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Evaluation of seed cotton yield and fiber properties portrayal of some candidate cotton varieties in national coordinated varietal trials in the Punjab province during seasons 2017 and 2018

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ABSTRACT	**Digital Object Identifier (DOI): https:/doi.org/10.33865/IJCRT.001.01.0243**

Thirty six candidate cotton varieties developed by different breeders of Pakistan were tested consecutively for two years (2017 and 2018) and at six locations of Province of Punjab in national coordinated varietal trials (NCVT). The trials were conducted to explore seed cotton yield potential and fiber properties against two check varieties (CIM-602 and FH-142/IUB-13). As per claim of the breeders, the samples of all varieties for both the years were sent to four designated biotechnological laboratories for conducting biochemical tests also. The results revealed highly significant differences among the varieties for both the years. During the year 2017, on an average of six location, top ten high yielding varieties recorded were MNH-1026, BH-221, BS-18, CEMB-100, MNH-1020, FH-444, CEMB-101, ICI-2121, Bahar-07 and IUB-69 which yielded 3202, 3058, 3051, 2948, 2923, 2888, 2880, 2870, 2783 and 2753 kg/ha seed cotton yield respectively. When the results of 2018 trial were looked at, averagely top ten high yielding varieties were BS-18, ICI-2121, MNH-1026, RH-Afnan, CIM-343, CIM-663, NIAB-898, FH-490, MNH-1020 and NS-191 with 2893, 2749, 2748, 2745, 2614, 2608, 2607, 2604, 2594, and 2512 kg/ha of seed cotton yield respectively. However, on an average of both the years (2017 and 2018), top ten high yielding varieties were MNH-1026, BS-18, ICI-2121, BH-221, MNH-1020, CIM-343, CIM-663, FH-490, FH-444 and NIAB-898 producing 2975, 2972, 2810, 2761, 2759, 2681, 2671, 2670, 2652 and 2629 kg/ha of seed cotton respectively. As regards fiber properties, almost half (18 candidate varieties) could qualify all fiber standards set by Punjab Seed Council including 12 varieties which were given relaxation of 1mm in staple length by the Expert Sub Committee of the Punjab Seed Corporation. The biochemical test results received from all four laboratories revealed that on an average of four laboratories and two years, the trait purity range recorded was from 42 to 96 percent, whereas, quantification of Bt toxin ranged from 0.81 to 2.62. From the present study, it was concluded that almost 15-20 candidate varieties have the potential to be included among already approved varieties for commercial cultivation in the province of the Punjab.

Key word: Cotton varieties, fiber, Punjab, Pakistan.

INTRODUCTION: Cotton (*Gossypium hirsutum* L.) is an important cash crop and plays a key role as compared to all other crops (Screenivasan, 2004). Pakistan is 4th largest cotton producer in the world after China, USA and India (GOP, 2018). Cotton is a major crop of Pakistan after wheat; it occupies the largest area in Pakistan compared to other crops. It earns the country's largest export revenues. In addition to the lint, the seed of cotton for oil and meal accounts for 80% of the national production of oilseed. Cotton and cotton related products contribute 10% to gross domestic product (GDP) and 55% to the foreign exchange earnings of the country. In Pakistan, cotton was cultivated on an area of 2700 thousand hectares (6672 thousand acres) during the year 2017-18 with the production of 11.95 million bales, whereas, the lint yield in Pakistan for the same year was 752 kg/ha (305 kg/acre). In Punjab, almost 100% Bt cotton with Mon53 event and Cry1Ac gene was sown on an area of 2053 thousand hectares (5073 thousand acres) which produced 8.78 million bales with lint yield of 669 kg/ha during the year 2017-18 (GOP, 2018). Five year's (2013-14 to 2017-18) data regarding cotton area, production and lint yield in Pakistan, Punjab and Sindh are depicted in Table 2. The cotton crop is judged by the genotype and its interaction with the varied environments for yield potential and quality performance (Koutu and Shastry, 2004). Most of components of economic characters are indicative of the yield potential or the integrated cotton quality and are under the control of genes of various magnitudes and influences of the environments (Narayana *et al.*, 2004). Stable cotton varieties with high yield potential are of paramount importance among the large number of varieties recommended for cultivation for a particular zone (Koutu and Shastry, 2004) (Kairon *et al.*, 2000). In the recent years, the release of high yielding, heat and leaf curl virus disease resistant Bt cotton varieties with pre-fixed fiber quality standards by the government of Punjab have accelerated momentum to fulfil the requirements of growers, textile industry and other stakeholders. In this context, the Pakistan Central Cotton Committee (PCCC) is playing a pivotal role by conducting the National Coordinated Varietal Trials (NCVT) on the candidate cotton varieties bred by public and private sector breeders. The two years NCVT is mandatory for variety approval process. Every year, NCVT is conducted at almost 17 locations of the Pakistan to test their adaptability and yield potential. If a variety excels the standard varieties in yield for consecutive two years in NCVT, that variety is forwarded in the Expert Sub Committee of the Punjab Seed Corporation headed by Director General Agriculture Research Punjab (in case of Punjab province) for further process. The Punjab Seed Corporation conducts spot examination where those candidate varieties are included which are in the second year of NCVT where fiber

