Research Article

Evaluation of DNH-105 Strain for Fibre Yield and Quality in Comparison to Standard Cotton Varieties of Pakistan

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Abstract | Yield and fibre quality performance of DNH-105 strain in comparison with standard cotton varieties (CIM-573, CRIS-342, Gomal-93, NIAB-112 and CIM-612) was assessed at Cotton Research Station, D.I. Khan, Pakistan, during growth season 2011-2013 in a randomized complete block design replicated thrice. The strain DNH-105 gave optimum yield owing to more bolls per plant (37.2), boll weight (3.4 g) plus higher ginning out turn (39.9%) compared to the standard varieties of cotton in Pakistan. The quality characteristics such as fibre length (29.2 mm), strength (28.5 g tex^{-1}), micronaire (4.3µg $inch^{-1}$) and uniformity (80.2%) were also higher for DNH-105 than other varieties. Ginning out turn ranged from 37.2 (CIM-612) to 39.9% (DNH-105). Fibre length ranged from a low of 28.3 (CIM-612) to a high of 29.2 mm (DNH-105) while fibre strength was observed 25.0 (CIM-612) to 28.5 (DNH-105) g tex^{-1}. Micronaire value ranged from 4.3 (DNH-105) to 4.8 µg $inch^{-1}$ (CIM-612). Fibre uniformity ranged from a low of 77.1 (CIM-612) to a high of 80.2% (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 as compared to the other varieties of cotton.

Editor | Tahir Sarwar, The University of Agriculture, Peshawar, Pakistan.
Received | December 11, 2014; **Accepted** | June 09, 2015; **Published** | June 19, 2015
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Citation | Usman, K., N. Khan and F. Yazdan. 2015. Evaluation of DNH-105 strain for fibre yield and quality in comparison to standard cotton varieties of Pakistan. *Sarhad Journal of Agriculture,* 31(2): 87-93.
DOI | http://dx.doi.org/10.17582/journal.sja/2015/31.2.87.93
Keywords | Cotton, DNH-105 strain, Genotype, Yield and quality

Introduction

Cotton (*Gossypium hirsutum* L) is important cash crop and main stay of the economy of Pakistan. It is 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; Arshad et al., 2003). 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 possible remedy to maintain cotton yield and quality is to identify a suitable variety with yield potential and quality in the favourable environments (Razaq et al., 2004). Research results have revealed that existing cotton varieties are early maturing with challenges associated to low yield, high micronaire, short fibre length that needs to be tackled genetically (Hanif et al., 2005).

The new strain (DNH-105) has been developed at Cotton Research Station, D. I. Khan, Khyber Pakhtunkhwa, Pakistan in the year 1999 through hybridization of DPL 70 × E-288. The strain is short duration (180 days) with yield potential (3000 kg ha^{-1} seed cotton yield), better ginning out turn, excellent fibre characteristics and tolerance to heat stress as compared to the existing variety in cultivation. It is advantageous with spinning on higher counts of fibre. We, therefore, compared the performance of DNH-105 strain in comparison with varieties already in cultivation for higher cotton yield and quality. 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 fibre characteristics among different cultivars for examples CIM-573, CRIS-342, Gomal-93, NIAB-112, and CIM-612 (Muhammad, 2001; Moser et al., 2000; Basbag and Temiz, 2004). These commercial varieties are still under cultivation. However, presently their performance is not satisfactory probably due to loss of their yield potential besides biotic and abiotic stresses (Ehsan et al., 2008). Thus the present study was focused on improving cotton yield and quality through advancement of cotton strain having high yield potential.

Materials and Methods

Experimental location and soil type

A field trial was carried out under irrigated conditions at Cotton Research Area, D. I. Khan, Khyber Pakhtunkhwa, Pakistan, during 2011, 2012 and 2013. Soil of the site 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 Meteorological Station, Dera Ismail Khan situated x km from the experimental site (Table 1). 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°±4 and 14°±6, 33°±5 and 14°±6, 34°±3 and 14°±6, respectively. Canal water was main source of irrigation. Soil samples taken from research field before sowing were analysed for soil physico-chemical characteristics. Soil was silty clay in texture, calcareous, having pH 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).

