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آیت کریمہ کی اشاعت آپ کی دینی واقفیت میں اضافہ کیلئے دی جاتی ہے
ان کے تقدس کی حفاظت کا خیال رکھنا آپ کا دینی فریضہ ہے

وَهُوَ الَّذِیْٓ اَنْزَلَ مِنَ السَّمَآءِ مَآءً فَاَخْرَجْنَا بِهٖ نَبَاتَ كُلِّ شَیْءٍ فَاَخْرَجْنَا مِنْهُ
خَضِرًا نُّخْرِجُ مِنْهُ حَبًّا مُّتَرَاكِبًا ۚ وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِیَةٌ وَّجَنّٰتٍ
مِّنْ اَعْنَابٍ وَّالزَّیْتُوْنَ وَالرُّمَّانَ مُشْتَبِهًا وَّغَیْرَ مُتَشَابِهٍ ۭ اُنْظُرُوْٓا اِلٰى ثَمَرِهٖٓ اِذَآ
اَثْمَرَ وَیَنْعِهٖ ۭ اِنَّ فِیْ ذٰلِكُمْ لَاٰیٰتٍ لِّقَوْمٍ یُّؤْمِنُوْنَ ۝ (سورئہ انعام آیت نمبر ۱۰۰)

ترجمہ: اور وہ اللہ ایسا ہے جس نے آسمان سے پانی برسایا پھر ہم نے اس کے زریعے ہر قسم کے نباتات کو نکالا۔ پھر ہم نے اس سے سبز شاخ نکالی۔ کہ اس سے ہم اوپر تلے دانے جڑے ہوئے نکالتے ہیں اور کھجور کے درختوں سے بھی ان کے جو مارے بوجھ کے نیچے لٹکے جاتے ہیں اور اسی سے ہم نے انگوروں کے باغ اور زیتون اور انار کے درخت پیدا کئے جو ایک دوسرے سے ملتے جلتے ہیں اور بعض ایک دوسرے سے ملتے جلتے نہیں ہوتے۔ زرا ہر ایک پھل کو تو دیکھو۔ جب وہ پھلتا ہے اور پھر اس پکنے کو دیکھو ان میں بھی دلائل توحید کے موجود ہیں۔ ان لوگوں کیلئے جو ایمان لانے کی فکر میں ہیں۔

100. He it is who sendeth down water from the sky and therewith we bring forth buds of every kind. We bring forth the green blade form which we bring forth the thick-clus tered grain. and from, the date-palm, from the pllan thereof, spring pendent bunches: and (We bring forth) gardens of grapes and the olive and the pomegranate, alike and unlike. Look upon the fruit thereof, when they bear fruit and upon its ripening. Lot herein Venly are portents for peoples who believe.

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COTTON V/S COMPETING CROPS

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INTRODUCTION:

1.1 In Pakistan cotton competes for area with three crops viz. sugarcane, rice and maize. Rice is area specific and area under maize is small when compared with cotton. Real competition for area is, therefore, with sugarcane.

1.2 Sugarcane is one-year crop while cotton is a six-month crop. In Pakistan cotton-wheat-cotton rotation is the norm. In between, a crop of Alfa-alfa is grown. One or two cuttings are used as fodder and sale in the market for cash. Last cutting is rotavated into the soil. Green manure and nitrogen provided by alfa-alfa enriches the soil. It may be pointed out that nitrogenous fertilizer alone accounts for 40 to 60 percent of yield (Afzal, 1986). Therefore, when per hectare monetary/economic return is calculated, income from one crop of sugarcane has to be equated with income generated by one crop of cotton, wheat and alfa-alfa. Cotton not only provides fibres but also edible oil, cotton seed oil cake for animals and dry stalks as fuel for rural house holds.

1.3 Government has been sanctioning establishment of sugar mills in Punjab and Sindh which are major cotton producing provinces. Recently, Pakistan Cotton Ginners Association (PCGA) has urged the government to discourage setting up of sugar mills in prime cotton growing areas (DAWN, 19.7.2003). Area of cotton has increased in Punjab from 1927.0 to 2405.2 '000 hectares. Area of sugarcane has also increased from 512.7 to 672.3 '000 hectares. However, in Sindh area under cotton has decreased from 601.7 to 562.0 '000 hectares. On the other hand area under sugarcane increased from 213.2 to 242.6 '000 hectares during the same period. Total area both under cotton and sugarcane has increased due to some increase in the Punjab and marked increase in Balochistan where virgin land has come under cotton. One other factor worth considering is water requirement of sugarcane against cotton. Sugarcane requires more water than cotton. In a country where sugarcane is not a rain grown crop but is irrigated, consumption of water is critical. Some how this point has escaped consideration.

1.4 Pakistan is a flat country. There is little natural drainage, as a consequence drainage canals had to be built. This is an other factor which goes against those crops which require excessive irrigation.

1.5 Maize occupies a small area (1.04 million hectares during 2005-06) as compared to cotton. However, it is an important food as well as animal feed crop. Maize can be a substitute for wheat at a critical time and can prevent famine. Cultivation of hybrid maize should be encouraged which can increase yield. Increased availability of maize can supplement food both for humans and cattle. Maize feed for cows will result in increased milk and meat production. Maize can also be used for the production of ETHANOL which can then be mixed with petrol to lessen the imported bill for oil. These can be plus points in favour of maize.

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1.6 Wheat is the major food crop not only for humans but provides dry fodder for animals as well. Yield of wheat has increased after wheat cultivars developed by CYMMIT were introduced. Increase in yield was mainly due to the introduction of dwarf cultivars (Afzal, 1986). Reasons for increase in yield as explained by Afzal, 1986 is that dwarf ness prevents lodging and the stalk is able to bear/tolerate the weight of large grain size and increased size of ear.

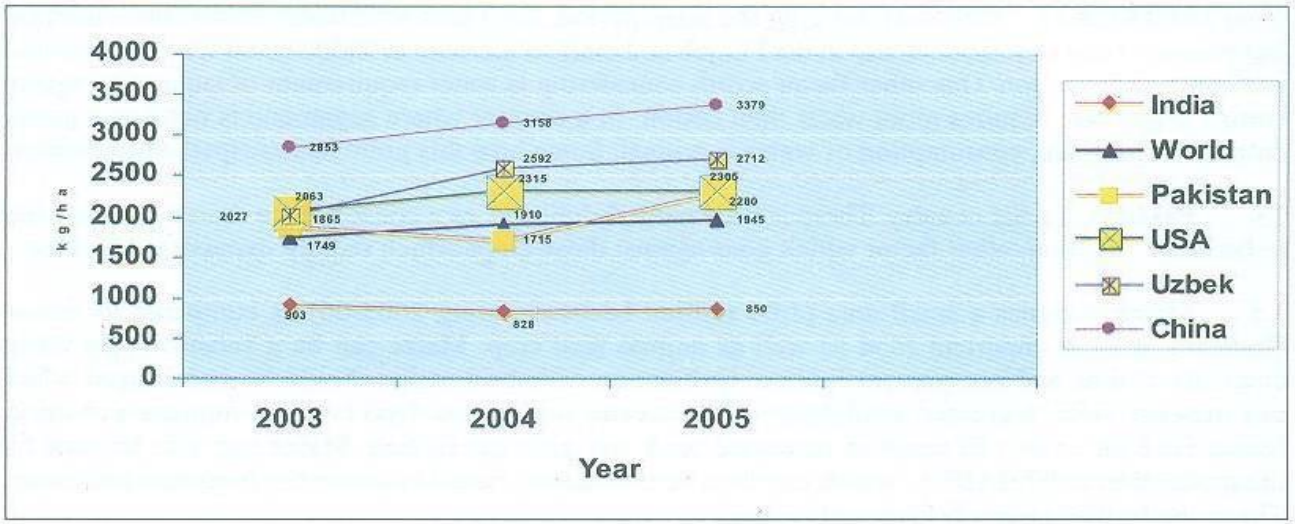
1.7 Rice is area specific and, therefore poses no competition to cotton. Yield of rice, like wheat, increased with the introduction of cultivars developed by IRRI and, better cultural practices. Pakistan has, however, the sole distinction of producing true BASMATI rice. Difference between Basmati and other rice is that the former is aromatic and translucent while the latter has no aroma and is opaque. Rice husk is used for animal feed but most of it goes towards the manufacture of chipboard.

2. COTTON

2.1 All aspects of cotton production have been dealt-with in detail by Afzal, (1986), Afzal and Baloch (2005), Afzal and et al (2006). According to GOP, cotton accounts for 8.2% of value added in agriculture and about 2.0% in the GDP of Pakistan. Even an increase of one million bales (170 kg) in production of cotton would result in sizeable increase in the country's GDP.

2.2 Yield of cotton and indeed of all crops and per hectare and economic return to the farmer are important. Yield of cotton for Pakistan and some other important cotton growing countries is shown in Fig-1.

Fig-1: YIELD OF COTTON (KG/HA)



Sources:

1. FAO
2. MINFAL-GOP.

Although in the present context yield of only Pakistan has to be in focus, however, yield of Pakistan alongwith few other countries will give a better and broader perspective.

2.3 Pakistan, in so far as cotton is concerned, is one of the major players of the world. Pakistan's importance in the world of cotton is clear from Table-1.

Table-1 PAKISTAN'S PLACE IN THE WORLD OF COTTON AND TEXTILES

	Percent	Rank
Production	9.5	4th
Consumption	10.0	3rd
Yarn Production	9.0	3rd
Yarn Export	26.0	2nd
Cloth Production	7.0	3rd
Cloth Export	14.0	3rd
Export of all made-up hosiery, towels bed sheets etc.	8159 million US dollars	N.A

Source:- i) Pakistan Central Cotton Committee (2006)

ii) Export Promotion Bureau of Pakistan.

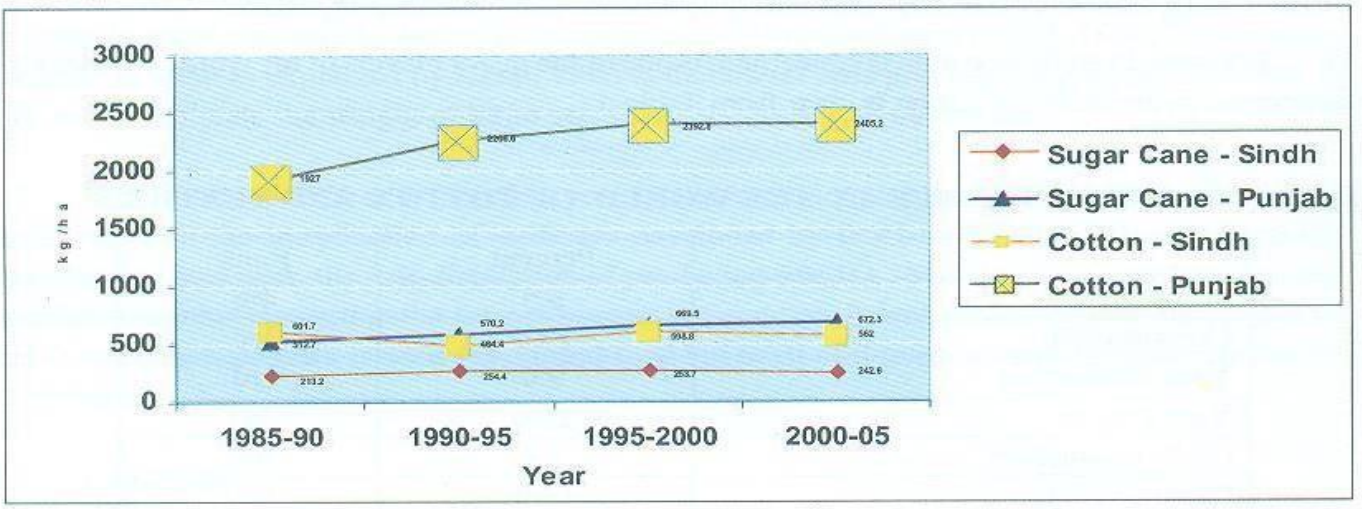
2.4 Export figures for various made-ups are difficult to reconcile as some figures are in tons while the others are in dozens. Therefore, only total export value of all made-ups for 2004-05 is given.

2.5 Ginning needs to be improved in both mechanical and quality departments. Price of lint will improve with the improvement of quality/ cleanliness. GOP is making a serious effort to improve ginning quality. Pakistan Cotton Standards Institute has been set up. It is contemplated to grade every bale. It is significant to note that Pakistan is the second country of the world, after USA, to develop its own colour grades. Technical and financial help for this project was provided by FAO and it is duly acknowledged.

2.6 AREA OF COTTON:-

According to State Bank of Pakistan's latest six monthly report as quoted by Nawa-e-Waqat (01.04.2007), area of wheat increased by 0.5%, sugarcane 12%, while area of rice decreased by 15.6%. Area of cotton has increased mainly due to increase in area in Balochistan. However, total area under both cotton and sugarcane has increased. Area under cotton in Sindh has decreased from 601.7 to 562.0 '000 hectares. Area under sugarcane in Sindh increased from 213.2 to 242.5 '000 hectares, during the same period. Changes in area under cotton and sugarcane both for Punjab and Sindh are shown in Fig.2.

FIGURE-2: AREA OF COTTON AND SUGARCANE ('000 HECTARES)



Sources: MINFAL-GOP

2.6.2 Province-wise area of cotton and Sugarcane on five year average basis is given in Table-2.

TABLE-2. AREA OF COTTON AND SUGAR CANE.

('000 hectares)

Year	COTTON					SUGARCANE				
	Punjab	Sindh	NWFP	Balochistan	Pakistan	Punjab	Sindh	NWFP	Balochistan	Pakistan
1985-90 5 year's Avg.	1927.0	601.7	1.8	0.4	2531.0	512.7	213.2	96.5	0.5	822.9
1990-95 5 year's Avg.	2268.6	484.4	0.5	0.7	2758.2	570.2	254.4	102.2	0.5	927.3
1995-2000 5 year's Avg.	2392.8	598.9	0.3	10.3	3002.3	669.5	253.7	105.8	0.7	1029.7
2000-2005 5 year's Avg.	2405.2	562.0	1.6	34.9	3003.8	672.3	242.6	104.7	0.7	1020.2

Source:- MINFAL, GOP.

2.7 ECONOMICS OF COTTON:-

2.7.1 Cotton farmers have a choice to sell their seed cotton to a commission agent (arthi), ginning factory, textile mill or get it ginned and export. This advantage is not available to farmers of other crops. Therefore, farmers of cotton have an advantageous position as compared to farmers of other crops particularly sugarcane. Farmers of sugarcane can sell their crop only to a sugar factory.

2.7.2 To facilitate cotton farmers and indeed farmers of sugarcane, wheat and rice as well GOP has been fixing MINIMUM SUPPORT PRICE. If the market price falls below the support price GOP steps in to intervene and purchase's at the support price. Support prices for various crops are calculated by AGRICULTURE PRICES COMMISSION and announced at the beginning of the season. Support price for cotton for 2005-06 was Rs. 975/- per Kg. In the past prices rarely fell below support price.

2.7.3 There are about 1,600,000 cotton farmers, about 1200 ginning factories and over 450 textile mills in the country. Hosiery, bed sheet, towel and garments factories are in addition to the above. Progress of textile industry is shown in Table-3

TABLE-3 GROWTH OF TEXTILE INDUSTRY.

Year	No. of Mills	No. of Spindles	Year	No. of Mills	No. of Spindles
1992-93	334	6860	1998-99	442	8392
1994-95	495	8610	2000-01	444	8601
1996-97	440	8230	2002-03	450	9260
			2004-05	458	10485

Source: APTMA.
Note: Spindles in (000).

2.7.4 Cotton industry, from farmer to the exporter of textiles, employees over one million people. It earns approximately 60% of total foreign exchange. Cotton economic activity and the multiplier effect is responsible for the relative prosperity that is seen in the country. It is, therefore, suggested that the cotton farmers may be treated kindly and, cotton culture encouraged to flourish.

3. WHEAT.

3.1 Wheat and rice are premier food grains of the world. Wheat alongwith rice occupies about 50% of the total area under cereals (Afzal, 1986). "Apparently the primary crops of the first agriculturist were wheat and barley – infact agriculture was founded on these crops. So to a small degree, therefore, the emergence of our culture seems to be linked to a mutation which affected the meiotic chromosome pairing and hence the fertility of a wild grass" (Riley, 1965).

3.2 Lodging at the time of heading results in high yield loss. Dwarf and semi dwarf cultivars give much higher yield when optimum degree of fertilizer is applied. However, tall cultivars tend to give higher yield under low soil fertility. Therefore it is clear that to get high yield from dwarf cultivars high doze of fertilizer is required.

3.3 Detailed statistics regarding area and yield are periodically published by GOP. Area and yield of cotton, wheat, sugarcane, rice and maize crops under discussion are given in Table-4.

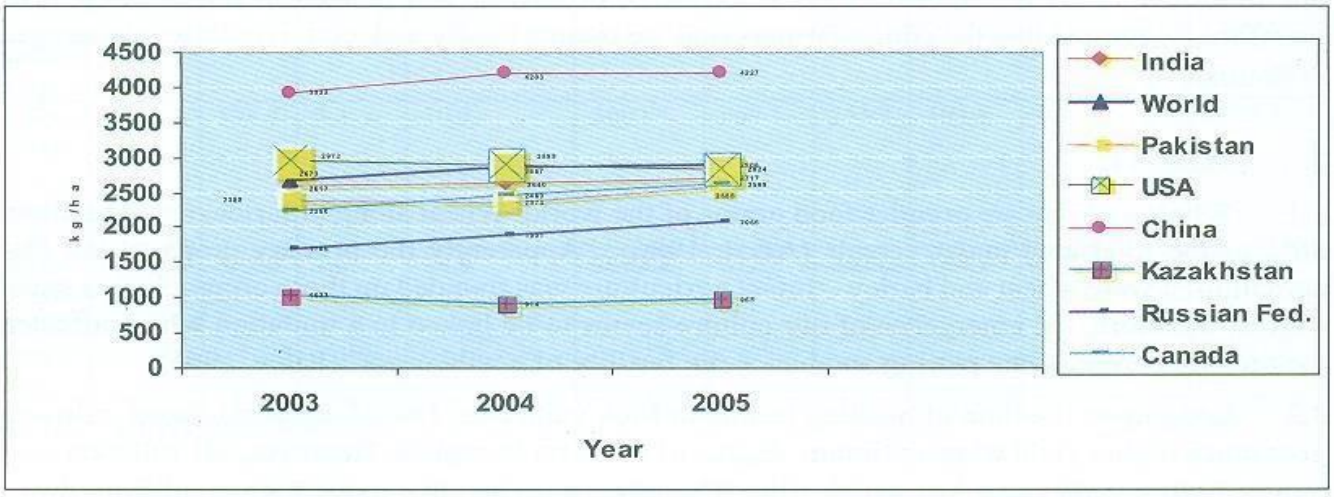
Table-4. AREA AND YIELD OF COTTON, WHEAT, SUGARCANE, RICE AND MAIZE.

