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# HETEROSIS STUDIES FOR SEED YIELD AND ITS COMPONENTS IN YELLOW *SARSON* (*BRASSICA RAPA* L.) UNDER TIMELY AND LATE SOWN CONDITIONS

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## ABSTRACT

The nature and magnitude of heterosis and their gene action were studied for yield and its contributing traits under 10 x 10 diallel fashion excluding reciprocals in timely ($E_1$) and late sown conditions ($E_2$). Highest heterosis over better parent observed for seed yield per plant for crosses Jagrati x NDYS 08-01 (25.19%) in timely sown condition and YST-151 x NDYS 425 (30.62%) in late sown condition and for oil content, Ragini x NDYS 07-02 (2.71%) in timely sown condition and NDYS 424 x Pusa Gold (2.41%) in late sown condition. Additionally, highest heterosis over standard variety for seed yield per plant is Ragini x NDYS 07-02 (115.77%) in timely sown condition and NDYS 427 x NDYS 08-01 (91.50%) in late sown condition and for oil content, Ragini x NDYS 07-02 (7.98%) in timely sown condition and Ragini x NDYS 07-02 (6.02%) in late sown condition.

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## INTRODUCTION

Oilseeds are important next to food grains in terms of area, production and value. Oilseed *Brassica* is commonly known as rapeseed-mustard and occupy an important position in the rainfed agriculture of our country because of low water requirement (80-240 mm), these crops fit well in rainfed cropping system. Rapeseed-mustard occupies a prominent place being next to groundnut and soybean in contribution to oilseed production (Kumar and Chauhan, 2005). Total production of rapeseed-mustard in India during 1978 was 1.6 m tonnes in an area of 3.54 m hectares which increased in 2010-11 by 7.67 m tonnes in an area of 6.51 m hectares with the productivity of about 1179 kg $ha^{-1}$. Rajasthan is leading state in production and accounting 2.95 (44.61%) million tones. Highest productivity of Rapeseed & Mustard is recorded in Haryana (1655kg $ha^{-1}$). Among rapeseed-mustard Indian rape varieties are endowed with higher oil content and early maturity but their productivity is comparatively low than mustard varieties.

Among the biometrical techniques, diallel analysis has been used extensively for deciphering nature of gene action and selection of suitable parents for hybridization. The information on genetic architecture of parents, extent of heterosis, transmissibility of characters and expected genetic advance will be of immense value to ascertain the selection of desirable parents in the choice of suitable breeding methodology for the improvement of Yellow *sarson* (*B. campestris*). The existence of significant amount of dominance variance is a pre-requisite for the exploitation of heterosis and the specific combining ability variances in the measure of dominance variance. If heterosis is very high for a specific cross and observations made are true for an economic character like yield, it is possible to utilize the cross as a commercial hybrid provided the pollination system of cross permits commercial seed production of the hybrids. The available reports indicate that there is a good reservoir of exploitable economic $F_1$ heterosis of more than 50 per cent in these crops (Dhillon *et al.*, 1990; and Kumar and Kumar, 1989). Heritability and genetic advance are also important selection parameters in predicting the gain under selection. Therefore, main objective to find out specific cross combination having high and stable heterotic value for commercial seed production from diverse genetic populations.

## MATERIALS AND METHODS

The material for present investigation comprised of ten parents of yellow *sarson* 45 $F'_1$s developed by crossing 10 diverse lines *viz*., YST151, Jagrati, NDYS 424, NDYS 425, Ragini, NDYS 427, NDYS 116-1, NDYS 08-01, NDYS 07-02 and Pusa Gold and their 45 $F'_1$s developed by crossing in all possible combinations excluding reciprocals. A total of 56 genotypes (45 $F_1$'s + 10 parents + 1 standard variety NDYS 2) were grown in randomized block design with three replications in two environments (timely sown and late sown) on 26th October ($E_1$) and 27th November ($E_2$), respectively at Research Farm of Department of Genetics & Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during *rabi*, 2010-11. Each entry was sown in a single row of 5 m length with inter and intra-row spacing of 45 cm and 10 cm, respectively. The distance between plant to plant was maintained by thinning after 15 days of flowering. All recommended agronomical practices and plant protection measures were adopted for raising the good crop. Observations were recorded on five randomly selected plants in each replication for every entry for all the characters except days to 50 percent flowering and days to maturity where, the observations were recorded on the plot basis. The mean of each plot was used for statistical analysis.

