

Heterosis Study for Yield and Oil Content in Sunflower

Y.V. Deshmukh¹, C.B. Salunke¹ and S.V. Bhosale¹

Abstract: The present investigation was undertaken at Post Graduate Intuitional farm Department of Botany Mahatma Phule Krishi Vidyapeeth, Rahuri. A field experiment was conducted during Rabi-2015 with a view to know the direction and magnitude of heterosis in sunflower. Three male sterile lines (SVSAL-1, SVSAL-2, SVSAL-3) and fifteen restorers (SVSR 1- 15) along with standard checks (Phule Raviraj, SVSH-475) were obtained from the Agricultural Research Station, Savali Vihir Farm (MPKV Rahuri), Kopergaon, Dist. Ahmednagar (M.S.). Forty five hybrids were sown along with parents and standard check viz; Phule Raviraj, SVSH-475 in December 2015. An appreciable amount of heterosis was found for almost all the characters. The magnitude of heterosis was high for total number of seed per head, number of filled seeds per head, seed yield per plant, head diameter, 100 seed weight, stem girth, plant height at maturity and per cent oil content. The hybrid SVSAL-1 x SVSR-7 (202.57%) showed highest standard heterosis for total number seed per head and hybrid SVSAL-1 x SVSR-9 (33.57%) showed highest standard heterosis for the characters like seed yield per plant over superior check

Keywords: Sunflower, heterosis, oil content, yield

INTRODUCTION

Sunflower (*Helianthus annuus*) is an important oilseed crop belong to the family Asteraceae, tribe Heliantheae, sub tribe Helianthae which includes 20 genera. Extensive use of sunflower as a source of edible oil began in 1830 after the crop reached to Russia. Sunflower has tremendous scope in Maharashtra and particularly in dry land areas. In order to boost the production of oil seeds and considering the advantages, this crop was introduced in India during 1916, but not given more emphasis because of low oil content and high susceptibility to viral diseases. It contains about 42 to 46 per cent of oil. The oil has a good flavor, colour and good quality from health point of view, due to high concentration of polyunsaturated fatty acids (55 to 60% linoleic acid, 25 to 30% oleic acid), which are known to reduce the risk of coronary disease by reducing the cholesterol in blood plasma. Oil also contains proteins and A, D, and E vitamins, and is used for culinary, salad, preparation of vanspati

ghee, manufacture of soaps and in cosmetics. Moreover, oil has excellent nutritional properties, particularly free from toxic compounds. Sunflower cake is rich in protein and used for cattle and poultry feed.

The success of heterosis breeding depends upon amount of variability present in breeding material under investigation. Since genetic diversity correlated to the amount of vigour expressed, heterosis breeding is used for substantial augmentation of yield. The first step in heterosis breeding is to identify and isolate the lines with high combining ability from available sources of germplasm. The present study was therefore, undertaken with following objective to study heterosis for yield and oil content in sunflower.

MATERIAL AND METHODS

Three male sterile lines (SVSAL-1, SVSAL-2, SVSAL-3) and fifteen restorers (SVSR 1- 15) along

¹ Department of Agricultural Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri-411722 Maharashtra (India) E-mail : sushantgpb@gmail.com

with standard checks (Phule Raviraj, SVSH-475) were obtained from the Agricultural Research Station, SavaliVihir Farm (MPKV Rahuri), Kopergaon, Dist. Ahmednagar (M.S.). The seed material was planted at Post Graduate Institute Farm, Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Kharif* 2015 in order to produce crosses in line x tester fashion. Forty five hybrids were sown along with parents and standard check viz; Phule Raviraj, SVSH-475 in December 2015.

OBSERVATIONS RECORDED

Five random competitive plants from each treatment of each replication were selected for recording the

observations averages were worked out for statistical analysis.

RESULTS AND DISCUSSION

Heterosis

Analysis of variance for line x tester analysis

From the ANOVA, it is revealed that mean sum of square due to female was significant for all the characters except for Seed filling percentage.

