

## Research Article

# Assessment of Yield Contributing Quantitative Traits in Upland Cotton (*Gossypium hirsutum*)

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**Abstract** | Pakistan is listed among 5<sup>th</sup> top cotton producer and consumer countries. In Textile and agricultural economics, cotton plays a significant role. Improving the level of mechanization and the scale of cotton production in Pakistan is an urgent need of the hour. A thorough examination of F<sub>2</sub> populations may reveal important information for the development of various breeding programmes. This study was on F<sub>2</sub> populations, derived from four parents of upland cotton, *i.e.* CRIS-134, VH-329, IUB-222, CIM-240 which were sown in the Plant Breeding and Genetics section, University of Agriculture, Faisalabad; Pakistan, during the normal growing season of cotton. A Randomized Complete Block design with three replications was used for the study. Plant height (PH), boll weight (BW), bolls/plant (BP), ginning out turn (GOT percent), hundred seed weight (100SW), yield/plant (YP), fiber fineness (FF), fiber length (FL), and fiber strength (FS) all revealed substantial variation in the analysis of variance (FS). The goal of this research was to quantify variability and conduct a correlation analysis to see potential for selection in the F<sub>2</sub> population. Plant height (cm) was found to have a positive relationship with boll weight, bolls/plant, fiber strength, fiber length, and fiber fineness when the correlation coefficient was calculated. The bolls/ plant revealed a positive correlation with the boll weight and the production of seed cotton. Boll weight revealed a positive correlation with fiber length and ginning gout turn. Fiber length this positively associated with fiber strength. Correlation analysis showed that 100 seeds (g) weight was positively linked to fiber fineness, yield per plant (g) and GOT. It is investigated from the data Genotype CIM-240×CRIS-134 had maximum yield and genotype CRIS-134×IUB-222 maximum fiber strength and proved as best for the selection in future breeding.

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**Keywords** | Cotton, F<sub>2</sub> population, Correlation, GOT, Boll weight, Plant height

## Introduction

Pakistan is based on agriculture, and cotton have significant share in country's economy. It is also described as white gold because the export of raw cotton, yarn and finished products, huge volume of convertibility for foreign exchange are obtained by

cotton. Cotton runs the local textile industry and provides employment to the millions of the people in the country. It produces fiber, seed cake for live stock and also produces edible oil. During 2020-21, the crop was cultivated on 2,079 thousand hectares, reflecting a contraction of 17.4 percent as compared to last year's sown area of 2,517 thousand hectares (PES,

2020-21). It was observed that during high pest pressure, there is decline in yield. The decline in yield is due to various factors, such as insect/pest, diseases, and climate change. To overcome this issue there is need to develop a genotype which have improved genetic makeup and have ability to withstand against the diverse environment and having better yield.

Cotton (*Gossypium hirsutum L.*) cultivars from the United States satisfy upto 90% of the global demand for fiber and vegetable oil. Cotton, as the king of fiber, provides raw material in the form of lint to worldwide textile industry, which relies on both natural and artificial sources of fiber for its production. Cotton accounts about 70% to 80% of all natural fiber. It can be found growing in a range of environments. It is Pakistan's most significant commodity, sustaining the economy through foreign exchange revenues and providing jobs to the workforce. Pakistan's economy is mostly based on cotton production, exportable waste cotton fiber, and fiber-based products (Haidar *et al.*, 2007; Haidar *et al.*, 2012). This crop not only serves the needs of the local business, but it also helps the environment (GoP, 2019).

Cotton breeders have done a lot of work to improve the cultivation and traits of the crop. The most fundamental of these qualities is yield, which is the ultimate goal of breeding. Yield is a complex quantitative trait influenced by a number of genes with little effects. Environmental and genetic variables have an impact on it. The association between distinct features and understanding of their contribution to yield is vital in developing a breeding programme to explore yield potential. Furthermore, in *Gossypium hirsutum L.* genotypes, a positive relationship between yield and its components has been discovered (Farooq *et al.*, 2014). They rely on their understanding of yield and its components to aid in the selection of attractive genotypes (Sarwar *et al.*, 2021).

