HERITABILITY AND INHERITANCE OF SOME QUANTITATIVE CHARACTERS IN WHEAT

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Inheritance of coleoptile length, heading date and grain yield was determined in eight wheat crosses between local standard and exotic varieties. The three characters behaved quantitatively, conditioned by polygenes in most of the crosses with a few exceptions in which the coleoptile length appeared to be simply inherited under a monogenic control. The F_2 frequency distributions for these characters were plotted, which followed a normal curve in some, approximated a normal curve in others, and sharply deviated from it in still other crosses, indicating a variety of gene action involved.

INTRODUCTION

Short stature in wheat is related mostly with short coleoptile and thus dwarf or semi-dewarf varieties show poor emergibility when sown deep because of their short coleoptiles. This fact places a severe limitation on the cultivation of short wheats under varying climatic, soil, and cultural conditions. An ideal short wheat variety must have a long coleoptile combined with generally accepted characters of virtue like early maturity and high yielding ability. To constitute such a variety requires to work out inheritance of these characters and their mutual relationship, if any. Some information on this point is available in the literature. Coleoptile length is reported to be a quantitatively inherited character controlled by two or three major genes (Chowdhry and Allan, 1963.) Heading time and grain yield are shown to be quite complex characters (Johnson *et al.*, 1966; Fieuzat *et al.*, 1953; Nanda *et al.*, 1959). Such information, however, has not yet become available from crosses involving local varieties and exotic ones characterized by varying plant height levels; and unless this becomes available, a satisfactory breeding strategy cannot be worked out to develop short-statured varieties of desired quality. The present study was aimed at finding out genetic relationships of the characters in crosses between some standard local and exotic wheats. The information obtained therefrom seems to be highly useful in carrying further the desired breeding objectives.

MATERIALS AND METHODS

Eight crosses, *i.e.*, Norin 53×C 271 and reciprocal, Norin 53×C 228 and reciprocal, Norin 53×Hard of Federation (H. F.) and reciprocal, Norin

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53×C 217 and reciprocal, Morin 53×C 258 and reciprocal, 11597×C 217 and reciprocal, Pitic 62×C 271 and C 228×Pitic 62, were analysed to determine inheritance patterns of coleoptile length, heading time and grain yield. Among the parental varieties, Norin 53 had short stature; C 271, C 228, C 258, C 217, and 11597 were tall, while Pitic 62 and Hard Federation were medium tall.

The F_1, F_2 and parental generations were space-planted in a randomized complete block design with three replications. F_2 seed was harvested from a minimum of 5 confirmed F_1 plants, and 300 F_2 plants, in all, derived at least from three different F_1 families were grown to collect data on grain yield and plant maturity. Means, standard deviations, coefficients of variability of these characters were calculated for all the generations, and the F_2 frequency distributions graphed. Grain yield per plant was measured in grams and the days taken to the earliest head emerged were counted from the planting day. For measurement of coleptile length, seeds of the parents and F_1 and F_2 generations were planted in rows on a moist blotting paper, later rolled and enclosed by a glazed paper sheet to check loss of moisture through evaporation. After planting the seed, the roll was banded securely and placed vertically in a darkened chamber maintained at 25°C. Seven days after seeding, coleoptiles had attained maximum length which was measured in millimeters. F_2 coleoptile length data did not include the reciprocal crosses. The broad-sense heritability estimates were calculated from the F_2 variance components by the method described by Mahmud and Kramer (1951).

RESULTS AND DISCUSSION

The data about the means, standard deviations, coefficients of variability of coleoptile length, heading date and grain yield obtained for different generations are presented in Table 1. Also presented graphically are the F_2 frequency distributions in Figs. 1-3. A perusal of these statistics and graphs indicates that these three characters have shown, in general, a parallel genetic behaviour *vis-a-vis* type of gene action, heterotic expression, and transgressive segregation in most of the crosses, although not very consistently.

