EVALUATION OF GROWTH AND YIELD PERFORMANCE OF F₁ HYBRIDS OF BT AND NON BT COTTON FOR DEVELOPMENT OF SUPERIOR GENOTYPES

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ABSTRACT

The present study was conducted at experimental field of Nuclear Institute of Agriculture, Tandojam during 2014 to assess the genetic variations among cotton genotypes for various morphological and yield traits. The experiment was based on randomized complete block design with four replications. Six cultivars and their crosses (nine hybrids), in which three female parents as lines (Bt-008, IR-1525 and neelam-131) and three male parents as testers (NIA Sadori, NIA Ufaq and NIA Perkh) were evaluated. Results revealed statistically greater significant variations for all the traits under study. The results obtained demonstrated higher plant height (147.93 cm) by the hybrid Bt-008 x NIA, sympodial branches plant⁻¹ (28.06) in parent Neelam-131, monopodial branches plant⁻¹ (2.69) in NIA Perkh, bolls plant⁻¹ (45.66) in parent Neelam-131, boll weight (3.13 g) in cross IR-1525 x NIA Perkh, seed index (7.28 and 7.23 g) in parent IR-1525 and cross IR-1525 x NIA Perkh, lint index (11.45 g) in parent IR-1525, GOT% (43.26) in parent Neemal-131, staple length (32.56 and 32.43 mm) in two parents (Bt-008 and Neelam-131) and higher seed cotton yield plant⁻¹ (13.00 g) in parent Neelam-131. It can make a potential material for hybrid seed development. From this study, it is suggested that better performance of Neelam-131 and hybrid IR-1525 x NIA Perkh should be selected for improvement of a particular character.

KEYWORDS: Evaluation, BT cotton, non-BT cotton, hybrids, yield, yield components

INTRODUCTION

Pakistan economy depends heavily on cotton crop which significantly contributes by providing raw material to the textile industry, such as cotton lint as an export item. It accounts for 7.0 percent of value added in agriculture and 1.5 percent of GDP. During 2012-13, the crop was sown on an area of 2879 thousand hectares, 1.6 percent more than last year (2835 thousand hectares). The production of 13.0 million bales during the period 2012-13 against the target of 14.5 million bales resulted in decline of 10.3 percent against the target and decrease of 4.2 percent over the preceding year production which was 13.6 million bales (GOP, 2012-13).

Today, man is still trying to change the cotton plant so as to improve its quantitative and qualitative traits in order to fulfill the ever increasing and changing requirements of the human beings. Seed cotton yield is related to its components and the components are related among themselves. The cause of relationship might be due to developmental (Adams and Grafius, 1971) or genetical factors (BingTang, 1992). The morphological yield components in cotton are developed in a sequence, where yield is the end product. Therefore, developmental relationship might play an important role in the association of yield and yield contributing characters. On the other hand, genetic relationship between yield and yield contributing characters may also exist because the characters are polygenically inherited and there is possibility of having loci of two or more characters on the same chromosome (Endrizzi et al., 1985). The genetic relationship is easy to manipulate by random mating before selection. But if the relationship is due to purely developmental factors then it is hard to manipulate (Grafius, 1978).

In making various crosses breeders have interests in discovering the answer to the following questions: how significant is genetic variation? How much of the variation is heritable? And what types of gene affecting that significance? However, these are answered by comparing the variances of the segregating and the non-segregating generations (Kearsey and Pooni, 1996). Another interest of the breeder is identifying plants with superior genotypes as judged by the performance of their progeny. Suitable inbreds or lines are selected based on combining ability effects with better mean performance. Jatoi et al.
(2007) showed significant difference among various genotypes for yield and its components. To develop an efficient breeding strategy for a crop, a sufficient knowledge of the mode of inheritance of quantitative traits is also very essential. In this context, heritability of a character helps the plant breeder in predicting the behaviour of the succeeding generations for making desirable selection. The higher the heritability, the simpler the selection process and greater the response to selection (Larik et al., 1999, 2000). This study was therefore, carried out in six cultivars and their crosses with a view to examine their performance and to select high yielding cultivars. This will also lead to selection of desired traits in the cultivars under study for utilizing them in future breeding program.