Year	Cotton		Wheat		Sugarcane		Rice		Maize	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
1990-95 Average	2758.2	595	8058.5	1951	927.3	4410	2098.9	1626	865.6	1410
1996-2000 average	3002.3	557	8306.6	2196	1029.7	4700	2333.8	1922	944.6	1658
2001-05 average	3003.8	633	8169.3	2388	1020.2	4790	2339.2	1969	950.0	2050
2005-06 average	3103.0	714	8447.9	2519	907.3	4920	2621.4	2116	1042.0	2984

Area '000' hectares
yield in Kg /ha.
Source: MINFAL, GOP.

3.4 According to GOP area under wheat in the Punjab, during 2005-06 increased by 1.6% as compared to 2004-05 due to enhancement in support price, however overall production (3.4%) decreased over previous year due to increase in temperature during February, 2006 and scanty rainfall during rabi season. The area and production in Sindh increased by 5.28 and 9.6 percent respectively. However, in NWFP and Balochistan provinces, both area and production increased due to climatic conditions and proper dozes of inputs, use of imported cultivars and the crop was free from any disease. On Pakistan level, the production shows a decrease of 1.6 percent. Yield of wheat for Pakistan, world and six other countries is shown in Fig.3.

Fig-3: YIELD OF WHEAT (KG/HA)



Sources: 1. FAO 2. MINFAL-GOP

3.5 ECONOMICS OF WHEAT

3.5.1 Pakistan may emerge as a wheat or wheat flour exporting country during 2007. Support price for 2005-06 for wheat was Rs. 415/- per 40 Kg.

3.5.2 According to GOP cotton + wheat combination shows some edge of over sugarcane in respect of returns to crop duration and irrigation water. However, in this analysis, alfa alfa has been ignored.

3.5.3 Wheat is the major food crop for the population of Pakistan. Wheat husk is an important feed for animals and therefore, is responsible for increased milk and meat production.

4. SUGAR CANE

4.1 Sugarcane besides sugar beat is the only crop from which sugar is obtained. It is a native of old world and was introduced into the new world by Columbus in 1493.

4.2 Before the introduction of sugar, honey was perhaps the only sweetener available to mankind.

4.3 Sugarcane can be sown (seed is very small) but more often it is reproduced through cuttings of the stem. Vegetative propagation is expensive as 10 to 15 percent of the crop has to be used for raising a new crop. However, cane is very suitable for ratooning. Farmers, therefore, prefer ratooning. Following are the number of ratoonings for some of the countries of the world.

a. Cuba – 4 to 8 crops
b. Hawaii – 2 crops
c. Peru – 5 crops
d. Pakistan – 2 crops

4.4 Sugarcane is a long duration crop and this is its main disadvantage when compared to other crops. The duration of the crop in some countries is given in Table-5.

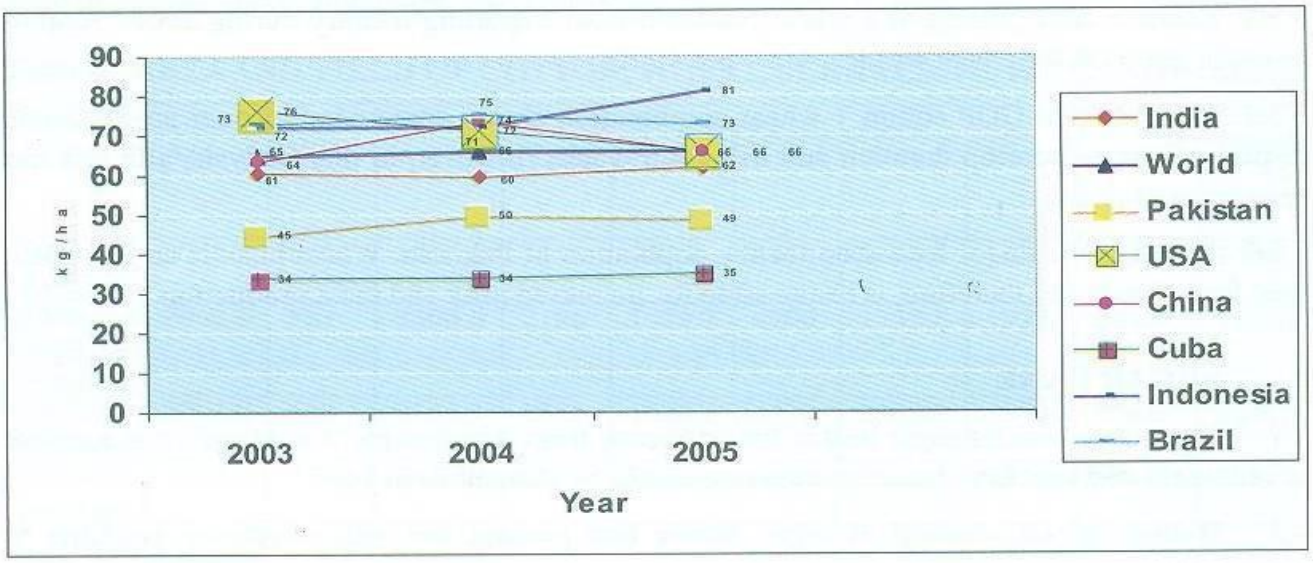
TABLE-5. DURATION OF SUGARCANE CROP.

Country	Duration (Months)	Country	Duration (Months)
Hawaii	24 – 28	South Africa	22 – 24
Jawa	15 – 22	Philippines	11 – 14
Mauritius	14 – 20	Pakistan	10 – 12
Australia	20 – 25		

Source: Report of Pakistan Sugar Commission.

4.5 Sugarcane is the highest yielder of all crops per unit area of land. In 1937, Willcox (1937) calculated the highest theoretical yield of sugarcane. Water stress can reduce or limit the yield of cane and, can also interfere with the accumulation of sucrose. Too much water can also cause harm in the forum of leaching of nutrients and also promote root-rot (Nickell, 1977). Yield of sugarcane in Pakistan and some other countries is given in Fig.4.

Fig-4: YIELD OF SUGAR CANE ('000 KG/HA)



Sources: 1. FAO 2. MINFAL

4.6 The sugar content recovery of sugarcane cultivars grown in the country varies from 7.5 to 8.0 percent, far away from international standards. Keeping this in view, the Pakistan Sugar Mills Association has put forward a proposal to develop local cane varieties with better yield and sugar content. The association has also recommended importing varieties and technology from Australia to bring cane yield at par with the international levels. Yield of sugarcane and sugar recovery in main sugarcane growing countries of world is given in Table-6.

TABLE-6 . YIELD OF SUGAR CANE, SUGAR RECOVERY AND SUGAR YIELD IN MAIN SUGAR GROWING COUNTRIES

Country	Cane yield (t/ha)	Sugar recovery (%)	Sugar yield (t/ha)
Australia	100.4	13.8	13.85
Egypt	110.8	11.5	12.74
Brazil	68.4	14.5	9.91
USA	80.2	11.7	9.38
Colombia	80.5	11.5	9.26
Mexico	79.5	11.6	9.22
India	66.9	9.9	6.62
Pakistan	50.3	9.2	4.63
World Avg.	64.4	10.6	6.82

Source: Daily DAWN, Karachi, dated 7th May, 2007.

4.7 Excessive requirement of water as compared to other crops will eventually cause water table to rise. It will be, ultimately harmful to agricultural ecosystem. In order to access the relative economic importance, water requirement, yield and, net economic return per hectare should be considered to arrive at a decision as to which crop should be given preference over other crops in the overall economic scenario and national interest. It is suggested that sugarcane cultivation should be restricted to its natural habitat. Number of sugar mill have grown in Pakistan and the progress of sugar mills is given in Table-7.

TABLE-7. NUMBER OF SUGAR MILLS

Year	Number of Sugar Mills	Year	Number of Sugar Mills
1992-93	62	1990-2000	67
1993-94	65	2000-01	65
1994-95	67	2001-02	65
1995-96	70	2002-03	69
1996-97	74	2003-04	71
1997-98	71	2004-05	71
1998-99	73	2005-06	74

Source:- Pakistan Sugar Mills Association (PSMA), Islamabad.

4.8 Arabs are supposed to have spread sugar cane culture from Persia to Mediterranean region. Arabs are also credited for the refining process and manufacture of candies. According to Encyclopedia Britannica, commercialization of refined sugar was started in Louisianan (USA) by Jean Etienne Bore in 1795. Refining of sugar started in 19th century in other countries.

4.9 Beet Sugar's development is due to two German Chemists namely Andreas Sigismund Margagraf's experiments during 1747 and Franz Karl Achard's experiments in 1802.

4.10 **BY-PRODUCTS.** There are more than 10,000 sugar derivatives. Chief by-products are :-

(a) Molasses – see para 4.11.
(b) Bagasse – fibrous material left over after crushing, and is mainly used as fuel.
(c) Beet Pulp – left over after suger is extracted, and mainly used as animal feed.
(d) Other by – products _____ Aconitic acid, carbohydrate ethers, Allyl sucrose for starch, amino acids etc.

4.11 Sugar molasses are increasingly used for producing Ethanol for mixing with gasoline. Brazil is in the forefront in this industry. Pakistan is also producing a sizeable quantity of ethanol. Export of sugarcane ethanol from Caribbean is going to jump to a record 1.9 billion liters (News week). According to same source Brazilian sugarcane- brewed ethanol sells for 22 cents a liter. It is reported that Brazil has committed 14.2 billion US dollars to expand ethanol production. It is interesting to note that Brazil is the only country that has managed to create a self-paying national ethanol industry (Newsweek –16.4.07).

4.12 Sugar is not a healthy product. Apart from diabetics, white refined sugar is not healthy to other humans as well. In some societies use of brown sugar is gaining favour. From health point of view, honey is least harmful and white refined sugar the most. Following is the best of sweeteners according to health point of view.

Honey - healthy and beneficial
Raw Sugar – (Gur + Shakkar)
Brown Sugar
White refined sugar + Chemical sweeteners (un healthy).

5. RICE.

5.1 Afzal (1986) has described the history of introduction of rice in the world. Rice growing started in Southern part of Indo – Pakistan sub continent before 5000 BC. Travaskis (1928) was of the opinion that, "rice cultivation is not so much agriculture as gardening and requires labour not so much arduous as continuous. Rice gives the largest yield per acre of any of the great cereal crops, and the cultivators can easily raise a crop considerably larger than is required for himself and his family. Hence rice growing tracts were able to maintain a dense population of intensive cultivators who were able to support themselves and an additional population of craftsmen and thinkers. Rice cultivation thus provides the condition for an early civilization." It has been reported that although the current production is less than that of wheat; in value it is more than that of wheat and maize combined. Historically it is believed that rice was introduced into Europe by Alexander, the great or his retreating army in 300 BC after his conquests in the orient.

5.2 Normally rice is grown under abundant water supply, with some water always standing in the crop. Rice is irrigated or grown under rain with 50 inches of rainfall during the growing season. In less developed countries only 52 percent of the rice is irrigated the rest 48 percent is rain fed. Table-8 is of interest.

TABLE-8. RICE AREA AND METHOD OF IRRGIATION

Water Supply		Million Hectares
Irrigation		72.1
Dry land (up land)		19.2
Rain Fed: 0-30 cm	29.8	
Deep Water 30-100 cm	12.8	
Floating	4.9	
Sub Total		47.5
Grand Total		138.6

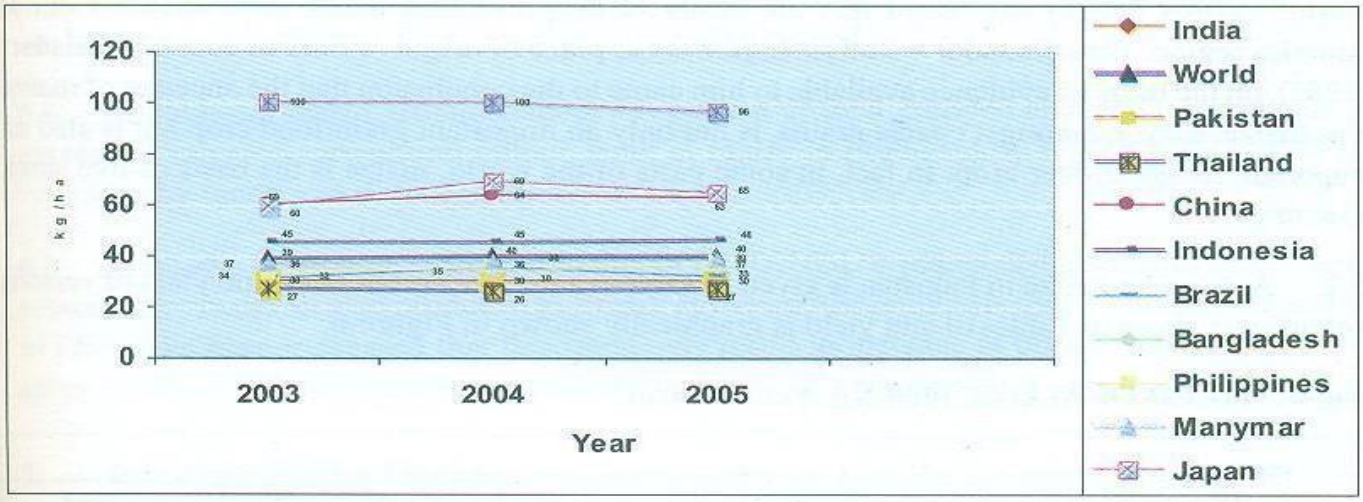
Source: Afzal, (1986).

5.3 YIELD OF RICE.

5.3.1 Chandler (1982) stated that formal rice breeding started in 1910 in Japan on rice race Japonica. Research was intensified during 1927. At that time plants handled by research workers were not too tall and, therefore, it prevented lodging and gave high yield. This fact was not known at that time.

5.3.2 The International Rice Research Institute (IRRI) was established at Los Banos, Philippines in 1986. There the scientists realized that dwarf or short statured plants did not lodge easily and gave high yield on rich fertile soils. Thus, the scientific basis for evolving short statured cultivars was established. Many cultivars were evolved and seed exported to various countries. Pakistan also imported IRRI cultivars and started growing them in 1966-67. These were in addition to Basmati which was tall and gave less yield. Yield of rice in Pakistan and several other countries is given in Fig.5.

Fig-5: YIELD OF RICE (PADDY) ('000 KG/HA)



Sources: 1. FAO 2. MINFAL - GOP

5.3.3 Basmati rice is sui generes because of its aromatic quality, translucence and characteristic elongation during cooking. For these reasons it is in great demand both at home and middle east. Basmati rice commands a higher price than IRRI rice because of its above qualities.

5.4 ECONOMICS OF RICE

5.4.1 In Pakistan rice is grown on 2.5 million hectares of land, earns 13 percent of total foreign exchange, is responsible for 6.1 percent of value added in agriculture and, contributes 1.3 percent to the GDP of the country (DAWN, 09.4.2007). Support price for rice is given in Table-9.

TABLE-9. SUPPORT PRICE FOR RICE (RUPEES / 40 KG)

Year	Basmati	IR-6	IR-8	Rehman	Kangni
1970-71	34.30	24.40	19.83	21.43	20.38
1980-81	137.00	63.00	-	-	41.80
1983-84	160.00	83.00	-	-	-
2005-06	492.00	Punjab = 306.00 Sindh = 275.00		-	-

Source: GOP.

6. MAIZE.

6.1 Maize is a plant of the NEW WORLD (Afzal, 1986). Columbus saw a crop of "MAHIZ" in the interior of Cuba on November, 02, 1494 and, in less than a century it spread all over the world. Vavilov (1951) has stated that the center of origin of flint maize is Mexico – Central America region. Peru-Ecuador – Bolivia region is the place of origin of flour maize. Mangelsdarf (1965), on the basis of evidence available to him came to the conclusion that the ancestor of maize was maize. Maize, amongst coarse grains, is not only an important grain/food crop but is also an important forage/fodder crop. In fact, in some parts of the world, maize is the basis of live stock industry.

6.2 Area under maize in Pakistan is given in Table-4 ante. Area production and yield of various countries is given in Table-10 and yield is graphically shown in Figure-6.

