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# Combining Ability Studies for Yield and Yield Contributing Traits in Desi Cotton (*Gossipium arboreum* L.)

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**ABSTRACT**

*Twenty four hybrid combinations derived by crossing six arboreum lines with four arboreum testers were tested along with their parents including two checks. The observations on thirteen yield attributing characters were recorded on randomly selected five plants. Among ten parental lines, four lines were found to be the best general combiners which had significant GCA effect for seed cotton yield. The results revealed that, hybrids developed from PA 734 X PA 528 was found to be the best combining ability which had significant SCA effect for seed cotton yield. The ratio of $6^2$ gca : $6^2$sca variance for general and specific combining ability was less than unity for the characters except seed cotton yield per plant indicating preponderance of non additive gene action for seed cotton yield and component charecters. Based on mean performance, female lines PA 743 and PA 713, male parents (tester) PA 255 and PA 528 and hybrids PA 760 x PA 255, PA -760 X PA 08 were found best for seed cotton yield. The parental lines PA 760, PA 713, PA 08 and PA 255 were found as best general combiners for seed cotton yield per plant and other yield contributing characters and fibre quality traits.The hybrids viz., PA 734 x PA 528 and PA 760 x PA 255 were found best specific combiner for seed cotton yield per plant and other yield contributing characters.*

***Key words:*** *Cotton, GCA, SCA, Line x tester analysis.*

## INTRODUCTION

India is perhaps the first country to make use of cotton. Cotton the 'white gold' enjoys a pre-eminent status among all cash crops in the country. It is grown commercially in the temperate and tropical regions of more than 70 countries. In the last few years there has been a significant reduction in area of *G. arboreum* cotton across the country and particularly in Maharashtra because of lower productivity and inferior fibre properties as compared to tetraploid cotton in rainfed eco-system and non availability of Bt variety / hybrid. Genetic improvement in *desi* cotton could be gain either through combination or exploitation of hybrid vigour. Therefore, more emphasis should be given to increase the seed cotton yield per unit area, by developing varieties with short structure, big boll size and medium to longer staple length with sustained yield in multiple environments.

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To achieve such desirable characteristics in a new variety, proper breeding strategies should be followed. The progress in breeding programme depends on magnitude of genetic variability present in breeding material. The existence of variability is essential for resistance to biotic and abiotic factor as well as for varietal adaptability. Selection is also effective when there is high degree of genetic variability among the individuals in a population. Sprague and Tatum in 1942 used the term combining ability to describe the average performance of a line in a series of cross combinations. The information on the nature and magnitude of gene action is important in understanding the genetic potential of population and decide the breeding procedure to be adopted in given population. Line x tester analysis is a precise method for obtaining such information when a large number of parents to be tested.

## MATERIAL AND METHODS

The present investigation was undertaken to study "combining ability studies for yield traits in *desi* cotton (*Gossypium arboreum* L.)" for seed cotton yield traits in line x tester programme involving twenty four hybrid combinations derived by crossing six *arboreum* lines(PA 713, PA 743, PA 734, PA760,PA 720, PAIG 326,PA 713) with four *arboreum* testers(PA 255, PA 402, PA 08, PA 528) were tested along with their parents including 2 checks(PKVDH 1, SWADESHI 651) at Cotton Research Station, Mahboob Baugh farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season of 2013-14. All the parental material was planted during summer 2013. Two sets of parental lines were sown at an interval of 8 days to ensure synchrony in flowering and to complete hybridization between selected parents. The line x tester (6 x 4) crossing was effected and total 24 crosses along with ten parents and 2 checks were grown in randomized block design with three replications with spacing of 60cm X 30cm. Observations were recorded on the following yield and yield components Days to 50 per cent flowering, Days to 50 per cent boll bursting, Days to maturity, Plant height (cm), Number of sympodia per plant, Number of bolls per plant, Number of seeds per boll, Boll weight (g), Seed index (g), Seed cotton yield per plant (g), Lint index, Harvesting index, Ginning out turn were recorded.

