Comparative Performance of Various Advance Cotton Strains as Tested in 2015-16 National Coordinated Varietal Trials (NCVT) of Pakistan Central Cotton Committee (PCCC)

Tassawar Hussain Malik [2], Muhammad Zahir Ahsan[3]

Abstract

Pakistan Central Cotton Committee (PCCC) has been delegated the authority, National Seed Council, to conduct National Coordinated Varietal Trials (NCVT) on its behalf every year with the objective to screen high yielding and stress resistant advance strains of cotton meeting national fiber standards tested and trialed at all agro-ecological zones of the national cotton belt. During the crop year 2015-16,seventy two (72) strains including 15 non-Bt, 57Bt (55 OPVs and 2 Hybrids) were tested against standard commercial varieties (non Bt CRIS-129 and CIM-573, Bt FH-142 and CIM-602) at twelve locations throughout the cotton belt of Pakistan. Total thirty two (42) strains (12 non-Bt and 30 Bt) were developed by public sector breeders and twenty (30) strains (3 non-Bt, twenty twoBt and two Bt hybrids) were submitted by private sector breeders for testing. These strains were divided into four sets. Set-A comprised of non-Bt strains, Set-B, C and were of Bt strains from public and private sector breeders. From non-Bt strains CRIS-129 (Standard) was on top with the national average yield 2987kg per hectare. From set-BBt Strains VH-327 gave highest seed-cotton yield i.e. 2527kg per hectare. Top performing Bt strain from Set-C was NIAB-878B with average national production of 2475kg per hectare. From Set-D Eagle-1 produced 2387kg per hectare seed cotton yield. All strain almost showed GOT% and other fiber characteristics higher than the recommended national standards. Twostrains viz. CEMB-77 and CEMB-88 were found to contain two insect-resistant genes (Cry1Ac and Cry2A) that were developed by the Centre of Excellence for Molecular Biology.

Introduction

Pakistan is a key player of cotton cultivation, production and processing in the world. Cotton is as a leader fiber, oil and cash crop for resource poor farming community of the Pakistan as well as world ((Malik et al 2016; Soomro et al. 2011).

Pakistan Central Cotton Committee (PCCC) of Ministry of Textile Industry, Government of Pakistan is the apex national organization with official mandate of cotton research and development in the country. This research system also has mandate of conducting National coordinated varietal trials (NCVT) on behalf of National Seed Council (NSC). Departmental R&D and testing activities are conducted through the Directorate of Agricultural Research (DAR) of PCCC which serves as National Coordinating Unit of PCCC.

The National Cotton Varietal Trial (NCVT) is a technically and legally sanctioned uniform system of trialing and testing and reporting data regarding yield and other plant and fiber traits of new strains developed by the public and private sector breeders. The trials are conducted annually on selected official locations across the cotton belt of Pakistan. The objective of this trial is to test the newly developed strains by the public and private sector breeders in different agro-ecological zones for adoptability and comparison against standard commercial varieties.

[2] *Director Agricultural Research, Pakistan Central Cotton Committee, Multan, Pakistan*

[3] *Scientific officer Cotton Research Station, Sahiwal, Pakistan.*

**Corresponding author: dr@pccc.gov.pk*

Material and Methods:

Planting Material:

Overall fifty-two (52) advance strains were submitted by the public and private sector breeders for 2015-16 NCVT as mentioned in Table-1 to Table-4. These strains were divided into four groups viz. Set-A comprised non-Bt strains, Set-B, Set-C and Set-D comprised Btstrains from public and private sector breeders. In each set performance of the strains compared with the local adaptive control that already cultivated in the region. The originality of the strains was masked by coding these strains.

Table 1: Public Sector non-Bt strains tested in NCVT during 2015-16.

Sr.	Strain	Breeder/Institute	Sr.	Strain	Breeder/Institute
1	NIAB-414	NIAB Faisalabad	7	CRIS-543	CCRI Sakrand
2	MPS-29	CRS MirpurKhas	8	PB-896	Uni, Agri, Faisalabad
3	TH-120	ARI Tandojam	9	GH-Hammad	CRS, Ghotki
4	TH-20	ARI Tandojam	10	DNH-40	CRS D.I. Khan
5	IUB-75	Islamia Uni. Bahawalpur	11	FH-442	CRI, Faisalabad
6	CRIS-585	CCRI Sakrand	12	CIM-620	CCRI Multan

Table 2: Private Sector non-Bt strains tested in NCVT during 2015-16.

Sr.	Strain	Breeder/Institute	Sr.	Strain	Breeder/Institute
1	AA-132	Ali Akbar Seeds Multan	2	GS-Ali-1	Gohar Seeds Multan
3	Tahafuz-7	Sun Crop Seeds Multan			

Table 3: Public Sector Bt strains tested in NCVT during 2015-16.

Sr.	Strain	Breeder/Institute	Sr.	Strain	Breeder/Institute
1	VH-327	CRS Vehari	16	FH-326	CRI Faisalabad
2	GH-Baghdadi	CRS Ghotki	17	VH-363	CRS Vehari
3	CIM-622	CCRI Multan	18	MNS-992	CRS Multan
4	BZU-75	BZU Multan	19	Zakariya-1	BZU Multan
5	CEMB-77	CEMB Lahore	20	CYTO-179	CCRI Multan
6	NIAB-874B	NIAB Faisalabad	21	QM-IUB-65	Islamia Uni. Bahawalpur
7	CYTO-178	CCRI Multan	22	SLH-12	CRS Sahiwal
8	IR-NIBGE-7	NIBGE Faisalabad	23	FH-Kehkashan	CRI Faisalabad
9	IUB-63	Islamia Uni. Bahawalpur	24	CEMB-88	CEMB Lahore
10	TH-21/09	ARI Tandojam	25	RH-651	CRI Rahim Yar Khan
11	BH-185	CRS Bahawalpur	26	NIA-85	NIA Tandojam
12	FH-Noor	CRI Faisalabad	27	SAU-1	Sindh AgriUniTandojam
13	RH-647	CRI Rahim Yar Khan	28	CIM-625	CCRI Multan
14	NIAB-878B	NIAB Faisalabad	29	NIA-86	NIA Tandojam
15	GH-Mubarak	CRS Ghotki	30	IR-NIBGE-8	NIBGE Faisalabad

Table 4: Private Sector Bt strains tested in NCVT during 2015-16.

Sr.	Strains	Breeder/Institute	Sr.	Strains	Breeder/Institute
1	AGC-Nazeer-1	Weal Ag. Corp, Multan	15	Sahara-120	Patron Seed corp, Multan
2	Sahara-150	Patron Seed corp., Multan	16	Suncrop-Hyb-1	Suncrop Pvt. Ltd.
3	Crystal-1	Waraich Seed Corp. Khanewal	17	Wheal-ag-Shahkar	Weal Ag. Corp, Multan
4	BS-70	Bundesha Seeds	18	BS-15	Bundesha Seeds
5	JS-33	Jullundar Seeds Pvt. Ltd.	19	NS-181	Neelum Seeds, Multan
6	Auriga-215	Auriga Seeds Lahore	20	Hamalia-1	
7	Sitara-14	Agri Farm Services, Multan	21	BPC-11	
8	Adan-11		22	Sahara-Buraq	Patron Seed corp, Multan
9	Suncrop-4	Suncrop Pvt. Ltd.	23	Crystal-12	WaraichSeed Corp. Khanewal
10	Tahafuz-5	Suncrop Pvt. Ltd	24	Wheal-ag-Gold	Weal Ag. Corp, Multan
11	Eagle-1	Four Brothers Group	25	Tarzen-4	Four Brothers Group
12	Saim-32		26	BPC-10	
13	Sitara-15	Agri Farm Services, Multan	27	Bt. Hyb-53	Four Brothers Group
14	TASSCO-1000	Tassco Seeds Tando Allahyar			

Sowing of the Material

Set-A: Non-Bt Strains National Coordinated Varietal Trial was conducted at 13 locations in Punjab, Sindh, Khyber Pakhtunkhwah and Balochistan. At each location fifteen strains from public and private sector breeders were tested against a standard variety (CIM-573 for Punjab and KPK and CRIS-129 for Sindh and Balochistan. Five locations were selected in Punjab (CCRI-Multan, CRS-Sahiwal, CRS Bahawalpur, NIAB, Faisalabad and Punjab Seed Corporation Khanewal), three in Sindh (CCRI-Sakrand,ARI Tandojam and CRS Ghotki), one in KPK (D.I. Khan) and four in Balochistan (Khuzdar, Loralai, Dhadar and ARI, Quetta). Entries were coded as A1 – A16.

Set-B: TwentyBt Strains from different institutes were submitted to conduct National Coordinated Varietal Trial at twelve different locations of cotton growing belt of the country (five locations in Punjab *viz.* CCRI-Multan, CRS-Vehari, CRS-Bahawalpur, CRS-Sahiwal and NIBGE-Faisalabad, Four Locations in Sindh viz. CCRI-Sakrand, CRS-Mirpur Khas, CRS-Ghotki and NIIA-Tandojam, one location in KPK *viz.* D.I. Khan and one location in Balochistan*viz.*CRS-Sibbi. Twenty candidate strains of breeders and two standards (CIM-602 and FH-142) were tested for yield and other parameters. The entries were coded as B1 – B22.

Set-C: Twenty candidate strains submitted by the public and private sector breeders for possible evaluation in NCVT. National Coordinated Varietal Trial was conducted on twelve locations, six in Punjab (CCRI-Multan, CRS-Sahiwal, CRS-Bahawalpur, CRS-Vehari, CRI-Rahimyar Khan, and NIBGE-Faisalabad), four in Sindh (CCRI-Sakrand, CRS-MirpurKhas, CRS-Ghotki and ARI-Tandojam, one in KPK (D.I. Khan) and one in Balochistan (CRS-Sibbi). At each location twenty Bt strains were tested against two standards varieties viz. CIM-602 and FH-142. The entries were coded as C1 – C22.

Set-D: For the evaluation of the 15 OP varieties and two Bt Hybrids the National Coordinated Varietal Trial was conducted on eleven locations, five in Punjab (CCRI-Multan, CRS Sahiwal, CRS Vehari, CRI-Rahimyar Khan and CRI-Faisalabad), four in Sindh (CCRI-SakrandCRS-Ghotki, CRS MirpurKhas

Figure1: Locations of NCVT 2014-15 acros the country

NIA-Tandojam), one in KPK (D.I. Khan) and one in Balochistan (CRS-Sibbi).Bt Hybrids performance was compared with the two standard varieties viz. CIM-602 and FH-142. The entries were coded as D1 – D19.