Fig-6: YIELD OF MAIZE (000 Kg. Per hectare)

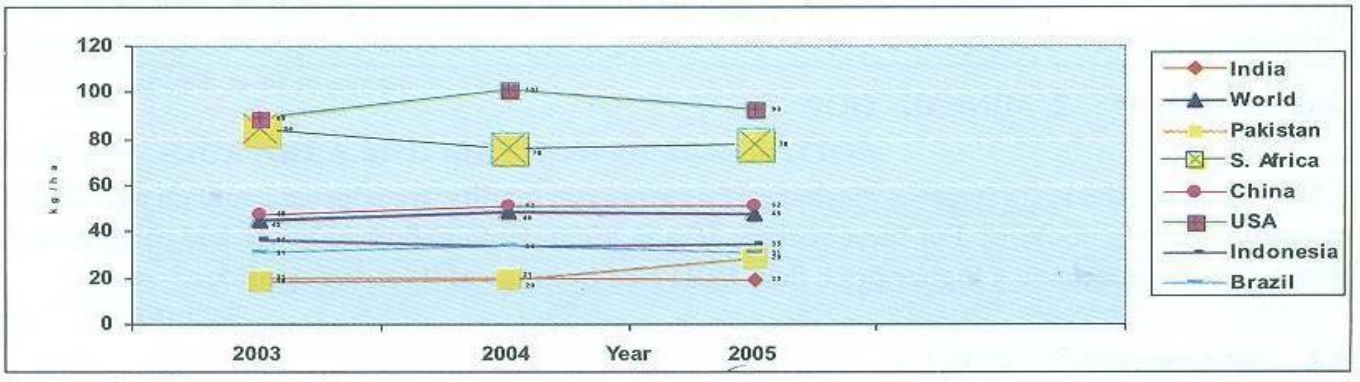


TABLE-10. AREA, PRODUCTION AND YIELD OF MAIZE

	Area '000' hectares			Production '000' tons			Yield Kg/ha.		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
World	143.4	145.0	147.6	640	705	701	4464	4860	4752
USA	28.8	29.6	30.4	25.7	298	282	8924	10052	9286
China	24.0	25.6	26.0	116.0	132	135	4815	5514	5753
Brazil	13.0	12.4	11.5	48.0	42	35	3704	3373	3039
India	7.0	6.8	7.4	14.7	14	14.5	2103	2059	1959
Pakistan	0.9	1.0	1.0	1.7	1.9	2.8	1856	2003	2848

Source: FAO, GOP.

6.3 Average yield of the world remained stagnant at about 1700 Kg/ha during 1886-1940 period. Hybrid maize was introduced in USA in 1930, however, effect on yield was marginal. Real break through occurred during 1955 to 1980. Increase in yield was pronounced due to the use of chemical fertilizers. Farm mechanization also helped.

6.4 In Pakistan, maize accounts about 4.8 percent of total cropped area and accounts for 3.5 percent of value of agricultural output. Bulk of maize in produced by NWFP, then Punjab and very little by Sindh and Balochistan.

6.5 In middle USA large scale production of ETHANOL is planned/started from maize. Some ethanol form maize in also produced in Brazil. However, the emphasis there is on sugarcane. Fear in USA have been expressed that this trend may result in increase in price of maize which may affect livestock industry resulting in increase in prices of meat and milk.

7. RECOMMENDATIONS:-

- Two high value crops i.e., COTTON and RICE deserve special and narrow focus attention.
- Yield of all crops must at least be doubled.
- Cotton farmers should be treated kindly.
- Cotton culture should be encouraged to flourish.
- All farmers should be provided with inputs at reasonable prices.
- Sugar factories should not be setup in prime cotton growing areas and sugarcane should be restricted to its natural habitat.
- Manufacture and use of raw (gur and shakkar) and brown sugar should be encouraged.
- Research and production of ETHANOL from sugar mollaces and maize must receive serious and narrow focus attention. Research for this must be started immediately in agricultural and engineering universities.

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ROLE OF PHOSPHOBACTERIUM IN SOIL P-AVAILABILITY AND LINT YIELD OF COTTON *(Gossypium hirsutum L.)*

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ABSTRACT

Field experiments were conducted on silt loam soils of Soltanpur series (Typic Ustochrepts) to study the influence of phosphobacterium [PB (Bacillus sp.)] seed treatment at different phosphorus (P) levels on some physiological parameters and lint yield of cotton. The treatments consisted of three phosphorus doses i.e. 0, 50, 100 kg P_2O_5 ha^{-1} and two seed treatments i.e. untreated and treated with phosphobacterium @ 70 g kg^{-1} cotton seed. The design of the experiment was split plot (main: phosphorus levels). Cotton cv. CIM-482 was used as a test crop. The experimental results showed that available soil-P increased from 6.21 to 12.13 mg kg soil with the application of 100 kg P_2O_5 ha^{-1} along with PB seed treatment. Average across PB seed treatment, main stem height increased from 108.0 cm to 119.5 cm, nodes on main stem from 27 to 29 and height to node ratio (HNR) from 3.91 to 4.10 cm as P-level increased from 0 to 100 kg P_2O_5 ha^{-1}. Similarly, main stem height increased from 112.7 to 116.3, nodes on main stem from 28 to 29 and HNR from 3.99 to 4.05 cm with PB seed treatment, irrespective of P-doses. Chlorophyll SPAD values increased from 41.5 to 45.5 with increased P-level whereas PB seed treatment caused little effect on chlorophyll SPAD values. A significant increase in total dry matter yield was produced due to increasing P-levels and PB seed treatment. Fruit retention percentage increased from 27.4 to 32.5 with highest P-level and from 29.2 to 30.6 with PB treatment. Number of bolls per plant increased from 19 to 25 and boll weight from 2.93 to 3.28 g as P-level increased from 0 to 100 kg P_2O_5 ha^{-1} in the presence of PB seed treatment. Lint yield increased significantly from 655 to 781 kg ha^{-1} with increased P-level and from 692 to 756 kg ha^{-1} with PB seed treatment.

INTRODUCTION

The availability of phosphorus in soils is limited generally due to the rapid sorption of applied phosphorus on calcium carbonate surfaces in calcareous soils (Bell and Black, 1970) and due to the oxides of Fe and Al in acidic soils (Freese et al., 1992). The amount of plant available-P in solution is controlled by several factors such as pH and calcium carbonate ($CaCO_3$) concentrations (Thelander and Silevertooth, 2000). In soils dominated by $CaCO_3$, solubility of P may be controlled by chemisorption of P on $CaCO_3$ surface with the formation of a surface complex of $CaCO_3$-P with a well defined chemical composition (Samadi and Gikes, 1999). Phosphorus use efficiency in our soils is about 15-20 percent of applied P fertilizer (Ahmad et al., 1996). Major portion of applied P in our soils is converted into non-available form, which is mostly due to high pH and activity of $CaCO_3$ (Sharif, 1985).

Phosphorus fertilization to cotton crop is controversial especially when wheat crop before cotton is fully fertilized with phosphatic fertilizer. Cotton response to phosphatic fertilizer has been found erratic and variable in most areas (Malik et al., 1996). However, there are cases where cotton response to phosphorus has been positive and economical (Gill, et al., 2000). Cotton is a deep rooted crop and has the inbuilt capacity to mine nutrients from variable depths (Malik et al., 1996).

Phosphate solubilising microorganisms are ubiquitous in soil and could play an important role in supplying P to plants in a more environmentally friendly and sustainable manner (Gyaneshwar et al., 2002). The microbial biomass in soil contains a significant amount of P and considerable pools are maintained even in soils considered to be P deficient for plant growth (Oberson et al., 2001). Phosphorus biofertilizers in the form of microorganisms can help in increasing the availability of accumulated phosphates for plant growth by solubilisation (Goldstein, 1986; Gyaneshwar et al., 2002). About 20-30 percent of the soil microorganisms (Mikonova et al., 1997) such as bacteria and fungi have been reported to solubilise the insoluble phosphates of soils into soluble forms by secreting organic acids and lowering pH (Cunningham and Kuiack,1992; Nahas, 1996) and are hence considered important for agricultural production (Motsara et al., 1995). The production of organic acids results in lowering of soil pH that causes dissolution of phosphorus compounds and chelation of cation calcium (Ca^{++}) bound to P (Whitelaw, 1999).

Phosphorus solubilising microorganisms (Phosphobacterium) have been reported not only to solubilise P from soil reserves but also to improve agronomic efficiency of the applied P-fertilizer (Vanadan and Subramanian, 2000). Various studies have revealed the potential of P-solubilising microorganisms on crops such as wheat, rice, maize etc. (Chabot et al., 1993; Rashid et al., 2000). Since there is an overall trend in nutrient depletion from soils due to intensive cultivation and development of new early maturing cotton cultivars, it seems justified to re-examine the response of cotton to phosphorus fertilization in the presence of phosphobacterium seed treatment. The present study was therefore, carried out to evaluate the potential use of phosphorus and phosphobacterium (PB) for physiological development and lint yield of field grown cotton.

MATERIALS AND METHODS

Field experiments were conducted at Central Cotton Research Institute, Multan during the cropping seasons 2001-03. Soil samples from the field were collected before sowing and chemical analysis of the composite samples was carried out as per methods prescribed by Ryan et al., (2001). Physio-chemical characteristics of the soil are given in Table 1.

Table 1: Pre-plant physio-chemical characteristics of the soil

Characteristics	Value
pHs	8.10
ECe (dSm^{-1})	2.20
$CaCO_3$ (%)	8.24
Organic matter (%)	0.48
Total Nitrogen (%)	0.04
$NaHCO_3$-extractable-P (mg Kg^{-1})	6.23
NH_4OAC-extractable-K (mg Kg^{-1})	126.0
Textural Class	Silt Loam
*Microbial population	11 x 10^5 TVC* g^{-1} soil

Depth : 0-30cm, *TVC = Total Viable Counts at 0-15 cm depth

The soil at experimental site is medium in texture, calcareous in nature and alkaline in reaction. Fertility rating indicates low level of organic matter, poor supply of nitrogen, low supply of phosphorus and sufficient level of exchangeable potassium for cotton production.

TREATMENTS

The experiment was laid out in split plot design (main: phosphorus levels) with four replications. The treatments consisted of three levels of phosphorus fertilizer (0, 50 and 100 kg ha^{-1}) and two phosphobacterium (PB) seed treatments [untreated check, treatment with PB @ 70 g peat (PB carrier) kg^{-1} cotton seed]. Seed treatment with PB (Bacillus megaterium), containing $6x10^7$ TVC per gram peat, was done about 45 minutes before sowing. Cottonseed was dried at room temperature before sowing in the field. Cotton cv. CIM-482 (Gossypium hirsutum L.) was sown during the 2nd week of May at a spacing of 75 cm between rows and 30 cm between plants. Phosphorus was applied in the form of triple super phosphate (TSP). Basal dose of potassium was applied at the rate of 50 kg K_2O ha^{-1} at the time of sowing. Nitrogen was applied at the rate of 150 kg ha^{-1} in three splits i.e. at sowing, flowering and boll formation stage. Crop husbandry practices were adopted as per crop requirement. Insect injury was kept below the economic threshold level (ETL) through regular sprays. Data regarding plant structure, chlorophyll (SPAD values), dry matter yield, fruit production, number of bolls per plant, boll weight and lint yield were recorded at maturity. Data were analyzed statistically according to methods described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Soil-P availability increased with the increasing level of applied P fertilizer (Table 2). Available-P increased from 6.21 to 10.02 mg kg^{-1} soil as P level increased from 0 to 100 kg P_2O_5 ha^{-1} showing an increase of 3.81 mg P kg^{-1} soil over P-unfertilized plots. In PB seed treated plots, available-P increased from 6.79 to 12.13 mg kg^{-1} soil as P level increased from 0 to 100 kg P_2O_5

ha^{-1} soil showing an increase of 5.34 mg P kg^{-1} soil. Seed treatment with PB caused more increase in available soil-P over non PB treated plots. The greater increase in the presence of PB may be related to the excretion of hydrogen ions or release of organic acids by the microorganisms which played effective role in maintaining higher P-levels in soil either through solubilising precipitated P or by preventing P-fixation in the form of Ca-P, Fe-P and Al-P (Jones, 1998). Such improvement in soil P availability was also found by Datta et al., (2002) who reported that available soil-P increased from 8.15 to 15.7 kg ha^{-1} with a single bacterial inoculation. Available soil-P decreased from 9.99 to 7.91 mg kg^{-1} soil as the crop aged from squaring to maturity. This may be attributed to the combined effect of increased P uptake by the plants or due to the formation of insoluble phosphorus compounds as the cropping season proceeded.

Plant structure showed significantl variations due to different treatments (Table 3). The inreasing levels of phosphorus fertilizer with or without PB seed treatment caused positive effects on main stem height, number of nodes on main stem and height to node ratio (HNR). The greatest effect on the developoment of plant structure was found where 100 kg P_2O_5 ha^{-1} was applied alongwith PB seed treatment. Main stem height increased from 107.5 to 121.5cm, nodes on main stem from 27 to 29 and HNR from 3.90 to 4.11cm when fertilizer was increased from 0 to 100 kg P_2O_5 ha^{-1} alongwith PB seed treatment. The main stem height increased due to increase in node numbers and HNR. The results are supported by those of Egamberdiyera and Hoflich (2004) and Makhdum et al. (2001) who reported that shoot growth and main stem height of cotton plant increased significantly due to P application. Since P is an essential element required for structural and metabolic functions (Bibi et al., 2005), an adequate supply of P will ensure better growth and development of cotton plant. Addition of PB alongwith P further improved plant structure over untreated check plots. Phosphorus solubilising microorganisms helped in increasing the availability of accumulated phosphates for plant growth by solubilization (Goldstein, 1986; Gyaneshwar et al., 2002). The effect of PB may be attributed to more P solubilisation and/or proliferation of growth promoting hormones such as Indole Acetic Acid (Arshad and Frankenberger, 1998), which promoted growth of cotton plant in addition to applied P.

Table 2: Effect of P-levels and PB seed treatment on soil-P availability during the cropping season (mg kg^{-1} soil)

P_2O_5 level (kg ha^{-1})	PB seed treatment	Squaring	Peak flowering	Maturity	Mean
0	-	6.25	6.20	6.18	6.21
	+	6.91	6.85	6.61	6.79
50	-	9.78	9.53	8.24	9.19
	+	11.67	10.73	8.76	10.39
100	-	11.31	10.20	8.54	10.02
	+	13.97	13.29	9.12	12.13
Mean		9.99	9.47	7.91	

Table 3: Effect of P-levels and PB seed treatment on plant structure at maturity[a]

P_2O_5 Levels (kg ha^{-1})	PB seed treatment	Main stem height (cm)	Nodes on main stem	Height to Node Ratio (cm)
0	-	107	27	3.90
	+	109	28	3.91
50	-	113	28	4.00
	+	119	29	4.14
100	-	118	29	4.08
	+	121	29	4.11
$LSD_{0.05}$	P_2O_5 levels	2.68**	0.9*	0.10**
	PB treatment	2.29**	0.7[b]	0.08[b]
	Interaction	2.62[b]	1.15[b]	0.14[b]

[a]means of sixteen values, [b]non sigificant, **significant at $p<0.01$

Increasing levels of phosphorus fertilizer with or without PB seed treatment caused significant increase in chlorophyll content (SPAD values). Seed treatment with PB further improved chlorophyll content. The chlorophyll SPAD values ranged from 41 to 46 in different treatments. Maximum SPAD value of 46 was observed at 100 kg P_2O_5 ha^{-1} alongwith PB seed treatment (Table 4).

Table 4: Effect of P-levels and PB seed treatment on chlorophyll content (SPAD values)[a]

P_2O_5 Levels (kg ha^{-1})	PB seed Treatment	
	-	+
0	41	42
50	43	44
100	45	46
LSD ($p<0.05$)	P_2O_5 levels	2.26**
	PB treatment	1.36[b]
	Interaction	2.36[b]

[a] means of sixteen values, [b]non-significant, ** significant at $p<0.01$

Increasing levels of P fertilizer caused increase in total dry matter yield at maturity. Dry matter yield of leaves did not vary siginificantly either due to P-levels or PB seed treatment. Siginficant differences in dry matter yield of stalk and fruit portions were however, observed in different treatments. Fruit dry weights responded more favourably to P-levels and PB seed treatment. Dry matter yield of fruit increased from 307 to 499 g m^{-2} with the application of highest P-level alongwith PB seed treatment. Similarly, maximum total dry matter yield was observed at 100 kg P_2O_5 alongwith PB seed treatment (Table 5). Increase in dry matter yield due to phosphorus application over control was in the range of 10-14 percent. The results are in conformity to those of Makhdum et al. (2001) and Bibi et al., (2005) who reported increase in total dry matter yield with the application of phosphorus to cotton. Seed treatment with PB at 0, 50 and 100 kg P_2O_5 level casued an increase in dry matter yield of 8, 13 and 11 percent, respectively, over untreated check. Phosphate solubilising microorganisms have been reported to increase the growth of plants by P solubilisation and production of phytohormones such as indole acetic acid (Arshad and Frankenberger, 1998). The increase in growth of cotton plant was reflected in the form of increased total dry matter production.

Table 5: Effect of P-levels and PB on dry matter yield (g m^{-2}) at maturity[a]

Treatments		Plant Organs			Total
P_2O_5 Levels (kg ha^{-1})	PB seed treatment	Leaves	Stalk	Fruit	
0	-	120	238	307	698
	+	126	240	390	756
50	-	128	243	383	754
	+	133	250	468	851
100	-	128	250	427	805
	+	125	260	499	894
LSD (p<0.05)	P_2O_5 levels	10.67[b]	6.18**	70.30**	42.07**
	PB treatment	4.08[b]	10.92[b]	39.27**	36.92**
	Interaction	7.07[b]	18.91[b]	68.01[b]	63.94[b]

[a]means of sixteen values, [b]non-significant, **significant at p<0.01

Application of phosphorus fertilizer and PB seed treatment caused positive effects on plant growth and development. As a result total number of fruiting positions, intact fruits and fruit retention percentage increased over control plots (Table 6). Averaged across PB treatment, increasing levels of P caused 8.0, 11.0 percent increase in fruiting positions, 17, 24 percent increase in intact fruit and 9.0, 19.0 percent increase in fruit retention over unfertilized plots. Averaged across P-levels, PB seed treatment caused an increase of 4.0 percent in fruiting positions, 7.0 percent in intact fruits and 5.0 percent in fruit retention. Added P with or without PB seed treatment rendered sufficient P available for plant acquisition and translocation of photosynthates to reproductive organs which helped the plant not only to produce more numbers of fruiting points but also to retain more fruit than the control plots. Phosphorus is known to play an important role in the energy metabolism of the plant cells and is required in large amounts by reproductive organs (Thelander and Silvertooth, 2000). Seed treatment with PB further increased fruit production and its retention by making more P-available for developing bolls and/or by producing growth promoting hormone like Indole Acetic Acid (Arshad and Frankenberger, 1998) which increased fruit production and its retention (Guinn, 1998).