properties of the varieties are analyzed. The variety which qualifies the pre-fixed fiber properties standards is then recommended to Punjab Seed Council for approval and commercial cultivation in the Punjab. Distinctiveness, Uniformity and Stability (DUS) studies are also conducted by the Federal Seed Certification and Registration Department (FSC&RD) for two years of the candidate varieties simultaneously which are included in NCVT. These trials/studies (NCVT, Spot examination and DUS) are mandatory for a variety to complete the variety approval process. Considering the above approval process for cotton varieties, the two years (2017 and 2018) data were extracted from the NCVT results distributed by Director Research, PCCC for evaluation of yield and fiber properties of candidate varieties and to see which varieties could qualify and fit in the variety approval process done by the Punjab Seed Council.

OBJECTIVES: To evaluate seed cotton yield and fiber properties of candidate varieties which completed two years in National Cotton Variety Tests during 2017 and 2018 cotton seasons.

MATERIAL AND METHODS: The studies were carried out to screen out the most outstanding high yielding varieties in different agro-ecological zones of Punjab province. 36 candidate Bt cotton varieties from public and private sectors duly coded by the Director, Research PCCC were sown and tested at six public sector research centers (CCRI, Multan; CRS Bahawalpur, CRI Khanpur, CRS Vehari and NIBGE Faisalabad) against two standard/check varieties (CIM-602 and IUB-13) during the years 2017 and 2018 in the month of May. The coded variety seed provided by the Director Research, PCCC was sown on bed and furrow with row to row distance at 2.5 ft and 1 ft plant to plant distance at all the six locations. The coded variety seed provided by the Director Research, PCCC was sown on the bed and furrow at all the six locations. The plot size, however, varied location-wise with the choice of the scientist or availability of land at the station who was deputed for conducting NCVT by the station in charge. The trials were arranged in randomized complete a block design replicated three times at each location. The trials were arranged in randomized complete block design (Gomez and Gomez, 1984) replicated three times at each location.

The trials were agronomically and entomologically supervised and protected by the agronomist and entomologist of each location. The required yield data were recorded at all the stations when the crop was fully matured and was ready to harvest. The data were statistically analyzed after Gomez and Gomez (1984) calculating C.V. % and CD values at 5 % and 1% probability levels to differentiate the varieties included in the trials. Each year after compilation of data, the yield results are sent back to Director Research PCCC with same variety codes. On the basis of yield and fiber properties results, the better performing varieties could then be released as a commercial variety for the general cultivation in the province of Punjab.

