**Journal of Global Biosciences**
**ISSN 2320-1355**
**Volume 4, Special Issue 1, 2015, pp. 1902-1909**
**Website: www.mutagens.co.in**
**E-mail: submit@mutagens.co.in**
**researchsubmission@hotmail.com**

***Research Paper***

# COMBINING ABILITY STUDIES IN GRAIN *SORGHUM*

Vitthal Ramdas Patil[1] and Nandkumar Surendra Kute[2]

[1]Senior Research Assistant

[2]Associate Professor of Botany
Mahatma Phule Krishi Vidyapeeth,
Rahuri, Maharashtra, India.

**Abstract**

Combining ability for grain yield and its components was studied using three cytoplasmic male sterile (cms) lines and fifteen testers at Sorghum improvement Project, MPKV., Rahuri ,Maharashtra. Mean sum of squares due to lines, testers and line × tester were highly significant indicating the existence of variability for most of the characters. The estimates of general combining ability (gca) and specific combining ability (sca) variances indicated the presence of higher magnitude non-additive gene action for most of the characters. The line RMS 2010-24A and testers RSV 1059, RSV1145,RSLG2291,RSV 1009 and RSV 912 were found to be good general combiners for yield and yield contributing traits. The hybrids 185A x RSV 1145, RMS 2010-10A x RSR 2231, and RMS 2010-24Ax RSV 1130 were identified with significant and positive SCA for grain yield which could be exploited for development of hybrid.

Key words: line × tester, GCA, SCA, Rabi sorghum.

## INTRODUCTION

Sorghum (Sorghum bicolor (L.). Moench) is an important food and fodder crop of dry land agriculture. It has wide range of adaptability to various agro ecological situations of the region. Combining ability studies provide useful information regarding the selection of suitable parents for effective hybridization programme. It also provides information on various types of gene action involved in the expression of quantitative characters. Such information is of potential use in formulating and executing an efficient breeding programme for achieving maximum genetic gain with minimum resources and time. Hence this study was conducted with the aim to understand the combining ability of the selected lines and testers in sorghum.

## MATERIALS AND METHODS

The present investigation was carried out at Sorghum Improvement Project, MPKV., Rahuri during *rabi* 2013-14. Three cytoplasmic male sterile lines (185A, RMS 2010-10A, and RMS 2010-24A) were crossed with fifteen testers (RSR 2231, RR 2145, RSV 1059, RSV 799, CSV 216,RSV 1093, RSV 1200, RSV912, RSV 458, RSV 1098, RSV 1130, RSV 1151, RSV 1145, RSLG 2291, RSV 1009) in line x tester mating design to produce 45 $F_1$ s. The resulting 45 $F_1$s along with their 18 parents and one check (CSH-15R) were evaluated for grain yield and yield contributing traits in sorghum during *rabi* 2013-14.

The parents and hybrids were planted in separate blocks in a Randomized Block Design (RBD) with two replications. Each entry was consisted two rows having 3 m length with inter

and intra spacing of 45 cm and 15 cm respectively. Data were recorded on five randomly selected plants in each replication for the characters viz., days to 50 % flowering, plant height (cm), days to physiological maturity, 1000-grain weight (g), dry matter yield, grain yield and harvest index. The collected data were subjected to statistical analysis as per Arunachalam (1974) to understand the magnitude of general combining ability effects of parents and specific combining ability effects of $F_1$s.

**RESULTS AND DISCUSSION**

Analysis of variance for combining ability and estimates of GCA and SCA variance are presented in Table 2. The mean sum of squares due to lines, testers as well as lines vs tester interaction and hybrids were found significant for all the traits under studies viz., days to 50 % flowering, plant height (cm), days to physiological maturity, 1000-grain weight (g) , dry fodder yield, grain yield and harvest index.

The knowledge of combining ability is necessary in selection of appropriate parent since it gives an idea whether particular parent combines well or not. It is not only the mean performance but also the combining ability which decide the fate of parents and specific cross combination in commercial exploitation [7], [5].

Mean performance and general combining ability (GCA) effects

The mean performance and general combining ability effects of parents for yield and its contributing characters in *rabi* sorghum are presented in Table 1 and Table 3., respectively.

The GCA effect of parents is indicative of its value as a parent to be used in hybrid breeding programme and is not always associated with the mean performance of parents.

Genotypes which flower early with negative gca values are preferred, because it matures early and escape from drought. Among the line, 185A recorded low mean value (64.5) and significant gca effects (-1.92) in the desirable direction where as the testers *viz.*, RSV 458, RSR 2231 and RSV 799 displayed low mean performance (70.0, 66.5 and 65 days) and significant negative gca effects ( -7.86, -2.52 and -2.02), respectively.

