12
KRL 1-4 x HP 1633	-2.32**	15.18	0.00	15.17	-0.30	8.63	0.14	8.54
KRL 1-4 x K 816	0.19	18.32	-2.51	13.87	0.79**	9.65	0.96**	9.38
HP 1633 x K 816	-1.30	14.22	0.45	16.38	0.76**	9.77	-0.70**	7.46
SE (Sij)	0.857		1.327		0.164		0.154	
SE (Sij – Sjk)	1.260		1.951		0.242		0.230	

Contd .....

Table 3 : Contd.....

Hybrid/cross combination	Protein content (%)				Gluten content (%)			
	F_1		F_1		F_2		F_2	
	sca	Mean	sca	Mean	sca	Mean	sca	Mean
PBW 343 x K9107	1.71**	14.14	0.30*	13.77	1.16**	10.71	0.08	10.09
PBW 343 x K88	-0.32	11.52	-2.37*	9.84	0.88**	8.33	-1.20**	8.08
PBW 343 x K8962	-2.23**	10.60	1.35**	14.07	-1.48**	8.21	1.28**	10.75
PBW 343 x K9533	-2.07**	10.50	-2.32**	10.17	-1.43**	8.20	-1.77**	7.72
PBW 343 x K7903	-1.11**	11.28	1.57**	14.20	-0.79**	8.50	1.33**	10.95
PBW 343 x HUW234	0.80**	12.39	1.21**	14.03	0.52**	9.33	1.08**	10.77
PBW 343 x KRL 1-4	1.36**	13.08	-0.61**	11.59	1.36**	10.50	-0.99**	8.30
PBW 343 x HP 1633	0.06	11.31	1.25**	14.27	0.32	9.33	0.40**	10.43
PBW 343 x K816	2.06**	13.52	1.82**	14.13	1.20**	10.19	1.19**	10.75
K 9107 x K 88	1.75**	14.21	0.90**	13.75	1.42**	11.07	0.31**	9.76
K 9107 x K 8962	-1.37**	12.08	0.95**	14.30	-0.40*	9.73	0.80**	10.45
K 9107 x K 9533	-0.31	13.50	1.34**	14.46	0.16	10.22	1.18**	10.83
K 9107 x K 7903	-1.84**	11.17	0.01	13.27	-0.85**	8.88	-0.03	9.77
K 9107 x HUW 234	0.94**	13.17	-0.41**	13.05	1.06**	10.31	-0.26**	9.60
K 9107 x KRL 1-4	-2.15**	10.20	1.37**	14.20	-1.84**	7.74	1.07**	10.53
K 9107 x HP 1633	1.02**	13.02	-0.20	13.46	1.17**	10.62	-0.70**	9.50
K 9107 x K 816	0.24	12.33	1.57**	11.37	-0.83**	8.62	-1.02**	8.71
K 88 x K 8962	1.36**	14.21	1.41**	13.50	1.15**	10.95	0.54**	9.46
K 88 x K 9533	-0.53*	12.07	1.41**	13.28	-0.88**	8.85	0.89**	9.82
K 88 x K 7903	-0.07	12.33	-0.72**	11.28	-0.23	9.17	-0.42**	8.65
K 88 x HUW 234	0.49*	12.11	1.40**	13.60	0.28	9.19	0.97**	10.11
K 88 x KRL 1-4	1.34**	13.08	0.01	13.59	0.75**	10.00	-0.44**	8.30
K 88 x HP 1633	-1.42**	9.97	-1.12**	11.28	-1.36**	9.77	-1.26**	8.22
K 88 x K 816	-0.35	11.13	0.77**	12.46	0.77**	9.87	0.43**	9.54
K 8962 x K 9533	0.61**	14.20	-0.92**	11.45	1.76**	11.97	-0.51**	8.61
K 8962 x K 7903	0.76**	14.17	-0.84**	11.66	0.71**	10.58	-0.54**	8.72
K 8962 x HUW 234	0.70**	13.32	-2.49**	10.21	-0.11	9.50	-1.72**	7.61
K 8962 x KRL 1-4	1.48**	14.23	1.29**	13.36	1.02**	10.74	1.22**	10.15
K 8962 x HP 1633	0.96**	13.35	0.04	12.54	0.01	9.60	0.00	9.67
K 8962 x K 816	0.83**	13.31	-0.23	11.96	0.01	9.58	0.48**	9.72
K 9533 x K 7903	-0.80**	12.34	0.94**	13.22	-1.21**	8.60	0.30**	9.57
K 9533 x HUW 234	-1.07**	11.29	0.72**	13.19	-0.66**	8.66	0.70**	10.05
K 9533 x KRL 1-4	1.64**	14.12	-0.82**	11.03	1.04**	10.69	-0.76**	8.18
K 9533 x HP 1633	2.07**	14.20	-0.40**	12.28	1.55**	11.04	-0.15	9.53
K 9533 x K 816	1.17**	13.39	-0.99**	10.97	0.76**	10.27	-0.81**	8.40
K 7903 x HUW 234	-0.24	11.93	-2.73**	9.88	-0.41*	8.58	-1.79**	7.70
K 7903 x KRL 1-4	1.83**	14.13	-2.29**	9.69	1.69**	11.01	-1.36**	7.72
K 7903 x HP 1633	0.72**	12.66	1.73**	14.54	0.37	9.67	1.14**	10.56
K 7903 x K 816	0.86**	12.89	1.34**	13.44	0.55**	9.72	1.10**	10.45
HUW 234 x KRL 1-4	-1.37**	10.13	1.55**	13.74	-0.53**	8.31	1.37**	10.52
HUW 234 x HP 1633	-0.95**	10.21	1.53**	14.53	-0.67**	8.05	1.12**	10.01
HUW 234 x K 816	0.92**	12.17	2.29**	14.48	1.33**	10.02	1.64**	11.06
KRL 1-4 x HP 1633	-0.85**	10.43	1.12**	13.51	-0.73**	8.32	0.96**	10.45
KRL 1-4 x K 816	-0.75**	10.63	0.77**	12.44	-0.41*	8.61	0.41**	9.43
HP 1633 x K 816	-0.32	10.70	1.77**	14.27	-0.55**	8.35	1.19**	10.95
SE (Sij)	0.228		0.122		0.189		0.104	
SE (Sij – Sjk)	0.337		0.184		0.281		0.151	

*Significant at 5 % Level; ** Significant at 1 % Level

The result exhibiting that out of 45 crosses, 10 combinations were significant and desirable at sca level in both the generation whereas a combinations in F_1 and 13 combinations in F_2 generation also were significant as negative for sca effects exhibited similar performance overall the seed hardness in related with the quality of the seed test suitable for flower making and good chapatti performance. Thus, the value of high sea effect was an indicative for good quality of grain.

The specific combining ability effects on quality components (Table 3) were highly significant and positive in both the generations. In present study out of 45 crosses, 10 combinations were positive and significant for sea effects in both F_1 and F_2 generations. Total quality of the grain of wheat protein quality in the present context related to the product making potential of a genotype at industrial level is the first concept.

In present study cross combination i.e. PBW343x HUW 234, PBW343x K816, K9107xK88, K88xK8962, K88xK816, K8962xKRL1-4, K7903x K816 and HUW 234x K816 showed significant and positive values in both the generations. Maximum number of F_2 crosses responded highly significant performance of sca effects than F1s gluten content is related with the elasticity of wet flower quality ready for chapatti and played an important role to judge the bread making quality in particular genotype. Thus, most of the crosses executed such types of performances which were most desirable in the the generations due to their values as estimated in the study.

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