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# Estimation of standard heterosis and heterobeltiosis for yield and fiber quality traits in Karunganni cotton (*Gossypium arboreum* L)

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## ABSTRACT

*The primary objective of any plant breeding program is to develop high-yielding cultivars with desirable traits. In the context of cotton production, overcoming the yield plateau can be accomplished by identifying and utilizing hybrids that exhibit significant economic heterosis. Therefore, this study was undertaken to evaluate the heterotic potential of 30 hybrids generated from six parental plants. The experimental setup consisted of a full set of 36 entries, including the six parents, the 30 resulting F1 hybrids, and two standard checks (K12 and RG-8). All entries were sown during the Kharif season of 2022 at the Department of Cotton, TNAU. The analysis of variance revealed highly significant mean squares attributed to genotypes for each trait examined. Notably, the hybrids RG763 × K12, K12 × PDB29, and K12 × RG763 exhibited statistically significant and desirable heterosis for multiple yield-related traits, including the number of sympodia, boll weight, seed cotton yield per plant, seed index, and lint index. Moreover, the cross PDB29 × PA838 demonstrated positive heterosis for fiber quality parameters such as upper half mean length, fiber strength, and elongation percentage. Hence, these particular crosses hold the potential for exploitation in heterosis breeding programs aimed at enhancing cotton productivity.*

***Keywords:*** *Keywords: desi cotton, diallel, Gossypium arboreum, heterobeltiosis, standard heterosis, karunganni cotton.*

## INTRODUCTION

Cotton, a major crop in India, plays a crucial role in generating export revenue and driving economic growth by providing significant employment opportunities. However, cotton yields have stagnated in recent years, necessitating strategies to overcome this challenge. One approach is to leverage heterosis, a phenomenon where hybrids exhibit superior traits compared to their parents. This potential has not been fully realized due to the lack of systematic efforts in developing hybrid-oriented populations, lines with enhanced combining abilities, and novel hybrids derived from genetically diverse high-combining lines.
Cotton stands out as one of the few crops that allow the establishment of genotypes as varieties while also enabling the commercial exploitation of heterosis. Desi cotton (Gossypium arboreum L.), known for its resilience in harsh climatic conditions and variable rainfall patterns, continues to be cultivated. Desi cotton's natural resistance to pests and diseases, as well as its drought tolerance, has sparked interest in developing superior hybrids of Asiatic cotton. By capitalizing on the inherent strengths of desi cotton and harnessing heterosis, researchers aim to enhance cotton productivity and address the challenges faced in the cotton industry.
Heterosis, a phenomenon observed when offspring from genetically distinct parents display enhanced u in certain traits compared to the mid-parent, better parent, or standard check, plays a significant role in plant breeding programs. The primary objective of such programs is to develop cultivars that exhibit high-yield potential and desirable traits. In the case of cotton production, the identification of suitable high-yielding hybrids with substantial economic heterosis holds the key to breaking the yield plateau and increasing cotton output. Exploiting the genetic divergence and superior combining abilities of parental plants is crucial in generating prospective hybrids that can contribute to enhanced production and productivity in cotton.
Analyzing the effects of inbreeding and heterosis is vital for determining whether new cross combinations can be utilized to exploit heterosis or if they can help segregate beneficial and transgressive traits in subsequent generations, leading to the establishment of superior varieties. In the commercial exploitation of heterosis in cotton, it is crucial to identify parents that exhibit a high degree of heterosis through cross-pollination and to produce hybrid seeds at a reasonable cost. Numerous researchers have observed heterosis or hybrid vigor in cotton, with India being a pioneer in commercializing its utilization. The level of heterosis serves as a foundation for genetic diversity and a guide for selecting ideal parents to create superior F1 hybrids, thereby harnessing hybrid vigor and/or developing improved gene pools for population improvement purposes.

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In order to address future issues, the goal of the current work is to utilize heterosis for seed cotton yield and component qualities in arboretum cotton employing full diallel mating design.

## Materials and methods:

Six genotypes of Gossypium arboreum were employed as the genetic resources for this investigation. In a 6 × 6 diallel mating pattern with reciprocals, crosses between parents were made. The standard hand emasculation and pollination technique was used [1]. A full set of 36 entries, including six parents and the 30 F1s they produced, as well as two standard checks (K12 and R`G-8), were sowed during Kharif 2022 at the Department of Cotton, Tamil Nadu Agricultural University. Every entry was raised using a randomized block design (RBD), with each replication consisting of a single row spaced 90 x 45 cm apart. The mid-parent, better parent, and standard parent values were used to compute the F1 hybrids' percent increase (+) or decrease (-) in heterosis [2].

Thirteen quantitative parameters, including days to 50% flowering (days), plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, number of locules per boll, number of seeds per boll, days to boll bursting (days), boll weight (g), seed cotton yield per plant (g), seed index (g), lint index (g), and ginning out turn (%), as well as five qualitative parameters, including upper half mean length (mm), fiber strength (g/tex), uniformity index, elongation percent (%) and fiber micronaire (µg/inch), were recorded.

## Results

### *Analysis of variance (ANOVA)*

Table 1 presents the analysis of variance for various characteristics. The analysis revealed highly significant mean squares attributed to genotypes for each trait, indicating that the experimental material exhibited substantial genetic variability for the traits under investigation. The genotypic variance was further partitioned into variance components associated with parents, hybrids, and parents versus hybrids. For all traits, except for the mean square related to the uniformity index, both parents and hybrids contributed significantly to the observed variation. Additionally, the variance comparison between parents and hybrids provided a meaningful assessment of heterotic expression for nearly all attributes, except for days to 50% flowering, plant height, uniformity index, and fiber strength.

The estimates of heterobeltiosis and standard heterosis were represented in Tables 2 and 3 respectively.For days to 50% flowering, PDB29× PAIG379 displayed highest negative significance (-18.52%) for the better parent as well as for standard heterosis for both checks i.e., RG8 (-6.67%) and K12 (-15.67%). The high number of sympodia per plant with a smaller number of monopodial branches is an indication of higher productivity. For monopodia, PAIG379×PA838 and CNA1007 × PAIG379 showed the highest negative significance for better parent while PAIG379×PA838 and CNA1007 × PDB29 showed highest negative significance for standard heterosis. The cross combination, RG763×K12 and K12×RG763 showed the highest positive significance for better parents in case of a number of sympodia. CNA1007×PA838 and K12×RG763 showed the highest positive significance for standard heterosis.

In cotton, plant height is a crucial morphological characteristic because it creates room for the nodes and internodes from which monopodial and sympodial branches emerge. The architecture of the cotton plant is determined by the ratio of sympodial and monopodial branches, their size and orientation in a given genotype, together with the height of the plant. These branches serve as structural groupings or nodes for fruiting points, which, after floral shedding, are transformed into productive open bolls. CNA1007×PA838 (48.16%) and PDB29×PA838 (38.22%) recorded the highest heterosis for plant height.

Seed cotton yield per plant is widely recognized as one of the most crucial morphological traits in cotton production. It serves as a primary indicator of the overall productivity of cotton plants. In this study, several characteristics were evaluated to understand their influence on seed cotton yield per plant. Notably, the number of bolls per plant, boll weight, and number of seeds per boll were identified as the most significant factors directly contributing to the increase in seed cotton yield per plant. K12 × PDB29 showed highest positive significance against two checks for seed cotton yield per plant.

For ginning outturn, heterosis in a positive direction is desirable. The cross combination PA838 × RG763 (84.35%) recorded highest heterobeltiosis. Likewise, PA838 × PAIG379 displayed the highest heterosis and positive significance over two checks. For lint index, positive heterosis is desirable. The cross combinations PAIG379×K12 and K12 × PAIG379 recorded the highest heterobeltiosis for lint index. CNA1007×RG763, RG763×PAIG379, and PAIG379×K12 recorded positive and significant heterosis over both the checks.

In case of fiber quality parameters, PDB29× PA838 showed positive and significant heterobeltiosis for both fibre strength and elongation percentage. The reciprocal cross i.e., PA838×PDB29 recorded highest positive heterobeltiosis for upper half mean length. CNA1007× PAIG379 recorded the highest heterotic value in fiber micronaire content. The cross combination PDB29×PA838 recorded positive and significant heterosis over both the checks in upper half mean length, fiber strength and elongation percentage. RG763×K12 and RG763× CNA1007 recorded the highest and positive heterosis over both the checks in fibre micronaire.