Procedure and measurements

Yield and fibre quality of DNH-105 strain in comparison with standard cotton varieties (CIM-573, CRIS-342, Gomal-93, NIAB-112 and CIM-612) was assessed at Cotton Research Station, D.I. Khan, Pakistan, during 2011, 2012 and 2013 in a randomized complete block design replicated thrice. The land was prepared by giving disk plough followed by tiller and rotavator. After levelling, the field was divided into the required experimental units. The subplot size for each treatment was 10 m × 3 m, with row to row distance of 75 cm, and plant to plant 22.5 cm. Cotton was planted on 15th May in 2011, 2012 and 2013 by dibbling method. A week after emergence, cotton seedlings were thinned to one seedling $dible^{-1}$. Pre- emergence weedicide Pendimethline 33% @ 2.5 was sprayed at the time of seedbed 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 units 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 (µg $inch^{-1}$), fibre strength (g per tex), fibre 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

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

cotton yield was determined by pooling over the picks including five plants 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 fibre. Fibre quality attributes such as micronaire/fibre fineness, fibre length (mm), fibre strength (g tex^{-1}) and uniformity were tested. Uniformity index was determined as "a ratio between the mean length and the upper half mean length of the fibres and was expressed in percentage (%). Low uniformity index indicates high content of short fibres that lowers the quality of the textile product.

Statistical analysis

Data were subjected to analysis of variance (ANOVA), using a randomized complete block design according to Steel and Torrie (1980). Treatment means were compared using least significant difference test at 5% level of probability. The MSTATC software (written by Dr. Russel Freed, Professor and Director of Crop and Soil Sciences Department of Michigan State University) was used for this purpose.

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 as 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 3). 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 favourable 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 signif

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

Source	D.F	Boll plant^{-1}	Boll weight	Seed cotton yield	GOT	Fiber length	Fiber strength	Micronaire	Uniformity
2011									
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 3years									
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}, boll weight (g), seed cotton yield (kg ha^{-1}) and GOT (%) of varieties during 2011-2013 growing seasons*

Varieties	Years			Mean	Years			Mean
	2011	2012	2013		2011	2012	2013	
	Bolls plant^{-1}				**Boll weight**			
DNH-105	37.9a±0.2	36.7a±0.7	37.0a±1.0	37.2a±0.1	3.5a±0.6	3.2a±0.3	3.4a±0.5	3.4a±0.4
CIM-573(std)	36.5b±0.1	34.4b±0.8	35.4a±2.0	35.4b±0.9	3.4ab±0.1	3.1a± 0.2	3.3ab±0.1	3.3a±0.1
CRIS-342	29.9c±1.1	29.4c±0.8	29.1b±0.7	29.5c±0.7	2.7cd±0.1	2.6b±0.1	2.8c ±0.1	2.7bc±0.0
Gomal-93	29.8c±0.2	29.7c±0.1	29.7b±0.1	29.7c±0.1	3.0bc±0.1	2.8ab±0.3	3.0bc±0.1	2.9b±0.2
NIAB-112	23.7d±0.8	23.7d±0.8	23.7c±0.8	23.7d±0.8	2.6cd±0.1	2.5b±0.2	2.8c± 0.1	2.6bc±0.1
CIM-612	22.0e±0.7	21.4e±1.5	22.8c±1.1	22.1e±0.6	2.5d±0.1	2.5b±0.1	2.7c±0.1	2.6c±0.0
$LSD_{0.05}$	1.0	1.3	1.9	0.9	0.4	0.4	0.4	0.3
	Seed cotton yield				**GOT**			
DNH-105	2315a±168	2626a±51	2874a±106	2605a±107	39.9a± 0.2	39.8a±0.1	40.0a±0.1	39.9a±0.1
CIM-573(std)	2245a±106	2356b±106	2660b±95	2420b±62	39.4a±0.5	39.5a±0.4	39.8a±0.1	39.6a ±0.3
CRIS-342	2130a±143	1948cd±61	2074d±90	2051c±68	37.7b±0.8	38.1bc±1.1	38.1b±1.1	38.0b±0.9
Gomal-93	2204a±134	2397b±167	2571b±106	2391b±98	39.1a±0.5	39.3ab±0.5	39.4a±0.4	39.3a±0.5
NIAB-112	1830b±57	2081c±79	2341c±206	2084c±39	37.8b±1.0	38.1bc±0.7	38.1b±0.7	38.0b±0.8
CIM-612	1752b±93	1875d±105	2071d±85	1899d±67	36.9b±0.5	37.1c±0.5	37.5b±0.3	37.2b±0.3
$LSD_{0.05}$	221.8	198.7	173.1	118.8	1.3	1.2	1.1	1.1

