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HERITABILITY AND CORRELATION OF GRAIN YIELD AND ITS COMPONENTS IN F_2 PLANTS OF TEN SIX-ROWED BARLEY CROSSES[1]

H.G. Nasr and W. Khayrallah[2]

ABSTRACT

F_2 and parental spaced plants of 5 x 5 diallel cross of six-rowed barley, *Hordeum vulgare* L., were grown in the 1971-72 growing season and broadsense heritability estimates for grain yield and its components were measured. Phenotypic correlation coefficients were also calculated between agronomic characters.

Heritability estimates were generally high for plant height (13 to 70%), low to intermediate for number of tillers per plant and number of kernels per plant (0 to 37 and 0 to 44%, respectively), and low for grain yield being 0 in eight of the ten crosses and intermediate in the remaining two.

Grain yield, in most crosses, was positively correlated with its components (number of kernels per plant, number of tillers per plant, and kernel weight) and with plant

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2- Assistant Professor of Plant Breeding and Genetics and former Graduate Assistant, respectively. The junior author's present address is Department of Agronomy, McDonald Campus of McGill University, Quebec, Canada.

height. The yield components were positively correlated with one another and with plant height except the correlation of number of tillers per plant with kernel weight which was very inconsistent.

INTRODUCTION

Understanding of the breeding behavior of barley crosses is helpful in planning a program for developing improved cultivars. Heritability estimates and correlations among grain yield and its components are reported by a number of investigators. Reports on heritability estimates of grain yield varied from 4.6% (5) to 64.6% (8); those of kernel weight varied from 28.8% (3) to 96% (4), and those of plant height from 58% (6) to 75% (9). Fiuzat and Atkins (3) estimated heritability for number of tillers to be 25.6%.

Nickell and Grafius (7) found highly significant negative correlation coefficients between grain yield components of six-rowed barley, and Crook and Poehlman (2) reported a negative correlation between kernel weight and number of tillers per plant. However, Yap and Harvey (11) reported correlations among grain yield components to be inconsistent from year to year, though correlations between grain yield and its components were significant and positive. Fiuzat and Atkins (3) obtained no significant correlation between kernel weight and any of several agronomic characters studied, but correlation between grain yield and number of tillers per plant was significant and positive.

The purpose of this study was to determine heritability estimates of, and correlation coefficients between grain yield and its components (the number of tillers per plant, number of kernels per plant and kernel weight) in the F_2 generation of 10 six-rowed barley crosses in the semi-arid region of the Middle East.

MATERIALS AND METHODS

F_2 seeds were produced by self pollination of F_1 plants of 10 six-rowed barley crosses involving the following five parents:

1. Beecher, a smooth awned, medium height and maturing cultivar, developed in California, U. S. A.
2. Athenais, a rough awned, short statured, early maturing cultivar, developed in Greece.
3. Atlas 46, a rough awned, white kerneled, medium height cultivar, developed in California, U. S. A.
4. 3130-4564-3, a black kerneled, smooth awned selection.
5. 3130-864-4, a white kerneled, rough awned, tall statured selection.

Both selection 3130-4564-3 and 3130-864-4 were developed at the American University of Beirut from an F_1 composite cross obtained from the U.S.D.A. The agronomic performance of the five parental lines varied largely for grain yield, kernel weight, plant height and days to heading (Table 1).

Table 1. Some agronomic performance of the five parental cultivars and selections involved in this study

Cultivar or selection	Days to heading	Plant height, (cm)	Kernel weight, (mg)	Grain yield, kg/ha
Beecher	149	100	44.9	4280
Athenais	146	90	43.4	3460
Atlas 46	151	98	36.5	3937
3130-4564-3	156	108	42.0	4483
3130-864-4	158	120	41.5	3647

F_2 and parental plants were grown in the 1971-72 season under rainfed conditions (450 mm) at the Agricultural Research and Education Center of the American University of Beirut, in the Beqa'a Plain, Lebanon. The rainfall condition of the 1971-72 season was considered average in terms of precyntatic and distribution.

The soil type was clay loam with a pH of 8.0 and had low available phosphorus and nitrogen and high exchangeable potassium. The experimental design was a randomized complete block with four replications. Fifteen to 20 seeds per replicate of each entry were grown in a single 2-m row plot, with 25 cm between rows and 10 cm between plants within the row. Oats were used as border plants.

Five agronomic characteristics were measured on individual plants. These were grain yield (g/plant), number of seed bearing tillers/plant, number of kernels/plant, kernel weight in mg, (measured mathematically by dividing g/plant over number of seeds/plant and multiplying by 1000) and plant height (cm) measured from the soil surface to the tip of the awns (all plants were awned).