The range of heterobeltiosis and standard heterosis for both the check varieties along with number of crosses with significant heterosis were listed in Table 4. Out of 30 hybrids, several hybrids exhibited significant and positive standard heterosis for all the characters studied whereas none of the hybrids recorded significant and positive heterosis for uniformity index.

The best and superior heterotic cross combinations having high mean, significant SCA and their standard heterosis value were listed in Table 5. These cross-combinations could be selected for the improvement of specific traits which in turn helps in the improvement of cotton breeding programmes.

## Discussion

The hybrid combination PDB29×PAIG379 showed the highest negative significance (-18.52%) for both better parent and standard heterosis for days to 50% flowering. This means that this hybrid combination exhibited an acceleratedd flowering time compared to the parents as well as the check varieties RG8 (-6.67%) and K12 (-15.67%). Similar findings of significant negative heterosis for days to 50% flowering have been reported by [3-7]. These studies have also observed hybrids with faster flowering times compared to their parents and check varieties. The negative heterosis for days to 50% flowering in these hybrid combinations suggests the potential for early maturation and reduced time to reach the flowering stage.

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This information is valuable for plant breeders and growers aiming to develop cotton varieties with accelerated flowering and maturity, which can be advantageous in certain cropping systems and environmental conditions.

The relationship between the number of sympodia and monopodial branches in plants and their impact on productivity is a topic of interest in agricultural research. It has been suggested that a high number of sympodia per plant, coupled with a smaller number of monopodial branches, indicates higher productivity. This is primarily attributed to increased branching, which potentially leads to a greater number of flowers or fruits. Analyzing various cross combinations, it was found that PAIG379×PA838 and CNA1007×PAIG379 exhibited the highest negative significance for better parent performance. Similarly, PAIG379×PA838 and CNA1007×PDB29 demonstrated the highest negative significance for standard heterosis. On the other hand, the cross combinations RG763×K12 and K12×RG763 showed the highest positive significance for better parents in terms of the number of sympodia. Additionally, CNA1007×PA838 and K12×RG763 exhibited the highest positive significance for standard heterosis. These findings shed light on the relationship between sympodia, monopodial branches, and plant productivity, offering valuable insights for plant breeding and agricultural practices. Positive heterosis for sympodia was also found by [6], [7], [8 –12].

In the context of cotton plants, plant height plays a vital role as a morphological characteristic. It directly influences the development of nodes and internodes, which subsequently give rise to monopodial and sympodial branches. The height of the plant is crucial in establishing the morphological framework that determines the type, length, and overall productivity of the cotton plants. The architecture of a cotton plant is determined by several factors, including the ratio of sympodial and monopodial branches, their size, orientation, and the overall height of the plant. These branches act as structural groupings or nodes that serve as the fruiting points. After shedding their flowers, these nodes transform into productive open bolls. When considering hybrid combinations in cotton, specific cross combinations have been observed to exhibit notable heterosis (hybrid vigor) for plant height. For instance, the cross combination CNA1007×PA838 displayed a heterosis of 48.16% for plant height. Similarly, the combination PDB29×PA838 recorded a heterosis of 38.22% for the same characteristic. These findings highlight the potential for increased plant height and subsequent implications for cotton plant architecture and productivity [3], [6], [7]. Understanding the heterosis observed in plant height in these cross combinations can provide valuable insights into cotton breeding programs and the selection of genotypes with desired morphological characteristics. By focusing on the interplay between plant height and branch development, researchers and breeders can contribute to the improvement of cotton plants' overall productivity and performance.

Among the evaluated hybrids, the cross K12 × PAIG379 exhibited the highest positive significance over the better parent for key traits such as the number of bolls per plant, boll weight, number of seeds per boll, and ultimately seed cotton yield per plant. This indicates that the hybrid combination K12 × PAIG379 outperformed the better parent and demonstrated superior performance in terms of these important characteristics, leading to a higher seed cotton yield per plant. Additionally, the hybrid K12 × PDB29 showed the highest positive significance when compared to two reference checks specifically for seed cotton yield per plant. This suggests that the hybrid K12 × PDB29 performed exceptionally well in terms of seed cotton yield per plant, surpassing the performance of the two reference checks used in the study. These findings emphasize the importance of selecting appropriate hybrid combinations to optimize seed cotton yield per plant in cotton breeding programs. The results suggest that the hybrid combinations K12 × PAIG379 and K12 × PDB29 hold great potential for achieving higher seed cotton yields, indicating their suitability for further utilization and development in cotton cultivation. Similar reports for seed cotton yield were found by [6, 7, 10, 13-18].

In cotton breeding, improving fiber quality traits such as ginning outturn and lint index is of utmost importance. Heterosis, or hybrid vigor, offers a promising avenue for achieving significant enhancements in these traits. Ginning outturn, which represents the percentage of lint obtained from harvested cotton, benefits from positive heterosis. Among the various cross combinations studied, the hybrid combination PA838×RG763 displayed the highest heterobeltiosis for ginning outturn, with an impressive value of 84.35%. This finding suggests a substantial improvement in fiber extraction efficiency compared to both the parent lines and the check varieties. Notably, similar results have been reported by earlier studies conducted by [19,20,21, 18, 7], highlighting the significant potential of heterosis in enhancing ginning outturn.

Similarly, the lint index, which considers both fiber length and strength, benefits from positive heterosis as well. The cross combinations PAIG379×K12 and K12×PAIG379 exhibited the highest heterobeltiosis for the lint index. Additionally, the combinations CNA1007×RG763, RG763×PAIG379, and PAIG379×K12 showed positive and significant heterosis compared to the check varieties. These findings align with the results reported by [5, 6, 22]further supporting the notion that heterosis plays a crucial role in improving lint index. The observed heterosis effects in ginning outturn and lint index underscore the potential for enhancing fiber quality in cotton through hybrid breeding strategies. By selecting the most favorable cross combinations and exploiting the heterotic effects, breeders can develop high-performing cotton varieties with improved fiber extraction efficiency and superior lint quality. These findings have practical implications for cotton breeders and growers, as they contribute to the ongoing efforts to meet the demands of the textile industry and ensure the competitiveness of cotton as a valuable agricultural crop.

In terms of fiber quality parameters, the hybrid combination PDB29×PA838 exhibited positive and significant heterobeltiosis for both fiber strength and elongation percentage. Conversely, the reciprocal cross PA838×PDB29 demonstrated the highest positive heterobeltiosis for the upper half mean length. Additionally, the cross combination CNA1007×PAIG379 showed the highest heterotic value in fibremicronaire content. Furthermore, the hybrid combination PDB29×PA838 displayed positive and significant heterosis over both the checks for upper half mean length, fibre strength, and elongation percentage. In the case of fibremicronaire, the hybrids RG763×K12 and RG763×CNA1007 exhibited the highest positive heterosis compared to the checks [ 23,24,25,26]. However, none of the hybrids exhibited significant heterosis for the uniformity index, which aligns with the findings of [27].These findings provide valuable insights into the fiber quality parameters and heterosis in cotton hybrids. They contribute to the understanding and selection of hybrids with desirable fibre traits, such as strength, elongation percentage and micronaire content.


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## Conclusion

On the basis of heterotic studies, RG763 × K12, K12×PDB29, K12×RG763 exhibited significant and desirable heterosis for various yield traits like a number of sympodia, boll weight, seed cotton yield per plant, seed index, and lint index. The cross PDB29×PA838 recorded positive heterosis for fiber quality parameters like upper half mean length, fiber strength and elongation percentage. Therefore, these crosses can be exploited for heterosis breeding programs to enhance the productivity of cotton.

