Indian J. Pl. Genet. Resources 7(2): 181-185, 1994; Special Issue

# STUDIES ON COMBINING ABILITY FOR GRAIN YIELD AND HARVEST INDEX OVER ENVIRONMENTS IN BREADWHEAT

**Uma Menon and S. N. Sharma**

Department of Genetics and Plant Breeding
Rajasthan Agricultural University
Agricultural Research Station
Durgapura, Jaipur 302 018 (Rajasthan)

Combining ability studies on grain yield per plant and its important component of harvest index from an 10 × 10 half-diallel cross of wheat over three environments each at two locations indicated that both goa and soa variances were important for controlling the traits. Additive gene effect in $F_2$ and non-additive gene effect in $F_1$ was of greater importance in the genetic control of traits. gca x E and sca x E interactions exhibited greater importance of environment in influencing the variances. Raj 1482 and HD 2204 were good general combiners for both grain yield and harvest index. The most consistent cross for high sca effect was Kharchia 65 x Chiroca which showed high sca under all the situations for the traits studied. The best crosses for grain yield were the combinations of Indian x exotic types and all these crosses also exhibited high harvest index. Diallel selective mating system, which exploit both additive and non- additive gene effects, simultaneously, could be useful in the genetic improvement of the characters studied.

**Key words :** Bread wheat, quantitative traits, combining ability, gene effects, heterosis

Improved harvest index represents increased physiological capacity to mobilise photosynthetes efficiently and their proper translocation from source to sink. Since economic yield is only a fraction of the dry matter produced, the harvest index forms an useful measure on a large number of plants. Strong positive correlation between harvest index and grain yield has been established (1-4). Moreover, it is known that both these quantitative characters are influenced by the environment. In view of this, the present study has been undertaken to analyse a 10 × 10 diallel cross over the three environments at both Jaipur and Ludhiana for grain yield and its important component of harvest index for estimating combining ability, component of variance, and combining ability x environment interation.

## MATERIALS AND METHODS

Ten varieties of breadwheat (*Triticum aestivum* (L.) Thell), namely, Moncho, Pavon, Brochis, Chiroca, HD 2204, Raj 1482, WL 711, Raj 821, D-65 and Kharchia 65, were crossed in all possible combinations excluding reciprocals. The resulting 45 $F_1$'s were grown to get $F_2$ seeds. Parents alongwith their 45 $F_1$'s and $F_2$'s at Agricultural Research Station, Durgapura, Jaipur and parents alongwith 45 $F_2$'s at Punjab Agricultural University, Ludhiana location were grown in a randomised block design with three replications under three diverse environments created by different dates of sowing in each location. Each plot consisted of single 5 m long row of parent and $F_1$ and ten rows of $F_2$ with the spacing of 30 × 15 cm. Ten competitive plants in parent $F_2$'s progenies were selected randomly for recording observations for harvest index (%) and grain yield per plant (g) under each environment and location.

The mean of each plot was used for statistical analysis. The data were first subjected to the analysis followed for a randomised block design for pooled over environment in each location. The combining ability analysis was done in each location (pooled over three environments) following Method II and Model I of Griffing (1956).

## RESULTS AND DISCUSSION

The analysis of variance for combining ability over environments for $F_1$ and $F_2$ generation at Jaipur and $F_2$ generation at Ludhiana (Table 1) revealed that the gca x environment and sca x environment interactions were highly significant for both harvst index and grain yield in both the generations at both the locations. In the presence of high gca x environment interaction, the gca variance was observed to be non-significant for both the traits in $F_1$ but significant in $F_2$ data at both the locations. However, sca variance was found to be non-significant only in $F_2$ at Jaipur for harvest index which may be due to drastic reduction in sca variances for this trait in $F_2$ generation. Thus, it is clear that both the additive and non-additive gene effects were important to control the inheritance of harvest index and grain yield in bread wheat but both were highly influenced by environment (Kumar *et al.*, 1983; Nanda *et al.*, 1983; Dasgupta and Mandal, 1988; Sharma *et al.*, 1980). The gca variance was found to be higher than sca in $F_2$ for both the traits at both the locations, indicating the preponderance of additive gene effects. However, sca variance was, predominant in $F_1$ generation for both the traits, signifying the important role of non-additive gene effects in this generation. The findings of Sharma and Sharma (1982), Lhatrath *et al.* (1986), Pawar *et al.* (1988), Rajorea (1992), Yadava *et al.* (1993), Singh *et al.* (1993) and Solanki *et al.* (1993). are in agreement with the present results.