The statistical analyses were as follows:

a) Broadsense heritability estimates were calculated according to the formula

$$H = \frac{V_{F_2} - \sqrt{V_{P_1} V_{P_2}}}{V_{F_2}} \times 100$$ as outlined

by Allard (1) where V_{F_2}, V_{P_1} and V_{P_2} are the variances of the F_2 populations and of their respective parents.

b) Phenotypic correlation coefficients between all characters studied were calculated for each of the 10 F_2 populations. The r values were tested for significance using Table A. 13 of Steel and Torrie (10).

RESULTS AND DISCUSSION

Heritability estimates calculated for grain yield, number of tillers per plant, number of kernels per plant and plant height are presented in Table 2. The estimates for grain

Table 2. Heritability estimates of grain yield and some of its components in the F_2 generation of ten six-rowed barley crosses grown in the 1971-72 season in Beqa'a Plain, Lebanon.

Cross*	Grain yield	No. of tillers/ plant	No. of kernels/ plant	Plant height
1x2	0.0	3.7	0.0	70.5
1x3	26.2	7.9	12.0	47.2
1x4	27.1	18.7	44.5	56.2
1x5	0.0	0.6	0.0	47.9
2x3	0.0	37.3	0.0	49.6
2x4	0.0	26.6	21.9	14.2
2x5	0.0	28.2	15.5	41.9
3x4	0.0	30.4	0.0	12.7
3x5	0.0	23.1	0.0	52.3
4x5	0.0	0.0	33.9	58.0

* 1 = Beecher, 2 = Athenais, 3 = Atlas 46, 4 = 3130-4564-3, 5 = 3130-864-4.

yield were zero in eight of the ten F_2 populations studied and intermediate in the remaining two, Beecher x Atlas (cross 1 x 3) and Beecher x 3130-4564-3 (cross 1 x 4). In the latter two crosses, and particularly in Beecher x 3130-4564-3 which exhibited intermediate to high heritability estimates for number of kernels per plant and number of tillers per plant, plant or head selection in intermediate generations could be more rapid in bringing about a high yielding cultivar.

The heritability estimates for number of tillers per plant ranged from 0 to 37.3% with five of the ten crosses having estimates of 23.0% or more. Such intermediate estimates are in close agreement with the results reported by Fiuzat and Atkins (3).

Intermediate heritability estimates for number of kernels per plant were only found in two crosses, Beecher x 3130-4564-3 (cross 1 x 4) and 3130-4564-3-3 x 3130-864-4 (cross 4 x 5), whereas in the remaining eight, the estimates were zero or low.

Plant height heritability estimates were generally high, ranging from 12.7 to 70.5% with eight of the F_2 crosses having estimates greater than 40.0%. These moderately high heritability estimates suggest the possible success of early generation selection in bringing about short-statured varieties that could be more lodging resistant. Lodging conditions often prevail in the Beqa'a region and lodging resistance is thus considered as an important agronomic character.

Highly significant positive correlations were found between grain yield and number of tillers per plant (x_2) for all F_2 crosses (Table 3). Grain yield was also significantly correlated with number of kernels per plant (x_3) in eight of the ten crosses and with kernel weight (x_4) in five of the ten crosses. These high positive correlations indicated that selection for yield components could help in the development of high yielding cultivars.

Correlation coefficients between grain yield and plant height (x_5) were significantly positive in seven of the ten crosses studied. Such positive correlations indicated that selection for high yielding lines could result in taller plants. However, the outcome of such a selection might also be lodging susceptibility which is a very undesirable agronomic character in areas where lodging conditions prevail.

Number of tillers per plant and number of kernels per plant were positively and significantly correlated in five of the ten crosses. This suggested that in such crosses, vigor may be expressed in both yield components.

The associations between number of tillers per plant and kernel weight were inconsistent, with the correlation coefficients being significantly positive in Athenais x Atlas 46 (2x3), significantly negative in the crosses Beecher x Athenais (1x2) and 3130-4564-3 x 3130-864-4 (4x5), and insignificant in the other crosses. However, number of tillers per plant and plant height were positively correlated in four of the ten crosses.

Plant height was positively correlated with number of kernels per plant in five of the ten crosses and with kernel weight in only two crosses. As to the association of kernel weight with number of kernels per plant, the correlation coefficients were insignificant except in the case of Athenais x 3130-864-4 (2x5) where the relationship was positive.

The primary conclusion of this study is that the crosses involving the five parental lines Beecher, Athenais, Atlas 46, 3130-4564-3 and 3130-864-4, brought about considerable variation in their F_2 populations. Such variations allow selection of better adapted progenies for the environmental conditions of the area. A secondary conclusion is that selection for grain yield would seem to be more rapid in some populations (crosses 1x4, 1x3) than others and for yield components than yield itself. Also, the results revealed that in some populations (crosses 1x3, 1x4, and 3x4) it is possible

to recover lines with high yielding and short to intermediate statured plants. Such a combination is desirable for areas where lodging conditions prevail and the annual rainfall is at least 400 mm.

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