Vol. XVI (1-2), 1979

HERITABILITY OF GRAIN YIELD AND ITS COMPONENTS IN SOME WHEAT CROSSES

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Narrow and broad sense heritabilities were computed for plant height, tillers per plant, spikelets and number of grains per spike, 100-kernel weight and grain yield from five spring wheat crosses involving old tall C 273 and new medium-statured strains. All of the characters indicated a quantitative pattern of inheritance and were consistently highly heritable except tillers per plant which showed moderate low heritability in several of the crosses. Additive gene effects were important for these characters.

INTRODUCTION

Grain yield is a complex character, the product of several genes interacting in a given environment. The problem of breeding for higher yield therefore becomes one of finding the genes controlling yield and its components and to build them into a variety for maximum effect. It is not an easy task to produce a plant with all the desirable attributes; even a limited success at times constitutes a great step forward.

Several new wheat varieties and strains of superior merit have been developed in the department from crosses of old and new wheat varieties. The new varieties have wide-ranging adaptation and hold great promise for crop productivity. Since much greater variation for characters of economic value can be generated by making suitable crosses, still better strains could be developed from these populations. Hashmi (1967), Anwar and Chowdhry (1969), Hoff *et al.* (1973) and Tikka *et al.* (1973), reported quantitative inheritance for plant height and various characters influencing yield in wheat. Tikka *et al.* (1971) and Gill *et al.* (1975) reported that plant height is largely determined by additive gene effects. Fonseca and Patterson (1968), Hashmi (1967), Tikka *et al.* (1973) and Ghafoor

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(1975) found high heritability for tillers per plant while Amaya *et al.* (1972) reported a low heritability. Chapman and Neal (1971), and Ghafoor (1975) reported high heritability for spikelets per spike and transgressive segregation in F2. Gill *et al.* (1975) and Fonseca and Patterson (1968) reported high heritability for grains per ear and suggested that grains/spike should be considered in selection. Chapman and Neal (1971) reported both additive and non additive gene effects for 100-grain weight. Tikka *et al.* (1973), Gill *et al.* (1973) and Ghafoor (1975) reported high heritability for yield/plant and concluded that major part of the variation was due to additive gene effects. The present study reports further information in this regard.

MATERIALS AND METHODS

The experimental material consisted of five crosses; C 273 × LU 21, C 273 × LU 235, C 273 × LU 75, LU 21 × LU 75 and LU 21 × LU 235, involving C 273 a tall indigenous variety and LU 75, LU 21, LU 235, newly evolved varieties with medium stature. In 1975-76 all populations, i.e., the parent, F1, BC1, BC2, and F2 were grown in the field in a randomized complete block design with three replications; each row containing 24 plants spaced roughly 24 cm apart. A replication consisted of one row each of F1's and the parents, three rows each of the F2's, and two rows each of the backcrosses. Where missing plants occurred, seedlings of LU 21 were transplanted to maintain a uniform stand. The following data were recorded on each plant: (1) mature plant height—the tallest tiller of each plant was measured from the ground level to the tip of the spike; (2) number of tillers per plant—fertile tillers per plant were counted from all the competitive plants at maturity; (3) number of grains per spike—number of grains per spike were counted from the heads borne on the central tiller; (4) number of spikelets per spike—the number of spikelets of the central spike were counted; (5) 100 grain weight—100 grains were counted from all the plants and their weight was recorded in grams; (6) grain yield—the grain produce obtained from each plant was recorded in grams.

Heritability estimates in the broad sense were computed by the method described by Mahmud and Kramer (1951), and narrow sense heritability estimates were determined by the method of Warner (1952)

RESULTS AND DISCUSSION

A quantitative pattern of inheritance was observed for all the characters studied as also reported by Anwar and Chowdhry (1973), Tikka *et al.* (1973), Hashmi (1967), Hoff *et al.* (1973) and Ghafoor (1975).