Table 6: Effect of different levels of P-fertility and PB seed treatment on fruit production at maturity[a]

Treatments		Plant Organs			Total
P_2O_5 Levels (kg ha^{-1})	PB seed treatment	Leaves	Stalk	Fruit	
0	-	120	238	307	698
	+	126	240	390	756
50	-	128	243	383	754
	+	133	250	468	851
100	-	128	250	427	805
	+	125	260	499	894
LSD (p<0.05)	P_2O_5 levels	10.67[b]	6.18**	70.30**	42.07**
	PB treatment	4.08[b]	10.92[b]	39.27**	36.92**
	Interaction	7.07[b]	18.91[b]	68.01[b]	63.94[b]

[a]means of sixteen values, [b]non-significant, **significant at p<0.01

Increasing levels of P-fertilizer and PB seed treatment caused increase in number of bolls per plant which ranged from 19 to 25 in different treatments. Similarly boll weight increased with the increasing levels of P-fertilizer and PB seed treatment (Table 7). the values of boll weight ranged from 2.93 to 3.28 g in different treatments. Adequate supply of phosphorus with or without PB seed treatment accelerated the translocation of assimilates to reproductive organs and developing bolls which resulted in increased boll weight and number of bolls per plant. The results are supported by the findings of Marcus-Wyner and Rains (1982) who reported that phosphorus is required in large amounts by reproductive organs and has a significant effect on boll development, size and time to maturity. The increased number of bolls and boll weight resulted in significant increase in lint yield (Fig. 1). Maximum yield was observed at 100 kg P_2O_5 ha^{-1} level in the presence of PB seed treatment. Averaged across PB seed treatment, lint yield increased from 655 to 781 kg ha^{-1} as P-level increased from 0 to 100 kg P_2O_5 ha^{-1}, showing an increase of 19 percent over unfertilized plot. Averaged across P-levels, lint yield increased from 692 to 756 kg ha^{-1} with PB seed treatment, showing an increase of 9.0 percent over non-treated plots. The significant increase in lint yield was observed in those plots where available-P remained >8.0 mg kg^{-1} soil during the whole cropping season. Makhdum et al., (2001) also stated that plots maintaining extractable-P in the range of 8-14 mg kg soil produced higher seed cotton yield compared to the plots having P < 8.0 mg kg^{-1} during the season. An increase in seed cotton yield due to phosphorus application has also been reported by Malik et al., (1990) and Howard and Roane (1999). The seed treatment with PB further improved available soil-P levels which ultimately favoured plant growth and development, fruit production, fruit retention and lint yield. Soil microorganisms are well known to solubilise the insoluble phosphates of soils into soluble forms by secreting organic acids and lowering pH (Cunningham and Kuiack,1992; Nahas, 1996). The seed treatment with PB might have stimulated the production of organic acids which caused lowering of soil pH and dissolution of phosphorus compounds either by chelation of cation calcium (Ca^{++}) bound to P (Whitelaw, 1999) or by inhibiting the reaction of applied P with soil which would otherwise form P compounds with low solubility. Similar results have been reported by a number of scientists. Application of phosphorites (a source of P) along with phosphate solubilising bacteria (PSB) increased P uptake by plants and yields indicating that PSB are able to solubilise phosphates and to mobilise phosphorus in crop plants (Rogers and Wolfram, 1993). The PSB-plant inoculations resulted in 10-15% increases in crop yields in 10 out of 37 experiments (Tandon, 1987). The results of this study show that the use of PB seed treatment may be practiced, in silt loam soils with low available-P, for optimum phosphorus availability and sustainable cotton production.

Table 7: Effect of P-levels and PB seed treatment on bolls per plant and boll weight[a]

P_2O_5 Levels (kg ha^{-1})	PB seed treatment	Number of bolles per plant	Boll weight (g)
0	-	19	2.93
	+	20	2.99
50	-	22	3.11
	+	24	3.18
100	-	23	3.20
	+	25	3.28
LSD (p<0.05)	P_2O_5 levels	1.36*	0.06*
	PB treatment	1.41*	0.03*
	Interaction	2.45[b]	0.06[b]

[a]means of sixteen values, [b]non-significant, *significant at p<0.05

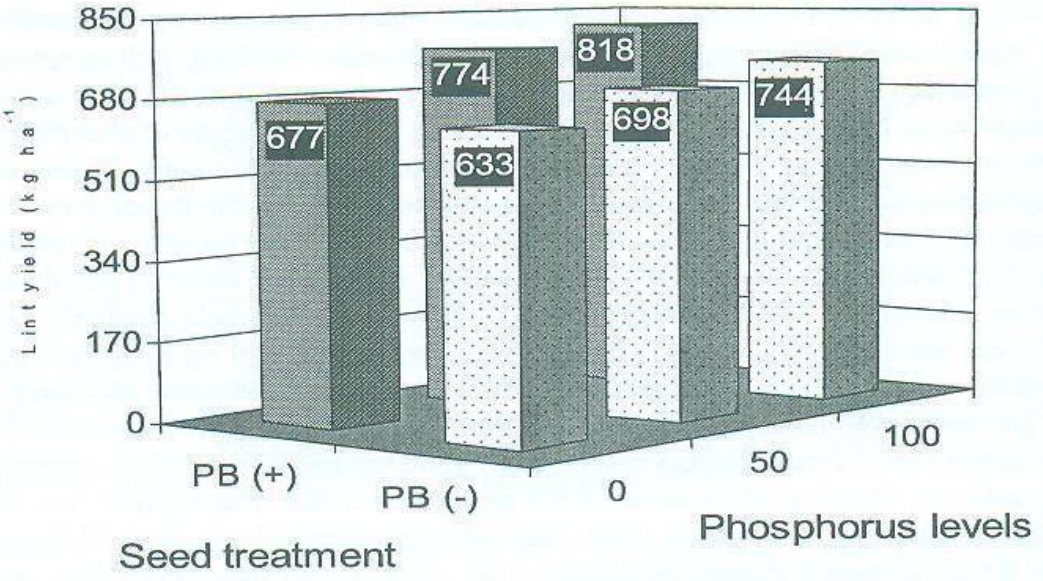

Fig. 1 Effect of P-levels and PB seed treatment on lint yield

CONCLUSION

Cotton crop responded favourably to P-levels and PB seed treatment. Available soil-P increased with the increasing levels of P fertilizer and PB seed treatment. The growth parameters such as main stem height, nodes on main stem and HNR increased with P-fertilization and PB seed treatment. Similarly chlorophyll SPAD values, dry matter production, fruit retention, boll number, boll weight and lint yield also increased with the increasing levels of P-fertilizer and PB seed treatment. It is therefore, concluded that phosphorus fertilizer may be applied to improve lint yield of cotton crop. Seed treatment with PB may be useful for further improvement in yield sustainability.

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DEVELOPMENT OF SEMIDTERMINANT, HIGH YIELDING AND HEAT TOLERANT COTTON VARIETY CIM-496

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ABSTRACT

The new variety CIM-496 has been evolved through hybridization at Central Cotton Research Institute, (CCRI) Multan. The new variety gave significantly higher yield in varietal trials compared with all commercial varieties. CIM-496 was also evaluated in varietal and Zonal Varietal Trials at farmers' fields and Govt. Farms. In varietal trials CIM-496 gave 3.3%, 14.5%, and 16.0%, increase over commercial varieties CIM-506, NIAB-111, and CIM-499, respectively for seed cotton yield (Table-1). While in Zonal varietal trial CIM-496 gave 11.1% and 9.8% increase in yield of seed cotton over standard varieties CIM-473 and CIM-499 respectively during 2003-04 (Table-2). In National Co-ordinated Varietal Trial (NCVT) CIM-496 surpassed all the existing varieties/strains for two consecutive years i.e. 2003-04 and 2004-05 for seed cotton yield (Table-4 & 5). CIM-496 possesses higher ginning out turn percentage, better fibre qualities and spinning performance compared with all the existing commercial varieties. This variety has also shown tolerance to Burewala Strain of cotton leaf curl virus (BSCuV) and sucking insect pests. The commercial cultivation of this variety will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of good quality raw cotton and superior value added products.

KEY WORDS: Evolution High Yielding Early Maturing and Cotton

INTRODUCTION

Cotton being the major cash crop of Pakistan plays an important role in the national economy, providing employment to million of people, raw material for basic industry of the country and a source of foreign exchange earning.

The research on cotton is mainly subjected to develop high yielding, early maturing varieties with better fibre characteristics, resistant to prevailing insect pests, diseases and more suited to the local agro-climatic conditions. A number of varieties have been released since long but with passage of time varieties become susceptible to those diseases for which those varieties are released. Therefore it is the cry of the day to evolve decent varieties which could face the problems of present scenario.

Efforts have been directed towards producing high yielding and early maturing varieties without loss of quality fibre traits. Hundreds of crosses attempted for this purpose has yielded a new variety CIM-496, which is early maturing, semi-determinant, possesses higher yield potential, better Ginning out turn and excellent fibre characteristics compared with the existing

commercial varieties. It is capable of spinning on higher counts of yarn for producing quality fabrics. It is hoped that the approval and release of this variety for commercial cultivation will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of quality raw cotton and superior quality products.

Singh et al (1973) reported that significant differences in raw cotton yield of American cottons were due to varieties. Ahmad et al (1982) also obtained highly significant differences in yield of upland cotton due to varieties. Soomro et al (1986) reported significant differences in yield, ginning out turn %age and staple length for varieties. Khan et al (1989) also observed significant differences in yield, ginning out turn and staple length for varieties. Afzal et al (2001) studied that there were highly significant variations among years, genotypes (varieties) and year x genotypes interaction for number of bolls per plant, boll weight and seed cotton yield. Afzal et al (2002) reported significant differences in yield, boll weight, number of bolls per plant and plant height due to difference in genotypes (varieties). Hanif et al (2001) also reported significant variations in seed cotton yield due to varieties. Khan et al (2002) found that varietal variation affect plant characters up to high extent in upland cotton. Arshad et al (2003) search out significant variation for various traits like seed cotton yield, number of bolls, boll weight etc due to the use of various genotypes. Arshad et al (2003) found significant variation for various characters like Ginning out percentage, staple length, number of bolls and boll weight due to the use different genotypes. Arshad et al (2003) studied that varieties affect the yield of the plant significantly. Arshad et al (2003) search out significant variation in cotton crop due to the use of different varieties.

The damage of cotton leaf curl virus has been minimized as a result of the evolution of CLCuV resistant varieties i.e. CIM-1100, CIM-448, CIM-443, CIM-446, CIM-482, CIM-473, CIM-499, CIM-496, CIM-707 and CIM-506 for the first time in the history of the country by the scientists of Central Cotton Research Institute Multan. Later on, Cotton Research Institutes/ Stations of Punjab and Federal Government respectively, evolved CLCuV resistant varieties i.e. FH-634, FVH-53, FH-900, FH-901 FH-1000, and NIAB-999 up to 2005.

Some times shedding occur which causes low yield. But this variety has the ability to recover, if there is shedding in early period. With the introduction of this new early maturing variety CIM-496 the above mentioned problems would be automatically solved. The commercial cultivation of this early maturing, semi-determinant medium long staple and up to some insect pest tolerant variety CIM-496 will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of raw cotton and superior quality products.

MATERIALS AND METHODS

PARENTAGE/PEDIGREE

The new variety CIM-496 has been developed through the hybridization from a cross indicated below,

(CIM-425 x a locally developed line 755-6/93)

BREEDING HISTORY

The cross was attempted in the year 1993-94 at Central Cotton Research Institute, Multan. Pedigree selection procedure was used to sort desirable genotypes from segregating population and lines with similar morphology, fibre and seed characters were selected. The strain was bulked in 1999-2000 in F6 generation. CIM-496 passed through a series of yield trials viz multi-locational varietal trials, zonal varietal trials at farmers' fields and Govt. farms, Coordinated varietal trials i.e. National Coordinated Varietal Trials (NCVT) of Pakistan Central Cotton Committee and Director Cotton Research (DCR) Trials of the Punjab Government.

RESULTS AND DISCUSSIONS

VARIETAL TRIALS

The new variety CIM-496 was tested in replicated Varietal Trials at Central Cotton Research Institute, Multan and its Testing Centres against commercial varieties for five years. The data presented in Table-1 shows that on the basis of two years average i.e. 2000 and 2001, it gave higher yield of seed cotton (3715 kg ha^{-1}) compared to commercial varieties CIM-446 and FH-900 i.e. 3237 and 3147 kg ha^{-1} respectively. While during the years 2001-02 and 2002-03 CIM-496 out yielded CIM-473 and CIM-446 by giving yield 4014 Kg ha^{-1} against the yield of 3660 and 3421 kg ha^{-1} for the above, mentioned commercial varieties. On two years bases during the year 2003-04 and 2004-05, CIM-496 giving 4589 kg ha^{-1} against the yield (3795 kg ha^{-1}) of CIM-499.

Table-1. Yield performance of CIM-496 in varietal trials from 2000 to 2004

Year	Name of Trial	Location	Varieties / yield of seed cotton ($kgha^{-1}$)									
			CIM-496	CIM-506	NIAB-111	CIM-499	CIM-473	CIM-482	FH-900	CIM-446	FH-1000	C.D. 5 %
2000-01	VT-1	Multan	4643	-	-	-	-	-	3500	3761	-	
		Khanewal	3510	-	-	-	-	-	2967	3369	-	
		Kot Addu	2844	-	-	-	-	-	2689	2451	-	
		Average	**3666**	-	-	-	-	-	**3052**	**3194**	-	97.4
2001-02	VT-1	Multan	3495	-	-	-	3514	3253	2938	3026	-	
		Khanewal	4039	-	-	-	3809	3364	3601	3651	-	
		Kot Addu	3757	-	-	-	3394	3003	3188	3159	-	
		Average	**3764**	-	-	-	**3572**	**3207**	**3242**	**3279**	-	98.8
	2 Years Average		**3715**	-	-	-	-	-	**3147**	**3237**	-	-
2002-03	VT-1	Multan	4724	-	-	-	3844	-	-	3596	-	
		Khanewal	4345	-	-	-	3916	-	-	3256	-	
		Kot Addu	3722	-	-	-	3480	-	-	3241	-	
		Average	**4264**	-	-	-	**3748**	-	-	**3564**	-	112.72
	2 Years Average		**4014**	-	-	-	**3660**	-	-	**3421**	-	
2003-04	VT-1	Multan	4977	-	-	3946	-	-	-	-	3542	
		Khanewal	3920	-	-	3050	-	-	-	-	3058	
		Average	**4449**	-	-	**3513**	-	-	-	-	**3300**	197.7
2004-05	VT-1	Multan	4885	4693	4190	4099	-	-	-	-	-	-
		Khanewal	4570	4465	4070	4054	-	-	-	-	-	-
		Average	4728	4579	4130	4077					-	148.9
	2 Years Average		**4589**	-	-	**3795**	-	-	-	**3346**	-	-
		% increase over	-	3.3	14.5	16.0					-	-

ZONAL VARIETAL TRIALS

CIM-496 was also evaluated in Zonal Varietal Trials at Government farms as well as with the progressive growers in different ecological zones for the year 2003-04 (Table-2).

Table-2. Yield performance of CIM-496 in Zonal Varietal Trial at farmers' fields during 2003-2004

Sr. No	Name of growers/locations	Varieties/Yield of seed cotton (kgha^{-1})		
		CIM-496	CIM-473	CIM-499
1	Dr. Khalid Khokhar, Multan	3551	3228	3282
2	Khuda Bux, 18-Kassi, Multan	3443	3120	3067
3	Abdul Ghafoor, 17/MR, Multan	3605	2991	3336
4	Tariq M. Bhutta,6 Faiz, Multan	3174	2798	2690
5	Dr. Zafar Hayat Ghullo Jalalpur	3309	2986	2959
6	Mian Abbas Qureshi, Kot Addu	3551	3161	3018
7	Mian M. Mahbub Qureshi, K Addu	3013	2959	3026
8	Brig.® G.M. Khan, T. Gurmani	4035	3239	3497
9	PSC Farm, 86-87, Khanewal	3497	3066	3293
10	Chaudhry Muhammad Akram	3295	3180	3188
11	Col. ® Fazal-ur-Rehman, KWL	3512	3171	3285
12	Ch. Rehmat Ali, 88/10-R, KWL	4116	3309	3497
13	Mian M. Naeem, Mailsi	3147	2986	3013
14	Chaudhry Tariq Aslam, Vehari	2959	2825	2878
15	Sh. Zaheer Ahmad, Burewala	3005	2959	2978
16	Ch. Sher Bahadar, 225/EB Burewala	3162	3108	3100
17	Mr. M. Hanif, 108/7-R, Sahiwal	2975	2620	2602
18	Ch. Ramzan Ahmad, Hasilpur	3567	3015	3108
19	G. Mustafa Chatta, Uch Sharif	4599	4304	4358
20	Ch. M. Ikram, R.Y.Khan	4226	3308	3389
21	Jhullundar Seed Corp, RYK	3147	2932	2825
22	M. Maqbool, 269/HR, Fortabbas	3255	2744	2690
23	Nazir Ahmad, 148/6R, H.abad	3568	3270	3300
24	Haji M. Arif, 182/GB, TT Singh	3162	3073	2859
25	Mukhtar A. Khatran, Pir Mahal	3086	2888	2908
26	Riaz Ahmad, 215/GB, F.abad	2905	2744	2798
	Average	**3418**	**3076**	**3113**
	% Increase over	**—**	**11.1%**	**9.8%**

During the year 2003-04 at 26 locations, CIM-496 gave 11.1% and 9.8 % increase over commercial varieties CIM-473 and CIM-499 respectively table-2. While during 2004-05 CIM-496 showed 2.6 and 6.2 % increase over the two standard varieties i.e. CIM-5o6 and CIM499 (Table-3).