All strains along with standard varieties were sown set wise in three replications according to RCBD in a four 30 feet extended rows with plant to plant distance 30cm and row to row distance was 75cm. All agronomic practices were uniformly done in all strains. Yield of this plot was multiplied by the factor (360) to obtain the yield as kg per hectare.

Fiber Trait Analysis

Lint samples of all strains were also tested for GOT (%), staple length (mm), fiber fineness (µg/inch), fiber strength (tppsi or g/tex) and uniformity index (%). The samples were

analyzed through HVI (High Volume Instrument) from each station and the data was averaged on national basis.

Bio-Chemical Testing of Transgene

Biochemical testing of transgenic strains was done in four biotechnology labs of *viz.*Agriculture Biotechnology Research Institute (ABRI) Faisalabad, National Institute for Biotechnology and Genetic Engineering (NIBGE) Faisalabad, Center of Excellence of Molecular Biology (CEMB) Lahore and National Institute for Genomics and Advanced Biotechnology (NIGAB, NARC) Islamabad. All strains were tested qualitatively and quantitatively. Purity of Cry1Ac and Cry2AB was tested through immune-strip analysis. Quantification of Cry1Ac protein was done through ELISA test. Confirmation of Cry1Ac event (Mon531) was also done through PCR.

Results and Discussion

Yield Performance:

Non-Bt Strain Trial (Set-A)

In Sindh Province CRIS-543 and GH-Hammad were the leading strains among all with the average production 2822 kg $ha^{-1}$and 2568 kg ha^{-1} respectively (Figure-1A), in Punjab maximum yield was obtained from PB-896 that produced 1497 kg $ha^{-1}$and NIAB-414 that produced 1422 kg KPK ha^{-1}. In KPK, IUB-75 and NIAB-414ranked top among all strains with the average production 1350kg $ha^{-1}$and 1305kg ha^{-1} respectively. In BalochistanMPS-29 produced seed cotton yield 3639kg ha^{-1} and TH-120 3516kg ha^{-1}. The figure-1Aalso depicted that all strains produced maximum yield in Balochistan followed by the Sindh, Punjab and KPK.

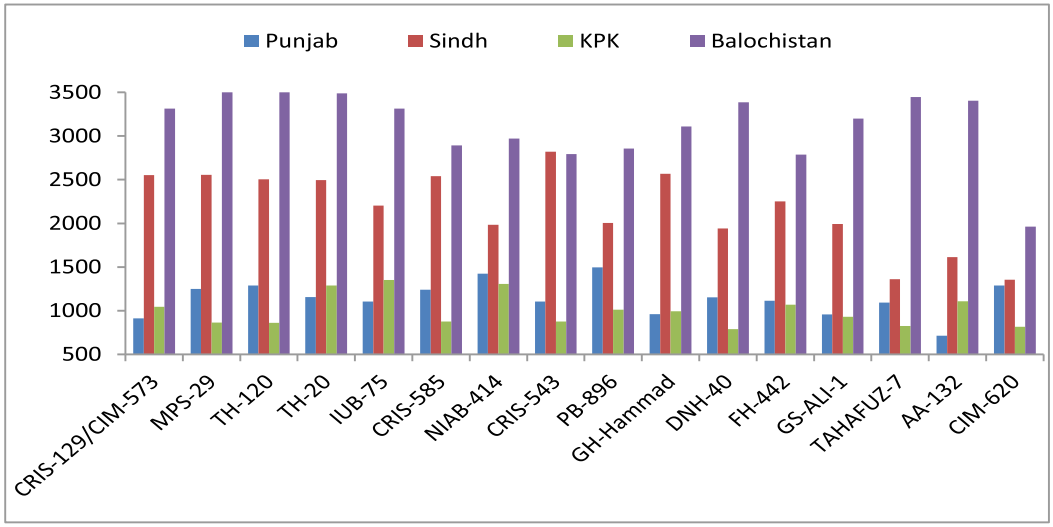

Figure 2A: Performance of Set-A strains in National Coordinated Varietal Trial 2015 -16 in four Provinces

On National Level CRIS-129was leading with the average production 2987kg ha^{-1} (standard for Sindh and Balochistan) followed by MPS-29 with the average production 2257kg ha^{-1}(Figure-2A). All Strains produced higher yield than the standard in Punjab and KPK but remain lower in Sindh and Balochistan.

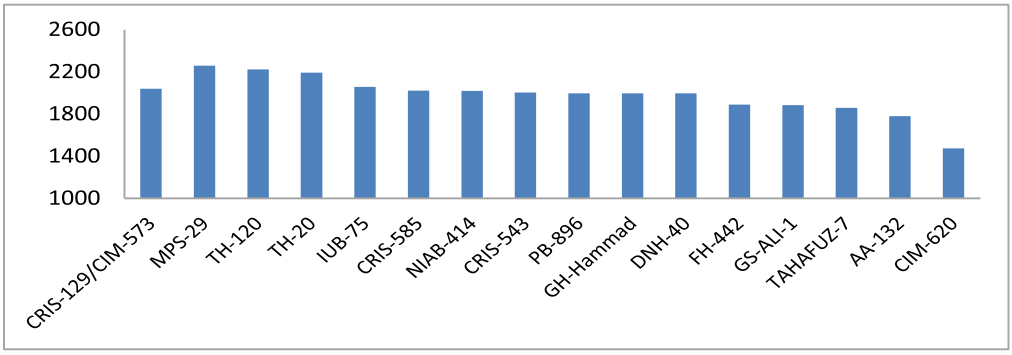

Figure 3A: Performance of Strains in NCVT 2015-16 on National Level.

Among the provinces, Balochistan was a leading among all with 3136kg ha^{-1}average seed-cotton yield followed by Sindh (2171kg ha^{-1}), Punjab (1140kg ha^{-1}) and KPK(999kg ha^{-1}). Punjab and KPK average was lower than the national average (1979kg ha^{-1}) figure-3A. It showed that climatic conditions were in favor of cotton production in Sindh and Balochistan as compared to Punjab and KPK.In Balochistan only CIM-620 remained lower than the national average and in Sindh four strains (DNH-40, Tahafuz-7, AA-132 and CIM-620) remained lower than the national average but in Punjab and KPK no strain met the national yield average (Figure-1A).

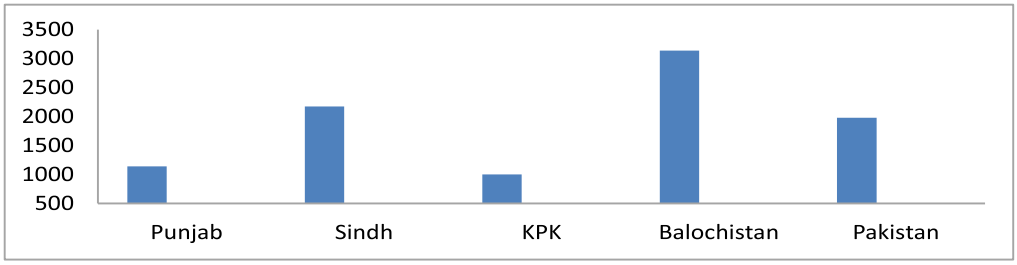

Figure 4A: Average performance of Set-A on Province and National Level.

Bt. Strain Trial (Set-B)

Province wise performance of different strains was demonstrated in figure-2B. In Punjab maximum yield was obtained from VH-327 i.e. 1927kg ha^{-1}followed by the BZU-75 i.e. 1903kg ha^{-1}. In Sindh VH-327 strain was super passed with the average production 3142kg ha^{-1}followed by the CIM-622 i.e. 3134kg ha^{-1}. In KPK province Bt. strain AGC-Nazeer-1 produced highest seed cotton yield i.e. 3064kg ha^{-1}followed by theNIAB-874B with average production 3017kg ha^{-1}. In Balochistan highest yield was obtained from BZU-75 i.e. 4140kg ha^{-1}followed by the IUB-63 i.e. 3600kg ha^{-1}.

On National Level (Figure-2B)VH-327 gave the highest seed-cotton yield of 2525kg ha^{-1}followed by the GH-Baghdadiwith the average production 2448kg ha^{-1}. However, on an average basis among all the candidate varieties VH-327 in Punjab and Sindh and AGC-Nazeer-1 in K P K andBZU-75 in Balochistan (Figure-1B) super passed all other varieties.

On National basis, Standard-1 (CIM-602) remained on 8th position and Standard-2 (FH-142) remained on 10th position.

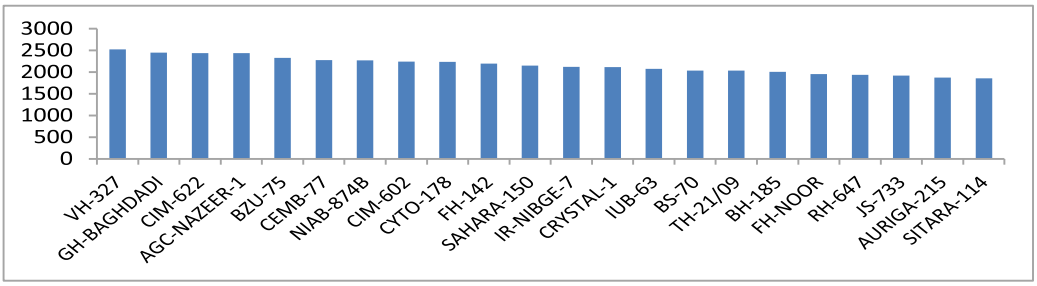

Figure 1B: Performance of Set-B strains in NCVT 2015-16 in four Provinces.

