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EVALUATION OF DNH-105 STRAIN FOR FIBER YIELD AND QUALITY IN COMPARISON TO STANDARD COTTON VARIETIES OF PAKISTAN

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RUNNING TITLE: PERFORMANCE OF DNH-105 COTTON STRAIN IN D.I.KHAN, PAKISTAN

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ABSTRACT

The performance of DNH-105 strain for fiber yield and quality in comparison to standard cotton varieties of Pakistan i.e. CIM-573, CRIS-342, Gomal-93, NIAB-112 and CIM-612 was assessed at Cotton Research Station, D.I. Khan, Pakistan, during 2011-2013 in a randomized complete block design replicated thrice. The strain DNH-105 gave optimum yield owing to more bolls per plant, boll weight plus higher ginning out turn compared to the standard varieties of cotton in Pakistan. The quality characteristics such as fiber length, strength, fineness and uniformity were also higher for DNH-105 than other varieties. Ginning out turn ranged from a low of 37.17% for CIM-612 to a high of 39.93% for DNH-105. Fiber length ranged from a low of 28.33 mm (CIM-612) to a high of 29.17 mm (DNH-105). Fiber strength was in the range of 24.97 g tex^{-1} (CIM-612) to 28.47 g tex^{-1} (DNH-105). Micronaire values ranged from a low of 4.26

(DNH-105) to a high of 4.80 (CIM-612). Uniformity ranged from a low of 77.13% (CIM-612) to a high of 80.17% (DNH-105). It is concluded that strain DNH-105 has high yield potential and best suited to ago-climatic conditions of Dera Ismail Khan, Pakistan.

***Keywords*:** Cotton, DNH-105 strain, Genotype, Yield and quality, Uniformity, GOT, Seed cotton

INTRODUCTION

Cotton (*Gossypium hirsutum* L) is an important cash crop and main stay of the economy of Pakistan cultivated on an area of 3.2 million hectares with total production of 13.21 million bales (PCCC-2013; Ahmed *et al*., 2009). However, cotton yield is declining in the country due to several biotic and abiotic factors such as adverse weather conditions, heavy insect pests attack, late maturing and lack of resistant varieties, weeds infestation and diseases like leaf curl viruses (Huque, 1994). The heavy insect pests and disease attack not only reduce cotton yield but also incur extra cost on crop management (Satpute *et al*., 1988; Roach and Culp, 1984). One of the possible remedies for maintaining improved cotton yield and quality is to develop a variety having higher yield potential and capable of maintaining yield and quality in low favorable production environments (Razaq *et al*., 2004).Developing a variety with an early maturity with no compromise on yield and quality is a challenging job of a breeder. Research results revealed that although the existing cotton varieties are early maturing but the challenges associated with these varieties are static yield, high micronaire besides short fiber length which need to be genetically tackled.

A new strain DNH-105 has been developed at Cotton Research Station, Dera Ismail Khan Khyber Pakhtunkhwa, Pakistan, through hybridization of DPL 70 × E-288. The cross was initiated in 1993-94 and the strain was bulked in1998-99 in F6 generation. The strain is of short duration having higher yield potential, better ginning out turn, excellent fiber characteristics and more heat tolerance compared with the existing commercial varieties. It is gifted with spinning on higher counts of fiber for producing quality cloth. In this study, DNH-105 strain was evaluated in comparison to the standard cotton varieties of the country for higher cotton yield and quality. The most important character of the DNH-105 strain is its best suitability to the ago-climatic conditions of D.I. Khan in particular and other regions like Multan, Rahim Yar Khan, Sahiwal, Sakrand etc in general. There is much variability between DNH-105 and standard cotton varieties in yield and quality characters. Literature review also revealed significant variations in cotton lint yield and fiber characteristics among different cultivars (Muhammad, 2001; Moser *et al*., 2000; Basbag and Temiz, 2004). The promising commercial varieties CIM-573, CRIS-342, Gomal-93, NIAB-112, and CIM-612 are still recommended varieties for general cultivation but their performance in comparison to DNH-105 is not up to the mark under agro-climatic conditions of D.I.Khan. Probably these varieties have lost their yield potential due to changes in soil and environmental conditions and vulnerable to attack of pests and diseases (Ehsan *et al*., 2008). Since a variety may perform better in a certain climate and may not in another (changed) climate, therefore, cotton performance for yield and quality attributes may help to build up breeding plan to get better and stable yield, and fiber quality (Bourland, 2003). Thus the present study was focused on improving cotton yield and quality through advancement of cotton strain having high yield potential with large range of its adaptability to soil and environmental condition.

