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Genetic Architecture of Heading and Maturity in Bread Wheat Under Early and Timely Sown Conditions

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ABSTRACT

A set of six generatoins, viz. P_1, P_2, F_1, F_2, BC_1 and BC_2 derived from the crosses KH Sel-1 x Raj 3077, Kh Sel-1 x Raj 1972, Raj 1777 x GW 496, HJ-72-4-15-2-1 x WH 147 and Raj 1771 x Lok 1 of bread wheat was used to estimate gene effects for days to heading and maturity under early and timely sown conditions. Both additive as well as non-additive gene effects were involved in the inheritance of the traits with preponderance of additive gene effects under early as well as timely sown conditions. Biparental mating approach would be useful for enhancing genetic variability and creation of transgressive segregates.

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INTRODUCTION

In Saurashtra region of Gujarat, wheat is generally grown in early (first week of November) as well as timely sown (mid of November) conditions. In this area, short duration genotypes can be adjusted easily in double cropping and they are also suitable for conditions of short winter and low irrigation water availability. Early heading and maturity are indices of general efficiency of a genotype in terms of maximum returns per unit time. Information on the genetic systems controlling duration would be useful in devising suitable breeding procedures for developing early genotypes. Since information on the genetic architecture of time of heading and maturity is extremely limited, therefore, the present study has been undertaken.

MATERIALS AND METHODS

The experimental material comprised of parents, F_1, F_2, BC_1 and BC_2 generations of five crosses, viz. Kh Sel-1 x Raj 3077, KH Sel-1 x Raj 1972, Raj 1777 x GW 496, HJ-72-4-15-2-1 x WH 147 and Raj 1771 x Lok 1. The trial was laid out in compact family block design with three replications at College Farm, Gujarat Agricultural University, Junagadh under early (1st Nov., 1993) and timely (15th Nov., 1993) sown conditions during *rabi*, 1993-94. Parents and F_1S in single row, BC_1S and BC_2S in two rows and F_2S in four rows of 1.5 m length were sown in each replication. Spacing was kept at 25 cm between rows and 5 cm between plants within the rows. Data on five competitive plants from each plot of parents and F_1S, 10 plants from

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TABLE 1

Scaling tests for days to heading and maturity in the five crosses of bread wheat under early (E_1)and timely (E_2) sown conditions.

Scaling tests	Kh Sel-1 x Raj 3077		Kh Sel-1 x Raj 1972		Raj 1777 x GW 496		HJ-72-4-15-2 x WH 147		Raj 1777 x Lok-1	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
Days to heading										
A	-10.00** ± 2.26	11.87** ± 3.61	-10.07** ± 3.03	5.40 ± 3.05	5.27 ± 2.75	2.40 ± 2.37	7.40** ± 2.75	1.20 ± 2.20	3.47 ± 3.21	-8.40** ± 2.30
B	17.47** ± 2.49	10.80** ± 2.21	10.20** ± 2.28	0.73 ± 1.69	12.00** ± 2.47	3.00 ± 1.98	16.80** ± 2.69	3.70 ± 2.05	10.27** ± 2.68	2.40 ± 2.64
C	-20.13** ± 4.50	0.73 ± 5.10	-10.80** ± 4.86	14.73** ± 2.46	-17.93** ± 4.21	-15.13** ± 3.48	-8.53 ± 4.44	-12.53** 3.72	-38.60 ± 2.89	-29.80** ± 3.71
X^2 (3df)	94.20**	34.18**	44.57**	37.36**	53.42**	30.91**	72.37**	19.16**	236.87**	75.62**
Days to maturity										
A	-4.93** ± 1.37	6.93** ± 2.38	-5.47** ± 1.98	14.93** ± 1.52	-3.87* ± 1.75	4.80** ± 1.45	13.60** ± 1.59	10.27** ± 1.83	-2.07 ± 2.67	1.20 ± 1.63
B	15.07** ± 0.89	7.20** ± 1.73	-8.67** ± 1.68	3.87 ± 2.08	7.07** ± 1.98	-1.47 ± 1.79	20.07** ± 1.89	28.80** ± 1.95	-1.33 ± 2.61	17.47** ± 1.84
C	-11.13 ± 20.78	26.27** ± 3.12	-13.67** ± 4.27	55.53** ± 2.28	-27.67** ± 4.10	-55.93** ± 2.56	-9.80 ± 4.20	-2.53 ± 3.14	-51.60** ± 2.86	4.07 ± 2.88
X^2 (3df)	352.52**	86.99**	29.18**	672.31**	91.78**	763.03**	268.17**	312.55**	338.14**	96.98**