For the advancement of high yielding genotypes, a thorough and accurate analysis of the variation, mean results, relationship of yield with different agronomic characteristics is necessary for cotton breeders. Several researches were carried out and therefore large number of cultivars with valuable combinations of traits was produced. Knowledge of various qualitative and quantitative characters must be available for this purpose because it would helpful to improve crop plant genetic makeup (Abbas *et al.*, 2008). The cur-

rent experiment was therefore conducted to find the relationship between yield and other characteristics such as ginning out turn, plant height, bolls per plant, fiber fineness, fiber strength, staple length. In future breeding program, this information will be useful for improving yield and fiber parameters in newly developed cultivars.

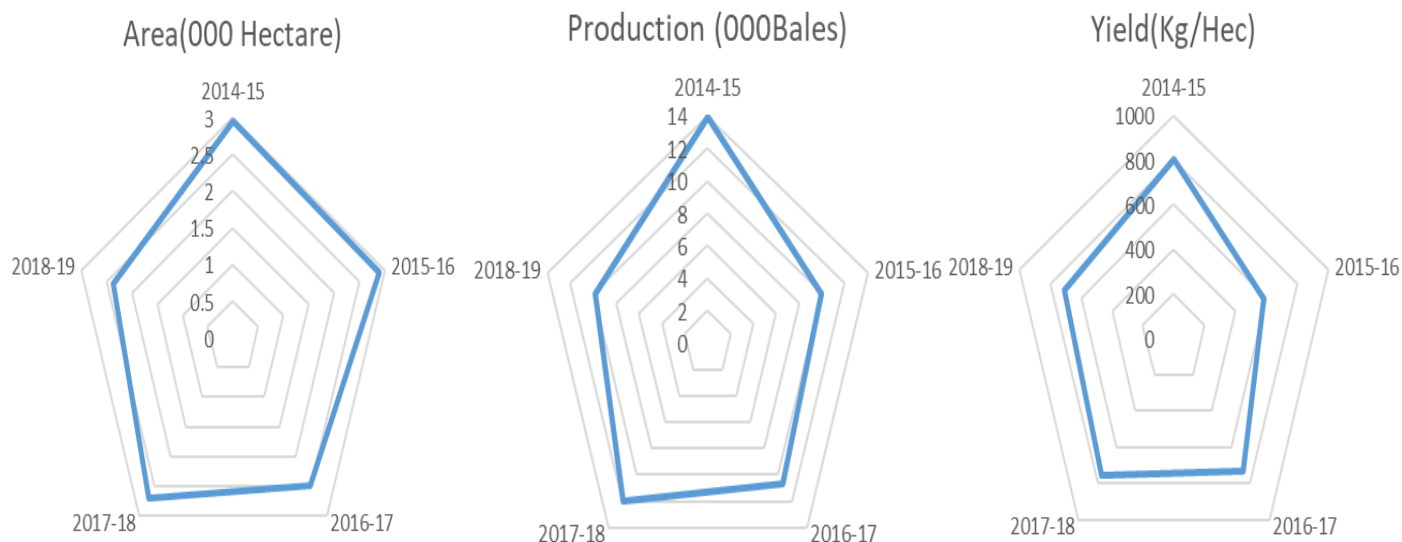
## Materials and Methods

### *Breeding material and procedure*

The F<sub>2</sub> population along with its parents was sown during the normal growing season of summer 2015, following randomized complete block (nested design) with two replications in field at breeding block of UAF. Each replication included one line for each parent and 15 rows for the F<sub>2</sub> population. Plant to plant distance was 30cm row to row distance was 75cm was maintained. The recommended agricultural practices were performed for healthy growth of plants. Soil condition of the field was sandy loam. Sowing was done at 31 may, 2015 and data were collected at maturity during the mid of September, 2015, from F<sub>2</sub> population along parents in each replication and the following traits was; plant height(cm), boll weight, boll/plant, Seed cotton yield per plant (g), 100 seed weight (g), fiber strength, fiber fineness, fiber length, GOT (Ginning out turn percent).