Significant positive GCA effects are desirable for plant height. Out of three lines, only one line RMS 2010-10 A (23.53) showed significant positive GCA effects and high mean performance (233.0). However, lines RMS 2010-24A (-19.57) and 185 A (-3.96) displayed significant and negative GCA effects. Among the testers, CSV 216 recorded highest significant positive GCA effects (16.96) and high mean performance (258.0) followed by RSV 1059(11.80 and 252.0), RSLG 2291 (10.30 and 278.5) and RSV 799 (7.96 and 253.5), respectively. Whereas, male parent RSV 458 (-25.54) recorded significant negative gca effect for plant height.

As regards to 1000 grain weight, Out of three lines, RMS 2010-10 A and 185A showed significant positive GCA effects (2.24 and 0.95) and high mean performance (36.9 and 36.8 g), respectively. However, line 2010-24A (-3.19) showed significant negative GCA effects. Among the testers, RSR 2231 (4.87 and 26.0) recorded highest significant positive gca effects with mean performance followed by RSV 912(1.60 and 35.4), RSLG 2291 (1.57 and 36.2) and RSV 1093 (1.93 and 32.1), respectively. Whereas, RSV 799 (-3.70) recorded significant negative GCA effects.

For days to physiological maturity, significant positive gca effects was recorded by line RMS 2010-10 A (2.08) while 185 A displayed significant negative gca effect (-1.93). In case of testers, RR 2145 (3.90) recorded highest significant positive gca effect followed by RSV 1145(1.90), RSV 1059 ( 1.57, CSV 216(1.57), RSV1093 (1.56) and RSV 912 (1.23). Whereas, RSV 458 (-6.93) recorded highest significant negative gca effect.

In case of dry fodder yield, only one line RMS 2010-10 A showed significant positive GCA effects (24.00) with high mean performance(143.1). However, lines 185 A (-16.32) and RMS 2010-24A (-7.28) were displayed significant and negative GCA effects. Among the testers, RSLG 2291 was recorded highest significant positive GCA effects (23.50) with high mean performance (179.8) followed by RSV 1059(20.17 and 102.3), RSV 1009 (12.33 and 136.5) and RSV 1145 (11.87 and 162.7), respectively. Whereas, RSV 799 (-23.33) recorded highest significant negative GCA effects.

For grain yield per plant, the line RMS 2010-24 A exhibited highest significant positive GCA effect (2.79) with mean performance (44.6) while significant negative gca effects were exhibited by 185A (-2.81). As regards to testers, significant positive and negative GCA effects were displayed by five and two testers, respectively. The higher magnitude of positive GCA effects with mean performance were recorded by the testers RSV 1009 (10.66 and 49.1), RSV1145 (7.79 and 51.7), RSLG 2291 (6.06 and 60.0) and RSV912 (5.96 and 48.6), respectively. The testers RSV 458 (-28.74) and RSV 799 (-14.68) were possessed highly significant negative GCA effects.

The data on GCA effects for harvest index indicated that only one line RMS 2010-24 expressed significant positive GCA effects (1.69). However, RMS 2010-10 was showed significant negative GCA effects (-1.65). As regards to testers, two testers showed significant positive GCA effects. The higher magnitude of positive GCA effects were showed by the tester RSV 912 (3.64) followed by RSV 1098 (2.09).

**Specific combining ability effects**

Specific combining ability is an indicative of heterosis. The specific combining ability effects of crosses for yield and its contributing characters is presented in Table 4.

For days to 50 per cent flowering, two combinations viz., RMS 2010-24A x RSR 2231( -3.01) and RMS 2010-10 x RSV 458 (-2.91) exhibited significant negative SCA effects.

Among forty five hybrids under study, the five hybrids *viz.,* RMS 2010-24A x RSR 2231 (27.74), 185A x RSV 1009 (21.16), 185A x RSV 1098 (19.16), RMS 2010-24A x RSV 1059 ( 16.57) and RMS 2010-10A x RR 2145 (14.30) recorded higher magnitude of significant positive SCA effects for plant height while the cross combinations 185A x RSR2231 (-39.87) exhibited highest significant negative sca effects followed by RMS 2010-24A x RSV 1009 (-19.03) and RMS 2010-24A x RSV 1098 (-16.53).

The significant positive SCA effects were observed in seventeen crosses for 1000 grain weight. Among the crosses, 185A x RR2145 (3.89), RMS 2010-10A x RSV 1200 (3.89) and RMS 2010-24A x RSV 799 (3.13) recorded higher magnitude of positive sca effects.