Table-3 Yield performance of CIM-496 in Zonal Varietal Trial at farmers' fields during 2004-2005

Sr. No	Name of growers/locations	Varieties/Yield of seed cotton (kg ha^{-1})		
		CIM-496	CIM-506	CIM-499
1	Mian Abdul Rasheed, Mian Pur	3604	3465	3370
2	Malik Manzoor Ahmad, Basti Malook	3590	3500	3472
3	Malik M. Mushtaq, Rawan	3496	3440	3377
4	Khuda Bux, 19-Kasi, Multan	3688	3568	3430
5	Tariq Mahmood Bhutta, 6-Faiz,Multan	3497	3410	3405
6	Mian Abbas Qureshi, Kot Addu	3478	3346	3320
7	Mian M. Mahbub Qureshi, K Addu	3570	3510	3467
8	Brig.® G.M. Khan, T.Gurmani	3430	3342	3396
9	PSC Farm, 86-87, Khanewal	3667	3650	3480
10	Ch. M. Akram, Basti Malook	3576	3598	3450
11	Mian Saeed Akhtar, 41-R, Khanewal	3430	3450	3408
12	Ch. Rehmat Ali, 88/10-R, KWL	3275	3240	3170
13	Mian M. Naeem, , Mailsi	3808	3770	3447
14	Haji Allah Ditta, Kukar Hatta	3694	3605	3490
15	Sh. Zaheer Ahmad, Burewala	3768	3782	3510
16	Ch. Sher Bahadar, 225/EB Burewala	4010	3450	3330
17	Mr. M. Hanif, 108/7-R, Sahiwal	2913	2460	2396
18	Ch. Ramzan Ahmad, Hasilpur	4117	3870	3565
19	G. Mustafa Chatta, Uch Sharif	3847	3801	3718
20	Ch. M. Ikram, , R.Y.Khan	4016	3567	3496
21	Jhullundar Seed Corp, RYK	3860	3697	3501
22	Mahfooz Ahmad, 270/HR, Fortabas	3442	3590	3282
23	M. Aslam 148/6R, Haroonabad	3110	3265	3260
24	Haji M. Arif, 182/GB, TT Singh	3040	3296	3186
25	Mukhtar A. Khatran, Pir Mahal	3555	3594	3208
26	Asghir Ali, 211/GB, Faisalabad	3568	3468	3470
	Average	**3579**	**3490**	**3369**
	% Increase over	--	**2.6 %**	**6.2%**

REGIONAL ADAPTABILITY TRIALS

National Coordinated Varietal Trials

CIM-496 was included in National Co-ordinated Varietal Trials for two years i.e. 2003-04 and 2004-05. The yield data for the year 2003-04 are given in Table-4 which indicated that during 2003-2004 in Faisalabad Region CIM-496 out yielded all the new strains and commercial variety yielding 3281 kgha^{-1}.

On the basis of average of all the locations in Punjab CIM-496 yielded 3026 kgha^{-1} and stood at 2nd position.

Table-4: Yield Performance of new strains in National Coordinated Varietal Trial at different locations during 2003-2004.

FAISALABAD ZONE

Code No.	Varieties	NIAB, FSD	CRS, Sahiwal	ARI, FSD	CRSS, Jhang	Average
V-1	NIAB-111/S	4756	3321	2602	1897	**3144**
V-2	CIM-506	4363	3690	2445	1675	**3043**
V-3	CRIS-168	3219	3644	1930	1314	**2527**
V-4	CIM-473 (Std)	3655	2698	2186	1329	**2467**
V-5	VH-144	4637	3143	2818	1363	**2990**
V-6	CRIS-468	4125	3759	2249	1551	**2921**
V-7	CIM-497	2826	2914	1910	1566	**2304**
V-8	SLH-279	3868	4374	2233	1650	**3031**
V-9	TH-41-83	3544	2506	1943	1008	**2250**
V-10	MNH-700	3194	3744	2165	1556	**2665**
V-11	BH-160	4774	2560	2478	1798	**2903**
V-12	**CIM-496**	**4731**	**3859**	**2760**	**1773**	**3281**
V-13	NIBGE-2	3689	3367	2882	1413	2838
V-14	FH-925	2912	3744	3036	1541	**2808**
V-15	NIAB-999	4142	3505	2398	1566	**2903**
V-16	RH-510	2793	2806	1968	1146	**2178**
	CD 5%	**725**	**275**	**409**	**351**	
	CV %	**13.3**	**5.77**	**12.09**	**16.3**	

Continued

MULTAN ZONE

Code No.	Varieties	Location / yield (kg ha^{-1})						Average	
		CCRI Multan	CRS Multan	CRS Vehari	PSC KWL	CRS B. Pur	CRS RYK	Average Multan	PUNJAB
V-1	CIM-496	4485	3398	3095	4089	2649	3274	3498	3059
V-2	CRIS-460	3656	2743	3261	2905	1896	4117	3096	2801
V-3	FH-115	4532	3577	3357	3911	2661	3328	3561	3069
V-4	NIAB-884	4094	3057	3378	4019	2811	3247	3434	3195
V-5	MJ-7	4351	3075	2355	3922	2177	2835	3119	2946
V-6	CIM-534	4591	3479	2893	4154	2111	3400	3438	2956
V-7	CRIS-461	3816	3254	2856	2825	2033	3499	3047	2900
V-8	FH-2000	3869	2923	2981	3078	2123	3229	3034	2644
V-9	NIAB-98	4201	3218	3101	3239	2482	3095	3223	3093
V-10	H-151-F2	3758	4303	3698	3013	2823	3588	3531	3123
V-11	CIM-499	4290	2322	1890	3331	2183	3463	2913	2535
V-12	TH-41/83	3587	2654	2287	2809	1854	2781	2662	2285
V-13	BH-162	4311	3326	3027	3341	2811	3220	3339	3063
V-14	PB-899	3482	3380	3095	3255	3050	3956	3370	2938
V-15	Neelum-NS-11	4507	3828	3027	4212	2248	3158	3497	3118
V-16	SLH-279	4430	2860	3900	3535	2661	3570	3493	3151
V-17	NIBGE-2	4165	3523	3324	3777	2811	3050	3442	3137
V-18	MNH-700	3936	3192	2704	3470	2309	3651	3210	2770
	CD 5%	168.1	623.8	472.9	130.9	599.1	347.7		
	CV %	2.88	13.8	11.0	2.64	12.5	10.0		

Table 4. Yield performance of CIM-496 in National Coordinated Varietal Trials during 2003 & 2004.

Years	Region	No. Of Trials	Varieties / Seed Cotton Yield (Kgha^{-1})			
			CIM-496	FH-1000	CIM-473	BH-160
2003	Multan (Punjab)	7	3285	2905	2767	-
	Faisalabad (Punjab)	4	2718	2718	2355	-
	Sindh	6	2709	2476	2465	-
	D.I. Khan (NWFP)	1	1406	1130	1009	-
	Average		2530	2307	2149	-
	% Increase over			9.7%	17.7%	-
						-
2004	Multan (Punjab)	6	3112	-	2346	2765
	Faisalabad (Punjab)	4	3043	-	2467	2903
	Sindh	5	1726	-	1588	1610
	D.I. Khan (NWFP)	1	854	-	592	646
	Average		2184	-	1748	1981
	% Increase over			-	24.9%	10.2%
	2 years average		2357	-	1949	-
	% Increase over			-	20.9%	-

Director Cotton Research (DCR) Trials

DCR Trials

CIM-496 was evaluated in DCR Trials for two years i.e. 2003-04 and 2004-05 by the Punjab

MULTAN ZONE

Code No.	Varieties	CCRI, Multan	CRS, Multan	CRS, Vehari	PSC, KWL	CRS, B.Pur	CRS, RYK	average	G. average
V-1	NIAB-111/S	3784	3081	837	3107	2609	638	2684	2888
V-2	CIM-506	4732	3081	1501	3706	2993	1044	3203	3112
V-3	CRIS-168	3187	2355	1225	2488	1466	399	2144	2314
V-4	CIM-473 (Std)	3105	2503	550	2946	2139	494	2249	2346
V-5	VH-144	3370	3216	873	3127	2650	781	2647	2800
V-6	CRIS-468	3718	2906	1434	2569	2300	415	2585	2735
V-7	CIM-497	3264	2759	592	3302	2435	670	2470	2396
V-8	SLH-279	3691	2408	1327	2549	2576	287	2510	2742
V-9	TH-41-83	2402	1924	933	2172	1190	167	1724	1957
V-10	MNH-700	3821	2785	783	3154	2778	726	2664	2664
V-11	BH-160	3397	2879	789	3363	2845	694	2655	2765
V-12	**CIM-496**	**4287**	**2866**	**861**	**3578**	**2515**	**726**	**2821**	**3026**
V-13	NIBGE-2	3841	2449	885	3605	2058	263	2568	2688
V-14	FH-925	2761	2382	915	2468	1998	359	2105	1417
V-15	NIAB-999	3872	2489	406	3040	2522	446	2466	2660
V-16	RH-510	2928	2270	1303	2844	1776	598	2224	2204
	CD 5%	273	492	237	159	535	263		
	CV %	5.46	13.04	14.93	15.64	16.32	29.01 Rej.		

During the year 2004-05 CIM-496 surpassed all the new strain along with standard varieties giving 2400 kg seed cotton yield Kg ha^{-1} at Faisalabad zone.

Table-5: Yield Performance of new strains in National Coordinated Varietal Trial at different locations during 2004-2005

FAISALABAD ZONE

Code No.	Varieties	Location / yield (kg ha^{-1})				
		NIAB, FSD	CRS, Sahiwal	CRI, FSD	NIABGE FSD	Average
V-1	CIM-496	2175	2154	2271	3001	2400
V-2	CRIS-460	2657	3124	1217	2434	2358
V-3	FH-115	2848	1831	2023	2627	2332
V-4	NIAB-884	4093	1832	2276	3144	2836
V-5	MJ-7	3924	2514	1953	2353	2686
V-6	CIM-534	2826	1939	1862	2306	2233
V-7	CRIS-461	3274	3270	1421	2755	2680
V-8	FH-2000	1917	2765	1285	2272	2060
V-9	NIAB-98	3162	2803	1902	3734	2900
V-10	H-151-F2	2949	3380	1494	2220	2511
V-11	CIM-499	2198	1293	1862	2522	1969
V-12	TH-41/83	1671	2083	875	2251	1720
V-13	BH-162	2994	2298	2005	3297	2649
V-14	PB-899	2399	2766	1556	2441	2291
V-15	Neelum-NS-11	4384	2299	1661	1857	2550
V-16	SLH-279	2859	4022	1417	2264	2641
V-17	NIBGE-2	2063	3089	2096	3469	2679
V-18	MNH-700	2736	1831	1247	2625	2110
	CD 5%	806.7	194.9	610.0	144.4	
	CV %	20	5.5	25.4	3.85	

Government. The yield data for year 2003-2004 given in Table-5 revealed that on the basis of average of all 18 locations CIM-496 gave 2731 kg ha^{-1} and stood at 2nd position and show 3.5%, 12.0%, 24.3% and 5.8% increase over BH-160, FH-901, CIM-707 and NIAB-111 respectively.

Table-5. **Yield performance of CIM-496 in Director Cotton Research Trials during 2003.**

Year	Region	No. Of Trials	Varieties / Seed Cotton Yield (Kg/ha)				
			CIM-496	BH-160	FH-901	CIM-707	NIAB-111
2003	Punjab	18	2667	2577	2382	2146	2520
Increase over				3.5%	12.0%	24.3%	5.8%

During the year 2004-05 CIM-496 giving 2684 Kg ha^{-1} and surpassed the standard variety CIM-473 (2587 Kg ha^{-1}) Table-6.

GINNING OUT TURN AND FIBRE CHARACTERS

CIM-496 had 41.1% ginning out turn 29.7mm staple length and desirable micronaire value of 4.6 Ug $inch^{-1}$. CIM-496 had 93.5 tppsi fibre strength, 0.98 maturity ratio and 48.6% uniformity ratio. CIM-496 had 2208 counts lea strength product (CLSP) value at 50 counts and falling in A grade.

Summary of salient characteristics of CIM-496

Sr. No.	Characters	Varieties				
		CIM-496	CIM-506	NIAB-111	CIM-499	CIM-473
1.	Yield of seed cotton (kg ha^{-1})	4728	4579	4130	4070	3748
2.	Ginning out turn (%)	41.1	38.7	36.1	40.1	40.0
3.	Staple length (mm)	29.7	28.6	29.7	29.5	29.9
4.	Micronaire value (µg $inch^{-1}$)	4.6	4.5	4.5	4.5	4.4
5.	Fibre strength (tppsi)	93.5	96.7	93.0	95.0	95.7
6.	Maturity ratio	0.98	0.98	0.96	0.97	0.97
7.	Uniformity ratio (%)	48.6	47.8	47.7	48.1	47.7

PLANT CHARACTERS

The data of plant characters i.e., plant height, number of monopodial and sympodial branches, maximum boll weight, average boll weight and number of bolls per plant presented in Table-7 indicated that on an average of three years, CIM-496 had 119.2 cm plant height, 2.4 and 25.6 monopodial and sympodial branches per plant respectively. It possessed 4.1g maximum boll weights, 3.1g average boll weight and 47.3 bolls $plant^{-1}$.

Table 7: Plant characters of CIM-496 (Two years average) recorded during 2002 to 2003

Year	CIM-496	CIM-499	CIM-473	FH-1000
Plant height (cms)	119.2	115.6	112.0	123.0
No. of monopodial branches/plant.	2.35	1.65	2.3	3.8
No. of sympodial branches/plant.	25.6	19.9	22.8	22.6
Boll weight (g) {average of good bolls}	4.1	4.1	4.3	4.6
Average boll weight (g).	3.1	3.2	3.3	3.8
No. of bolls/plant	47.3	42.3	38.0	32.8

Entomological studies

Entomological studies on CIM-496 were conducted by the Entomology Section of Central Cotton Research Institute, Multan in host plant resistant trial to assess its tolerance level against Jasid, whitefly, thrips and bollworm damage compared with commercial variety CIM-499. Data on pest population under un-sprayed conditions shown in Table-20 indicated that the new variety CIM-496 has about equal level of tolerance against sucking insects and bollworm as that of commercial variety CIM-499.

Table-8: Reaction of CIM-496 to sucking pests and bollworm damage at Central Cotton Research Institute, Multan during 2003-2004

Varieties	No. of insects/leaf			% bollworm damage
	Jassid	Whitefly	Thrips	
CIM-496	0.43	2.6	2.08	15.4
CIM499	0.60	2.68	0.78	13.4
C.D. 5%	N.S.	N.S.	N.S.	N.S.

Agronomic studies

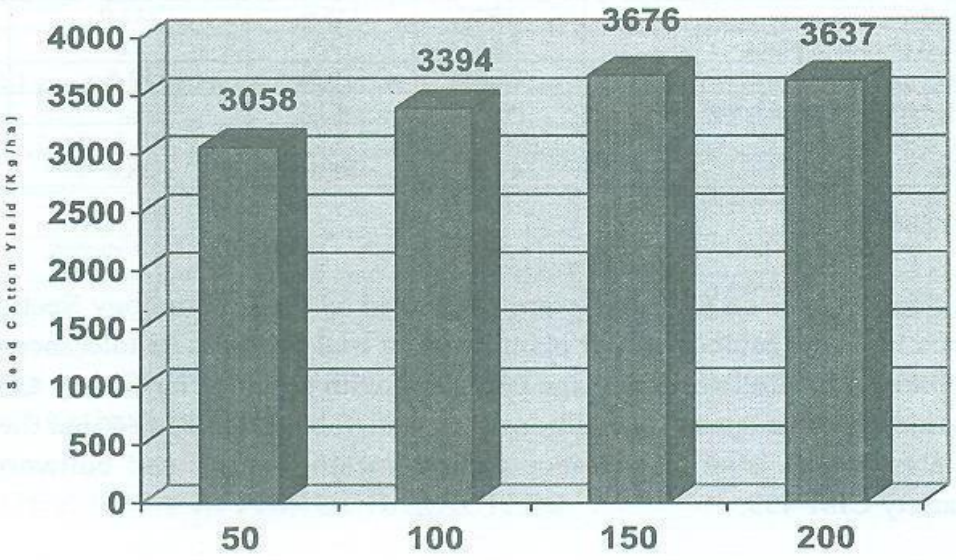
Fertilizer trial

The yield performance of CIM-496 was tested under four nitrogen levels i.e. 50, 100, 150 and 200 kg N ha^{-1}. Data given in Fig-I indicated that CIM-496 gave positive response up to 150 kg N ha^{-1}. (3676 kg ha^{-1}). However the differences between 150 and 200 kg N ha^{-1} were non-significant.

Sowing Date Trial

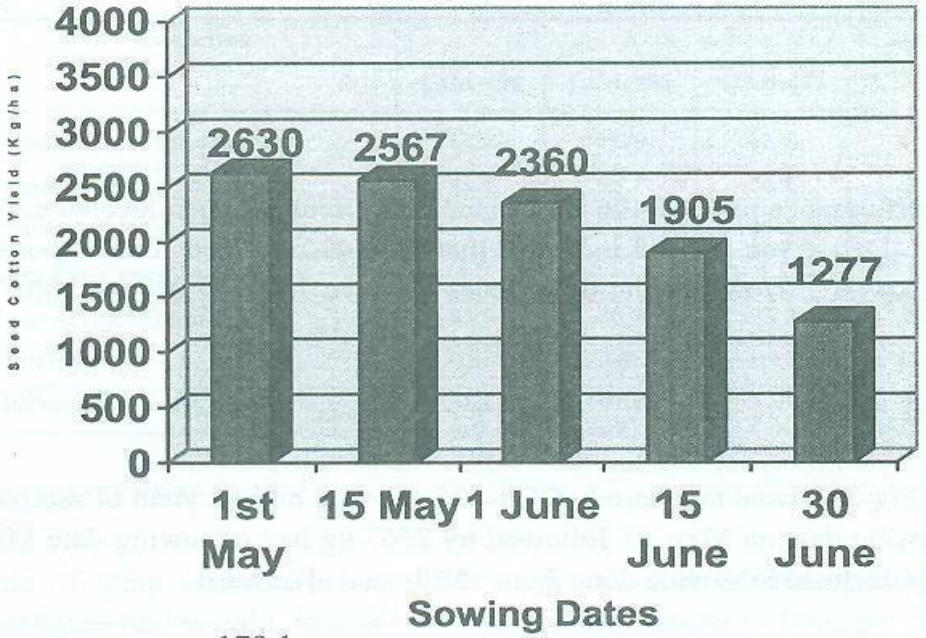
The data in Fig-2 showed that variety CIM-496 gave the highest yield of seed cotton (2630 kg ha^{-1}) in the sowing date on May, 01 followed by 2567 kg ha^{-1} of sowing date May 15th. The yield successively declined in sowing done from 15th June and onward.

