

Testing of New Strains of VT-1, VT-2, VT-3, VT-4, MVT-1, MVT-2, MVT-3, MVT-4, MVT-5, NCVT, SVT1, SVT-2, Selection and Early Generation Testing in Cotton Genotypes in Crop Year 2022-2023

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Abstract

Plant Breeding & Genetics Section develops new cotton varieties or lines with desirable fibre traits equipped with inbuilt resistance/tolerance against insect-pest and diseases by utilizing purposeful breeding (crossing) of closely or distantly related genotypes. Plants are cross-bred to introduce traits/genes from one variety or line into a new genetic background.

The promising hybrids, Bt. and non-Bt.. strains (in coded form) of all the cotton breeders of the country were evaluated under National Coordinated Variety Testing (NCVT) Program of Pakistan Central Cotton Committee. The prominent commercial varieties (Bt. and non-Bt..) were also tested for their performance under the local agro-climatic conditions of Multan zone in standard varietal trials. The breeding materials in different filial generations were screened out for selection into next generation. Major emphasis was laid on the selection of material having resistance/tolerance against biotic (Cotton Leaf Curl Virus (CLCuV), Pink boll worm etc) and abiotic factors (tolerance against heat-drought and Glyphosate etc) with excellent fibre characteristics. The genetic stock of World Cotton collections comprising of 6243 cultivars of four species of *Gossypium* from 41 countries of the World are being preserved for short (25 years), medium (50 years) and long (100 years) duration as well as for utilization in breeding program by cotton breeders in the country and abroad. Promising lines i.e. Bt.CIM-990 and Bt.CIM-909 developed by utilizing USDA and local cotton germplasm material were tested for second and first years respectively in NCVT. Trainings were also imparted to small farmers, progressive growers from core and non-core zones of the cotton belts along with technical staffs of different seed companies. Students from different universities were also trained thorough internship training program. Summary of above mentioned activities are given below.

Keywords: NCVT; Selection and Early Generation Testing in Cotton Genotypes i

PLANT BREEDING & GENETICS SECTION

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breeding (crossing) of closely or distantly related genotypes. Plants are cross-bred to introduce traits/genes from one variety or line into a new genetic background.

The promising hybrids, *Bt.* and non-*Bt.* strains (in coded form) of all the cotton breeders of the country were evaluated under National Coordinated Variety Testing (NCVT) Program of Pakistan Central Cotton Committee. The prominent commercial varieties (*Bt.* and non-*Bt.*) were also tested for their performance under the local agro-climatic conditions of Multan zone in standard varietal trials. The breeding materials in different filial generations were screened out for selection into next generation. Major emphasis was laid on the selection of material having resistance/tolerance against biotic (Cotton Leaf Curl Virus (CLCuV), Pink boll worm etc) and abiotic factors (tolerance against heat-drought and Glyphosate etc) with excellent fibre characteristics. The genetic stock of World Cotton collections comprising of 6243 cultivars of four species of *Gossypium* from 41 countries of the World are being preserved for short (25 years), medium (50 years) and long (100 years) duration as well as for utilization in breeding program by cotton breeders in the country and abroad. Promising lines i.e. *Bt.*CIM-990 and *Bt.*CIM-909 developed by utilizing USDA and local cotton germplasm material were tested for second and first years respectively in NCVT. Trainings were also imparted to small farmers, progressive growers from core and non-core zones of the cotton belts along with technical staffs of different seed companies. Students from different universities were also trained thorough internship training program. Summary of above mentioned activities are given below.

Testing of new strains

2.1.1 Varietal Trial-1

Objective: Testing and evaluation of promising medium long staple *Bt.* strains for the development of commercial varieties

Nine medium long staple promising *Bt.* strains viz., *Bt.*.CIM-793 - *Bt.*.CIM-801, were evaluated against one commercial variety *Bt.*.CIM-663 at CCRI, Multan. Data of seed cotton yield and other parameters are given in **Tables 2.1**.

The strain *Bt.*.CIM-798 produced the highest seed cotton yield of 2475 kg ha⁻¹ followed by *Bt.*.CIM-795 having yield 2341 kg ha⁻¹ while the standard variety *Bt.*.CIM-663 yielded 1956 kg ha⁻¹ .(**Table 2.1**).

The new strain *Bt.*.CIM-800 produced the highest lint percentage of 42.4 followed by *Bt.*.CIM-801 having lint percentage values of 41.2 compared with the standard *Bt.*.CIM-663 i.e. 39.0 (**Table 2.1**). The new strain *Bt.*.CIM-795 produced the longest staple of 28.7 mm, followed by *Bt.*.CIM-793 with 28.6mm while the standard *Bt.*.CIM-663 produced 27.2 mm of staple length (**Table 2.1**).

All the new strains possess desirable micronaire value ranging from 4.0 to 4.9 in comparison to *Bt.*.CIM-663 with 4.9. The fiber strength of all the new strains and standard are in the desirable range, i.e., 26.2 to 28.7 g/tex (**Table 2.1**).

