# HETEROSIS IN AMERICAN COTTON (*G. hirsutum* L.) FOR JASSID RESISTANCE AND ITS CONTRIBUTING CHARACTERS

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**ABSTRACT**

A study of heterosis over standard checks was carried out during 2015-16. Fourteen non transgenic lines of *G. hirsutum* cotton from different sources were utilized for the development of 91 diallel $F_1$'s excluding reciprocals. The hybrids exhibited high heterosis over susceptible non transgenic check RCH-2 for jassid resistant characters and over standard non transgenic check, Ajeet 155 for other characters. The highest standard heterosis over the susceptible check for jassid resistant characters was observed in the trait number of trichomes per square cm on bract (252.91%) for the cross SCS1062 x PKV RAJAT, similarly lowest standard heterosis (-64.18%) was observed in the cross P2151 x DHY286 for the trait number of jassids per three leaf at 45 DAS. Similarly, for yield and yield contributing characters highest standard heterosis over the best check Ajeet155 was observed for lint index (29.27%) in the cross PH1075 x PH348, whereas, lowest standard heterosis was observed for ginning outturn (-48.18%) in a cross AKH8828 x AKH081. The cross SCS1062 x PKV RAJAT was found to be most promising for jassid resistant on the basis of performance and heterosis response. This can be exploited in further breeding program.

Key words: Cotton, standard heterosis, trichome, jassids, sucking pests, seed cotton yield.

## Introduction

Cotton (*Gossypiumhirsutum*), is one of the major cash crop under cultivation in Maharashtra. Genetic improvement in cotton is possible either through the exploitation of hybrid vigour or population improvement. Cotton crop is mainly cultivated for fibre. The success of breeding programme depends on the identification of genotypes with the ability to transmit high production potential into specific genotypic combinations. Heterosis is a performance of F1 genotypic combinations and is useful in determining the most appropriate parents for specific traits (Khan et al., 2010). Development of hybrids as a commercial variety is getting importance. Heterosis has substantially remained as one of the significant developments in cotton breeding programs (Baloch et al., 2014). The yield increase through intra- and inter-specific heterosis over the best commercial cultivar (useful heterosis) has been documented (Yuan et al., 2002).

The losses of crops caused by insect pests are quite high in both developed and developing countries. The assessment of correct percentage of yield losses by insects is a difficult task. Although crop protection with added investments aims to avoid or prevent crop losses or to reduce them to economically acceptable levels, the availability of quantitative data on the effect of different categories of pests is very limited. Yield loss estimates vary depending upon type of cultivar, density of pest population, time of pest attack in relation to crop phenology and cultural practices followed. Additionally, the losses caused by individual pest are not distinguished from the whole pest complex.

(Dhaliwal et al., 2013). The losses caused by insect pests increased considerable from early 1960 (18%) to 2000 (50%) due to intensive agriculture (Dhaliwal et al., 2004).

The estimates of *per se* performance and heterosis provided useful information with regard to the possibilities and extent of improvement in the characters of breeding material through selection. Any breeding programme has to consider the improvement in resistance to different pests, especially in crop like cotton. For a simultaneous selection of both resistance and yield, knowledge of inter relationship between the components of jassid resistance and those of yield is a pre-requisite. In cotton, heterosis studies for seed cotton yield and other characters are many. But to know the nature and extent of heterosis for jassid resistance with seed cotton yield and other traits are limited.

Therefore, the present study objective was to estimate the effects of heterosis in F1 cross combinations, to obtain information heterotic potential as to develop hybrid with improved yield along with jassid resistance through diallel analysis.

**Material and Methods**

Fourteen lines *viz.,* ADB542, SCS1062, RAH1065, PH1075, P2151, GBHV170, SCS793, DHY286, AKH8828, AKH081, PKV RAJAT, LRA5166, PH348 and NH615 were crossed in diallel fashion without reciprocals to obtain $F_1$ generations during *kharif*2014.

An experiment comprising of 91 $F_1$'s, fourteen parents and two standard check (RCH2 and Ajeet155) were assessed in randomized block design with three replications at three locations in Maharashtra state i.e. Aurangabad, Jalgaon and Yavatmal during *kharif*2015. Each genotype was represented by single row of 6 m length with a spacing of 90 cm between rows and 60 cm between plants. Non-experimental guard rows were provided to every plot to avoid any possible border effect. All the cultural practices were followed as per the recommendations for *American* cotton.