The variance due to females v/s males interaction was significant for all the characters except days to 50 per cent flowering and head diameter. The mean sum of square due to crosses and male were significant for all character.

Table 1
Analysis of variance for line x tester design for 11 characters in sunflower

| Sr. No. | Source of variation | DF | Days of 50% flowering | Days to maturity | Plant height at maturity (cm) | Stem girth at base (cm) | Head Diameter (cm) | Total No. of seeds/head | Number of filled seeds/head | Seed filling percentage | 100 seed weight (g) | Percent oil content | Seed yield per plant (g) |
|---------|---------------------|----|-----------------------|------------------|-------------------------------|-------------------------|--------------------|-------------------------|-----------------------------|-------------------------|---------------------|---------------------|--------------------------|
| 1. | Replications | 1 | 1.06 | 0.01 | 10.41 | 0.10 | 0.79 | 322.01 | 1215 | 3.96 | 0.02 | 0.01 | 6.52 |
| 2. | Females | 2 | 143.033** | 82.878** | 2653.168** | 0.278** | 24.622** | 176360.7 | 101634.7 | 11.072 | 13.204** | 89.071** | 879.719** |
| 3. | Males | 14 | 10.019** | 9.425** | 434.778** | 0.037 | 3.926** | 231144.9* | 109010.90* | 11.064 | 1.751* | 3.201 | 189.668 |
| 4. | Females V/s males | 1 | 1.474 | 2.140* | 132.185** | 0.034** | 1.117 | 83617.6** | 42551.6** | 11.611** | 0.789** | 2.031** | 95.018** |
| 5. | Crosses | 44 | 10.627** | 8.128** | 343.055** | 0.046** | 3.079* | 134773.70** | 66383.06** | 11.413** | 1.660** | 6.359** | 160.802** |
| 6. | Error | 44 | 1.223 | 1.079 | 15.236 | 0.00 | 1.613 | 4508.877 | 2283.418 | 0.036 | 0.345 | 0.469 | 29.725 |

* Significant at 5 % level of probability or level of significance

** Significant at 1 % level of probability or level of significance

Estimates of Components of Heterosis

The range of heterosis over mid parent, better parent and standard checks is given in Table 2.

Days to 50 per cent flowering

Negative heterosis for this trait indicates earliness, hence were considered as desirable.

Out of 45, 42 hybrids showed negative heterosis. Among these hybrids higher values were recorded in the combinations, (SVSAL-2 X SVSR-8) -12.14 % followed by (SVSAL-2 X SVSR-12) -9.89 % and (SVSAL-1 X SVSR-8), (SVSAL-2 X SVSR-1) and (SVSAL-2 X SVSR-4) -9.29 %.

The range of heterobeltiosis, Out of 45, 40 hybrids showed negative heterobeltiosis. Among the hybrid, higher heterobeltiosis were recorded by the hybrids (SVSAL-2 X SVSR-8) -13.99 % followed by (SVSAL-1 X SVSR-15) -11.56 %, (SVSAL-1 X SVSR-8) and (SVSAL-2 X SVSR-4) -11.19 % and (SVSAL-2 X SVSR-2) and (SVSAL-2 X SVSR-12) -10.22 %.

Useful heterosis, 43 hybrids showed negative standard heterosis of which 38 were significantly higher than check Phule Raviraj.

The useful heterosis was ranged from (SVSAL-3 X SVSR-3) 9.23 % to (SVSAL-2 X SVSR-2) -5.38 %. Fourteen hybrids showed negative standard

