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To Study the effect of different Environments on some Quantitative Traits in Bread Wheat (*Triticum aestivum* L. em. Thell.)

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ABSTRACT: The present study was undertaken to evaluation of variance and mean performance of yield and its associated traits in ten bread wheat genotypes grown in randomized block design with three replication under normal, late and very late sown conditions during *rabi* 2021-22 at Rajasthan Agriculture Research Institute, Durgapura. The pooled as well as individual analysis of variance revealed that the treatments were highly significant for all the characters under study indicating sufficient genetic diversity present among the parents selected. Environmental factors have negative impact on growth, development and ultimately yield potential of wheat. The mean performance of different studied characters decreased under both (late and very late sown) environmental conditions as compared to normal sown condition indicating delayed sowing influenced by various temperature fluctuations.

Keywords: analysis of variance, mean performance, temperature fluctuations, bread wheat etc.

INTRODUCTION

Wheat is a self-pollinated, monocotyledonous, C_3 cereal crop belonging to the family Poaceae. It is believed to be originated from the Near East Region of South West Asia (Lupton, 1987), but now cultivated worldwide so, it has become the principal food crop in many parts of the world. Wheat grains are typically milled into flour and consumed in the form of chapati about 80-85%. Soft wheat is used for making chapati, bread, cake, biscuits, pastry and other bakery products. Hard wheat is used for manufacturing *rawa, suji and sewaya*. In areas where rice is a staple food grain, wheat is eaten in the form of *puri* and *uppumav*. It is also used for making flakes and sweets like *kheer, shira, etc*. Wheat (*Triticum aestivum*) is widely consumed by human globally and it provides one-third of the total protein requirements of the populations (Shewry, 2009). In India, it is grown in about 30.54 million hectares with the production of about 106.41 million tonnes with an average productivity of 3484 kg/ha (Anonymous, 2021-22). Now a day the demand of high yielding wheat varieties increase with the increasing food requirement of world's population. The responsiveness of genotypes depends on environments. Therefore, the knowledge of genotype and environmental interactions is necessary for the development of wheat varieties with a consistent high yield in diverse environments.

MATERIALS AND METHODS

Ten bread wheat genotypes were selected and crossed in a diallel fashion excluding reciprocals, during *rabi* 2018-19 at RARI, Durgapura. In *kharif* 2019, half of F_1's seed was raised at IARI Regional Station Wellington (Tamil Nadu) to get F_2's seed for experimentation. In *rabi* 2021-22 the experimental material consisting of ten parents along with their 45 F_1's and 45 F_2's progenies were planted in a randomized block design with three replications in three environments created by using different dates of sowing *viz.*, normal, late and very late sown (15 Nov., 1 Dec. and 15 Dec.) respectively. The experimental material was planted in three replications for each environment at Agricultural Research Farm of RARI, Durgapura. The 10 parents and 45 F_1's were grown by dibbling seeds in two rows each and the 45 F_2's in a plot of four rows each, in three replications in every environment. Each row was 3 m long with row to row spacing of 30 cm and plant to plant spacing of 10 cm was maintained in all the plots. Non-experimental rows were planted all around the experimental plot to eliminate the border effects, if any. Recommended uniform agronomical package and practices were adopted to raise a good crop population in the field. The observations were recorded on days to 50% heading, days to maturity, plant height, productive tillers per plant, flag leaf area, number of grains per spike, 1000-grain weight, biomass per plant, grain yield per spike, grain yield per plant and harvest index. The mean values of different parents F_1's and F_2's for all the characters were embayed to analysis of variance separately for individual environment as well as pooled data, to determine the significance of difference among genotypes (parents, F_1's and F_2's), environments and genotype × environment interaction effects. The analysis of variance calculated from the method suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

1. Analysis of variance. The pooled analysis of variance (Table 1) indicated significant differences over three environments (sowing dates) for all the characters under study reflected varying effects of environments in the expression of these characters. The pooled analysis of variance also indicated that the mean sum of squares due to genotypes including parents and generations (F_1's and F_2's) were significant for all the characters under investigations. The significant difference stated wide diversity among parents. Moreover, the mean sum of squares due to parents *vs* generations showed significant differences for all the characters under study. The G x E interaction was also found significant for all studied characters, which specified a non-linear response of genotypes with change in the environment. This is in compliance with the general assumption that G × E interaction is useful in crop species (Allard and Bradshaw, 1964). Sprague and Federer (1951) suggested that biasness in estimates of genetic parameters due to G × E interaction is of unknown magnitude and direction and it may not be the same for each parameter. Considering, significant G × E interaction for all the characters, the analysis of variance was carried out for the individual environment separately (Table 2).