Hybrids for plant height usually transgressed the mid-parental heights (Table 1) indicating partial dominance but the additive genetic component was more apparent from the narrow-sense heritability which was of a rather high magnitude. Tikka *et al.* (1971) and Gill *et al.* (1975) also reported that plant height is largely determined by additive gene effects. Most of the F2's produced transgressive segregation for both tall and short stature. LU 21 × LU 75 produced a preponderance of short statured segregates and could thus yield most ideal genotypes with high yield potential in view also of usually high heritabilities. Lack of heterosis, negligible difference between the F^1 and F^2 means (Table 1) and impressive heritability estimates (Table 2) both in the broad and narrow sense for tillers/plant indicated the presence of additive gene action. Similar findings were also reported by Hashmi (1967), Fonseca and Patterson (1968), Tikka *et al.* (1973) and Ghafoor (1975).

The presence of heterosis in the crosses C 273 × LU 235 and C 273 × LU 75 was significant and a corresponding inbreeding depression in F2's (Table 1) provided evidence of substantial amounts of non-additive effects for spikelets/spike while in the other F1's such effects were rather modest since the F1's barely exceeded the midparent values. Additive effects in these crosses were expressed to a considerable extent inasmuch as the magnitude of the narrow sense heritability estimates was high and this agreed to the finding of Chapman and Neal (1971) that spikelets/spike are mainly determined by additive gene action. Ghafoor (1975) also reported high broad-sense heritability and genetic advance for spikelets/spike. Both additive and non additive gene action operated in these crosses for number of grains/spike as the F1's (Table 1) were equal to the mid-parent or reached the better parent. The heritability estimates were fairly high. Transgressive segregation of a higher magnitude appeared in all the crosses in F2, which suggested that grains/spike should be considered while making selection.

Chapman and Neal (1971) reported that both additive and non additive (dominance) type of gene action influenced kernel weight, and this agreed with the present study in which F1's (Table 1) approached the better parent or equalled the mid-parent and there was considerable difference between broad sense and narrow sense heritability estimates.

Table 1. *Means with standard errors.*

Parent or cross	No. of plants	Adult plant height cm	Tillers/plant	Grains/spike	Spikelets/spike	100 grain weight gm	Yield/plant gm
Parent							
C 273	30	135.55±0.92	16.84±0.58	64.85±0.78	21.45±0.15	5.23±0.05	32.47±1.22
LU 21	30	110.12±0.71	13.83±0.60	80.55±1.09	23.85±0.18	4.02±0.05	38.68±1.28
LU 235	30	114.00±0.89	20.53±0.66	65.75±1.92	21.55±0.16	4.75±0.05	39.94±1.21
LU 75	30	104.25±0.61	18.23±0.56	69.65±1.36	21.95± .24	4.76±0.05	36.22±1.23
Cross and generation							
C273 × LU21							
F_1	30	131.00±1.02	15.85±0.72	78.80±1.10	23.06± .18	5.39±0.05	34.58±1.27
F_2	220	123.38±1.13	14.26±0.36	72.00±0.98	22.94±8.18	4.89±0.06	32.77±0.94
BC_1	100	133.29±1.44	14.83±0.43	68.00±1.27	23.08±0.23	5.00±0.08	33.43±1.22
BC_2	100	122.09±1.60	14.25±0.43	73.69±1.17	23.84±0.22	4.61±0.07	37.83±1.26
C273 × LU 235							
F_1	30	132.90±1.08	19.80±0.59	70.90±1.20	22.60±0.14	5.26±0.02	36.21±1.25
F_2	220	125.57±1.09	18.50±0.48	66.12±1.05	21.60±0.14	4.96±0.05	34.29±1.25
BC_1	100	128.10±1.13	17.59+0.62	65.05±1.27	22.42±0.16	4.98±0.07	35.76+1.61
BC_2	100	117.62±1.28	19.00±0.57	71.89±1.33	22.14±0.14	4.75±0.06	37.01±1.56