**Table 1. Analysis of variance for combining ability under diverse environments**

| Source of variation | d.f. | Harvest Index (%) | | | Grain Yield (g) | | |
|---|---|---|---|---|---|---|---|
| | | Jaipur | | Ludhiana | Jaipur | | |
| | | $F_1$ | $F_2$ | $F_2$ | $F_1$ | $F_2$ | $F_2$ |
| Environment (E) | 2 | 1947.88** | 1285.47** | 12856.47** | 2971.46** | 2108.22** | 1110.69** |
| gca | 9 | 30.19 | 39.40* | 112.28** | 24.23 | 57.77* | 20.21** |
| sca | 45 | 24.71** | 12.27 | 73.73* | 59.84** | 36.10** | 2.69** |
| gca x E | 18 | 19.50** | 11.93** | 25.95** | 13.41** | 18.05* | 1.81** |
| sca x E | 90 | 11.03** | 9.31** | 43.05** | 15.50** | 18.61** | 1.15** |
| Error | 324 | 2.42 | 3.21 | 5.85 | 1.46 | 11.86 | 0.63 |

*,P = 0.05 **, 0.01

A persual of gca estimates (Table 2) revealed that for harvest index and grain yield there was no significant differences between the parental types for gca estimates in $F_1$. On the basis of $F_2$ analysis, parents HD 2204 ad WL 711 were the highest combines while Chiroca was the lowest combiner for harvest index at Jaipur. However, parent Raj 1482 was the highest combiner while Kharchia 65 and Brochis were the poorest combiners for harvest index. There seemed to be no similarity of the gca estimates for this trait in the two locations.

For grain yield, Raj 1482 was found to be the best combiner. Pavon and Brochis were the poorest combiners, while all others were average combiners. At Ludhiana, Raj 1482 and HD 2204 were found to be high combiners, Kharchia 65 and Brochis the low combiners and all others were average combiners for grain yield. From the overall position, HD 2204 and Raj 1482 seems to be the best parents for combining harvest index in bread wheat and both these parents were also found to be best combiners for grain yield. it is, therefore, recommended that we should breed for superior combining ability for the harvest index which ultimately improves the grain yield in wheat.

The analysis of sca effects revealed that WL 711 x Chiroca showed the highest sca effects for grain yield in $F_1$ and $F_2$ at Jaipur. This cross also exhibited the maximum heterosis of 89 per cent in $F_1$ at Jaipur. Apart from this cross, however, there seem to be no correlation between the rank for sca and the rank for heterosis. This could be expected also because heterosis estimates are worked out from the mean values whereas the sca estimates

**Table 2. Estimates of general combining ability effects under diverse environemts**

| Parents | Harvest Index (%) | | Grain Yield (g) | |
|---|---|---|---|---|
| | Jaipur | Ludhiana | Jaipur | Ludhiana |
| | $F_2$ | $F_2$ | $F_2$ | $F_2$ |
| Moncho | 0.08 | –0.92 | –1.15 | 0.07 |
| Pavon | –0.36 | –0.17 | –1.54L | 0.18 |
| Brochis | –0.37 | –2.75L | –1.85L | –0.80L |
| WL 711 | 1.55H. | –0.08 | 1.29 | 0.12 |
| D 65 | –0.68 | 0.75 | 1.08 | –0.51 |
| Kharchia 65 | –0.52 | –3.33L | 0.11 | –1.77L |
| Chiroca | –1.77L | 0.75 | –0.92 | 0.48 |
| HD 2204 | 1.41H | 1.92 | 1.23 | 1.16H |
| Raj 1482 | 0.43 | 2.92H | 1.38 | 0.73H |
| Raj 821 | 0.72 | 0.92 | 0.38 | 0.41 |
| S. Em.± | 0.55 | 0.80 | 0.67 | 0.21 |
| C.D. | 1.60 | 2.35 | 1.96 | 0.62 |