For days to physiological maturity, four combinations exhibited significant negative SCA effects which is desirable so as to develop early maturing hybrids. The cross combination, RMS2010-10A x RSV 458 (-2.97) exhibited highest magnitude of significant negative sca effect followed by RMS 2010-10A x RSV 799 (-2.30), 185A x RSV 1200(-2.07) and 185A x RSV 1130(-2.07).

As regards to dry fodder per plant, ten hybrids displayed significant positive and twelve displayed significant negative SCA effects. The highest positive SCA effect was exhibited by RMS 2010-10A xRSV799 ( 33.30) followed by 185A x RSV 1145 (30.62) , RMS 2010-10A x RSV 1093 ( 27.43), and 185A x RSV458(26.62). The ratio of gca variances to sca variances indicates that all most all the characters are under the control of dominance type of gene action and these characters can be improved by developing the hybrid.

Out of 45 hybrids studied, only three crosses viz., 185A x RSV1145 (10.34) , RMS 2010-10A x RSR 2231 (9.32) and RMS 2010-24A x RSV1130 (7.21) showed significant positive SCA effects for grain yield per plant and two crosses viz., RMS 2010-10A x RSV912 ( 3.98) and RMS 2010-10A xRSV458 (2.90) showed significant positive SCA effects for harvest index. In the present study, the analysis of combining ability studies indicates that crosses between parents having average GCA effects ( RMS 2010-10A x RSR 2231) or poor x good ( 185A x RSV 1145) or good x poor (RMS 2010-24A x RSV 1130) also led to hybrids with significant positive SCA effects for grain yield per plant. [7] pointed out that crosses where SCA effects are high should be selected for yield. [8], [5] and [3] reported the importance of non-additive gene action for yield and yield contributing characters.

From the studies on mean performance (Table 1) and combining ability, it is in general inferred that the hybrids 185A x RSV 1145, RMS 2010-10A x RSR 2231 and RMS 2010-24A x RSV 1130 showed high mean performance, significant SCA effects and one of parents in cross combination with high gca effects appeared promising and could be used for its commercial exploitation by developing the hybrid. The results of the current studies are in conformity with the findings of [1], [6], [4] and [9].

**Table 1. Mean performance of parents and hybrids for yield and yield contributing characters in *rabi* sorghum (L x T).**