Coleoptile length data revealed heterotic effects for long coleoptile in all the crosses except two, Norin 53×C 258 and Pitic 62×C 271, of which the F_1s, nevertheless, exceeded the mid-parent values. A comparison of the F_1 and F_2 means and of the F_2 frequency distribution curves suggested that the coleoptile inheritance was controlled by polygenes acting additively in some and nonadditively in other crosses. In several crosses including Norin 53×C 228, Norin 53×Hard Federation, Norin 53 × C 217, 11597 × C 217, and C 228× Pitic 62, the F_1s transgressed the respective better parents, showing over-dominance for those cross combinations. The F_2 frequency distribution curves in

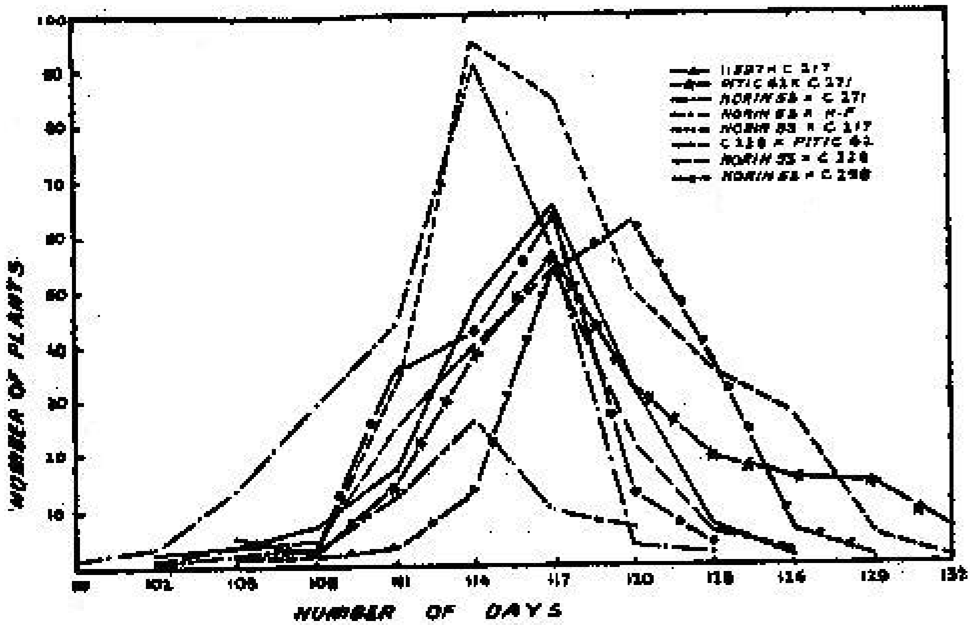

Fig. 1. F_3 frequency distributions for time taken to earing of eight wheat crosses.