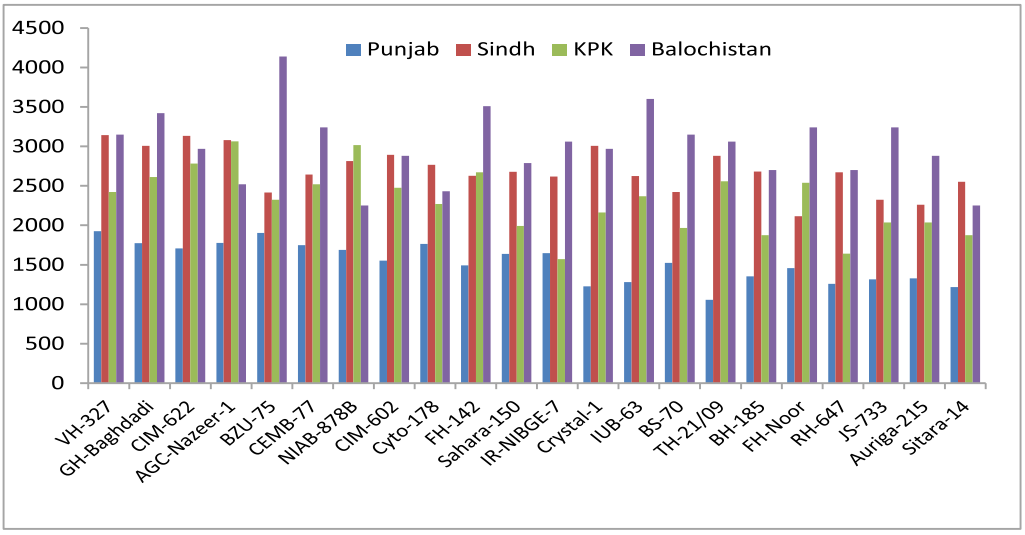

Figure 2B: Performance of Strains in NCVT 2015-16 Set-B on National Level.

All strains performed better in Balochistan and Sindh as compared to Punjab and KPK. Highest seed-cotton yield was obtained from Balochistan i.e. 3006kg ha^{-1}followed by the Sindh 2698kg ha^{-1}but in KPK yield was 2308kg ha^{-1}and in Punjab 1558kg ha^{-1}which was lower than the national average yield i.e. 2158kg ha^{-1}(Figure-3B).

Figure 3B: Average performance of Set-B on Province and National Level.

Bt. Strain Trial (Set-C)

In Punjab highest seed cotton yield was obtained from GH-Mubarak i.e. 1975kg ha^{-1}followed by the NIAB-878B.The standard-1 (CIM-602) produced 1464 kg ha^{-1} and standard-2 (FH-142) produced 1613 kg ha^{-1} seed cotton yield. In Sindh NIAB-878B produced highest seed cotton yield i.e. 2713kg ha^{-1} followed by the FH-326 i.e. 2699 kg ha^{-1}. The standard-1 yield was 2494 kg ha^{-1} and standard-2 yield was 2397 kg ha^{-1}. In KPK NIAB-878B was top produced variety with the average yield 3370 kg ha^{-1} followed by the Suncrop-4 that produced 3129 kg ha^{-1}. In Balochistan MNS-992 produced highest seed cotton yield 4590 kg ha^{-1}followed by the RH-651 that produced 4320 kg ha^{-1}in Balochistan Standard-1 produced 3780 kg ha^{-1} and Standard-2 produced 2880 kg ha^{-1}.

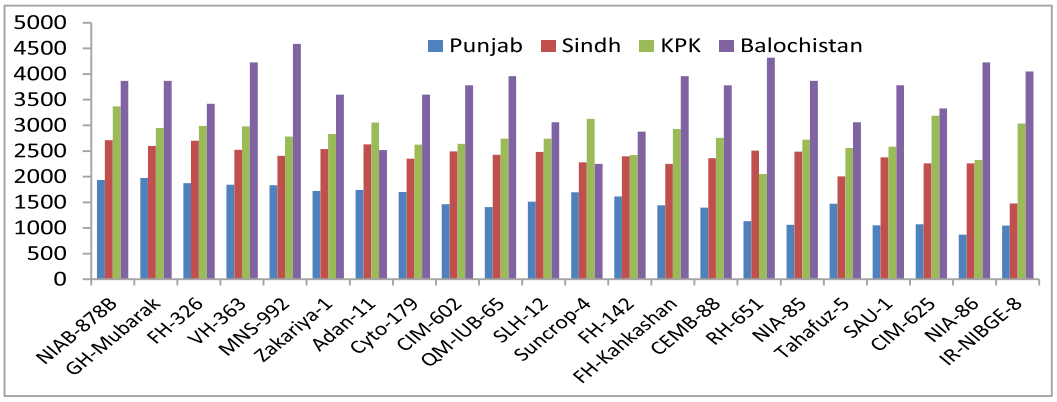

Figure 1C: Performance of Set-C strains in NCVT 2015-16 in four Provinces.

On National basis NIAB-878B produced highest seed-cotton yield i.e. 2475kg ha^{-1}followed by the GH-Mubarak which produced 2422 kg ha^{-1}. Standard-1 (CIM-602) produced 2098kg ha^{-1} and remained on 9th position and standard-2 produced 2047 kg ha^{-1} and stood on 13th position. The lowest yield was produced by the IR-NIBGE-8 and NIA-86 i.e. 1607 kg ha^{-1} and 1735 kg ha^{-1} respectively.

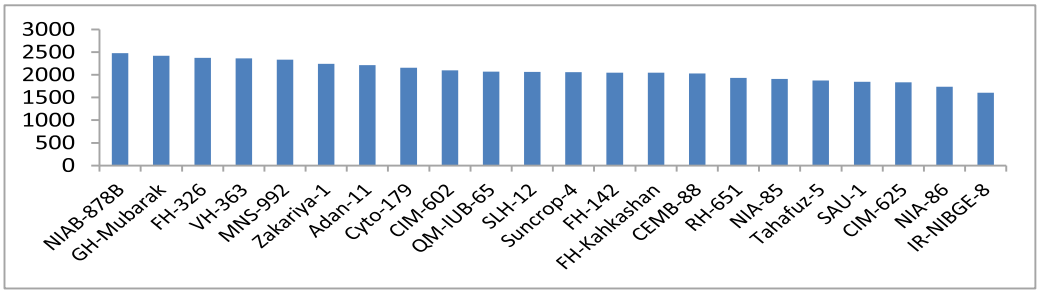

Figure 2C: Performance of Strains in NCVT 2015-16 Set-C on National Level.

If we made comparison of provincial seed cotton yield with the National seed cotton yield in Set-C only in Punjab yield was lower than the national seed-cotton yield average i.e. 2078kg ha^{-1}. Punjab average seed-cotton yield was 1494kg ha^{-1}highest yield was obtained from Balochistan i.e. 3636kg ha^{-1}followed by the KPK i.e. 2791 kg ha^{-1}Sindh 2387kg ha^{-1}.

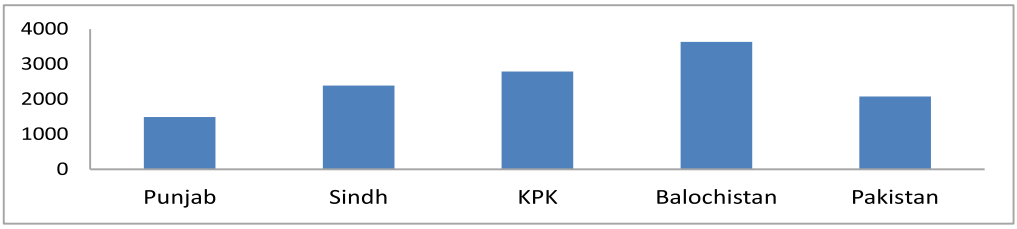

Figure-3C: Average performance of Set-C on Province and National Level.

Bt. Strain Trial (Set-D)

In Punjab candidate Bt strain SAIM-32 produced 2148kg ha^{-1}yield followed by the Eagle-1 which was 2097 kg ha^{-1}. The Standard-1 (CIM-602) produced 1498 kg ha^{-1} and standard-2 (FH-142) produced 1687 kg ha^{-1}. In Sindh Eagle-1 remained top by producing 2500 kg ha^{-1} seed cotton yield followed by the Sahara-Buraq that produced 2455 kg ha^{-1} seed cotton yield. In Balochistan top yielder strain was Suncrop Hyb-1 by producing 3870 kg ha^{-1} yield followed by the Eagle-1 and SAIM-32 by producing yield 2250 kg ha^{-1} and 2160 kg ha^{-1} respectively. In KPK Eagle-1 produced 3525 kg ha^{-1} and remained top followed by the BPC-11 that produced 3442 kg ha^{-1} seed cotton yield.

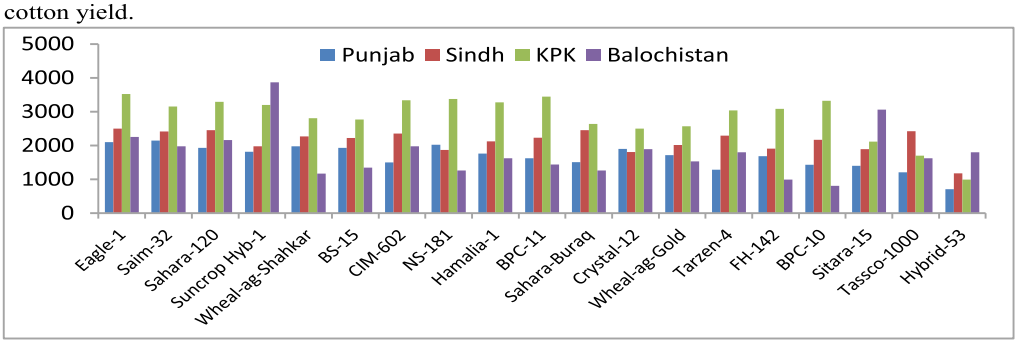

Figure 1D: Performance of Set-D strains in NCVT 2015-16 in four Provinces.

Figure 2D showed that on an average of national basis, (Punjab, Sindh, Khyber Pakhtunkhwah and Balochistan), Eagle-1 produced the highest yield of2387kg ha^{-1} followed by the SAIM-32 which was 2322 kg ha^{-1}. The Standard-1 (CIM-602) produced 2019 kg ha^{-1} and ranked 7th and Standard-2 (FH-142) produced 1832 kg ha^{-1} and ranked 15th among all strains.