C 273 × LU	75						
F_1	30	122.9 ± 1.18	17.20 ± 0.59	68.20 ± 1.03	23.10 ± 0.16	5.29 ± 0.04	34.46 + 1.00
F_2	220	120.74 ± 1.85	16.91 ± 0.31	65.68 ± 0.98	22.74 ± 0.14	4.65 ± 0.05	33.29 ± 0.84
BC_1	100	131.67 + 1.26	16.58 ± 0.42	62.48 ± 1.17	22.37 ± 0.17	4.89 ± 0.06	33.93 + 1.09
BC_2	100	110.64 ± 1.30	17.58 ± 0.39	63.54 ± 1.21	21.87 ± 0.18	4.49 ± 0.06	34.92 ± 1.11
LU 21 × LU	75						
F_1	30	107.20 ± 0.82	16.20 ± 0.35	80.20 ± 1.19	23.70 ± 0.19	4.79 ± 0.03	46.84 ± 1.29
F_2	220	102.30 ± 0.35	14.17 ± 0.39	75.25 ± 1.08	22.95 ± 0.17	4.74 ± 0.05	86.05 ± 1.26
BC_1	100	109.06 ± 1.49	14.47 ± 0.50	83.68 ± 1.40	23.18 ± 0.21	4.73 ± 0.05	45.53 ± 1.58
BC_2	100	102.69 ± 1.43	16.93 ± 0.37	74.48 ± 1.32	23.15 ± 0.22	4.31 ± 0.05	33.12 ± 1.44
LU 21 × LU	235						
F_1	30	112.70 ± 0.03	16.80 ± 0.58	80.10 ± 1.11	23.10 ± 0.17	4.94 ± 0.05	39.25 ± 1.88
F_2	220	110.63 ± 0.75	15.34 ± 0.34	75.34 ± 1.00	23.03 ± 0.13	4.53 ± 0.05	37.82 ± 1.86
BC_1	100	1 6.11 ± 0.80	14.87 ± 0.48	75.31 ± 1.23	23.45 ± 0.16	4.83 ± 0.06	38.88 ± 1.33
BC_2	100	113.00 ± 0.97	16.54 ± 0.49	71.34 ± 1.26	23.09 ± 0.16	4.40 ± 0.06	36.02 ± 1.32

Table 2. ***Heritability Estimates* in 5 Wheat Crosses***

Crosses	Plant Height		Tillers/Plant		Grains/Spike		Spikelets/Spike		100 Grain Weight		Plant Yield	
	Broad Sense	Narrow Sense	Broad Sense	Narrow Sense	Broad Sense	Narrow Sense	Broad Sense	Narrow Sense	Broad Sense	Narrow Sense	Broad Sense	Narrow Sense.
C273xLU21	93.07	60.38	61.19	51.03	87.95	60.20	90.68	62.39	88.96	52.12	68.18	42.38
C273xLU235	90.58	67.90	77.66	60.97	91.07	61.57	83.24	51.25	79.86	56.59	81.09	52.73
C273xLU75	93.04	64.04	53.49	42.44	88.16	66.46	72.20	53.05	75.00	51.75	61.29	42.43
LU21xLU75	96.23	75.64	70.28	59.55	86.31	55.77	79.82	54.51	75.99	66.71	83.69	52.02
LU21xLU235	84.35	69.21	53.76	43.27	86.22	59.01	77.26	59.83	80.31	53.40	81.99	58.94

* Heritability in percentage.

In yield/plant, F1's (Table 1) generally reached the parental means and their F2 means did not suffer inbreeding depression indicating preponderance of additive effects, although non additive effects were also present for plant height, tillers/plant, spikelets/spike, grains/spike and 100 grain weight. The nonadditive action was also obvious in some crosses as the yield behaviour appeared closer to the tillers/ plant indicating that the contribution of the tillers/plant to the final yield was significant. Moreover, the differences between narrow and broadsense heritability (Table 2) indicated that both additive and nonadditive types of gene action influenced yield. Such observations find support from Tikka *et al.* (1973), Gill *et al.* (1975) and Ghafoor (1975).

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