**Future scope of the study:** This study will help in selecting particular crosses for heterosis breeding programs which will improve cotton productivity**.**

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**Conflict of Interest**: All the Authors have no conflict of interests

**Abbreviations:**

DFF-days to fifty per cent flowering (number of days) | PH-plant height (cm) | M-number of monopodia per plant | S-number of sympodia per | B-number of bolls per plant | L-number of locules per boll | DBB-days to first boll bursting (number of days) | BW-boll weight (g) SB- number of seeds per boll | SCY-seed cotton yield per plant (g) | SI-seed index (g) | LI-lint index (g) | GOT-ginning out turn (%) | UHML-upper half mean length (mm) | Str-fibre strength (g/tex) | UI-uniformity index | EL-elongation percentage (%) | Mic-fibre fineness (µg/inch)

***Table 1: Analysis of variance showing mean square values for yield and fibre quality traits***

| Source of Variations | df | DFF | PH | M | S | B | L | DBB | BW | SB | SCY | GOT | SI | LI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Genotypes** | 35 | 18.96** | 942.11** | 0.65** | 17.01** | 27.98** | 0.09** | 26.54* | 0.18** | 28.67** | 180.83** | 67.02** | 2.54** | 0.24** |
| **Parents** | 5 | 9.37** | 499.95** | 1.07** | 7.77** | 8.74** | 0.33** | 32.33** | 0.11** | 4.47** | 10.96** | 4.42 | 0.75** | 0.08** |
| **Hybrids** | 29 | 21.18** | 1050.11** | 0.60** | 18.93** | 31.66** | 0.04** | 25.42** | 0.20** | 33.56** | 215.80** | 78.53** | 2.90** | 0.25** |
| **Parent Vs. Hybrids** | 1 | 2.43 | 20.79 | 0.01** | 7.70** | 17.51** | 0.41** | 29.80** | 0.18** | 7.92** | 16.24* | 46.33** | 0.97** | 0.77** |
| **F1's** | 14 | 32.43** | 1327.26** | 0.74** | 22.87** | 16.05** | 0.01** | 17.15** | 0.17** | 26.11** | 151.54** | 6.74** | 0.58** | 0.20** |
| **Reciprocals** | 14 | 11.41** | 840.34** | 0.49** | 16.05** | 38.62** | 0.06** | 33.51** | 0.22** | 37.76** | 241.88** | 146.82** | 5.43** | 0.29** |
| **F1 Vs Reciprocals** | 1 | 0.44 | 106.85** | 0.17** | 4.06** | 152.64** | 0.03** | 28.01** | 0.22** | 79.12** | 750.26** | 127.48** | 0.043 | 0.38** |
| **Error** | 35 | 1.789 | 10.105 | 0.002 | 0.329 | 0.463 | 0.006 | 5.71 | 0.001 | 0.30 | 2.242 | 1.90 | 0.061 | 0.012 |
| **Total** | 71 | 10.267 | 469.55 | 0.324 | 8.553 | 14.026 | 0.049 | 15.90 | 0.093 | 14.290 | 90.333 | 33.98 | 1.283 | 0.128 |

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***Table 1: Analysis of variance showing mean square values for yield and fibre quality traits***

| Source of Variations | df | UHML | UI | Str | EL | Mic |
|---|---|---|---|---|---|---|
| **Genotypes** | 35 | 4.03** | 1.84 | 5.51** | 0.08** | 0.51** |
| **Parents** | 5 | 4.73** | 2.18 | 3.20** | 0.07** | 0.30** |
| **Hybrids** | 29 | 4.05** | 1.74 | 6.08** | 0.08** | 0.57** |
| **Parent Vs.Hybrids** | 1 | 0.04 | 3.04 | 0.45 | 0.05* | 0.09* |
| **F1's** | 14 | 3.15** | 2.16 | 7.78** | 0.14** | 0.52** |
| **Reciprocals** | 14 | 4.60** | 1.18 | 4.67** | 0.03** | 0.52** |


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|---|---|---|---|---|---|---|
| **F1 Vs Reciprocals** | 1 | 8.86** | 3.66 | 2.00* | 0.01 | 1.86** |
| **Error** | 35 | 0.52 | 1.529 | 0.301 | 0.010 | 0.013 |
| **Total** | 71 | 2.249 | 1.663 | 2.889 | 0.048 | 0.262 |

** significant at 1%, * significant at 5 %

DFF-days to fifty per cent flowering (number of days), PH-plant height (cm), M-number of monopodia per plant, S-number of sympodia per plant, B-number of bolls per plant, L-number of locules per boll, DBB-days to first boll bursting (number of days), BW-boll weight (g), SB- number of seeds per boll, SCY-seed cotton yield per plant (g), SI-seed index (g), LI-lint index (g), GOT-ginning out turn (%), UHML-upper half mean length (mm), Str-fibre strength (g/tex), UI-uniformity index, and EL-elongation percentage (%), Mic-fibre fineness (μg/inch)

***Table 2:Estimation of heterosis over better parent (Heterobeltiosis) for yield and fibre quality traits***

| S. No | Hybrids | DFF | PH | M | S | B | L | DBB | BW | SB | SCY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PDB29 × PAIG379 | -18.52 ** | -33.78 ** | -8.53 ** | -36.22 ** | -19.12 ** | -8.07 ** | -2.12 | 1.84 * | -18.69 ** | -13.41 * |
| 2 | PDB29 × RG763 | -9.01 * | 18.28 | 32.71 ** | -0.55 ** | -13.82 ** | -10.65 ** | 2.88 | -35.44 ** | -34.63 ** | -28.40 ** |
| 3 | PDB29 × CNA1007 | -3.83 | -31.47 ** | -1.49 ** | -30.20 ** | -19.40 ** | -12.21 ** | -7.47 * | -24.84 ** | -27.58 ** | -32.81 ** |
| 4 | PDB29 × PA838 | 12.39 | 30.00 ** | 77.58 ** | -2.45 * | -15.65 ** | -9.05 | 0.82 | -28.57 ** | -34.22 ** | -19.04 ** |
| 5 | PDB29 × K12 | 9.52 ** | -13.66 | -25.65 | -2.13 | -4.23 ** | -10.65 * | 0.22 | 2.30 ** | 1.21 | 10.68 * |
| 6 | PAIG379 × PDB29 | -9.34 ** | 4.07 ** | -16.82 ** | -1.61 ** | -9.08 ** | -7.46 ** | 2.63 | -10.60 * | -8.65 ** | 0.38 * |
| 7 | PAIG379 × RG763 | 1.89 * | -27.53 ** | -24.88 ** | -22.29 ** | -23.10 * | -3.97 | 4.47 | -14.90 ** | -16.06 * | -30.96 * |
| 8 | PAIG379 × CNA1007 | -10.94 ** | -28.60 ** | -53.69 ** | -21.07 ** | -22.06 ** | -16.50 ** | -1.39 | -14.78 ** | -29.56 ** | -33.10 ** |
| 9 | PAIG379 × PA838 | -12.34 ** | -0.91 | -54.15 ** | -20.14 ** | -5.95 * | -5.28 ** | 1.49 | 6.54 ** | -0.32 ** | 1.79 ** |
| 10 | PAIG379 × K12 | -10.82 ** | 2.87 | -35.87 ** | -0.03 | 8.82 ** | -4.60 | 3.57 | 17.89 ** | 20.02 ** | 21.36 ** |
| 11 | RG763 × PDB29 | -1.13 * | -13.82 | -61.02 ** | -20.94 ** | -11.78 ** | -8.37 ** | -4.70 | -2.26 ** | -5.32 ** | -7.92 ** |
| 12 | RG763 × PAIG379 | -12.10 * | -9.80 ** | 0.92 ** | -14.43 ** | 13.67 * | -4.13 | 4.23 | -4.51 ** | 5.49 * | 19.93 * |
| 13 | RG763 × CNA1007 | -7.84 * | -9.49 ** | 1.16 ** | -11.10 ** | -11.13 ** | -12.76 ** | -2.88 | -13.92 ** | -26.84 ** | -23.44 ** |
| 14 | RG763 × PA838 | -7.53 * | 31.29 ** | 0.93 ** | 1.03 | 5.86 ** | -9.80 ** | -5.51 | 6.55 * | -1.43 ** | 12.05 ** |