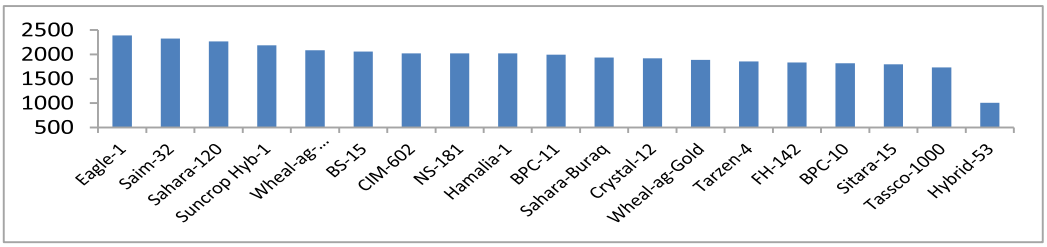

Figure 2D: Performance of Strains Set-D in NCVT 2015-16 on National Level

If we compare the performance on provincial basis then Balochistan was on top with 2874kgfollowed by the Sindh that produced 2134 kg ha-1. Punjab and KPK produced lower yield than the Nation average. National average for the Set-D was 2695kg ha^{-1}.

Figure 3D: Average performance of Set-D on Province and National Level.

Set A, B, C and D performance is illustrated in figure-4. It is clear from the figure that average performances of Strains were higher in Balochistan and Sindh as compared to the Punjab and KPK. Highest yield was produced by the Set-C in Balochistan i.e. 3636 kg ha^{-1}followed by the Set-A Balochistan i.e. 3136 kg ha^{-1}

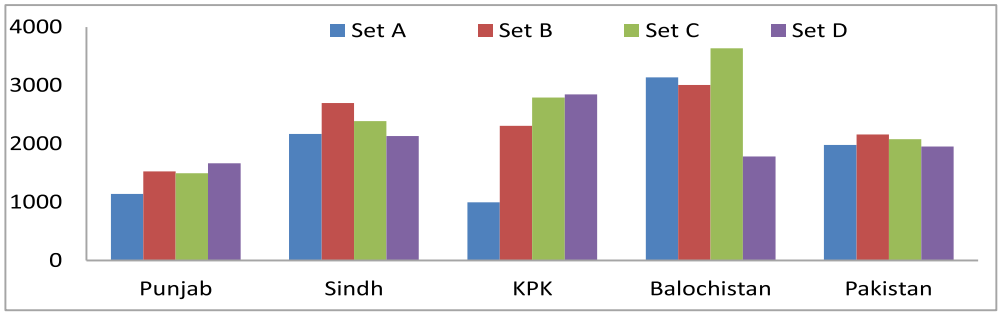

Figure 5: Performance of Sets on Provincial and National Level

Standard-1 (CIM-602) was 2548kg ha^{-1}and standard-2 (FH-142) was 2413kg ha^{-1}and remained on 9th and 17th position respectively (Figure-1B). In Balochistan highest seed-cotton yield was obtained from RH-647 i.e. 2703kg ha^{-1}(18% and 11% higher than the standard-1, CIM-602 (2289kg ha^{-1}) and standard-2, FH-142 (2433kg ha^{-1}) respectively). VH-327 was ranked 2nd by producing 2576kg ha^{-1}which is 13% higher than the standard-1 and 6% higher than the standard-2. Standard-1 (CIM-602) was on 15thposition (2289kg ha^{-1}) while standard-2 was on 4th position (2433kg ha^{-1}).

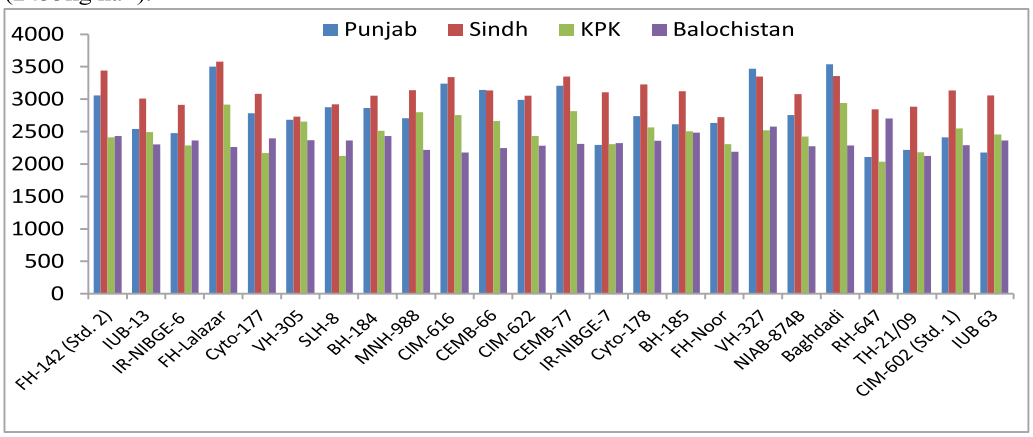

Figure 1B: Performance of Set-B strains in NCVT 2014-15 in four Provinces.

On National Level (Figure-2B) FH-Lalazar gave the highest seed-cotton yield of 3271kg ha^{-1}which was 24% higher than the standard-1 (CIM-602, 2644kg ha^{-1}) and 8% higher than the standard-2 (FH-142, 3028kg ha^{-1}). Baghdadi VH-327 ranked 2nd and 3rd with the average production 3220kg $ha^{-1}$and 3201kg ha^{-1}respectively. However, on an average basis among all the candidate varieties Baghdadi in Punjab and K P K, FH-Lalazar in Sindh and RH-647 in Balochistan (Figure-1B) super passed all other varieties.

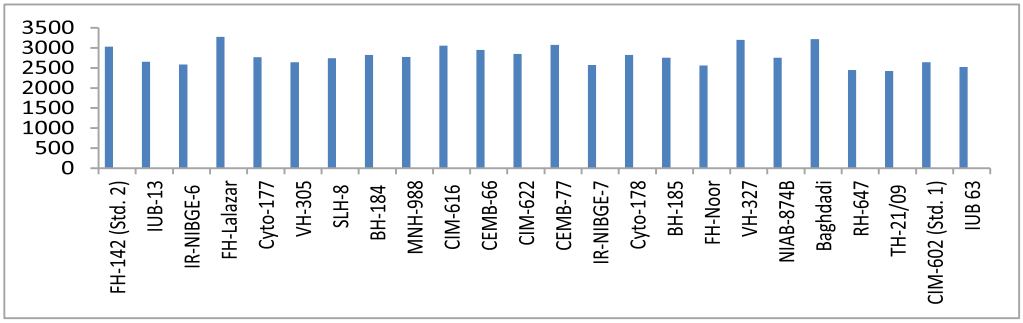

Figure 2B: Performance of Strains in NCVT 2014-15 Set-B on National Level.

All strains performed better in Sindh and Punjab as compared to KPK and Balochistan. Highest seed-cotton yield was obtained from Sindh i.e. 3109 kg ha^{-1}followed by the Punjab 2793 kg ha^{-1}but in KPK yield was 2493 kg $ha^{-1}$and in Balochistan 2338 kg ha^{-1}which was lower than the national average yield i.e. 2683 kg ha^{-1}(Figure-3B).

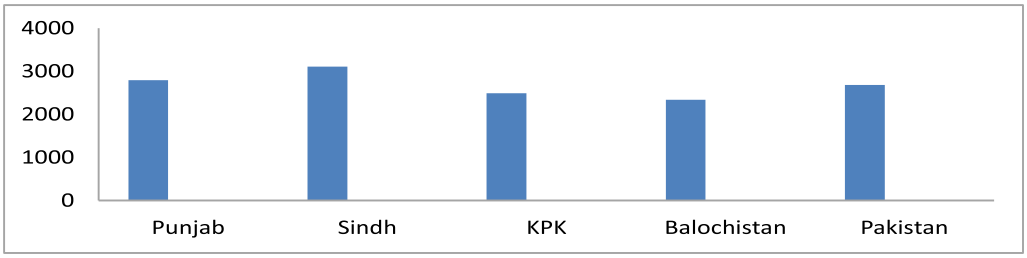

Figure 3B: Average performance of Set-B on Province and National Level.

Private Sector Bt. Strain Trial (Set-C)

In Punjab highest seed cotton yield was obtained from Crystal-1 i.e. 3242kg ha^{-1}followed by the standard-2 FH-142 (3103kg ha^{-1}) which was 10% and 5% higher than the standard-1 CIM-602 that produced 2912kg ha^{-1}. All other strains gave lower yield than standard-2. In Sindh none of the strain gave higher yield than the standard-2 (2927 kg ha^{-1}). Crystal-1, SAHARA-120 and Eagle-1 were on 2nd, 3rd and 4th position by producing 2925kg ha^{-1}, 2811kg ha^{-1} and 2752kg ha^{-1}seed-cotton yield respectively.Crystal-1 showed 22 %, SAHARA-120 showed 18 % and Eagle-1 showed 15 % higher seed cotton yield than standard-1 (CIM-602, 2389 kg ha^{-1}). However, the difference in yield between Crystal-1 (2925kg ha^{-1}) and Standard-2 (2927 kg ha^{-1}) was negligible. In KPK Crystal-1 gave the maximum yield of 2916kg ha^{-1}(44 % and 54 % higheryield than standard-1 & 2 respectively) followed by AGC-999 which produced 2719kg ha^{-1}.

Leader-5 was ranked 3rd by producing2333kg ha^{-1}which is 15% higher than standard-1 and 23% higher than Standard-2. Standard-1 (CIM-602) gave 2028kg $ha^{-1}$and was on 12th position. In Balochistan strain Tahafuz-3 gave the highest yield of 2411kg ha^{-1}(25% and 21 % higher yield

than standard-1 & 2 respectively) followed by SAHARA-120 (2373kg ha^{-1}) and Eagle-1 (2252kg ha^{-1}). SAHARA-120produced 23 % and 19 % higher yield than standard-1 & 2 respectively whereas; Eagle-1 gave 17 % and 13 % higher yield than standard-1 & 2 respectively. Over all strains perform much better in Punjab and Sindh as compared to KPK and Balochistan.