| Sr.No | Name of parents/ crosses | Days to 50 % flower | Plant height (cm plant$^{-1}$) | 1000 grain weight (g) | Days to physio-logical maturity | Dry fodder (g plant$^{-1}$) | Grain yield (g plant$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| | **Female (Lines )** | | | | | | | |
| 1. | 185A | 64.5 | 194.0 | 36.8 | 108.5 | 131.7 | 43.6 | 19.0 |
| 2. | RMS2010-10A | 73.0 | 233.0 | 36.9 | 118.0 | 143.1 | 56.8 | 21.5 |
| 3. | RMS2010-24A | 69.5 | 247.5 | 33.2 | 114.5 | 143.3 | 44.6 | 18.2 |
| | **Lines mean** | **69.0** | **224.8** | **35.6** | **113.7** | **139.4** | **48.3** | **19.5** |
| | **Male (Testers)** | | | | | | | |
| 4. | RSR 2231 | 66.5 | 247.0 | 26.8 | 111.5 | 86.5 | 29.4 | 18.2 |
| 5. | RR 2145 | 69.5 | 253.5 | 35.6 | 112.5 | 130.1 | 50.2 | 20.9 |
| 6. | RSV 1059 | 69.0 | 252.0 | 35.8 | 114.0 | 102.3 | 49.8 | 24.0 |
| 7. | RSV 799 | 65.0 | 253.5 | 35.2 | 109.0 | 124.7 | 48.0 | 20.8 |
| 8. | CSV 216 | 66.5 | 258.0 | 36.2 | 111.5 | 135.9 | 51.2 | 22.0 |
| 9. | RSV 1093 | 64.5 | 226.0 | 32.1 | 105.5 | 134.5 | 34.0 | 16.5 |
| 10. | RSV 1200 | 69.0 | 248.3 | 30.4 | 112.5 | 97.9 | 45.0 | 23.4 |
| 11. | RSV 912 | 69.0 | 240.5 | 35.4 | 110.0 | 114.9 | 48.6 | 22.7 |
| 12. | RSV 458 | 70.0 | 245.0 | 35.7 | 113.5 | 136.8 | 50.8 | 20.6 |
| 13. | RSV 1098 | 71.0 | 253.5 | 32.9 | 113.5 | 172.3 | 65.4 | 21.7 |
| 14. | RSV 1130 | 66.0 | 267.0 | 38.2 | 111.0 | 136.5 | 53.2 | 21.8 |
| 15. | RSV 1151 | 67.5 | 267.3 | 35.3 | 112.0 | 156.7 | 58.4 | 20.9 |
| 16. | RSV 1145 | 73.0 | 281.5 | 32.3 | 118.5 | 162.7 | 51.7 | 19.5 |
| 17. | RSLG 2291 | 73.0 | 278.5 | 36.2 | 116.5 | 179.8 | 60.0 | 20.9 |
| 18. | RSV 1009 | 68.6 | 256.3 | 34.5 | 112.5 | 136.5 | 49.1 | 20.3 |
| | **Testers mean** | **68.3** | **255.2** | **34.2** | **112.3** | **133.9** | **49.6** | **20.9** |
| | **Hybrids** | | | | | | | |
| 19. | 185A x RSR 2231 | 67.5 | 276.5 | 32.9 | 112.5 | 180.4 | 36.0 | 13.1 |
| 20. | 185A x RR 2145 | 73.0 | 290.0 | 33.1 | 118.0 | 171.0 | 51.6 | 21.1 |
| 21. | 185A x RSV 1059 | 72.0 | 286.0 | 35.3 | 117.0 | 196.3 | 51.6 | 16.9 |
| 22. | 185A x RSV 799 | 71.5 | 282.5 | 39.8 | 116.5 | 176.1 | 54.4 | 18.8 |
| 23. | 185A x CSV 216 | 74.0 | 267.0 | 37.9 | 118.0 | 118.7 | 59.5 | 26.2 |
| 24. | 185A x RSV 1093 | 63.0 | 247.0 | 31.0 | 106.0 | 136.1 | 26.6 | 12.1 |
| 25. | 185A x RSV 1200 | 72.5 | 254.0 | 37.5 | 115.5 | 166.3 | 48.8 | 19.0 |
| 26. | 185A x RSV 912 | 73.0 | 259.5 | 38.1 | 116.5 | 172.9 | 41.0 | 15.6 |
| 27. | 185A x RSV 458 | 73.5 | 260.5 | 34.0 | 115.5 | 160.7 | 40.2 | 16.5 |
| 28. | 185A x RSV 1098 | 73.5 | 290.0 | 35.1 | 118.5 | 176.9 | 54.4 | 19.0 |
| 29. | 185A x RSV 1130 | 73.0 | 280.5 | 34.9 | 116.0 | 210.1 | 59.2 | 18.7 |
| 30. | 185A x RSV 1151 | 72.5 | 271.5 | 37.7 | 117.5 | 172.9 | 55.4 | 20.2 |
| 31. | 185A x RSV 1145 | 64.0 | 246.0 | 38.0 | 109.0 | 138.0 | 50.4 | 20.7 |
| 32. | 185A x RSLG 2291 | 71.5 | 216.5 | 27.0 | 116.5 | 155.1 | 51.1 | 22.8 |
