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A comprehensive report of the National Coordinated Varietal Trial (NCVT) of cotton conducted during 2019-20 in National Cotton Varietal Testing Program

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ABSTRACT **Digital Object Identifier (DOI): https:/doi.org/10.33865/IJCRT.002.01.0353**

One hundred and two cotton cultivars, developed by the different scientists were grouped in four sets and tested at six locations in Punjab, four locations in Sindh, three locations in Balochistan and one location in KPK to test the adaptability of seed cotton yield. The quantitative and qualitative analysis of Bt toxin of these cultivars was conducted at four designated labs. The results revealed highly significant differences among the cultivars for seed cotton yield per hectare. In Set-A top performance cultivar is Saim-102 (2519kgha^{-1}) followed by the Tahafuz 12 (2350kgha^{-1}), in set-B Rustram-11 (2655kgha^{-1}) and BF-1 (2288kgha^{-1}) perform best as compared to the other cultivars. In Set–C cultivar, NIAB-1011 (2604kgha^{-1}) and GH-Uhad (2531kgha^{-1}) out yield the all other cultivars and in Set-D cultivar, Bt-CIM-775 (2588kgha^{-1}) and Sahara-Klean-5 (2508kgha^{-1}) surpass the yield from other candidate cultivars. Overall top varieties in Punjab, Sindh, Balochistan and National level were Rustam-11 (2484kgha^{-1}), Sahara-Klean-5 (2714kgha^{-1}), Diamon-2 (3742kgha^{-1}), GH-Hamaliya (2594kgha^{-1}), Rustam-11 (2655kgha^{-1}),The average trait purity for BG-I (Cry1Ac) was 25 to 100%, for BG-II (Cry1Ac and Cry2Ab) none of the variety observed positive and for BG-III (Cry1Ac, Cry2Ab and RR) trait purity was 57 to 100%.

Key word: National coordinated varietal trial, NCVT, biochemical tests, Bt toxin protein.

INTRODUCTION: Cotton is Pakistan's most valuable cash crop and exports of cotton goods account for 55% of the country's overall foreign exchange earnings. Nearly 26% of farmers cultivate cotton, and more than 15% of the overall cultivated area is dedicated to this crop, with two provinces producing primarily. In Punjab, which has dry conditions, about 65% of Pakistan's cotton is grown, and the rest is grown in Sindh, which has a wetter climate, with cotton areas in Khyber Pakhtunkhwa and Balochistan being marginal. Cotton output accounts for 4.5% of the Ag GDP value added and 0.8% of GDP, respectively. It serves as the raw material for the textile industry, hiring 17% of the country's largest agro-industrial market, receiving 60% of foreign exchange and contributing 8.5% to GDP (GOP, 2019, Niamatullah *et al.,* 2019).

Cotton production in Pakistan has been underwhelming, considering its significance. In terms of area under cotton production, the country now ranks 4th, but ranks 39th in cotton output per hectare. In 2019/20, cotton yield in Pakistan is projected to be about 513 kgs per hectare, against 1660 kgs per hectare in Brazil, which ranks fifth in cotton cultivation area (Wajid *et al.,* 2020).

Among the vast number of varieties recommended for cultivation in a specific region, stable cotton varieties with a high yield potential are of paramount importance. In the recent years, the release of high yielding Bt cotton varieties with pre-fixed fiber consistency criteria resistant to heat and leaf curl virus disease has increased momentum to meet the requirements of the farmers, the textile industry and the other stakeholders. In this context, by conducting National Coordinated Varietal Trials (NCVT) on the candidate cotton varieties bred by public and the private sector breeders, the Pakistan Central Cotton Committee (PCCC) plays a pivotal role.

OBJECTIVES: The objective of this experiment was to evaluate the adaptability and stability of seed cotton yield of different cotton cultivars throughout the cotton belt of Pakistan and to recommend the best performed cultivars to higher authority for proper approval and inclusion in seed system of the country.

MATERIALS AND METHODS: In the National Coordinated Varietal Trial NCVT (table 1), a total of 102 candidate strains produced by the various cotton research institutes and private seed sector breeders were grown at fifteen locations throughout Pakistan's cotton belt during 2019-2020. The experiment was carried out during the regular growing season. In a randomized complete block design of three replications, each genotype was planted in a plot of four rows of 5 meters in length and spacing was held 75 cm between rows and 30 cm between plants. Gap filling and thinning was done accordingly to sustain the plant population. All agronomic maintenance was conducted as needed, i.e. weeding, irrigation, inter-cultivation, application of fertilizers, application of pesticides. Picking of the plot was carried out at maturity and yield was determined as kg per hectare by multiplying the yield to the hectare area.