MATERIALS AND METHODS
The present study was conducted at the experimental field of Nuclear Institute of Agriculture, Tandojam during 2014 to assess the genetic variations among cotton genotypes for various morphological and yield traits. The experiment was based on randomized complete block design with four replications. Six cultivars and their crosses, in which three female parents as lines (Bt-008, IR-1525 and neelam-131) and three male parents as testers (NIA Sadori, NIA Ufaq and NIA Perkh) were used during F1 crosses. The varietal performance was evaluated for yield and yield components. The detail of the genetic materials and their crosses is given below:

Parents and their crosses
Female parents
P1 = Bt-008  
P2 = IR-1525  
P3 = Neelam-131

Male parents
P4 = NIA Sadori  
P5 = NIA Ufaq  
P6 = NIA Perkh

F1 hybrids
C1 = Bt-008 × NIA Sadori  
C2 = Bt-008 × NIA Ufaq  
C3 = IR-1525 × NIA Sadori  
C4 = IR-1525 × NIA Ufaq  
C5 = IR-1525 × NIA Perkh  
C6 = Neelam-131 × NIA Sadori  
C7 = Neelam-131 × NIA Ufaq  
C8 = Neelam-131 × NIA Perkh

The seeds of parents and their F1 hybrids were obtained from Nuclear Institute of Agriculture and sown through dibbling method while keeping row to row distance by 75 cm apart using seed rate of 30 kg ha⁻¹ in Randomized Complete Block Design with four replications. Before first irrigation, seedlings were thinned to maintain plant to plant distance of 30 cm, while row to row distance was kept 75 cm. Fertilizer at the rate of 125-75 kg NP ha⁻¹ was applied in the form of Urea and DAP. Full dose of phosphorus with 1/3rd of nitrogen was applied at the time of land preparation while remaining 2/3rd nitrogen was splitted in three equal doses at first irrigation, flowering and boll setting stages respectively. All the required cultural practices including weeding etc. were adopted uniformly in all replications throughout the growing period. For collection of the data for yield and yield components, ten randomly tagged index plants in each sub-plot of each replication. The data were recorded on plant height (cm), sympodial branches plant⁻¹, monopodial branches plant⁻¹, bolls plant⁻¹, boll weight (g), seed index (g), lint index (g), GOT (%), staple length (mm) and seed cotton yield plant⁻¹ (g).

1. Plant height (cm)
Height of each selected plant was measured in centimeters from ground to the tip of the plant with the help of measuring tape.

2. Sympodial branches plant⁻¹
Branches bearing fruiting bodies were counted in each index plant and average recorded.

3. Monopodial branches plant⁻¹
Branch arise from the base of the main stem and resemble like main stem counted in each index plant and average recorded.

4. Bolls plant⁻¹
Number of bolls from each tagged plant were counted and recorded.
5. Boll weight (g)
For boll weight seed cotton of 10 randomly selected bolls was picked at maturity and weighed through electric balance and average worked out.

6. Seed index (g)
Three samples of 100-seeds each were taken at random from each index plant and weighed in grams and finally average worked out and recorded as seed index.

7. Lint index (g)
Lint index is the weight of lint in grams obtained from one hundred seeds.

8. Ginning outturn (G.O.T.) % or lint percentage.
Clean and dry sample of seed cotton per plant was weighed and then ginned on single roller electric gin. The lint obtained from each plant was weighed and G.O.T. % worked out by dividing lint weight by total seed cotton weight in terms of percentage.

\[
\text{Ginning outturn percentage} = \frac{\text{weight of lint plant}^{-1} (g)}{\text{Weight of seed cotton plant}^{-1} (g)} \times 100
\]

9. Staple length (mm)
Staple length was measured in millimeters by tuft method. Three samples were drawn from each plant, tufts were made and measured in millimeters. The average staple length was then calculated.

10. Seed cotton yield plant
At maturity, seed cotton of all the tagged plants was picked separately and weighed through electric balance in grams.

**Statistical analysis**
The data were computed through analysis of variance (ANOVA) to found the significant differences among cultivars (Gomez and Gomez, 1984), while LSD test (P≤0.05) was performed for mean comparison among cultivars by using computer software Statistix 8.1 (Math Soft Inc., Cambridge, MA, USA).