Table 2.1 Performance of advanced strains in Varietal Trial-1 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple length (mm)	Micro-naire value	Fibre strength (g/tex)	Av. boll wt. (g)	Plant Pop. (ha ⁻¹)
1.	<i>Bt.</i> CIM-793	1845	38.5	28.6	4.8	27.8	3.2	28604
2.	<i>Bt.</i> CIM-794	1749	39.3	28.3	4.5	27.8	3.2	32639

3.	<i>Bt. CIM-795</i>	2341	38.0	28.7	4.0	27.5	2.8	28693
4.	<i>Bt. CIM-796</i>	2025	40.4	27.8	4.9	26.8	2.9	32011
5.	<i>Bt. CIM-797</i>	2114	39.9	27.5	4.1	28.7	2.5	30397
6.	<i>Bt. CIM-798</i>	2475	37.7	27.5	4.5	26.2	2.7	28693
7.	<i>Bt. CIM-799</i>	2213	40.2	27.6	4.8	27.0	2.9	34611
8.	<i>Bt. CIM-800</i>	1980	42.4	26.8	4.9	26.2	2.6	26183
9.	<i>Bt. CIM-801</i>	2049	41.2	28.1	4.8	28.5	2.9	35060
10.	<i>Bt. CIM-663</i>	1956	39.0	27.2	4.9	25.9	3.0	35060

Sowing date 01.04.2022, CD (5%) for seed cotton: Strains =356.65; CV % =10.75

2.1.2 Varietal Trial-2

Objective: Testing and evaluation of promising strains with high ginning out turn for the Development of commercial varieties

Nine new strains with medium-long staple viz., *Bt.CIM-782*, *Bt.CIM-783*, *Bt.CIM-784*, *Bt.CIM-787*, *Bt.CIM-802*, *Bt.CIM-803*, *Bt.CIM-804*, *Bt.CIM-805*, *Bt.CIM-806* and *Bt.CIM-663* were tested at CCRI, Multan and Punjab Seed Corporation Farm, Khanewal against a commercial variety *Bt.CIM-602*.

Data presented in **Table 2.4** showed that averaged across locations the new strain *Bt.CIM-782* produced the highest seed cotton yield of 2367 kg ha⁻¹, followed by *Bt.CIM-806* with 2128 kg ha⁻¹ while the standard varieties *Bt.CIM-602* produced 777 kg ha⁻¹.

The strain *Bt.CIM-804* had the highest lint percentage of 44.3, followed by 43.4% of *Bt.CIM-782* in comparison to the commercial varieties *Bt.CIM-602* produced 43.3 lint percentages. The strain *Bt.CIM-802* produced the longest staple of 29.8 mm followed by *Bt.CIM-787* having 29.5 mm (**Table 2.5**) while standard *Bt.CIM-602* produced 27.8 mm staple length

All the strains possess desirable micronaire value ranging from 4.0 to 4.8 The fibre strength of the strains ranged from 26.0 to 28.5 g/tex (**Table 2.6**).

Table 2.2 Performance of advanced strains in Varietal Trial-2

Sr. #	Strains	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple length (mm)	Micro-naire value	Fibre strength (g/tex)	Av. boll wt. (g)	Plant Pop. (ha ⁻¹)
1.	Bt CIM-782	2367	43.4	28.3	4.8	26.6	2.9	33356
2.	Bt CIM-783	1728	42.8	28.1	4.5	27.1	3.4	19996
3.	Bt CIM-784	1527	39.1	28.5	4.0	26.9	2.9	26900
4.	Bt CIM-787	1703	42.3	29.5	4.5	28.5	4.3	25107
5.	Bt CIM-802	1795	42.1	29.8	4.7	26.8	3.3	30756
6.	Bt CIM-803	1616	42.7	29.4	4.4	28.4	3.1	28873
7.	Bt CIM-804	1289	44.3	29.1	4.2	28.3	3.3	23493
8.	Bt CIM-805	1649	43.0	28.9	4.4	27.5	3.5	23941
9.	Bt CIM-806	2128	42.3	29.3	4.3	28.5	3.1	29859
10.	Bt CIM-663	777	43.3	27.8	4.7	26.0	3.0	23672

Sowing date 19.05.2020 C.V =6.68

CD (5%) for seed cotton: Locations (L) = 87.713; Varieties (V) = 170.60: L x V = 181.05

2.1.3 Varietal Trial-3

Objective: Testing and evaluation of promising medium long staple *Bt.* strains for the development of commercial varieties

Nine medium staple promising *Bt.* Strains *Bt.*CIM-807, *Bt.*CIM-808, *Bt.*CIM-809, *Bt.*CIM-810, *Bt.*CIM-811, *Bt.*CIM-812, *Bt.*CIM-813 were evaluated against commercial variety *Bt.*CIM-663 at CCRI, Multan. Data on seed cotton yield and other parameters are given in **Tables 2.7**.

The strain *Bt.*CIM-810 produced the highest seed cotton yield of 2182 kg ha⁻¹ followed by *Bt.*CIM-807 having yield of 1912 kg ha⁻¹ while the standards *Bt.*CIM-663 produced yield of 923 kg ha⁻¹ (**Table 2.7**).

Table 2.7 Performance of advanced strains in Varietal Trial-3

Sr. #	Strains	Plant Pop. (ha-1)	SCY (Kg/ha)	Av. Boll Weight (g)	GOT%	Staple Length (mm)	Uniformity Index %	Mic	Fiber Strength (g/tex) 1/8"
1.	CIM-807	27795	1912	3.0	41.9	28.1	83.3	4.7	29.0
2.	CIM-808	24119	1418	2.8	43.4	24.4	81.5	6.1	21.7
3.	CIM-809	25105	1238	2.7	42.7	25.8	82.2	5.5	23.0
4.	CIM-810	37120	2182	3.2	43.2	28.3	84.2	5.1	27.1
5.	CIM-811	30485	1685	2.5	40.5	25.7	82.9	5.0	25.4
6.	CIM-812	17663	1146	2.4	36.0	27.9	83.8	4.2	28.0
7.	CIM-813	15242	1147	2.6	42.0	27.0	83.6	5.0	26.7
8.	CIM-663	30126	923	2.6	36.9	25.0	81.9	4.9	24.3

Sowing date 15.04.2022,

The new strains *Bt.*CIM-808 produced the highest GOT% of 43.4, followed by *Bt.*CIM-810 having lint percentage value of 43.2 (Table 2.7). *Bt.*CIM-810 produced the longest staple of 28.3 mm, followed by *Bt.*CIM-807 with 28.1 mm while the standards *Bt.*CIM-663 produced 25.0 mm staple length (**Table 2.7**).