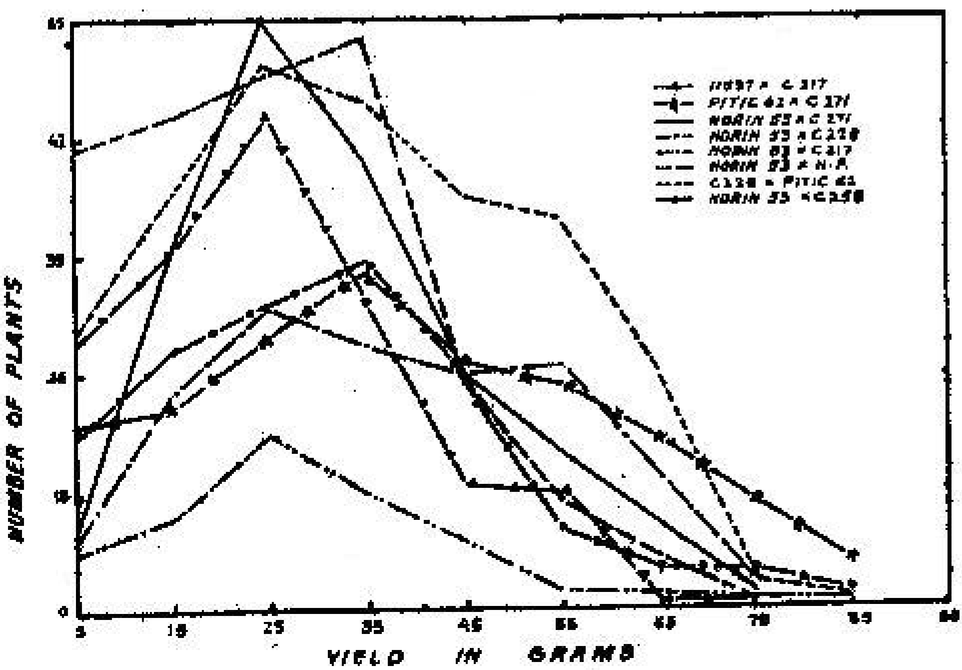

Fig. 2. F_3 frequency distributions for yield per plant of eight wheat crosses.

the crosses, Norin 53 × C 217, Norin 53 × C 258, were distinctly bimodal, suggesting a monogenic control, with the long coleoptile behaving as a dominant character. Transgressive segregates for long coleoptiles were also recovered in several of the crosses.

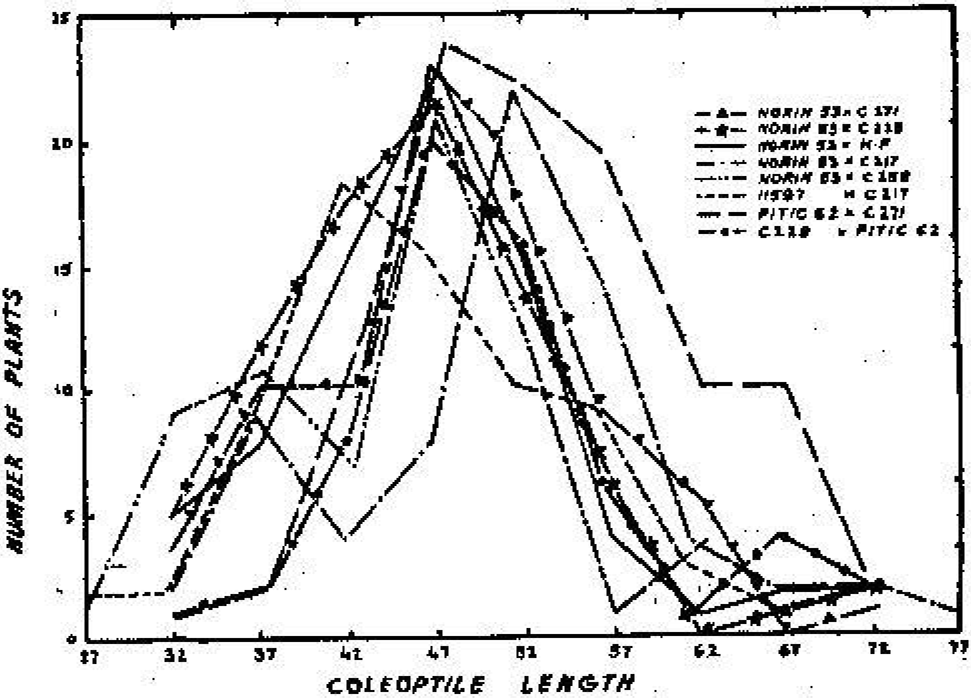

Fig. 3. F_2 frequency distributions for coleoptile length in eight wheat crosses.

A comparative appraisal of the data on heading date indicates the occurrence of heterosis for early heading in all but two crosses, 11597 × C 217 and Norin 53 × Hard Federation. Amongst the parents, the earliest to head was Hard Federation (107.4 days) and the one that took the longest (125. 4 days) was Pitic 62; the earliest heading F_1 (103.8 days) also involved Hard Federation as one of the two parents. The F_2 frequency distributions of the crosses, Norin 53 × C 271 and Norin 53 × C 228, followed a normal curve (Fig. 2), while Norin 53 × C 217 closely approximated it. The type of gene action involved in these crosses seems to be additive, while in all other crosses, the distributions were either erratic or skewed towards late heading, indicating a polygenic control tampered with dominance.