Bt toxin profiling: Quantitative and qualitative profiling of all genotypes were tested for gene expression at following four designated labs.

- National Institutes for Genomics and Biotechnology (NIGAB) NARC Islamabad.
- National Institute for Biotechnology and Genetic Engineering (NIBGE) Faisalabad.
- Center of Excellence and Molecular Biology (CEMB) Lahore.
- Agriculture Biotechnology Research Institute (ABRI) AARI Faisalabad.

Approximately, after eighty days of sowing validation and gene trait purity, PCR and Cry protein (Bt toxin) quantification were performed by sandwich-ELISA in all of the entries. Sample was taken from the fully expended third leaf tissue of each entry.

Table 1: Genotypes tested under set-A

Code	Strain	Institute	Code	Strain	Institute
PC-1901	Weal-AG-201	Weal-Ag Seeds Corporation, Multan	PC-1913	Diamond-2	Suncrop Seeds Corporation, Multan
PC-1902	Weal-AG-301	Weal-Ag Seeds Corporation, Multan	PC-1914	Suncrop-3	Suncrop Seeds Corporation, Multan
PC-1903	Weal-AG-8	Weal-Ag Seeds Corporation, Multan	PC-1915	CIM-602 (Bt-Std)	Central Cotton Research Institute Sakrand
PC-1904	Weal-AG-7	Weal-Ag Seeds Corporation, Multan	PC-1916	Tahafuz-12(C-II)	Suncrop Seeds Corporation, Multan
PC-1905	Weal-AG-10	Weal-Ag Seeds Corporation, Multan	PC-1917	Suncrop (C-II)	Suncrop Seeds Corporation, Multan
PC-1906	Weal-AG-9	Weal-Ag Seeds Corporation, Multan	PC-1918	Sayban-209	Auriga Seed Corporation Lahore
PC-1907	PC-1907		PC-1919	Saim-102	
PC-1908	PC-1908		PC-1920	Rohi-2	Rohi Seeds Corporation, Rajanpur
PC-1909	PC-1909		PC-1921	Rohi-1	Rohi Seeds Corporation, Rajanpur
PC-1910	Tassco-115	Tassco Seeds Corporation TandoAllahyar	PC-1922	TJ-King (C-II)	RCA Seeds Corporation Khanewal
PC-1911	Tassco-112	Tassco Seeds Corporation TandoAllahyar	PC-1923	PC-1923	
PC-1912	Tahafuz-15	Suncrop Seeds Corporation, Multan	PC-1924	NS-211	Neelum Seeds Corporation, Jahanian

RESULTS AND DISCUSSION: Seed cotton yield: During 2019-20, total 102 cotton cultivars were divided into four sets and tested on fourteen locations all over the country. These cultivars were tested on six locations in Punjab, four locations in Sindh, 3 locations in Baluchistan and 1 in KPK.

Set-A had twenty-four cultivars from PC-1901 to PC-1924 (table 1). In Punjab Set-A was conducted at seven locations (Cotton Research Station Faisalabad, Cotton Research Station Sahiwal, Central Cotton Research Institute Multan, ICI Seeds Multan, Cotton Research Station Vehari, Cotton Research Station Bahawalpur and Cotton Research Station Khanpur) (table 5). Saim-102 (2364 kgha^{-1}) followed by the Tahafuz-12 (C-II) 2283 kgha^{-1} produced highest seed cotton yield and lowest seed cotton yield was obtained from the cultivars PC-1909 (1525 kgha^{-1}) and Tassco-115 (1343 kgha^{-1}) (table 6). In Sindh province set-A was experimented at four locations (Cotton Research Station Ghotki, Central Cotton Research Institute Sakrand, Agriculture Research Institute Tandojam and Cotton Research Station Mirpur Khas) (table 5). Highest average seed cotton yield was obtained from the Tahafuz-12 (2475 kgha^{-1}) followed by the Tahafuz-15 (2383 kgha^{-1}) in contrast lowest yield was harvested from Weal-AG-9 (1640 kgha^{-1}) and Rohi-2 (1569 kgha^{-1}) (table 6). In Balochistan the trial was conducted on three locations (Cotton Research Station Lasbela, Cotton Research Station Sibbi and Agriculture Research Institute Khuzdar) (table 5) and maximum yield was harvested from Diamon-2 (3742 kgha^{-1}) and Saim-102 (3431 kgha^{-1}) and Weal-AG-8 and Sayban-209 produced lowest yield i.e. 2260 kgha^{-1} and 231 kgha^{-1} respectively (table 6). In KPK the trial was conducted at Cotton Research Institute D.I. Khan (table 5) and in KPK Tahafuz-15 and TJ-King are highest yield producing cultivars with average yield 2014 kgha^{-1} and 1982 kgha^{-1} respectively and poor yield was obtained from PC-1907 (978 kgha^{-1}) and Tassco-115 (833 kgha^{-1}) (table 6). Over all in Pakistan, the trial was conducted at 14 locations, and in average seed cotton yield the cultivars Saim-102 and Tahafuz-12 surpassed the other cultivars with average yield 2519kgha^{-1} and 2350 kgha^{-1} respectively and in contrast TJ-King (1843 kgha^{-1}) and PC-1909 (1794 kgha^{-1}) and lowest yield producing cultivars (table 6).