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

icantly out yielded in Y2, Y3, and mean over years (Table 3). 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

Table 4: *Fibre length (mm), fibre strength (g tex-1), micronaire (µg inch-1) and uniformity ratio (%) of varieties during 2011-2013 growing seasons*

Varieties	Years			Mean	Years			Mean
	2011	2012	2013		2011	2012	2013	
	Fiber length				Fiber strength			
DNH-105	29.3±0.2	29.0a±0.1	29.2±0.1	29.2±0.1	28.6a±0.2	28.3a±0.4	28.5a±0.1	28.5a±0.1
CIM-573(std)	29.3±0.4	29.1a±0.2	29.0±0.2	29.1±0.2	27.6ab±0.3	27.8ab±0.4	27.8ab±0.4	27.7ab±0.3
CRIS-342	28.4±0.6	28.2b±0.4	28.4±0.6	28.4±0.5	26.3c±0.5	25.9d±0.4	26.3c±0.5	26.2d±0.3
Gomal-93	29.1±0.6	28.8ab±0.1	29.1±0.6	29.0±0.4	27.4b±0.6	27.1bc±0.5	27.2abc±0.9	27.2bc±0.6
NIAB-112	29.2±0.5	29.0a±0.1	28.8±0.2	29.0±0.2	26.8bc±1.0	26.5cd±0.5	26.8bc±1.0	26.7cd±0.8
CIM-612	28.3±0.6	28.3b±0.6	28.3±0.6	28.3±0.6	25.0d±0.6	25.0e±0.6	25.0d±0.6	25.0e±0.6
$LSD_{0.05}$	NS	0.5	NS	NS	1.1	0.9	1.3	1.0
	Micronaire				Uniformity ratio			
DNH-105	4.3c±0.1	4.4b±0.1	4.2c±0.1	4.3d±0.1	80.0a±0.1	79.8a±0.2	80.7a±0.2	80.2a±0.1
CIM-573(std)	4.4c±0.1	4.5b±0.2	4.4b±0.1	4.4cd±0.1	79.0ab±0.2	79.1b±0.2	79.4ab±0.2	79.2b±0.1
CRIS-342	4.5bc±0.1	4.6b±0.1	4.5b±0.1	4.5bc±0.1	77.9bc±0.2	77.8c±0.1	77.1d±0.1	77.6cd±0.2
Gomal-93	4.4c±0.1	4.5b±0.1	4.5b±0.1	4.4cd±0.1	79.2ab±1.1	78.1c±0.5	78.7bc±0.5	78.7b±0.2
NIAB-112	4.7ab±0.3	4.6b±0.2	4.6ab±0.2	4.6ab±0.2	78.8abc±0.6	77.8c±0.0	77.8cd±0.0	78.1c±0.2
CIM-612	4.8a±0.1	4.8a±0.1	4.8a±0.2	4.8a±0.1	77.5c±0.1	77.5c±0.1	76.5d±0.1	77.1d±0.1
$LSD_{0.05}$	0.2	0.2	0.2	0.2	1.5	0.7	1.4	0.5

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

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 3). 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.

Fibre length (mm)

There were significant variations among genotypes regarding fibre 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 fibre length compared to the rest of the genotypes (Table 4). Year to year variation may be ascribed to changes in environmental conditions for instance precipitation and temperature. However, variation in fibre length within a year among the varieties might be due to varietal character. Earlier studies showed that fibre length varied widely with genotype and environmental conditions as reported by Ashokkumar and Ravikesavan (2011).

Fibre strength (g tex-1)

Data regarding fibre strength is significantly different for different varieties (Table 2). The strongest fibres were obtained from DNH-105 being closely followed by CIM-573 (std) (Table 4). Other varieties showed weaker fibres compared to DNH-105 and CIM-573 (std). Research indicated that fibre 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), fibre strength of DNH-105 comes in very strong class.

Micronaire value (µg inch-1)

Micronaire value indicates fibre 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 4). 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 fibre 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 4). Fibre 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

The DNH-105 strain comparatively performed better than the genotypes CIM-573, CRIS-342, Gomal-93, NIAB-112 and CIM-612 regarding yield and fibre quality under agro-climatic conditions of Dera Ismail Khan-Pakistan. Therefore, it is recommended for general cultivation in the region.

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