MATERIALS AND METHODS

Experimental site

A field trial was carried out under irrigated conditions at Cotton Research Area, D.I. Khan, Khyber Pakhtunkhwa, Pakistan, during 2011- 2013. The experimental soil was Hyperthermic and Typic Torrifluvents with 0.78% organic matter and a pH of 7.9 with a history of wheat-cotton production under irrigated condition (Soil Survey Staff 2009). The study area comes in arid to semi arid region and requires irrigation for raising crops. The annual rainfall ranges from 180-280 mm with more rainfall during monsoon season. Weather data was obtained from meterological station, Dera Ismail Khan situated near study area (Table1). Mean rainfall during 2011, 2012 and 2013 growing seasons were 125, 221and 117 mm, respectively. Mean maximum and minimum temperatures during 2011, 2012 and 2013 growing seasons were 35˚ and 14˚, 33˚ and 14˚, 34˚ and 14˚, respectively. Canal water is the main source of irrigation; however, tube well water is also used in winter when river water is closed for cleaning of the canal.

Soil analysis

Soil samples taken from the research field before sowing were analyzed for physico-chemical characteristics. It was silty clay in texture, calcareous, having pH above normal (7.9), and deficient in organic matter (0.78 %), total nitrogen (0.05 %), AB-DTPA extractable phosphorus (7.80 mg per kg soil), and rather high in available potash (193 mg per kg soil). Organic matter, total soil nitrogen, phosphorus, and potash were determined through Walkley and Black method (Nelson and Sommers, 1982), Kjeldhal (Bremner and Mulvaney 1982), spectrophotometer and flame photometer, respectively. The extractable phosphorus and potash in soil samples were determined by the AB-DTPA extractable method (Soltanpour, 1985). Usman *et al*. (2010) reported detail of the site earlier.

Trial procedure

Strain DNH-105 was evaluated against commercial varieties for fiber yield and quality under the agro-climatic conditions of Dera Ismail Khan. The experiment was designed as randomized complete block with three replications. The subplot size for each treatment was 10 m × 3 m, with row to row 75 cm, and plant to plant 22.5 cm. Cotton was planted on 15th May by dibbling method. A week after emergence, cotton seedlings were thinned to one seedling dibble^{-1}. Pre-emergence weedicide Pendimethline 33% @ 2.5 was sprayed at the time of seed bed preparation, while post-emergence herbicides i.e. haloxyfop-R-methyl and lactofen 24 EC were applied 35 days after sowing. Nitrogen and phosphorus were applied to all experimental plots at 150 kg N ha^{-1} as urea and 50 kg P ha^{-1} as triple superphosphate (TSP). Whole of the P and one third of nitrogen was given at planting whereas rest of the two third of nitrogen was given in 2 equal splits with 2nd and 3rd irrigation. Crop was irrigated six times as per water requirement with two weeks interval from the start of square stage to the bolls through the growing season during both the years. All the agronomic practices were equally adopted. Common pesticides were regularly sprayed to keep crop free from insect pest attack.

Data recording

Data was recorded on bolls per plant, boll weight (g), seed cotton yield (kg ha^{-1}), ginning outturn (GOT, %), micronaire, fiber strength (g per tex), fiber length (mm), and uniformity. For cotton yield and yield attributes, five plants of cotton were tagged at random in each subplot and open matured bolls were counted at harvest. Data was also recorded on seed cotton yield $plant^{-1}$ and boll weight (gram seed cotton per boll). Data on seed cotton was recorded on two central rows by handpicking in November. Total seed cotton yield was determined by pooling over the picks including the five plant sample yield. After recording the yield, GOT was determined by taking 100 g sample of seed cotton which was passed through ginning to separate lint and seed. Samples of lint were sent to Central Cotton Research Institute, Multan, for quality analysis of fiber. Fiber quality attributes such as micronaire/ fiber fineness, fiber length (mm), fiber strength (g tex^{-1}) and uniformity were tested.