| 33. | 185A x RSV 1009 | 70.0 | 258.5 | 31.5 | 115.0 | 176.7 | 61.2 | 21.4 |
| 34. | 2010-10A x RSR 2231 | 69.0 | 249.5 | 29.7 | 114.0 | 102.4 | 40.8 | 21.1 |
| 35. | 2010-10A x RR 2145 | 70.5 | 256.5 | 29.1 | 115.5 | 125.2 | 48.2 | 22.0 |
| 36. | 2010-10A x RSV 1059 | 70.0 | 226.5 | 32.9 | 115.0 | 136.0 | 55.4 | 24.8 |
| 37. | 2010-10A x RSV 799 | 70.0 | 231.5 | 26.1 | 113.5 | 148.7 | 49.4 | 20.3 |
| 38. | 2010-10A x CSV 216 | 70.5 | 237.0 | 31.2 | 115.5 | 135.8 | 57.4 | 23.4 |
| 39. | 2010-10Ax RSV 1093 | 64.0 | 199.5 | 29.2 | 109.0 | 105.9 | 23.4 | 13.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 40. | 2010-10Ax RSV 1200 | 70.5 | 197.0 | 32.0 | 113.0 | 145.0 | 61.1 | 24.5 |
| 41. | 2010-10A x RSV 912 | 70.5 | 230.0 | 28.5 | 115.5 | 138.2 | 59.8 | 22.0 |
| 42. | 2010-10A x RSV 458 | 71.0 | 234.0 | 28.2 | 113.5 | 143.2 | 56.6 | 22.5 |
| 43. | 2010-10Ax RSV 1098 | 72.0 | 225.5 | 32.0 | 115.0 | 125.7 | 53.8 | 24.3 |
| 44. | 2010-10Ax RSV 1130 | 69.5 | 232.5 | 32.1 | 111.0 | 163.2 | 56.0 | 20.9 |
| 45. | 2010-10A x RSV1151 | 70.0 | 211.5 | 26.9 | 112.5 | 146.7 | 68.4 | 23.9 |
| 46. | 2010-10Ax RSV 1145 | 65.0 | 180.0 | 32.2 | 110.0 | 104.6 | 28.2 | 16.6 |
| 47. | 2010-10AxRSLG 2291 | 72.0 | 195.5 | 29.6 | 115.0 | 147.0 | 45.4 | 18.6 |
| 48. | 2010-10A x RSV 1009 | 71.0 | 170.0 | 22.3 | 113.5 | 109.2 | 44.8 | 22.6 |
| 49. | 2010-24A x RSR 2231 | 74.0 | 270.0 | 35.9 | 118.0 | 165.2 | 43.4 | 16.0 |
| 50. | 2010-24A x RR 2145 | 75.5 | 279.0 | 26.2 | 119.5 | 147.0 | 42.2 | 17.7 |
| 51. | 2010-24A x RSV 1059 | 75.0 | 273.0 | 29.7 | 119.0 | 177.8 | 56.4 | 21.1 |
| 52. | 2010-24A x RSV 799 | 76.0 | 268.5 | 30.3 | 121.0 | 194.3 | 54.0 | 19.0 |
| 53. | 2010-24A x CSV 216 | 76.5 | 276.0 | 31.9 | 121.5 | 192.6 | 53.6 | 18.9 |
| 54. | 2010-24A x RSV 1093 | 76.0 | 264.0 | 36.0 | 121.0 | 207.0 | 60.6 | 20.1 |
| 55. | 2010-24A x RSV 1200 | 75.5 | 264.0 | 32.4 | 120.5 | 156.8 | 46.0 | 20.5 |
| 56. | 2010-24A x RSV 912 | 76.0 | 268.5 | 34.0 | 121.0 | 179.8 | 53.4 | 20.6 |
| 57. | 2010-24A x RSV 458 | 62.5 | 213.5 | 38.9 | 105.5 | 171.8 | 39.2 | 20.7 |
| 58. | 2010-24A x RSV 1098 | 76.0 | 269.5 | 37.4 | 121.0 | 193.3 | 58.8 | 21.3 |
| 59. | 2010-24A x RSV 1130 | 77.5 | 273.5 | 30.0 | 122.5 | 191.5 | 52.8 | 19.1 |
| 60. | 2010-24A x RSV 1151 | 77.0 | 257.0 | 32.2 | 122.0 | 177.9 | 47.6 | 17.7 |
| 61. | 2010-24A x RSV 1145 | 77.5 | 279.0 | 31.4 | 122.5 | 159.8 | 53.8 | 20.1 |
| 62. | 2010-24A x RSLG 2291 | 76.0 | 256.0 | 30.1 | 121.0 | 200.7 | 34.6 | 12.2 |
| 63. | 2010-24A x RSV 1009 | 75.5 | 280.0 | 27.8 | 120.5 | 159.2 | 51.4 | 20.6 |
| 64. | CSH 15R (Ch) | 69.5 | 216.5 | 40.2 | 113.5 | 140.6 | 55.7 | 24.1 |
| | Hybrid mean (HM) | 71.8 | 249.4 | 32.4 | 116.1 | 158.7 | 49.9 | 19.8 |
| | General mean (GM) | 70.9 | 249.6 | 33.0 | 115.1 | 152.0 | 49.7 | 20.0 |
| | SE ± | 1.15 | 6.25 | 0.39 | 0.98 | 5.13 | 3.41 | 1.55 |
| | CD at 5 % | 3.26 | 17.67 | 1.11 | 2.78 | 14.50 | 9.62 | 4.38 |
| | CD at 1% | 4.33 | 23.48 | 1.47 | 3.70 | 19.27 | 12.79 | 5.82 |