### *Measurement of characters*

With the use of a measuring tape in centimeters, the plant height (cm) of each selected plant was measured from the cotyledonary node to the halted apical bud. After that, for each population in each replication, the average of these measurements was derived. The total seed cotton per plant was divided by the total number of bolls picked from that plant to get the boll weight (BW). The average number of bolls per plant (B/P) for each population in each replication was computed after recording the number of bolls per plant (B/P). The mature bolls were picked and seed cotton was gathered for seed cotton yield (SCY). Picking began once the dew had dissipated. In each replication, the average yield of seed cotton for each parent and F<sub>2</sub> population was calculated. After ginning, 100 cotton seeds were manually counted and weighed in grammes using an electrical balance for seed weight (SW). For each plant, a seed weight of 100 was computed. In each replication, the average 100 seed weight for each parent and F<sub>2</sub> population was computed. USTER® HVI-1000 was used to



**Figure 1:** Area, production, and yield of cotton during the last five years. (Source: Pakistan Economic Survey 2018–19).

**Table 1:** Mean squares of parents and F2 population in cotton genotypes.

|       | DF | Mean Square |
|-------|----|-------------|
| PH    | 32 | 2656.51**   |
| BP    | 32 | 70.06**     |
| BW    | 32 | 0.87**      |
| GOT   | 32 | 96.41**     |
| 100SW | 32 | 49.31**     |
| SCYP  | 32 | 97.50**     |
| FF    | 32 | 0.59**      |
| FL    | 32 | 84.90**     |
| FS    | 32 | 0.82**      |

\*\* significance at 1%, \*significance at 5%.

**PH:** Plant height, **BP:** bolls/plant, **BW:** boll weight, **100SW:** hundred seed weight, **GOT:** ginning out turn, **SCYP:** seed cotton yield per plant, **FF:** fiber fineness, **FS:** fiber strength and **FL:** fiber length.

calculate fiber quality attributes such as fiber length, fiber strength, and fiber fineness for each plant. Ginning was done using a single-roller ginning machine. GOT percent (ginning out turn) was computed as:

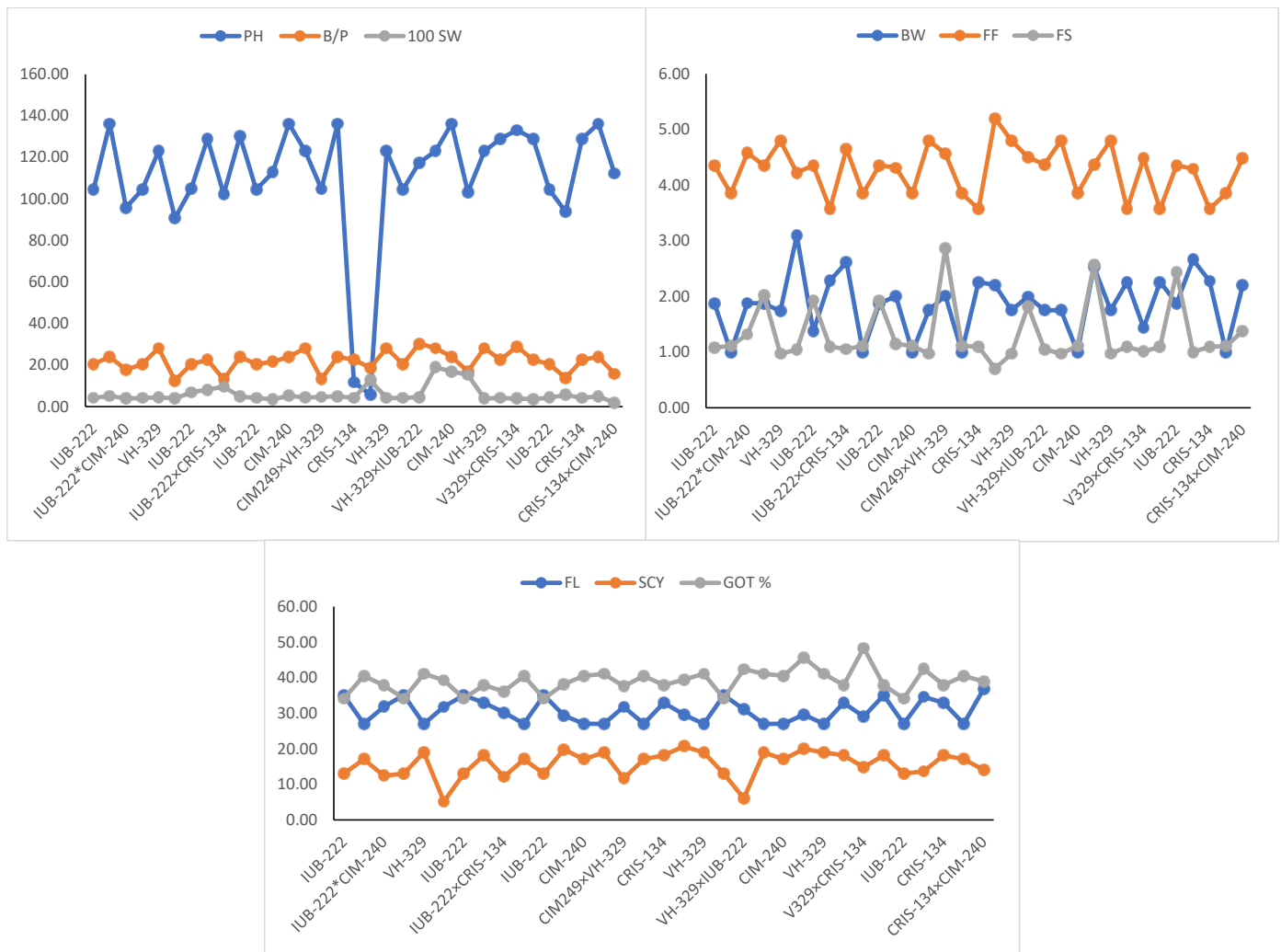
$$GOT \% = \frac{\text{Lint weight}}{\text{seed cotton weight}} \times 100$$