All the new strains possess desirable micronaire values ranging from 4.2 to 5.1 except *Bt.*CIM-808 and *Bt.*CIM-809 The fibre strength of all the new strains and standard is in the range of 21.7 to 29.0 g/tex (**Table 2.7**).

2.1.4 Varietal Trial-4

Objective: Testing and evaluation of promising medium long staple *Bt.* strains for the development of commercial varieties

Eight medium staple promising *Bt.* Strains *Bt.*CIM-785, *Bt.*CIM-759, *Bt.*CIM-778, *Bt.*CIM-762, *Bt.*CIM-792, *Bt.*CIM-781, and *Bt.*CIM-782, were evaluated against commercial variety *Bt.*CIM-663 at CCRI, Multan. Data on seed cotton yield and other parameters are given in **Tables 2.7, 2.8 and 2.9**.

Averaged across location, the strain *Bt.*CIM-792 produced the highest seed cotton yield of 3536 kg ha⁻¹ followed by *Bt.*CIM-782 having yield of 3201 kg ha⁻¹ while the standard *Bt.*CIM-663 produced 2366 kg ha⁻¹ yield (**Table 2.7**).

Table 2.8 Performance of advanced strains in Varietal Trial-4 at Central Cotton Research Institute, Multan

Sr. #	Strains	Seed cotton yield (kg ha ⁻¹)	Boll weight (g)	Plant Pop. (ha ⁻¹)
1.	CIM-758	2893	3.2	26181
2.	CIM-759	2812	3.1	25064
3.	CIM-778	2560	3.2	27169
4.	CIM-762	2508	3.0	39543
5.	CIM-792	3536	3.0	32818
6.	CIM-781	2509	3.1	33087
7.	CIM-782	3201	3.2	36584
8.	CIM-663	2366	3.2	32011

* Sowing date =16.04.2022 CV = 6.7%

CD (5%) for seed cotton: Locations (L) =57.57; Varieties (V) =128.73; L x V = 182.05

The new strains *Bt.*CIM-672 produced the highest lint percentage of 41.4, followed by *Bt.*CIM-782 having lint percentage value of 40.8 (Table 2.8). The new strains *Bt.*CIM-792 produced the longest staple of 29.4 mm, followed by *Bt.*CIM-759 with 29.0 mm while the standard *Bt.*CIM-663 produced 27.8 mm staple length (Table 2.8).

All the new strains possess desirable micronaire values ranging from 4.8 to 5.0 including the standard *Bt.*CIM-663. The fibre strength of all the new strains and standard is in the desirable range. (Table 2.9).

Table 2.9 Lint percentage and staple length of advanced strains in Varietal Trial-4 at Central Cotton Research Institute, Multan

Sr. #	Strains	Lint (%age)	Staple Length (mm)
1.	CIM-785	40.3	28.8
2.	CIM-759	40.7	29.0
3.	CIM-778	40.2	27.0
4.	CIM-762	41.4	27.6
5.	CIM-792	39.0	29.4
6.	CIM-781	40.6	26.9
7.	CIM-782	40.8	28.2
8.	CIM-663	39.4	27.8

Table 2.10. Micronaire value and fibre strength of advanced strains in Varietal Trial-4 at Central Cotton Research Institute, Multan,

Sr. #	Strains	Micronaire value	Fibre strength (g/tex)
1.	CIM-758	4.9	27.3
2.	CIM-759	4.8	27.5
3.	CIM-778	4.7	28.1
4.	CIM-762	4.8	27.1

5.	CIM-792	4.5	28.7
6.	CIM-781	5.6	24.6
7.	CIM-782	4.8	25.1
8.	CIM-663	5.0	25.4

2.2.1 Micro Varietal Trial-1

Objective: Testing of newly bulked medium staple *Bt.* strains to develop Commercial varieties

Nine newly bulked strains numbering from MV-1/22 to MV-9/22 were tested against commercial variety *Bt.*CIM-663 at CCRI, Multan for the second year. The strain MV-4/22 surpassed all the strains and standard variety in seed cotton yield by producing 2582 kg ha⁻¹ followed by MV-1/22 with 2264 kg ha⁻¹ compared with 1469 kg ha⁻¹ of *Bt.*CIM-663 (Table 2.10).

The strain MV-7/22 produced the highest GOT% of 44.2 followed by 42.9 percent in MV-2/22 and MV-4/22 while the commercial variety *Bt.*CIM-663 produced the GOT% of 40.1. The strain MV-1/22 and MV-7/22 produced the longest staple of 28.5 mm, followed by 28.0 mm in MV-4/22 compared with the fibre length of 25.2 mm in commercial variety *Bt.*CIM-663. Micronaire values of all the strains are in acceptable limit except MV-2/22 and MV-3/22. The strain MV-7/22 maintained the maximum fibre strength of 29.5 g/tex, followed by 29.3 g/tex in MV-1/22 while standard *Bt.*CIM-663 had 25.5 g/tex.