**Table 2. Analysis of variance for combining ability and estimates of GCA and SCA variances in *rabi* sorghum.**

| Sources | DF | Days to 50 % flowering | Plant height (cm plant$^{-1}$) | 1000 grain weight (g) | Days to physiological maturity | Dry fodder yield (g plant$^{-1}$) | Grain yield (g plant$^{-1}$) | Harvest index. (%) |
|---|---|---|---|---|---|---|---|---|
| Replication | 1 | 108.6 | 1578.7 | 5.79 | 65.7 | 173.8 | 0.10 | 3.0 |
| Treatments | 62 | 34.6** | 1546.5** | 29.73** | 36.5** | 1703.4** | 210.5** | 22.5** |
| Parents | 17 | 40.4** | 2565.6** | 32.52** | 43.8** | 1653.7** | 145.4** | 11.7* |
| Line | 2 | 28.7** | 330.2* | 53.11** | 13.2* | 1082.6** | 190.6** | 19.0* |
| Testers | 14 | 33.7** | 532.2** | 25.42** | 34.1** | 650.1** | 110.7** | 11.5* |
| Line vs. Tester | 1 | 158.7** | 35504.4** | 90.74** | 240.4** | 16847.1** | 539.4** | 0.2 |
| Parent vs. | 1 | 484.1** | 142.4 | 94.03* | 603.5** | 12679.4* | 98.1* | 32.7* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| hybrid | | | | * | | * | | |
| Hybrids | 44 | 22.1** | 1184.6** | 27.19** | 20.8** | 1473.1** | 238.2** | 26.4** |
| Error | 62 | 2.69 | 77.8 | 0.31 | 1.95 | 53.2 | 23.5 | 4.8 |
| Estimates | | | | | | | | |
| $\sigma^2_{gca}$ | | 0.32 | 14.25 | 0.26 | 0.29 | 13.56 | 3.19 | 0.32 |
| $\sigma^2_{sca}$ | | 1.29 | 180.37 | 6.67 | 1.72 | 354.85 | 23.89 | 2.31 |
| $\sigma^2_{A}$ | | 0.64 | 28.50 | 0.52 | 0.58 | 27.12 | 6.38 | 0.64 |
| $\sigma^2_{D}$ | | 1.29 | 180.37 | 6.67 | 1.72 | 354.85 | 23.89 | 2.31 |
| $\sigma^2_{A}/\sigma^2_{D}$ | | 0.50 | 0.16 | 0.08 | 0.34 | 0.08 | 0.27 | 0.28 |

* Significant at 5% level, ** Significant at 1% level

**Table 3: General combining ability effects of parents for yield and yield contributing characters in *rabi* sorghum.**

| Sr. No. | Parents | Days to 50 % flowering | Plant height (cm plant$^{-1}$) | 1000 grain weight (g) | Days to physiological maturity | Dry fodder yield (g plant$^{-1}$) | Grain yield (g plant$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| | Females | | | | | | | |
| 1 | 185 A | -1.92** | -3.96* | 0.95** | -1.93** | -16.62** | -2.81** | -0.04 |
| 2 | RMS 2010-10A | 2.08** | 23.53** | 2.24** | 2.13** | 24.00** | 0.02 | -1.65** |
| 3 | RMS 2010-24A | -0.16 | -19.57* | -3.19* | -0.20 | -7.38* | 2.79** | 1.69* |
| | SE ± | 0.30 | 1.61 | 0.10 | 0.25 | 1.33 | 0.89 | 0.40 |
| | Males | | | | | | | |
| 4 | RSR 2231 | -2.52** | -11.87** | 4.87** | -2.60** | 2.00 | 1.59 | -0.05 |
| 5 | RR 2145 | 2.98** | -6.04 | -1.40** | 3.90** | 7.20* | 3.12 | 1.05 |
| 6 | RSV 1059 | 1.14 | 11.80** | 0.14 | 1.57* | 20.17** | 5.19* | -0.03 |
| 7 | RSV 799 | -2.02** | 7.96* | -3.70** | -1.10 | -23.33** | -14.68** | -2.71** |
| 8 | CSV 216 | 1.31 | 16.96** | -0.86** | 1.57** | -4.33 | -0.08 | 1.15 |
| 9 | RSV 1093 | 0.64 | 5.13 | 1.19** | 1.56** | -1.57 | 2.19 | 1.70 |
| 10 | RSV 1200 | -0.86 | 6.13 | 0.20 | -0.77 | 3.40 | 0.52 | -0.25 |
| 11 | RSV 912 | 0.64 | 4.30 | 1.60** | 1.23* | -16.30** | 5.96** | 3.64** |
| 12 | RSV 458 | -7.86** | -25.54** | -2.73** | -6.93** | -20.93** | -28.74** | -9.33** |
| 13 | RSV 1098 | 0.98** | -16.60** | -0.20 | -0.10 | -10.03** | 1.56 | 2.09* |
| 14 | RSV 1130 | 1.14 | -6.37 | 0.50* | 0.23 | -4.43 | -0.27 | -0.11 |
| 15 | RSV 1151 | 1.81** | -3.20 | -0.85** | 0.40 | 0.47 | -0.88 | -0.33 |
| 16 | RSV 1145 | 2.48** | 6.63 | -0.15 | 1.90** | 11.87** | 7.79** | 1.45 |
| 17 | RSLG 2291 | -0.19 | 10.30** | 1.57** | -1.10 | 23.50** | 6.06** | 0.25 |
| 18 | RSV 1009 | 0.31 | 0.40 | -0.21 | 0.23 | 12.33** | 10.66** | 1.49 |
| | SE(gi) ± | 0.67 | 3.60 | 0.23 | 0.57 | 2.98 | 1.98 | 0.90 |