## RESULTS AND DISCUSSION

General combining ability is the average performance of a genotype in cross combinations involving a set of other genotypes. It is specific for the set of lines and testing environment, whereas specific combining ability is the average performance of a specific cross combination expressed as deviation from the population mean. The gca effect reflects the breeding value of the parental genotypes and assists in identifying genotypes to be used for developing superior populations. Specific combining ability effects represent the non-reliable component of the genotypic value arising due to contribution from dominance deviation and interaction deviation. Hence, sca effect is the main cause for superiority of a cross. It is inferred that superiority of a cross cannot be fixed through selection. The estimates of general combining ability effects of females and males are presented in Table 2.1 and 2.2, respectively. Amongst the females, PAIG 326 (-0.819) amongst 4 male parents male parent PA 08 and PA 255 showed significant negative GCA effects for days to boll bursting. In parents PA 760 (2.796), PA 720 (1.613) and PA 255 (1.349) expressed significant positive GCA effects. Amongst female parents PA 713 (0.099) and amongst males PA 402 (0.113) showed highly positive significant GCA effects and PA 528 (-0.107) exhibited highly negative significant GCA effects. One female parent PA 743 (12.14) showed highly positive significant GCA effects for plant height.PA 743 (1.472) showed positive GCA effects for days to maturity. Amongst the six female lines PA 713 (2.475) and PA 760 (2.546) and in male parents PA 255 (2.361) and PA 08 (2.900) showed significant positive GCA effects for seed cotton yield per plant. As far as lint yield per plant is concerned, among the male parents PA 402 (0.280) and PA 08(0.253) showed positive gca effect. The female parents PA 743 (0.668) was expressed

highly significant positive desirable GCA effects for seed index. Female parents PA 760 (1.858) and PA 720 (1.823) showed positive significant GCA effects for harvest index. The lines, PA 760 (1.661) positive and PA 743 (-1.388), PA 743(-1.011) showed highly significant negative gca effects for ginning out turn. The study of gca effects for these traits revealed that the parent PA 08 and PAIG 326 showed significant negative gca effect for days to 50 per cent boll bursting while PA 734 days to maturity which is in the desirable direction. Parents PA 760, PA 720 and PA 255 showed significant positive GCA effect for number of sympodia for plant height. PA 734 and PAIG 326 showed significant desirable positive gca effect for plant height. Similar result were observed by Jatoi *et al.,*[6], and Mendez-Natera *et al.,*[8], Hybrid combinations PA 760 x PA 08 (1.917), PA 743 X PA 255(1.778), PAIG 326 x PA 08(1.750) showed positive significant SCA effects for days to 50% flowering. PA 743 x PA 08 (-2.514), PA 713 x PA 08(-2.097) showed positive significant to SCA effects towards days to 50 per cent boll bursting. PA 760 x PA 08 (4.167), PAIG 326 x PA 08 (4.167) and PA 743 x PA 255(3.361) showed significant positive SCA effects towards days to maturity. The cross PA 713 x PA 08 (6.12), PA 720 x PA 528(5.71) and PA 743 x PA 255 (3.23) showed significant positive SCA effects Number of sympodia per plant. Number of bolls per plant among hybrids, the crosses PAIG 326 x PA 528 (2.34), showed positive significant SCA effects. The cross PA 720 x PA 528 (3.54), PAIG 326 x PA 08 (2.07) and PA 743 x PA 255(2.40) for number of seeds per boll trait, PA 760 x PA 528(0.32), PAIG 326 x PA 255 (0.25) and PA 720 x PA 08 (0.21) for Boll weight. PA 743 x PA 528 (4.35) for Seed cotton yield per plant PA 743 x PA 255 (4.28) and PA 743x PA 255(4.27) for harvesting index showed the maximum significant positive results. The hybrid PA 713 x PA 08 (-0.53) showed maximum significant negative SCA effects for lint index. The hybrid PA 760 x PA 528 (0.62) showed maximum significant positive SCA effects followed by PA 720 x PA 08(0.56) and PA 743 x PA 528 (0.49) for seed index. The hybrid PA 713 x PA 402 (1.69) showed maximum significant positive SCA effects followed by cross PA 720 x PA 08 (1.44 for ginning outturn.

The seed cotton yield in intraspecific crosses of diploid cotton is generally contributed by number of bolls per plant and boll weight and number of seed per boll. Hence, in the present study, the results of these traits discussed as component characters of seed cotton yield. Among parents PA 402 exhibit significant positive gca effect for boll weight, similar findings which were observed by Dai Gang *et al.,* [4],Kumar *et al.,*[7]. Among crosses PAIG 326 x PA 528 for number of bolls per plant, where as the crosses PA 760 x PA 528 and PAIG 326 x PA 255 for boll weight showed significant positive sca effect among yield and yield components group. While the crosses PA 734 x PA 528 and PA 760 x PA 255 for seed cotton yield showed significant positive sca effect. Similar results were reported by) Nadagundi *et al.,*[9], and Kumar *et al.,*[7]. The crosses PA 743 x PA 255, PA 720 x PA 528 and PAIG 326 x PA 08 showed significant positive for number of seed per boll. Jatoi *et al.,*[6], reported similar results for this character.