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

each plot of BC_1S and BC_2S and 20 plants from each plot of F_2 were recorded on days to heading and maturity. Crosses showing significant variation among generations in compact family block design were subjected to generation mean analysis. Epistatic gene interactions were detected by scaling test of Hayman and Mather (1955) and joint scaling test of Cavalli (1952). Gene effects were estimated as per the Hayman (1958).

RESULTS AND DISCUSSION

The estimates of A, B and C scaling tests and significant x^2 – values of joint scaling test revealed inadequacy of additive- dominance model for days to heading and maturity in all the five crosses under both the conditions (Table 1).

From the analysis of six-parameter model, it can be inferred that both fixable and non-fixable gene effects were significant in most of the character – cross-environment combinations (Table 2).

Both additive and dominance gene effects were significant for days to heading in Kh Sel-1 x Raj 3077, Raj 1777 x GW 496 and Raj 1771 x Lok 1 under both the conditions as well as in Kh Sel-1 x Raj 1972 and HJ-72-4-15-2-1 x WH 147 under timely sown conditions (Table 2). For days to maturity, both the main gene effects were also significant in Raj 1777 x GW 496 and Raj 1771 x Lok 1 under both the conditions; in KH Sel-1 x Raj 1992 under timely sown condition; and in HJ-72-4-15-2-1 x WH 147 under early sown condition. Preponderence of additive and dominance gene effects for both traits had been reported by Nayeem (1994). The additive component was predominant for days to heading in the cross Kh Sel-1 x Raj 1972 under early sown condition; and for days to maturity in the cross Kh Sel-1 x Raj 3077 under both the conditions and in Kh Sel-1 x Raj 1972 under early sown condition. The dominance component was negligible in them. Predominance of additive gene effects has been reported by Tandon *et al.* (1989) for days to heading and Sharma *et al.* (1978) for days to maturity. However, the dominance component was predominant for days to heading and maturity in the cross HJ-72- 4-15-2-1 x WH 147 under early and timely sown conditions, respectively.

Digenic interactions were significant for most of the cases, however, their magnitude varied depending on the character (s), parent(s) and environment(s) chosen (Table 2). Presence of epistatic effect for the inheritance of days to heading has been reported by Virk *et al.* (1989), while Reghuvanshi *et al.* (1988) reported that the inheritance of days to maturity was controlled due to additive and non-additive gene actions. Epistasis was observed more frequently in the crosses where the parents had greater diversity (Gorsline, 1961), as also observed in this study. Simultaneous occurence of significant eastimates of dominance and epistasis in most cases suggested that both types of gene actions could be due to the action of same gene (s).

It is evident from above results that rapid improvement in these traits under early as well as timely sown conditions through conventional breeding method may not produce quick and desirable results. However, maximum gain could be attained by maintaining considerable heterozygosity through mating of selected plants in early segregating generations. Such an approach would provide transgressive segregates for exploitation of further selection.

TABLE 2

Estimates of gene effects for days to heading and maturity based on digenic epistatic model in five crosses of bread wheat under early (E_1) and timely (E_2) sown conditions.