Set-B had twenty-six cultivars starting from PC-1925 to PC-1950 (table 1). In Punjab Set-B was experimented at seven locations, in Sindh on four locations and in Balochistan on three locations and in KPK on single location. In Punjab, the trial was conducted at Cotton Research Station Faisalabad, Cotton Research Station Sahiwal, Central Cotton Research Institute Multan, ICI Seeds Multan, Cotton Research Station Vehari, Cotton Research Station Bahawalpur and Cotton Research Station Khanpur (table 5). Out of twenty-six cultivars, highest yield was taken from Rustam-11 (2484 kgha^{-1}) and followed by the NIAB-SANAB-M (2337 kgha^{-1}) and lowest yield was obtained from the Rustam-Beej-111 and Rustam-Beej-11 (1704kgha^{-1}) (table 7). In Sindh Province, the Set-B (table 2) trial was conducted at four locations i.e. Cotton Research Station Ghotki, Central Cotton Research Institute Sakrand, Agriculture Research Institute Tandojam and Cotton Research Station Mirpur Khas (table 5). The highest yield was marked by the Rustam-11 (2424 kgha^{-1}) and Bahar-136 (2359 kgha^{-1}) and poor seed cotton yield was obtained from Badar-3 (1527kgha^{-1}) and Badar-4 (1493 kgha^{-1}) (table 7). In Balochistan Province Set-B, trial was conducted at Cotton Research Station Lasbela, Cotton Research Station Sibbi and Agriculture Research Institute Khuzdar (table 5). In Balochistan cultivars Rustam-11 and Eye-20 was marked as highest yielding cultivars with the average production 3553 kgha^{-1} and 3310 kgha^{-1} respectively. The lowest producing cultivars were identified as Eagle-4 2321 kgha^{-1} and NIAB-SANAB-M (2320 kgha^{-1}). In KPK province, the trial was experimented at Cotton Research Station D.I. Khan (table 5). Overall yield in KPK was low as compared to the locations. Anyway highest yield was harvested from the cultivar Rustam-11 (2086 kgha^{-1}) followed by the ICI-2424 (1989 kgha^{-1}) and lowest was obtained from the cultivar Rustam-Beej-111 (594 kgha^{-1}) and Badar-3 (558 kgha^{-1}) (table 7). All over the country, the trial was planted at fifteen locations. Highest national average yield was exhibited by the Rustam-11 (2655 kgha^{-1}) followed by the BF-1 (2288 kgha^{-1}) and lowest seed cotton yield was contributed by the Badar-4 (1815 kgha^{-1}) and Rustam-Beej-111 (1760 kgha^{-1}) (table 7).

Set-C (table 3) had twenty-five cultivars from PC-1951 to PC-1975 (table 1). In Punjab Set-C was conducted at seven locations Nuclear Institute for Agriculture and Biology Faisalabad, Cotton Research Station Sahiwal, Central Cotton Research Institute Multan, Four Brother Seeds Multan, Cotton Research Station Vehari, Cotton Research Station Bahawalpur and Cotton Research Station Khanpur) (table 5). NIAB-1011 (2321 kgha^{-1}) followed by the NIAB-135 (2209 kgha^{-1}) produced highest seed cotton yield and lowest seed cotton yield was obtained from the cultivars RH-Kashish (1386 kgha^{-1}) and