RESULTS AND DISCUSSION: Thirty six candidate cotton varieties were yielding tested consecutively for two years (2017 and 2018) and at six locations of the Province of Punjab in national coordinated varietal trials (NCVT). The trials were conducted to explore seed cotton yield potential and fiber properties of these candidate varieties against two standard/check varieties (CIM-602 and FH-142/IUB-13). The samples of all varieties for both the years were sent to four designated biotechnological laboratories for biochemical tests also. Table –1 shows the sources of the 36 + 2 standards cotton candidate varieties sown for two years in the Punjab during 2017 and 2018, cotton seasons at public sector research institutions. Table-2 depicts the cotton area, production and yield of Pakistan, Punjab and Sindh for the last five years (2013-14 to 2017-18) which serves as ready reference for the readers to judge the ups and downs in cotton crop in the last half decade. Table 3 demonstrates the yield performance and also results of statistical analysis (CD at 1 and 5% level of probability, including CV%) of the candidate varieties during 2017, whereas, table 4 revealed the yield and statistical analysis results for 2018 cotton season against the two check varieties. The two years average yield performance of candidate varieties was calculated and is presented in table 5. Table 1 demonstrated that out of 36 candidate varieties, 13 were introduced by the private sector which shows the breeding ability of their research centers and strength of their R & D system. The data presented in table 3 and table 4 revealed highly significant yield differences among the varieties during both years of trialing. In the year 2017, on an average of six locations (Table-3), top ten high yielding varieties recorded were MNH-1026, BH-221, BS-18, CEMB-100, MNH-1020, FH-444, CEMB-101, ICI-2121, Bahar-07 and IUB-69 which yielded 3202, 3058, 3051, 2948, 2923, 2888, 2880, 2870, 2783 and 2753 kg/ha seed cotton yield respectively. Regarding 2018 trial results (Table 4), on an average of six locations of the Punjab, top ten high yielding varieties were BS-18, ICI-2121, MNH-1026, RH-Afnan, CIM-343, CIM-663, NIAB-898, FH-490, MNH-1020 and NS-191 with 2893, 2749, 2748, 2745, 2614, 2608, 2607, 2604, 2594, and 2512 kg/ha of seed cotton yield respectively. However, when the results of 2017 and 2018 (both seasons) were summed up, top ten high yielding varieties were MNH-1026, BS-18, ICI-2121, BH-221, MNH-1020, CIM-343, CIM-663, FH-490, FH-444 and NIAB-898 producing 2975, 2972, 2810, 2761, 2759, 2681, 2671, 2670, 2652 and 2629 kg/ha of seed cotton respectively (Table 5). It is interesting to note that among top 10 high yielding varieties, only four varieties (MNH-1026, BS-18, ICI-2121 and MNH-1020) were with stable yield performance due to the fact that these varieties keep their superiority in individual year (2017 and 2018) and also when the average performance was looked at. Other varieties showed their stability in a particular single year, but were included in top 10 varieties when the yield results were averaged. Seeing the yield results, it is suggested that the top four high yielding varieties (MNH-1026, BS-18, ICI-2121 and MNH-1020) with stability in performance must be approved by the Punjab Seed Council to revive the cotton production of the province and not to waste/garbage this high yielding stuff. The fiber results of these four varieties are almost meeting prefixed fiber standards. Two varieties BS-18 and ICI-2121 meet all fiber standards, but are minutely lurking behind the standard of 28 mm staple length. BS-18 and ICI-2121 measured 27.58 and 27.94 mm staple length respectively by the difference of 0.42 and 0.06 mm (Table 6).

These results could be confirmed referring the annual progress reports 2017 and 2018 of the above mentioned testing research centers or CCRI, Multan reports. Kairon *et al.* (2000); Koutu and Shastry (2004) were also of the opinion and recommended that

stable cotton varieties with high yield potential are of paramount importance among the large number of varieties therefore may be released for general cultivation in a particular zone. These results could be confirmed, referring the annual progress reports 2017 and 2018 of the above mentioned testing research centers or CCRI, Multan reports. Regarding fiber properties (Table 6), 18 candidate varieties could qualify all fiber standards prefixed by Punjab Seed Council, including 12 varieties which were given relaxation of 1mm in staple length by the Expert Sub Committee of the Punjab Seed Corporation.