* Significant at 5% level, ** Significant at 1% level

**Table 4: Specific combining ability (sca) effects for yield and yield contributing characters in 45 crosses of *rabi* sorghum.**

| Sr.No | Crosses | Days to 50 % flowering | Plant height (cm plant$^{-1}$) | 1000 grain weight (g plant$^{-1}$) | Days to maturity | Dry fodder (g plant$^{-1}$) | Grain yield (g plant$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 x 4 | -0.74 | -39.87** | -2.48** | -0.73 | -0.11 | -5.26 | -1.10 |
| 2 | 1 x 5 | 2.26 | -6.70 | 3.89** | 2.27* | 6.09 | 6.41 | 0.25 |
| 3 | 1 x 6 | 0.59 | -10.04 | -1.40** | 1.10 | -6.68 | -7.86* | -1.96 |
| 4 | 1 x 7 | 0.76 | -6.70 | -3.96** | 0.77 | -19.98** | -3.19 | 0.77 |
| 5 | 1 x 8 | 0.42 | -9.20 | 2.05** | -0.90 | 4.62 | 3.01 | -0.40 |
| 6 | 1 x 9 | 0.59 | 1.13 | 0.20 | 0.60 | -25.95** | 0.34 | 2.15 |
| 7 | 1 x 10 | -1.91 | 1.63 | 0.54 | -2.07* | -8.51 | 0.21 | 0.90 |
| 8 | 1 x 11 | -1.91 | 7.96 | 0.14 | -1.57 | 22.39** | -2.02 | -1.83 |
| 9 | 1 x 12 | 0.59 | 5.80 | 0.42 | 0.60 | 25.62** | -4.52 | -4.01* |
| 10 | 1 x 13 | 0.26 | 19.16** | -3.81** | 0.77 | -21.88** | -3.82 | 1.12 |
| 11 | 1 x 14 | 0.09 | 1.13 | 0.49 | -2.07* | -10.48* | 1.61 | 2.62 |
| 12 | 1 x 15 | 0.42 | 2.46 | 2.09** | 1.27 | 6.52 | 4.41 | 0.79 |
| 13 | 1 x 16 | 0.76 | 1.13 | -1.36** | -0.23 | 30.62** | 10.34** | 0.05 |
| 14 | 1 x 17 | -1.58 | 10.96 | 2.17** | 0.27 | -16.81** | -0.12 | 1.35 |
| 15 | 1 x 18 | -0.58 | 21.16** | 1.05* | -0.07 | 14.55** | 0.48 | -0.73 |
| 16 | 2 x 4 | 3.76** | 12.14 | -0.38 | 2.70** | 3.17 | 9.32** | 2.26 |
| 17 | 2 x 5 | -1.24 | 14.30* | -2.01** | -1.30 | -14.93** | -1.52 | -0.14 |
| 18 | 2 x 6 | 0.09 | -6.53 | 0.31 | -0.97 | -10.80* | 4.72 | 2.40 |
| 19 | 2 x 7 | -2.24 | -4.70 | 0.84* | -2.30* | 33.30** | 0.58 | -2.72 |
| 20 | 2 x 8 | -0.08 | -0.20 | -1.74** | 0.53 | 4.90 | 1.58 | 1.41 |
| 21 | 2 x 9 | -0.41 | 7.64 | -1.64** | -0.47 | 27.43** | -0.68 | -3.39* |
| 22 | 2 x 10 | 0.59 | 3.14 | 3.89** | 1.37 | 2.27 | 3.78 | 0.46 |
| 23 | 2 x 11 | 1.59 | -10.53 | 0.59 | 0.87 | -35.43** | 3.45 | 3.98* |
| 24 | 2 x 12 | -2.91* | -0.70 | -2.03** | -2.97** | -13.40* | 5.25 | 2.90* |
| 25 | 2 x 13 | -0.24 | -2.63 | 1.94** | -0.30 | 5.90 | -2.85 | -1.62 |
| 26 | 2 x 14 | 0.09 | -7.36 | 1.84** | 0.37 | 6.90 | -8.82* | -2.87 |
| 27 | 2 x 15 | -0.08 | -9.53 | -0.86* | -0.80 | -10.20 | -9.02* | -1.75 |
| 28 | 2 x 16 | -0.74 | 10.14 | -0.51 | 0.70 | -5.40 | -3.48 | -0.99 |
| 29 | 2 x 17 | 1.42 | -3.03 | -2.38** | 1.20 | 16.17* | 3.05 | -0.14 |
| 30 | 2 x 18 | 0.42 | -2.13 | 2.16** | 1.37 | -9.87 | -5.35 | 0.18 |
| 31 | 3 x 4 | -3.01* | 27.74** | 2.86** | -1.97 | -3.05 | -4.06 | -1.17 |
| 32 | 3 x 5 | -1.01 | -7.60 | -1.87** | -0.97 | 8.85 | -4.89 | -0.12 |
| 33 | 3 x 6 | -0.68 | 16.57* | 1.09** | -0.13 | 17.48** | 3.14 | -0.44 |
| 34 | 3 x 7 | 1.49 | 11.40 | 3.13** | 1.53 | -13.32* | 2.61 | 1.95 |
| 35 | 3 x 8 | -0.34 | 9.40 | -0.31 | 0.37 | -9.52 | -4.59 | -1.02 |
| 36 | 3 x 9 | -0.18 | -8.76 | 1.44** | -0.13 | -1.49 | 0.34 | 1.23 |
| 37 | 3 x 10 | 1.32 | -4.76 | -4.42** | 0.70 | 6.25 | -3.99 | -1.37 |
| 38 | 3 x 11 | 0.32 | 2.57 | -0.72 | 0.70 | 13.05* | -1.42 | -2.15 |
| 39 | 3 x 12 | 2.32 | -5.10 | 1.61** | 2.37* | -12.22* | -0.72 | 1.11 |
| 40 | 3 x 13 | -0.01 | -16.53* | 1.88** | -0.47 | 15.98** | 6.68 | 0.50 |
| 41 | 3 x 14 | -0.18 | 6.24 | -2.32** | 1.70 | 3.58 | 7.21* | 0.25 |
| 42 | 3 x 15 | -0.34 | 7.07 | -1.22** | -0.47 | 3.68 | 4.61 | 0.96 |
| 43 | 3 x 16 | -0.01 | -11.26 | 1.88** | -0.47 | -25.22** | -6.86 | 0.93 |
| 44 | 3 x 17 | 0.16 | -7.93 | 0.21 | -1.47 | 0.65 | -2.92 | -1.22 |
| 45 | 3 x 18 | 0.16 | -19.03** | -3.21** | -1.30 | -4.69 | 4.88 | 0.55 |
| SE (Sij) ± | | 1.16 | 6.24 | 0.40 | 0.99 | 5.16 | 3.43 | 0.56 |