Table 2
Range of heterosis over mid parent, better parent and standard check

| Sr. Character No. | Percent range of heterosis over | | | |
|------------------------------------|---------------------------------|------------------|-----------------|-----------------|
| | MP | BP | SC-I | SC-II |
| 1. Days to 50 per cent flowering | 2.90 to -12.14 | -0.72 to -13.99 | 0.71 to -12.77 | 9.23 to -5.38 |
| 2. Days to maturity | 0.28 to -7.69 | -1.09 to -10.16 | 0.55 to -8.74 | 30.37 to -6.18 |
| 3. Plant height at maturity (cm) | 18.50 to 64.26 | -4.38 to 55.37 | -19.40 to 16.86 | -23.85 to 10.20 |
| 4. Head diameter (cm) | 13.88 to 109.70 | 7.56 to 100.00 | -17.12 to 23.63 | -27.11 to 8.73 |
| 5. Stem girth (cm) | 3.62 to 75.64 | -3.80 to 68.44 | -26.29 to 11.38 | -24.44 to 14.17 |
| 6. Total number of seeds per head | 33.40 to 280.78 | 24.21 to 264.31 | -48.95 to 27.76 | -55.68 to 10.93 |
| 7. Number of filled seeds per head | 37.34 to 311.74 | 30.64 to 284.84 | -48.98 to 14.57 | -55.71 to 14.57 |
| 8. Seed filling percentage | -2.37 to 15.02 | -6.25 to 13.54 | -7.36 to 6.83 | -8.16 to 5.90 |
| 9. Hundred seed weight (g) | -4.03 to 156.30 | -20.78 to 139.72 | -8.89 to 96.29 | -15.19 to 82.72 |
| 10. Per cent oil content | -3.23 to 26.81 | -5.28 to 21.92 | -9.54 to 13.40 | -13.81 to 8.06 |
| 11. Seed yield per plant (g) | 67.05 to 354.13 | 28.71 to 280.80 | -42.14 to 39.11 | -44.44 to 33.57 |

heterosis of which five are significant over check SVSH-475.

Days to maturity

Negative heterosis desirable for this trait as it indicates earliness.

Average heterosis, Out of 45 under evaluation, 44 hybrids showed negative heterosis effects of which 31 showed significant negative heterosis, the rest being non-significant.

The heterobeltiosis, all hybrids showed negative heterobeltiosis effects, of which thirty-nine were significant.

Standard heterosis, Out of 45, 42 hybrids, showed negative useful heterosis over check Phule Raviraj of which twenty-six were found significant.

Useful heterosis, Out of 45, 23 hybrids, showed negative useful heterosis over check SVSH-475 and six were found significant.

Plant height at maturity

All hybrids showed significant positive heterosis. The hybrid showed higher heterosis for this trait were (SVSAL-1 X SVSR-13) (64.26%), (SVSAL-1 X SVSR-10) (54.37 %) and (SVSAL-2 X SVSR-10) (53.12 %).

Heterosis for better parent was found to be between (SVSAL-1 X SVSR-3) -4.38 % to (SVSAL-1

X SVSR-13) 55.37 %. Out of 45, 40 hybrids showed significantly positive heterosis.

Useful heterosis was found to be between (SVSAL-1 X SVSR-1) -19.40 % to (SVSAL-3 X SVSR-3) 16.86 %. Out of 45, 13 hybrids showed positive heterosis over check Phule Raviraj in which 5 found significant.

Standard heterosis was ranged from (SVSAL-1 X SVSR-1) -23.85 % to (SVSAL-3 X SVSR-3) 10.20 %. Out of 45, 3 hybrids showed positive over the check SVSH-475 in which one found significant.

Stem girth

Heterosis ranged from (SVSAL-2 X SVSR-2) 3.62 % to (SVSAL-1 X SVSR-3) 75.64 %. Out of 45 hybrids, 43 showed positive significant heterosis for the stem girth.

The hybrids showed higher heterobeltiosis were (SVSAL-1 X SVSR-1) (58.78 %), (SVSAL-1 X SVSR-3) (45.14 %) and (SVSAL-1 X SVSR-2) (37.36 %).

The range of heterosis over check SVSH-475 from (SVSAL-2 X SVSR-2) -25.28 % to (SVSAL-1 X SVSR-3) (16.11 %). Four hybrids showed positive heterosis of which three were significant over check.