The grain yield data are presented in Table 2. Amongst the lowest yielding parents were Hard Federation (26. 0 gms), C 271 (34.0 gms C 217

Table 1. Means, Standard Deviations and Coefficients of variability of the Parents [F and F] Populations for Grain Yield per Plant, Time taken to Earning and Coleoptile Length.

Population		Yield per Plant $\bar{x}$	s	c.v.	N	Time Taken to Earning $\bar{x}$	s	c.v.	N	Coleoptile Length ; $\bar{x}$	s	c.v.	N
Norin 53 ...	P_1	49.50	8.05	16.26	20	111.6	2.85	2.55	20	36.6	4.06	11.09	15
x C 271 ...	P_2	34.00	8.98	26.41	20	113.2	2.36	2.08	20	53.3	2.91	5.45	16
	F_1	61.00	10.20	16.72	5	109.2	3.42	3.13	5	49.5	4.77	9.63	6
	F_2	31.48	14.80	47.01	213	115.7	4.05	3.50	184	48.1	7.70	5.02	78
C 271 ...	F_1	73.0	7.50	10.27	5	105.6	2.51	2.38	5	...	...	...	...
x Norin 53 ...	F_2	30.0	13.97	46.57	212	114.2	4.27	3.74	223				
Norin 53 ...	P_1	49.5	8.05	16.26	20	111.6	2.85	2.55	20	36.6	4.06	11.09	15
x C 228 ...	P_2	35.6	8.45	23.21	14	113.8	1.85	1.60	14	51.5	5.23	10.13	14
	F_1	81.0	4.90	6.05	5	106.8	1.64	1.54	5	57.0	3.06	5.36	5
	F_2	37.7	18.19	50.13	170	115.5	4.17	3.61	159	46.1	8.30	18.00	80
C 228 ...	F_1	73.0	7.49	10.26	5	106.8	3.42	3.20	5				
x Norin 53 ...	F_2	36.3	18.36	50.57	147	116.3	3.64	3.13	150				
Norin 53 ...	P_1	49.5	8.05	16.25	20	11.6	2.85	2.55	20	36.6	4.05	11.09	15
x H. F. ...	P_2	28.0	9.90	34.23	20	107.4	2.30	2.14	20	49.1	4.57	9.30	14
	F_1	41.0	8.00	19.51	5	106.8	3.42	3.20	5	55.0	5.06	9.20	5
	F_2	27.1	13.97	51.55	242	112.9	3.91	3.46	242	46.9	8.25	17.39	75
H. F. ...	F_1	39.0	4.90	12.56	5	103.8	3.42	3.29	5				
x Norin 53 ...	F_2	26.9	14.50	53.90	127	112.8	2.60	2.30	127				
Norin 53 ...	P_1	49.5	8.05	16.26	20	111.6	2.85	2.55	20	36.6	4.06	11.09	15
x C 217 ...	P_2	34.5	11.20	32.46	20	109.9	2.43	2.21	20	59.7	5.05	8.78	13
	F_1	76.7	6.50	8.47	6	105.0	2.12	2.02	5	68.0	3.75	5.51	5
	F_2	29.9	16.90	56.52	62	113.8	3.79	3.33	61	51.3	9.19	17.91	68
C 217 ...	F_1	59.0	4.90	8.31	5	106.8	1.64	1.54	5				
x Norin 53 ...	F_2	27.5	14.34	52.15	181	115.9	3.89	36.36	179				

