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# GENETICAL ANALYSIS OF SOME QUANTITATIVE COMPONENTS OF YIELD IN BREADWHEAT

J. S. AMAWATE AND P. N. BEHL

*Division of Genetics, Indian Agricultural Research Institute, New Delhi 110012*

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## ABSTRACT

**Absence of epistasis was noticed in some cross combinations between semidwarf/dwarf and tall wheats for grain yield per plant, ear length and grains/ear. Duplicate epistasis of additive x dominance interaction was involved for plant height and 1000-grain weight in some crosses. However, plant height and grain weight per ear was governed by additive x additive gene action in one cross, while it was due to dominance x dominance gene interaction in other cross.**

**Key words:** Epistasis, additive x additive, additive x dominance, duplicate epistasis, wheat.

The success in breeding programme depends on the amount of variability present for different characters in a pouplation and its efficient management and utilization. Progress in varietal improvement in crops has been slow due to lack of imagination, vision and efficiency in utilizing to assess the components of genetic variation for various quantitative traits, which is likely to provide genetic basis for choosing parents for the breeding programme [1].

One of the objectives of this study was to find out relative magnitude of different gene effects, their interactions and relevance to breeding methodologies. It is, therefore, desirable to understand the nature of genetic system that accounts for variation for different characters based on first degree and higher order statistics [2, 3].

## MATERIALS AND METHODS

The four crosses, namely Kalyan Sona x K 65, UP 301 x Hyb 65, UP 301 x K 65, and HD 2122 x K 65, used in this study were selected from 25 crosses studied for heterosis and inbreeding depression [4]. The six population, viz. both parents, $F_1$, $F_2$, $BC_1$ ($F_1$ x parent 1) and $BC_2$ ($F_1$ x Parent 2) of these crosses, were planted under irrigated conditions in lattice design with four replications.

The plot consisted of 3 m long rows, spaced at 20 cm and 10 cm between and within rows, respectively. The plots received 80 kg N, 60 kg $P_2O_5$ and 40 kg $K_2O$ per hectare with four irrigations at appropriate intervals. Observations on five random plants per plot in all the six generations were recorded for grain yield and tillers/plant, plant height, ear length, spikelets, grains and grain weight/ear, and 1000-grain weight.

The parameters of components of variation were estimated by using mean and weighted variances of six generations. The means and its weighted variance for each generation were calculated by pooling the data over four replications. The three-parameter model based on expected mean from the observed generation was tested by weighted $\chi^2$ method [5]. In the crosses where the 3- parameter model was found inadequate, the 6-parameter model was used to detect digenic interactions, if any.

## RESULTS AND DISCUSSION

For grain yield per plant, the $F_1$ exceeded the better parent in the crosses Kalyansona x K 65 and UP 301 x K 65, indicating overdominance (Table 1). Out of these two crosses, the estimates of dominance component (h) was highly significant in the cross Kalyan Sona x K 65, suggesting dominance of the genes for higher grain yield over their alleles causing low grain yield (Table 2).

There was wide variation among generation means for all the characters, except spikelets/ear and grain yield/plant in the cross Kalyan Sona x K 65. Out of 37 crosses, the estimates of additive (d), dominance (h), additive x additive (i), additive x dominance (j), and dominance x dominance (l) gene effects were significant for different characters in 10, 17, 16, 1 and 3 cases, respectively (Table 3).

The three parameter model (additive–dominance) was satisfactory to detect the genetic differences in two crosses each for spikelets/ear (Kalyan Sona x K 65 and UP 301 x Hyb 65), grain yield/plant, and ear length (Kalyan Sona x K 65 and HD 2122 x K 65), plant height (Kalyan Sona x K 65 and UP 301 x K 65), and for grains/ear in one cross (HD 2122 x K 65). In all these cases, the relative importance of additive–dominance effects varied with characters and crosses, suggesting that epistasis is not operative in these crosses. Absence of epistasis for the above components was also reported earlier [6, 7].

Additive gene effects were observed for plant height and grains/ear in the cross HD 2122 x K 65, and for grain weight in UP 301 x Hyb 65. This indicates that it would be easier to select and isolate higher performing pure lines for these characters, some of which happen to be important components of grain yield. Also, fixation of transgressants for these characters is possible by simple selection in the segregating generations. Additive gene action has been earlier reported for plant height, grains/ear, and grain weight [8].