Fig 1. YIELD PERFORMANCE OF CIM-496 UNDER DIFFERENT DOSES OF NITROGEN



LSD 5% =236.4

Fig 2. YIELD PERFORMANCE OF CIM-496 UNDER DIFFERENT SOWING DATES



LSD 5% = 179.1

SALIENT CHARACTERS OF CIM-496

1. It possesses good yield potential.
2. It has excellent fibre characteristics
3. It has higher lint percentage.
4. It is heat tolerant, early maturing and suitable for timely planting of wheat.
5. It is drought tolerant and has wider adaptability.
6. It is hairy and tolerant to the attack of jassid.
7. It has big boll size and very good fluffy opening.
8. Due to excellent fibre characteristics it has the ability to spin on higher count.

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Table 6: Yield performance of new strains in DGR Trial during 2004-2005

Sr. No.	Varieties	CRSS Sargodha	CRI FSD	NIAB FSD	Agri. Uni. FSD	CRS Sahiwal	ARS KWL	CRSS KWL	PSC KWL	CRS Vehari	CRS Multan	CCRI Multan	CRS Bahawal pur	ARS Bahawal nagar	CRI RYK	CRSS Khan pur	Average
1	FH-2006	1805	848	1794	1722	1435	2711	2022	2332	2400	2281	2943	1752	2613	2857	160	2072
2	FH-2000	2265	1542	2422	976	1854	2830	1854	2452	2800	2754	4174	2350	2562	2358	150	2323
3	FH-115	1895	1951	3379	2157	2093	2920	2238	3648	3500	3515	3923	3109	3586	2588	139	2816
4	NIAB-884	2243	2392	4216	1492	1375	2775	2752	3468	2700	2755	4296	2416	3484	2537	175	2712
5	MNH-732	2713	1689	2362	1297	1434	2512	2106	3050	2710	2755	4367	2488	3125	2627	111	2470
6	MNH-700	2433	1734	3199	2077	1615	2432	2333	3110	3235	2941	4313	2422	2767	2460	114	2579
7	MNH-768	1839	1792	3229	1888	1914	2472	2573	2691	3035	3644	4274	2547	2818	2652	145	2581
8	RH-510	1974	816	2033	1349	2093	1874	2010	2811	3035	3830	4536	2081	3740	2947	175	2460
9	SLH-279	2366	1650	3289	930	3647	2352	2776	3110	2510	3041	3870	2607	4150	3229	153	2732
10	VH-148	2288	2692	3468	2559	1854	2631	2692	3229	3750	2998	4525	2410	2920	2678	165	2837
11	BH-162	1828	1610	3498	2123	1495	2392	2357	3468	2710	2482	4161	2272	3228	2114	104	2496
12	BH-163	2108	1292	3259	1205	1255	2727	2154	3050	2525	3199	3515	2763	2920	2358	114	2396
13	CIM-534	1928	1527	3110	1641	1855	2647	2393	3409	3030	3859	4612	2207	3330	2358	170	2625
14	**CIM-496**	**1553**	**2140**	**4156**	**2043**	**1615**	**2512**	**2668**	**3528**	**3575**	**3027**	**4553**	**2201**	**2669**	**2627**	**199**	**2684**
15	RH-512	1929	1193	2272	1343	1913	2671	2213	3349	3040	2841	3991	2105	2971	2563	194	2366
16	NIAB-824	1817	1936	3289	1136	2511	2671	2932	3409	2910	2927	4221	2129	2766	2627	142	2588
17	ALSEEMI-H-151	2332	1835	3588	1744	2810	2352	2513	3289	3210	3544	3990	2691	3228	3524	129	2832
18	**CIM-473**	**2725**	**1422**	**3169**	**2295**	**2392**	**1634**	**2213**	**3169**	**2725**	**3199**	**3887**	**2045**	**2869**	**3396**	**168**	**2587**
19	FH-1000	1615	1935	3558	1985	1795	1754	2572	3468	2740	2625	4125	2117	1998	2089	109	2379
20	FH-2925	2893	1324	2781	1865	2219	1746	2369	3409	2150	3257	3220	2009	2152	3024	186	2407
21	NIBGE-2	1649	1565	2900	2204	2153	2368	2322	2990	3200	3357	4015	2242	2715	2294	155	2482
22	PB-843	2366	1138	2811	2123	2273	2145	2058	3229	3310	3443	3696	2344	3586	3203	262	2653
23	PB-899	2803	1791	3199	1917	3109	2488	2333	3528	3505	3371	4004	2440	2869	2716	139	2788
24	MJ-7	2196	1814	3708	2031	2392	2280	2273	3050	2705	3070	4290	2087	3791	1679	186	2603

EVOLUTION OF A HIGH YIELDER AND COTTON LEAF CURL VIRUS TOLERANT VARIETY OF *G. hirsutum* L. MNH-786

*Dr. Muhammad Iqbal, Rana Tauqeer Ahmad, Khezir Hayat and Noor-ul-Islam Khan**

ABSTRACT

The new cotton variety MNH- 786 has been developed through hybridization at Cotton Research Station, Multan during 1996-1997. The new variety gave significantly higher yield in varietial trails compared with commercial varieties. MNH-786 was also evaluated in zonal varietial trails at Govt. and private Farms. In National Coordinated Varietial Trial MNH-786 suppressed all the existing varieties (2006-07). MNH-786 possesses acceptable ginning out turn (38.5), fiber quality and spinning performance as decleared by the Govt. of Pakistan for variety approval. This variety has also shown the outstanding resistance to CLCV and sucking insect pests. The commercial cultivation of this variety will significantly contribute to the over all cotton production as well as will increase in foreign exchange earning.

KEY WORDS: CLCV, Boll weight, seed cotton yield, NCVT

INTRODUCTION

Cotton the silver fiber, occupies a key position in national economy and provides livelihood to million of people associated with its production, ginning, transport, spinning, textile and other allied industries. A considerable quantity of its production is exported in the form of yarn; cloth and value added readymade garments to earn precious foreign exchange needed for the development of the country.

Breeding is a continuous process due to the fact that it leads to search for betterment with the increasing demands of present industry and changing environment. If old variety is not replaced by recent one the process to feed more mouth on the Earth will automatically stop. Therefore it is the need of the day (Evolve to Solve) to evolve new varieties, which can solve the problem of the present time. This is clear from the fact that after the debacle of 1983, cotton production in the country has been steadily increasing till it reached the highest ever record production of 12.8 million bales during 1991-92 (Agricultural Statistics of Pakistan 1991-92). However there was reversal trend in production in the following years due to severe out break of cotton leaf curl virus and production decreased to 8.0 million bales in 1993-94 (Agricultural Statistics of Pakistan 1993-94). Cotton leaf curl virus was first observed in the year 1967 at Multan (Hussain and Ali, 1975). The disease was not considered economically important in the past due to its low incidence, but with the passage of time the inoculums was increased and disease was spread causing large scale production loss.

Cotton Research Station, Multan*
Cotton Research Institute, Faisalabad**

Singh *et al* (1973) reported that significant differences in raw cotton yield of America cotton were due to varieties. Ahmed *et al* (1982) also obtained highly significant differences in yield of upland cotton due to varieties. Soomro *et al* (1986) reported significant differences in yield, ginning out turn % and staple length for varieties. Afzal *et al* (2001) studied that there were highly significant difference in yield, boll weight number of bolls per plant and plant height due to planting of various genotypes (varieties). Hanif *et al* (2001) also reported significant variations in seed cotton yield due to varieties.

The damage of cotton leaf curl virus has been minimized as a result of evolution of CLCV resistance varieties i.e.CIM-473, CIM-499, CIM-506, CIM-496 etc. With the introduction of this new variety MNH-786 the above mentioned problems would be automatically solved. The commercial cultivation of this high yielder and CLCV tolerant variety MNH-786 significantly contribute to the over all production as well as earn more foreign exchange through the export of raw cotton and superior quality products.

MATERIALS AND METHODS

The new cotton variety MNH- 786 has been developed through hybridization of local strains (S-14 x CIM- 448) X (MNH-564 x MNH-516). The normal crossing procedure was adopted at Cotton Research Station, Multan during 1996-97. Pedigree selection procedure was used to sort out desirable genotypes from segregating population and lines with similar morphology, fiber and seed characters were bulked in F_6 generation during 2003-04.

The new strain passed through a series of yield trails i.e. micro- varietals trials, Multi-location varietals trails, Zonal varietals trial at private and Govt. farms CRSS, Khanewal, CRSS, Kot Chutta, CRSS, Thatha Gurmani, National Coordinated Varietals Trials (NCVT) and DCR trials.

RESULTS AND DISCUSSION

AYT and PYT Trials

The variety MNH- 786 was tested in replicated Advance Yield Trials and Preliminary Yield Trials at Cotton Research Station, Multan against commercial varieties. The data presented in Table-1 show that on the basis two years average i.e. 2004 - 05 and 2005 - 06 it gave higher yield of seed cotton compared to commercial varieties. The differences among the verities were statistically significant.

Table 1a. Yield performance of MNH-786 in preliminary yield trial at different locations

Year	Experiments	Variety/strain	CRS,Multan	CRSS,KWL	Av.yield kg/ha
2004-05	PYT-4	MNH-786	2997	3121	3059
		FH-900	2817	2780	2798
		% INC./DEC.	+6.38	+12.26	+9.33
2005-06	PYT-1	MNH-786	3372	3561	3467
		CIM-499	2912	3264	3088
		%INC./DEC.	+15.80	+9.09	+12.27
	CD 0.05%	694			
	PYT-4	MNH-786	3285	3461	3373
		CIM-496	3007	3111	3059
		%INC./ DEC.	+9.24	+11.25	+10.26
	CD 0.05%	500			

Table 1b. YIELD PERFORMANCE OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

Year	Experiment	VARIETY/ STRAIN	CRS, MULTAN	CRSS, KWL	CRSS, K.Chutta	CRSS, T.Gurmani	AV. Kg/ha
2004-05	AYT-3	MNH-786	3809	3917	3578	3677	3745
		CIM-499	3348	3301	3271	3447	3342
		%INC./DEC.	+13.77	+18.66	+9.4	+6.67	+12.06
2005-06	AYT-1	MNH – 786	3492	3677	2977	3318	3574
		CIM-473	2545	2714	2697	2668	2656
		%INC./DEC.	+37.21	+35.48	+10.38	+24.36	+34.56
		CD 0.05	529				
	AYT- 2	MNH – 786	3238	3438	3076	2971	3181
		CIM-499	2800	2912	2992	2901	2901
		%INC./DEC.	+15.64	+18.06	+2.81	+2.41	+9.65
		CD 0.05	370				
	AYT – 3	MNH -786	3984	3778	3217	3318	3574
		CIM -499	2403	2691	2689	2809	2648
		%INC./DEC.	+65.79	+40.39	+19.63	+18.12	+34.96

ZONAL VARIETIAL TRIALS

MNH-786 was also evaluated in Zonal Varietals Trials through out province. The new variety gave 11.78% and 23.63 % higher yield than CIM-496 and FH-901 respectively

Table 2: YIELD OF MNH-786 (Mds/ac) IN ZONAL VARIETAL TRIAL AT DIFFERENT LOCATIONS

S.NO.	NAME OF FARMERS/ADDRESS	MNH-786	CIM-496	FH-901
1	Rabnawaz Khichhi,Darkhana wala Dist. Vehari	45	38	35
2	Rana Tariq, Chichawatni	40	39	34
3	Mian Shafiq, Herappa	42	38	33
4	Khadim Husain Bangish, Abdual Hakeem, KWL	40	38	31
5	Fakhar Imam, Kaberwala	38	36	30
6	Sajid Mehdi Naseem Shah,Vehari	40	37	34
7	Javed Ali Shah	36	34	31
8	Athar Saeed Qureshi, Lodhran	40	37	33
9	Ch. Irshad, Jahanian	45	38	35
10	Ch. Liaqat, Jahanian	41	37	34
11	RCA, Kabeerwala	36	32	29
12	K- 2 SeedCorp. Kabeerwala	35	31	29
13	Zaheer Seed Corp. Vehari	38	34	31
14	Jallander Seed Crop. Burewala	39	36	33
15	Baba Freed Seed Crop. Arifwala	44	39	37
16	Shan Seed Corp. Kabeerwala	38	34	30
17	Modern Seed Crop. Rahim Yar Khan	36	32	28
18	Farmer Equity Seed	35	30	28
19	Imtiaz Dogil, Vehari	28	24	22
20	Mukhtar Khitran, Rahim Yar Khan	35	29	27
21	Abdul-Rahim, Zahirpur	46	39	35
22	Dr. M. Shafiq, Multan	28	24	22
23	Waqar Seed Crop. Multan	34	30	28
24	Haq Nawaz, T.T.S.	33	29	26
25	Khurram Khan, Karoor Pakka	36	32	29
26	Amir Fayyaz, Muzzafar Garh	29	26	24
27	Yasrab Seed Crop. Bahawalpur	36	33	30
28	Ahsan Sajjad Khan, Vehari	39	35	32
29	Ghulam Qasim Khokar, Multan	38	34	31
30	Abbassia Seed Crop. Rahim Yar Khan	40	36	34
31	M. Munsha Kumbo, Kabeerwala	27	24	21
32	Abdul Hameed Awan, Vehari	38	35	31
33	Haji Pehlwan, Ratta Tibba	29	25	23
	Average	37.09	33.18	30
	% inc/dec		11.78	23.63

REGIONAL ADAPTABILITY TRIALS

National Coordinated Varietals Trials (NCVT)

MNH- 786 was included in NCVT Trials during 2005-06 and 2006-07. The yield data of Punjab are presented in Table –3a and Table-3b. It is revealed from the data that MNH-786 (avg. Yield, 3192 kg / ha) produced 57.5% more seed cotton yield than CIM-499 (Avg. Yield, 2026 kg / ha), which indicated the adaptability of new variety.

Director Cotton Research Trials (DCR)

The new strain MNH- 786 was evaluated in DCR trials conducted by Director Cotton Research Institute, Faisalabad during 2005-06 and 2006-07.The yield data presented in Table- 4a and Table-4b. In DCR trials in Punjab, MNH- 786 (Avg. yield 2196 kg/ ha) recorded 9% increase over FH-901 (Avg. yield 2008 kg/ ha).

Ginning Outturn Percentage and Fiber Characters

MNH-786 had 39.2 ginning out-turn %age, which is higher than CIM- 499, CIM-496 and FH- 901 as presented in Table-5. The staple length of MNH-786 is higher than CIM-496 and FH-901which is 27.5mm higher than the staple length (27.0mm) limit laid down by Agri. Department, Govt. of Punjab for cotton variety for breeders as presented in Table-6 while the fineness is also better than CIM- 496. MNH- 786 had 4.7ug/inch fineness and fiber strength is 99.5 tappsi, presented in Table 7 and 8 respectively.