The analysis of variance in individual environment (Table 2) depicted significant differences among the genotypes for all the characters, established the circumstances that characters displayed the presence of ample genetic diversity among the parents. Further, analysis of variance showed significant mean squares due to parents and generations for all studied characters in all the environments. Likewise, F_1 and F_2 generations also exhibited significant differences for all studied characters in each environment. Kamaluddin *et al*. (2007); Pancholi *et al*. (2012); Zare-Kohan and Heidari (2012); Singh *et al*. (2012); Nageshwar *et al*. (2021) also reported similar findings for above studied characters. The mean squares due to F_1 *vs* F_2 were found significant for all characters under study in all the three environments.

Correspondingly, the differences among the parents *vs* generations were significant for all studied characters revealed the presence of heterosis in all the three environments. Gothwal (2006) and Singh *et al*. (2012) also reported similar results.

2. Effect of different environmental conditions on mean performance of various characters. In the present study, the mean of most of the characters usually decreased under late and very late sown conditions. The percent decrease in mean performance of yield and its contributing traits mentioned in the Table 3. There was a percent reduction of 6.49 and 12.14 among the parents, 7.91 and 11.66 among the F_1's and 8.09 and 11.97 among the F_2's for days to 50% heading; 5.35 and 10.88 among the parents, 5.19 and 10.55 among the F_1's and 5.69 and 10.24 among the F_2's for days to maturity; 7.51 and 11.72 among the parents, 8.64 and 14.95 among the F_1's and 9.08 and 18.12 among the F_2's for plant height; 21.68 and 39.22 among the parents, 20.20 and 40.40 among the F_1's and 15.54 and 40.25 among the F_2's for productive tillers per plant; 9.24 and 21.02 among the parents, 10.52 and 24.55 among the F_1's and 13.77 and 28.85 among the F_2's for flag leaf area; 25.00 and 44.10 among the parents, 24.13 and 43.74 among the F_1's and 24.02 and 43.60 among the F_2's for spike length; 15.11 and 19.60 among the parents, 11.88 and 21.48 among the F_1's and 14.53 and 23.73 among the F_2's for number of grains per spike; 4.69 and 10.04 among the parents, 5.61 and 13.07 among the F_1's and 5.55 and 14.43 among the F_2's for 1000-grain weight; 11.62 and 21.60 among the parents, 9.01 and 28.41 among the F_1's and 11.01 and 27.77 among the F_2's for biomass per plant; 27.11 and 41.80 among the parents, 29.52 and 48.09 among the F_1's and 29.75 and 48.29 among the F_2's for grain yield per spike; 20.67 and 48.09 among the parents, 20.79 and 47.45 among the F_1's and 26.57 and 49.34 among the F_2's for grain yield per plant; 10.20 and 33.72 among the parents,12.88 and 26.43 among the F_1's and 17.76 and 29.94 among the F_2's for harvest index under late and very.

Among the parents and generations (F_1's and F_2's) maximum reduction was revealed in productive tillers per plants, spike length, flag leaf area, number of grains per spike, biomass per plant, grain yield per spike, grain yield per plant and harvest index which, indicated that delayed sowing of wheat extensively affect grain yield and its contributing traits. The results were in accordance with earlier researches such as Nazeem *et al*. (2014); Sallam *et al.* (2014); Abdallah *et al.* (2019).

Table 1: Pooled analysis of variance showing mean sum of squares over three environments for parents, F_1's and F_2's for yield and its contributing traits.