Table 1: Candidate cotton varieties tested in National Coordinated Varietal Trials (NCVT) during 2017 and 2018

S. No.	Name of Candidate Variety	Source of variety
1	MNH-1026	Cotton Research Institute, Multan
2	BH-221	Cotton Research Station, Bahawalpur
3	BS-18	Bandesha Seed Corporation, Jahanian
4	CEMB-100 (DG)	Center of Excellence in Molecular Biology, Lahore
5	MNH-1020	Cotton Research Institute, Multan
6	FH-444	Cotton Research Institute, AARI, Faisalabad
7	CEMB-101(DG)	Center of Excellence in Molecular Biology, Lahore
8	ICI-2121	ICI Pakistan Limited, Multan/Lahore
9	Bahar-07	Bahar Seed Corporation, Rahimyar Khan
10	IUB-69	Islamia University, Bahawalpur
11	CIM-343	Central Cotton Research Institute, Multan
12	FH-490	Cotton Research Institute, AARI, Faisalabad
13	CIM-663	Central Cotton Research Institute, Multan
14	Cyto-515	Central Cotton Research Institute, Multan
15	CKCotton-1	Center of Excellence in Molecular Biology, Lahore
16	NIAB-898	Nuclear Institute of Agriculture & Biology, Faisalabad
17	Ghauri-1 (C3)	4 Brothers Seed Corporation, Multan/Lahore
18	Badar-1 (DG)	4 Brothers Seed Corporation, Multan/Lahore
19	CKCotton-2	Center of Excellence in Molecular Biology, Lahore
20	Tahafuz-10 (DG)	Suncrop group, Multan
21	Weal-AG-6	Allahdin Group, Multan
22	RH-Afnan	Cotton Research Station, Khanpur
23	CIM-602 Std-1	Central Cotton Research Institute, Multan
24	TJ-MAX (DG)	Robert Cotton Associates, Khanewal
25	Bahar-2017	Bahar Seed Corporation, Rahimyar Khan
26	RH-Manthar	Cotton Research Station, Khanpur
27	VH-189	Cotton Research Station, Vehari
28	Weal-AG-5	Allahdin Group of Companies, Multan
29	GS-Ali-7	Gohar Seed Corporation, Makhdum Rashid
30	NS-191	Neelum Seeds Private Limited, Jahanian
31	CIM-717	Central Cotton Research Institute, Multan
32	IUB-13 Std-2	Islamia University, Bahawalpur
33	SLH-6	Cotton Research Station, Sahiwal
34	AA-933	Ali Akbar Group, Multan
35	VH-383	Cotton Research Station, Vehari
36	Sitara-16	Agri Farms Private Limited, Multan
37	SLH-19	Cotton Research Station, Sahiwal
38	Cyto-225	Central Cotton Research Institute, Multan

Source: Director Research PCCC, Multan, Pakistan

Table 2: Pakistan, Punjab and Sindh Cotton Area, production and yield for last five years (2013-14 to 2017-18)

Year-Wise	2013-14	2014-15	2015-16	2016-17	2017-18
PAKISTAN					
Area (000 hectares)	2805.65	2958.30	2901.98	2488.97	2700.27
Production (000 million bales)	12768.88	13959.58	9917.41	10671.00	11945.60
Yield (kg/ha)	774	802	581	729	752
PUNJAB					
Area (000 hectares)	2199.02	2322.85	2242.72	1815.34	2052.93
Production (000 million bales)	9145.00	10277.00	6343.00	6978.00	8077.00
Yield (kg/ha)	707	752	481	653	669
SINDH					
Area (000 hectares)	567.98	596.21	621.25	636.65	611.68
Production (000 million bales)	3523.42	3572.54	3475.60	3596.88	3775.76

Yield (kg/ha)	1055	1019	951	960	1049

Source: Cotistics august 2018 bulletin published by Pakistan Central Cotton Committee, Multan

Table 3: Seed cotton yield (kg/ha) of 36 cotton candidate varieties tested in NCVT at Six Locations of the Punjab during 2017.