NIA-89 (1117 kgha^{-1}) (table 8). In Sindh Province Set-C was experimented at four locations (Cotton Research Station Ghotki, Central Cotton Research Institute Sakrand, Nuclear Institute for Agriculture Tandojam and Cotton Research Station Mirpur Khas) (table 5). Highest average seed cotton yield was obtained from the NIAB-1011 (2564 kgha^{-1}) followed by the GH-Sultan (2536 kgha^{-1}) in contrast lowest yield was harvested from RH-Kashish (1733 kgha^{-1}) and IUB-73 (1676 kgha^{-1}) (table 8). In Balochistan the trial was conducted on three locations (Cotton Research Station Lasbela, Cotton Research Station Sibbi and Agriculture Research Institute Khuzdar) (table 5) and maximum yield was harvested from NIAB-1011 (3453 kgha^{-1}) and GH-Uhad (3399 kgha^{-1}) and FH-492 and FH-155 produced lowest yield i.e. 2224 kgha^{-1} and 2235 kgha^{-1} respectively (table 8). In KPK the trial was conducted at Cotton Research Institute D.I. Khan (table 5) and in KPK GH-Hamaliya and GH-Sultan are highest yield producing cultivars with average yield 2594 kgha^{-1} and 2548 kgha^{-1} respectively and poor yield was obtained from NIAB-135 (1745 kgha^{-1}) and RH-Kashish (1591 kgha^{-1}) (table 8). Over all in Pakistan, the trial was conducted at 14 locations, and in average seed cotton yield the cultivars NIAB-1011 and GH-Uhad surpassed the other cultivars with average yield 2604 kgha^{-1} and 2531 kgha^{-1} respectively and in contrast RH-Kashish (1691 kgha^{-1}) and IUB-73 (1673 kgha^{-1}) and lowest yield producing cultivars (table 8).

Set-D had twenty-seven cultivars starting from PC-1976 to PC-2002 (table 1). In Punjab Set-D (table 4) was experimented at seven locations, in Sindh on four locations and in Balochistan on three locations and in KPK on single location. In Punjab, the trial was conducted at National Institute for Biotechnology and Genetic Engineering Faisalabad (NIBGE), Cotton Research Station Sahiwal, Central Cotton Research Institute Multan, Neelum Seeds Multan, Cotton Research Station Vehari, Cotton Research Station Bahawalpur and Cotton Research Station Khanpur (table 5). Out of twenty-seven cultivars, highest yield was taken from Bt-CIM-775 (2423 kgha^{-1}) and followed by the Sahara-Klean-5 (2165 kgha^{-1}) and lowest yield was obtained from the CIM-602 (1661 kgha^{-1}) and Cyto-124 (1394 kgha^{-1}) (table 9). In Sindh Province, the Set-B trial was conducted at four locations i.e. Cotton Research Station Ghotki, Central Cotton Research Institute Sakrand, Sindh Agriculture University Tandojam and Tassco Seeds Tandojam (table 5). The highest yield was obtained from the Sahara-Klean-5 (2714 kgha^{-1}) and CEMB-Klean-Cotton-4 (2547 kgha^{-1}) and lowest seed cotton yield was obtained from Bt-CIM-303 (1527 kgha^{-1}) and PC-1997 (1100 kgha^{-1}) (table 9). In Balochistan Province Set-B, trial was conducted at three locations *viz.* Cotton Research Station Lasbela, Cotton Research Station Sibbi and Agriculture Research Institute Khuzdar (table 5). In Balochistan cultivars Bt-CIM-775 and Bt-CIM-785 was marked as highest yielding cultivars with the average production 3328 kgha^{-1} and 3291 kgha^{-1} respectively. The lowest producing cultivars was identified as Cyto-226 (2203 kgha^{-1}) and CYTO-124 (2009 kgha^{-1}) (table 9). In KPK province, the trial was experimented at Cotton Research Station D.I. Khan (table 5). Highest yield was harvested from the cultivar Bt-Cyto-533 (2731 kgha^{-1}) followed by the Bt-Cyto 535 (2583 kgha^{-1}) and lowest was obtained from the cultivar CRIS-644 (1851 kgha^{-1}) and CIM-602 (1647 kgha^{-1}) (table 9). All over the country, the trial was planted at fifteen locations. Highest national average yield was exhibited by the Bt-CIM-775 (2655 kgha^{-1}) followed by the Sahara-Klean-5 (2508 kgha^{-1}) and lowest seed cotton yield was contributed by the PC-1997 (1677 kgha^{-1}) and Cyto-124 (1583 kgha^{-1}) (table 9).