**RESULTS AND DISCUSSION**
The present study was conducted at the experimental field of Nuclear Institute of Agriculture, Tandojam to assess the genetic variations among cotton cultivars for various morphological and yield traits. Six cultivars and their crosses, in which three female parents as lines (Bt-008, IR-1525 and neelam-131) and three male parents as testers (NIA Sadori, NIA Ufaq and NIA Perkh) were evaluated during this study. In this study 10 different characters of cotton cultivars and their crosses were investigated which included plant height (cm), sympodial branches plant\(^{-1}\), monopodial branches plant\(^{-1}\), bolls plant\(^{-1}\), boll weight (g), seed index (g), lint index (g), GOT (%), Staple length (mm) and seed cotton yield plant\(^{-1}\) (g). The results of statistical analysis regarding performance of parents and their F\(_1\) hybrids for analysis of variance is given in Table 1. While, Mean performance of parents and their hybrids for various quantitative and qualitative characters is presented in Table 2. The analysis of variance (ANOVA) for all the characters is given in Table 1. Results showed that parents and their F\(_1\) hybrids differed highly significantly (P≤0.01) for plant height, sympodial branches plant\(^{-1}\), monopodial branches plant\(^{-1}\), bolls plant\(^{-1}\), boll weight, seed index, lint index, GOT%, staple length and seed cotton yield plant\(^{-1}\). This shows the presence of considerable genetic variability among the parents and their F\(_1\) hybrids for further evaluation and use. Similar significant differences among cotton cultivars for growth, yield and yield related traits were reported by Baloch et al. (2010). Mean performance of parents and their hybrids for various quantitative and qualitative characters is presented in Table 2. The LSD test for comparison of means at 5% probability level revealed that cross Bt-008 x NIA Sadori produced significantly tallest plants (147.93 cm) followed by plant height of 144.13 and 142.70 cm in crosses of Bt-008 x NIA Perkh and Neelam-131 x NIA Ufaq which were statistically at par from one another. While cross Neelam-131 x NIA Perkh exhibited shortest plants of 109.67 cm as compared to the rest of the genotypes. As regards sympodial branches plant\(^{-1}\), parents Neelam-131 and NIA Perkh showed non-significantly highest number (28.06 and 27.90) followed by 25.83, 27.26 in the parents of NIA Sadori and NIA Ufaq while 25.13, 24.96, 24.76 and 24.73 in progeny of Bt-008 x NIA Ufaq, Bt-008 x NIA Perkh IR-1525 X NIA Sadori and IR-1525 X NIA Perkh respectively which were statistically non-significant from each other. However, the crosses Neelam-131 x NIA Ufaq and Neelam-131 x NIA Ufaq displayed non-significantly lowest number of sympodia plant\(^{-1}\). Hu ShouLin et al. (2001) while working on cotton also noted significant differences among the various cultivars for morphological traits including sympodia. Whereas for the character monopodial branches per plant, the parents NIA Ufaq NIA Perkh manifested highest but statistically at par monopodia (2.68 and 2.69) followed by 2.17 monopodia plant\(^{-1}\) in progeny Neelam-131 x NIA Perkh and the genotype Neelam-131 showed lowest monopodial branches (0.80) per plant. In case of bolls plant\(^{-1}\), two parents IR-1525 and Neelam-131 and one cross Bt-008 x NIA Perkh revealed highest bolls plant\(^{-1}\) (44.33, 45.66 and 45.90) which were statistically at par from each other while the crosses IR-1525 x NIA Sadori, IR-1525 x NIA Ufaq and IR-1525 x NIA Perkh demonstrated non-significantly the lowest bolls plant\(^{-1}\) (28.43, 27.80 and 26.43).
Remaining genotypes and their crosses showed non-significant differences for number of bolls plant\(^{1}\). Similarly, significantly higher boll weight of 3.13 g was recorded at the cross of IR-155 x NIA Perkh followed by 2.84 g in parent IR-1525 while non-significantly lower boll weight of 2.41, 2.42, 2.31 and 2.32 g in parents like Bt-008, Neelam-131 and NIA Sadari along with one cross Neelam-131 x Sadari. Statistically, all the remaining parents and their crosses revealed at par differences of boll weight. Baloch et al. (2010) also recorded similar substantial variations among cotton cultivars for boll weight. The findings of Jatoi et al. (2007) and Tahira et al. (2007) are in accordance with this result where cotton cultivars were evaluated for studying their yield and yield related traits.