S. No.	Genotypes	CCRI Mul	CRS BPR	CRS SWL	CRI K. Pur	CRS VehariNIBGE F. Abad	Punjab Avg.
1	MNH-1026	2906	1768	2620	4928	3437	3551	3202
2	BH-221	2825	3021	2760	3323	2538	3879	3058
3	BS-18	3581	2227	3100	3627	2517	3251	3051
4	CEMB-100 (DG)	2746	2445	2960	4410	2640	2489	2948
5	MNH-1020	2835	1397	2700	4452	2613	3542	2923
6	FH-444	2368	2652	1660	4415	2611	3622	2888
7	CEMB-101(DG)	2547	1448	2240	4152	2991	3900	2880
8	ICI-2121	2524	1730	2100	4170	2350	4349	2870
9	Bahar-07	2185	2307	2760	4261	1528	3660	2783
10	IUB-69	2667	1256	2400	3900	2584	3712	2753
11	CIM-343	2380	1397	2320	4071	2635	3685	2748
12	FH-490	2368	1512	1880	4109	2781	3766	2736
13	CIM-663	2189	1832	2240	3847	2558	3730	2733
14	Cyto-515	2344	1691	2260	3557	3024	3237	2686
15	CKCotton-1	2158	2435	2060	3829	1918	3660	2677
16	NIAB-898	2248	1166	2420	3352	2965	3748	2650
17	Ghauri-1 (C3)	2549	1459	2660	3438	2210	3565	2647
18	Badar-1 (DG)	3116	1843	2180	3210	1707	3543	2600
19	CIM-602 Std-1							2577
20	CKCotton-2	2264	1792	2620	3458	1166	4059	2560
21	Tahafuz-10 (DG)	2626	1089	2640	3209	1919	3873	2559
22	IUB-13 Std-2							2537
23	Weal-AG-6	2756	1230	2020	4237	1663	3265	2529
24	RH-Afnan	2838	1512	1760	3571	1874	3506	2510
25	TJ-MAX (DG)	2088	1262	2580	3786	1438	3748	2484
26	Bahar-2017	2604	1920	2140	3314	1713	3072	2461
27	RH-Manthar	1866	1397	2420	4037	2034	2941	2449
28	VH-189	2300	1134	2480	3744	1367	3004	2338
29	Weal-AG-5	2349	1518	2000	3298	1683	3156	2334
30	GS-Ali-7	2033	1723	2080	4402	2091	1628	2326
31	NS-191	2392	1269	1500	3349	2468	2493	2245
32	CIM-717	2427	1474	2600	3149	2277	1492	2236
33	SLH-6	2022	833	2580	3589	1321	2914	2210
34	AA-933	1821	2010	1780	2993	994	3453	2175
35	VH-383	2169	993	1720	3187	1266	3219	2092
36	Sitara-16	1729	743	2240	3066	1275	3344	2066
37	SLH-19	1631	839	2160	3510	1577	2618	2056
38	Cyto-225	2169	1896	1120	3946	1757	996	1981
	CD 5%	655**	345**	606**	680**	764**	782**	-
	CD 1%	864**	455**	800**	898**	1008**	1032**	-
	CV%	16.62	13.25	16.4	11.3	24.9	14.61	-

Table 4: Seed cotton yield (Kg/ha) of 36 cotton candidate varieties tested in NCVT at six locations of the Punjab during 2018.

S. No.	Genotypes	CCRI Mul	CRS BPR	CRS SWL	CRI K. Pur	CRS VehariNIBGE F. Abad	Punjab Avg.
1	BS-18	3487	2308	1384	3742	2727	3707	2893
2	ICI-2121	3010	2308	1305	3662	2260	3947	2749
3	MNH-1026	3315	2454	1152	3511	2637	3420	2748
4	RH-Afnan	3233	2282	778	3793	2440	3947	2745
5	CIM-343	3360	2202	1445	3395	2888	2392	2614
6	CIM-663	3356	2560	1317	3735	1884	2798	2608
7	NIAB-898	3028	2415	1035	3173	2404	3588	2607
8	FH-490	3572	2176	1035	3676	2440	2727	2604
9	MNH-1020	2943	2494	1350	3300	2225	3253	2594
10	NS-191	3208	2123	868	3144	2548	3181	2512
11	VH-383	2995	2334	1638	3726	2648	1721	2510
12	Cyto-515	3215	2361	1170	3277	2063	2894	2497