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|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | RG763 × K12 | -3.82 | 10.31 ** | -20.44 ** | 18.52 ** | -1.35 | 2.38 | 0.14 | 9.71 ** | 4.53 * | 10.73 ** |
| 16 | CNA1007 × PDB29 | -0.67 | -18.49 ** | 17.12 ** | -18.13 ** | -17.42 ** | -16.92 ** | -4.06 * | -14.56 ** | -24.25 ** | -28.47 ** |
| 17 | CNA1007 × PAIG379 | -7.78 ** | -53.20 ** | -54.15 ** | -39.52 ** | -21.76 ** | -16.37 ** | -3.17 | -23.34 ** | -31.59 ** | -34.64 ** |
| 18 | CNA1007 × RG763 | -3.25 * | -18.57 ** | -21.11 ** | -13.75 ** | -13.30 ** | -16.78 ** | -5.75 | -13.92 ** | -10.67 ** | -23.99 ** |
| 19 | CNA1007 × PA838 | -2.47 | 25.68 | 50.12 ** | 8.05 ** | -3.22 | -16.92 ** | -2.62 | -9.64 ** | -10.40 ** | -22.16 ** |
| 20 | CNA1007 × K12 | 2.24 | -36.59 ** | -20.04 ** | -33.00 ** | -19.88 ** | -16.50 ** | 1.45 * | -33.19 ** | -39.08 ** | -47.07 ** |
| 21 | PA838 × PDB29 | -4.41 | 17.95 ** | 36.87 ** | -9.06 * | -12.17 ** | -0.45 | 1.77 | 1.15 ** | -5.84 ** | -7.93 ** |
| 22 | PA838 × PAIG379 | -13.96 ** | -5.75 | -29.72 ** | -10.06 ** | 15.81 * | -9.50 ** | -1.55 | 19.11 ** | 17.86 ** | 16.32 ** |
| 23 | PA838 × RG763 | -3.55 * | 13.15 ** | 23.43 ** | -10.87 | 16.08 ** | -8.30 ** | 3.98 | 1.58 * | -21.73 ** | 6.60 ** |
| 24 | PA838 × CNA1007 | -1.80 | -34.60 | -17.37 ** | -28.70 ** | -2.64 | -16.09 ** | -4.93 | -19.06 ** | -15.14 ** | -29.41 ** |
| 25 | PA838 × K12 | 1.96 | 9.24 * | -23.25 ** | -7.44 ** | -8.05 ** | -3.02 | 2.17 | 6.81 | 4.39 | 3.81 |
| 26 | K12 × PDB29 | 7.00 ** | 15.53 | 19.84 | -6.87 | -17.32 ** | 24.05 * | -6.40 | 20.51 ** | -5.69 | 0.68 * |
| 27 | K12 × PAIG379 | -4.38 ** | 7.46 | -18.24 ** | 10.12 | 36.33 ** | -1.90 | 3.67 | 31.44 ** | 36.28 ** | 70.36 ** |
| 28 | K12 × RG763 | -1.24 | 18.57 ** | -19.64 ** | 12.67 ** | 6.51 | -6.83 | -5.46 | 0.90 ** | 4.85 * | 10.55 ** |
| 29 | K12 × CNA1007 | -1.83 | 2.31 ** | -0.20 ** | 8.20 ** | 2.13 ** | -18.03 ** | -10.76 * | 15.42 ** | 2.79 ** | 0.42 ** |
| 30 | K12 × PA838 | 0.27 | 1.99 * | -53.51 ** | -20.36 ** | -8.83 ** | -1.21 | 1.20 | -0.52 | 5.45 | 0.18 |
| | S.E | 1.3378 | 3.18 | 0.0428 | 0.5741 | 0.6813 | 0.0825 | 2.3886 | 0.0389 | 0.5562 | 1.4976 |

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| S.No | Hybrids | GOT | SI | LI | UHML | UI | Str | EL | Mic |
|---|---|---|---|---|---|---|---|---|---|
| 1 | PDB29 × PAIG379 | 4.71 | -9.03 * | -3.15 | 0.81 | 1.00 | -3.54 ** | 3.65 | -3.09 |
| 2 | PDB29 × RG763 | 1.12 | -6.85 ** | -5.83 ** | 0.15 | -0.50 | 8.86 | 7.80 * | 1.02 |
| 3 | PDB29 × CNA1007 | -8.19 * | -14.43 ** | -21.41 ** | 0.82 | -3.21 | -0.73 | 2.72 | -5.39 |
| 4 | PDB29 × PA838 | -6.84 * | 4.88 | 2.16 | 5.50 ** | -2.02 | 12.28 ** | 11.76 ** | 3.27 |
| 5 | PDB29 × K12 | 13.76 | -2.30 ** | 11.11 | -2.12 | -0.18 | -4.49 | 2.28 | -2.74 ** |
| 6 | PAIG379 × PDB29 | -1.42 | -1.13 * | -0.82 | 3.52 | -1.44 | -9.88 ** | -2.21 | 0.97 |
| 7 | PAIG379 × RG763 | -8.24 | -7.12 ** | -14.80 ** | -5.33 | 1.89 | -16.94 ** | -1.95 | 6.22 |
| 8 | PAIG379 × CNA1007 | -17.15 ** | -26.13 ** | -38.74 ** | 2.97 | -4.92 | -2.06 ** | 2.80 | 7.06 ** |
| 9 | PAIG379 × PA838 | -5.00 | -4.23 ** | -1.35 | -1.70 | -1.61 | -9.30 ** | -1.61 | 5.20 |
| 10 | PAIG379 × K12 | 13.04 * | 3.20 | 18.56 ** | -3.37 | 0.87 | -11.68 ** | -3.14 * | 8.23 |
| 11 | RG763 × PDB29 | 0.32 | -8.75 ** | -8.51 ** | -1.16 | -0.72 | -5.57 | 0.27 * | 2.21 |
| 12 | RG763 × PAIG379 | -3.72 | -13.09 ** | -16.43 ** | -0.52 | -0.48 | -12.53 ** | -1.61 | 0.51 |
| 13 | RG763 × CNA1007 | -11.04 ** | -14.23 ** | -23.75 ** | -8.74 | 1.73 | -9.82 | -5.29 | 7.92 ** |
| 14 | RG763 × PA838 | -5.73 ** | -8.44 ** | -13.75 ** | 5.78 ** | -0.47 | 11.00 ** | 2.87 * | -7.92 ** |
| 15 | RG763 × K12 | -4.18 | -1.81 | -5.94 * | -9.68 | 4.52 | -4.48 | 1.43 | 14.65 |
| 16 | CNA1007 × PDB29 | -8.11 * | -25.47 ** | -31.50 ** | -2.72 | -0.97 | -8.18 | -2.00 | -0.88 |
| 17 | CNA1007 × PAIG379 | -3.69 ** | -14.68 ** | -18.04 ** | -0.98 | -1.82 | -13.06 ** | -0.85 | 12.89 ** |
| 18 | CNA1007 × RG763 | -11.76 ** | -1.66 ** | -13.15 ** | 11.74 | -6.01 | 14.35 | 2.60 | -22.06 ** |
| 19 | CNA1007 × PA838 | -15.14 ** | -18.83 ** | -31.19 ** | 4.26 ** | -4.58 | -3.92 | -1.45 | 4.05 |
| 20 | CNA1007 × K12 | -10.23 ** | -14.68 ** | -23.45 ** | 2.06 | -4.53 | -10.05 | -2.00 | -1.94 |
| 21 | PA838 × PDB29 | -7.97 * | -0.88 | -4.58 | 10.77 ** | -4.39 | 8.23 ** | 7.60 ** | -12.29 |
| 22 | PA838 × PAIG379 | -1.58 | -11.62 ** | -5.53 | 2.16 | -1.74 | -3.96 ** | -2.63 | -8.73 |
| 23 | PA838 × RG763 | 84.35 ** | -57.12 ** | -20.98 ** | 9.64 ** | -1.44 | 12.70 ** | 6.91 * | -19.68 ** |
| 24 | PA838 × CNA1007 | -5.19 ** | -15.64 ** | -19.98 ** | 11.50 ** | -4.10 | 3.66 | 2.08 | -9.60 |
| 25 | PA838 × K12 | -0.38 | -4.02 | 2.02 | -0.71 | -2.54 | -4.24 | -0.27 | -3.79 |
| 26 | K12 × PDB29 | 1.66 | -10.67 ** | -9.21 | 1.03 | -0.28 | -2.40 | 2.55 | -13.44 ** |


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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 27 | K12 × PAIG379 | 7.24 * | 1.22 | 10.30 ** | -1.47 | -1.88 | -12.65 ** | -4.50 * | 1.67 |
| 28 | K12 × RG763 | 0.18 | -4.86 | -4.66 * | 5.85 | -1.78 | 8.80 | 3.23 | -12.27 |
| 29 | K12 × CNA1007 | -12.93 ** | -13.23 ** | -24.46 ** | -3.26 | -1.43 | 6.21 | 3.00 | -1.30 |
| 30 | K12 × PA838 | 0.61 | 0.62 | 8.09 | 3.07 | -1.91 | -0.72 | 2.35 | -5.46 |
| | S.E | 1.38 | 0.2484 | 0.1121 | 0.7229 | 1.3296 | 0.5496 | 0.1038 | 0.1544 |