## RESULTS AND DISCUSSION

The ANOVA for design of experiment of diallel crosses revealed significant differences for all the characters in both timely sown and late sown conditions (table 1) (Kumar *et al.,* 2013, and Kumar *et al.,* 2014). Genetic analysis showed that additive and non-additive gene effects were predominant for yield and its contributing traits. Thus, improvement of such characters should be based on the simultaneous exploitation of both additive as well as non-additive components of genetic variance. The presence of higher magnitude of dominance component also suggests the possibility of improving yield and its components by heterosis breeding.

In general, considerable amount of heterosis over better parent was observed for all the characters under study. Highest heterosis over better parent for days to 50% flowering was found in cross NDYS 116-1 x Pusa Gold (-4.84%) in Timely sown condition and NDYS 427 x NDYS 116-1 (-1.11%) in late sown condition; for days to maturity NDYS 424 x NDYS 07-02 (-4.79%) in timely sown condition and Ragini x Pusa Gold (-5.69%) in late sown condition; for plant height YST-151 x NDYS 425 (3.69%) in timely sown condition and Ragini x NDYS 427 (8.16%) in late sown condition; for primary branches per plant Ragini x NDYS 07-02 (9.95) in timely sown condition and NDYS 424 x NDYS 425 (13.54%) in late sown condition; for length of fruiting zone YST-151 x NDYS 08-01 (2.50%) in timely sown condition and YST-151 x Jagrati (3.89%) in late sown condition; number of siliqua on main raceme YST-151 x Jagrati (6.07%) in timely sown condition and NDYS 427 x NDYS 08-01 (21.59%) in late sown condition; for seeds per siliqua YST-151 x Jagrati (3.14%) in timely sown condition and YST-151 x NDYS 425 (14.80%) in late sown condition; for 1000-seed weight Jagrati x Ragini (21.23%) in timely sown condition and NDYS 424 x NDYS 07-02 (14.08%) in late sown condition; for biological yield per plant YST-151 x NDYS 427 (35.69%) in timely sown condition and NDYS 116-1 x NDYS 07-02 (50.11%) in late sown condition; for seed yield per plant Jagrati x NDYS 08-01 (25.19%) in timely sown condition and YST-151 x NDYS 425 (30.62%) in late sown condition; for harvest index YST-151 x Jagrati (21.90%) in timely sown condition and YST-151 x Jagrati (36.89%) in late sown condition; for oil content Ragini x NDYS 07-02 (2.71%) in timely sown condition and NDYS 424 x Pusa Gold (2.41%) in late sown condition.

Maximum heterosis over standard variety was observed for all the characters under study. Highest heterosis over standard variety for days to 50% flowering cross Ragini x NDYS 116-1 (-5.69%) in timely sown condition and Ragini x NDYS 116-1 (-8.29%) in late sown condition; for days to maturity Jagrati x NDYS 07-02 (-5.38%) in timely sown condition and Ragini x Pusa Gold (-6.35%) in late sown condition; for plant height YST-151 x NDYS 425 (18.84%) in timely sown condition and YST-151 x NDYS 425 (21.05%) in late sown condition; for primary branches per plant Ragini x NDYS 07-02 (31.55%) in timely sown condition and Ragini x NDYS 427 (38.56%) in late sown condition; for length of fruiting zone length YST-151 x NDYS 427 (28.83%) in timely sown condition and YST-151 x Jagrati (23.99%) in late sown condition; number of siliquae on main raceme YST-151 x Jagrati (46.13%) in timely sown condition and NDYS 427 x NDYS 08-01 (40.48%) in late sown condition; for seeds/siliqua NDYS 424 x Ragini (28.13%) in timely sown condition and NDYS 424 x Ragini (36.45%) in late sown condition; for 1000-seed weight Jagrati x Ragini (44.37%) in timely sown condition and NDYS 424 x Pusa Gold (46.79%) in late sown condition; for biological yield per plant NDYS 427 x NDYS 116-1 (65.77%) in timely sown condition and NDYS 424 x NDYS 08-01 (71.85%) in late sown condition; for seed yield per plant Ragini x NDYS 07-02 (115.77%) in timely sown condition and NDYS 427 x NDYS 08-01 (91.50%) in late sown condition; for harvest index Ragini x NDYS 07-02 (71.83%) in timely sown condition and