Table 2.10 Performance of advanced strains in Micro Varietal Trial-1 at CCRI, Multan

Sr. #	Strains	SCY (Kg/ha)	GOT%	Staple Length (mm)	Mike	Fiber Strength (g/tex) 1/8"	Av. Boll weight (g)	Plant Pop. (ha-1)
1.	MV-1	2264	41.7	28.5	4.3	29.3	2.7	39809
2.	MV-2	1784	42.9	24.2	5.6	22.0	2.6	37299
3.	MV-3	1547	42.8	27.4	5.3	24.4	2.7	32816
4.	MV-4	2582	42.9	28.0	5.0	26.1	2.5	42679
5.	MV-5	1988	41.5	27.3	5.1	26.0	3.0	35685
6.	MV-6	2099	40.8	25.6	4.9	25.3	2.3	37837
7.	MV-7	1497	44.2	28.5	4.7	29.5	2.6	30485
8.	MV-8	1543	35.4	27.1	3.9	28.0	2.4	28692
9.	MV-9	1483	35.4	27.1	3.9	28.0	2.7	24029
10.	CIM-663	1469	40.1	25.2	4.8	25.5	2.9	39809

Sowing date 30.03.2022

2.2.2 Micro Varietal Trial-2

Objective: Testing of newly bulked medium-long staple *Bt.* strains to develop commercial varieties

Nine newly bulked strains numbering from MV-10/22 to MV-18/22 were tested against commercial variety *Bt.*CIM-632 at CCRI, Multan. The new strain MV-16/22 surpassed all the strains and standard variety in seed cotton yield by producing 2315 kg ha⁻¹, followed by MV-15/22 with 2269 kg ha⁻¹ compared with 1281 kg ha⁻¹ of *Bt.*CIM-602 (Table 2.11).

The strain MV-10/22 produced the highest lint percentage of 43.4 followed by 42.6 percent lint in MV-18/22 while the commercial variety *Bt.CIM-602* produced the lint percentage of 41.3. The strain 17/22 produced the longest staple of 29.2 mm, followed by 29.1 mm in MV-11/22 compared with the fibre length of 26.1 mm in commercial variety *Bt.CIM-602*. All the strains have desirable micronaire and fiber strength values.

Table 2.12. Performance of advanced strains in Micro-Varietal Trial-2 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple Length (mm)	Micro-naire value	Fibre Strength (g/tex)	Av. boll wt. (g)	Plant Pop. (ha ⁻¹)
1.	MV-10	1828	43.4	28.0	4.3	28.0	2.9	30128
2.	MV-11	1971	41.8	29.1	4.6	29.8	2.6	31921
3.	MV-12	1575	39.5	27.5	4.9	27.4	3.7	30307
4.	MV-13	1980	40.8	27.5	4.3	27.9	3.1	29052
5.	MV-14	2269	39.6	28.8	4.7	28.9	3.3	23134
6.	MV-15	1597	42.1	27.3	5.1	27.7	2.7	21879
7.	MV-16	2315	39.6	28.4	5.0	27.5	3.5	23313
8.	MV-17	1944	42.2	29.2	4.6	30.3	2.6	28693
9.	MV-18	2099	42.6	28.3	4.7	28.5	2.8	22775
10.	CIM-663	1281	41.3	26.1	5.0	26.8	2.9	25107

Sowing date 19.05.2020, CD (5%) for seed cotton = 275.15, CV. % = 6.90

2.2.3 Micro Varietal Trial-3

Objective: Testing of newly bulked medium-long staple strains to develop commercial varieties

Nine newly bulked strains numbering from MV-19/22 to MV-27/22 were tested against commercial variety *Bt.CIM-632* at CCRI, Multan. Data presented in **Table 2.12** indicated that the new strain MV-25/22 surpassed all the new strains yielding 2344 kg ha⁻¹, followed by strains MV-22/22 produced 2263 kg ha⁻¹ while the standard *Bt.CIM-632* yielding 975 kg ha⁻¹. The new strain MV-24/22 produced the lint percentage of 44.4 followed by MV-22/20 with 43.4 % in comparison to *Bt.CIM-632* having 42.6 lint percentages. The strains MV-20/22 has the longest staple of 29.8 mm followed by MV-19/22 and MV-26 with the staple of 29.1 mm compared with the staple length of 26.5 mm in standard variety *Bt.CIM-632*. All the genotypes have desirable micronaire value except MV-23 and MV-27 where as fineness of standard CIM-663 is also undesirable. All the strains were showing fibre strengths ranging from 26.3 to 30.3 g/tex.

Table 2.13. Performance of advanced strains in Micro-Varietal Trial-3 at CCRI, Multan

Sr. #	Strains	Seed cotton yield (kg ha ⁻¹)	Lint (% age)	Staple Length (mm)	Micro naire value	Fibre Strength (g/tex)	Av. boll weight (g)	Plant Pop. (ha ⁻¹)
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1.	MV-19	2160	40.7	29.1	3.8	29.4	3.2	39274
2.	MV-20	2008	39.8	29.8	4.0	30.3	3.2	38915
3.	MV-21	2161	37.5	28.9	4.3	28.6	3.0	38019
4.	MV-22	2263	43.4	28.2	4.9	26.7	3.6	38019
5.	MV-23	1421	42.5	28.2	5.0	26.9	2.9	32459
6.	MV-24	2219	44.4	29.0	4.8	28.4	2.8	38377
7.	MV-25	2344	41.9	27.8	4.8	28.0	3.7	35508
8.	MV-26	1808	40.5	29.1	4.7	29.3	3.1	38915
9.	MV-27	1145	41.0	28.4	5.1	27.1	2.9	26362
10.	CIM-663	975	42.6	26.5	5.2	26.3	2.9	29052

Sowing date = 19.05.2020, CD (5%) for seed cotton: 315.786, CV% = 11.65

2.2.4 Micro-Varietal Trial-4

Objective: Testing of medium long staple *Bt.* strains to develop commercial varieties

Seven newly bulked elite *Bt.* strains from MV-28/22 to MV-34/22 were tested against commercial variety *Bt.* CIM-663 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.14**.