**Table 1: ANOVA for line x tester analysis**

| Source | d.f. | Days to 50% flowering | Days to 50% boll bursting | No. of sympodia/ plant | No. of boll/ plant | No. of seed / boll | Boll Weight (g) | Plant height (cm) | Days to maturity | Seed cotton yield/ plant | Lint index | Seed index | Harvest index | Ginning outturn (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Replications | 2 | 1.451 | 1.892 | 4.759 | 2.006 | 4.023 | 0.029 | 22.66 | 1.922 | 10.990 | 0.030 | 0.034 | 2.947 | 2.241 |
| Crosses | 23 | 4.464** | 9.695** | 34.377** | 5.206** | 8.772** | 0.093** | 821.98** | 23.301** | 75.896** | 0.523** | 1.195** | 17.266* | 6.794** |
| Lines | 5 | 3.000 | 8.114 | 44.684 | 2.847 | 4.646* | 0.073 | 1274.42 | 13.322 | 55.135 | 0.383 | 1.809 | 24.628 | 14.669* |
| Testers | 3 | 1.000 | 16.051 | 20.663 | 7.311 | 2.382 | 0.164 | 58.539 | 12.759 | 289.61** | 1.523 | 1.741 | 3.448* | 10.395 |
| L X T | 15 | 5.644** | 8.951** | 33.684** | 5.571 | 11.426** | 0.085** | 823.854** | 28.737** | 40.07** | 0.369** | 0.881** | 17.576 | 3.449** |
| Error | 66 | 2.0267 | 1.954 | 5.836 | 3.752 | 3.092 | 0.019 | 207.43 | 6.265 | 7.269 | 0.060 | 0.103 | 9.361 | 1.363 |

* Significant 5 per cent level

** Significant 1 per cent level

**Table 2.1 General combining ability effects (GCA) for lines**

| Parents | Days to 50% flowering | Days to 50% boll bursting | No. of sympodia/ plant | No. of boll/ plant | No. of seed / boll | Boll Weight (g) | Plant height (cm) | Days to maturity | Seed cotton yield/ plant | Lint index | Seed index | Harvest index | Ginning outturn (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PA 713** | -0.667 | -0.736 | -2.45** | 0.187 | -0.202 | 0.099* | 5.554 | -0.611 | 2.475** | 0.120 | -0.43** | -0.776 | -0.134 |
| **PA 743** | 0.000 | -0.319 | -0.708 | -0.213 | -0.910 | 0.081 | 0.037 | 0.306 | -0.567 | 0.100 | 0.668** | -0.895 | -1.388** |
| **PA 734** | 0.750 | 1.264** | 0.046 | -0.797 | 0.635 | 0.058 | 12.14** | 1.472* | -0.033 | -0.315** | -0.064 | -0.829 | -1.011** |
| **PA 760** | 0.083 | 0.681 | 2.796** | -0.030 | 0.252 | 0.068 | -0.059 | -0.111 | 2.546** | 0.119 | -0.074 | 1.858* | 1.661** |
| **PA 720** | -0.417 | -0.069 | 1.613* | 0.197 | 0.648 | -0.036 | 1.078 | -1.611* | -2.579** | 0.091 | 0.182 | 1.823* | 0.502 |
| **PAIG 326** | 0.250 | -0.819* | -1.295 | 0.656 | -0.423 | -0.072 | -18.75** | 0.556 | -1.842* | -0.115 | -0.278** | -1.182 | 0.370 |
| **S.E.(Gi)** | 0.4110 | 0.4035 | 0.697 | 0.559 | 0.508 | 0.041 | 4.158 | 0.723 | 0.778 | 0.071 | 0.093 | 0.883 | 0.337 |
| **S.E.(Gi-Gj)** | 0.5812 | 0.5707 | 0.986 | 0.791 | 0.718 | 0.058 | 5.879 | 1.022 | 1.101 | 0.101 | 0.131 | 1.249 | 0.477 |
| **CD @5%** | 0.8272 | 0.812 | 1.404 | 1.126 | 1.022 | 0.082 | 8.369 | 1.454 | 1.567 | 0.414 | 0.187 | 1.778 | 0.678 |
| **CD @1%** | 1.1043 | 1.084 | 1.874 | 1.503 | 1.364 | 0.109 | 11.171 | 1.942 | 2.091 | 0.192 | 0.250 | 2.373 | 0.906 |