S. No.	Genotypes	CCRI Mul	CRS BPR	CRS SWL	CRI K. Pur	CRS Vehari	NIBGE F. Abad	Punjab Avg.
13	BH-221	2665	2468	864	3477	2242	3062	2463
14	Bahar-2017	3021	2056	863	3553	2296	2942	2455
15	Weal-AG-6	3425	2046	1215	3854	2565	1506	2435
16	FH-444	2731	2096	1233	3417	1884	3134	2416
17	VH-189	3102	1807	1161	3906	2616	1847	2407
18	Badar-1(DG)	3031	2154	981	3909	1848	2116	2340
19	AA-933	2197	2030	1080	3165	1686	3851	2335
20	RH-Manthar	2367	1986	1192	4188	2189	2044	2328
21	Ghauri-1 (C3)	3480	1873	846	3620	2081	1829	2288
22	Tahafuz10 (DG)	2636	1699	1728	3472	2045	2080	2277
23	CIM-602 Std-1							2260
24	CKCotton-2	2623	2378	1206	3532	1848	1883	2245
25	Bahar-07	2242	1990	1458	2752	1884	3133	2243
26	IUB-13 Std-2							2212
27	CEMB-100 (DG)	2582	1986	945	3698	1884	2080	2196
28	CKCotton-1	3118	2033	1071	3429	1560	1811	2170
29	CEMB-101(DG)	2618	2130	1251	3397	1848	1686	2155
30	IUB-69	2269	2083	1008	2889	2009	2583	2140
31	Sitara-16	2511	1544	1053	3564	2117	1757	2091
32	CIM-717	2541	1511	1154	2903	1830	2033	1995
33	Weal-AG-5	2475	1711	897	3015	2045	1560	1951
34	SLH-19	2797	1424	857	3388	1507	1721	1949
35	Cyto-225	2034	1843	1038	4110	771	1579	1896
36	TJ-MAX (DG)	2206	2046	818	3026	1722	1417	1873
37	SLH-6	2313	1101	1120	2776	1669	1757	1789
38	GS-Ali-7	1815	1475	618	3396	2081	1232	1770
	CD 5%	467**	351**	196**	966*	432**	874**	-
	CD 1%	623**	468**	261**	1287*	576**	1165**	-
	CV%	10	10	10	17	12	17	-

Table 5: Two year's average performance (seed cotton yield kg/ha) of thirty six cotton candidate varieties tested in NCVT at six locations of the Punjab during 2017 and 2018 cotton seasons.

Sr. No.	Genotypes	CCRI Mul	CRS BPR	CRS SWL	CRI K. Pur	CRS Vehari	NIBGE F. Abad	Punjab Avg.
1	MNH-1026	3111	2111	1886	4220	3037	3486	2975
2	BS-18	3534	2268	2242	3685	2622	3479	2972
3	ICI-2121	2767	2019	1703	3916	2305	4148	2810
4	BH-221	2745	2745	1812	3400	2390	3471	2761
5	MNH-1020	2889	1946	2025	3876	2419	3398	2759
6	CIM-343	2870	1800	1883	3733	2762	3039	2681
7	CIM-663	2773	2196	1779	3791	2221	3264	2671
8	FH-490	2970	1844	1458	3893	2611	3247	2670
9	FH-444	2550	2374	1447	3916	2248	3378	2652
10	NIAB-898	2638	1791	1728	3263	2685	3668	2629
11	RH-Afnan	3036	1897	1269	3682	2157	3727	2628
12	Cyto-515	2780	2026	1715	3417	2544	3066	2592
13	CEMB-100 (DG)	2664	2216	1953	4054	2262	2285	2572
14	CEMB-101(DG)	2583	1789	1746	3775	2420	2793	2518
15	Bahar-07	2214	2149	2109	3507	1706	3397	2513
16	Weal-AG-6	3091	1638	1618	4046	2114	2386	2482
17	Badar-1(DG)	3074	1999	1581	3560	1778	2830	2470
18	Ghauri-1 (C3)	3015	1666	1753	3529	2146	2697	2468
19	Bahar-2017	2813	1988	1502	3434	2005	3007	2458
20	IUB-69	2468	1670	1704	3395	2297	3148	2447
21	CKCotton-1	2638	2234	1566	3629	1739	2736	2424
22	CIM-602 Std-1							2419
23	Tahafuz10 (DG)	2631	1394	2184	3341	1982	2977	2418
24	CKCotton-2	2444	2085	1913	3495	1507	2971	2403
25	RH-Manthar	2117	1692	1806	4113	2112	2493	2389
26	NS-191	2800	1696	1184	3247	2508	2837	2379