Biochemical testing: Biochemical Testing of Bt toxin was performed in designated four biotechnology labs. For BG-I (Cry1Ac) almost all cultivars that was claimed this technology was tested positive through PCR, but their trait purity was different and ranged from 35% to 100%. Most of the cultivars showed above 50% trait purity only Tahafuz 12 (35%), the cultivars those did not claimed any gene technology also showed positive for BG-I tested but their trait purity is less and gene expression is also very low. The Bt toxin protein quantification was carried out through ELISA test. It was observed as high as 4.32 µg/g in RH-Afnan-2 and 4.2 µg/g in Rohi-2 and as low as 0.74µg/g (VH-402), 0.88 µg/g in SLH-33 and 0.96 µg/g in MNH-1035 this might be due to the mixing of germplasm or outcrossing with unknown source in the field. No cultivar was confirmed positive for BG-II (Cry1Ac +Cry2Ab) so the ELISA test was not performed for BG-II. For BG-III technology nine cultivars was reported positive and they had 70% to 100% trait purity. The Centre of Excellence of Molecular Biology (CEMB) also developed their own BG-II and BG-III technology. Nine cultivars claimed CEMB BG-II technology and were reported positive for this technology through PCR, the trait purity was also 100%. Five cultivars i.e. Eagle-3, Bahar-136, ASL-709, NIAB-SANAB-M and VH-383 did not claimed BG-II technology but were also reported positive with high trait purity. Fourteen cultivars claimed CEMB BG-III technology and all were reported positive with high trait purity. The Bt protein toxin level for BG-III technology in these cultivar was in the range of 2.6 to 3.8 µg/g i.e. higher than the commercial standard of toxin recommended by the USDA (table 10, table 11, table 12 and table 13).

Table 2: Genotypes tested under set-B

Code	Strain	Institute	Code	Strain	Institute
PC-1925	Eye-22	Kanzo Seed Corporation Multan	PC-1938	Ghauri-2(CKC)	Four Brothers Seed Corporation Multan
PC-1926	Eye-111	Kanzo Seed Corporation Multan	PC-1939	Badar-3(C-II)	Four Brothers Seed Corporation Multan
PC-1927	Eye-20	Kanzo Seed Corporation Multan	PC-1940	Badar-4(C-II)	Four Brothers Seed Corporation Multan
PC-1928	Rustam-Beej-111(CKC)	Jullundur Seeds Corporation, Rahim Yar Khan	PC-1941	BF-1	Baba-Fareed Seed Corporation, Vehari
PC-1929	Rustam-Beej-11(C-II)	Jullundur Seeds Corporation, Rahim Yar Khan	PC-1942	PC-1942	
PC-1930	Rustam-11	Jullundur Seeds Corporation, Rahim Yar Khan	PC-1943	PC-1943	
PC-1931	ICI-2424	ICI, Pakistan, Multan	PC-1944	Bahar-136	Bahar Seed Corporation

					Sadiqabad
PC-1932	YBG-2323(CKC)		PC-1945	ASPL-710	
PC-1933	YBG-2222(C-II)		PC-1946	ASPL-709	
PC-1934	Eagle-4	Four Brothers Seed Corporation Multan	PC-1947	IR-NIBGE-15	NIBGE, Faisalabad
PC-1935	CIM-602 (Bt-Std)	Central Cotton Research Institute Sakrand	PC-1948	IR-NIBGE-14	NIBGE, Faisalabad
PC-1936	Eagle-3	Four Brothers Seed Corporation Multan	PC-1949	IR-NIBGE-13	NIBGE, Faisalabad
PC-1937	Hatf-3(CKC)	Four Brothers Seed Corporation Multan	PC-1950	NIAB-SANAB-M	NIAB, Faisalabad

Table 3: Genotypes tested under set-C

Code	Strain	Institute	Code	Strain	Institute
PC-1951	NIAB-512	NIAB, Faisalabad	PC-1964	RH-Afnan-2	Cotton Research Institute, Khanpur
PC-1952	NIAB-973	NIAB, Faisalabad	PC-1965	RH-670	Cotton Research Institute, Khanpur
PC-1953	NIAB-819	NIAB, Faisalabad	PC-1966	GH-Hamaliya	Cotton Research Station Ghotki
PC-1954	NIAB-135	NIAB, Faisalabad	PC-1967	GH-Sultan	Cotton Research Station Ghotki
PC-1955	NIAB-1011	NIAB, Faisalabad	PC-1968	GH-Uhad	Cotton Research Station Ghotki
PC-1956	NIA-89	NIA, Tandojam	PC-1969	FH-Anmol	Cotton Research Station Faisalabad
PC-1957	IUB-73	Islamia University Bahawalpur	PC-1970	FH-492	Cotton Research Station Faisalabad
PC-1958	VH-383	Cotton Research Station Vehari	PC-1971	FH-155	Cotton Research Station Faisalabad
PC-1959	VH-189	Cotton Research Station Vehari	PC-1972	FH-Super-Cotton-2017	Cotton Research Station Faisalabad
PC-1960	CIM-602 (Bt-Std)	Central Cotton Research Institute Multan	PC-1973	FH-AM-Cotton-2017	Cotton Research Station Faisalabad
PC-1961	VH-402	Cotton Research Station Vehari	PC-1974	BH-224	Cotton Research Station Bahawalpur
PC-1962	SLH-33	Cotton Research Station Sahiwal	PC-1975	BH-223	Cotton Research Station Bahawalpur
PC-1963	RH-Kashish	Cotton Research Institute, Khanpur			