Statistical analysis

Data was analyzed statistically in a randomized complete block design with MSTATC software (Steel and Torrie, 1980). Treatments with significant effects were compared using LSD test at $P \leq 5\%$.

RESULTS AND DISCUSSION

Bolls plant^{-1}

Significant differences were observed among varieties for bolls $plant^{-1}$ (Table 2). The strain DNH-105 produced maximum bolls per plant in the study years compared to standard variety, CIM-573 (Table 3). The lowest number of bolls per plant was obtained from CIM-612 in individual years and mean over years. Variations among varieties for bolls per plant may be owing to differences in genetic potential of the genotypes under study. Other researchers communicated analogous results who reported that there were significant variations among varieties for number of bolls per plant in a comparative study of new cotton cultivars for yield performance (Anwar *et al.,* 2002; Copur, 2006). Moser *et al*. (2000) also reported similar findings. Although the other cotton varieties were also high yielding but their yield performance in the study region was not up to the mark. The possible reason may be the loss of their yield potential and their less adaptability to the changing edaphic and environmental conditions besides their susceptibility to various pests and diseases (Ehsan *et al*., 2008).

Boll weight (g)

Boll weight has direct relation with the final seed cotton yield. Boll weight was found significant in all the three years individually as well as mean over years (Table 2). Heavier boll weight was obtained from strain DNH-105 compared to CIM-573 (standard variety), while CIM-612 gave the lowest boll weight among the tested varieties (Table 4). Other researchers also reported similar findings while evaluating genotypes for yield and yield components (Hofs *et al*., 2006). The differences in boll weight may be due to the differences in varietal characteristics in response to change in environmental conditions. The most favorable response of DNH-105 for producing heaviest boll weight among the varieties indicates its best suitability to the agro climatic conditions of the study site (Anonymous, 1997).

Seed cotton yield (Kg ha^{-1})

Yield response of different genotypes was different (Table 2). DNH-105 gave similar yield to CIM-573(std), CRIS-342, and Gomal-93 in Y1 but significantly out yielded in Y2, Y3, and mean over years (Table 5). The higher seed cotton yield in case of DNH-105 may be attributed to higher yield components such as bolls plant^{-1} and boll weight. The better performance of DNH-105 may be due to its more suitability to the environmental conditions of the study site such as photoperiod, and temperature condition in addition to its peculiar genetic potential for higher yield as reported by other researchers (Copur, 2006; Hofs *et al.,* 2006).

Ginning out turn (%)

Ginning out turn (GOT) was different significantly for various genotypes in Y1, Y2, Y3 and mean over years (Table 2). The strain DNH-105, CIM-573(std) and Gomal-93 gave higher GOT than CRIS-342, NIAB-112 and CIM-612 (Table 6). The variation in GOT among different genotypes can be due to environmental or genetic factors/ hetrosis as reported by other researchers (Wang *et al*., 2004; Arshad *et al*., 2003). The results revealed that strain DNH-105 produced optimum GOT under agro-climatic conditions of D.I.Khan indicating its suitability to the study region.

Fiber length (mm)

There were significant variations among genotypes regarding fiber length (mm) in Y2, however, no variations occurred in Y1, Y3, and mean over years (Table 2). Data in Y2 revealed that DNH-105, CIM-573, and NIAB-112 gave higher fiber length compared to the rest of the genotypes (Table 7). Year to year variation may be ascribed to changes in environmental conditions for instance precipitation and temperature. However, variation in fiber length within a year among the varieties might be due to varietal character. Earlier studies showed that fiber length varied widely with genotype and environmental conditions as reported by Ashokkumar and Ravikesavan (2011).

Fiber strength (g tex^{-1})

Data regarding fiber strength is significantly different for different varieties (Table 2). The strongest fibers were obtained from DNH-105 being closely followed by CIM-573 (std) (Table 8). Other varieties showed weaker fibers compared to DNH-105 and CIM-573 (std). Research indicated that fiber strength in the range of 22-24 g tex^{-1} as medium class, 25 - 27 g tex^{-1} as strong class and 28 - 35 g tex^{-1} as very strong class (Basbağ and Temiz, 2004). According to the criteria reported by Basbağ and Temiz (2004), fiber strength of DNH-105 comes in very strong class.