The strain MV-28/22 out-yielded all the strains and standard variety by producing 2893 kg ha⁻¹ seed cotton, followed by MV-29/22 having seed cotton yields of 2812 kg ha⁻¹ against commercial variety *Bt.* CIM-663 which produced 2066 kg ha⁻¹ seed cotton. The strain MV-28/22 produced the higher lint percentage of 42.9 followed by MV-34/22 with 42.1% compared with that of 41.4% by *Bt.* CIM-663.

The strain MV-33/22 produced the longest staple of 28.6 mm, followed by the 28.4 mm of strain MV-34/22 compared with the 28.4 mm of *Bt.* CIM-663. All the strains have desirable micronaire values ranging from 4.0 to 4.8. The fibre strength of all the new strains was observed within the range i.e. 26.0 to 28.0.

Table 2.14. Performance of advanced strains in Micro-Varietal Trial-4 at CCRI, Multan

Sr.#	Strains	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple Length (mm)	Micro naire value	Fibre Strength (g/tex)	Av. boll weight (g)	Plant Pop. (ha ⁻¹)
1.	MV-28/22	2893	42.9	28.1	4.8	26.8	2.9	36584
2.	MV-29/22	2812	41.7	28.3	4.7	26.3	2.7	23313
3.	MV-30/22	2560	39.1	27.6	4.8	28.0	2.7	32280
4.	MV-31/22	2508	40.0	27.1	4.6	27.6	3.3	35867
5.	MV-32/22	2236	39.2	27.6	4.8	27.9	3.1	37839
6.	MV-33/22	2509	41.8	28.6	4.0	27.2	2.5	35508
7.	MV-34/22	2201	42.1	28.4	4.2	27.1	2.8	32459
8	<i>Bt.</i> CIM-663	2066	41.4	28.4	4.2	26.0	2.4	30307

Sowing date 01.04.2022, CD (5%) for seed cotton 212.65 CV. % = 9.18

2.2.5 Micro-Varietal Trial-5

Objective: Testing of medium long staple *Bt.* strains to develop commercial varieties

Eight newly bulked elite strains MV-36/22 to MV-42/22 were tested against commercial variety *Bt.*CIM-663 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.15**.

The strain MV-39/22 out-yielded all the strains and standard variety by producing 2479 kg ha⁻¹ seed cotton followed by MV-38/22 having seed cotton yields of 2250 kg ha⁻¹ against commercial variety *Bt.*CIM-663 which produced 1845 kg ha⁻¹ seed cotton. The strains MV-42/22 produced the higher lint percentage values of 42.1% followed by MV-41/22 with 42.0% compared with that of 40.2% by *Bt.*CIM-663.

The strain MV-36/22 and MV-41/22 produced the longest staple of 28.9 mm, followed by 28.8 mm in MV-38/22 compared with the fibre length of 27.7 mm in commercial variety *Bt.*CIM-663. All strains have desirable micronaire values ranging from 4.0 to 4.8 The strain MV-39/22 maintained the maximum fibre strength of 28.5 g/tex followed by MV-35/22 and MV-38/22 with 27.5 g/tex while standard *Bt.*CIM-663 had 26.7 g/tex fibre strength.

Table 2.15 Performance of advanced strains in Micro-Varietal Trial-5 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple Length (mm)	Micro-naire value	Fibre Strength (g/tex)	Av. boll weight (g)	Plant pop. (ha ⁻¹)
1.	MV-35/22	1780	40.2	28.1	4.0	27.7	2.9	40529
2.	MV-36/22	2044	40.5	28.9	4.1	26.7	2.6	31563
3.	MV-37/22	1493	41.9	27.9	4.5	26.2	2.8	38198
4.	MV-38/22	2250	40.0	28.8	4.8	27.5	2.6	39812
5.	MV-39/22	2479	41.8	28.1	4.8	28.5	2.5	40529
6.	MV-40/22	2094	40.8	28.2	4.4	27.2	2.6	39991
7.	MV-41/22	2240	42.0	28.9	4.0	26.3	2.5	41067
8.	MV-42/22	1875	42.1	28.8	4.6	26.3	2.6	39812
9.	<i>Bt.</i> CIM-663	1845	40.2	27.8	4.2	26.7	2.4	35149

Sowing date = 01.04.2022; CD (5%) for seed cotton = 383.01; CV. % = 11.23

2.3 Coordinated Variety Testing Program

2.3.1 National Coordinated Varietal Trials (Set-B)

Objective: Testing of promising *Bt.* strains of different cotton breeders of Pakistan

Twenty three strains from different cotton breeders of the country were received under coded numbers from Director Research PCCC for evaluated at CCRI Multan.

The data presented in **Table 2.17** showed that the Shara-Klean-10 produced the highest seed cotton yield of 1600 kg ha⁻¹, followed by CEMB-ASS-3 having 1479 kg ha⁻¹ seed cotton yield while *Bt.*CIM-600 produced lowest yield 662 kg ha⁻¹.

Data also revealed that the strain PC-2227 produced the highest lint percentage of 42.2, followed by PC-2234 with 42.1%. Strain PC-2233 produced the longest staple with 27.9 mm length followed by PC-2224 with 27.8 mm.

All strains have micronaire values ranging from 4.2 to 5.6. Maximum fibre strength was maintained by PC-2235 having 28.4 g/tex, followed by PC-2241 with 27.9 g/tex.