Norin 53	...	P_1	49.5	8.05	16.26	20	111.6	2.85	2.55	20	36.6	4.06	11.09	15
x														
C 258	...	P_2	33.5	10.62	31.70	20	111.4	1.76	1.58	20	51.6	3.30	6.39	13
		F_1	63.0	7.49	11.89	5	105.6	2.51	2.38	5	52.0	2.85	5.48	6
		F_2	31.2	17.49	56.06	162	114.8	3.47	3.02	161	44.4	8.44	19.01	66
C 258	...	F_1	59.0	4.90	8.31	5	106.8	1.64	1.54	5				
x														
Norin 53	...	F_2	29.3	18.77	64.06	141	113.1	4.58	4.05	157				
11597	...	P_1	36.00	24.17	31.56	[illegible]	123.6	3.02	2.44	20	43.6	5.79	13.28	18
x														
C 217	...	P_2	34.50	11.17	32.37	20	109.9	2.43	2.21	20	59.7	4105	6.78	13
		F_1	61.00	10.20	16.72	5	108.6	2.51	2.31	5	6610	4.05	6.14	5
		F_2	25.80	15.06	58.37	175	119.4	3.31	2.77	177	47.1	9.09	19.29	71
C 217	...	F_1	69.00	10.20	14.78	5	106.8	3.42	3.20	5				
x														
11597	...	F_2	22.40	14.66	65.45	120	120.7	3.97	3.29	114				
Pitic 62	...	P_1	46.0	9.43	20.50	20	125.4	2.68	2.14	20	45.8	4.93	10.76	17
x														
C 271	...	P_2	34.0	8.89	26.15	20	113.2	2.36	2.08	20	53.3	2.91	5.46	16
		F_1	77.0	7.55	9.81	5	112.2	3.42	3.05	5	54.5	4.75	8.72	6
		F_2	38.8	18.63	48.20	199	119.2	6.00	5.03	199	53.4	5.51	10.31	101
C 228	...	P_1	36.4	8.45	23.21	14	113.8	1.85	1.60	14	51.6	5.23	10.13	14
x														
Pitic 62	...	P_2	46.0	9.43	20.50	20	125.4	2.68	2.14	20	45.8	4.93	10.76	17
		F_1	81.0	10.20	12.59	5	111.0	2.12	1.91	5	62.7	3.44	5.48	7
		F_2	33.0	20.90	63.33	258	117.5	4.69	3.99	340	50.5	8.11	16.06	60

x=Mean, s=Standard deviation, $c.v.$=Coefficient of variability, N=Total Plants.

Table 2. Broad-sense Heritability Estimates for Grain Yield, Heading Date and Coleoptile Length in 8 Wheat Crosses.

Cross	Heritability in Percentage		
	Grain Yield	Heading Date	Coleoptile Length
Norin 53 × C 271	67	59	81
Norin 53 × C 228	78	71	69
Norin 53 × H.F.	63	58	70
Norin 53 × C 217	69	53	80
Norin 53 × C 258	69	59	81
11598 × 217	44	44	69
Pitic 62 × C 271	78	83	68
C 228 × Pitic 62	82	78	60

(34.5 gms), and C 250 (33.5 gms) and the highest yielder was Norin 53 (49.5 gms), followed by Pitic 62 (46.0 gms). The F_2 values far exceeded the parental and the F_2 means in all crosses except the Norin 53 × Hard Federation cross. This shows dominance and/or over-dominance for the loci responsible for an excessive heterotic effect on grain yield in these crosses. On the other hand, sharp reduction in yield occurred in all the F_2 generation, indicating marked susceptibility of these loci to inbreeding depression. Yield curves, as a whole, were erratic. None of them showed a normal pattern except in the Norin 53 × C 271 cross where the F_2 frequency distributions followed a unimodal curve, sharply skewed towards low yield. Graphic presentations (Fig. 3) for other crosses also showed much pronounced skewness toward low yield and revealed preponderance of F_2 segregates of low grain yield. It appears that the most productive F_1 combinations for grain yield readily *broke* down in the F_2 generation resulting in poor yield.

Broad-sense heritability estimates computed for the three characters are given in Table 2. Heritability values for coleoptile length ranged from 60 to 81 per cent in all the crosses. The estimates obtained for grain yield and heading date were also quite high in all the crosses except in the 11597 × C 217 cross for which the heritability valu of each of the two characters was 44 per cent. The estimates in all the other crosses ranged from 63 to 82 per cent for grain yield and from 59 to 83 per cent for heading date in the various crosses. The results of this study suggest that considerable genetic advance could be achieved in selecting for these characters from the crosses analysed and that the synthesis of genotypes of desired values seems a distinct possibility.

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