**Table 1. Generation means in the parental and hybrid populations of wheat**

| Character | Cross | Parent | | $F_1$ | $F_2$ | $BC_1$ | $BC_2$ |
|---|---|---|---|---|---|---|---|
| | | female | male | | | | |
| Yield/Plant (g) | K. Sona x K 65 | 18.2 | 14.8 | 32.3 | 26.4 | 24.8 | 22.8 |
| | HD 2122 x K 65 | 21.2 | 19.1 | 29.5 | 22.9 | 26.7 | 25.8 |
| | UP 301 x Hyb 65 | 20.9 | 19.3 | 28.1 | 20.2 | 20.3 | 30.1 |
| | UP 301 x K 65 | 20.9 | 21.7 | 30.7 | 23.1 | 22.2 | 30.4 |
| Plant height (cm) | K. Sona x K 65 | 91.7 | 110.3 | 109.9 | 105.0 | 101.4 | 101.8 |
| | HD 2122 x K 65 | 88.9 | 109.1 | 98.0 | 97.2 | 89.3 | 96.8 |
| | UP 301 x Hyb 65 | 66.9 | 110.6 | 98.6 | 93.0 | 95.3 | 110.8 |
| | UP 301 x K 65 | 63.7 | 106.9 | 94.0 | 92.1 | 99.4 | 103.1 |
| Ear length (cm) | K. Sona x K 65 | 12.3 | 12.6 | 13.3 | 12.3 | 12.4 | 12.3 |
| | HD 2122 x K 65 | 10.8 | 11.5 | 12.2 | 11.5 | 11.7 | 11.6 |
| | UP 301 x Hyb 65 | 10.5 | 11.0 | 11.4 | 11.2 | 11.9 | 11.5 |
| | UP 301 x K 65 | 11.2 | 11.6 | 12.1 | 11.3 | 10.9 | 11.5 |
| Spikelets/ear | K. Sona x K 65 | 20.3 | 18.9 | 21.3 | 19.5 | 20.3 | 20.3 |
| | HD 2122 x K 65 | 18.9 | 17.8 | 19.7 | 18.1 | 18.9 | 18.8 |
| | UP 301 x Hyb 65 | 19.5 | 19.5 | 20.4 | 19.7 | 20.5 | 19.7 |
| | UP 301 x K 65 | 19.4 | 19.2 | 20.1 | 21.4 | 19.7 | 19.9 |
| Grains/ear | K. Sona x K 65 | 70.1 | 50.3 | 63.7 | 55.0 | 74.5 | 58.7 |
| | HD 2122 x K 65 | 52.7 | 54.3 | 61.0 | 55.3 | 56.2 | 58.8 |
| | UP 301 x Hyb 65 | 54.0 | 51.3 | 59.8 | 62.1 | 52.8 | 59.4 |
| | UP 301 x K 65 | 56.1 | 57.4 | 64.6 | 61.4 | 57.2 | 65.3 |
| Grain wt./ear (g) | K. Sona x K 65 | 2.1 | 2.1 | 2.6 | 2.1 | 2.8 | 2.5 |
| | HD 2122 x K 65 | 1.9 | 2.5 | 2.6 | 2.1 | 2.2 | 2.6 |
| | UP 301 x Hyb 65 | 1.8 | 2.2 | 2.5 | 2.2 | 1.7 | 2.9 |
| | UP 301 x K 65 | 1.9 | 2.5 | 2.9 | 2.3 | 2.2 | 2.9 |
| 1000-grain wt. (g) | K. Sona x K 65 | 30.8 | 43.2 | 41.3 | 33.9 | 37.7 | 42.8 |
| | HD 2122 x K 65 | 37.1 | 46.9 | 42.5 | 38.2 | 39.6 | 45.7 |
| | UP 301 x Hyb 65 | 33.2 | 43.3 | 43.6 | 37.4 | 32.0 | 49.9 |
| | UP 301 x K 65 | 33.3 | 44.3 | 45.1 | 36.7 | 39.9 | 43.6 |

Additive x additive gene interactions were noted in cross UP 301 x Hyb 65 for plant height, Kalyan Sona x K 65, HD 2122 x K 65, and UP 301 x Hyb 65 for grain weight/ear, and Kalyan Sona x K 65 and HD 2122 x K 65 for 1000-grain weight (Table 2). Such interactions for these characters were also reported earlier [9]. These interactions would enhance chances for making improvement through selection. However, it would be somewhat difficult to isolate better performing lines with significant dominance effects. Additive x dominance (j) interaction for 1000-grain weight was observed in the cross UP 301 x Hyb 65. Yadav and