*Statistical analysis*

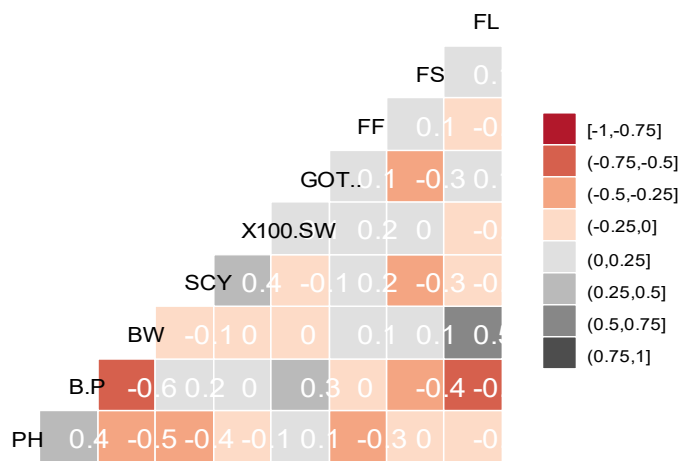
The Analysis of variance was performed to decide the significant difference in plant character between the genotypes under studied (Steel et al., 1997). For basic statistics, two softwares were used: Statistix 8.1 and Minitab-17. Correlation was computed using the formula given by Dewey and Lu (1959) using R studio.

**Results and Discussion**

The results ANOVA showed that all traits i.e. plant height (PH), boll weight (BW), bolls/plant (BP), ginning out turn (GOT%), hundred seed weight (100SW), yield per plant (SCYP), fiber strength (FS), fiber fineness(FF), and fiber length (FL) showed highly significant results as shown in Table 1. The mean performance of crosses (F2 population) and parents was given in Figure 2. The maximum value of PH was showed by CIM-240 that was 136.2 in parents while in F<sub>2</sub> population the value was 133.09 that was showed by Vh-329 x CRIS-134. In F<sub>2</sub> population the maximum bolls per plant was showed by VH-329 x IUB-222 (30.322), in parents the value was 28.2 that was exhibited by Vh-329. Thousand seed weight was an important yield contributing trait and maximum value of 100SW was showed by VH-329 x CIM-240 (15.29) and in parents the VH-329 also showed maximum 100SW (18.92). BW was also an important yield contributing traits the maximum BW was showed by IUB-222 x VH-329 that was 3.09gm and in parents the maximum value was shown by CRIS-134 (2.28). The maximum GOT % was Vh-329 x CRIS-134 that was 48.34 and the maximum value was showed by VH-329 (41.10). The highest value of FF was observed in CIM-240 x IUB-222 (4.31) and CRIS-134 (3.57). For FS the maximum value was showed by CIM-249 x Vh-329 (2.87) and IUB-222 (2.43) and for FL the maximum value was showed by CRIS-134 x CIM-240 (36.85) and IUB-222 (35.05). The maximum value of SCYP was observed in CIM-240 x CRIS-134 (20.68) and VH-329 (18.92). The correlation of PH was positively and significantly correlated



**Figure 2:** Mean Performance of yield contributing traits and yield in F<sub>2</sub> population and parents.  
**PH:** Plant height, **BP:** bolls/plant, **BW:** boll weight (Gram, **100SW:** hundred seed weight, **GOT:** ginning out turn, **SCYP:** seed cotton yield per plant, **FF:** fiber fineness, **FS:** fiber strength and **FL:** fiber length.