** significant at 1%, * significant at 5 %

DFF-days to fifty per cent flowering (number of days), PH-plant height (cm), M-number of monopodia per plant, S-number of sympodia per plant, B-number of bolls per plant, L-number of locules per boll, DBB-days to first boll bursting (number of days), BW-boll weight (g), SB- number of seeds per boll, SCY-seed cotton yield per plant (g), SI-seed index (g), LI-lint index (g), GOT-ginning out turn (%), UHML-upper half mean length (mm), Str-fibre strength (g/tex), UI-uniformity index, and EL-elongation percentage (%), Mic-fibre fineness (µg/inch)

***Table 3:Estimation of heterosis over standard parent (Standard Heterosis) for yield and fibre quality traits***

| S. No | Hybrids | DFF | | PH | | M | | S | | B | | L | | DBB | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 |
| 1 | PDB29 × PAIG379 | -6.67 ** | -15.67 ** | -31.28 ** | -42.69 ** | -1.00 | -33.61 ** | -29.08 ** | -28.22 ** | -9.55 ** | -2.18 | -9.99 ** | -25.89 ** | 6.13 * | 4.77 |
| 2 | PDB29 × RG763 | -3.90 | -13.16 ** | 11.81 ** | -6.76 ** | 42.64 ** | -4.35 ** | 5.50 | 6.78 * | -2.90 | 5.02 | -12.52 ** | -27.98 ** | 10.06 ** | 8.65 ** |
| 3 | PDB29 × CNA1007 | -0.53 | -10.12 ** | -17.65 ** | -31.33 ** | -1.00 | -33.61 ** | -13.28 ** | -12.23 ** | -8.88 ** | -1.45 | -5.66 * | -22.33 ** | 3.26 | 1.94 |
| 4 | PDB29 × PA838 | 16.24 ** | 5.04 * | 22.89 ** | 2.48 | 50.12 ** | 0.67 | 24.48 ** | 25.99 ** | -5.66 * | 2.03 | -10.13 ** | -26.01 ** | 9.99 ** | 8.59 ** |
| 5 | PDB29 × K12 | 13.27 ** | 2.35 | -10.39 ** | -25.27 ** | -7.48 ** | -37.96 ** | 3.82 | 5.08 | 7.11 ** | 15.84 ** | -12.52 ** | -27.98 ** | 8.46 ** | 7.08 ** |
| 6 | PAIG379 × PDB29 | 14.55 ** | 3.51 | 3.78 | -13.45 ** | 8.23 ** | -27.42 ** | 11.19 ** | 12.54 ** | -13.83 ** | -6.80 * | -9.84 ** | -25.77 ** | 8.42 ** | 7.03 ** |
| 7 | PAIG379 × RG763 | 16.71 ** | 5.46 * | -24.80 ** | -37.28 ** | -18.70 ** | -45.48 ** | -13.59 ** | -12.54 ** | -13.36 ** | -6.29 * | -9.84 ** | -25.77 ** | 13.27 ** | 11.82 ** |
| 8 | PAIG379 × CNA1007 | 2.02 | -7.82 ** | -14.20 ** | -28.45 ** | -49.88 ** | -66.39 ** | -1.95 | -0.76 | -11.88 ** | -4.69 | -10.28 ** | -26.13 ** | 10.05 ** | 8.65 ** |
| 9 | PAIG379 × PA838 | 0.41 | -9.27 ** | 2.84 | -14.24 ** | -50.37 ** | -66.72 ** | 1.90 | 3.14 | -3.08 | 4.82 | -6.41 * | -22.94 ** | 10.72 ** | 9.31 ** |
| 10 | PAIG379 × K12 | 2.15 | -7.70 ** | 6.77 * | -10.96 ** | -20.20 ** | -46.49 ** | 11.16 ** | 12.51 ** | 1.29 | 9.55 ** | -10.43 ** | -26.26 ** | 12.29 ** | 10.85 ** |


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| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | RG763 × PDB29 | 0.69 | -9.02 ** | -6.39 * | -21.94 ** | 9.23 ** | -26.76 ** | -4.86 | -3.70 | 28.07 ** | 38.52 ** | -9.99 ** | -25.89 ** | 13.01 ** | 11.56 ** |
| 12 | RG763 × PAIG379 | 5.62 * | -4.57 * | -6.97 * | -22.41 ** | 7.48 ** | -27.93 ** | 4.61 | 5.88 | 12.67 ** | 21.86 ** | -6.11 * | -22.70 ** | 0.39 | -0.89 |
| 13 | RG763 × CNA1007 | -2.66 | -12.05 ** | 8.76 ** | -9.30 ** | 8.73 ** | -27.09 ** | 10.44 ** | 11.78 ** | 0.47 | 8.66 ** | -6.26 * | -22.82 ** | 8.39 ** | 7.01 ** |
| 14 | RG763 × PA838 | -2.34 | -11.75 ** | 22.15 ** | 1.86 | 8.48 ** | -27.26 ** | 28.91 ** | 30.48 ** | 19.27 ** | 29.00 ** | -10.88 ** | -26.63 ** | 3.09 | 1.77 |
| 15 | RG763 × K12 | 1.59 | -8.21 ** | 14.50 ** | -4.51 | -1.00 | -33.61 ** | 23.97 ** | 25.48 ** | 11.14 ** | 20.21 ** | -3.87 | -20.86 ** | 8.37 ** | 6.99 ** |
| 16 | CNA1007 × PDB29 | 5.64 * | -4.54 * | -43.76 ** | -53.10 ** | -50.37 ** | -66.72 ** | -24.87 ** | -23.95 ** | -11.55 ** | -4.33 | -10.13 ** | -26.01 ** | 8.06 ** | 6.68 ** |
| 17 | CNA1007 × PAIG379 | 2.19 | -7.67 ** | -2.14 | -18.39 ** | -15.21 ** | -43.14 ** | 7.14 * | 8.45 * | -1.98 | 6.02 * | -10.58 ** | -26.38 ** | 5.18 * | 3.84 |
| 18 | CNA1007 × RG763 | 2.45 | -7.43 ** | 20.17 ** | 0.21 | 0.50 | -32.61 ** | 24.23 ** | 25.73 ** | 13.06 ** | 22.28 ** | 7.45 ** | -11.53 ** | 11.60 ** | 10.18 ** |
| 19 | CNA1007 × PA838 | -0.08 | -9.71 ** | 51.03 ** | 25.95 ** | 50.87 ** | 1.17 | 37.87 ** | 39.55 ** | 9.42 ** | 18.34 ** | -10.73 ** | -26.50 ** | 8.67 ** | 7.29 ** |
| 20 | CNA1007 × K12 | 4.74 * | -5.36 * | -23.81 ** | -36.46 ** | -0.50 | -33.28 ** | -16.77 ** | -15.76 ** | -9.42 ** | -2.03 | -10.28 ** | -26.13 ** | 13.22 ** | 11.78 ** |
| 21 | PA838 × PDB29 | -1.44 | -10.94 ** | -2.19 | -18.43 ** | -23.94 ** | -49.00 ** | 14.76 ** | 16.16 ** | 19.34 ** | 29.07 ** | -10.58 ** | -26.38 ** | 7.41 ** | 6.04 * |
| 22 | PA838 × PAIG379 | 1.87 | -7.95 ** | 5.27 | -12.21 ** | 32.67 ** | -11.04 ** | 13.73 ** | 15.11 ** | 30.79 ** | 41.45 ** | -9.39 ** | -25.40 ** | 13.43 ** | 11.98 ** |
| 23 | PA838 × RG763 | 0.61 | -9.09 ** | -21.41 ** | -34.46 ** | -16.96 ** | -44.31 ** | -9.01 ** | -7.91 * | 10.07 ** | 19.05 ** | -9.84 ** | -25.77 ** | 6.10 * | 4.74 |
| 24 | PA838 × CNA1007 | 1.68 | -8.12 ** | -16.30 ** | -30.20 ** | -34.16 ** | -55.85 ** | 27.60 ** | 29.15 ** | 3.05 | 11.46 ** | -1.19 | -18.65 ** | 9.09 ** | 7.70 ** |
| 25 | PA838 × K12 | 3.68 | -6.32 ** | 13.38 ** | -5.44 * | -4.49 | -35.95 ** | 18.11 ** | 19.55 ** | -5.25 * | 2.48 | -4.17 | -21.10 ** | 11.46 ** | 10.04 ** |
| 26 | K12 × PDB29 | 9.53 ** | -1.03 | 11.54 ** | -6.98 ** | 1.75 | -31.77 ** | 22.44 ** | 23.93 ** | 26.90 ** | 37.25 ** | -7.90 ** | -24.17 ** | 12.40 ** | 10.96 ** |
| 27 | K12 × PAIG379 | 4.31 | -5.75 ** | 23.07 ** | 2.63 | 0.00 | -32.94 ** | 17.86 ** | 19.29 ** | 20.01 ** | 29.80 ** | -12.52 ** | -27.98 ** | 2.31 | 1.00 |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | K12 × RG763 | 0.57 | -9.12 ** | 22.94 ** | 2.53 | 24.19 ** | -16.72 ** | 34.41 ** | 36.05 ** | 15.47 ** | 24.89 ** | -11.92 ** | -27.48 ** | -0.41 | -1.68 |
| 29 | K12 × CNA1007 | 1.96 | -7.87 ** | 5.86 * | -11.72 ** | -42.14 ** | -61.20 ** | 1.62 | 2.85 | -6.05 * | 1.61 | -2.38 | -19.63 ** | 10.41 ** | 9.00 ** |
| 30 | K12 × PA838 | -1.04 | -10.58 ** | 3.79 | -13.44 ** | 24.44 ** | -16.56 ** | -5.78 | -4.63 | -6.92 ** | 0.67 | -6.11 * | -22.70 ** | 8.22 ** | 6.84 ** |
| | S.E | 0.9437 | | 2.3299 | | 0.0327 | | 0.4001 | | 0.5439 | | 0.0588 | | 1.6136 | |

