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M. Feldman

INHERITANCE OF HEIGHT AND OTHER CHARACTERS UNDER CONDITIONS OF THE COAST OF PERU

R. VILLANUEVA NOVOA

Agricultural Experiment Station,
La Molina, Peru

SUMMARY

From a cross of 'La Molina 60' with a dwarf wheat, an analysis of population mean and frequency distribution for plant height suggests the operation of more than one type of gene action.

The results obtained on the inheritance of tillering, weight of kernels head and heading time suggest the operation of small numbers of genes.

The inheritance of number of kernels per head apparently was governed by polygenic action. The F_2 distribution was the only one that approached a normal curve.

Probably both major and minor factors controlled the expression of rachis length. In F_2 transgressive segregation occurred.

Significant correlation was obtained between the following characters: number of tillers per plant x rachis length; number of kernels per head x rachis length; and weight of kernels per head x number of kernels per head.

INTRODUCTION

Many wheat-breeding programs in several wheat-producing countries employ the use of dwarf germplasm. Recent release of dwarf varieties with remarkable yields have stimulated much interest in breeding for this character. A reduction in plant height generally reduces lodging, increases the grain-straw ratio, permits heavier fertilization and irrigation, and results in potentially higher grain production.

A better understanding of the genetics of dwarfness and its interrelations with other traits is needed to assist the breeders in the incorporation of this character into improved varieties. This kind of information is especially useful for Peru, because it is necessary to combine the rust resistance of Peruvian varieties with the short stature of foreign varieties.

The term "dwarf" is used in the present study to describe short-statured, agronomically useful wheat selections and not "hybrid dwarfness" that is a form of hybrid weakness.

MATERIALS AND METHODS

The two wheat varieties used in this paper belong to the species *Triticum aestivum* L. 'La Molina 60' is a Peruvian wheat obtained in 1960 from a Maria Escobar x A.V.18/1.1.1.1.1. cross. The dwarf wheat which was received in 1964 from Colombia has the following pedigree: Yt 54-Nor. 10B. 21.1. c x Kt 54 A M-11-S131-2t-1b-4t-1b.

The characters studied are shown in Table 1.

The La Molina 60 x Dwarf cross was made in the spring of 1966 at La Molina Agricultural Experiment Station. The F_1 plants were grown in 1967 at the same Station. The F_2 population together with its parents were sown in 1968 in 4-m rows, 0.30 m apart. Seeds were spaced 10 cm apart, making 40 per row. In this way 600 F_2 plants and 64 plants for each parent were studied. The date at which the head of the main tiller had emerged was recorded as heading time.

Prior to the harvest, the number of tillers per plant was counted, and the height of plant was measured from the ground level to the apex of the head. Then the main head of each F_2 and parent plant was harvested, and in the laboratory the number of kernels per head, the weight of these kernels, and the rachis length were recorded.

Table 1. Parents, F_1, and F_2 means and standard errors for the six characters studied

Character	La Molina 60		Dwarf Wheat		F_1		F_2	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Plant height (cm)	129.18	± 1.18	62.82	± 0.68	81.00	± 3.92	91.42	± 0.78
Tillers/plant	17.81	± 0.72	10.68	± 0.70	16.33	± 3.11	11.68	± 0.19
Kernels/head	22.53	± 1.83	48.00	± 1.42	59.88	± 2.49	35.77	± 0.48
Kernel wt./head (g)	1.06	± 0.07	1.61	± 0.04	1.90	± 0.16	1.17	± 0.03
Rachis length (cm)	7.55	± 0.33	9.02	± 0.09	10.52	± 0.25	8.11	± 0.06
Heading time (days)	83.09	± 0.61	85.57	± 0.40	83.66	± 0.06	82.35	± 0.39

RESULTS AND DISCUSSION

Analysis of population means (Table 1) and F_2 frequency distribution for plant height (Table 2) suggests the operation of more than one type of gene action. F_1 and F_2 means that approximate the mid-parent value suggest additive gene action. The F_2 distribution for plant height exceeded the lower limit of the dwarf parent. The distribution pattern for this character failed to correspond to the normal distribution, chi square being 57.4785, 18d.f., P less than 0.01. This result indicates that the inheritance of height is relatively simple. The slightly bimodal distribution of the F_2 population, with major groupings in the classes of 68 and 98 centimeters, suggests the operation of a small number of genes in the expression of plant height. Similar results were found by AGUINAGA (1967), ALLEN *et al.* (1961), BOROJEVIC (1965), CHANG WAY (1967), JOHNSON *et al.* (1966), MOREYRA (1967), and REITZ *et al.* (1968).