Particulars		Mean Squares											
Source of variation	**Df**	**Days to 50% heading**	**Days to maturity**	**Plant height**	**Productive tillers/plant**	**Flag leaf area**	**Spike length**	**Number of grains/ spike**	**1000-grain weight**	**Biomass/ plant**	**Grain yield/plant**	**Grain yield/spike**	**Harvest index**
Env.	2	6485.5**	11658.63**	11457.02**	909.77**	5821.86**	1769.06**	10055.17**	2752.9**	16743.62**	11417.75**	71.58**	13921.7**
Reps./Env.	6	1.52	2	17.02	0.37	7.29	0.39	2.19	2.24	6.37	0.48	0.01	4.85
Genotypes	99	214.16**	401.46**	462.78**	10.42**	499.82**	9.07**	244.08**	79**	160.01**	84.21**	0.64**	135.1**
Parents	9	106.44**	80.88**	241.24**	5.35**	169.91**	1.53**	55.12**	27.44**	21.71**	13.33**	0.32**	37.52**
Generations	89	224.31**	431.68**	477.62**	10.29**	532.16**	9.67**	260.37**	82.78**	163.54**	87.78**	0.66**	144.61**
Parents vs Generations	1	280**	597**	1135.71**	66.81**	591.45**	23.19**	495.63**	206.83**	1090.7**	403.7**	2.39**	167.34**
G x E	198	22.4**	18.59**	45.19**	1.25**	14.67**	1.62**	18.93**	4.86**	22.13**	15.69**	0.13**	51.39**
Error	594	2.97	6.41	18.33	0.31	4.34	0.33	4.74	1.46	6.51	2.48	0.01	7.49

*, ** significant at 5 and 1% per cent levels, respectively

Table 2: Analysis of variance showing mean squares in individual environment for parents, F_1's and F_2's for yield and its contributing traits.

Characters	Env.	Source of variation								
		Replication	**Genotypes**	**Parents**	**Generation**	**F_1's**	**F_2's**	**F_1 *vs* F_2**	**Parents vs generation**	**Error**
Df		**(2)**	**(99)**	**(9)**	**(89)**	**(44)**	**(44)**	**(1)**	**(1)**	**(198)**
Days to 50% heading	E_1	0.57	101.46**	41.49**	107.83**	86.49**	130.69**	40.83**	73.67**	3.5
	E_2	0.12	78.83**	65.05**	78.87**	66.11**	92.92**	22.53**	198.45**	2.4
	E_3	3.87	78.67**	23.51**	84.68**	77.37**	93.62**	12.89*	39.85**	2.99
Days to maturity	E_1	0.37	131.06**	30.81**	139.88**	119.41**	160.65**	126.76**	248.43**	7.62
	E_2	1.44	144.72**	42.83**	153.95**	129.45**	181.22**	32.03*	240.01**	7.11
	E_3	4.2	162.87**	29.47**	176.81**	115.84**	237.95**	169.61**	122.47**	4.52
Plant height	E_1	39.2	242.74**	97.27**	258.57**	214.92**	302.45**	248.39**	143.69**	20.54
	E_2	4.32	194.59**	74.56**	205.86**	158.33**	254.99**	134.92*	272.47**	22.78
	E_3	7.54	115.82**	86.28**	110.07**	94.79**	126.78**	47.3*	892.63**	11.69
Productive tillers/plant	E_1	0.43	5.68**	2.07**	5.78**	3.81**	7.79**	3.95**	29.46**	0.37
	E_2	0.41	3.82**	1.77**	3.67**	2.69**	4.68**	2.76**	35.57**	0.36
	E_3	0.27	3.41**	1.74**	3.54**	3.14**	3.98**	1.13*	7.65**	0.2
Flag leaf area	E_1	10.04	218.75**	59.01**	232.29**	216.42**	252.86**	25.35*	452.01**	5.5
	E_2	11.39	179.21**	58.49**	191.18**	186.44**	199.77**	21.61*	200.24**	4.53
	E_3	0.43	131.19**	54.98**	139.87**	117.89**	163.47**	68.62**	45.05**	2.99
Spike length	E_1	0.99	6.98**	1.62**	7.48**	6.51**	8.54**	3.73**	10.81**	0.43
	E_2	0.05	3.3**	0.93**	3.48**	2.6**	4.4**	1.99*	8.97**	0.36
	E_3	0.13	2.01**	0.84**	2.1**	1.58**	2.66**	1*	4.24**	0.2
Number of grains/spike	E_1	0.06	77.59**	23.98**	81.12**	66.46**	96.8**	36.36*	245.84**	5.77
	E_2	2.41	121.69**	33.56**	128.18**	110.21**	148.24**	35.91**	338.05**	5.28
	E_3	4.1	82.66**	27.67**	88.92**	74.47**	104.86**	23.59**	20.2*	3.18
1000-grain weight	E_1	2.58	21.96**	9.4**	21.72**	20.39**	23.36**	7.9*	156.3**	1.57
	E_2	2.43	22.92**	10.4**	23.36**	19.79**	27.28**	7.97*	96.89**	1.26
	E_3	1.71	43.84**	14.29**	47.24**	41.62**	53.78**	7.01*	6.58*	1.55
Biomass/plant	E_1	5.23	93.31**	37.11**	92.11**	67.81**	117.19**	57.57*	706.03**	10.79
	E_2	12.17	67.13**	16.49*	64.16**	50.79**	73.32**	248.77**	787.72**	7.19
	E_3	1.71	43.84**	14.29**	47.24**	41.62**	53.78**	7.01*	6.58*	1.55
Grain yield/plant	E_1	1.01	63.51**	13.75**	65.99**	60.85**	69.49**	138.07**	290.83**	4.2
	E_2	0.42	29.72**	10.18**	31.04**	26.55**	35.98**	11.24*	87.75**	2.15
	E_3	0.02	22.36**	9.14**	23.16**	20.91**	25.84**	4.36*	70.22**	1.1
Grain yield/spike	E_1	0.01	0.64**	0.41**	0.64**	0.56**	0.73**	0.18**	2.4**	0.02
	E_2	0.008	0.15**	0.09**	0.15**	0.13**	0.17**	0.1**	0.79**	0.01
	E_3	0.004	0.12**	0.05**	0.13**	0.11**	0.15**	0.057*	0.06*	0.014
Harvest index	E_1	0.25	109.41**	16.12*	119.25**	100.84**	120.89**	857.07**	73.11**	8.33
	E_2	12.42	38.62**	23.47**	40.27**	37.01**	43.74**	30.37*	28.1*	5.62
	E_3	1.87	89.85**	43.31**	91.44**	84.38**	99.35**	54.49*	366.97**	8.53