Table 4: Genotypes tested under set-D

Code	Strain	Institute	Code	Strain	Institute
PC-1976	MNH-1050	Cotton Research Institute, Multan	PC-1990	Bt-CIM-789	Central Cotton Research Institute Multan
PC-1977	MNH-1035	Cotton Research Institute, Multan	PC-1991	Bt-CIM-678	Central Cotton Research Institute Multan
PC-1978	CEMB-Klean-Cotton-6	CEMB, Lahore	PC-1992	Bt-CIM-303	Central Cotton Research Institute Multan
PC-1979	CEMB-Klean-Cotton-5	CEMB, Lahore	PC-1993	CIM-602 (Bt-Standard)	Central Cotton Research Institute Multan
PC-1980	CEMB-Klean-Cotton-4	CEMB, Lahore	PC-1994	Cyto-124 (Non-Bt Standard)	Central Cotton Research Institute Multan
PC-1981	CEMB-Klean-Cotton-3	CEMB, Lahore	PC-1995	NIAB-929	NIAB, Faisalabad
PC-1982	CRIS-638	Central Cotton Research Institute Sakrand	PC-1996	NIA-88	NIA, Tandojam
PC-1983	CRIS-673	Central Cotton Research Institute Sakrand	PC-1997	PC-1997	
PC-1984	CRIS-671	Central Cotton Research Institute Sakrand	PC-1998	CRIS-644	Central Cotton Research Institute Sakrand
PC-1985	Bt-Cyto-535	Central Cotton Research Institute Multan	PC-1999	Cyto-226	Central Cotton Research Institute Multan
PC-1986	Bt-Cyto-533	Central Cotton Research Institute Multan	PC-2000	Sahara-Klean-5	Patron Seeds Corporation Multan
PC-1987	Bt-CIM-785	Central Cotton Research Institute Multan	PC-2001	Sahara-300	Patron Seeds Corporation Multan
PC-1988	Bt-CIM-775	Central Cotton Research Institute Multan	PC-2002	MZM-7	Agri-Farms Services, Multan
PC-1989	Bt-Cyto-511	Central Cotton Research Institute Multan			

Table 5: Location of NCVT sowing across the different areas of Pakistan

Sr.	Province	Zone	Station	Sets
1	Khyber Pakhtunkhawa	D.I. Khan	Cotton Research Station D.I. Khan	A,B,C,D
2	Punjab	Faisalabad	Cotton Research Station Faisalabad	A,B
			Nuclear Institute for Agriculture and Biology	C
			National Institute for Biotechnology and Genetic Engineering	D
		Sahiwal	Cotton Research Station Sahiwal	A,B,C,D
		Multan	Central Cotton Research Institute Multan	A,B,C,D
			ICI, Multan	A,B
			Four Brothers Seed Corporation Multan	C
			Neelum Seeds	D
		Vehari	Cotton Research Station Vehari	A,B,C,D

		Bahawalpur	Cotton Research Station Bahawalpur	A,B,C,D
		Khanpur	Cotton Research Station Khanpur	A,B,C,D
		Ghotki	Cotton Research Station Ghotki	A,B,C,D
		Sakrand	Central Cotton Research Institute Sakrand	A,B,C,D
3	Sindh	Tandojam	Agriculture Research Institute Tandojam	A,B
			Nuclear Institute for Agriculture Tandojam	C
			Sindh Agriculture University Tandojam	D
			Tassco Seeds Tandojam	D
		Mirpur Khas	Cotton Research Station Mirpur Khas	A,B,C
		Lasbela	Cotton Research Station Lasbela	A,B,C,D
4	Balochistan	Sibbi	Cotton Research Station Sibbi	A,B,C,D
		Khuzdar	Agriculture Research Institute Khuzdar	A,B,C,D