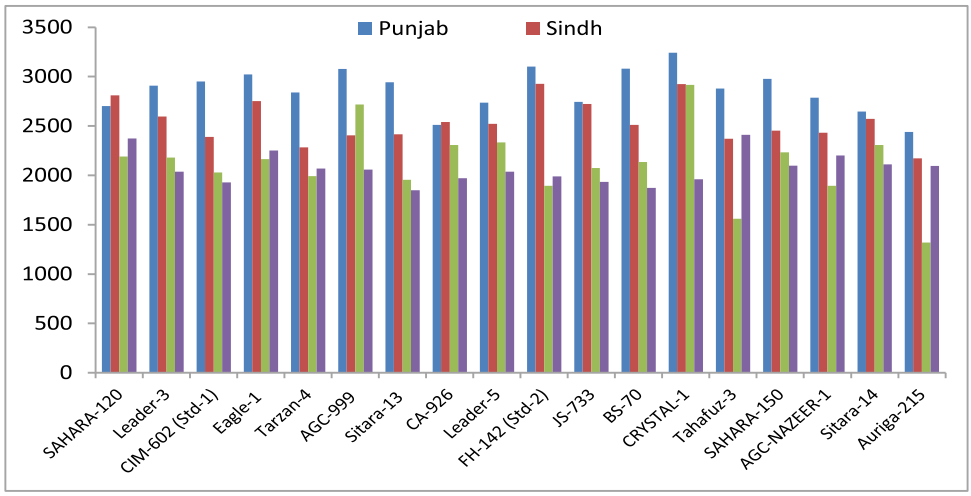

Figure 1C: Performance of Set-C strains in NCVT 2014-15 in four Provinces.

On National basis Crystal-1 produced highest seed cotton yield i.e. 2896kg ha^{-1}(15% and 5% higher than the standard-1 (CIM-602)and standard-2(FH-142), respectively. All other strains remained lower than the standard-2 (FH-142) which produced 2758kg ha^{-1}(10 % higher than standard-1). However, on an average basis, Crystal-1 gave highest yield in Punjab, Sindh and KPK, whereas in Balochistan Tahafuz-3 gave the maximum yield among all the candidate strains.

If we made comparison of provincial seed cotton yield with the National seed cotton yield in Set-C only in Punjab yield was higher than the national seed cotton yield average i.e.2564kg ha^{-1}. Punjab average seed cotton yield was 2866kg ha^{-1}followed by the Sindh 2544kg ha^{-1}, KPK 2122kg ha^{-1}and Balochistan 2069kg ha^{-1}.

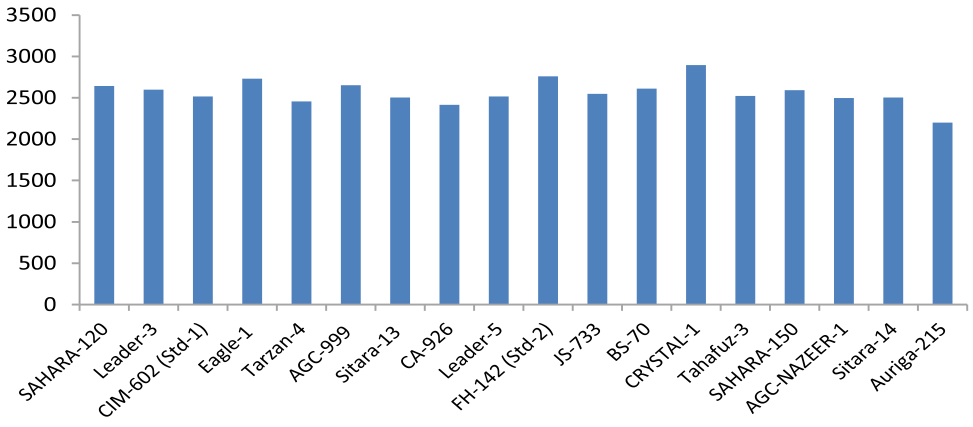

Figure 2C: Performance of Strains in NCVT 2014-15 Set-C on National Level.

Figure-3C: Average performance of Set-C on Province and National Level.

Hybrid Bt. Strain Trial (Set-D)

In Punjab candidate Bt. Hybrid Alseemi HBt-209 produced 3175kg ha^{-1}yield which was 20% and 9% higher than standard-1 (CIM-602) and standard-2 (FH-142) respectively. But Bt Hybrid-53 failed to produce higher yield than the standards. In Sindh Bt. hybrid-53 produced maximum yield of 2559kg ha^{-1}which was higher than standard-1 (2440kg ha^{-1}) by 5%.However, there was no difference in yield between the candidate Hybrid and Standard-2 which produced 2552kg ha^{-1}. Alseemi H. Bt. 209 was on 4thposition and produced 3% and 8% lower yield than standard-1 and 2 respectively. In KPK Bt. hybrid-53 and Alseemi H. Bt. 209 produced 1770 and 1619kg ha^{-1}seed cotton yield and was on 2nd and 3rd positions respectively. Standard-2 (FH-142) was on 1st position.Bt hybrid-53 produced 11% higher yield than standard-1 whereas 1% lower than standard-2.Standard-2 (FH-142) produced 1789 kg ha^{-1}and 12% higher than standard-1. In Punjab the yield of hybrids as well as standards was higher than the other provinces. In Balochistan, Bt. hybrid-53 and Alseemi H. Bt.209 produced 2054 and 2000kg ha^{-1}and was on 2ndand 3rdpositions respectively. Standard-1 (CIM-602) was on 1stposition.Bt. hybrid-53 produced 3% higher yield than standard-2 and 3 % lower than standard-1 which produced 2108kg ha^{-1}.Standard-2 produced 2000kg ha^{-1}. However, yield differences in all the varieties were non-significant.

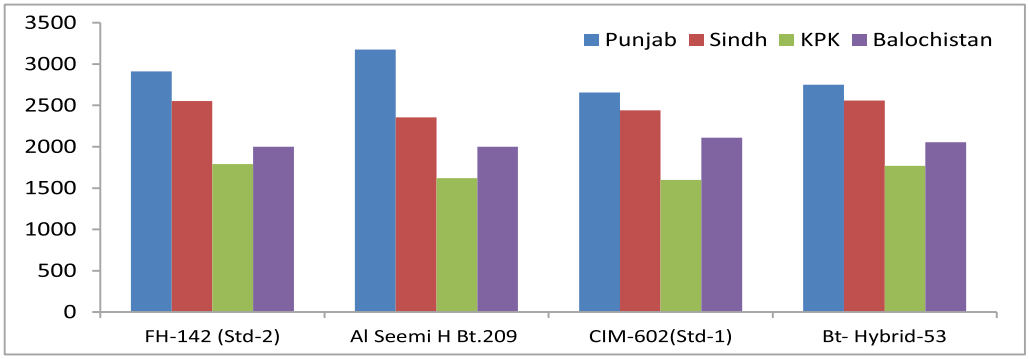

Figure 1D: Performance of Set-D strains in NCVT 2014-15 in four Provinces.

Figure 2D showed that on an average of national basis, (Punjab, Sindh, Khyber Pakhtunkhwah and Balochistan), Alseemi H. Bt.209 produced the highest yield of2778 kgha^{-1}which was 12% higher than standard-1 (2471kgha^{-1}) and 4% higher than standard-2 (2662kgha^{-1}). But Bt. Hybrid-53 failed to produce higher yield than the standards.

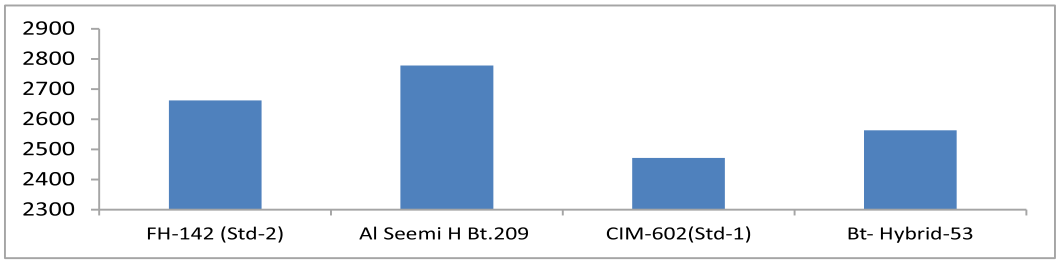

Figure 2D: Performance of Strains Set-D in NCVT 2014-15 on National Level

If we compare the performance on provincial basis then Punjab was on top with 2874kg ha^{-1}seed cotton yield but Sindh, KPK and Balochistan were lower than the national average. Lowest yield was obtained from KPK i.e. 1695kgha^{-1}. National average for the Set-D was 2695kgha^{-1}.

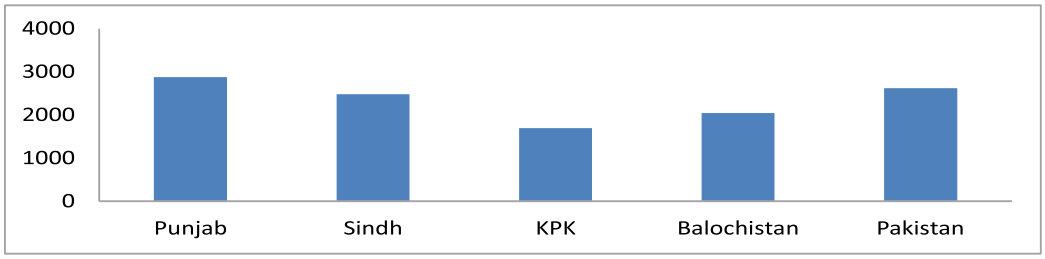

Figure 3D: Average performance of Set-D on Province and National Level.

Set A, B, C and D performance is illustrated in figure-4. It is clear from the figure that average performance of Bt. Strains and Bt. Hybrids were relatively same in Punjab but non-Bt Strains performance was lower. In Sindh Bt. Strains from public sector breeders performed much better than private sector, Hybrids and Non-Bt Strains. Yield was lower in KPK for all sets except Set-B. In Balochistan the situation seems opposite, non-Bt Performance better than the Bt Strains and Hybrids. On National Level the performance of Bt Strains from Public sector breeders leading with the average production 2797kgha^{-1} followed by the hybrids, Bt Strain from privates sector and non Bt. Strains.