Micronaire value

Micronaire value indicates fiber fineness which is an important parameter from industrial point of view. It is evident from analysis of variance that there were significant differences among various varieties regarding micronaire value (Table 2). Mean values revealed that micronire value was higher for CIM-612 followed by NIAB-112 in individual years and mean over years representing lower fiber fineness (Table 9). Lower micronaire values were recorded for DNH-105, CIM-573 (std) and Gomal-93 in all years of study. However, overall mean revealed higher fineness of fiber in DNH-105. Copur (2006) communicated similar findings by reporting significant variations among cultivars with respect to fiber fineness.

Uniformity (%)

Significant differences were observed for uniformity (%) among various genotypes (Table 2). Mean values revealed that the highest uniformity (80.17%) was observed in DNH-105 while CIM-612 had the lowest uniformity of 77.13% (Table 10). Fiber uniformity ratio (%) was consistently higher for DNH-105 compared to all other genotypes in all the study years. Our results are analogous to that of Lale *et al.* (2013) who reported significant differences among genotypes regarding fiber uniformity.

CONCLUSIONS AND RECOMMENDATIONS

This study comprised of comparative performance of DNH-105 strain for fiber yield and quality with standard cotton varieties of Pakistan i.e. CIM-573, CRIS-342, Gomal-93, NIAB-112 and CIM-612. DNH-105 strain had the best performance among all other genotypes. Although the other cotton varieties were also high yielding that were produced and suggested for general cultivation in the past but they did not perform well in agro-climatic condition of D.I.Khan in comparison to DNH-105. The results revealed that strain DNH-105 has high yield potential and best suited to ago-climatic conditions of Dera Ismail Khan which is suggested and recommended for general cultivation.

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Table 1. Average air temperature and rainfall at Cotton Research Station, Dera Ismail Khan during 2011-2013 growing seasons.

2011					2012				2013			
Month	Temperature (oC)			Rainfall (mm)	Temperature (oC)			Rainfall (mm)	Temperature (oC)			Rainfall (mm)
	Max	Min	Average		Max	Min	Average		Max	Min	Average	
April	34	16	25	12	32	18	25	41	33	17	25	2
May	43	27	35	7	38	24	31	3	39	23	31	80
June	42	26	34	35	40	26	33	3	41	25	33	22
July	38	26	32	50	37	27	32	49	40	28	34	-
August	37	27	32	17	35	26	31	36	37	27	32	-
September	36	24	30	4	33	23	27	75	37	25	31	6
October	30	18	24	-	32	16	24	-	33	21	27	6
November	28	12	20	-	27	11	19	-	26	10	18	1

Table 2. Mean square values of bolls plant^{-1}, boll weight (g), seed cotton yield (kg ha^{-1}), ginning out turn (%), fiber length (mm), fiber strength (g tex^{-1}), micronaire and uniformity (%) for different genotypes during 2011-2013.

2011									
Source	D.F	Boll plant^{-1}	Boll weight	Seed cotton yield	GOT	Fiber length	Fiber strength	Micronaire	Uniformity
Replication	2	0.6	0.1	15622	0.1	0.1	0.2	0.0	0.2
Varieties	5	125.0**	0.5**	162128**	4.1**	0.6ns	4.7**	0.1**	0.9*
Error	10	0.3	0.1	14866	0.5	0.3	0.3	0.0	0.2
2012									
Replication	2	2.0	0.0	3016	0.0	0.2	0.3	0.0	0.1
Varieties	5	104.8**	0.3**	256391**	3.3**	0.4*	4.5**	0.1*	0.9**
Error	10	0.5	0.0	11923	0.4	0.1	0.2	0.0	0.1
2013									
Replication	2	1.8	0.0	43491	0.0	0.1	0.1	0.0	0.0
Varieties	5	102.2**	0.2*	320056**	3.3**	0.4ns	4.6**	0.1**	2.7**
Error	10	1.1	0.0	9055	0.4	0.2	0.5	0.0	0.2
Mean 3yr									
Replication	2	1.1	0.0	14300	0.0	0.1	0.2	0.0	0.0
Varieties	5	110.0**	0.3**	218723**	3.6**	0.4ns	4.5**	0.1**	1.3**
Error	10	0.3	0.0	4266	0.4	0.1	0.3	0.0	0.0

ns, non significant; Rep (y*), replication over year. *Significant at the 0.05 probability level. **Significant at the 0.01 probability level.