**Figure 3:** Correlation between yield and yield contributing traits of parents and F<sub>2</sub> Population.  
**PH:** Plant height, **BP:** bolls/plant, **BW:** boll weight, **100SW:** hundred seed weight, **GOT:** ginning out turn, **SCYP:** seed cotton yield per plant, **FF:** fiber fineness, **FS:** fiber strength and **FL:** fiber length.

with NBP (0.4) and negative correlation was found with BW (-0.5) that was also significant. NBP was significantly and negatively associated with BW (-0.6) and FL (-0.5) and FS (-0.4). BW was found to have a substantial and favorable relationship with FL (0.5). However, SCY was found to have a substantial and favorable relationship with 100SW (0.4) and FF (0.2) but that was non-significant as shown in Figure 3 (maroon color showed the negative correlation and black color showed the positive and significant correlation between traits).

A positive association between Plant Height (PH) and the No of Bolls Per Plant (NBPP) was shown by the results (Farooq et al., 2014; Magadum et al., 2012; Shahid et al., 2019). The PH showed a negative correlation with the SCY. The results showed that No of Bolls Per Plant (NBPP) positively linked with GOT% (Shahid et al., 2019). Whereas results

presented by (Butany *et al.*, 1966) shows that No of Bolls Per Plant (NBPP) had negative association with BW. The results showed that the BW is positively related to the length of Fiber and seeds per boll (Ashok kumar and Ravikesavan, 2010). In the experiment performed, BW had a positive relationship with SCY (Bibi *et al.*, 2010). The result shows that the BW was correlated positively with the SCY (Farooq *et al.*, 2014; Alkuddsi *et al.*, 2013; Erande *et al.*, 2014). In the experiment the results showed that SCY correlates significantly with PH, No of Bolls Per Plant (NBPP), Fiber Length (FL), Fiber Strength (FS) and Ginning Out Turn (GOT). The findings suggested that the SCYP could be increased by increasing the lint percentage (Wang, 2005). The results revealed that the 100 SW have a positive effect on the yield cotton (Karademir *et al.*, 2010; Natera *et al.*, 2012). The findings showed that fiber traits were negatively associated with GOT (Hussain *et al.*, 2010; Zeng and Meredith, 2009). The findings showed that the SCYP was positively correlated with fiber fineness (Batool *et al.*, 2010). The results showed that Fineness percentage also not significantly linked with the FL and FS (Imran *et al.*, 2011). The result showed that the FL was positively related to the FS (Khan *et al.*, 2014; Malagouda *et al.*, 2014; Sun *et al.*, 2017). From research, it was concluded that FL was negatively associated with FF. The FS was positively correlated with the PH. The results showed in his experiment FS positively correlated with SL (Nawaz *et al.*, 2019). The results suggest that FS and FF are positively associated with the yield of (Rasheed *et al.*, 2010).

## Novelty Statement

This study highlights the relationship between yield and other characteristics such as ginning out turn, plant height, bolls per plant, fiber strength, staple length.

## Author's Contribution

**Samaria Nisar:** Conducted research and data collection

**Tariq Manzoor Khan:** Supervised the research study  
**Muhammad Ahsan Iqbal:** Helped in write-up of the manuscript

**Rahmat Ullah:** Helped in overall format setting

**Muhammad Asim Bhutta:** Assisted in statistical analysis

**Saghir Ahmad:** Helped in proofreading

**Amna Bibi:** Provided technical guidelines

**Hafeez ur Rehman:** Helped in results and discussion section

**Umar Farooq:** Helped in data analysis

**Muhammad Zubair Ishaq:** Helped in reference and proofreading of the manuscript

## Conflict of interest

The authors have declared no conflict of interest.

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