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# Extent of Heterosis in Single, Double and Three-way Crosses of Barley*

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SIX DIVERSE STRAINS (AB-12/59; EB-1556; BG-1; A-59; K-572/10 and IB-226) were used for making all possible single, three-way and double cross hybrids. These 15 single, 60 three-way and 45 double cross hybrids along with their parents were grown in the adjacent fields having almost similar fertility levels, following randomized block design with four replications. Each cross was accommodated in a 3 metre-long single row plot. Seeds were sown in furrows made by a hand plough. Care was taken to sow the seeds at equal depth. Observations were recorded on 5 randomly selected plants in each of the single crosses as well as parental strains. In three-way and double cross hybrids data were recorded on 15 plants. Data on heterosis, measured as deviation from the better parent as well as from the best parent under study are presented in Tables 1 and 2. A persual of these Tables suggested that maximum heterosis over better parent in the desired direction was shown by the single cross hybrid (AB-12/59 × EB-1556) followed by three-way ((AB-12/59 × K-572/10) × IB-226) and double cross hybrid [(AB-12/59 × A-59) × 4-99) × (BG-1 × K-572/10)]. However, when compared to best parent, the best single cross hybrid did not exceed the best three-way or double cross hybrid. More or less similar trend was observed in the negative direction. Considering all the crosses of one type together, average heterosis was negative, the extent being almost same in all the three categories.

For a better comparison, five best crosses of each kind were considered at a glance. These crosses have been underlined in both the Tables. Such a comparision indicated that:

1. Considering heterosis over best parent, three-way hybrids showed a higher degree of heterosis, followed by double and single crosses.

2. When compared to better and best parent, extent of heterosis in double and three-way crosses was almost same. But this was not so in case of single crosses. Thus increasing the number of parents in a hybrid appears to nullify the contribution of the poor parent.

3. Best double cross did not result from crossing the best single crosses. Similarly, best three-way cross was not the result of best single cross

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*TABLE 1*

**Heterosis in single and three-way crosses.**

| *Cross* | *Single cross* | | *Heterosis* — *Third parent in three-way cross* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | *a** | *b*** | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| 1 × 2 | 41·9 | 29·8 | | | | | 8·8 | —11·0 | —17·9 | —20·1 | —35·2 | —35·2 | —9·2 | —11·3 |
| 1 × 3 | 5·9 | **—8·8** | | | —11·5 | —13·6 | | | 9·7 | —5·0 | —3·6 | —3·6 | —11·5 | —20·9 |
| 1 × 4 | **28·8** | **14·1** | | | —2·6 | —4·7 | 5·1 | —9·7 | | | —34·6 | —34·6 | —10·8 | —20·3 |
| 1 × 5 | **—10·5** | **—10·5** | | | —19·1 | —19·1 | 1·9 | 1·9 | —15·0 | —15·0 | | | **34·7** | **34·7** |
| 1 × 6 | —2·9 | —12·3 | | | —8·6 | —10·7 | —0·1 | —9·6 | —7·8 | —17·2 | —20·4 | —20·4 | | |
| 2 × 3 | **—2·1** | **—4·2** | —17·7 | —19·8 | | | | | 5·2 | —3·0 | —14·1 | —14·1 | —31·5 | —33·6 |
| 2 × 4 | —22·3 | —24·5 | 3·9 | 1·8 | | | —3·6 | —5·7 | | | —27·8 | —27·8 | —15·8 | —18·0 |
| 2 × 5 | —39·2 | —39·2 | —20·6 | —20·6 | | | —13·2 | —13·2 | —20·2 | —20·2 | | | **21·7** | **21·7** |
| 2 × 6 | —49·5 | —51·6 | —28·2 | —30·3 | | | 2·9 | 0·7 | —26·7 | —28·8 | —0·5 | —0·5 | | |
| 3 × 4 | 4·0 | —22·3 | —8·4 | —23·1 | —35·3 | —37·5 | | | | | —6·1 | —6·1 | 1·5 | —7·9 |
| 3 × 5 | —38·7 | —38·7 | 2·9 | 2·9 | —19·2 | —19·2 | | | **11·3** | **11·3** | | | —0·8 | —0·8 |
| 3 × 6 | —16·8 | —26·2 | 15·4 | 6·0 | 7·4 | 5·2 | | | 15·3 | 5·8 | —19·5 | —19·5 | | |
| 4 × 5 | —11·8 | —11·8 | —33·6 | —33·6 | —21·9 | —21·9 | 3·5 | 3·5 | | | | | —6·8 | —6·8 |
| 4 × 6 | —6·2 | —15·6 | —2·1 | —11·6 | **20·3** | **18·2** | —0·1 | —9·5 | | | —36·7 | —36·7 | | |
| 5 × 6 | —29·4 | —29·4 | —0·6 | —0·6 | **23·6** | **23.6** | —13·0 | —13·0 | 8·7 | 8·7 | | | | |
| Average | —9·9 | —16·7 | | | | | | | —7·5 | —10·3 | | | | |

