Combining ability study using diallel mating design in Indian mustard

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Abstract The present investigation on Indian mustard was comprised of a half diallel set of 5 parents and their 10 crosses. Three cross combinations exhibited positive significant heterobeltiosis for seed yield/plant. On the basis of per se performance and estimates of heterosis, the cross IC-342777 × IC-339953 found to be most promising for seed yield/plant. GCA effects revealed that IC-335858 followed by IC-355856 having significant and positive GCA effects was found to be the best combiner for most of the yield contributing traits and on the basis of SCA, IC-342777 × IC-339953 and IC-342777 × IC-355856 was recorded best specific combination for most of the yield contributing traits. It may be concluded that IC-355856 is a good general combiner and IC-342777 × IC-355856 is a best specific combination for higher yield.

Key words: significant, yield, cross combinations, heterobeltiosis

Introduction

Indian mustard [Brassica juncea (L.) Czern & Coss.] commonly known as Indian mustard is globally used as vegetable, oilseed and condiments (Saleem et al., 2017, Kumar et al. 2019). Mustard belongs to family Brassicaceae and with Brassica genus. Indian mustard is a natural amphidiploids (2n=36) of B. rapa (2n=20) and B. nigra (2n=16) (Kaur et al., 2020). Indian mustard is the important oilseed crop after groundnut and contributes nearly 27% to edible oil pool of the country (Gideon et al., 2015). UP, Rajasthan, M.P., Punjab, Haryana, West Bengal, Assam and Bihar are the Major mustard growing states in India. Combining ability analysis is a useful breeding method and provides knowledge regarding the suitable parents for breeding program, magnitude and nature of gene action which control the inheritance of quantitative traits (Ceyhan et al., 2008). The knowledge of combining ability is useful to get information on selection of parents and nature of gene actions involved (Gideon et al., 2015). Combining ability analysis is a powerful method to test the value of parental lines to produce superior hybrids and for recombinants. Indian mustard being a self pollinated crop, the mating of diallel analysis for combing ability is very useful for screening of suitable lines for any breeding program. F1 hybrids provide information about the genetic components and inform to the breeders to select a suitable breeding procedure for improvement of population and cultivar development (Channa et al., 2018). The present investigation was undertaken to study combining ability in IC lines of Indian mustard.

Methods and materials

Genetic material and field procedure

The research work on combining ability analysis of yield and yield components in Indian mustard crossed in an 5×5 diallel fashion was conducted at experimental farm, Mata Gujri College Fatehgarh Sahib, Punjab. Seeds for the experiment were obtained from the national Bureau of Plant Genetic Resources (NBPRG). All the 10 F1 populations along with six parents were sown with in a randomized block design (RBD) with three replications during mid of September in three rows of five-meter length with plants and rows spacing of 20 and 40 cm, respectively. Data were recorded on selected F1 plants and single plant selection was carried out in this generation. The data were recorded on days to first flowering, number of primary branches, number of secondary branches, plant height (cm), number of siliqua per plant, siliqua length (cm), number of seeds/siliqua, days to maturity, biological yield / plant (g), harvest index (%), Test weight (g), seed yield/plant (g).

Result and discussion

The success of any breeding programme largely depends upon the choice of parents and breeding procedure adopted. Combining ability is an efficient tool to discriminate good as well as poor combiners and for choosing suitable parental lines in hybridization
The estimates of combining ability effects for number of siliqua length/plant revealed that none of the parent exhibited significant positive or negative gca effects for this trait. For positive significant sca effects, cross IC338586 × IC355856 (-10.965) had recorded significant negative sca effects for this trait.

One of the parent IC335858 (-0.662) exhibited significant negative GCA effect for number of seeds/siliqua. One of the cross IC335858 × IC338586 (2.051) shows a positive and the cross IC338586 × IC339953 (-1.640) exhibits negative sca effects for number of seeds/siliqua. Similar results were also observed by Singh et al. (2019b)

One parent IC355856 (5.448) exhibit significant positive and one of the parent IC 342777 (5.314) exhibit negative gca effect for days to maturity. For days to maturity, one cross IC338586 × IC342777 (14.762) had recorded significant positive gca effects while out of two crosses the cross IC338586 × IC355856 (-12.667) exhibited significant negative effects for this trait.

