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# HETEROSIS AND COMBINING ABILITY IN RAPESEED (*BRASSICA NAPUS* L.)

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## ABSTRACT

**A nine-parent diallel study conducted on the yield components and oil content in rapeseed (*Brassica napus* L.) revealed that mean squares due to general and specific combining ability were significant, suggesting the importance of both additive and dominance components. Parents GSL, 8809, HPN-1, GSL 1501 and HNS 8803 were good combiners for seed yield and some of its components, and oil content. Estimates of heterosis over better parent (BP) for various traits indicated significant magnitude for seed yield (–14.8 to 82.8%), primary branches (–26.0 to 193.6%) and siliquae per plant (–21.9 to 162.6%). Unidirectional dominance was observed for most of the traits studied. The cross GSB 7027 x HNS 8803 gave highest positive heterosis for seed yield per plant.**

**Key words:** Heterosis, combining ability, rapeseed, *Brassica napus* L.

Information on gene action and combining ability helps in the choice of suitable parents for hybridization programme for developing superior $F_1$ hybrids so as to exploit hybrid vigor and/or building genotypes to be used in breeding programme. Several studies have suggested that rapeseed (*Brassica napus* L.) is a crop with high heterotic advantage [1–3]. This study aims to determine the extent of heterosis and gene action for this trait.

## MATERIALS AND METHODS

Nine diverse inbreds (HPN-1, GSL 8809, GSL 1501, GSB 7027, ISN 114, ISN 129, No. 70-21, ISN 706 and HNS 8803) were selected as parental lines. These nine parents were hand crossed in a half diallel design to produce 36 cross combinations during 1991–92. The $F_1$ families and nine homozygons parents were grown in randomized block design with three replications. Observations were recorded on ten random plants for yield and its components. Oil content was estimated with the help of nuclear magnetic resonance (NMR). The magnitude of heterosis over better parent (BP) was estimated. The combining ability analysis was done using mean values [4].

## RESULTS AND DISCUSSION

Significant differences were observed for general (gca) and specific combining ability (sca) for all the characters under study. Both additive and non-additive genetic effects were important for inheritance of these traits. The magnitude of variance due to gca was higher for all the traits except for siliquae per plant and oil content, suggesting preponderance of additive gene effects for primary branches, secondary branches and seeds/siliquae; whereas predominance of nonadditive genetic variance was observed for siliquae/plant and oil content.

The parent GSL 8809 was the best general combiner for seed yield, primary branches, secondary branches and siliquae per plant (Table 1). Similarly, HPN-1 and GSL 1501 also exhibited positive significant gca effect for seed yield, secondary branches and siliquae/plant, and HNS 8803 for seeds/siliquae.

**Table 1. Estimates of gca effects and per se performance (in parentheses) of nine parents in rapeseed**

| Parent | Primary branches per plant | Secondary branches per plant | Siliquae per plant | Seeds per siliquae | Seed yield per plant | Oil content |
|---|---|---|---|---|---|---|
| HPN-1 | 0.429<br>(6.7) | 1.150**<br>(7.9) | 31.962**<br>(259) | –0.852**<br>(18.3) | 12.91**<br>(165.0) | 0.132<br>(41.10) |
| GSL 8809 | 1.225**<br>(6.3) | 2.779**<br>(9.6) | 43.712**<br>(215) | 0.335<br>(19.7) | 27.73**<br>(262.5) | 0.136<br>(42.80) |
| GSL 1501 | 0.347<br>(4.9) | 1.488**<br>(6.5) | 21.240*<br>(213) | –0.462*<br>(15.9) | 11.20<br>(207.5) | 0.064<br>(39.90) |
| GSB 7027 | 0.193<br>(5.5) | 0.961<br>(4.8) | –7.093<br>(152) | 0.534**<br>(15.9) | –3.32<br>(145.0) | –0.468**<br>(40.95) |
| ISN 114 | 0.011<br>(5.5) | –0.758<br>(6.1) | 0.675<br>(238) | 0.738**<br>(20.2) | 0.22<br>(240) | –0.518**<br>(41.05) |
| ISN 129 | 0.539<br>(4.2) | –1.630**<br>(3.5) | –11.711<br>(196) | –0.124<br>(19.8)) | –5.32<br>(128.5) | 0.077<br>(42.00) |
| No 70–72 | –0.539<br>(5.7) | –0.794<br>(8.4) | 5.525<br>(221) | 0.236<br>(17.4) | 1.77<br>(207.0) | 0.255<br>(39.90) |
| ISN 706 | –0.798**<br>(4.9) | –3.467**<br>(3.8) | –58.190**<br>(130) | –0.227*<br>(19.0) | –26.86**<br>(140.0) | 0.009<br>(41.90) |
| HNS 8803 | –0.325<br>(4.8) | –0.153<br>(4.4) | –24.775*<br>(175) | 0.772**<br>(16.8) | –17.8*<br>(125.0) | 0.314*<br>(41.80) |
| SE ($g_i$) | 0.285 | 0.584 | 10.84 | 0.196 | 3.44 | 0.150 |