Table 6: Seed cotton yield (kg/ha) of twenty four candidate varieties tested in NCVT set-A during 2019-20

Code	Strain	Punjab	Sindh	Balochistan	KPK	Average
PC-1901	Weal-AG-201	1914	1688	2896	1172	2001
PC-1902	Weal-AG-301	2197	2186	2894	1630	2296
PC-1903	Weal-AG-8	1821	1726	2260	1553	1866
PC-1904	Weal-AG-7	1959	2005	2274	1275	1989
PC-1905	Weal-AG-10	1876	2045	2856	1411	2086
PC-1906	Weal-AG-9	2013	1640	2542	1537	1988
PC-1907	PC-1907	1838	2028	2596	978	1983
PC-1908	PC-1908	2119	2044	2613	1401	2150
PC-1909	PC-1909	1525	1677	2783	1181	1794
PC-1910	Tassco-115	1344	2140	3132	833	1880
PC-1911	Tassco-112	1996	2188	2937	1498	2202
PC-1912	Tahafuz-15	2148	2383	2559	2014	2284
PC-1913	Diamond-2	2024	1912	3742	1343	2292
PC-1914	Suncrop-3	1696	1936	2528	1701	1927
PC-1915	CIM-602 (Bt-Std)	1706	1954	2707	1582	1964
PC-1916	Tahafuz-12(C-II)	2283	2475	2535	1766	2350
PC-1917	Suncrop (C-II)	1911	1827	2438	1956	1997
PC-1918	Sayban-209	2010	2128	2231	1530	2054
PC-1919	Saim-102	2364	2260	3431	1905	2519
PC-1920	Rohi-2	1721	1569	2760	1808	1894
PC-1921	Rohi-1	1655	1921	2797	2127	1986
PC-1922	TJ-King (C-II)	1553	1687	2683	1982	1843
PC-1923	PC-1923	2124	1866	2502	1934	2118
PC-1924	NS-211	2061	2153	2695	1708	2189
	Average	**1911**	**1977**	**2725**	**1576**	**2069**
	CV	**10.3**	**13.2**	**11.3**	**7**	**-**

Table 7: Seed cotton yield (kg/ha) of twenty four candidate varieties tested in NCVT set-B during 2019-20

Code	Strain	Punjab	Sindh	Balochistan	KPK	Average
PC-1925	Eye-22	1924	2103	2765	1960	2142
PC-1926	Eye-111	2081	2094	3003	1262	2215
PC-1927	Eye-20	2116	2071	3310	1023	2270
PC-1928	Rustam-Beej-111(CKC)	1704	1537	2575	594	1760
PC-1929	Rustam-Beej-11(C-II)	1704	1686	2600	1343	1854
PC-1930	Rustam-11	2484	2424	3553	2086	2655
PC-1931	ICI-2424	2151	2011	2610	1989	2195
PC-1932	YBG-2323(CKC)	1841	1524	2932	1013	1920
PC-1933	YBG-2222(C-II)	2037	2089	2888	1417	2179
PC-1934	Eagle-4	2059	2147	2321	1340	2087
PC-1935	CIM-602 (Bt-Std)	1826	2228	3105	1046	2137
PC-1936	Eagle-3	1784	1854	2636	1201	1934
PC-1937	Hatf-3(CKC)	1845	1862	2405	1068	1910
PC-1938	Ghauri-2(CKC)	1866	1891	2672	1114	1984
PC-1939	Badar-3(C-II)	1758	1527	2827	558	1830
PC-1940	Badar-4(C-II)	1715	1493	2867	645	1815
PC-1941	BF-1	2030	2241	3197	1556	2288
PC-1942	PC-1942	2083	2039	3228	904	2222
PC-1943	PC-1943	1717	1765	2960	1210	1944
PC-1944	Bahar-136	2031	2359	2398	1081	2129
PC-1945	ASPL-710	2188	2150	2907	649	2219
PC-1946	ASPL-709	2093	1844	2686	781	2058
PC-1947	IR-NIBGE-15	2035	1935	3186	600	2143
PC-1948	IR-NIBGE-14	2156	1954	2547	1181	2116

PC-1949	IR-NIBGE-13	2206	1923	2578	1201	2138
PC-1950	NIAB-SANAB-M	2337	2229	2320	1766	2267
	Average	**1991**	**1961**	**2811**	**1176**	**2093**
	CV	**10.0**	**11.9**	**11.1**	**10.2**	**-**

Table 8: Seed cotton yield (kg/ha) of twenty four candidate varieties tested in NCVT set-C during 2019-20