Gene effects	Kh Sel-1 x Raj 3077		Kh Sel-1 x Raj 1972		Raj 1777 x GW 496		HJ-72-4-15-2-1 x WH 147		Raj 1771 x Lok-1	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
Days to heading										
m	61.53± 1.05	60.78 ± 1.24	63.48 ± 0.97	64.72 ± 0.49	58.00 ± 0.95	56.45 ± 6.14	60.61 ± 0.67	56.61 ± 0.60	53.37 ± 0.55	53.33 ± 0.78
(d)	6.87** ± 1.54	13.13** ± 2.07	8.30** ± 1.48	14.40** ± 1.63	11.20** ± 1.72	7.30**± 0.12	2.33 ± 1.35	10.03** ± 1.08	11.57** ± 1.98	4.77** ± 1.54
(h)	24.87** ± 5.27	13.80* ± 6.49	4.70 ± 5.10	-18.00** ± 3.88	36.23** ± 5.21	15.00 ± 3.65	20.96** ± 4.19	14.50** ± 3.52	53.50**± 4.63	26.77**± 4.51
(i)	27.60** ± 5.21	21.93** ± 6.47	10.93* ± 4.89	-8.60* ± 3.81	35.20** ± 5.13	15.73** ± 3.44	17.93** ± 3.79	16.80** ± 3.23	52.33**± 4.54	23.80**± 4.40
(j)	-13.73** ± 1.62	0.53 ± 2.10	-10.13** ± 1.71	2.33** ± 1.69	-3.37 ± 1.75	-2.70* ± 1.34	-12.10** ± 1.56	-0.93 ± 1.14	-3.40 ± 1.99	-5.40**± 1.67
(l)	-35.07** ± 7.64	-44.60 ± 9.70	-11.70 ± 7.65	2.47 ± 6.98	-52.47** ± 8.08	-16.33** ± 5.94	-27.33** ± 6.99	-21.07 ± 5.70	-66.07**± 8.42	-17.80**± 7.19
Days to maturity										
m	104.73 ± 5.19	109.90 ± 0.73	102.65 ± 0.91	113.80 ± 0.45	95.98 ± 0.81	87.13 ± 0.41	101.23 ± 0.78	96.90 ± 0.50	92.80 ± 0.60	101.85± 0.54
(d)	7.83** ± 0.70	11.93** ± 1.39	17.33** ± 0.97	18.77** ± 1.16	8.53** ± 0.80	8.97** ± 0.97	10.40** ± 0.55	-0.13 ± 1.01	13.90** ± 1.75	3.87** ± 0.95

Gene effects	Kh Sel-1 x Raj 3077		Kh Sel-1 x Raj 1972		Raj 1777 x GW 496		HJ-72-4-15-2-1 x WH 147		Raj 1771 x Lok-1	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
(h)	20.37 ± 20.82	5.87 ± 4.09	-3.13 ± 4.27	-51.23** ± 3.02	34.87** ± 0.38	78.50** ± 2.73	48.83** ± 3.59	48.27** ± 3.09	50.67** ± 4.32	20.40** ± 3.03
(i)	21.27 ± 20.81	-12.13** ± 4.05	-0.47 ± 0.41	-44.46** ± 2.94	30.87** ± 3.63	59.27** ± 2.55	43.47** ± 3.30	41.60** ± 2.84	48.20** ± 4.25	14.60** ± 2.87
(j)	-10.00** ± 0.76	0.13 ± 1.46	1.60 ± 1.09	9.40** ± 1.22	-5.47 ± 0.90	3.13** ± 1.11	-3.23** ± 0.86	-9.27** ± 1.04	-0.37 ± 1.83	-8.13** ± 1.09
(l)	-31.40 ± 20.97	-2.00 ± 6.39	14.60* ± 5.76	33.40** ± 5.17	-34.07** ± 5.21	-62.60** ± 4.64	-77.13** ± 4.74	-80.66** ± 5.11	-44.80** ± 7.55	-33.27** ± 4.79

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

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