Observations on fifteen characters (viz., jassids per three leaf at 30 DAS, jassids per three leaf at 45 DAS, jassids per three leaf at 60 DAS, number of trichomes per square cm on leaf, number of trichomes per square cm on stem, number of trichomes per square cm on bract, length of trichomes on leaf, days to 50 per cent flowering, plant height, boll weight, number of bolls per plant, seed cotton yield, ginning outturn, seed index and lint index) were recorded in three environments and average values computed. Data were subjected to analysis and heterosis over standard check (SC) was calculated as per the standard procedure of Meredith and Bridge (1972).

**Results and Discussion**

The analysis of variance for mean sum of squares due to genotypes were highly significant for all the traits studied, which indicated the presence of substantial genetic variability among genotypes for all the characters studied. The mean squares due to hybrids as well as parents vs. hybrids comparison for all the characters were found highly significant indicating substantial amount of heterosis present in the population. The measures of heterosis over standard parent (RCH-2 and Ajeet155) are rational parameters for assessing its practical utility. Therefore, in present investigation heterosis is reported over standard parents. Several workers reported substantial heterosis for various agronomic traits.

The ranges for heterosis over standard checks for fifteen characters have been presented in Table 1, and the crosses showing maximum beneficial heterosis over standard check for different traits are presented in Table 2.

The highest negative heterosis for number of jassids per three leaf at 30 DAS which is desirable was recorded up to -40.36 percent in cross combination PH-1075 x LRA5166 over susceptible standard check RCH2, whereas highest positive heterosis over check Ajeet-155 was recorded by cross SCS793 x AKH8828. Similarly, highest heterosis in desirable direction for number of jassids per three leaf at 45 DAS was observed in a cross P2151 x DHY286 (-64.18%) followed by DHY286 x AKH081 over susceptible check RCH2. The manifestation of heterosis for number of jassids per three leaf at 60 DAS was ranged from -55.84 to 281.88 per cent. The highest negative useful heterosis was recorded by PH1075 x NH615

(-55.84%) followed by SCS1062 x PH348 (-46.23) and P2151 x DHY286 (-44.94). The parent DHY286 found to be associated with the jassid resistant in many of the heterotic cross combinations.

The number of trichomes per sq cm on leaf, stem and bract also plays an important role in imparting jassid resistant. The length and density of trichome had significant impact on the population of jassids. The highest standard heterosis for trichome density was observed over the susceptible check RCH2 in all the three parts. The cross SCS1062 x SCS793 (194.32 & 110.21%) showed highest useful heterosis for trichome density on leaf followed by DHY286 x NH615 (159.35 & 85.24%), whereas, SCS1062 x P2151 (134.81 & 52.57%) followed by RAH1065 x DHY286 (117.14 & 41.09%) for trichome density on stem and the cross SCS1062 x PKV Rajat (252.91 & 121.75%) followed by the cross P2151 x DHY286 (240.86 & 114.17%) was found promising over standard checks RCH2 and Ajeet155, respectively. The heterosis for length of trichome on leaf was found maximum in cross GBHV170 x AKH081 (55.84 & 39.56%) followed by DHY286 x PH348 (49.50 & 33.03%) and AKH8828 x AKH081 (34.42 & 19.61%) over the standard checks RCH2 and Ajeet155, respectively. The parents SCS1062, DHY286 and P2151 were found to be involved as a one of the parents in heterotic cross for the characters showing jassid resistance. Cotton trichomes are also found to be associated with reduced attack of leaf hopper (Jenkins and Wilson 1996; Bourland et al. 2003).

The early maturing hybrids are desirable to avoid the terminal stress occurred during growth, hence negative heterosis is desirable. The crosses, ADB542 X AKH8828 (-9.51 & -2.47%) and P251 X AKH8828 (-9.15 & -2.09%) were recorded significant negative heterosis for days to flowering over checks RCH2 and Ajeet155 and found earliest amongst all the hybrids studied. Significant negative heterosis for earliness was also reported by Das and Shunmugavalli (1986), Rajput et al. (1997), Potdukhe (2001) and Sawarkar et al. (2015).