Table 3a. PERFORMANCE OF DIFFERENT VARIETIES AT DIFFERENT LOCATION IN NCVT DURING 2005-06 (yield kgs/ha)

Faisalabad zone					Multan Zone							Inc/dec (%)
NIAB FSD	Sahiwal	CRI FSD	NIBGE	Ave.	CCRI Multan	CRS. Mul	Vehari	PSC Kwl	R.Y.Khan	Ave	Varieties	
4380	2574	2031	2335	2830	3515	2242	2623	2932	2131	2437	BH162	30.9
5088	3190	2314	1577	3042	3534	1883	2757	3336	2275	2491	NIAB884	28.1
4860	3498	1962	2007	3082	3664	2452	2555	2878	2104	2477	MJ-7	28.8
3794	2575	1930	1648	2487	2186	1206	2623	2717	1026	1734	TH-84/89	84.0
4058	3036	2105	1713	2728	3807	1994	2757	2852	2079	2392	FH-115	33.4
4956	3171	2240	2244	3153	3622	1923	3026	2340	2212	2326	NIAB824	37.2
3789	3959	1963	1859	2892	3697	3209	2858	2959	2267	2699	MNH789	18.2
4375	3383	2140	2234	3033	4719	2322	2858	3632	1986	2847	CIM534	12.1
4362	3613	2114	2181	3068	2164	2491	2757	2771	2741	2729	FH207	16.9
5091	3844	2166	1836	3234	3534	2162	3228	2932	2784	2748	CRIS466	16.1
3726	4313	1841	1425	2826	3485	3428	3329	3013	3102	3192	MNH786	
5135	4136	2532	2126	3482	3554	2680	2757	3094	2903	2751	PB-899	16.0
4364	3960	2815	2299	3359	3837	2930	3161	3201	2856	2882	H-151-F2	10.7
4494	4036	2454	2227	3303	3559	2352	2791	2932	2702	2636	CRIS-461	21.0
4828	3921	2671	1704	3281	3357	2471	3295	2905	2541	2646	TH-35/99	20.6
4319	3429	2143	2381	3068	4323	2491	2757	2905	1678	2538	NIBGE-4	25.7
4548	2845	2267	2026	2921	3878	1893	2656	3013	2238	2433	CIM499	31.1
4096	2345	1854	1206	2375	3161	384	2219	2986	1489	1867	GH-99	70.9
4855	2730	2478	1819	2970	4226	2143	2556	3255	1933	2555	CIM538	24.9
4480	3398	2211	1939	3007	3675	2245	2819	2982	2276	2546	Average	
6.16	11.86	14.8	3.75		2.38	18.44	16.01	3.92	16.24		CV %	
						C.V. High	C.V. High		C.V. High		Remarks	
**	**	**	**		**	**	NS	**	**		Sig.	
390.727	570.263	463.319	120.642		124.064	586.092	639.017	165.258	608.166		CD 5%	
521.4895	761.1106	618.3753	161.6483		165.5836	782.2371	852.017	220.5639	810.384		CD 1%	

Table 3b. YIELD DATA OF NCVT IN PUNJAB DURING 2006 – 07 (Kg/ha)

Varieties	CCRI, Multan	CRS, Multan	PSC, Khanewal	CRS, Bahawalpur	ARI Bahawalpur	CRS, R.Y.Khan	CRSS, K.Chutta	CRI, Faisalabad	NIBGE, Faisalabad	CRS, Sahiwal	Average Punjab	%inc/des
NIBGE-115	4127.25	2531.00	1950.50	2434.25	2448.75	3354.33	2723	1145	3847	3741	2925	0.61
MJ-6	4199.00	1714.00	1950.25	2508.50	1634.75	2457.67	3010	1312	2244	2828	2310	27.3
GH-99	2786.00	1016.50	2118.50	2192.50	1480.00	2735.67	2938	594	851	2203	1698	73.3
CIM-541	2688.25	1644.00	1883.00	2609.25	1850.25	2637.00	2279	1568	1753	2306	2051	43.4
CIM-496	3335.75	2212.00	2152.25	2750.50	2395	3032.00	3028	2157	2132	3228	2603	13
TH-35/99	4193.00	1514.75	2320.25	2871.50	2428.75	2834.33	3884	1202	1777	3997	2594	13.4
MNH-786	**4234.25**	**3966.00**	**1916.75**	**3133.75**	**2327.5**	**2727.00**	**4720**	**2162**	**2044**	**3587**	**2944**	
CIM-538	2216.50	1155.75	1984.00	5454.50	2038.5	3121.67	3501	1656	1457	2511	2114	39.2
NIAB-824	3544.00	2501.00	2017.75	2743.75	2213.5	2942.00	3788	1237	2574	2818	2516	17
FH-127	2893.75	1624.00	1782.50	2575.75	2011.5	2906.00	2912	1205	1845	2716	2154	36.6
BH-167	3174.00	1474.50	1849.50	2802.50	2072	2476.00	2183	1710	1407	2255	2044	44.2
CRIS-342	4571.00	1843.50	2387.50	3053.25	2441.75	2601	3315	796	2857	3690	2667	10.3
NIAB-846	3415.00	2929.75	2320.25	2427.75	3000.25	2753.00	2907	1767	2663	3485	2730	7.8
ASR-1	2910.00	2102.50	1950.50	2918.50	1897.00	2996.00	3395	1323	2158	2613	2313	27.2
TH-84/99	2755.00	807.00	2051.25	1441.00	1560.75	1570.00	2264	1420	803	871	1419	107.3
CRIS-466	3936.25	1992.75	2219.50	2508.50	2102.25	2601.00	3732	672	1502	2511	2144	37.2
FH-113	3935.25	2411.25	2454.75	2754.25	3511.50	3300.00	2902	1441	2197	3433	2698	9.08
NIBGE-4	4356.00	2371.50	2354.00	2972.50	1977.75	2726.00	3315	1083	2641	3382	2618	12.4
SLH-284	4646.75	3457.75	2019.50	3259.50	2173.00	3256.00	2978	925	2543	3946	2792	5.4
MNH-789	3850.00	1923.00	2223.00	2637.00	1453.00	2655.00	2993	570	1964	2614	2127	38.3
CD 5%	561.98	862.07	316.03	512.36	510.08	782.5	190	447	461	253.99		

Table 4a. DCR TRIAL IN PUNJAB DURING 2005-06 (kg/ ha)

Variety	CRI FSD	ARI FSD	CRSS Jhang	CRSS SGD	CRS SWL	ARS KWL	PSC KWL	CRSS KWL	CRS MUL	CRS BWP	ARS BWP	ARS Karo-re	CRSS K.Pur	CRSS T.Gur	CRI R.K	CRI,MI	NIBGE ESD	NIAB	AV	% inc/dec
SLH-284	2388	1488	329	1268	2126	2816	3407	2022	1700	861	1305	453	1006	2172	2723	3200	1323	4442	1946	12.8
PB-899	2543	1400	1384	1398	2179	3048	3346	1854	2072	969	1534	715	2406	1827	2099	3533	1229	4152	2094	4.8
N-846	3037	1424	1038	1844	2232	2460	3468	2238	1089	538	1237	382	2083	1742	1674	2768	1248	4149	1925	14.0
FH-113	2946	3077	1401	1692	2397	2091	3468	2752	1939	789	1389	1280	2352	2733	2809	3056	1016	4751	2330	-5.7
CIM-534	2124	1407	519	1485	2020	3212	3346	2106	1368	825	1632	233	1523	1637	2034	4455	1297	5209	2024	8.4
SLH-317	2448	1421	1453	1361	1914	2433	3526	2333	1660	789	1258	667	1738	2336	2212	3772	1091	4927	2074	5.8
VH-156	2872	1066	726	1464	2232	3246	3407	2573	1673	753	1297	400	1383	2450	1889	3272	963	3865	1974	11.2
H-151	2852	1986	2041	1735	2764	2781	3346	2010	2511	1076	1552	1440	2368	1146	2320	4107	881	4315	2291	-4.14
CIM-538	2398	1697	311	1453	2126	2569	3468	2776	1434	502	1178	196	1437	1243	1459	4358	1112	3595	1851	18.6
FH-115	2296	1710	242	1323	1914	2228	3289	2692	1408	610	1316	231	1884	2273	1948	2279	1107	4001	1820	20.6
MNH-786	2286	1252	1436	1633	2073	2898	3407	2992	2657	897	1527	684	1921	2580	2562	3309	917	4497	2196	
BH-162	2167	1401	536	1410	1861	2884	3407	2154	1554	502	1200	429	1706	2423	2212	2616	1090	2999	1808	21.4

Continued

Table 4a.

FH-207	2197	1226	1159	1312	2126	2775	2988	2393	1249	574	1255	329	2637	2040	1927	3023	1181	4991	1966	11.6
VH-148	2338	2195	848	1833	2020	3649	3346	2668	1036	789	1474	338	1975	2470	2842	2936	934	4408	2117	3.7
MNH-789	1984	1091	917	1284	1967	2132	3346	2953	2524	861	1158	231	2223	2531	1932	3262	984	3843	1957	12.2
N-884	2621	1414	657	1447	2285	2529	3827	2932	1329	538	942	284	2007	2370	1711	3451	943	4022	1962	11.9
BH-164	1855	1347	623	1312	2126	1968	2869	2513	691	359	1027	124	1937	2082	1389	1905	804	2679	1534	43.1
N-824	2509	1367	1263	1622	2339	2911	3468	2213	1554	682	1151	604	2223	1800	2287	3212	1154	3824	2010	9.2
NIB-4	1641	1300	225	1632	2285	2105	3407	2572	1820	538	1107	217	1868	2050	1835	4489	1336	4276	1968	11.5
FH-901	2743	1030	1159	1676	2126	2474	3407	2369	1833	718	1485	478	1937	2550	1943	3016	1141	3956	2008	9.3
SLH-279	2391	1044	1142	1273	2020	2146	3346	2262	1368	897	1244	555	2099	2183	1997	3674	1347	4428	1968	11.5
MJ-6	2109	1198	917	1610	1807	2501	3526	1998	571	603	1045	180	1884	2047	1378	2435	953	4094	1714	28.1
RH-511	2330	1064	657	1182	1648	2125	3586	2333	1355	1077	1235	622	2115	2387	1744	2396	1063	3578	1805	21.6
MJ-7	2753	1508	1090	1578	2179	3526	3289	2273	1355	718	1355	320	1991	2387	1911	3046	854	4483	2034	7.9
(0.05)	737	263	408	367	210	463	245	435	708	303	349	38	897	107	811	194	61	1043		

Table-4b. YIELD (Kg/ha)& (mds/ac) RECORD OF DGR TRIAL DURING 2006-07

SR. NO.	CODE	Varieties	PSC, KWL	ARS KWL	CRI, R.Y.K	CRS, Vehari	CRS, Swl	CRS, B.Pur	ARS, B.Pur	ARS KAROR	CRS, Multan	CCRI, Multan	ALI AKBAR MULTAM	ARI, FSD	CRI, FSD	NIBGE, FSD	CRSS, SGD	AV.	Yield mds/ac	% inc/dec
1	DGR-17	FH-113	2352	1777	3932	1377	2923	2511	2648	2223	2488	4326	4504	2744	2682	1849	1498	2672	28.97	2.6
2	DGR-10	MNH-786	2752	2474	3315	1529	3196	2841	3960	1793	3839	4242	3585	1022	1767	1498	1470	2601	28.20	
3	DGR-3	FH-941	2451	1763	3444	918	1768	2411	3433	2583	2685	3765	3953	2789	2808	1817	1591	2545	27.60	2.2
4	DGR-23	FH-942	2271	1790	4865	1332	2923	3329	3548	2223	2426	3994	4680	722	664	1355	1366	2489	27.10	4
5	DGR-1	NIAB-777	2752	2105	3028	1136	2857	2913	3695	2045	2387	4086	3861	1256	1489	1780	1783	2478	26.87	4.9
6	DGR-13	CIM-496	2612	2187	3667	874	2310	2554	3476	2892	2029	3790	4312	1000	1924	1467	1318	2421	26.25	7.4
7	DGR-3	RH-514	2630	2050	3129	1401	2584	2640	3114	2501	3241	3850	3217	1033	2009	972	1357	2382	25.83	9.1
8	DGR-14	NIAB-846	2451	1804	3143	1091	3331	2224	3185	1625	2208	3933	4404	1144	1624	1530	1585	2351	25.49	10.6
9	DGR-7	FH-207	2989	1749	3401	1239	2380	2784	2433	2574	2247	3855	3763	889	1453	1514	1552	2322	25.17	12
10	DGR-15	NIBGE-115	2691	2228	3129	1033	2719	2066	2195	1889	2267	4207	3861	1022	1161	2603	1557	2302	24.96	12.9
11	DGR-11	MNH-6070	2691	2449	2268	1894	2719	1500	2211	2512	3792	4174	3585	800	1166	1060	1400	2280	24.72	14
12	DGR-4	SLH-284	2989	1777	3043	1081	3331	1421	3128	2079	3082	4269	3401	522	1130	1546	1096	2260	24.50	15
13	DGR-21	NIAB-824	2271	1585	3344	1239	2515	2454	3476	2462	1695	4283	2913	1167	1561	1243	1344	2237	24.25	16.2
14	DGR-5	VH-156	2573	1831	3028	1160	3196	2382	1875	1687	1923	3780	3769	1000	1552	1977	1135	2191	23.76	18.7
15	DGR-19	MNH-789	2573	1831	3530	1081	2584	1736	2185	2440	2148	4045	3308	1000	628	1753	1613	2164	23.46	20.1
16	DGR-6	MJ-6	2393	1626	3165	654	2176	1968	2975	1911	2264	3879	3401	1800	1036	1865	1300	2161	23.43	20.3
17	DGR-2	NIBGE-4	2271	2105	3049	1195	2379	2454	1776	2139	1909	3822	3768	1000	1328	1530	1547	2151	23.33	20.9
18	DGR-16	VH-209	2630	2187	3100	917	2041	1866	1542	1840	2479	4388	4136	722	798	1118	1580	2088	22.64	24.5
19	DGR-22	VH-148	2393	1599	2849	712	1902	2368	3442	2940	1013	3589	3768	611	1309	1291	1301	2072	22.47	25.5
20	DGR-24	ASR-1	2393	2064	1830	575	2176	1851	3378	1983	1175	3189	4495	1222	1404	1148	1313	2013	21.83	29.2
21	DGR-18	BH-168	2630	1695	3846	747	1902	2841	2025	2008	1742	3449	3217	645	753	733	1510	1983	21.50	31.1
22	DGR-9	BH-167	2630	1777	2217	482	1837	1685	2740	2032	1963	3146	3851	967	1413	1275	1491	1967	21.33	32.2
23	DGR-20	CIM-541	2451	1736	2985	530	1698	1866	3355	2008	904	3546	3308	1189	1202	1371	1322	1967	21.32	32.2
24	DGR-12	CIM-538	2214	1968	2404	344	1494	1485	1801	1795	1055	2438	3309	933	1247	1227	1309	1668	18.09	55.9

Table5a. G.O.T. % of MNH-786 in preliminary yield trial at different locations

Year	Experiments	Variety/strain	CRS,Multan	CRSS,KWL	Av. kg/ha
2004-05	PYT-4	MNH-786	39.2	38.9	39
		FH-900	38.4	38.4	38.4
		% INC./DEC.	+2.08	+1.30	+1.56
2005-06	PYT-1	MNH-786	39.2	39.0	39.3
		CIM-499	39.0	39.0	39.1
		%INC./DEC.	+0.51	+0.0	+0.51
	PYT-4	MNH-786	39.5	39.6	39.5
		CIM-496	38.7	38.6	38.5
		%INC./ DEC.	+2.06	+2.59	+2.59

Table 5b.G.O.T. % OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

Year	Experiment	VARIETY/ STRAIN	CRS, MULTAN	CRSS, KWL	CRSS, K.Chutta	CRSS, T.Gurmani	AV. Kg/ha
2004-05	AYT-3	MNH-786	39.1	39.6	39.8	39.5	39.5
		CIM-499	38.7	38.6	38.7	38.6	38.6
		%INC./DEC.	+1.03	+2.59	+2.84	+2.33	+2.33
2005-06	AYT-1	MNH - 786	39.5	39.5	39.5	39.7	39.5
		CIM-473	38.6	38.7	38.9	38.7	38.7
		%INC./DEC.	+2.33	+2.06	+1.54	+2.58	+2.06
	AYT- 2	MNH - 786	39.5	39.6	39.4	39.7	39.5
		CIM-499	38.4	38.5	38.7	38.9	38.6
		%INC./DEC.	+2.86	+2.86	+1.81	+2.05	
	AYT – 3	MNH -786	39.7	39.5	39.4	39.5	39.5
		CIM -499	38.2	38.5	33.4	38.6	38.4
		%INC./DEC.	+3.93	+2.59	0.0	+2.33	+2.86

Table 6a.STAPLE LENGTH (mm) OF MNH – 786 IN PRELIMINARY YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	Experiment	VARIETY/ STRAIN	CRS MUL	CRSS KWL	AV.
2004-05	PYT – 4	MNH-786	28	27.8	27.9
		FH-900	27	27.5	27.1
		%INC/DEC	+3.7	+1.09	+2.95
2005006	PYT – 1	MNH-786	27.7	27.8	27.8
		CIM-499	27.5	27.8	28.7
		%INC/DEC	+0.72	0.0	+3.13
	PYT – 4	MNH-786	27.5	27.8	27.7
		CIM-496	28	27.8	27.7
		%INC/DEC	-1.81	0.0	0.0

Table 6b.STAPLE LENGTH (mm) OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	VARIETY/ STRAIN	Experiment	CRSS MUL	CRSS KWL	CRSS K.Chutta	CRSS T.Gurmani	AV.
2004-05	AYT - 3	MNH-786	27.5	28	27.7	27.7	27.8
		CIM-499	28.5	28	28.5	28	28.3
		%INC/DEC	-3.5	0.0	-2.81	-1.07	-1.77
2005-06	AYT - 1	MNH-786	27.8	27.5	27.6	27.6	27.6
		CIM-473	27.9	27.5	27.8	27.9	27.7
		%INC/DEC	+0.35	0.0	+0.72	+1.08	+0.36
	AYT – 2	MNH-786	28	27.5	27.7	27.9	27.9
		CIM-499	27	27.5	27	27	27.3
		%INC/DEC	+3.7	0.0	+2.5	+3.33	+2.19
	AYT - 3	MNH-786	27.5	27.9	27.7	27.9	27.8
		CIM-496	28.5	28.5	28	28	28.3
		%INC/DEC	-3.5	-2.11	-1.07	-0.35	-1.76

Table 7a.FINENESS OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	Experiment	Variety/ Strain	CRS MUL	CRSS KWL	AV
2004-05	PYT – 4	MNH-786	4.7	4.7	4.7
		FH-900	4.5	4.6	4.5
2005-06	PYT – 1	MNH-786	4.8	4.7	4.6
		CIM-496	5.0	4.9	4.9
	PYT – 4	MNH-786	4.8	4.7	4.7
		CIM-496	5.0	4.9	4.9

Table 7b.FINENESS OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	Experiment	Variety/ Strain	CRS MUL	CRSS KWL	CRSS K.Chutta	CRSS T.Gurmani	AV.
2004-05	AYT – 3	MNH-786	4.7	4.8s	4.8	4.7	4.7
		CIM-499	4.5	4.5	4.6	4.7	4.6
2005-06	AYT – 1	MNH-786	4.7	4.7	4.8	4.6	4.7
		CIM-473	4.3	4.4	4.3	4.4	4.5
	AYT – 2	MNH-786	4.8	4.7	4.8	4.7	4.7
		FH-900	4.6	4.6	4.6	4.6	4.7
	AYT – 3	MNH-786	4.7	4.6	4.7	4.8	4.5
		CIM-499	4.5	4.6	4.5	4.6	4.6