Head diameter

The range of heterosis for head diameter was from (SVSAL-2 X SVSR-8) 13.88 % to (SVSAL-1 X SVSR-

2) 109.70 %. All hybrids exhibited positive heterosis of which 44 were found significantly superior over mid parent.

The range of heterobeltosis was from (SVSAL-2 X SVSR-8) 7.56 % to (SVSAL-1 X SVSR-2) (100 %). Out of 45, all hybrids exhibited positive heterobeltosis of which 41 showed significant values.

Heterosis over standard check Phule Raviraj was from (SVSAL-2 X SVSR-8) -17.12 % to (SVSAL-1 X SVSR-3) 23.63 %. Out of 45, 26 hybrids showed positive heterosis of which 4 were significantly positive.

Useful heterosis over standard check SVSH-475 was from (SVSAL-2 X SVSR-3) -27.11 % to (SVSAL-1 X SVSR-3) 8.73 %. Out of 45 hybrids 4 hybrids exhibited positive heterosis.

Total number of seeds per head

All hybrids showed significantly positive heterosis. The combinations showed higher heterosis were (SVSAL-3 X SVSR-5) (280.78 %) followed by (SVSAL-1 X SVSR-7) (255.97) and (SVSAL-3 X SVSR-14) (195.58 %).

The range of better parent heterobeltosis was from (SVSAL-2 X SVSR-12) 24.21 % to (SVSAL-3 X SVSR-5) 264.31 %. Out of 45, all hybrids showed positive heterosis of which forty-four hybrids were significant.

Useful Heterosis over check Phule Raviraj was between (SVSAL-2 X SVSR-12) -48.95 % to (SVSAL-1 X SVSR-7) 27.76 %. 10 hybrids showed positive heterosis and 8 found significant.

Heterosis over standard check SVSH-475 was between (SVSAL-2 X SVSR-12) -55.68 % to (SVSAL-1 X SVSR-7) 10.93 %.

Number of filled seeds per head

Heterosis over mid parent was ranged from (SVSAL-2 X SVSR-9) 37.34 % to (SVSAL-3 X SVSR-5) 311.74 %. All hybrids exhibited significant positive heterosis.

Heterobeltiosis ranged from (SVSAL-2 X SVSR-9) 30.64 % to (SVSAL-3 X SVSR-5) 284.84 %. All hybrids showed significant positive heterosis.

The range of useful heterosis over check Phule Raviraj was from (SVSAL-2 X SVSR-12) -48.98 % to (SVSAL-3 X SVSR-5) 31.96 %. 11 hybrids exhibited positive heterosis and 8 found significant.

The range of standard heterosis over check SVSH-475 was between (SVSAL-2 X SVSR-12) -55.71 % to (SVSAL-3 X SVSR-5) 14.57 %. 8 hybrids exhibited significantly positive heterosis.

Seed filling percentage

Heterosis over mid parent was between (SVSAL-1 X SVSR-13) -2.37 % to (SVSAL-1 X SVSR-4) 15.02 %. Out of 45, 41 hybrids showed positive heterosis of which forty found significant.

The range of heterobeltiosis was from (SVSAL-1 X SVSR-13) -6.25 % to (SVSAL-1 X SVSR-4) 13.54 %. Out of 45, 27 hybrids exhibited positive heterosis of which twenty-six showed significance.

Heterosis over standard check Phule Raviraj was between (SVSAL-2 X SVSR-6) -7.36 % to (SVSAL-1 X SVSR-4) 6.83 %. 16 hybrids showed positive heterosis in which thirteen were found significant.

The range of useful heterosis over check SVSH-475 was between (SVSAL-2 X SVSR-6) -8.16 % to (SVSAL-1 X SVSR-4) 5.90 %. 13 hybrids found positive heterosis in which eleven were significant.

100 seed weight

Heterosis ranged between (SVSAL-3 X SVSR-7) -4.03 % to (SVSAL-1 X SVSR-8) 156.30 % followed by (SVSAL-1 X SVSR-4) 147.28 % showed higher significant heterosis for this character. Out of 45, 37 hybrids showed significant positive heterosis.