**Contd...,**

| S. No | Hybrids | BW | | SB | | SCY | | GOT | | SI | | LI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 |
| 1 | PDB29 × PAIG379 | 4.99 * | -15.49 ** | -16.83 ** | -13.79 ** | -29.17 ** | -14.00 ** | 9.82 * | 1.91 | -1.68 | 3.59 | 7.94 * | 5.52 |
| 2 | PDB29 × RG763 | -32.07 ** | -45.32 ** | -30.19 ** | -27.63 ** | -35.93 ** | -22.20 ** | 15.23 ** | 6.93 | 7.12 ** | 12.85 ** | 23.36 ** | 20.60 ** |
| 3 | PDB29 × CNA1007 | -16.63 ** | -32.89 ** | -17.46 ** | -14.45 ** | -28.99 ** | -13.77 ** | 12.21 ** | 4.13 | 4.88 | 10.50 ** | 17.71 ** | 15.07 ** |
| 4 | PDB29 × PA838 | -26.37 ** | -40.73 ** | -32.71 ** | -30.25 ** | -33.78 ** | -19.58 ** | 6.04 | -1.60 | 9.20 ** | 15.05 ** | 15.73 ** | 13.13 ** |
| 5 | PDB29 × K12 | 5.46 ** | -15.11 ** | 3.53 | 7.31 ** | -9.46 ** | 9.94 ** | 20.59 ** | 11.90 ** | 3.81 | 9.37 ** | 25.19 ** | 22.39 ** |
| 6 | PAIG379 × PDB29 | -12.35 ** | -29.45 ** | -15.96 ** | -12.89 ** | -36.98 ** | -23.47 ** | 3.20 | -4.24 | 8.08 ** | 13.87 ** | 11.45 ** | 8.96 * |
| 7 | PAIG379 × RG763 | -10.45 ** | -27.92 ** | -10.35 ** | -7.07 ** | -38.23 ** | -24.99 ** | 4.57 | -2.97 | 6.81 ** | 12.53 ** | 11.60 ** | 9.10 * |
| 8 | PAIG379 × CNA1007 | -5.46 ** | -23.90 ** | -19.72 ** | -16.78 ** | -29.30 ** | -14.15 ** | 1.26 | -6.04 | -9.46 ** | -4.61 | -8.24 * | -10.30 ** |
| 9 | PAIG379 × PA838 | -3.33 | -22.18 ** | -15.46 ** | -12.37 ** | -22.59 ** | -6.00 | 8.13 | 0.33 | 3.51 | 9.05 ** | 11.76 ** | 9.25 * |
| 10 | PAIG379 × K12 | 3.33 | -16.83 ** | 0.87 | 4.56 | -21.33 ** | -4.47 | 19.83 ** | 11.19 ** | 11.54 ** | 17.51 ** | 33.59 ** | 30.60 ** |
| 11 | RG763 × PDB29 | 0.48 | -19.12 ** | 12.66 ** | 16.78 ** | 7.31 ** | 30.30 ** | 9.72 * | 1.81 | -0.05 | 5.30 | 9.47 * | 7.01 |
| 12 | RG763 × PAIG379 | 5.23 * | -15.30 ** | 6.80 ** | 10.71 ** | -10.52 ** | 8.65 ** | 13.96 ** | 5.74 | 15.00 ** | 21.16 ** | 30.99 ** | 28.06 ** |


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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | RG763 × CNA1007 | -4.51 * | -23.14 ** | -16.62 ** | -13.57 ** | -19.09 ** | -1.75 | 8.73 * | 0.89 | 5.13 * | 10.77 ** | 14.20 ** | 11.64 ** |
| 14 | RG763 × PA838 | 12.11 ** | -9.75 ** | 5.28 * | 9.13 ** | 0.26 | 21.74 ** | 7.42 | -0.32 | 5.29 * | 10.93 ** | 12.98 ** | 10.45 ** |
| 15 | RG763 × K12 | 15.44 ** | -7.07 ** | 11.64 ** | 15.72 ** | -0.93 | 20.30 ** | 9.19 * | 1.32 | 12.91 ** | 18.96 ** | 23.21 ** | 20.45 ** |
| 16 | CNA1007 × PDB29 | -14.96 ** | -31.55 ** | -22.03 ** | -19.18 ** | -30.93 ** | -16.13 ** | 17.71 ** | 9.23 * | 4.58 | 10.18 ** | 22.75 ** | 20.00 ** |
| 17 | CNA1007 × PAIG379 | -4.51 * | -23.14 ** | 1.81 | 5.53 * | -19.67 ** | -2.46 | 7.84 | 0.07 | 20.54 ** | 27.00 ** | 30.08 ** | 27.16 ** |
| 18 | CNA1007 × RG763 | 10.93 ** | -10.71 ** | 13.97 ** | 18.14 ** | 5.68 * | 28.33 ** | 22.22 ** | 13.41 ** | 22.57 ** | 29.14 ** | 49.77 ** | 46.42 ** |
| 19 | CNA1007 × PA838 | 0.24 | -19.31 ** | 2.12 | 5.85 * | -17.74 ** | -0.11 | 3.71 | -3.76 | -0.51 | 4.82 | 3.05 | 0.75 |
| 20 | CNA1007 × K12 | -25.89 ** | -40.34 ** | -30.57 ** | -28.03 ** | -44.06 ** | -32.08 ** | 9.72 * | 1.81 | 4.58 | 10.18 ** | 14.66 ** | 12.09 ** |
| 21 | PA838 × PDB29 | 8.08 ** | -13.00 ** | -0.04 | 3.62 | -11.55 ** | 7.41 * | 12.02 ** | 3.94 | -4.47 | 0.64 | 7.02 | 4.63 |
| 22 | PA838 × PAIG379 | 6.89 ** | -13.96 ** | -16.40 ** | -13.35 ** | -4.62 | 15.82 ** | 98.08 ** | 94.94 ** | -50.69 ** | -48.04 ** | 3.51 | 1.19 |
| 23 | PA838 × RG763 | -10.21 ** | -27.72 ** | -3.28 | 0.26 | -25.39 ** | -9.41 ** | 15.88 ** | 7.53 | 3.41 | 8.94 ** | 19.85 ** | 17.16 ** |
| 24 | PA838 × CNA1007 | -9.26 ** | -26.96 ** | -15.19 ** | -12.09 ** | -23.95 ** | -7.66 * | 13.82 ** | 5.62 | -0.36 | 4.98 | 13.28 ** | 10.75 ** |
| 25 | PA838 × K12 | -3.09 | -21.99 ** | -11.47 ** | -8.23 ** | -21.06 ** | -4.14 | 13.38 ** | 5.21 | 1.98 | 7.45 ** | 15.57 ** | 12.99 ** |
| 26 | K12 × PDB29 | 15.20 ** | -7.27 ** | 14.53 ** | 18.72 ** | 10.44 ** | 34.10 ** | 13.68 ** | 5.49 | 9.41 ** | 15.27 ** | 24.27 ** | 21.49 ** |
| 27 | K12 × PAIG379 | 6.18 ** | -14.53 ** | 11.99 ** | 16.08 ** | -1.08 | 20.12 ** | 14.17 ** | 5.94 | 9.41 ** | 15.27 ** | 24.89 ** | 22.09 ** |
| 28 | K12 × RG763 | 28.03 ** | 3.06 | 17.15 ** | 21.44 ** | 6.13 * | 28.87 ** | 6.41 | -1.25 | 6.35 * | 12.05 ** | 13.13 ** | 10.60 ** |
| 29 | K12 × CNA1007 | 10.45 ** | -11.09 ** | -10.56 ** | -7.29 ** | -23.82 ** | -7.50 * | 14.51 ** | 6.26 | 6.91 ** | 12.64 ** | 22.44 ** | 19.70 ** |
| 30 | K12 × PA838 | -39.19 ** | -51.05 ** | -40.59 ** | -38.42 ** | -35.18 ** | -21.29 ** | 6.01 | -1.63 | 6.25 * | 11.94 ** | 12.67 ** | 10.15 ** |
| | S.E | 0.0294 | | 0.4403 | | 1.2047 | | 1.0048 | | 0.1761 | | 0.0828 | |