Table 2.17 Performance of different Bt. Strains of public Sector in National Coordinated Varietal Trial (Set-B) at CCRI, Multan

Sr.#	Strains	Seed-cotton Yield (kg ha-1)	Lint (%age)	Staple length (mm)	Micronaire value	Fibre strength (g/tex)	Boll Weight	Plant Pop. (ha-1)
1.	IUB-4	1386	41.6	26.3	4.7	26.8	2.8	42482
2.	Bahar-GTG-155	1084	39.6	27.8	4.8	26.4	2.2	39370
3.	FH-189	807	40.4	24.5	4.3	21.5	2.3	42003
4.	Sahara-Klean-10	1600	40.9	25.8	5.3	22.5	2.6	43170
5.	VH-447	1084	42.2	25.9	5.6	20.4	2.5	42362
6.	KZ-181	951	37.8	26.6	5.1	22.9	2.3	42362
7.	IUB-23	1203	40.7	27.6	4.6	26.6	2.5	42003
8.	RH-Bagh-O-Bahar	1467	39.0	26.9	4.6	25.1	2.6	39131
9.	Silver-Queen-33	1225	38.1	26.6	4.6	25.3	2.5	42601
10.	Captain-300	975	40.0	27.7	4.2	26.9	2.3	38413
11.	IR-NIBGE-17	915	39.9	27.9	4.6	26.6	2.3	40447
12.	KZ-111	1181	42.1	26.1	5.2	22.6	2.6	42482
13.	CEMB-AAS-3	1479	35.7	27.3	4.5	28.4	2.5	42483
14.	Silver-Queen-44	963	41.8	25.1	5.5	20.6	2.3	38533
15.	PC-2234	680	40.9	25.9	4.3	23.7	2.2	42721
16.	CIM-600 (Bt. Standard)	662	41.3	25.1	4.5	23.8	2.1	42242
17.	NIAB-868	965	40.1	26.6	4.9	25.3	2.6	42362
18.	RH-Gold-1	1263	42.0	25.4	5.5	21.8	2.5	42721
19.	Tipu-10	1022	41.6	26.7	4.7	27.9	2.3	42362
20.	Diamond-2024	1204	41.3	27.5	4.9	25.5	2.4	42242
21.	PC-2237	1026	38.9	26.0	5.2	22.6	2.7	42721
22.	FH-415	832	38.0	26.3	4.7	24.5	2.4	38543
23.	IR-NIBGE-20	1158	40.9	27.3	5.1	24.7	2.9	41046

Sowing date : 30-04-2022

2.4 Testing of Commercial Varieties

2.4.1. Standard Varietal Trial-1

Objective: To test the performance of commercial varieties of Pakistan under the agro-climatic conditions of Multan

Seven commercial Non *Bt.* varieties of the country were tested at CCRI, Multan. Data recorded on seed cotton yield and other parameters are presented in **Table 2.18**. The results indicated that varieties CIM-496 and CIM-482 excelled among all varieties by producing seed cotton yield 1421 kg ha⁻¹ followed by the variety CIM-608 with 1396 kg. ha⁻¹ seed cotton production. Variety CIM-608 had the highest lint percentage of 42.6, followed by variety Cyto-124 having lint percentage of 41.5 The variety CIM-608 maintained the staple length of 28.7 mm, followed by the variety the CIM-124 with 27.9 mm staple length.

Micronaire values of all the varieties were according to the standard. Fibre strength of all the genotypes was in the desirable range.

Table 2.18 Performance of commercial varieties in Standard Varietal Trial-I at CCRI, Multan

Sr. #	Varieties	Year of released	Seed Cotton Yield (kg ha ⁻¹)	Lint (% age)	Staple length (mm)	Micro-naire value	Fibre Strength (g/tex)	Av. Boll wt. (g)	Plant Pop. (ha ⁻¹)
1.	CIM-482	2000	1421	39.9	27.0	4.7	27.7	2.4	29590
2.	CIM-496	2005	1421	39.0	26.3	4.1	27.3	2.5	28155
3.	CIM-573	2012	1236	40.2	26.3	4.7	25.3	2.6	29590
4.	CIM-608	2013	1396	42.6	28.7	4.8	29.5	2.6	40171
5.	Cyto-124	2015	1326	41.5	27.9	4.8	28.3	2.8	34073
6.	CIM-620	2016	1025	40.2	27.1	4.4	27.7	2.5	27976
7.	CIM-610	2018	1243	40.0	27.0	4.8	27.8	2.6	30128

Sowing date = 01.04.2022, CD (5%) for seed cotton: 295.35, CV% = 9.90

2.4.2. Standard Varietal Trial-2

Objective: To test the performance of commercial *Bt.* varieties of Pakistan under the agro-climatic conditions of Multan

Ten *Bt.* commercial varieties of the country were tested at CCRI, Multan. Data recorded on seed cotton yield and other parameters are presented in Table 2.21. The results indicated that variety *Bt.* CIM-678 excelled among all varieties by producing seed cotton yield of 2433 kg ha⁻¹, followed by the variety *Bt.* CIM-600 with 2151 kg ha⁻¹ while *Bt.* CIM-598 produced lowest (1181 kg ha⁻¹) seed cotton production. *Bt.* Cyto-179 had the highest GOT% of 42.9, followed by *Bt.* CIM-678 showing 42.3%. Longest staple length of 28.9 observed in *Bt.* Cyto-535. Micronaire and fiber strength of all the varieties were up to the standard.