**2.2 General combining ability effects (GCA) for testars**

| Parents | Days to 50% flowering | Days to 50% boll bursting | No. of sympodia/ plant | No. of boll/ plant | No. of seed / boll | Boll Weight (g) | Plant height (cm) | Days to maturity | Seed cotton yield/ plant | Lint index | Seed index | Harvest index | Ginning outturn (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PA 255 | 0.222 | 1.042** | 1.349* | 0.426 | -0.460 | -0.044 | -1.626 | 0.972 | 2.361** | -0.106 | 0.151 | 0.263 | -1.020** |
| PA 402 | 0.056 | 0.486 | -1.270* | 0.602 | -0.055 | 0.113** | 2.291 | 0.028 | 0.567 | 0.216** | -0.280** | 0.125 | 0.554* |
| PA 08 | -0.333 | -1.069** | -0.098 | -0.785 | 0.101 | 0.037 | 0.574 | -1.083 | 2.900** | 0.253** | 0.370** | 0.261 | -0.139 |
| PA 528 | 0.056 | -0.458 | 0.019 | -0.243 | 0.415 | -0.107** | -1.239 | 0.083 | -5.828** | -0.363** | -0.236** | -0.649 | 0.604* |
| **S.E.(Gi-)** | 0.336 | 0.330 | 0.569 | 0.457 | 0.415 | 0.033 | 3.395 | 0.590 | 0.636 | 0.058 | 0.076 | 0.721 | 0.275 |
| **S.E.(Gi-Gj)** | 0.475 | 0.466 | 0.805 | 0.646 | 0.586 | 0.047 | 4.801 | 0.834 | 0.899 | 0.082 | 0.107 | 1.019 | 0.389 |
| **CD @5%** | 0.675 | 0.821 | 1.146 | 0.919 | 0.834 | 0.067 | 6.833 | 1.188 | 1.279 | 0.117 | 0.153 | 1.452 | 0.554 |
| **CD @1%** | 0.902 | 1.096 | 1.530 | 1.227 | 1.114 | 0.089 | 9.121 | 1.585 | 1.708 | 0.156 | 0.204 | 1.938 | 0.740 |

* Significant 5 per cent level

** Significant 1 per cent level

**Table 3 Specific combining ability effects (SCA) for hybrids**

| Hybrids | Days to 50% flowering | Days to 50% boll bursting | No. of sympodia/ plant | No. of boll/ plant | No. of seed / boll | Boll Weight (g) | Plant height (cm) | Days to maturity | Seed cotton yield/ plant | Lint index | Seed index | Harvest index | Ginning outturn (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PA 713 x PA 255 | -1.889* | 0.792 | -1.258 | 0.229 | -0.340 | 0.142 | 2.013 | 4.722** | -1.311 | -0.111 | -0.286 | 1.409 | 0.416 |
| PA 713 x PA 402 | 1.278 | 1.014 | -3.239* | -0.144 | 1.955 | 0.099 | -19.638* | 2.556 | 2.217 | 0.544** | 0.132 | -1.309 | 1.691* |
| PA 713 x PA 08 | -1.000 | -2.097** | 6.122** | -0.554 | 0.366 | -0.092 | 7.746 | -0.667 | 1.333 | -0.536** | -0.253 | -1.058 | -0.605 |
| PA 713 x PA 528 | 1.611 | 0.292 | -1.625 | 0.468 | -1.981 | -0.148 | 9.879 | 2.833 | -2.239 | 0.103 | 0.408* | 0.958 | -1.502* |
| PA 743 x PA 255 | 1.778* | 1.375 | 3.230* | 0.013 | 2.402* | -0.138 | 3.397 | 3.361* | 1.064 | -0.422** | 0.252 | 4.272* | -0.771 |
| PA 743 x PA 402 | -0.056 | 1.597 | 2.616 | -0.910 | -2.370* | 0.044 | 10.213 | 0.306 | -0.642 | 0.190 | 0.057 | -3.247 | -0.762 |
| PA 743 x PA 08 | 1.667* | -2.514** | -3.089* | 0.803 | 0.608 | 0.094 | 7.863 | -3.917** | 1.875 | 0.190 | 0.305 | 1.451 | 1.055 |
| PA 743 x PA 528 | -0.056 | -0.458 | -2.757 | 0.095 | -0.640 | -0.002 | -21.473 | 0.250 | -2.297 | 0.042 | -0.614** | -2.476 | 0.478 |
| PA 734 x PA 255 | 0.028 | -0.542 | -2.691 | 0.727 | 2.023 | 0.105 | -10.974 | -0.139 | -6.519** | -0.369* | -0.183 | -4.284* | -0.564 |
| PA 734 x PA 402 | 0.194 | 1.681* | 0.062 | -0.283 | -0.533 | -0.038 | 6.576 | 1.139 | -1.925 | -0.035 | 0.152 | 2.234 | -0.082 |
| PA 734x PA 08 | -1.083 | -0.097 | 1.823 | 1.814 | -1.205 | -0.056 | 16.359 | -2.750 | 4.092* | 0.232 | -0.463* | -1.125 | 0.445 |
| PA 734 x PA 528 | 0.861 | -1.042 | 0.806 | -2.258* | -0.285 | -0.012 | -11.961 | 1.750 | 4.353** | 0.172 | 0.494* | 3.175 | 0.201 |