**Table 1: ANOVA for set of 10 x 10 diallel crosses in yellow *sarson* under timely sown and late sown conditions involving parents and $F_1$s**

| Charactersd.f. | Replications | | Treatments | | Error | |
|---|---|---|---|---|---|---|
| | 2 | | 55 | | 110 | |
| | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ |
| Days to 50% flowering | 2.86 | 1.08 | 27.80** | 9.16** | 1.27 | 1.04 |
| Days to maturity | 2.30 | 1.20 | 20.63** | 46.54** | 2.73 | 4.70 |
| Plant height (cm) | 3.33 | 11.32 | 217.85** | 190.29** | 4.89 | 4.54 |
| No. of primary branches per plant | 0.04 | 0.07 | 1.14** | 1.29** | 0.19 | 0.19 |
| Length of fruiting zone | 8.11 | 13.51 | 54.70** | 61.05** | 3.93 | 4.99 |
| No. of siliquae on main raceme | 7.23 | 0.47 | 35.84** | 29.22** | 3.57 | 3.57 |
| No. of seeds per siliqua | 3.79 | 1.25 | 37.91** | 36.78** | 2.57 | 2.56 |
| 1000-seed weight (g) | 0.18* | 0.16 | 0.38** | 0.43** | 0.05 | 0.07 |
| Biological yield per plant (g) | 13.50 | 2.61 | 160.17** | 177.07** | 5.63 | 5.63 |
| Seed yield per plant (g) | 0.91 | 0.23 | 24.10** | 20.69** | 0.73 | 0.93 |
| Harvest index (%) | 2.64 | 9.80 | 107.26** | 116.25** | 3.09 | 3.39 |
| Oil content (%) | 0.002 | 0.04 | 1.24** | 1.88** | 0.02 | 0.01 |

*, ** significant at 5% & 1% probability levels, respectively.

**Table 2: Estimates of heterosis (%) over better parent and standard variety in a set of 10 x 10 diallel crosses of yellow *sarson* under timely sown and late sown conditions**

| Characters | Crosses | BP | | Crosses | SV | |
|---|---|---|---|---|---|---|
| | | $E_1$ | $E_2$ | | $E_1$ | $E_2$ |
| Days to 50% flowering | NDYS 116-1 X Pusa Gold | -4.84% | - | Ragini X NDYS 116-1 | -5.69% | - |
| | NDYS 427 X NDYS 116-1 | - | -1.11% | Ragini X NDYS 116-1 | - | (-8.29%) |
| Days to maturity | NDYS 424 X NDYS 07-02 | -4.79% | - | Jagrati X NDYS 07-02 | -5.38% | - |
| | Ragini X Pusa Gold | - | -5.69% | Ragini X Pusa Gold | - | -6.35% |
| Plant height | YST-151 X NDYS 425 | 3.69% | - | YST-151 X NDYS 425 | 18.84% | - |
| | Ragini X NDYS 427 | - | 8.16% | YST-151 X NDYS 425 | - | 21.05% |
| Pri. branches per plant | Ragini X NDYS 07-02 | 9.95 | - | Ragini X NDYS 07-02 | 31.55% | - |
| | NDYS 424 X NDYS 425 | - | 13.54% | Ragini X NDYS 427 | - | 38.56% |
| Length of fruiting zone | YST-151 X NDYS 08-01 | 2.50% | - | YST-151 X NDYS 427 | 28.83% | - |
| | YST-151 X Jagrati | - | 3.89%) | YST-151 X Jagrati | - | 23.99% |
| No. sili. main raceme | YST-151 X Jagrati | 6.07% | - | YST-151 X Jagrati | 46.13% | - |
| | NDYS 427 X NDYS 08-01 | | 21.59% | NDYS 427 X NDYS 08-01 | - | 40.48% |
| Seeds per siliqua | YST-151 X Jagrati | 3.14% | - | NDYS 424 X Ragini | 28.13% | - |
| | YST-151 X NDYS 425 | - | 14.80%) | NDYS 424 X Ragini | - | 36.45% |
| 1000-seed weight | Jagrati X Ragini | 21.23% | - | Jagrati X Ragini | 44.37% | - |
| | NDYS 424 X NDYS 07-02 | - | 14.08% | NDYS 424 X Pusa Gold | - | 46.79% |
| Bio. yield per plant | YST-151 X NDYS 427 | 35.69% | - | NDYS 427 X NDYS 116-1 | 65.77% | - |
| | NDYS 116-1 X NDYS 07-02 | - | 50.11% | NDYS 424 X NDYS 08-01 | - | 71.85% |
| Seed yield per plant | Jagrati X NDYS 08-01 | 25.19% | - | Ragini X NDYS 07-02 | 115.77% | - |
| | YST-151 X NDYS 425 | - | 30.62% | NDYS 427 X NDYS 08-01 | - | 91.50% |
| Harvest index | YST-151 X Jagrati | 21.90% | - | Ragini X NDYS 07-02 | 71.83% | - |
| | YST-151 X Jagrati | - | 36.89% | YST-151 X Jagrati | - | 61.13% |
| Oil content | Ragini X NDYS 07-02 | 2.71% | - | Ragini X NDYS 07-02 | 7.98%) | - |
| | NDYS 424 X Pusa Gold | - | 2.41% | Ragini X NDYS 07-02 | - | 6.02% |