Table 2.21 Performance of commercial varieties in Standard Varietal Trial-2 at CCRI, Multan

Sr.#	Strains	Plant Pop. (ha ⁻¹)	SCY (Kg/ha)	Av. Boll weight (g)	GOT%	Staple Length (mm)	Uniformity Index %	Mike	Fiber Strength (g/tex) 1/8"
1.	CIM-663	38853	1619	2.6	40.3	25.3	82.0	5.3	24.3
2.	CIM-602	35984	1874	2.3	38.0	27.6	80.7	4.4	28.0
3.	CIM-600	35267	2151	2.6	35.9	28.0	80.4	4.4	28.6
4.	CIM-598	39570	1181	2.4	41.6	28.2	81.0	4.5	29.0
5.	Cyto-179	41244	1717	2.8	42.9	25.3	81.2	4.8	26.1
6.	Cyto-535	24746	1734	3.4	41.0	28.9	82.7	4.6	29.7
7.	CRIS-508	41125	1459	2.0	31.8	25.8	80.8	3.3	27.5
8.	CIM-632	27855	1560	2.6	42.1	28.0	81.2	4.7	28.1
9.	CIM-785	38973	1836	2.8	41.7	27.7	81.8	5.0	27.4
10.	CIM-678	39331	2433	2.7	42.3	28.0	80.9	4.3	28.6

Sowing date = 30.03.2022

2.5 Breeding Material

2.5.1 Selection from Breeding Material

Single plants were selected from the filial generation in different segregating populations for further testing and screening against biotic and a biotic stresses. Details of breeding material planted and number of plants selected during 2022-23 are given in **Table 2.20**.

Table 2.20 Detail of single plants selected from breeding material

Generation/Trial	No. of plants Selected	Range	
		Lint (%age)	Staple length (mm)
VT	302	37.7-43.5	28.3-30.2
MVT	422	39.3-43.7	28.1-30.9
F ₆ single lines	773	38.2-44.6	28.2-30.2
F ₅ single lines	913	38.0-42.2	28.2-30.2
F ₄ generation	1199	38.7-42.5	28.7-30.5
F ₃ generation	1922	37.2-42.5	27.1-30.5
F ₂ generation	2475	36.9-42.9	27.6-31.5
Others	637	37.3-45.6	27.1-32.7

2.5.2. Hybridization program

Detail of the crossing program of the Section for the development of breeding material to evolve cotton varieties of high yield potential equipped with desirable fibre traits and wider adoptability along with inbuilt resistance/tolerance against insect-pest. Details are given in Table-2.21-to 2.25.

Table-2.21. CROSS REFERENCE CHART F₁ HB-1 OF BREEDING AND GENETICS SECTION AT CENTRAL COTTON RESEARCH INSTITUTE, MULTAN DURING 2022-23

Hybrid No.	Parentage	Hybrid No.	Parentage
04	02 x CKC-6	09	535 x CKC-5
06	02 x CKC-6	10	06 x B-2240
05	02 x CKC-5	11	05 x B-2240
07	02 x CKC-5	12	03 x B-2240
08	535 x CKC-6	13	03 x CKC-6

Table-2.22. CROSS REFERENCE CHART F₁ HB-2 OF BREEDING AND GENETICS SECTION AT CENTRAL COTTON RESEARCH INSTITUTE, MULTAN DURING 2022-23

Hybrid No.	Parentage	Hybrid No.	Parentage
H-2303	H-2371 x H-2240	H-2311	H-2378 x CM-11/23
H-2304	H-2372 x CKC-6	H-2312	H-2371 x CM-19/23
H-2305	H-2373 x CIM-790		
H-2306	H-2373 x CIM-791 (Big Boll)	H-2313	H-2372 x Cyto-547
H-2307	H-2374 x CIM-790	H-2314	H-2373 x H-2377
H-2308	H-2375 x H-2385	H-2315	CIM-651 x Cyto-547
H-2309	H-2376 x H-2377	H-2316	CIM-651 x H-2373
H-2310	H-2377 x Okara Leaf	H-2317	CIM-651 x Okara Leaf

Table-2.23. CROSS REFERENCE CHART F₁ HB-3 OF BREEDING AND GENETICS SECTION AT CENTRAL COTTON RESEARCH INSTITUTE, MULTAN DURING 2022-23

Sr. No.	Parentage	Sr. No.	Parentage
H-2318	Pronto X GH-Uhud	H-2329	GH-Sanabal x G. Okra
H-2319	SAS-1 x GH-Sanabal	H-2330	FH-189 x Cyto-537
H-2320	Pronto x GH-Sultan	H-2331	GH-Sanabal x MNH-1090
H-2321	CKC-2 x MNH-1090	H-2332	GH-Sultan x MNH-1090
H-2322	NIAB-868 x Cyto-537	H-2333	NIAB-868 x GH-Snabal
H-2323	NIAB-868 x Cyto-537	H-2334	Cyto-533 x MNH-1090
H-2324	GH-Sanabal x GH-Hamalia	H-2335	SAS-1 x GH-Hadi
H-2325	GH-Sanabal x MNH-1090	H-2336	SAS-1 x GH-Sanabal
H-2326	SASI x Cyto-537	H-2337	Cyto-535 x MNH-1090
H-2327	GH-Sanabal x MNH-1090	H-2338	GH-Hadi x Cyto-533
H-2328	GH-Sanabal x CIM-343		

Table-2.24. CROSS REFERENCE CHART F₁ HB-3 OF BREEDING AND GENETICS SECTION AT CENTRAL COTTON RESEARCH INSTITUTE, MULTAN DURING 2022-23

Hybrid No.	Origin	Hybrid No.	Origin
H-2339	CIM-343 x MNH-1090	H-2344	431/SDK x MNH-1050
H-2340	CIM-785 x MNH-1090	H-2345	MNH-1050 x CIM-663

H-2341	CIM-789 x MNH-1090	H-2346	MNH-1090 x CIM-506
H-2342	Cyto-511 x MNH-1090	H-2347	MNH-1090 x Samroz-317
H-2343	CIM-663 x MNH-1050	H-2348	Okra x MNH-1090

Table-2.25. CROSS REFERENCE CHART F₁ HB-5 OF BREEDING AND GENETICS SECTION AT CENTRAL COTTON RESEARCH INSTITUTE, MULTAN DURING 2022-23