*, ** significant at 5 and 1% per cent levels, respectively

Table 3: Per cent decrease in the mean performance of different quantitative characters under late (E_2) and very late (E_3) sown environmental conditions in comparison to normal environment.

Characters	Parents		F_1's		F_2's	
	E_1 *vs* E_2	**E_1 *vs* E_3**	**E_1 *vs* E_2**	**E_1 *vs* E_3**	**E_1 *vs* E_2**	**E_1 *vs* E_3**
Days to 50% heading	6.49	12.14	7.91	11.66	8.09	11.97
Days to maturity	5.35	10.88	5.19	10.55	5.69	10.24
Plant height	7.51	11.72	8.64	14.95	9.08	18.12
Productive tillers per plant	21.68	39.22	20.20	40.40	15.54	40.25
Flag leaf area	9.24	21.02	10.52	24.55	13.77	28.85
Spike length	25.00	44.10	24.13	43.74	24.02	43.60
Number of grains per spike	15.11	19.60	11.88	21.48	14.53	23.73
1000-grain weight	4.69	10.04	5.61	13.07	5.55	14.43
Biomass per plant	11.62	21.60	9.01	28.41	11.01	27.77
Grain yield per spike	27.11	41.80	29.52	48.09	29.75	48.29
Grain yield per plant	20.67	48.09	20.79	47.45	26.57	49.34
Harvest index	10.20	33.72	12.88	26.43	17.76	29.94

CONCLUSION

The pooled as well as individual analysis of variance revealed that the treatments were highly significant for all the traits under present study indicating wide genetic diversity among the parents. The significant difference for G x E interaction for all studied traits specified a non-linear response of genotypes with changing environment. The mean performance of all the studied characters decreased under late and very late sown conditions. Hence, delayed sowing is the main cause of reducing grain yield due to reduced growth period and facing high temperature conditions during the critical phases of growth and reproduction in wheat crop. Therefore, breeding for higher grain yield should focus on developing cultivars with strong genetic potential, which can survive under high temperature fluctuations.

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Conflict of Interest. None.

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