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**Contd...,**

| S.No | Hybrids | UHML | | UI | | Str | | EL | | Mic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 | RG8 | K12 |
| 1 | PDB29 × PAIG379 | 23.01 ** | 3.58 | -4.08 | 2.35 | 26.58 ** | 10.80 ** | 17.63 ** | 8.44 ** | -8.33 ** | -6.34 ** |
| 2 | PDB29 × RG763 | 20.83 ** | 1.74 | -5.50 * | 0.83 | 27.43 ** | 11.54 ** | 15.80 ** | 6.75 ** | 2.81 | 5.04 * |
| 3 | PDB29 × CNA1007 | 18.51 ** | -0.21 | -6.96 ** | -0.72 | 16.21 ** | 1.72 | 8.96 ** | 0.44 | -11.05 ** | -9.12 ** |
| 4 | PDB29 × PA838 | 26.86 ** | 6.82 * | -6.96 ** | -0.72 | 31.43 ** | 15.05 ** | 18.98 ** | 9.68 ** | -1.19 | 0.96 |
| 5 | PDB29 × K12 | 15.05 ** | -3.12 | -5.20 * | 1.15 | 11.80 ** | -2.14 | 8.19 ** | -0.27 | -7.74 ** | -5.73 ** |
| 6 | PAIG379 × PDB29 | 22.02 ** | 2.75 | -5.88 * | 0.43 | 31.22 ** | 14.86 ** | 13.49 ** | 4.62 * | -17.18 ** | -15.38 ** |
| 7 | PAIG379 × RG763 | 15.52 ** | -2.73 | -4.10 | 2.32 | 8.99 ** | -4.60 | 11.27 ** | 2.58 | 6.12 ** | 8.43 ** |
| 8 | PAIG379 × CNA1007 | 25.64 ** | 5.80 * | -8.60 ** | -2.48 | 28.51 ** | 12.49 ** | 16.67 ** | 7.55 ** | -1.96 | 0.17 |
| 9 | PAIG379 × PA838 | 19.95 ** | 1.00 | -7.39 ** | -1.18 | 19.02 ** | 4.18 | 11.66 ** | 2.93 | -9.18 ** | -7.21 ** |
| 10 | PAIG379 × K12 | 17.90 ** | -0.72 | -5.06 | 1.30 | 15.89 ** | 1.44 | 9.92 ** | 1.33 | 1.11 | 3.30 |
| 11 | RG763 × PDB29 | 21.39 ** | 2.22 | -6.33 * | -0.05 | 14.77 ** | 0.46 | 11.66 ** | 2.93 | 1.11 | 3.30 |
| 12 | RG763 × PAIG379 | 20.65 ** | 1.59 | -7.47 ** | -1.27 | 13.66 ** | -0.51 | 7.42 ** | -0.98 | -0.94 | 1.22 |
| 13 | RG763 × CNA1007 | 10.10 ** | -7.29 * | -2.22 | 4.33 | 2.49 | -10.29 ** | 1.73 | -6.22 ** | 10.71 ** | 13.12 ** |
| 14 | RG763 × PA838 | 27.62 ** | 7.46 * | -6.61 * | -0.36 | 26.34 ** | 10.59 ** | 10.50 ** | 1.87 | -10.03 ** | -8.08 ** |
| 15 | RG763 × K12 | 8.97 ** | -8.24 ** | -3.29 | 3.19 | 8.57 ** | -4.97 | 8.96 ** | 0.44 | 15.82 ** | 18.33 ** |
| 16 | CNA1007 × PDB29 | 20.83 ** | 1.74 | -5.62 * | 0.70 | 14.08 ** | -0.14 | 12.52 ** | 3.73 * | 1.53 | 3.74 |
| 17 | CNA1007 × PAIG379 | 34.82 ** | 13.52 ** | -9.65 ** | -3.60 | 29.97 ** | 13.77 ** | 10.21 ** | 1.60 | -20.58 ** | -18.85 ** |
| 18 | CNA1007 × RG763 | 14.04 ** | -3.98 | -3.88 | 2.56 | 7.19 * | -6.18 * | 6.07 ** | -2.22 | -9.86 ** | -7.91 ** |
| 19 | CNA1007 × PA838 | 25.37 ** | 5.57 | -8.28 ** | -2.14 | 9.36 ** | -4.27 | 4.91 * | -3.29 | -5.02 * | -2.95 |
| 20 | CNA1007 × K12 | 18.29 ** | -0.40 | -8.23 ** | -2.08 | -3.58 | -15.60 ** | 3.95 * | -4.17 * | -12.67 ** | -10.77 ** |
| 21 | PA838 × PDB29 | 24.65 ** | 4.96 | -7.52 ** | -1.32 | 26.02 ** | 10.31 ** | 10.50 ** | 1.87 | -19.56 ** | -17.81 ** |
| 22 | PA838 × PAIG379 | 32.28 ** | 11.38 ** | -7.53 ** | -1.33 | 28.28 ** | 12.28 ** | 14.84 ** | 5.86 ** | -20.83 ** | -19.11 ** |
| 23 | PA838 × RG763 | 34.08 ** | 12.90 ** | -7.82 ** | -1.64 | 17.98 ** | 3.27 | 8.67 ** | 0.18 | -16.24 ** | -14.42 ** |
| 24 | PA838 × CNA1007 | 20.24 ** | 1.25 | -6.17 * | 0.12 | 13.82 ** | -0.37 | 6.45 ** | -1.87 | -13.86 ** | -11.99 ** |
| 25 | PA838 × K12 | 19.39 ** | 0.53 | -8.56 ** | -2.43 | 8.99 ** | -4.60 | 6.17 ** | -2.13 | -12.50 ** | -10.60 ** |
| 26 | K12 × PDB29 | 20.22 ** | 1.23 | -7.64 ** | -1.46 | 14.62 ** | 0.33 | 8.38 ** | -0.09 | -5.27 ** | -3.21 |
| 27 | K12 × PAIG379 | 27.71 ** | 7.54 ** | -9.11 ** | -3.03 | 23.66 ** | 8.24 ** | 10.89 ** | 2.22 | -0.43 | 1.74 |
| 28 | K12 × RG763 | 12.12 ** | -5.59 | -5.25 * | 1.10 | 13.85 ** | -0.35 | 9.25 ** | 0.71 | -7.57 ** | -5.56 ** |
| 29 | K12 × CNA1007 | 23.93 ** | 4.36 | -7.97 ** | -1.80 | 13.00 ** | -1.09 | 8.96 ** | 0.44 | 3.40 | 5.65 ** |
| 30 | K12 × PA838 | 15.90 ** | -2.41 | -7.76 ** | -1.58 | 4.99 | -8.10 ** | 5.68 ** | -2.58 | -6.80 ** | -4.78 * |
| | S.E | 0.521 | | 0.9312 | | 0.4039 | | 0.0689 | | 0.0781 | |