Heterobeltiosis ranged from (SVSAL-3 X SVSR-7) -20.78 % to (SVSAL-1 X SVSR-8) 139.72 %. Forty-four hybrids exhibited positive heterobeltiosis and thirty-one were found significant.

The range useful heterosis over check Phule Raviraj was between (SVSAL-2 X SVSR-6) -8.89 % to (SVSAL-1 X SVSR-4) 96.29 %. Out of 45, 38 hybrids showed positive heterosis and twenty-one were significant.

Standard heterosis over check SVSH-475 was in the range from (SVSAL-2 X SVSR-6) -15.19 % to (SVSAL-1 X SVSR-4) 82.72 %. Out of 45 hybrids, 19 showed significantly positive heterosis.

Per cent oil content

Heterosis for percent oil content was ranged from (SVSAL-1 X SVSR-11) -3.23 % to (SVSAL-3 X SVSR-13) 26.81 %. 39 hybrids showed positive heterosis of which 36 were significant. The crosses (SVSAL-3 X SVSR-13) (26.81 %) followed by (SVSAL-2 X SVSR-13) (24.89 %) and (SVSAL-3 X SVSR-14) (23.72 %) showed high heterosis for percent oil content.

Heterosis for better parent was in the range of (SVSAL-1 X SVSR-11) -5.28 % to (SVSAL-3 X SVSR-13) (21.92 %). Thirty-three hybrids showed positive heterosis over better parent for oil content in which it was significant in twenty-three hybrids.

Standard heterosis was over check Phule Raviraj in the range from (SVSAL-1 X SVSR-3) -9.54 % to (SVSAL-2 X SVSR-12) 13.40 %. Out of 45, 22 hybrids showed positive heterosis of which 11 were significant.

Useful heterosis over check SVSH-475 was in the range between (SVSAL-1 X SVSR-3) -13.81 % to (SVSAL-2 X SVSR-12) 8.06 %. Out of 45 hybrids, 7 showed positive heterosis.

Seed yield per plant

Heterosis over mid parent was in the range from (SVSAL-3 X SVSR-6) 67.05 % to (SVSAL-2 X SVSR-10) 354.13 % followed by (SVSAL-3 X SVSR-10) 337.04 % and (SVSAL-3 X SVSR-5) 301.60 % showed very high magnitude of heterosis for seed yield per plant. All hybrids showed significant positive heterosis.

Heterosis for better parent was in the range from (SVSAL-3 X SVSR-6) 28.71 % to (SVSAL-3 X SVSR-2) 280.80 %. Out of 45, 44 crosses showed significantly positive heterosis. The hybrids (SVSAL-3 X SVSR-1) and (SVSAL-3 X SVSR-2) (280.80 %) and (SVSAL-3 X SVSR-5) (277.53 %) showed more than 250 % of heterobeltiosis for seed yield per plant.

Useful heterosis over check Phule Raviraj was in the range between (SVSAL-2 X SVSR-12) -42.14

% to (SVSAL-1 X SVSR-7) 39.11 %. Out of 45 hybrids, 7 showed significant positive heterosis for this trait.

Standard heterosis over check SVSH-475 was ranged between (SVSAL-2 X SVSR-12) -44.44 % to (SVSAL-1 X SVSR-9) 33.57 %. Out of 45 hybrids, 21 showed positive heterosis of which 5 were significant.

In the present study considerable amount of heterosis, heterobeltiosis and standard heterosis were observed for almost all the characters.

Percent oil content

Good amount of heterosis for per cent oil content was observed in the present study. Thirty-nine hybrids exhibited positive heterosis over the mid parent of which thirty-six were significant. The cross SVSAL-3 X SVSR-13 (37.88 %) expressed high significant heterosis over mid parents.