Mean performance regarding seed index, the higher seed index (7.28 and 7.23 g) was obtained from parent IR-1525 and cross IR-1525 x NIA Perkh followed by 6.94 g in the cross IR-1525 x NIA Sadari while, the cross Neelam-131 x NIA Ufaq gave minimum seed index (5.78 g). Whereas, the three parents such as Bt-008, IR-1525 and Neelam-131 exhibited non-significantly highest lint index of 11.40, 11.45 and 11.29 g among all the entries while, the parent NIA Sadari gave lowest lint index (8.92 g). Statistically, the remaining parents and their crosses showed at par differences for lint index in which the parents indicated higher lint index over their crosses. The findings of present research for lint % findings were in agreement with those of Baloch (2002). The parent Neelam-131 gave highest GOT% (43.26%) followed by 42.73% in parent IR-1525 whereas the cross Neelam-131 x NIA Ufaq was the lowest (30.83%). Kakar et al. (2013) suggested that selection based on greater GOT% often indicates enhancement in the yield plant\(^{1}\) as well as per unit area. Maximum but non-significant staple length (32.56 and 32.43 mm) was obtained from parent of Bt-008 and Neelam-131 followed by 32.10 mm in parent IR-1525 and 31.23 and 31.56 mm in crosses of Neelam-131 x NIA Ufaq and Neelam-131 x NIA Perkh which statistically at par from each other. However, the genotypes NIA Sadari and NIA Ufaq revealed lower but non-significant staple length of 23.86 and 24.70 mm. The yield components play an important role in yield as shown by parent Neelam-131 which revealed high seed cotton yield plant\(^{1}\) (135.00 g plant\(^{-1}\)) because most of the components were higher at this genotype. While the parent NIA Sadari gave lowest seed cotton yield of 97.60 g plant\(^{-1}\). Similar findings about seed cotton yield of various cotton genotypes were reported by Panhwar et al. (2008). It can make a potential material for hybrid seed development.

Conclusion

The genotype Neelam-131 revealed better performance in 10 quantitative and qualitative characteristics. Among the progenies, the cross IR-1525 x NIA Perkh displayed better performance for boll weight and seed index. It is suggested that better performance of Neelam-131 and hybrid IR-1525 x NIA Perkh should be selected for improvement of a particular character.

Table 1: Mean squares of Parents and F\(_1\)s for seed cotton yield and its components

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Character</th>
<th>DF (n-1)</th>
<th>Mean squares</th>
<th>F-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plant height (cm)</td>
<td>14</td>
<td>320.730</td>
<td>6.61</td>
<td>**</td>
</tr>
<tr>
<td>2</td>
<td>Sympodia Plant(^{1})</td>
<td>14</td>
<td>46.0787</td>
<td>30.81</td>
<td>**</td>
</tr>
<tr>
<td>3</td>
<td>Monopodia Plant(^{1})</td>
<td>14</td>
<td>1.06495</td>
<td>83.08</td>
<td>**</td>
</tr>
<tr>
<td>4</td>
<td>Bolls plant(^{1})</td>
<td>14</td>
<td>137.425</td>
<td>3.13</td>
<td>**</td>
</tr>
<tr>
<td>5</td>
<td>Boll weight (g)</td>
<td>14</td>
<td>0.15895</td>
<td>7.40</td>
<td>**</td>
</tr>
<tr>
<td>6</td>
<td>Seed index (g)</td>
<td>14</td>
<td>0.71690</td>
<td>13.44</td>
<td>**</td>
</tr>
<tr>
<td>7</td>
<td>Lint index (g)</td>
<td>14</td>
<td>1.48639</td>
<td>4.06</td>
<td>**</td>
</tr>
<tr>
<td>8</td>
<td>GOT %</td>
<td>14</td>
<td>28.6196</td>
<td>12.80</td>
<td>**</td>
</tr>
<tr>
<td>9</td>
<td>Staple length (mm)</td>
<td>14</td>
<td>26.5027</td>
<td>23.41</td>
<td>**</td>
</tr>
<tr>
<td>10</td>
<td>Seed cotton yield plant(^{1}) (g)</td>
<td>14</td>
<td>445.425</td>
<td>6.30</td>
<td>**</td>
</tr>
</tbody>
</table>

** = Significant at 1% level of probability
### Table 2: Mean performance of parents and their crosses for quantitative and qualitative traits in F1 generation