* Better parent
** Best Parent

*TABLE 2*

**Heterosis over better parent (upper line) and best parent (lower line) in barley double cross hybrids.**

| *Crosses* | 2 × 3 | 2 × 4 | 2 × 5 | 2 × 6 | 3 × 4 | 3 × 5 | 3 × 6 | 4 × 5 | 4 × 6 | 5 × 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 × 2 | | | | | —1·7<br>—3·8 | —13·9<br>—13·9 | —12·8<br>—14·9 | —10·8<br>—10·8 | —6·7<br>—8·8 | —19·2<br>—19·2 |
| 1 × 3 | | —23·0<br>—25·1 | —14·2<br>—14·2 | 9·9<br>7·7 | | | | —22·8<br>—22·8 | 5·0<br>—4·4 | —6·1<br>—6·1 |
| 1 × 4 | —22·1<br>—24·2 | | —21·1<br>—21·1 | 10·2<br>8·1 | | 33·5<br>**33·5** | 13·8<br>4·3 | | | —2·5<br>—2·5 |
| 1 × 5 | 5·4<br>5·4 | 2·1<br>2·1 | | 9·7<br>**9·7** | —12·3<br>—12·3 | | —19·5<br>—19·5 | | 13·7<br>**13·7** | |
| 1 × 6 | —10·1<br>—12·3 | —31·1<br>—33·2 | —1·9<br>—1·9 | | 19·8<br>**16·3** | —1·6<br>—1·6 | | —11·7<br>—11·7 | | |
| 2 × 3 | | | | | | | | —36·1<br>—36·1 | —35·2<br>—37·3 | —5·6<br>—5·6 |
| 2 × 4 | | | | | | 11·2<br>**11·2** | —5·1<br>—7·3 | | | —3·4<br>—3·4 |
| 2 × 5 | | | | | —19·1<br>—19·1 | | —27·1<br>—27·1 | | —17·4<br>—17·4 | |
| 2 × 6 | | | | | —21·3<br>—23·5 | —20·7<br>—20·7 | | —42·1<br>—42·1 | | |
| 3 × 4 | | | | | | | | | | —28·9<br>—28·9 |
| 3 × 5 | | | | | | | | | —20·4<br>—20·4 | |
| 3 × 6 | | | | | | | | —20·0<br>—20·0 | | |
| Average | | | | | | —9·6 | —17·4 | | | |

hybrid and best parent, suggesting non-additive type of gene action.

4. Among these 15 best crosses, the more frequently involved varieties were AB-12/59 and K-572/10. Both of them were involved in the best three-way hybrid but not in the best single cross. Both of these varieties have been reported poor general combiner for grain yield. Similarly, BG-1, the least frequent genotype among these selected hybrids, was found best general combiner for this trait (Chadudhary *et al* 1976). Thus, here again non-additive type of gene action was evident.

It appeared from these observations that in order to exploit heterosis in barley, three-way hybrids should be prefered over the double or single cross hybrids. For this purpose, the parents are to be selected on the basis of diversity among them, but they are to be tried in several combinations as the order of parents in three-way crosses plays an important role in the performance of these hybrids (Rawling and Cockerham, 1962; Ponnuswamy *et al.*, 1974 and Chaudhary *et al*, 1975).

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