Heterosis for tillering is indicated by an F_1 mean larger than that of either parent (Table 1), but the F_2 mean was only larger than the dwarf parent and smaller than the mid-parent value (Table 2). The F_2 distribution for tillering surpassed the upper limit of La Molina 60. The tillering distribution was tested for its approach to a normal

curve and like plant height failed to correspond to normal distribution (chi square 126.501, 14 d.f., P less than 0.01). There was one major grouping in the class of 10.5 tillers. The results indicate that the inheritance of the character is controlled by only a few genetic

Table 2. Frequency distribution of the F_2 population of La Molina 60 x dwarf wheat and its parents in relation to six characters studied. Dwarf parent, dotted line; La Molina 60, continuous line. Value for beginning class shown at top, for end class at bottom.

Height (by 5 cm)	Tillers/pl. (by 2's)	Kernels/hd. (by 5's)	Kern.wt/hd. (by 0.2 g)	Head.time (by 2 days)	Rachis length (by 0.5 cm)
46-50	2-3	1-5	0.01-0.20	64-65	3.6-4.0
1	4	3	6	2	1
2	27	11	12	4	4
18	76	12	20	20	14
26	98	34	43	25	21
59	132	53	72	42	27
41	100	79	108	57	37
50	58	102	68	66	38
46	35	108	57	70	43
49	31	65	88	54	114
48	9	76	75	42	67
62	15	26	27	34	79
53	6	22	11	30	33
39	5	3	8	28	62
34	2	5	3	27	26
28	1	1	2	20	18
23	0		2.81-3.00	12	7
8	1			11	4
7	34-35			9	2
4		86-90		14	2
1				6	
1				8	
				8	1
151-155				7	14.1-14.5
				1	
				3	
				112-113	
600	600	600	600	600	600

factors. Similar results were obtained by JOHNSON *et al.* (1966).

Heterosis for number of kernels per head was indicated by the F_1 and supported by the F_2, whose mean was larger than the mid-parent value. The F_2 distribution for this character fell within the range of the two parents, with the pattern approaching a normal curve (chi square 20.933, 12 d.f., P = 0.100-0.050). This result indicates that the inheritance of number of kernels per head is more complex than that of the other traits here studied. The continuous distribution suggests either polygenic inheritance or pronounced environmental influence in relation to genetic expression.

Heterosis for weight of kernels per head was indicated by an F_1 mean larger than those of either parent, but the F_2 mean was smaller than the mid-parent value and that of the dwarf parent. The F_2 distri-

bution for this character fell within the range of the two parents. The pattern failed to correspond to a normal distribution (chi square 47.403, 12 d.f., P less than 0.01). The bimodality of the distribution, with major groupings in the classes 1.10 and 1.70 g, suggests a small number of genes for weight of kernels per head.

An F_1 mean for rachis length larger than the mean of either parent provided evidence for heterosis, but the F_2 mean was smaller than the mid-parent value and that of the dwarf parent. In the F_2 distribution for this character occurred transgressive segregation. The distribution pattern for this character failed to correspond to normal distribution (chi square 83.631, 19 d.f., P less than 0.01). The trimodal distribution, with major groupings in the classes of 7.8, 8.8, and 9.8 mm., suggests the operation of a small number of genes for rachis length. Probably both major and minor factors are involved.

Earliness appears to be completely dominant, with the F_1 mean identical to that of the early parent. The F_2 mean is smaller than the mid-parent value (REITZ, *et al.*, 1968), and there was strong transgressive segregation. The distribution failed to correspond to normal (X^2= 166.838, 18 d.f., P<0.01). The bimodal distribution of the

Table 3. Significant correlation coefficients among six traits in La Molina 60 x dwarf wheat cross

Characters	r_{xy}
Tillers per plant x heading time	0.143*
Tillers per plant x rachis length	0.198*
Kernels per head x rachis length	0.325**
Wt. kern./head x no. kern./head	0.572**

* Significant at the 0.05 level of probability
** Significant at the 0.01 level of probability

population, with a big peak at 78.5 days and a minor peak at 100.5 days, suggests the operation of a small number of genes in the expression of heading time. Probably both major and minor factors control its expression. These results are like those found by JOHNSON *et al.* (1966).

Finally, the correlation coefficients were determined in the F_2 distributions for each pair of characters in the 15 possible combinations, but only four combinations had significant values (Table 3). If the object of a breeding program is to increase the value of two traits, then a positive correlation between them would be considered an asset, while a negative correlation would be detrimental to the program. The opposite is true in the case where one is trying to increase the value of one trait while decreasing the other. For this particular cross, the program objectives would likely be a short straw, high tillering capacity, high number and weight of kernels per head, early heading time and a reasonable rachis length. Considering these objectives, it can be seen that, of the four significant correlations observed in this study, three of them may be considered advantageous.

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