Sr. No.	Genotypes	CCRI Mul	CRS BPR	CRS SWL	CRI K. Pur	CRS Vehari	NIBGE F. Abad	Punjab Avg.
27	IUB-13 Std-2							2375
28	VH-189	2701	1471	1821	3825	1992	2426	2373
29	VH-383	2582	1664	1679	3457	1957	2470	2301
30	AA-933	2009	2020	1430	3079	1340	3652	2255
31	TJ-MAX (DG)	2147	1654	1699	3406	1580	2583	2179
32	Weal-AG-5	2412	1615	1449	3157	1864	2358	2143
33	CIM-717	2484	1493	1877	3026	2054	1763	2116
34	Sitara-16	2120	1144	1647	3315	1696	2551	2079
35	GS-Ali-7	1924	1599	1349	3899	2086	1430	2048
36	SLH-19	2214	1132	1509	3449	1542	2170	2003
37	SLH-6	2168	967	1850	3183	1495	2336	2000
38	Cyto-225	2102	1870	1079	4028	1264	1288	1939

Table 6: Summary report of fiber quality

	Genotypes	GOT (%)	Mic.	Staple Length (mm)	Fiber strength (g/tex)	Fiber uniformity (%)	Fiber maturity (%)
	Standards	**>37.5**	**<5.0**	**28.00**	**>25.5**	**>80**	**>80**
1	MNH-1026	42.00	4.51	28.20	33.90	82.85	97.00
2	BH-221	40.00	4.48	26.70	28.75	80.20	91.00
3	BS-18	40.00	4.67	27.58	31.35	83.10	96.00
4	CEMB-100 (DG)	42.00	4.87	27.89	30.80	82.43	98.00
5	MNH-1020	43.00	4.68	28.09	33.88	83.10	97.00
6	FH-444	43.00	4.50	28.59	32.53	83.63	97.00
7	CEMB-101(DG)	42.00	5.01	27.34	29.40	83.30	91.00
8	ICI-2121	42.00	4.82	27.94	31.18	82.73	93.00
9	Bahar-07	43.00	4.52	26.49	27.98	80.28	94.00
10	IUB-69	40.00	5.52	27.93	32.80	82.23	90.00
11	CIM-343	42.00	4.80	27.07	32.13	80.88	89.00
12	FH-490	43.00	4.26	28.14	31.08	83.23	99.00
13	CIM-663	41.00	4.51	27.15	31.78	81.28	87.00
14	Cyto-515	37.00	5.24	26.38	28.73	81.45	89.00
15	CKCotton-1	42.00	4.84	29.01	32.05	83.48	99.00
16	NIAB-898	43.00	4.89	26.95	29.45	82.18	93.00
17	Ghauri-1 (C3)	39.00	5.22	25.60	31.48	80.60	99.00
18	Badar-1 (DG)	42.00	4.30	27.01	28.10	81.23	98.00
19	CKCotton-2	42.00	5.32	25.35	25.80	80.23	88.00
20	Tahafuz-10 (DG)	39.00	4.72	27.06	30.90	81.85	96.00
21	Weal-AG-6	43.00	4.70	26.76	27.95	81.35	98.00
22	RH-Afnan	38.00	4.77	26.28	29.25	80.93	91.00
24	TJ-MAX (DG)	41.00	4.61	26.70	30.55	82.10	87.00
25	Bahar-2017	39.00	4.75	27.80	31.73	82.60	96.00
26	RH-Manthar	40.00	4.74	26.54	30.35	81.55	88.00
27	VH-189	38.00	5.16	27.58	31.23	82.73	89.00
28	Weal-AG-5	40.00	4.77	26.88	31.30	80.58	94.00
29	GS-Ali-7	41.00	4.30	27.49	28.30	81.93	97.00
30	NS-191	39.00	4.60	26.12	32.93	81.58	93.00
31	CIM-717	42.00	4.95	26.52	30.98	80.65	89.00
33	SLH-6	42.00	4.47	27.45	31.80	81.75	93.00
34	AA-933	43.00	4.66	26.57	28.88	81.40	94.00
35	VH-383	41.00	4.71	27.82	32.05	81.95	90.00
36	Sitara-16	41.00	4.76	26.30	28.95	81.40	93.00
37	SLH-19	42.00	4.68	27.63	30.78	81.93	93.00
38	Cyto-225	41.00	4.23	28.32	34.48	82.73	98.00