The estimates of combining ability effects for biological yield/plant revealed that one parent IC 335858 (14.040) expressed the positive significant gca effects and the parent IC 355856 (21.912) showed significant negative gca effects for this trait. For positive significant gca effects, Out of three crosses, one cross IC342777 × IC339953 (52.216) had recorded significant positive gca effects while one cross IC339953 × IC355856 (48.987) exhibited significant negative gca effects for this trait.

The estimates of combining ability effects for harvest index revealed that one parent IC 355856 (2.768) expressed positive significant gca effects and the parent IC335858 (-2.378) exhibited significant negative gca effects for this trait. For positive significant gca effects, one cross IC339953 × IC355856 (9.757) had recorded significant positive gca effects while out of five crosses one cross IC338586 × IC355856 (8.059) exhibited significant negative gca effects for this traits.

The estimates of combining ability effects for test weight revealed that out of two, one parent IC 335858 (1.478) expressed positive significant gca effects whereas out of three the parent IC342777 (-0.920) exhibited significant negative gca effects for this trait. For positive significant gca effects, Out of ten crosses, one cross IC335858 × IC338586 (2.544) had recorded significant positive gca effects whereas out of two crosses the cross IC338586 × IC355856 (-2.159) exhibited significant negative gca effects for this traits. Similar results were also discussed by Singh et al. (2019a).

The estimates of combining ability effects for seed yield revealed that one parent IC338586 (-1.727) expressed significant gca effects whereas one parent IC355856 (-3.650) exhibited significant negative gca effects for this trait. reported significant GCA and
non-significant SCA effect for seed yield. Ram et al. 2018 and Inayat et al. 2019.

For positive significant sca effects, Out of ten crosses, one cross IC342777 × IC339953 (8.485) had recorded significant positive sca effects while out of two crosses one cross IC339953 × IC355856 (-6.644) exhibited significant negative sca effects for this traits.

**Conclusion**

On the basis of per se performance cross combination IC342777 × IC339953 found to be most promising for seed yieLD/plant. GCA effects revealed that IC335858 followed by IC355856 having significant and positive GCA effects was found to be the best combiner for most of the yield traits and on the basis of SCA, IC342777 × IC339953 and IC342777 × IC355856 was recorded best specific combination for most of the yield contributing traits. It may be concluded that IC355856 is a good general combiner and IC342777 × IC355856 is a best specific combination for higher yield.

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Table 1: Estimates for GCA effect for various character in Indian mustard.

| S.No. | Genotypes | Days to first flowering | Days to 50% flowering | No. of primary branches | No. of secondary branches | Plant height (cm) | No. of siliquae per plant | Siliqua length (cm) | No. of seeds/siliqua | Days to maturity | Biological yield / plant (g) | Harvest index (%) | Test weight (g) | Seed yield/plant (g) |
|-------|-----------|------------------------|-----------------------|------------------------|--------------------------|-------------------|--------------------------|-------------------|----------------------|----------------|------------------------|-------------------|----------------|----------------------|
| 1     | IC335858  | 2.876**                | 1.190                 | -0.081                 | -3.238*                  | -1.516            | -50.924**                | 0.233             | -0.662               | 1.352          | 14.040**               | -2.378**         | 1.478**        | 1.327                |
| 2     | IC338586  | -2.124**               | -3.000**              | 0.329                  | -0.124                   | -0.202            | -15.257                  | 0.145             | -0.233               | 2.981          | 5.737                  | -0.430            | -0.833**       | 1.727*               |
| 3     | IC342777  | -3.648**               | -0.810                | -0.124                 | 1.314                    | 6.722*            | -18.793                  | -0.184            | -0.052               | 5.314**        | 2.376                  | 0.505             | 0.920**        | 1.322                |
| 4     | IC339953  | 0.971                  | 0.619                 | -0.095                 | 2.210                    | 4.750             | 21.386                   | -0.044            | 0.562                | 1.495          | -0.241                 | -0.464            | -0.588*        | -0.726               |
| 5     | IC355856  | 1.924**                | 2.000**               | -0.029                 | -0.162                   | -9.754**          | 63.588**                 | -0.150            | 0.386                | 5.448**        | -21.912**               | 2.768**          | 0.862**        | -3.650**              |
|       | GI - Gj at 95% | 2.411**            | 2.718**               | 1.077**                | 6.672**                  | 12.065**          | 52.776**                 | 0.668             | 1.240**              | 7.153**       | 13.263**               | 2.443**          | 1.055**        | 3.300**               |
|       | GI - Gj at 99% | 3.998**            | -4.507**              | 1.786**                | 11.064**                 | 20.006**          | 87.516**                 | 11.108            | 2.056**              | 11.662**     | 21.994**               | 4.052**          | 1.750**        | 5.472**               |
| h2 narrow sense | 0.481          | 0.367                  | -0.092                | 0.053                  | 0.209                    | 0.475             | 0.027                    | 0.128             | 0.248               | 0.234         | 0.148                  | 0.401             | 0.263          |                     |
| h2 broad sense | 0.913          | 0.818                  | 0.398                  | 0.616                  | 0.783                    | 0.827             | 0.376                    | 0.681             | 0.800               | 0.944         | 0.935                  | 0.910             | 0.852          |                     |