Table 3. Bolls plant^{-1} of varieties during 2011-2013 growing seasons.

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	37.90 a	36.73 a	37.03 a	37.20 a
CIM-573(std)	36.53 b	34.40 b	35.37 a	35.43 b
CRIS-342	29.93 c	29.43 c	29.10 b	29.47 c
Gomal-93	29.83 c	29.70 c	29.70 b	29.73 c
NIAB-112	23.70 d	23.70 d	23.70 c	23.70 d
CIM-612	22.03 e	21.43 e	22.77 c	22.07 e
$LSD_{0.05}$	1.031	1.333	1.931	0.9115

Note: Means followed by common letters or no letters do not differ significantly at $P\leq 0.05$.

Table 4. Boll weight (g) of varieties during 2011-2013 growing seasons.

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	3.53 a	3.20 a	3.40 a	3.37 a
CIM-573(std)	3.40 ab	3.10 a	3.27 ab	3.27 a
CRIS-342	2.70 cd	2.60 b	2.80 c	2.70 bc
Gomal-93	3.00 bc	2.83 ab	2.97 bc	2.93 b
NIAB-112	2.63 cd	2.53 b	2.77 c	2.63 bc
CIM-612	2.50 d	2.46 b	2.70 c	2.57 c
$LSD_{0.05}$	0.4267	0.3859	0.3902	0.3203

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 5. Seed cotton yield (kg ha^{-1}) of varieties during 2011-2013 growing seasons.

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	2315 a	2626 a	2874 a	2605 a
CIM-573(std)	2245 a	2356 b	2660 b	2420 b
CRIS-342	2130 a	1948 cd	2074 d	2051 c
Gomal-93	2204 a	2397 b	2571 b	2391 b
NIAB-112	1830 b	2081 c	2341 c	2084 c
CIM-612	1752 b	1875 d	2071 d	1899 d
$LSD_{0.05}$	221.8	198.7	173.1	118.8

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 6. GOT (%) of varieties during three growing seasons (2011-2013).

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	39.93 a	39.83 a	40.00 a	39.93 a
CIM-573 (std)	39.43 a	39.53 a	39.80 a	39.60 a
CRIS-342	37.73 b	38.10 bc	38.10 b	37.97 b
Gomal-93	39.10 a	39.30 ab	39.40 a	39.27 a
NIAB-112	37.80 b	38.13 bc	38.13 b	38.03 b
CIM-612	36.93 b	37.10 c	37.50 b	37.17 b
$LSD_{0.05}$	1.250	1.203	1.108	1.082

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 7. Fiber length (mm) of varieties during three growing seasons (2011-2013).

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	29.33	29.00 a	29.20	29.17
CIM-573 (std)	29.27	29.10 a	29.03	29.13
CRIS-342	28.43	28.23 b	28.43	28.37
Gomal-93	29.13	28.77 ab	29.13	29.00
NIAB-112	29.20	28.97 a	28.80	29.00
CIM-612	28.33	28.33 b	28.33	28.33
$LSD_{0.05}$	NS	0.5335	NS	NS

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 8. Fiber strength (g tex^{-1}) of varieties during three growing seasons (2011-2013).

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	28.63 a	28.30 a	28.50 a	28.47 a
CIM-573 (std)	27.60 ab	27.80 ab	27.83 ab	27.73 ab
CRIS-342	26.30 c	25.93 d	26.30 c	26.17 d
Gomal-93	27.43 b	27.07 bc	27.23 abc	27.23 bc
NIAB-112	26.80 bc	26.50 cd	26.80 bc	26.70 cd
CIM-612	24.97 d	24.97 e	24.97 d	24.97 e
$LSD_{0.05}$	1.070	0.8552	1.273	0.9609

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 9. Micronaire of varieties during 2011-2013 growing seasons.

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	4.27 c	4.40 b	4.17 c	4.26 d
CIM-573 (std)	4.40 c	4.53 b	4.40 b	4.43 cd
CRIS-342	4.50 bc	4.60 b	4.53 b	4.53 bc
Gomal-93	4.37 c	4.47 b	4.47 b	4.43 cd
NIAB-112	4.70 ab	4.60 b	4.60 ab	4.63 ab
CIM-612	4.83 a	4.83 a	4.77 a	4.80 a
$LSD_{0.05}$	0.2372	0.2074	0.2228	0.1908

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 10. Uniformity ratio (%) of varieties during 2011-2013 growing seasons.