Source: Spot Examination of Cotton Candidate Varieties Held On 22.10.2018 at PSC Farms, Khanewal

Table 7: Biochemical test results (average of four laboratories)

Genotypes	2017		2018		Average of 2 years	
	Trait Purity	Quantification	Trait Purity	Quantification	Trait Purity	Quantification
MNH-1026	92	2.24	89	1.36	90.50	1.80
BH-221	65	2.30	76	2.37	70.50	2.34

Genotypes	2017		2018		Average of 2 years	
	Trait Purity	Quantification	Trait Purity	Quantification	Trait Purity	Quantification
BS-18	100	1.63	80	1.46	90.00	1.55
CEMB-100 (DG)	93	1.50	82	1.44	87.50	1.47
MNH-1020	77	2.63	55	0.87	66.00	1.75
FH-444	78	1.48	100	1.08	89.00	1.28
CEMB-101(DG)	92	1.45	100	2.66	96.00	2.06
ICI-2121	82	2.81	100	0.94	91.00	1.88
Bahar-07	85	1.05	64	1.47	74.50	1.26
IUB-69	85	2.04	64	1.00	74.50	1.52
CIM-343	75	2.45	100	1.23	87.50	1.84
FH-490	77	2.64	89	1.10	83.00	1.87
CIM-663	65	2.02	100	2.70	82.50	2.36
Cyto-515	77	2.00	80	1.59	78.50	1.80
CKCotton-1	93	1.06	100	1.33	96.50	1.20
NIAB-898	78	1.53	64	1.00	71.00	1.27
Ghauri-1 (C3)	85	1.35	89	1.58	87.00	1.47
Badar-1 (DG)	93	2.12	73	2.00	83.00	2.06
CKCotton-2	68	1.20	100	2.38	84.00	1.79
Tahafuz-10 (DG)	82	4.14	72	1.09	77.00	2.62
Weal-AG-6	85	1.85	89	1.23	87.00	1.54
RH-Afnan	65	2.66	100	1.38	82.50	2.02
CIM-602 Std-1	85	1.41	100	1.54	92.50	1.48
TJ-MAX (DG)	85	2.01	100	1.62	92.50	1.82
Bahar-2017	85	1.05	89	1.04	87.00	1.05
RH-Manthar	77	2.00	89	1.33	83.00	1.67
VH-189	92	1.22	89	1.48	90.50	1.35
Weal-AG-5	93	1.35	62	1.26	77.50	1.31
GS-Ali-7	52	0.77	33	1.08	42.50	0.93
IUB-13 Std-2	82	1.80	64	1.18	73.00	1.49
NS-191	52	0.93	93	1.47	72.50	1.20
CIM-717	90	1.12	40	0.90	65.00	1.01
SLH-6	85	1.85	67	0.98	76.00	1.42
AA-933	82	2.17	75	2.43	78.50	2.30
VH-383	93	1.67	87	1.18	90.00	1.43
Sitara-16	85	3.07	89	1.41	87.00	2.24
SLH-19	52	1.62	67	0.91	59.50	1.27
Cyto-225	58	0.70	33	0.93	45.50	0.82

The biochemical test results (Table 7) revealed that on an average of four laboratories and two years, the trait purity range recorded wa from 42 to 96 percent, whereas, quantification of Bt toxin ranged from 0.81 to 2.62. From the present study, it was concluded that almost 15-20 candidate varieties have the potential to be included among already approved varieties for commercial cultivation in the province of the Punjab.

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