YST-151 x Jagrati (61.13%) in late sown condition; for oil content Ragini x NDYS 07-02 (7.98%) in timely sown condition and Ragini x NDYS 07-02 (6.02%) in late sown condition.

Early flowering and maturity in *Brassica* genotypes is preferred over late flowering/ maturing genotypes because earliness of these traits might certainly help to get early maturing lines that could not only tolerate or escape heat stress but could also provide sufficient time for the cultivation of next crop. In addition it would helps to reduce losses occurred due to shattering that would ultimately enhance yields. Keeping in view the importance of early flowering and maturity emphasis was focused on negative heterosis for these characteristics. In the present investigation, negative heterotic values for these traits were noted for majority of the crosses. Crosses showing significant negative values suggested that these crosses could be used to develop new early maturing lines. Earlier findings of Turi *et al.* (2006) verified the results of this study. They reported significant negative mid-parent and better-parent heterosis for flowering and maturity in *Brassica juncea* genotypes. Since, number of primary branches plant$^{-1}$ is one of the major yield contributing trait hence more primary branches plant$^{-1}$ are desirable, therefore positive values are preferred. The presence of significantly positive heterosis for primary branches plant$^{-1}$ in crosses indicates the potential of their use for developing high yielding genotypes. The presence of high level of mid and high-parent heterosis indicates a considerable potential to embark on breeding of hybrid cultivars in *Brassica rapa*. The results of this study are similar to earlier findings of Turi *et al*. (2006) who reported significant positive heterosis for number of branches plant$^{-1}$ in *Brassica napus* genotypes.

**Heritability and genetic advance**

The important function of the heritability is in its predictive role, expressing the reliability of the phenotypic value as the guide to breeding value. Only the phenotypic values of individuals can be directly measured but, it is the breeding value that determines their influence on to the parent according to their phenotypic values, his success in changing the characteristic of the population can be predicted only from knowledge of the degree of correspondence between phenotypic values and breeding values. This degree at correspondence is measured by heritability, as the following considerations will show. The heritability in narrow sense is defined as the ratio of additive genetic variance to phenotypic variance.

The result of present investigation revealed the high heritability estimates in narrow sense were recorded for days to 50% flowering, plant height, primary branches per plant, fruiting zone, siliquae on main raceme, seed per siliqua, seed yield per plant and oil content in both timely and late sown conditions, respectively, and days to maturity in timely sown condition; moderate heritability was observed for 1000-seed weight, biological yield per plant, harvest index in both timely and late sown condition; days to maturity in late sown condition. The results are in conformity with Singh *et al.* (2004); Ghosh and Gulati (2002); and Pant and Singh (2001) for seed yield/plant.

Expected genetic advance in per cent of mean was found to be high for harvest index, seed yield and biological yield per plant in both timely and late sown conditions; moderate for primary branches per plant, seeds per siliqua in both timely and late sown conditions; plant height, number of siliquae on main raceme in timely sown condition; fruiting zone length in late sown condition; while low genetic advance was recorded for days to 50% flowering, days to maturity, oil content, 1000 seed weight in both timely and late sown conditions; fruiting zone length in timely sown condition, plant height, siliquae on main raceme in late sown condition.

High heritability coupled with high genetic advance was observed for seed yield plant$^{-1}$ in both timely and late sown conditions. Moderate heritability along with high genetic advance was observed for biological yield plant$^{-1}$ in both environments. Remaining traits in one or both environments showed moderate heritability in narrow sense coupled with low genetic advance in per cent of mean. Singh & Mishra (2001), Ali *et al*. (2002) and Singh *et al*. (2003) also reported such type of findings.

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