Hybrid No.	Origin	Hybrid No.	Origin
H-2349	CIM-632 x CKC6	H-2354	CIM-990 x FH-333
H-2350	CKC3 x 2240	H-2355	CIM-995 x FH333
H-2351	CIM-632 x FH-333	H-2356	CKC6 x C-22
H-2352	MNH-1090 x CKC3	H-2357	SLAD-115 x C-22
H-2353	CM-28 x Super Gold	H-2358	CIM-221 x C20

2.6 Maintenance of Genetic Stock of World Cotton Collection

2.6.1 Maintenance/Preservation of Cotton Genetic Stock at CCRI Multan

Six thousand one hundred and fourty three genotypes are being maintained at the Cold Room of CCRI Multan for Long (100 years), medium (50 years) and short term (25 years). One third of the seed was planted in the field for production of fresh seed as well as to utilize in the hybridization program. Detail of genetic stock is given in **Table 2.26**. The seed of genetic stock were also supplied, locally and abroad, to different scientists, cotton growers, academia and different institutes/research stations for their research/breeding programs. The detail is given in **Table 2.26**.

Table 2.26 Detail of Genetic Stock of World Cotton Collection

Local genotypes	1310
Exotic genotypes	4933
Total	6243
Species-Wise Detail	
<i>Gossypium herbaceum</i> L.	556
<i>Gossypium arboreum</i> L.	1025
<i>Gossypium hirsutum</i> L.	4553
<i>Gossypium barbadense</i> L.	109
Total Accessions	6243

2.7. Comparison of exotic versus local cotton varieties at the agro-climatic condition of Multan

Sr. No.	Name of varieties	Name of country	Seed cotton yield (Kg ha ⁻¹)
1	MNH-1035	Pakistan (Punjab)	1148
2	Israr Shaheed DIK	Pakistan (K.P.)	2654
3	CIM-663	Pakistan (Punjab)	1148
4	SLH-Chandi	Pakistan (Sindh)	1419
5	Sindh-1	Pakistan (Sindh)	1435
6	GH-Sultan	Pakistan (Sindh)	646
7	USA Acala-5-918	USA	717

8	USSR SA-71	Russia	739
9	Turkey Carolina Queen	Turkey	574
10	Brazil BPA	Brazil	857
11	France BJA-HC-27-B/163	France	736
12	Samroz-317	Turkey	837

2.8. Study of Phenotypic diversity

Sr. #	Genotype	Peculiar Characters	Picture show
1	Acala 63-69	Open Bushy type plant	
2	Acala SJ4	Open Bushy type plant	
3	BW-76-31DH	Open Bushy type plant	
4	Coker-310	Open type plant	
5	Gumbo Okra	Okra Leaf	
6	HG-11	Nectariless	
7	LA-23897	Frego Bract and Nectariless	
8	LB-609	Open type plant with long sympodia	
9	NCN-2-65	Open type plant	
10	PD-695	Open type plant	
11	Red Leaf Cotton	Red plant color with red leaves	
12	Stoneville	Nectariless and Low Gossypol	
13	Green Lint	Green colored lint	
14	Khaki Cotton	Brown colored lint	
15	Chure 2A-121	Long Sympodia	
16	DPL-61	Okra Leaf	
17	Pronto	Okra leaf with susceptibility to drought	
18	Reshmi	Thick leaf open type	
19	Xiao YiMian	Open type plant with long sympodia	
20	H88-8-J-69-J-70	Open type plant with long sympodia	

2.7. Early Generation Seed production of commercial varieties

Single lines of *Bt.* and *non Bt.* approved varieties were sown in the fields. All the agronomic practices were made sure throughout the cropping season. Single plants were selected from pure and uniform families. These single plants were ginned for further fibre traits testing and multiplication of pure seed. The selected plants will be sown next year. The detail is given in **Table 2.28**.

Table 2.28 Detail of pre-basic seed produced during 2022-23

Sr. #	Variety	Total Families	Seed weight (Kg)
1	Bt.CIM-632	39	22
2	Bt.CIM-785	26	70
3	Bt.CIM-678	39	75
4	Bt.CIM-602	26	36
5	Bt.CIM-600	26	31

6	CIM-554	13	06
7	CIM-620	13	05
8	CIM-610	13	06

2.8 Study of gene flow in Cotton crop.

2.8.1 Three cotton varieties i.e. CIM-496, Bt.CIM-632 and Russian red leaf with distinguishable morphological traits (Lear color normal green and red colors) were sown. Normal plant protection and agronomic practices were adopted to get normally formed bolls. Bolls were and ginned and the seed will sown next year to study the gene flow/out crossing.

2.9 Pak-US ICARDA Cotton Project CCRI Multan Component

2.10 Ratooning of resistant/tolerant USA cotton germplasm for flower induction

44 accessions of US germplasm were ratooned for the last 6-8 years at the research farm CCRI Multan. Out of these 44 accessions square formation and flower induction were started in only few accessions in the month of December 2022 as detailed in Table 2.24. In Set-D accessions USG-1087/13 one boll was formed. While in Set K only one accession USG-618/14 having flowers and bolls formations were observed. In Set N in only one accession i.e. USG-2269/14 buds formation and flower induction were observed. The seed formed in all bolls were found non-viable due to the harsh climatic condition of this year.

Table 2.24 Ratoon crop of resistant accessions of 2022-23 having bud and flower formation

Sr. No.	Set No.	Year	No of total Accessions	Resistant accessions	Accessions having buds and flower formation
1.	C	2013	200	3	0
2.	D	2013	200	10	01
3.	K	2014	200	3	01
4.	N	2014	600	28	01
		Total	1200	46	03

Besides the above facts Breeding and Genetics were made successes by developing to high yielding strains i.e. *Bt.CIM-990* and *Bt.CIM-909* (First year) were tested in NCVT of Pakistan Central Cotton Committee trails.