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	80.00a	79.83a	80.73a	80.17a
CIM-573 (std)	79.00ab	79.07b	79.40ab	79.17b
CRIS-342	77.91bc	77.79c	77.13d	77.63cd
Gomal-93	79.24ab	78.08c	78.67bc	78.67b
NIAB-112	78.84abc	77.79c	77.79cd	78.13c
CIM-612	77.46c	77.46c	76.47d	77.13d
$LSD_{0.05}$	1.505785	0.688202	1.379556	0.513871

Note: Means followed by common letters or no letters do not differ significantly at $P \leq 0.05$.

Table 1: Average air temperature and rainfall at Cotton Research Station, Dera Ismail Khan during 2011-2013 growing seasons

2011					2012				2013			
Month	Temperature (°C)			Rainfall (mm)	Temperature (°C)			Rainfall (mm)	Temperature (°C)			Rainfall (mm)
	Max	Min	Average		Max	Min	Average		Max	Min	Average	
April	34	16	25	12	32	18	25	41	33	17	25	2
May	43	27	35	7	38	24	31	3	39	23	31	80
June	42	26	34	35	40	26	33	3	41	25	33	22
July	38	26	32	50	37	27	32	49	40	28	34	-
August	37	27	32	17	35	26	31	36	37	27	32	-
September	36	24	30	4	33	23	27	75	37	25	31	6
October	30	18	24	-	32	16	24	-	33	21	27	6
November	28	12	20	-	27	11	19	-	26	10	18	1

Table 2: Mean square values of bolls plant^{-1}, boll weight (g), seed cotton yield (kg ha^{-1}), ginning out turn (%), fiber length (mm), fiber strength (g tex^{-1}), micronaire and uniformity (%) for different genotypes during 2011-2013

2011									
Source	D.F	Boll plant^{-1}	Boll weight	Seed cotton yield	GOT	Fiber length	Fiber strength	Micronaire	Uniformity
Replication	2	0.6	0.1	15622	0.1	0.1	0.2	0.0	0.2
Varieties	5	125.0**	0.5**	162128**	4.1**	0.6ns	4.7**	0.1**	0.9*
Error	10	0.3	0.1	14866	0.5	0.3	0.3	0.0	0.2
2012									
Replication	2	2.0	0.0	3016	0.0	0.2	0.3	0.0	0.1
Varieties	5	104.8**	0.3**	256391**	3.3**	0.4*	4.5**	0.1*	0.9**
Error	10	0.5	0.0	11923	0.4	0.1	0.2	0.0	0.1
2013									
Replication	2	1.8	0.0	43491	0.0	0.1	0.1	0.0	0.0
Varieties	5	102.2**	0.2*	320056**	3.3**	0.4ns	4.6**	0.1**	2.7**
Error	10	1.1	0.0	9055	0.4	0.2	0.5	0.0	0.2
Mean 3yr									
Replication	2	1.1	0.0	14300	0.0	0.1	0.2	0.0	0.0
Varieties	5	110.0**	0.3**	218723**	3.6**	0.4ns	4.5**	0.1**	1.3**
Error	10	0.3	0.0	4266	0.4	0.1	0.3	0.0	0.0

ns, non significant; Rep (y*), replication over year. *Significant at the 0.05 probability level. **Significant at the 0.01 probability level.

Table 3: Bolls plant^{-1} of varieties during 2011-2013 growing seasons

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	37.90 a	36.73 a	37.03 a	37.20 a
CIM-573(std)	36.53 b	34.40 b	35.37 a	35.43 b
CRIS-342	29.93 c	29.43 c	29.10 b	29.47 c
Gomal-93	29.83 c	29.70 c	29.70 b	29.73 c
NIAB-112	23.70 d	23.70 d	23.70 c	23.70 d
CIM-612	22.03 e	21.43 e	22.77 c	22.07 e
$LSD_{0.05}$	1.031	1.333	1.931	0.9115

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 4: Boll weight (g) of varieties during 2011-2013 growing seasons