The cross SVSAL-3 X SVSR-13 (21.92%) showed high significant heterosis over superior parent. Heterobeltiosis for oil content was in the range of -5.28% to 21.92%. Naware (1999) reported the highest heterobeltiosis to the extent of 32.73 per cent. Lande *et al.* (1998), Nehru *et al.* (2000) and Dhude (2004) noted highest heterosis and heterobeltiosis for oil content.

Twenty-two hybrids showed positive useful heterosis over superior check Phule Raviraj among which eleven were significant. Varied amount of heterosis for oil content was reported by Gangappa *et al* (1997a).

Seed yield per plant

Heterosis over the mid parent ranged from 67.05% to 354.13%. All hybrids showed significant positive heterosis. Very high magnitude of average heterosis and heterobeltiosis was noticed in the hybrid in the present study. The range of heterobeltiosis was from 28.71 per cent to 280.80 per cent. The hybrids SVSAL-3 X SVSR-1 and SVSAL-3 X SVSR-2 (280.80 %), and SVSAL-3 X SVSR-5 (277.53 %) showed very high magnitude of positive heterosis over superior parent.

High degree of heterosis (more than 100 %) for seed yield was reported by Limbore *et al* (1998) and Lande

et al (1998) in sunflower. Seven hybrids showed positive significant useful heterosis over superior check Phule Raviraj.

Naware (1999) noticed highest standard heterosis to the extent of 85.63 per cent in the hybrid 302 A x SS-56.

CONCLUSION

An appreciable amount of heterosis was found for almost all the characters. The magnitude of heterosis was high for total number of seed per head, number of filled seeds per head, seed yield per plant, head diameter, 100 seed weight, stem girth, plant height at maturity and per cent oil content. The cross combinations SVSAL-2 x SVSR-8 (-13.99%) for days to 50 per cent flowering, SVSAL-2 x SVSR-4 (-10.47%) for days to maturity, SVSAL-1 x SVSR-13 (55.37%) for plant height at maturity, SVSAL-1 x SVSR-3 (68.44%) for stem girth, SVSAL-1 x SVSR-2 (100.00%) for head diameter, SVSAL-3 x SVSR-5 (264.31%) for total number of seeds per head and (284.84%) number of filled seeds per head, SVSAL-1 x SVSR-4 (13.54%) for seed filling percentage, SVSAL-1 x SVSR-8 (139.72%) for 100 seed weight, SVSAL-3 x SVSR-13 (21.92%) for oil content and SVSAL-3 x SVSR-2 (280.80%) for seed yield per plant

showed highest values of heterosis over their better parents.

The hybrid SVSAL-1 x SVSR-7 (202.57%) showed highest standard heterosis for total number seed per head and hybrid SVSAL-1 x SVSR-9 (33.57%) showed highest standard heterosis for the characters like seed yield per plant over superior check.

References

- Dudhe, M. Y., (2004), Diallel analysis of Restorer lines in sunflower (*Helianthus annuus* L.) (Unpub). Dr .PDKV, Akola.
- Gangappa, E., Channa Krishnaiah, K. M., Ramesh, S and Harini, H. S., (1997a), Exploitation of heterosis in sunflower (*Helianthus annuus* L.) Crop Res. 13 (2) : 339-248.
- Lande, S. S., Narkhede, M. N., Weginwar, D. G., Patel, M. C and Golhar, S. R., (1998), Heterotic studies in sunflower Ann. Plant. Physiol. 12 (1): 15-18
- Limbore, A. R., Weginwar, D. B., Lande, S. S., Gite, B. D and Ghodke, K. M., (1998), Heterosis in sunflower Ann. Plant Physiol. 12 (1): 38-42.
- Naware, M. S., (1999), Genetic analysis of some quantitative traits in sunflower. Thesis submitted to M.P.K.V., Rahuri (M.S).
- Nehru, S. D., Majunath, A., Basavarajaiah, D., (2000), Extent of heterosis for seed yield and oil content in sunflower. Karnataka J. Agric. Sci. 13 (3): 718-720.