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

The parent GSL 8809 showed highest gca and maximum per se performance for seed yield and secondary branches per plant, but not for the remaining traits (Table 1). So, both the parameters, i.e. gca and per se performance, jointly can help the breeder in selecting good parental materials for crossing programmes. The importance of per se performance has been emphasized by earlier workers also [5, 6].

EXPLOITATION OF HETEROSIS

The estimates of BP heterosis for various traits indicated sufficient heterosis required for developing commercial hybrids in this crop (Table 2). In case of seed yield/plant, twelve crosses exceeded their BP values by a significant positive margin ranging from 21.9% (GSL 8809 x GSB 7027) to 82.8% (GSL 7027 x HNS 8803) and was significantly positive in 14 crosses for primary branches/plant. Similarly, 17 hybrids exhibited significant heterosis for secondary branches in the range of –26.0 –370.8%. BP heterosis was also of very high order

**Table 2. Estimates of BP heterosis (%) for different characters in rapeseed**

| Cross | Primary branches per plant | Secondary branches per plant | Siliquae per plant | Seeds per siliqua | Seed yield per plant | Oil content |
|---|---|---|---|---|---|---|
| HPN-1 x GSL 8809 | 11.9 | 73.9* | 50.2* | –11.2 | –20.0 | 0.12 |
| HPN-1 x GSL 1501 | –2.8 | 68.4 | 30.4 | –3.0 | 22.8 | 4.37** |
| HPN-1 x GSB 7027 | 11.9 | 141.8** | 39.7 | –6.9 | 41.5** | –6.76** |
| HPN-1 x ISN 114 | 29.9** | 73.4* | 29.6 | –9.4 | 1.7 | 0.60 |
| HPN-1 x ISN 129 | 4.5 | 148.1* | 103.7* | –11.6 | 54.5** | –1.90 |
| HPN-1 x No 70-21 | 13.4 | 39.2 | 39.3 | –8.5 | –21.8 | –0.24 |
| HPN-1 x ISN 706 | 26.9 | 60.8 | 24.7 | 8.9 | –10.3 | 2.36 |
| HPN-1 x HNS 8803 | 26.9 | 53.8 | 67.4* | 1.0 | 23.0* | 2.03 |
| GSL 8809 x GSL 1501 | 55.6** | 129.2** | 162.4** | 1.0 | 53.3** | –0.70 |
| GSL 8809 x GSL 7027 | 25.4 | 28.1 | 55.5* | 1.5 | 21.9* | –0.70 |
| GSL 8809 x ISN 114 | 73.0** | 77.1* | 147.0** | –11.4 | 74.4** | –5.40 |
| GSL 8809 x ISN 129 | 46.8* | 4.2 | 35.3 | –13.4 | –10.1 | –10.16 |
| GSL 8809 x No 70-12 | 58.7** | 181.0** | 132.4** | 0.5 | 50.5** | –0.20 |
| GSL 8809 x ISN 706 | 28.5 | –26.0 | 30.3 | –1.5 | –20.0* | –7.35 |
| GSL 8809 x HNS 8803 | 25.4 | 102.1** | 56.0* | 18.3* | –42.9** | –10.40** |
| GSL 1501 x GSB 7027 | 3.6 | 67.1 | 26.1 | –3.0 | –33.7** | –3.90 |
| GSL 1501 x ISN 114 | 70.9** | 127.7** | 75.8** | –12.9 | 17.3 | 4.00 |
| GSL 1501 x ISN 129 | 65.5** | 127.6** | 97.2** | –10.6 | 47.0** | 1.19 |