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	3.53 a	3.20 a	3.40 a	3.37 a
CIM-573(std)	3.40 ab	3.10 a	3.27 ab	3.27 a
CRIS-342	2.70 cd	2.60 b	2.80 c	2.70 bc
Gomal-93	3.00 bc	2.83 ab	2.97 bc	2.93 b
NIAB-112	2.63 cd	2.53 b	2.77 c	2.63 bc
CIM-612	2.50 d	2.46 b	2.70 c	2.57 c
$LSD_{0.05}$	0.4267	0.3859	0.3902	0.3203

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 5: Seed cotton yield (kg ha^{-1}) of varieties during 2011-2013 growing seasons

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	2315 a	2626 a	2874 a	2605 a
CIM-573(std)	2245 a	2356 b	2660 b	2420 b
CRIS-342	2130 a	1948 cd	2074 d	2051 c
Gomal-93	2204 a	2397 b	2571 b	2391 b
NIAB-112	1830 b	2081 c	2341 c	2084 c
CIM-612	1752 b	1875 d	2071 d	1899 d
$LSD_{0.05}$	221.8	198.7	173.1	118.8

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 6: GOT (%) of varieties during three growing seasons (2011-2013)

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	39.93 a	39.83 a	40.00 a	39.93 a
CIM-573 (std)	39.43 a	39.53 a	39.80 a	39.60 a
CRIS-342	37.73 b	38.10 bc	38.10 b	37.97 b
Gomal-93	39.10 a	39.30 ab	39.40 a	39.27 a
NIAB-112	37.80 b	38.13 bc	38.13 b	38.03 b
CIM-612	36.93 b	37.10 c	37.50 b	37.17 b
$LSD_{0.05}$	1.250	1.203	1.108	1.082

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 7: Fiber length (mm) of varieties during three growing seasons (2011-2013)

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	29.33	29.00 a	29.20	29.17
CIM-573 (std)	29.27	29.10 a	29.03	29.13
CRIS-342	28.43	28.23 b	28.43	28.37
Gomal-93	29.13	28.77 ab	29.13	29.00
NIAB-112	29.20	28.97 a	28.80	29.00
CIM-612	28.33	28.33 b	28.33	28.33
$LSD_{0.05}$	NS	0.5335	NS	NS

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 8: Fiber strength (g tex^{-1}) of varieties during three growing seasons (2011-2013)

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	28.63 a	28.30 a	28.50 a	28.47 a
CIM-573 (std)	27.60 ab	27.80 ab	27.83 ab	27.73 ab
CRIS-342	26.30 c	25.93 d	26.30 c	26.17 d
Gomal-93	27.43 b	27.07 bc	27.23 abc	27.23 bc
NIAB-112	26.80 bc	26.50 cd	26.80 bc	26.70 cd
CIM-612	24.97 d	24.97 e	24.97 d	24.97 e
$LSD_{0.05}$	1.070	0.8552	1.273	0.9609

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 9: Micronaire of varieties during 2011-2013 growing seasons

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	4.27 c	4.40 b	4.17 c	4.26 d
CIM-573 (std)	4.40 c	4.53 b	4.40 b	4.43 cd
CRIS-342	4.50 bc	4.60 b	4.53 b	4.53 bc
Gomal-93	4.37 c	4.47 b	4.47 b	4.43 cd
NIAB-112	4.70 ab	4.60 b	4.60 ab	4.63 ab
CIM-612	4.83 a	4.83 a	4.77 a	4.80 a
$LSD_{0.05}$	0.2372	0.2074	0.2228	0.1908

Note: Means followed by same letter do not differ significantly at 5% level of probability.

Table 10: Uniformity ratio (%) of varieties during 2011-2013 growing seasons

Varieties	Years			Mean
	2011	2012	2013	
DNH-105	80.00a	79.83a	80.73a	80.17a
CIM-573 (std)	79.00ab	79.07b	79.40ab	79.17b
CRIS-342	77.91bc	77.79c	77.13d	77.63cd
Gomal-93	79.24ab	78.08c	78.67bc	78.67b
NIAB-112	78.84abc	77.79c	77.79cd	78.13c
CIM-612	77.46c	77.46c	76.47d	77.13d
$LSD_{0.05}$	1.505785	0.688202	1.379556	0.513871

Note: Means followed by same letter do not differ significantly at 5% level of probability.