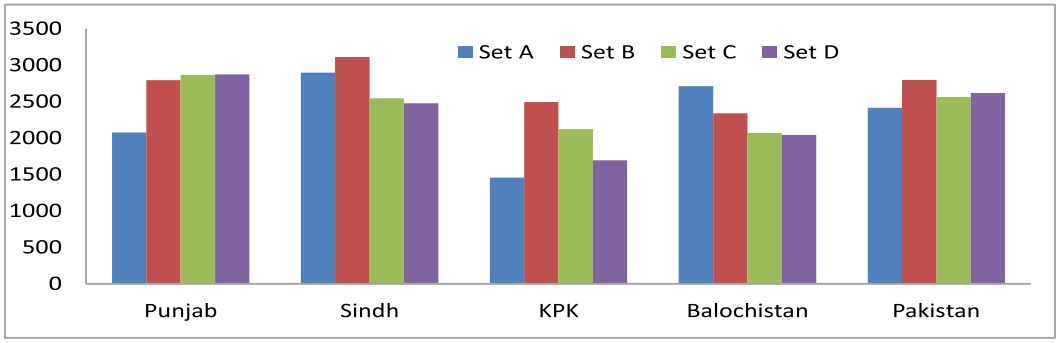

Figure 6: Performance of Sets on Provincial and National LevelFiber Characteristics

Ginning Turnout and Fiber Characteristics

Almost all strains of Set-A showed the GOT% in acceptable range except CRIS-342 (Control), DNH-40 and MPS-27 (Table 6). Highest ginning turnout was observed from CRIS-585 i.e. 40.9% followed by the TH-112/05 (40.1%) and CIM-620 (39.9%). The staple length of the strains was in the range of medium to medium long. Highest staple length i.e. 28.6 mm was observed for CIM-573 (Control) followed by the CIM-620 (28.4mm). Only three strains showed higher staple length than 27mm. almost all strains showed micronaire value on higher side only NIAB-414 and CIM-573 had good micronaire value. High fiber strength was depicted by the CIM-573, CIM-620 and NIAB-414. Maximum uniformity index was showed by the CIM-620 (85.6%) and GS-433 (84.2%).

Almost all strains showed the GOT% in acceptable range except NIBGE-6 and VH-327 (Table-7). Highest ginning turnout was observed from NIAB-874B i.e. 41.9% followed by the BH-184 (40.2%) and MNH-988 (39.9%). The staple length of the strains was in the range of medium to medium long. Highest staple length i.e. 29.3 mm was observed for CIM-602 (Control) followed by the FH-Lalazar (29.2 mm). All strains showed higher staple length than 27mm. almost all strains showed micronaire value on less course side, CIM-616, IR-NIBGE-7, FH Noor and IUB-63 showed higher micronaire values. High fiber strength was depicted by the IUB-13, Cyto-177 and FH-Noor. Maximum uniformity index was showed by the IR-NIBGE-6 (84.2%), SLH-8 (84.4%), CIM-622 (84.4%),IR-NIBGE-7 (84.2%) and FH-Noor (84.4%).

Table-6: GOT% and other fiber traits of non-Bt strains in NCVT during 2014-15

Sr.	Strains	GOT %	Staple Length (mm)	Fiber Fineness (µginch^{-1})	Fiber Strength (tppsi)	Uniformity Index (%)
1	CRIS-533	39.6	25.9	4.9	28.1	81.9
2	TH-112/05	40.1	26.4	4.9	30.3	80.7
3	BH-177	39.5	26.2	5.4	30.1	81.4
4	MPS-27	37.4	26.5	5	27	82.5
5	CRIS-585	40.9	27.7	5	29.3	83.4
6	NIAB-414	39.3	29	4.6	30.5	83.1
7	CIM-573*/	39.2	28.6	4.6	34.8	83.5
8	CRIS-342**	36.6	26	4.7	30.4	82.9
9	DNH-40	37.4	27	4.8	31.4	82.3
10	TH-120	38.1	25.7	5	26.7	82.1
11	IUB 75	38.3	26.9	5.1	32.8	83.9
13	CIM-620	39.9	28.4	5.1	30.9	85.6
14	AA-132	39.6	26.1	5.3	27.9	82.4
15	GS-433	38.5	26.6	4.9	28.6	84.2

Almost all strains from private sector showed excellent ginning turnout (Table-8). Highest ginning turnout was observed from Crystal-1 i.e. 40.5% followed by the Sahara-120 (40.1%). The staple length of the strains was in the range of medium to medium long. Highest staple length i.e. 29.0mm was observed for CIM-602 (control) followed by the Tarzen-4 (28.6mm). All strains showed higher staple length than 27mm. almost all strains showed micronaire value on less course side;High fiber strength was depicted by the Sahara-120, Eagle-1, AGC-999, BS-70 and Sitara-14. Maximum uniformity index was showed by the AGC-999, Eagle-1 and JS-733.

Table 7-a: GOT% and other fiber traits of Bt. strains from public sector breeders in NCVT during 2014-15

Sr.	Strains	GOT %	Staple Length (mm)	Fiber Fineness (µginch^{1})	Fiber Strength (tppsi)	Uniformity Index (%)
1	FH-142 (Std-2)	39.7	27.4	4.4	29.1	83.4
2	IUB-13	38.8	27.6	4.8	33.4	83.5
3	IR-NIBGE-6	36.8	28.6	4.7	30.8	84.2
4	FH-Lalazar	38.3	29.2	4.3	32.5	83.7
5	Cyto-177	39.6	28.8	4.5	33.3	83.5
6	VH-305	39.4	28.1	4.7	32.5	83.9
7	SLH-8	37.9	29	4.5	30.4	84.4
8	BH-184	40.2	28.4	4.7	30.9	82.6
9	MNH-988	39.9	27.8	4.9	31.7	83.9
0	CIM-616	39.8	27.8	5.1	30.5	83.2
11	CEMB-66*	38.1	28	4.8	31.9	83.4
12	CIM-622	38.2	27.6	4.8	31.6	84.4
13	CEMB-77*	39.5	27.6	4.6	29.6	82.7
14	IR-NIBGE-7	38.3	27.6	5	31.8	84.2
15	Cyto-178	38.8	27.1	4.7	29.9	82.9
16	BH-185	39.3	28.4	4.6	30.9	83.3
17	FH-Noor	38.5	28.9	5.1	33.2	84.4
18	VH-327	36.2	29.1	4.9	31.8	83.9
19	NIAB-874B	41.9	27	4.6	29.1	82.4
20	Baghdadi	39.8	27.8	4.5	30.4	83.9
21	RH-647	39.1	27.6	4.9	30.4	83
22	TH-21/09	37.9	28.4	4.2	31.2	82.6
23	CIM-602 (Std-1)	37.9	29.3	4.3	29.8	83.3
24	IUB 63	37.5	27	5.2	32.8	83.7

Table-7-b: GOT% and other fiber traits of Bt. strains from private sector breeders in NCVT during 2014-15

Sr.	Strains	GOT %	Staple Length (mm)	Fiber Fineness (µginch^{1})	Fiber Strength (tppsi)	Uniformity Index (%)
1	Sahara-120	40.1	27.7	4.4	32.1	82.0
2	Leader-3	39.2	27.3	4.7	30.3	82.3
3	CIM-602 (Std-1)	38.8	29.0	4.2	30.9	81.4
4	Eagle-1	39.3	27.2	4.7	31.2	82.9
5	Tarzan-4	38.6	28.6	4.9	30.8	82.4
6	AGC-999	39.8	27.3	4.7	31.2	83.0
7	Sitara-13	38.8	27.7	4.9	30.7	82.0
8	CA-926	39.7	27.5	5.1	30.3	81.9
9	Leader-5	39.9	26.8	4.9	29.5	81.9
10	FH-142 (Std-2)	39.1	27.3	4.6	30.7	81.9
11	JS-733	39.4	26.8	4.8	30.5	82.9
12	BS-70	39.8	27.1	4.7	31.4	82.4
13	Crystal-1	40.5	26.2	5.0	30.2	81.5
14	Tahafuz-3	39.2	27.3	4.9	29.6	82.3
15	Sahara-150	39.7	27.5	4.4	30.7	82.1
16	AGC-Nazeer-1	38.6	27.2	4.6	30.3	82.3
17	Sitara-14	39.7	27.2	4.9	31.1	82.5
18	Auriga-215	38.5	27.0	4.9	30.3	82.4

Both hybrids showed better ginning turnout than the standards (Table 8). Highest GOT was observed for Alseemi H. Bt-209 (42.9) followed by the BtHybrid-53 (41.3%).The staple length of the hybrids was Bt Hybrid-53 (27.9mm) and Alseemi H. Bt-53 (27.1mm). High fiber strength was depicted by FH-142 and Bt Hybrid-53. Maximum uniformity index was showed by the FH-142 and Alseemi H. Bt-209.

Table 8: GOT% and other fiber traits of Bt. hyb rids in NCVT during 2014-15

Sr.	Strains	GOT %	Staple Length (mm)	Fiber Fineness (µginch^{1})	Fiber Strength (tppsi)	Uniformity Index (%)
1	FH-142 (Std-2)	40.9	27.2	4.7	31.4	83.7
2	Alseemi H. Bt-209	42.9	27.1	4.8	29.9	83.3
3	CIM-602 (Std-1)	39.2	28.2	4.5	29.2	82.6
4	Bt-Hybrid-53	41.3	27.9	4.9	30.9	82.9

Transgenic Expressions:

The toxin expression level of Cry1Ac recommended by the USDA/EPA is 1.5 µg g^{-1} fresh leaf weights for durable resistance. But the strains developed by the public sector breeders had toxin expression below this level. Six strains *viz.* IR-NIBGE-6 (1.532), Cyto-177 (1.644), BH-184 (1.838), MNH-988 (1.591), CEMB-66 (1.636) and IR-NIBGE-7 (1.561) had expression level of toxin higher than the recommended level. The remaining strains had expression of toxin protein lower than the recommended. Two strains developed by the CEMB Lahore had two transgenic events Cry1Ac (CEMB) and Cry2Ab (CEMB) the expression level of Cry1Ac was 0.912µg/g and Cry2Ab was 0.525µg/g. In all strains Cry1Ac event was positively confirmed through PCR.

Table 2: Transgenic Expressions of Bt. strains from public sector breeders in NCVT 2014 -15.