*(Contd.)*

**Table 2 (contd.)**

| Cross | Primary branches per plant | Secondary branches per plant | Siliquae per plant | Seeds per siliqua | Seed yield per plant | Oil content |
|---|---|---|---|---|---|---|
| GSL 1501 x ISN No. 70-21 | 40.4* | 58.3 | 71.0* | –18.6* | 31.3** | 3.38 |
| GSL 1501 – ISN 706 | 63.3** | 83.1* | 53.8** | –24.7** | 6.0 | 0.95 |
| GSL 1501 x HNS 8803 | 63.3** | 193.8** | 61.5* | –24.7** | –15.7 | 1.44 |
| GSB 7027 x ISN 114 | 56.4* | 155.7** | 32.0 | 8.9 | –33.3** | –3.53 |
| GSB 7027 x ISN 129 | 80.0** | 254.2** | 162.6** | –10.9 | 58.6** | –3.57 |
| GSB 7027 x No 70-21 | 1.8 | –3.6 | 31.3 | 32.8** | 12.3 | 2.31 |
| GSB 7027 x ISN 706 | 23.6 | 153.1** | 141.7** | –12.4 | 5.2 | –4.53** |
| GSB 7027 x HNS 8803 | 70.9** | 370.8** | 133.7** | 18.0* | 82.8** | 3.42 |
| ISN 114 x ISN 129 | –7.3 | 36.1 | –21.9 | 4.9 | –44.8** | –0.90 |
| ISN 114 x No 70-21 | 7.0 | 139.6** | 61.1 | –8.4 | –32.3** | 2.30 |
| ISN 114 x ISN 706 | 0.0 | 19.7 | 12.5 | –5.9 | –30.4** | 2.40 |
| ISN 114 x ISN 129 | –3.6 | 31.1 | 21.8 | 6.9 | –30.2** | –4.10 |
| ISN 129 x No 70-21 | –3.5 | 39.6 | 44.8 | 6.9 | –17.4 | –0.47 |
| ISN 129 x ISN 706 | –8.2 | 42.1 | 7.7 | 1.0 | –27.2* | –4.28 |
| ISN 129 x HNS 8803 | 20.8 | 11.82 | 32.0 | 15.2** | –16.7 | 0.70 |
| No 70-21 x ISN 706 | –28.0 | –7.1 | 34.9 | 30.5** | –34.2** | 2.55 |
| No 70-21 x HNS 8803 | 5.3 | 3.6 | 39.4 | 20.7* | –20.3 | –0.50 |
| ISN 706 x HNS 8803 | 30.6* | 52.3 | 34.5 | 9.5 | –1.8 | 1.67 |

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

for siliquae per plant (–21.9 –162.6%) with as many as 16 crosses exceeding their better parents by a significant margin. Only six crosses exhibited significant positive heterosis for seeds per siliquae. For oil content, negative heterosis was estimated for most of the crosses, except HPN-1 x GSL 1501 (4.3%).

The sca effects, per see performance and BP heterosis may be used for identifying best cross combinations. Separating top five crosses for different traits using the aforesaid criteria, it was apparent that at least 2–3 crosses out of five best ones were selected as common crosses in all the three methods, though their ranking gets changed from one method to another. In the present study, the cross HPN-1 x GSL 8809 was top yielder on the basis of sca effect and BP heterosis but last among the five best hybrids selected on the basis of their per se performance. In case of siliquae per plant, the above refered cross ranked first in sca effect and per se performance, but got excluded in the third criterion. Thus it is not necessary that high parental performance is inherited in the crosses as well.

The first five top yielding crosses indicated that if gca effects of parents are considered, good x good and good x average combinations should give high heterosis. In the present study, out of five top yielders, three crosses, namely, GSL 8809 x ISN 114, GSL 8809 x GSL 1501 and GSL 8809 x No. 70-21, had good x good and good x average gca parents. Most of the promising crosses had at least one high gca parent.

As reported earlier [5], considerable heterosis was observed for different characters. Good or average general combiners should be used to develop $F_1$ hybrids which has become feasible with the stabilization of CMS system and identification of fertility restorers [3] in this crop. The parents GSL 1501 and GSL 8809 may be used as parents in developing CMS lines in hybrid development programme in winter rapeseed.

## REFERENCES

1. J. L. Sernyk and B. R. Stefansson. 1983. Heterosis in summer rape (*Brassica napus* L.). Can. J. Plant Sci., **63**: 407–413.

2. I. Grant and W. D. Beversdorf. 1986. Heterosis and combining ability estimates in spring-planted oilseed rape (*Brassica napus* L.). Can. J. Genet. Cytol., **27**: 472–478.

3. S. S. Banga and S. Gurjeet. 1994. Polima CMS system for producing $F_1$ hybrids in oilseed rape. Crucifarae Newsl., No. **16**: 71–72.

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

5. Hari Singh and S. K. Thakural. 1986. Combining ability of seed yield, biological yield, harvest index and other quantitative traits in rapeseed. (*Brassica napus* L.). Oil Crops Newsl., No. **3**: 60–62.

6. A. M. Olivieri and P. Parrini. 1983. Analysis of yield and its components in a diallel cross of rapeseed. Proc. VI Intern. Rapeseed Conf. Paris. Vol. I: 332–338.