Table 3 continuation

| Hybrids | Days to 50% flowering | Days to 50% boll bursting | No. of sympodia / plant | No. of boll/ plant | No. of seed / boll | Boll Weight (g) | Plant height (cm) | Days to maturity | Seed cotton yield/ plant | Lint index | Seed index | Harvest index | Ginning outturn (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PA 760 x PA 255 | -0.306 | -1.625* | 0.659 | 1.049 | -0.927 | -0.205* | 12.359 | -0.222 | 4.251** | 0.280 | 0.094 | -1.318 | 1.024 |
| PA 760 x PA 402 | -0.806 | -1.403 | 2.379 | 0.696 | 0.784 | -0.021 | 7.909 | -1.944 | -2.204 | -0.035 | -0.475* | 1.337 | -0.077 |
| PA 760 x PA 08 | 1.917* | 1.486 | -0.594 | -0.337 | -0.422 | -0.092 | 1.426 | 4.167** | 1.663 | 0.041 | -0.237 | 0.661 | -0.974 |
| PA 760 x PA 528 | -0.806 | 1.542 | -2.444 | -1.409 | 0.565 | 0.318** | -21.694* | -2.000 | -3.710* | -0.286 | 0.618** | -0.679 | 0.026 |
| PA 720 x PA 255 | 0.528 | 0.125 | -1.791 | -0.064 | -0.956 | -0.160 | -1.112 | 2.278 | 1.526 | 0.221 | -0.135 | 0.174 | -0.797 |
| PA 720x PA 402 | -0.639 | -1.653* | -2.705 | -0.360 | -1.162 | 0.023 | -1.095 | -2.111 | 1.421 | -0.281 | 0.663** | -0.688 | -1.041 |
| PA 720x X PA 08 | 0.083 | 0.569 | -1.210 | -0.330 | -1.417 | 0.218* | -16.045 | -1.000 | -5.113** | 0.262 | 0.564** | -0.033 | 1.439* |
| PA 720x x PA 528 | 0.028 | 0.958 | 5.706** | 0.755 | 3.535** | -0.081 | 18.252* | 0.833 | 2.165 | -0.202 | -1.091** | 0.547 | 0.399 |
| PAIG 326 x PA 255 | -0.139 | 0.125 | 1.851 | -1.953 | -2.202* | 0.255** | -5.683 | -0.556 | 0.989 | 0.400** | 0.258 | -0.252 | 0.692 |
| PAIG 326 x PA 402 | 0.028 | -1.236 | 0.887 | 1.001 | 1.326 | -0.108 | -3.966 | -0.056 | 1.133 | -0.382* | -0.528** | 1.673 | 0.271 |
| PAIG 326 x PA 08 | 1.750* | 2.653** | -3.052* | -1.396 | 2.070* | -0.072 | -17.349* | 4.167** | -3.850* | -0.189 | 0.084 | 0.104 | -1.355* |
| PAIG 326 x PA 528 | -1.639 | -1.292 | 0.314 | 2.349* | -1.194 | -0.075 | 26.998** | -3.667* | 1.728 | 0.171 | 0.185 | -1.526 | 0.397 |
| **S.E. ±** | 0.810 | 0.799 | 1.365 | 1.103 | 1.007 | 0.081 | 8.265 | 1.434 | 1.562 | 0.140 | 0.184 | 1.750 | 0.669 |

* Significant 5 per cent level
** Significant 1 per cent level

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