**Table 2. Estimates of genetic parameters in hybrid populations of wheat**

| Character | Cross | (m) | (d) | (h) | (i) | (j) | (l) | $\chi^2$ |
|---|---|---|---|---|---|---|---|---|
| Yield/plant (g) | K. Sona x K 65 | 26.4** | 2.0 | 5.4 | 10.4 | 0.3 | 12.9 | 2.6 |
| | HD 2122 x K 65 | 22.9** | 0.9 | 22.9 | 13.5 | –0.1 | –19.3 | 1.2 |
| | UP 301 x Hyb 65 | 20.2** | –9.7 | 25.2* | 20.2 | –10.5* | –30.6 | 5.2 |
| | UP 301 x K 65 | 23.1** | –7.6 | 23.1 | 13.8 | 7.2 | –16.0 | 1.6 |
| Plant height (cm) | K. Sona x K 65 | 105.0** | –0.4 | 5.8* | –13.7 | –8.9 | 27.3 | 40.2** |
| | HD 2122 x K 65 | 97.2** | –7.4* | –13.6 | –6.6 | 6.6 | 30.4 | 118.2** |
| | UP 301 x Hyb 65 | 93.0** | –14.9 | 51.6* | 41.3** | 7.4 | 30.4 | 212.3** |
| | UP 301 x K 65 | 92.1** | –23.5** | 5.9 | –3.5 | –2.0 | 1.4 | 293.8** |
| Ear length (cm) | K. Sona x K 65 | 12.3** | 0.4 | 0.3 | 1.2 | 1.8** | 0.3 | 1.8 |
| | HD 2122 x K 65 | 11.5** | 0.2 | 1.5 | 0.7 | 0.7 | 0.1 | 7.6 |
| | UP 301 x Hyb 65 | 11.2** | –0.4 | 2.4 | 1.8 | –0.7 | –4.5* | 7.6 |
| | UP 301 x K 65 | 11.3** | –0.6 | 0.1 | –0.6 | –0.4 | 2.9 | 25.3** |
| Spikelets/ear | K. Sona x K 65 | 19.5** | 9.5** | 4.9* | 3.2 | 0.6 | 2.7 | 5.7 |
| | HD 2122 x K 65 | 18.1** | 0.1 | 3.9 | 2.6 | –0.4 | –1.6 | 5.3 |
| | UP 301 x Hyb 65 | 18.8** | 0.7 | 5.9* | 5.0* | 0.7 | 5.5 | 4.9 |
| | UP 301 x K 65 | 19.7** | –0.2 | 1.0 | 0.3 | –0.3 | –0.7 | 0.2 |
| Grains/ear | K. Sona x K 65 | 61.4** | 15.7** | 24.3 | 20.8 | 5.6 | 39.4 | 17.4* |
| | HD 2122 x K 65 | 55.0** | 0.6 | 13.5 | 6.5 | 0.1 | –3.3 | 1.3 |
| | UP 301 x Hyb 65 | 55.3** | 6.6 | 10.6 | 3.5 | –7.9 | –3.3 | 0.8 |
| | UP 301 x K 65 | 62.1** | –8.1 | 4.7 | –3.2 | –7.5 | 0.8 | 0.4 |
| Grain wt./ear (g) | K. Sona x K 65 | 2.9** | 0.2 | 2.9** | 2.4** | 0.2 | 3.4** | 20.3** |
| | HD 2122 x K 65 | 2.0** | –0.4 | 1.3** | 1.0* | –0.1 | –0.8 | 22.0** |
| | UP 301 x Hyb 65 | 2.2** | –1.3** | 0.9 | 0.4 | –1.1** | –0.7 | 24.4** |
| | UP 301 x K 65 | 2.3** | –0.6** | 1.7* | 1.1 | –0.3 | –1.0 | 18.5** |
| 1000-grain wt. (g) | K. Sona x K 65 | 33.9** | –5.0 | 29.9** | 25.6** | 1.1 | –30.1** | 66.9** |
| | HD 2122 x K 65 | 38.2** | 6.2** | 18.3** | 17.9** | –1.3 | –19.5 | 35.6** |
| | UP 301 x Hyb 65 | 37.4** | –17.8 | 19.5* | 14.1 | –12.7** | –14.3 | 113.2** |
| | UP 301 x K 65 | 36.7** | –3.7 | 26.7* | 20.3 | 1.7 | –19.5 | 45.8** |

*,**Significant at 5% and 1% levels, respectively.

Sethi [6] also observed both additive and dominance gene actions for this character in breadwheat.

Dominance x dominance (l) effects were significant in three crosses for plant height, grain weight/ear, and 1000-grain weight. Duplicate epistasis was recorded for plant height in the cross UP 301 x Hyb 65 and 1000-grain weight in Kalyan Sona x K 65, which is an undesirable interaction for selection of these traits.

Table 3. Significant gene effects in four crosses of wheat

| Character | Kalyan Sona x K 65 | HD 2122 x K 65 | UP 301 x Hyb 65 | UP 301 x K 65 |
|---|---|---|---|---|
| Grain yield/plant | (h) | (h) | | |
| Plant height | (h) | (d) | (h), (i), ( ), D | (d), (h) |
| Ear length | (h) | (d), (h) | | |
| Spikelets/ear | (h) | | (d), (h) | (d) |
| Grains/ear | (d) | (h) | | |
| Grain wt./ear | (h), (i), ( ) | (d), (h), (i) | (d), (i) | (d), (h) |
| 1000-grain wt. | (h), (i), ( ), D | (d), (h), (i) | (d), (h), (j) | (h) |

Improvement of quantitative traits through recombinant breeding is not an easy task for the plant breeder. However, additive and additive x additive gene effects observed for plant height and grains/ear and 1000-grain weight, respectively, may be relatively important for inheritance of the yield components and also easier for selection in the segregating populations. Similarly, additive x dominance gene interaction for 1000-grain weight may be a useful for improvement of this important yield component. The additive, additive x additive, and additive x dominance gene interactions observed in this study for important yield characters may help in deciding the breeding methodology and future strategy for breadwheat improvement.

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