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parents and crosses</th>
<th>Plant height (cm)</th>
<th>Symp. Plant$^1$</th>
<th>Monop. Plant$^1$</th>
<th>Bolls plant$^1$</th>
<th>Boll weight (g)</th>
<th>Seed index (g)</th>
<th>Lint index (g)</th>
<th>GOT %</th>
<th>Staple length (mm)</th>
<th>Seed cotton yield plant$^{-1}$ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bt-008</td>
<td>141.00abc</td>
<td>17.20d</td>
<td>1.22e</td>
<td>41.20b</td>
<td>2.41cd</td>
<td>6.61a-d</td>
<td>11.40a</td>
<td>41.73abc</td>
<td>32.56a</td>
<td>128.47abc</td>
</tr>
<tr>
<td>2</td>
<td>IR-1525</td>
<td>127.67a-d</td>
<td>18.30d</td>
<td>1.13ef</td>
<td>44.33a</td>
<td>2.88ab</td>
<td>7.28a</td>
<td>11.45a</td>
<td>42.73ab</td>
<td>32.10ab</td>
<td>131.73ab</td>
</tr>
<tr>
<td>3</td>
<td>Neelam-131</td>
<td>120.87cd</td>
<td>28.06a</td>
<td>0.80f</td>
<td>45.66a</td>
<td>2.42cd</td>
<td>6.60a-d</td>
<td>11.29a</td>
<td>43.26a</td>
<td>32.43a</td>
<td>135.00a</td>
</tr>
<tr>
<td>4</td>
<td>NIA Sadori</td>
<td>125.27bcd</td>
<td>25.83ab</td>
<td>0.96ef</td>
<td>30.80a</td>
<td>2.31d</td>
<td>5.89ef</td>
<td>8.92c</td>
<td>36.46d</td>
<td>23.86e</td>
<td>97.60d</td>
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<tr>
<td>5</td>
<td>NIA Ufaq</td>
<td>128.93abcd</td>
<td>27.26ab</td>
<td>2.68a</td>
<td>35.33a</td>
<td>2.52bcd</td>
<td>6.22c-f</td>
<td>9.73abc</td>
<td>37.60cd</td>
<td>24.70e</td>
<td>98.07d</td>
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<tr>
<td>6</td>
<td>NIA Perkh</td>
<td>134.80abc</td>
<td>27.90a</td>
<td>2.69a</td>
<td>37.80c</td>
<td>2.72a-d</td>
<td>6.10def</td>
<td>9.44bc</td>
<td>36.10d</td>
<td>25.96cde</td>
<td>99.63d</td>
</tr>
<tr>
<td>7</td>
<td>Bt-008 x NIA Sadori</td>
<td>147.93a</td>
<td>24.03b</td>
<td>1.93bcd</td>
<td>40.43b</td>
<td>2.66bcd</td>
<td>6.83abc</td>
<td>10.20abc</td>
<td>38.38bcd</td>
<td>25.53de</td>
<td>105.63cd</td>
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<td>8</td>
<td>Bt-008 x NIA Ufaq</td>
<td>134.07abc</td>
<td>25.13ab</td>
<td>1.79cd</td>
<td>43.20b</td>
<td>2.50bcd</td>
<td>6.50b-e</td>
<td>10.30bac</td>
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<td>9</td>
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<td>144.13ab</td>
<td>24.96ab</td>
<td>1.73d</td>
<td>45.90a</td>
<td>2.47bcd</td>
<td>6.591bcd</td>
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<td>124.73bcd</td>
<td>24.76ab</td>
<td>1.80cd</td>
<td>28.43d</td>
<td>2.66bcd</td>
<td>6.94ab</td>
<td>10.62abc</td>
<td>39.53a-d</td>
<td>26.80cde</td>
<td>111.03a-d</td>
</tr>
<tr>
<td>11</td>
<td>IR-1525 x NIA Ufaq</td>
<td>133.00abc</td>
<td>23.60bc</td>
<td>1.72d</td>
<td>27.80d</td>
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<td>12</td>
<td>IR-1525 x NIA Perkh</td>
<td>139.77abc</td>
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<td>26.43d</td>
<td>3.13a</td>
<td>7.23a</td>
<td>10.09abc</td>
<td>40.16a-d</td>
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<td>13</td>
<td>Neelam-131 x NIA Sadori</td>
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<td>1.87bcd</td>
<td>33.90c</td>
<td>2.32d</td>
<td>6.13def</td>
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<td>14</td>
<td>Neelam-131 x NIA Ufaq</td>
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<td>18.03d</td>
<td>2.09bc</td>
<td>34.03c</td>
<td>2.49bcd</td>
<td>5.78f</td>
<td>10.59abc</td>
<td>30.83e</td>
<td>31.23ab</td>
<td>109.17bcd</td>
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<tr>
<td>15</td>
<td>Neelam-131 x NIA Perkh</td>
<td>109.67d</td>
<td>20.20cd</td>
<td>2.170b</td>
<td>30.60a</td>
<td>2.42cd</td>
<td>5.82ef</td>
<td>10.82ab</td>
<td>41.76abc</td>
<td>31.56ab</td>
<td>109.97a-d</td>
</tr>
</tbody>
</table>

S.E.   | 5.84    | 0.92    | 0.10    | 2.31    | 0.11    | 0.21    | 0.38    | 1.22    | 0.87    | 6.33    |
LSD 5% | 21.64   | 3.42    | 0.343   | 8.57    | 0.43    | 0.77    | 1.42    | 4.52    | 3.23    | 23.47   |

*Mean bearing the same letters are statistically alike*
REFERENCES