* Significant at 5% level, ** Significant at 1% level

**REFERENCES**

1. Amsalu, A.A., Bapat, D.R. 1990. Diallel analysis of combining ability in sorghum. *J. Maharashtra Agric.Univ.*15(3): 302 305.
2. Arunachalam, V. 1974. The fallacy behind the use of a modified Line x Tester design. *Indian J. Genet.*, 34: 280-285.
3. Chaudhary, S.B., J.V. Patil., B.B. Thombare and V.M. Kulkarni, 2006. Selection of parents based on combining ability studies in sorghum (*Sorghum bicolor* L. Moench). *Ann. Plant Physiology.* 20 (1) : 95-97.
4. Kaul, S.L., Rafiq, F.M., Singh, K. 2003. Heterobeltiosis and combining ability for grain yield components in post rainy season sorghum. *Int. sorghum Millets Newslett.*,44: 21 23.
5. Murumkar, P.N., Atale, S.B., Shivankar, R.S., Meshram, M.P. and Bhandarwar, A.D. 2005. Combining ability studies in newly established MS and R lines in rabi sorghum. Indian J. agric. Res., 39(4): 263-268.
6. Rafiq, S.M, Thete, R.Y, Madhusudhana, R., Umakhanth, A.V. 2002. Combining ability studies for grain yield and its components in post rainy season where sorghum grown in medium deep and shallow soils. *Int. Sorghum Millets Newslett.,* 43:33 77.
7. Rao, N.G.P. 1970. Combining Ability and Components of Genetic Variation. *Indian J. Genetics,* 30(2):362-376.
8. Salunke, C.B., Pawar, B.B., Deshmukh, R.B. and Narkhede, B.N. 1996. Combining ability studies in rabi sorghum under irrigated and moisture stress environments. J. Maharashtra Agric. Univ., 21(3): 426-429.
9. Thakare D.P., Ghorade R.B. and Bagade A.B. 2014 Combining ability studies in Grain Sorghum using line X tester analysis. *Int.J.Curr.Microbiol.App.Sci* (2014) 3(10) 594-603