are relative to the gca of the parents. The most consistent cross for high sca effect was Kharchia 65 x Chiroca which showed high sca under all situations. Brochis x Kharchia 65 also showed high sca in $F_1$ and $F_2$ at Jaipur. Apparently, therefore, there is some consistency of sca effects over generations. Other crosses Brochis x Raj 821 and Brochis x D 65 also showed high sca effects for grain yield. It is noteworthy that all the best five crosses for grain yield also showed high sca for harvest index, which confirms the strong relationship between these two traits in wheat (Gill *et al.*, 1980; Sharma and Singh, 1983; Singh and Upadhyay, 1986; Dindsa and Bains, 1987). Another interesting feature of the present investigation was that all the crosses showing high sca effects in both $F_1$ and $F_2$ generations were combinations of Indian x exotic types. This emphasis the need for combining the two diverse germplasms.

The present study suggested that improvement for grain yield may be expected by exploiting the additive genetic variance first, and at the same time retaining the non-additive genetic variances in the population. The diallel selective mating system which allowes the infusion of new germplasm at various stages of breeding seems to be the best available method.

## ACKNOWLEDGEMENT

The authors are thankful to the Director of Research, Rajasthan Agricultural University for providing necessary facilities during the course of investigations.

## REFERENCES

Dasgupta, T. and A.B. Mandal. 1988. Diallel analysis in wheat. *Indian J. Genet.* 4(2): 167-170.

Dindsa, G.S. and K.S. Bains. 1987. Genetics of harvest index in wheat. *Indian J. Agric. Sci.* 58: 529-534.

Gill, K.S., G.S. Nanda, Gurdev Singh and L.K. Bajaj. 1980. Genetic analysis of harvest index in wheat. *Crop Improv.* 7 : 119-122.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9 : 463-493.

Kumar, H., G.S. Sharma and R.B. Singh. 1983. Genotype x environment interaction in relation to combining ability in spring wheat. *Indian J. Genet.* 43 (2): 232-238.

Lhatrath, R., D.R. Satiya and V.P. Gupta. 1986. Genetic analysis of grain yield in wheat. *Indian J. Genet.* 46: 466-471.

Nanda, G.S., P.S. Virk and K.S. Gill. 1983. Diallel analysis over environments in wheat yield and its components. *Indian J. Genet.* 36(2): 184-196.

Pawar, I.S., R. S. Paroda and S. Singh. 1988. Gene effects for six metric traits in four spring wheat crosses. *Indian J. Genet.* 46:48:195-199.

Rajora, M.P. 1992. Heterosis, Combining ability and stability parameters in wheat. Ph.D. Thesis. RAU, Bikaner, India.

Sharma, S.K. and R.K. Sharma. 1982. Note on diallel cross analysis of harvest index and its components in wheat. *Indian J. Agric. Sci.* 50: 451-461.

Sharma, S.K., R.K. Sharma, M. Singh and I.D. Tiwari. 1980. Genetic studies of harvest index (HI) and its components in wheat. *In*: Proc. National Seminar on Genetic and Wheat Improvement, *Hissar.* (2) 12.

Sharma, S.K. and R.K. Singh. 1983. Combining ability for harvest index and its component in wheat. *Indian J. Genet.* 43 : 229-231.

Singh, Iqbal, A.S. Redhu, S.C. Sharma, Y.S. Solanki and R.P. Singh. 1993. *In*: Abstr. National Symp. on Plant Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.

Solanki, Y.S., A.S. Redhu, Iqbal Singh, R.B. Srivastava and R.S.A. Lamba. 1993. Combining ability analysis in diallel crosses in wheat. *In*: Abstr. National Symp. on Plant Breeding Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.

Singh, M. and M.K. Upadhyay. 1986. Wheat improvement in India. *Indian J. Genet.* 46: 187-197.

Yadav, B., Mohd. Yunus and S. Madan. 1993. Genetic control of yield components and quality traits in wheat. *In*: Abstr. National Symp. on Plant Breeding Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.