The manifestation of heterosis for plant height (cm) and number of bolls/ plant was to the extent of 61 per cent and 44.11 per cent over standard check RCH2 and 25.72 per cent and 6.47 per cent over standard check Ajeet155, respectively. The cross SCS1062XGBHV170 had highest positive heterosis over standard parents for both the characters. In case of boll weight the highest economic heterosis was recorded by the crossADB542 x PH348 (61.99 & 3.78%) which was followed by ADB542 x AKH081 (49.82 & -4.02%) over standard checks RCH2 and Ajeet155, respectively. Deva et al.(2002), Kharde et al.(2004), Solanki et al.(2014) and Sawarkar et al. (2015) reported similar results in upland cotton. However, low and negative heterosis was reported by Thombre et al. (1982).

Seed cotton yield (kg/ha) is considered to be the most important character but in present study none of the cross showed significant positive heterosis for seed cotton yield (kg/plot) over the checks as they were most promising hybrids of the market. The range of heterosis for ginning outturn was from -48.18 per cent to 175.61 per cent. The highest magnitude of standard heterosis*i.e* 175.61 and 0.36% was showed by cross SCS1062XPH348 followed by SCS1062XP2151 (171.83 and -1.01%) over both checks, respectively. Seed index and lint yield are important quality attributing traits, for seed index highest value showed by cross AKH8828XAKH081 (31.75 and 12.67%) which was followed by the cross SCS1062XPKVRAJAT and P2151XAKH8828. In case of lint index, cross PH1075XPH348 exhibited highest standard heterosisi.e 14.43 and 29.27% followed by RHA1065XLAR166. The high and positive heterosis for yield, lint index and seed index were also observed bySiddiqui (1993), Pavasia et al. (1999), Deva et al.(2002), Patnaik et al.(2004), Khadi et al.(2004) Tuteja et al. (2013).

Thus, from the present investigation, it is concluded that while selecting potential crosses for its further use in breeding programs per se performance of parents and hybrids for various attributes must be taken into consideration in addition to percentage heterosis. Further, selection of crosses should not rest only on the per se performance of parents and heterosis for cotton seed yield but the performance of parents and their hybrids for various attributes should also be considered.

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**Table 1. Range of standard heterosis (%) for various characters**

| Sr. No. | Character | Range of heterosis (%) over check | | | |
|---|---|---|---|---|---|
| | | RCH2 | | Ajeet155 | |
| 01 | Jassids/3 leaf at 30 DAS | -40.36 | 27.71 | -37.47 | 33.89 |
| 02 | Jassids/3 leaf at 45 DAS | -64.18 | 32.34 | -32.08 | 150.94 |
| 03 | Jassids/3 leaf at 60 DAS | -55.84 | 58.7 | 6.25 | 281.88 |
| 04 | No of trichomes/ sq cm on leaf | -50.05 | 194.32 | -64.32 | 110.21 |
| 05 | No of trichomes/ sq cm on stem | -28.56 | 134.81 | -53.58 | 52.57 |
| 06 | No of trichomes/ sq cm on bract | -23.5 | 252.91 | -51.93 | 121.75 |
| 07 | Length of trichome on leaf (µM) | -51.07 | 56.84 | -56.46 | 39.56 |
| 08 | Days to 50% flowering | -9.51 | 14.08 | -2.47 | 22.96 |
| 09 | Plant height (cm) | 0.75 | 61.89 | -21.76 | 25.72 |
| 10 | Boll weight (gm) | -0.74 | 61.99 | -36.41 | 3.78 |
| 11 | No. of bolls/plant | 1.39 | 44.11 | -25.09 | 6.47 |
| 12 | Seed cotton yield (kg/plot) | -4 | 2.86 | -5.62 | 1.12 |
| 13 | Ginning outturn (%) | 42.32 | 175.61 | -48.18 | 0.36 |
| 14 | Seed index (g) | -5.61 | 31.75 | -19.28 | 12.67 |
| 15 | Lint Index (g) | -43.13 | 14.43 | -35.76 | 29.27 |