Sr.	Strains	Technology Tests				Double gene Presence	
		Cry1Ac	Cry2Ab	Toxin expression	Event Confirmation	Cry1Ac (CEMB)	Cry2Ab (CEMB)
1	FH-142 std	70	0	1.298	+ve	-	-
2	IUB-13	90	0	1.358	+ve	-	-
3	IR-NIBGE-6	90	0	1.532	+ve	-	-
4	FH-Lalazar	80	0	1.361	+ve	-	-
5	Cyto-177	90	0	1.644	+ve	-	-
6	VH-305	90	0	1.360	+ve	-	-
7	SLH-8	30	0	0.701	2+ve, 2 -ve	-	-
8	BH-184	90	0	1.838	+ve	-	-
9	MNH-988	80	0	1.591	+ve	-	-
10	CIM-616	100	0	1.413	+ve	-	-
11	CEMB-66	80	0	1.636	+ve	0.912	0.525
12	CIM-622	90	0	1.410	+ve	-	-
13	CEMB-77	80	0	1.196	+ve	0.859	0.532
14	IR-NIBGE-7	70	0	1.561	+ve	-	-
15	Cyto-178	90	0	1.034	+ve	-	-
16	BH-185	20	0	0.422	+ve	-	-
17	FH-Noor	100	0	0.842	+ve	-	-
18	VH-327	90	0	0.758	+ve	-	-
19	NIAB-874B	70	0	1.219	+ve	-	-
20	Baghdadi	90	0	1.288	+ve	-	-
21	RH-647	40	0	1.258	+ve	-	-
22	TH-21/09	70	0	2.389	+ve	-	-
23	CIM-602 (Std. 1)	60	0	0.742	+ve	-	-
24	IUB 63	80	0	0.765	+ve	-	-

From sixteen strains developed by the private sector breeders along with two standards transgene was analyzed through Strip, PCR and ELISA tests. In all strains event was confirmed through PCR. But only two strains Tarzen-4 and CA-926 showed higher protein toxin expression than the recommended level (1.5µg/g) by the USDA/EPA. Strain CA-926 had double gene developed by the CEMB Lahore both these had expression 0.813 and 0.518µg/g.

Table 3: Transgenic Expressions of Bt. strains from private sector breeders in NCVT 2014-15.

Sr.	Strains	Technology Tests				Double gene Presence	
		Cry1Ac	Cry2Ab	Toxin expression	Event Confirmation	Cry1Ac (CEMB)	Cry2Ab (CEMB)
1	SAHARA-120	80	0	1.068	+ve	-	-
2	Leader-3	70	0	1.381	+ve	-	-
3	CIM-602 (Std-1)	**60**	**0**	**0.742**	**+ve**	**-**	**-**
4	Eagle-1	100	0	0.886	+ve	-	-
5	Tarzan-4	90	0	3.929	+ve	-	-
6	AGC-999	100	0	1.387	+ve	-	-
7	Sitara-13	80	0	1.127	+ve	-	-
8	CA-926	**90**	**0**	**2.731**	**+ve**	**0.813**	**0.518**
9	Leader-5	80	0	1.212	+ve	-	-
10	FH-142 (Std-2)	70	0	1.298	**+ve**	**-**	**-**
11	JS-733	60	0	0.98	+ve	-	-
12	BS-70	80	0	1.173	+ve	-	-
13	CRYSTAL-1	100	0	1.239	+ve	-	-
14	Tahafuz-3	90	0	1.318	+ve	-	-
15	SAHARA-150	60	0	0.665	+ve	-	-
16	AGC-NAZEER-1	100	0	1.153	+ve	-	-
17	Sitara-14	80	0	0.856	+ve	-	-
18	Auriga-215	80	0	1.175	+ve	-	-

In both hybrids and Standards PCR showed positive confirmation of the event. Highest Cry1Ac gene expression was showed by the Bt-Hybrid-53 i.e. 1.802µg/g. but the other hybrid and standards showed expression less than the recommended level.

Table 4: Transgenic Expressions of Bt. hybrids in NCVT 2014-15

Sr.	Strains	Technology Tests				Double gene Presence	
		Cry1Ac	Cry2Ab	Toxin expression	Event Confirmation	Cry1Ac (CEMB)	Cry2Ab (CEMB)
1	FH-142 (Std-2)	70	0	1.298	+ve	-	-
2	Alseemi H Bt.209	80	0	1.251	+ve	-	-
3	CIM-602(Std-1)	60	0	0.742	+ve	-	-
4	Bt- Hybrid-53	100	0	1.802	+ve	-	-

Directorate of Agricultural Research

Pakistan Central Cotton Committee, Multan

Summarize Results of All 4 Trials of NCVT-2014 (Pakistan Yield Descending) Table-68

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
S. No.	Code	Varieties	Source	Public / Private	Bt./ Non Bt. /Hybrid Bt.	Year of Trial in 2014	Average Seed Cotton Yield kg/ha					Plant Population Average (Pakistan)	Fibre traits (Average)					Technology Tests				Double gene Presence	
							Punjab	Sindh	KPK	B tan	Pakistan		GOT %	Staple length Mm	Fiber Strength g/tex	Fineness µ g/inch	Uniformity Index %	Cry1Ac	Cry2Ab	Toxin expression	Event Confirmation	Cry1Ac (CEMB)	Cry2Ab (CEMB)
											Lab Standard		*37.5 (Min)*	*28 (Min)*	*92 tppsi*	*3.8-4.9*	*80*	*100%*	*0*	*1.8-2.2*	+ve		
1	**B-4**	**FH-Lalazar**	CRI, Faisalabad	Public	Bt.	2nd	3500	3579	2915	2262	**3271**	**35704**	38.3	29.2	32.5	4.3	83.7	80	0	1.361	+ve	-	-
2	**B-20**	**Baghdadi**	CRS, Ghotki	Public	Bt.	1st	3538	3357	2942	2288	**3220**	**37251**	39.8	27.8	30.4	4.5	83.9	90	0	1.288	+ve	-	-
3	**B-18**	**VH-327**	CRS, Vehari	Public	Bt.	1st	3471	3347	2521	2576	**3201**	**34990**	36.2	29.1	31.8	4.9	83.9	90	0	0.758	+ve	-	-
4	**B-13**	**CEMB-77**	**CEMB, Lahore**	**Public**	**Bt.**	**1st**	**3209**	**3347**	**2816**	**2309**	**3072**	**36448**	**39.5**	**27.6**	**29.6**	**4.6**	**82.7**	**80**	**0**	**1.196**	**+ve**	**0.859**	**0.532**
5	**B-10**	**CIM-616**	CCRI, Multan	Public	Bt.	2nd	3238	3342	2754	2176	**3055**	**35089**	39.8	27.8	30.5	5.1	83.2	100	0	1.413	+ve	-	-
6	**B-1**	**FH-142 (Std-2 Bt. Public)**	**CRI, Faisalabad**	Public	Bt.	-	**3058**	**3441**	**2413**	**2433**	**3028**	**36252**	**39.7**	**27.4**	**29.1**	**4.4**	**83.4**	**70**	**0**	**1.298**	**+ve**	**-**	**-**
7	**B-11**	**CEMB-66**	**CEMB, Lahore**	**Public**	**Bt.**	**2nd**	**3144**	**3133**	**2664**	**2246**	**2951**	**37554**	**38.1**	**28.0**	**31.9**	**4.8**	**83.4**	**80**	**0**	**1.636**	**+ve**	**0.912**	**0.525**
8	**C-13**	**CRYSTAL-1**	Waraich Seed corp.	Private	Bt.	1st	3242	2925	2916	1961	**2896**	**36858**	40.5	26.2	30.2	5.0	81.5	100	0	1.239	+ve	-	-
9	**B-12**	**CIM-622**	CCRI, Multan	Public	Bt.	1st	2989	3053	2431	2281	**2846**	**35952**	38.2	27.6	31.6	4.8	84.4	90	0	1.41	+ve	-	-
10	**B-8**	**BH-184**	CRS, Bhawalpur	Public	Bt.	2nd	2863	3052	2512	2430	**2825**	**36677**	40.2	28.4	30.9	4.7	82.6	90	0	1.838	+ve	-	-
11	**B-15**	**Cyto-178**	CCRI, Multan	Public	Bt.	1st	2738	3226	2565	2359	**2823**	**34124**	38.8	27.1	29.9	4.7	82.9	90	0	1.034	+ve	-	-
12	**A-9**	**TH-120**	ARI, Tandojam	Public	Non Bt.	1st	2633	3388	1736	2818	**2795**	**37331**	38.1	25.7	26.7	5.0	82.1	-	-	-	-	-	-
13	**D-2**	**Al Seemi HBt.209**	Alseemi Seed, Multan	Private	Hybrid Bt.	2nd	**3175**	2357	1619	2000	**2778**	**33876**	42.9	27.1	29.9	4.8	83.3	80	0	1.251	+ve	-	-
14	**B-9**	**MNH-988**	CRS, Multan	Public	Bt.	2nd	2705	3137	2799	2217	**2775**	**35656**	39.9	27.8	31.7	4.9	83.9	80	0	1.591	+ve	-	-
15	**B-5**	**Cyto-177**	CCRI, Multan	Public	Bt.	2nd	2782	3081	2171	2396	**2767**	**32144**	39.6	28.8	33.3	4.5	83.5	90	0	1.644	+ve	-	-

16	C-10	FH-142 (Std-2 Bt. Private)	CRI, Faisalabad	Public	Bt.	-	3103	2927	1893	1988	2758	36190	39.1	27.3	30.7	4.6	81.9	70	0	1.298	+ve	-	-
17	B-19	NIAB-874B	NIAB, Fsd	Public	Bt.	1st	2754	3080	2422	2274	2755	36654	41.9	27.0	29.1	4.6	82.4	70	0	1.219	+ve	-	-
18	B-16	BH-185	CRS, Bhawalpur	Public	Bt.	1st	2615	3123	2503	2486	2753	36706	39.3	28.4	30.9	4.6	83.3	20	0	0.422	+ve	-	-
19	B-7	SLH-8	CRS, Sahiwal	Public	Bt.	2nd	2875	2921	2126	2364	2743	33922	37.9	29.0	30.4	4.5	84.4	30	0	0.701	2+ve, 2 -ve	-	-
20	C-4	Eagle-1	Four Brother	Private	Bt.	2nd	3023	2752	2163	2252	2732	35459	39.3	27.2	31.2	4.7	82.9	100	0	0.886	+ve	-	-
21	A-6	NIAB-414	NIAB, Fsd	Public	Non Bt.	1st	2466	3216	1589	2882	2700	35291	39.3	29.0	30.5	4.6	83.1	-	-	-	-	-	-
22	D-1	FH-142 (Std-2 Hybrid Bt.)	CRI, Faisalabad	Public	Bt.	-	2913	2552	1789	2000	2662	35105	40.9	27.2	31.4	4.7	83.7	70	0	1.298	+ve	-	-
23	C-6	AGC-999	Wheal Ag	Private	Bt.	2nd	3077	2404	2719	2058	2653	34163	39.8	27.3	31.2	4.7	83.0	100	0	1.387	+ve	-	-
24	B-2	IUB-13	IUB, Bhawalpur	Public	Bt.	2nd	2540	3008	2494	2303	2653	32803	38.8	27.6	33.4	4.8	83.5	90	0	1.358	+ve	-	-
25	B-6	VH-305	CRS, Vehari	Public	Bt.	2nd	2684	2731	2655	2366	2644	33096	39.4	28.1	32.5	4.7	83.9	90	0	1.36	+ve	-	-
26	B-23	CIM-602 (Std-1 Bt. Public)	CCRI, Multan	Public	Bt.	-	2412	3135	2548	2289	2644	34673	37.9	29.3	29.8	4.3	83.3	60	0	0.742	+ve	-	-