*, ** significant at 5% and 1% level, respectively
Table 2: Estimates of SCA effects for various characters in Indian mustard.

| S.No. | Genotypes                  | Days to first flowering | No. of primary branches | No. of secondary branches | Plant height (cm) | No. of silique per plant | Silique length (cm) | No. of seeds/silique | Days to maturity | Biological yield/plant (g) | Harvest index (%) | Test weight (g) | Seed yield/plant (g) |
|-------|----------------------------|-------------------------|--------------------------|---------------------------|-------------------|--------------------------|---------------------|---------------------|-----------------|------------------------|------------------|------------------|---------------------|
| 1     | IC335858 × IC338586        | 2.825                   | -0.448                   | 0.505                     | 16.927*           | 39.964                  | 10.352              | 2.051*              | 1.095           | -7.427                 | 2.753            | 2.544**          | 1.461               |
| 2     | IC335858 × IC342777        | 5.349**                 | 1.171                    | 4.679                     | 5.137             | 68.500                  | 10.381              | -0.063              | -3.238          | 5.435                  | -1.566           | 2.121**          | -0.634              |
| 3     | IC335858 × IC339953        | 1.063                   | 1.343                    | 7.051                     | 9.308             | 45.321                  | 10.354              | -1.511              | 1.619           | -9.248                 | 4.960**          | 1.133            | 4.513*              |
| 4     | IC335858 × IC355856        | 5.111**                 | -0.590                   | -1.511                    | 20.946*           | -39.048                 | 10.786              | 0.365               | -4.333          | 5.699                  | -0.832           | 0.043            | 3.137               |
| 5     | IC338586 × IC342777        | 0.016                   | -0.238                   | -2.235                    | 9.956             | 4.333                   | 10.103              | 1.475               | 14.762**        | -11.733                | -2.813           | -0.611           | -5.134*             |
| 6     | IC338586 × IC339953        | 0.397                   | -0.600                   | -9.130*                   | 3.927             | 13.155                  | -10.237             | -1.640*             | -2.714          | 19.354*                | -3.951*          | -0.510           | 0.413               |
| 7     | IC338586 × IC355856        | 2.444                   | 1.333                    | 9.241*                    | -7.235            | -66.714                 | -10.965*            | 0.137               | -12.667*        | 43.055**                | -8.059**         | -2.159**         | 1.337               |
| 8     | IC342777 × IC339953        | -1.413                  | 0.186                    | 8.765*                    | 8.670             | -27.310                 | -10.176             | 0.179               | -4.381          | 52.216**                | -3.413*          | 0.344            | 8.485**             |
| 9     | IC342777 × IC355856        | -2.366                  | 0.452                    | 0.803                     | 8.841             | -90.262*                | 10.030              | -0.178              | -5.333          | 31.0896                | -4.998**         | -1.672*          | 4.742*              |
| 10    | IC339953 × IC355856        | -3.984                  | 0.757                    | -7.092                    | -7.187            | 67.810                  | -10.177             | -1.159              | -9.476*         | -48.987**               | 9.757**          | 1.343            | -6.644**            |
| Sij<0 at 95% | 3.208                  | 1.433                    | 8.878                     | 16.052                    | 70.218            | 10.889                  | 1.649               | 9.518               | 17.647          | 3.251                  | 1.404            | 4.390            |        |
| Sij>0 at 99% | 4.608                  | 2.059                    | 12.754                    | 23.060                    | 100.877           | 1.277                   | 2.369               | 13.673              | 25.352          | 4.670                  | 2.017            | 6.307            |        |

*, ** significant at 5% and 1% level, respectively