Code	Strain	Punjab	Sindh	Balochistan	KPK	Average
PC-1951	NIAB-512	2079	2223	2435	1908	2184
PC-1952	NIAB-973	1496	1864	2481	2102	1856
PC-1953	NIAB-819	1519	2110	2318	2061	1898
PC-1954	NIAB-135	2209	2426	2804	1745	2365
PC-1955	NIAB-1011	2321	2564	3453	1914	2604
PC-1956	NIA-89	1117	2173	2965	2060	1882
PC-1957	IUB-73	1499	1676	1926	1939	1673
PC-1958	VH-383	1777	1972	2794	1934	2062
PC-1959	VH-189	1800	2139	2239	2227	2022
PC-1960	CIM-602 (Bt-Std)	1536	2119	2527	2084	1954
PC-1961	VH-402	1576	1825	2262	2259	1843
PC-1962	SLH-33	1647	1899	2482	1961	1920
PC-1963	RH-Kashish	1386	1733	2281	1591	1691
PC-1964	RH-Afnan-2	1856	2123	2526	1972	2084
PC-1965	RH-670	1701	2441	2912	2103	2201
PC-1966	GH-Hamaliya	2061	2471	3077	2594	2434
PC-1967	GH-Sultan	1964	2536	3081	2548	2408
PC-1968	GH-Uhad	2193	2452	3399	2270	2531
PC-1969	FH-Anmol	1796	2104	2580	2064	2071
PC-1970	FH-492	1831	2057	2224	2043	1995
PC-1971	FH-155	1834	2442	2235	2031	2108
PC-1972	FH-Super-Cotton-2017	1957	2418	3034	2066	2327
PC-1973	FH-AM-Cotton-2017	1771	2071	3152	2078	2175
PC-1974	BH-224	1857	2016	3003	2090	2165
PC-1975	BH-223	1807	2178	2589	2043	2098
	Average	**1784**	**2161**	**2671**	**2067**	**2102**
	CV	**7.3**	**9.5**	**10.1**	**5**	**-**

Table 9: Seed cotton yield (kg/ha) of twenty four candidate varieties tested in NCVT set-D during 2019-20

Code	Strain	Punjab	Sindh	Balochistan	KPK	Average
PC-1976	MNH-1050	1808	2032	2631	1930	2041
PC-1977	MNH-1035	2034	1660	2867	2115	2106
PC-1978	CEMB-Klean-Cotton-6	2109	2378	2796	2102	2318
PC-1979	CEMB-Klean-Cotton-5	2094	2355	3011	2188	2353
PC-1980	CEMB-Klean-Cotton-4	2078	2547	3001	2268	2400
PC-1981	CEMB-Klean-Cotton-3	2161	2476	2730	2144	2358
PC-1982	CRIS-638	1920	1645	2876	2151	2053
PC-1983	CRIS-673	2091	2136	2571	2148	2203
PC-1984	CRIS-671	1946	2211	2548	2331	2163
PC-1985	Bt-Cyto-535	1961	2072	2952	2583	2230
PC-1986	Bt-Cyto-533	2015	2009	2835	2731	2225
PC-1987	Bt-CIM-785	1830	1748	3291	2573	2150
PC-1988	Bt-CIM-775	2423	2331	3328	2552	2588
PC-1989	Bt-Cyto-511	2070	1840	2843	2335	2181
PC-1990	Bt-CIM-789	1986	2027	3275	2441	2285
PC-1991	Bt-CIM-678	1768	1945	3148	2378	2132
PC-1992	Bt-CIM-303	1791	1513	2789	2419	1958
PC-1993	CIM-602 (Bt-Standard)	1661	1949	2419	1647	1889
PC-1994	Cyto-124 (Non-Bt Std)	1394	1519	2009	1890	1583
PC-1995	NIAB-929	2116	1616	2600	2082	2077
PC-1996	NIA-88	1977	2257	3248	1908	2301
PC-1997	PC-1997	1700	1100	2256	2090	1677
PC-1998	CRIS-644	1746	2198	2802	1851	2085
PC-1999	Cyto-226	1786	1679	2203	2425	1883
PC-2000	Sahara-Klean-5	2165	2714	3170	2102	2508
PC-2001	Sahara-300	2068	2370	2874	2008	2306
PC-2002	MZM-7	1952	1734	2767	1971	2058
	Average	**1950**	**2002**	**2809**	**2199**	**2152**
	CV	**7.5**	**7.1**	**9**	**5**	**-**

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