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
27	C-1	SAHARA-120	Patron seed	Private	Bt.	2nd	2702	2811	2190	2373	2641	36093	40.1	27.7	32.1	4.4	82.0	80	0	1.068	+ve	-	-
28	C-12	BS-70	Bandesha Seed	Private	Bt.	1st	3080	2510	2136	1872	2610	33309	39.8	27.1	31.4	4.7	82.4	80	0	1.173	+ve	-	-
29	A-12	AA-132	Ali Akbar group	Private	Non Bt.	1st	2395	2809	1539	2960	2599	32347	39.6	26.1	27.9	5.3	82.4	-	-	-	-	-	-
30	C-2	Leader-3	Sun Grow, Multan	Private	Bt.	2nd	2908	2595	2181	2036	2598	35338	39.2	27.3	30.3	4.7	82.3	70	0	1.381	+ve	-	-
31	C-15	SAHARA-150	Patron seed	Private	Bt.	1st	2976	2452	2234	2097	2593	35693	39.7	27.5	30.7	4.4	82.1	60	0	0.665	+ve	-	-
32	B-3	IR-NIBGE-6	NIBGE, Fsd	Public	Bt.	2nd	2476	2911	2287	2363	2587	35720	36.8	28.6	30.8	4.7	84.2	90	0	1.532	+ve	-	-
33	B-14	IR-NIBGE-7	NIBGE, Fsd	Public	Bt.	1st	2296	3106	2306	2323	2572	34137	38.3	27.6	31.8	5.0	84.2	70	0	1.561	+ve	-	-
34	D-4	Bt- Hybrid-	Four	Private	Hybri	1st	2751	2559	1770	2054	2563	33518	41.3	27.9	30.9	4.9	82.9	100	0	1.802	+ve	-	-

		53	Brother, Multan		d Bt.																		
35	**B-17**	**FH-Noor**	CRI, Faisalabad	Public	Bt.	1st	2635	2724	2305	2188	**2563**	**34103**	38.5	28.9	33.2	5.1	84.4	100	0	0.842	+ve	-	-
36	**C-11**	**JS-733**	Jullundur seed	Private	Bt.	1st	2743	2723	2073	1934	**2546**	**36065**	39.4	26.8	30.5	4.8	82.9	60	0	0.98	+ve	-	-
37	**A-11**	**CIM-620**	CCRI, Multan	Public	Non Bt.	1st	2608	2521	1916	2606	**2534**	**29932**	39.9	28.4	30.9	5.1	85.6	-	-	-	-	-	-
38	**B-24**	**IUB 63**	IUB, Bhawalpur	Public	Bt.	1st	2178	3057	2458	2365	**2525**	**33588**	37.5	27.0	32.8	5.2	83.7	80	0	0.765	+ve	-	-
39	**C-14**	**Tahafuz-3**	SunCrop	Private	Bt.	1st	2878	2372	1561	2411	**2522**	**36611**	39.2	27.3	29.6	4.9	82.3	90	0	1.318	+ve	-	-
40	**C-3**	**CIM-602 (Std-1 Bt. Private)**	**CCRI, Multan**	**Public**	**Bt.**	**-**	**2952**	**2389**	**2028**	**1929**	**2517**	**35223**	**38.8**	**29.0**	**30.9**	**4.2**	**81.4**	**60**	**0**	**0.742**	**+ve**	**-**	**-**
41	**C-9**	**Leader-5**	Sun Crop	Private	Bt.	2nd	2736	2523	2333	2038	**2515**	**34267**	39.9	26.8	29.5	4.9	81.9	80	0	1.212	+ve	-	-
42	**C-17**	**Sitara-14**	Agri Farm Services	Private	Bt.	1st	2645	2573	2306	2112	**2504**	**33515**	39.7	27.2	31.1	4.9	82.5	80	0	0.856	+ve	-	-
43	**C-7**	**Sitara-13**	Agri Farm Services	Private	Bt.	2nd	2942	2416	1956	1850	**2502**	**34939**	38.8	27.7	30.7	4.9	82.0	80	0	1.127	+ve	-	-
44	**C-16**	**AGC-NAZEER-1**	Wheal Ag	Private	Bt.	1st	2786	2431	1893	2202	**2496**	**33735**	38.6	27.2	30.3	4.6	82.3	100	0	1.153	+ve	-	-
45	**D-3**	**CIM-602 (Std-1 hybrid Bt.)**	**CCRI, Multan**	**Public**	**Bt.**	**-**	**2656**	**2440**	**1600**	**2108**	**2471**	**35509**	**39.2**	**28.2**	**29.2**	**4.5**	**82.6**	**60**	**0**	**0.742**	**+ve**	**-**	**-**
46	**C-5**	**Tarzan-4**	Four Brothers	Private	Bt.		2840	2283	1992	2070	**2455**	**32602**	38.6	28.6	30.8	4.9	82.4	90	0	3.929	+ve	-	-
47	**B-21**	**RH-647**	CRI, R Y Khan	Public	Bt.	1st	2110	2844	2036	2703	**2448**	**33673**	39.1	27.6	30.4	4.9	83.0	40	0	1.258	+ve	-	-
48	**A-5**	**CRIS-585**	CCRI, Sakrand	Public	Non Bt.	2nd	1864	3313	1453	2720	**2430**	**36501**	40.9	27.7	29.3	5.0	83.4	-	-	-	-	-	-
49	**B-22**	**TH-21/09**	ARI, Tandojam	Public	Bt.	1st	2219	2883	2180	2125	**2421**	**34054**	37.9	28.4	31.2	4.2	82.6	70	0	2.389	+ve	-	-
50	**A-7**	**CIM-573***	**CCRI, Multan**	Public	Non Bt.	**-**	**1955**	**-**	**1391**	**-**	**2416**	**32289**	**40.5**	**28.6**	**34.8***	**4.6***	**83.5**	**20**	**0**	**0.618**	**+ve**	**-**	**-**

		CRIS-342**	**CCRI, Sakrand**	Public	Non Bt.	-	-	3214	-	2651	-		**36.6**	**26.0**	**30.4**	**4.7****	**82.9**	**0**	**0**	**0.072**	**2 +ve, 2 -ve**	-	-
51	**A-3**	**BH-177**	CRS, Bhawlpur	Public	Non Bt.	2nd	1863	3011	1516	2881	**2414**	**36552**	39.5	26.2	30.1	5.4	81.4	-	-	-	-	-	-
52	**C-8**	**CA-926*****	**Ali Akbar group**	**Private**	**Bt.**		**2512**	**2540**	**2306**	**1970**	**2414**	**33761**	**39.7**	**27.5**	**30.3**	**5.1**	**81.9**	**90**	**0**	**2.731**	**+ve**	**0.813**	**0.518**
53	**A-1**	**CRIS-533**	CCRI, Sakrand	Public	Non Bt.	2nd	1830	3432	1359	2629	**2409**	**36327**	39.6	25.9	28.1	4.9	81.9	-	-	-	-	-	-
54	**A-4**	**MPS-27**	CRS, M Khas	Public	Non Bt.	2nd	2030	3033	1474	2626	**2402**	**34502**	37.4	26.5	27.0	5.0	82.5	-	-	-	-	-	-
55	**A-8**	**DNH-40**	CRS, D. I. Khan	Public	Non Bt.	1st	2147	2710	1510	2570	**2358**	**31573**	37.4	27.0	31.4	4.8	82.3	-	-	-	-	-	-
56	**C-18**	**Auriga-215**	Auriga Seed	Private	Bt.	1st	2439	2171	1319	2094	**2199**	**28640**	38.5	27.0	30.3	4.9	82.4	80	0	1.175	+ve	-	-
57	**A-10**	**IUB 75**	IUB, Bhawlpur	Public	Non Bt.	2nd	2173	2057	1200	2320	**2116**	**25350**	38.3	26.9	32.8	5.1	83.9	-	-	-	-	-	-
58	**A-2**	**TH-112/05**	ARI, Tandojam	Public	Non Bt.	2nd	1141	2915	1317	2929	**2114**	**35565**	40.1	26.4	30.3	4.9	80.7	-	-	-	-	-	-
59	**A-13**	**GS-433**	Gohar Seed	Private	Non Bt.	1st	1876	2048	911	2640	**2076**	**24110**	38.5	26.6	28.6	4.9	84.2	-	-	-	-	-	-

*** Double Gene Varieties	* Standard for Punjab & D I Khan ** Standard for Sindh & Balochistan	Values Below Lab Standard

Note: Cry 1 Ac Expression LeAel recommended by USDA/EPA = 1.5 µg/g fresh leaf weight for durable resistance

References:

Channa, A.R., M.W. Sanjrani, M.Z. Ahsan (2016) Correlation analysis of Yield with qualitative and Quantitative traits in developing cultivars of upland cotton (*Gossypium hirsutum*L.) *J. Environ. Agric Res* 8: 60-64.

Directorate of Agricultural Research (2014-15) Report of National Coordinated Varietal Trial.Pakistan Central Cotton Committee Multan.

Malik, T.H., M.Z. Ahsan (2016) Review of Cotton Market in Pakistan and its future Prospects. Oil & Fat Crops and Lipids 23(6): 1-7

Raza, S.H (2009) Cotton production in Pakistan.A grower's view.Presentation (.ppt) at the 68th ICAC Plenary Meeting.International Cotton Advisory Committee (ICAC). United States of America.

Soomro, M.H., G.S. Markhand, B.A.Soomro(2011) Screening Pakistani cotton for drought tolerance. *Pak.JBot.* 44(1):383-388.