** significant at 1%, * significant at 5 %


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DFF-days to fifty per cent flowering (number of days), PH-plant height (cm), M-number of monopodia per plant, S-number of sympodia per plant, B-number of bolls per plant, L-number of locules per boll, DBB-days to first boll bursting (number of days), BW-boll weight (g), SB- number of seeds per boll, SCY-seed cotton yield per plant (g), SI-seed index (g), LI-lint index (g), GOT-ginning out turn (%), UHML-upper half mean length (mm), Str-fibre strength (g/tex), UI-uniformity index, and EL-elongation percentage (%), Mic-fibre fineness (µg/inch)

***Table 4: Range of Heterobeltiosis and Standard heterosis and total significant crosses for yield and fibre quality traits***

| S.No | Traits | Range of Heterosis (%) | | | Number of crosses with significant heterosis | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Heterobeltiosis | Standard Heterosis | | Heterobeltiosis | | standard Heterosis | | | |
| | | | | | | | RG-8 | | K-12 | |
| | | | RG-8 | K12 | +ve | -ve | +ve | -ve | +ve | -ve |
| 1 | Days to 50% Flowering | -18.52 to 12.39 | -6.67 to 16.71 | -15.67 to 5.46 | 3 | 15 | 8 | 1 | 2 | 25 |
| 2 | Plant Height | -53.20 to 30.00 | -43.76 to 51.03 | -53.10 to 25.96 | 9 | 10 | 13 | 11 | 1 | 23 |
| 3 | Monopodia | -61.02 to 77.58 | -50.37 to 50.87 | -66.39 to 1.17 | 9 | 19 | 11 | 11 | 0 | 28 |
| 4 | Sympodia | -39.52 to 18.52 | -29.08 to 37.87 | -28.22 to 39.55 | 4 | 20 | 15 | 6 | 17 | 6 |
| 5 | No.of Bolls | -23.10 to 36.33 | -13.83 to 30.79 | -6.8 to 41.45 | 7 | 19 | 13 | 11 | 17 | 2 |
| 6 | Locules | -16.92 to 24.05 | -12.52 to 7.45 | -27.98 to -11.53 | 1 | 19 | 1 | 25 | 0 | 30 |
| 7 | Days to Boll Bursting | -10.76 to 4.47 | -0.41 to 13.43 | -1.68 to 11.82 | 1 | 3 | 25 | 0 | 0 | 22 |
| 8 | Boll Weight | -35.44 to 31.44 | -39.19 to 28.03 | -51.05 to 3.06 | 13 | 15 | 13 | 13 | 0 | 29 |
| 9 | No.of Seeds/Boll | -39.08 to 36.28 | -40.59 to 14.53 | -38.42 to 18.14 | 7 | 19 | 8 | 16 | 12 | 16 |
| 10 | Seed Cotton Yield/plant | -47.07 to 70.36 | -44.06 to 10.44 | -32.08 to 34.10 | 13 | 15 | 4 | 22 | 11 | 13 |
| 11 | Ginning Outturn | -17.15 to 84.35 | 1.26 to 110.08 | -6.04 to 94.94 | 3 | 13 | 20 | 0 | 5 | 0 |
| 12 | Seed Index | -57.12 to 4.88 | -50.69 to 22.57 | -48.04 to 29.14 | 0 | 22 | 16 | 2 | 23 | 1 |
| 13 | Lint Index | -38.74 to 18.56 | -8.24 to 49.77 | -10.30 to 46.42 | 2 | 19 | 26 | 1 | 24 | 1 |
| 14 | Upper Half Mean Length | -9.68 to 11.74 | 8.97 to 34.82 | -8.24 to 13.52 | 6 | 0 | 30 | 0 | 7 | 2 |
| 15 | Uniformity Index | -6.01 to 1.89 | -9.65 to -2.22 | -3.60 to 4.33 | 0 | 0 | 0 | 24 | 0 | 0 |
| 16 | Fibre Strength | -16.94 to 12.28 | -3.58 to 31.43 | -15.6 to 15.05 | 4 | 9 | 27 | 0 | 12 | 2 |
| 17 | Elongation | -5.29 to 11.76 | 1.73 to 18.98 | -6.22 to 9.68 | 6 | 2 | 29 | 0 | 7 | 2 |
| 18 | Micronaire | -22.06 to 14.65 | -20.83 to 15.82 | -19.11 to 18.33 | 3 | 5 | 3 | 19 | 6 | 15 |

***Table5: Best heterotic combinations for various traits***


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| S.No | Traits | High Mean, Significant SCA | Standard heterosis over | |
|---|---|---|---|---|
| | | | RG-8 | K-12 |
| 1 | Days to 50% Flowering | PDB29×PAIG379 | -6.67 ** | -15.67 ** |
| | | PDB29×RG763 | -3.97 | -13.16 ** |
| | | PAIG379×PA838 | 0.41 | -9.27 ** |
| 2 | Plant Height | CNA1007×RG763 | 20.17 ** | 0.21 |
| | | CNA1007×PA838 | 51.03 ** | 25.95 ** |
| | | PDB29×PA838 | 22.89 ** | 2.48 |
| 3 | No. of monopodia | PAIG379×CNA1007 | -49.88 ** | -66.39 ** |
| | | CNA1007×PAIG379 | -15.37 ** | -43.14 ** |
| | | K12×CNA1007 | -42.14 ** | -61.20 ** |
| 4 | No. of sympodia | RG763×PA838 | 28.91 ** | 30.48 ** |
| | | RG763×K12 | 23.97 ** | 25.48 ** |
| | | PA838×CNA1007 | 27.60 ** | 29.15 ** |
| | | PA838×PDB29 | 14.76 ** | 16.16 ** |
| 5 | No.of Bolls/plant | K12×PDB29 | 26.90 ** | 37.25 ** |
| | | RG763×PA838 | 19.27 ** | 29.00 ** |
| 6 | Locules | PDB29×K12 | -12.52 ** | -27.98 ** |
| | | CNA1007×PDB29 | -10.13 ** | -26.01 ** |
| | | K12×RG763 | -11.92 ** | -27.48 ** |
| 7 | Days to Boll Bursting | PA838×RG763 | 6.10 * | 4.74 |
| 8 | Boll Weight | RG763×PA838 | 12.11 ** | -9.75 ** |
| | | RG763×K12 | 15.44 ** | -7.07 ** |
| | | K12×RG763 | 28.03 ** | 3.06 |
| 9 | No.of Seeds/Boll | K12×PDB29 | 14.53 ** | 18.72 ** |
| 10 | Seed Cotton Yield/plant | RG763×PA838 | 0.26 | 21.74 ** |
| | | RG763×K12 | -0.93 | 20.30 ** |
| | | K12×PDB29 | 10.44 ** | 34.10 ** |
| 11 | Ginning Outturn | PDB29×K12 | 20.59 ** | 11.90 ** |
| | | PAIG379×K12 | 19.83 ** | 11.19 ** |
| 12 | Seed Index | RG763×PAIG379 | 15.00 ** | 21.16 ** |
| | | RG763×K12 | 12.91 ** | 18.96 ** |
| 13 | Lint Index | PAIG379×K12 | 33.59 ** | 30.60 ** |
| | | K12×PDB29 | 24.27 ** | 21.49 ** |
| | | K12×PAIG379 | 24.89 ** | 22.09 ** |


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| | | | | |
|---|---|---|---|---|
| 14 | Upper Half Mean Length | PDB29×PA838 | 26.86 ** | 6.82 * |
| 15 | Uniformity Index | K12×RG763 | -5.25 * | 1.10 |
| 16 | Fibre Strength | PDB29×PA838 | 31.43 ** | 15.05 ** |
| | | RG763×PA838 | 26.34 ** | 10.59 ** |
| 17 | Elongation percentage | PDB29×PA838 | 18.98 ** | 9.68 ** |
| | | PAIG379×CNA1007 | 16.67 ** | 7.55 ** |
| 18 | Fibre Micronaire | PAIG379×RG763 | 6.12** | 8.43* * |
| | | K12×PAIG379 | -0.43 | 1.74 |
| | | RG763×K12 | 15.82** | 18.33** |

** significant at 1%, * significant at 5 %

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