**Table 2. Crosses showing maximum beneficial standard heterosis for various characters**

| Sr. No. | Character | Range of heterosis % | | Best performing three crosses |
|---|---|---|---|---|
| | | Min | Max | |
| 01 | Jassids/3 leaf at 30 DAS | PH1075x LRA5166 | SCS793x AKH8828 | PH1075 x LRA5166 (-40.36% and -37.47%), PH1075 x GBHV170 (-39.56% and -36.63%) and P2151 x AKH8828 (-36.55% and -33.47%). |
| 02 | Jassids/3 leaf at 45 DAS | P2151x DHY286 | AKH8828 xAKH081 | P2151 x DHY286 (-64.18% and -32.08%), DHY286 x AKH081 (-58.21% and -20.75%) and PKV RAJAT x PH348 (-58.21% and -20.75%) |
| 03 | Jassids/3 leaf at 60 DAS | PH1075x NH615 | SCS793x AKH8828 | PH1075 x NH615 (-55.84% and 6.25%), SCS1062 x PH348 (-46.23% and 29.38%) and P2151 x DHY286 (-44.94% and 32.50%) |
| 04 | No of trichomes/ sq cm on leaf | RAH1065x LRA5166 | SCS1062x SCS793 | SCS1062XSCS793 (194.32% and 110.21%), DHY286XNH615 (159.35% and 85.24%) and ADB542XGBHV170 (155.06% and 82.18%) |
| 05 | No of trichomes/ sq cm on stem | AKH081x PKV RAJAT | SCS1062x P2151 | SCS1062 x P2151 (134.81% and 52.57%), RAH1065 x DHY286 (117.14% and 41.09%) and P2151 x LRA5166 (116.96% and 40.98%) |
| 06 | No of trichomes/ sq cm on bract | AKH081x PH348 | SCS1062x PKV RAJAT | SCS1062 x PKV RAJAT (252.91% and 121.75%), P2151 x DHY286 (240.86% and 114.17%) and SCS1062 x PH348(217.42% and 99.45%) |
| 07 | Length of trichome on leaf (micrometer) | RAH1065x DHY286 | SCS793x PH348 | GBHV170 x AKH081 (56.84% and 39.56%), DHY286 x PH348 (49.50% and 33.03%) and AKH8828 x AKH081 (34.42% and 19.61%) |
| 08 | Days to 50% flowering | ADB542x AKH8828 | SCS1062x SCS793 | ADB542 x AKH8828 (-9.51% and -2.47%), P2151 x AKH8828 (-9.15% and -2.09%) and AKH081 x PKV RAJAT (-8.98% and -1.90%) |
| 09 | Plant height (cm) | ADB542x NH615 | SCS1062x GBHV170 | SCS1062 x GBHV170 (61.89% and 25.72%), PH1075 x AKH081 (-53.95% and 19.55%) and PH1075 x GBHV170 (52.86% and 18.71%) |
| 10 | Boll weight (gm) | DHY286x NH615 | ADB542x PH348 | ADB542 x PH348 (61.99% and 3.78%), ADB542 x AKH081 (49.82% and -4.02%) and ADB542 x SCS793 (45.39% and -6.86%) |
| 11 | No. of bolls/plant | AKH8828x AKH081 | SCS1062x GBHV170 | SCS1062 x GBHV170 (44.11% and 6.47%), PH1075 x AKH081 (43.31% and 5.88%) and PH1075 x GBHV170 (41.59% and 4.61%) |
| 12 | Seed cotton yield (kg/plot) | PH1075x GBHV170 | ADB542x GBHV170 | None of the hybrid showed significant superiority over checks |
| 13 | Ginning outturn (%) | AKH8828x AKH081 | SCS1062x PH348 | SCS1062 x PH348 (175.61% and 0.36%), SCS1062 x P2151 (171.83% and -1.01%) and PH1075 x SCS793 (159.24% and -5.60%) |
| 14 | Seed index (g) | RAH1065x AKH8828 | AKH8828x AKH081 | AKH8828 x AKH081 (31.75% and 12.67%), SCS1062 x PKV RAJAT (23.83% and 5.90%) and P2151 x AKH8828 (23.40% and 5.53%) |
| 15 | Lint Index (g) | DHY286x AKH8828 | PH1075x PH348 | PH1075 x PH348(14.43% and 29.27%), RAH1065 x LRA5166 (10.96% and 25.34%) and SCS1062 x PH1075 (10.26% and 24.56%) |