Table 8a.FIBRE STRENGTH (tppsi) OF MNH – 786 IN PRELIMINARY YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	Experiment	Variety/ Strain	CRS MUL	CRSS KWL	CRSS K.Chutta	CRSS T.Gurmani	AV.
2004-05	AYT – 3	MNH-786	4.7	4.8s	4.8	4.7	4.7
		CIM-499	4.5	4.5	4.6	4.7	4.6
2005-06	AYT – 1	MNH-786	4.7	4.7	4.8	4.6	4.7
		CIM-473	4.3	4.4	4.3	4.4	4.5
	AYT – 2	MNH-786	4.8	4.7	4.8	4.7	4.7
		FH-900	4.6	4.6	4.6	4.6	4.7
	AYT – 3	MNH-786	4.7	4.6	4.7	4.8	4.5
		CIM-499	4.5	4.6	4.5	4.6	4.6

Table 8b.FIBRE STRENGTH (tppsi) OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	VARIETY/ STRAIN	Experiment	CRSS MUL	CRSS KWL	CRSS K.Chutta	CRSS T.Gurmani	AV.
2004-05	AYT - 3	MNH-786	99	100	101	100	99.7
		CIM-499	96	96	95	95	95.5
		%INC/DEC	+3.12	+4.16	+6.32	+5.26	+4.39
2005-06	AYT - 1	MNH-786	99	99	100	101	99.7
		CIM-473	92	94	94	94	94
		%INC/DEC	+7.61	+5.31	+6.38	+7.44	+6.06
	AYT – 2	MNH-786	100	100	100	99	100
		CIM-499	91	91	92	92	91.5
		%INC/DEC	+9.89	+9.89	+8.69	+7.60	+9.29
	AYT - 3	MNH-786	100	101	100	101	100.5
		CIM-496	96	94	95	96	95
		%INC/DEC	+4.16	+7.45	+5.26	+5.21	+5.79

Spot Examination Report

The salient points about MNH-786 from spot examination report are reproduced below:

i) Good fruit bearing

ii) A few good fruit bearing plants having long sympodia and oblong bolls observed. According to the SCO, FSC & RD these off-types plants are at the approved category standard of 2% and are required to be roughed out for bringing the crop purity at pre-basic standard.

iii) Bigger boll size with good fluffy opening

Although CLCV disease incidence was observed upto 60% was low as the growth continued despite CLCV infestation , hence found as tolerant. The summary of the data collected during spot examination is given in the following Table:

Summary of Fiber Traits of MNH-786 and CIM-496 OF Spot Examination Traits

Traits		MNH-786	CIM-496
GOT(%)		38.04	41.36
Staple Length (mm)	Avg range	27.99 (27.1-28.4)	29.02 (27.8-30.1)
Yet disease intensity level Mike(g/inch)	Avg range	5.09 (4.6-5.31)	5.18 (4.8-5.4)
Maturity (%)	Avg range	83.86 (80.9-86.5)	84.68 (83.5-86.9)
Strength (gm/tex)	Avg range	34.53 (97.4-98.6)	34.53 (26.5-33.9)
Strength (tppsi)	Avg range	98.08 (97.4-98.6)	86.45 (85.3-87.0)

PLANT CHRACTERS

The data of plant characters i.e. plant height, number of monopodial and sympodial branches, boll weight, and number of bolls per plant presented in Table- 9. MNH-786 had 130-150 cm plant height, 1-3 mono-podial and 30 sympodial branches per plant respectively. MNH-786 possesses boll weight surpassing all available commercial varieties. Earliness in maturity of new variety was determined in terms of percentage of cotton picked on different picking dates starting from 15th Sep. to 15th Dec. Summary of data presented in Table-10 showed that it gave 95.2 % yield Oct 15th and 100% on Ist Nov with 75.3% of CIM-496 on 15th Oct and 85.3% on Ist Nov at Cotton Research Station, Multan. At Punjab Seed Corporation, Khanewal Farm 77.1% was picked after 139 days of sowing, although sowing was late than routine/ normal sowing.

Table 9aAV. BOLL WEIGHT (gm) PERFORMANCE OF MNH – 786 IN PRELIMINARY YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	Experiment	VARIETY/ STRAIN	CRS MUL	CRSS KWL	AV.Boll Weight
2004-05	PYT – 4	MNH-786	4.37	4.32	4.32
		FH-900	3.45	3.35	3.4
		%INC/DEC	+26.67	+28.95	+27.65
2005006	PYT – 1	MNH-786	4.26	4.19	4.22
		CIM-499	3.56	3.49	3.5
		%INC/DEC	+19.66	+20.06	+20.57
	PYT – 4	MNH-786	4.37	4.31	4.34
		CIM-496	3.48	3.47	3.47
		%INC/DEC	+25.57	+24.21	+25.07

Table 9b. AV. BOLL WEIGHT (gm) PERFORMANCE OF MNH – 786 IN ADVANCE YIELD TRIAL AT DIFFERENT LOCATIONS

YEAR	VARIETY/ STRAIN	Experiment	CRSS MUL	CRSS KWL	CRSS K.Chutta	CRSS T.Gurmani	AV.Boll Weight
2004-05	AYT - 3	MNH-786	4.15	4.16	4.16	4.35	4.21
		CIM-499	3.50	3.65	3.45	3.50	3.52
		%INC/DEC	+18.57	+13.97	+20.57	+24.28	+19.60
2005-06	AYT - 1	MNH-786	4.18	4.33	4.41	4.17	4.25
		CIM-473	3.65	3.49	3.50	3.40	3.51
		%INC/DEC	+14.52	+24.06	+26.0	+22.64	+21.08
	AYT – 2	MNH-786	4.32	4.34	4.36	4.32	4.34
		CIM-499	3.45	3.51	3.55	3.52	3.51
		%INC/DEC	+25.22	+23.64	+22.82	+22.72	+23.64
	AYT - 3	MNH-786	4.26	4.35	4.15	4.23	4.25
		CIM-496	3.03	3.45	3.45	3.52	3.48
		%INC/DEC	+40.59	+26.09	+20.29	+20.17	+22.13

Table 10: SUMMARY PERCENT COTTON PICKED IN MNH – 786 DURING 2005 – 06

Testing CENTER	VAREITY	S. DATE	15/9	1/10	15/10	1/11	15/11	1/12	15/12
CRS MUL	MNH-786	15/5	50.3	81.5	92.5	100.0	*	*	*
CRS MUL	CIM-496	15/5	30.5	50.8	75.3	85.3	95.2	100.0	*
PSC KWL	MNH-786	28/6	*	*	58.2	*	77.1 (139DAYS)	*	100.0

ENTOMOLOGICAL STUDIES

Entomological studies on MNH-786 were conducted at Cotton Research Station, Multan Table –11 to asses its tolerance level against Jassid, Whitefly, Thrips and bollworm damage compared with commercial variety CIM-496. The data of pest population indicated that the new variety had about equal level of tolerance against insect pests as the commercial variety CIM-496. The results of DCR trials recorded by Director, Entomological Research Institute, Faisalabad are given below.

Table 11.COMPARISON OF INSECT ATTACK

VARIETY	NUMBER OF INSECTS PER LEAF			BOLL WORM (% DAMAGE)
	JASSID	WHITEFLY	THRIPS	
MNH-786	0.75	2.35	1.45	3.5
CIM-496	0.80	2.75	1.00	3.4

PHOTOLOGICAL STUDIES

The pathological studies on MNH-786 relating to cotton leaf curl virus were conducted at Cotton Research Station, Multan and as well as Ayub Agricultural Research Institute. Faisalabad. The data of virus incidence presented in Table- 12 showed that in field screening at Multan MNH-786 proved tolerance against this disease. CLCV data established the fact that MNH-786 has built-in higher degree of field tolerance, which is the most catastrophic among the biotic stress.

AGRONOMIC STUDIES

Fertilizer Trials

The yield performance of MNH-786 was tested under different levels of Nitrogen. The data presented in Table–13 indicated that MNH-786 showed responsiveness to fertilizer (Urea). MNH-786 is an efficient utilizer of nitrogen fertilizer. It produce1543 kg/ha seed cotton yield when

TABLE 12.CLCV INCIDENCE RECOERDED BY VIROLOGIST, VIROLOGY STATION, AARI, FAISALABAD ON DGR TRIAL OF COTTON SOWN AT CRS SAHIWAL DURING 2005 – 06

SOWING DATE = 17 – 05 – 2005
OBSERVATION DATE = 27 – 09 – 2005

CODE	STRAIN	NO. OF PLANTS		% CLCV INCIDENCE	SEVERELY AFFECTED PLANTS	
=	=	TOTAL	DISEASED	=	NO.	%AGE
V1	SL – 284	16	12	75.0	6E	37.5
V2	Punjab-899	36	16	44.4	5	13.9
V3	NIAB-846	73	28	38.4	5	6.8
V4	FH-113	76	39	51.3	5E	6.6
V5	CIM-534	49	40	81.6	5E	10.2
V6	SLH-317	68	27	39.7	5	7.4
V7	VH-156	56	43	76.8	5E	8.9
V8	H-151	77	9	11.7	5E	6.5
V9	CIM-538	37	35	94.6	5E	16.2
V10	FH-115	56	54	96.4	6E	10.7
V11	MNH-786	71	32	45.1	6E	7.0
V12	BH-162	61	43	70.5	5E	9.8
V13	FH-207	62	40	64.5	5	8.1
V14	VH-148	49	48	98.0	6E	12.2
V15	MNH-789	45	40	88.9	5	11.1
V16	NIAB-884	58	56	96.6	6E	10.3
V17	BH-164	57	57	100	6	10.5
V18	NIAB-824	80	75	93.8	5	6.3
V19	N-4	55	49	89.1	5	9.1
V20	FH-901	31	26	83.9	5	16.1
V21	SLH-279	34	29	85.3	5	14.7
V22	MJ-6	67	63	94.0	6	9.0
V23	RH-511	56	22	39.3	4	7.1
V24	MJ-7	68	62	91.2	5E	7.4

56kg/ha was applied. The maximum seed cotton yield is 3981kg/ha was obtained by applying 196kg/ha at Cotton Research Station, Multan.

Table 13.YIELD PERFORMANCE OF MNH – 786 UNDER DIFFERENT DOSES OF NITROGEN

NITROGEN (Kg/ha)	YIELD kg ha^{-1}
0	1352.0
56	1543.0
84	1832.0
112	2833.0
140	2370.0
168	3115.0
196	3981.0

The effect of mineral nutrient supply increase in photosynthate supply to the sink sites (Borowski, 2001). The effect of nitrogen with foliar spray of potassium and mepiquat chloride increase the no. of bolls/Plant, boll wt, seed index, lint index and seed cotton yield/ Plant (Zakaria *et al*, 2006). The seed cotton yield is influenced by no. of bolls per unit area and boll wt. Both crop growth rate and fruiting were enhanced by nitrogen fertilization (ogunlela *et al*, 2005).

SOWING DATE TRIALS

The data presented in Table–14 showed that MNH-786 gave the highest yield of seed cotton in the sowing date on 01-05-06, closely followed 15-05-06. So the best sowing date is from 1st to 15th may

Table 14.YIELD PERFORMANCE OF MNH – 786 UNDER DIFFERENT SOWING DATES 2006-07

Dates	MNH-786	CIM-496	% INC/DEC.
01-05-06	3898	1149	239.3
15-05-06	3564	1436	148.2
01-06-06	2535	1435	76.7
15-06-06	1440	800	80
01-07-06	560	270	107.4
LSD (0.05)	558.2		

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INDIGENOUSE EVOLUTION OF DETERMINANT AND HIGH YIELDING UPLAND COTTON VARIETY CIM-534

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ABSTRACT

The new variety CIM-534 has been evolved through hybridization at Central Cotton Research Institute, (CCRI) Multan. CIM-534 gave significantly higher yield in varietal trials compared with all commercial varieties. CIM-534 was also evaluated in varietal and Zonal Varietal Trials at farmers' fields and Govt. Farms. In varietal trials CIM-534 gave 6.7%, 12.9%, 17.6%, 12.0%, 10.7%, and 16.9%, increase over commercial varieties CIM-496, NIAB-111, CIM-506 CIM-499 CIM-473 and FH-1000, respectively for seed cotton yield (Table-1). While in Zonal varietal trial CIM-534 gave 2.3% and 2.6% increase in yield of seed cotton over standard varieties CIM-496 and CIM-506, respectively during 2005-06 (Table-2). While during 2006-07 CIM 534 gave 2.7% and 4.5% increase in seed cotton yield over commercial varieties, i.e. CIM-496 and CIM-506, respectively. In National Co-ordinated Varietal Trial (NCVT) CIM-534 surpassed commercial variety CIM-499 during 2004-05 in Punjab. CIM-534 possesses desirable traits i.e., high ginning outturn percentage, better fibre qualities and spinning performance. The commercial cultivation of this variety will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of good quality raw cotton and superior value added products.

KEY WORDS: Evolution, High Yielding, Early Maturing and Cotton

INTRODUCTION

Cotton being the major cash crop of Pakistan plays an important role in the national economy, providing employment to million of people, raw material for basic industry of the country and a source of foreign exchange earning.

The research on cotton is mainly subjected to develop high yielding, early maturing varieties with better fibre characteristics, resistant to prevailing insect pests, diseases and more suited to the local agro-climatic conditions. A number of varieties have been released since long but with the passage of time varieties become susceptible to those diseases for which those varieties are evolved. Therefore, it is the cry of the day to evolve decent varieties which could face the problems of present scenario.

Efforts have been directed towards producing high yielding and early maturing varieties without losing of quality fibre's traits. Hundreds of crosses attempted for this purpose has yielded a new variety CIM-534, which is early maturing, possesses higher yield potential, better Ginning-

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out turn and excellent fibre characteristics compared with the existing commercial varieties. It is capable of spinning on higher counts of yarn for producing quality fabrics. It is hoped that the approval and release of this variety for commercial cultivation will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of quality raw cotton and superior quality products.

Ahmad et al. (1982) obtained highly significant differences in yield of upland cotton due to varieties. Soomro et al. (1986) reported significant differences in yield, ginning out turn %age and staple length for varieties. Khan et al. (1989) also observed significant differences in yield, ginning outturn %age and staple length for varieties. Afzal et al. (2001) studied that there were highly significant variations among years, genotypes (varieties) and year x genotypes interaction for number of bolls per plant, boll weight and seed cotton yield. Hanif et al. (2001) also reported significant variations in seed cotton yield due to varieties. Afzal et al. (2002) reported significant differences in yield, boll weight, number of bolls per plant and plant height due to difference in genotypes (varieties). Khan et al. (2002) found that varietal variation affect plant characters up to high extent in upland cotton. Arshad et al. (2003) search out significant variation for various traits like seed cotton yield, number of bolls, boll weight etc due to the use of various genotypes. Arshad et al. (2003) found significant variation for various characters like ginning out percentage, staple length, number of bolls and boll weight due to the use of different genotypes. Arshad et al. (2003) studied that varieties affect the yield of seed cotton significantly. Arshad et al. (2003) search out significant variation in cotton crop due to the use of different varieties.

The damage of cotton leaf curl virus has been minimized as a result of the evolution of CLCuV resistant varieties i.e., CIM-1100, CIM-448, CIM-443, CIM-446, CIM-482, CIM-473, CIM-499, CIM-534, CIM-707, CIM-506 and CIM-496 for the first time in the history of the country by the scientists of Central Cotton Research Institute, Multan. Later on, Cotton Research Institutes/Stations of Punjab and Federal Government, respectively, evolved CLCuV resistant varieties i.e., FH-634, FVH-53, FH-900, FH-901 FH-1000, NIAB-999, NIAB-111, BH-160 NIBGE-2 and MNH-786 up to 2006.

The commercial cultivation of this early maturing, medium long staple and up to some insect pest tolerant variety, CIM-534 will significantly contribute to the overall cotton production as well as earn more foreign exchange through the export of raw cotton and superior quality products.

MATERIALS AND METHODS

PARENTAGE/PEDIGREE

The new variety CIM-534 has been developed through the hybridization from a cross indicated below,

{5-4/94 (local line) x CIM-1100}

BREEDING HISTORY

The cross was attempted in the year 1995-96 at Central Cotton Research Institute, Multan. Pedigree selection procedure was used to sort out desirable genotypes from segregating population and lines with similar morphology, fibre and seed characters were selected. The strain was bulked in 2001-02 in F_6 generation. CIM-534 passed through a series of yield trials viz. multi-locational varietal trials, zonal varietal trials at farmers' fields and Govt. farms, Coordinated varietal trials i.e., National Coordinated Varietal Trials (NCVT) of Pakistan Central Cotton Committee and Director Cotton Research (DCR) Trials of the Punjab Government.

RESULTS AND DISCUSSIONS

VARIETAL TRIALS

The new variety CIM-534 was tested in replicated Varietal Trials at Central Cotton Research Institute, Multan and its Testing Centres against commercial varieties 1-5 years, respectively. The data presented in Table-1 shows that on the basis of five years average i.e., 2002-06, it gave higher seed cotton yield (4169 kg ha^{-1}) compared to commercial varieties CIM-496, NIAB-1111, and CIM-506, CIM-499 CIM-473 and FH-1000 i.e., 3907, 3978, 3544, 3777, 3625, and 3340 kg ha^{-1}, respectively.

Table-1. Yield performance of CIM-534 in varietal trials at Central Cotton Research Institute, Multan during 2002 to 2006

Year	Name of Trial	Location	Varieties & yield of seed cotton kg ha^{-1}							C.D 5 %
			CIM-534	CIM-496	NIAB-111	CIM-506	CIM-499	CIM-473	FH-1000	
2002-03	VT-3	Multan	4353	-	-	-	-	3839	-	
		Khanewal	3888	-	-	-	-	3629	-	
		Average	**4121**	-	-	-	-	**3785**	-	44.27
2003-04	VT-3	Multan	4316	-	-	-	3828	3658	3411	
		Khanewal	3493	-	-	-	3555	3369	3268	
		Average	**3905**	-	-	-	**3692**	**3514**	**3340**	58.43
	2 Years Average		**4013**	-	-	-	-	**3625**	-	
2004-05	VT-2	Multan	4800	-	4350	4586	3985	-	-	
		Khanewal	4318	-	3795	3981	3737	-	-	
		Average	**4559**	-	**4073**	**4284**	**3861**	-	-	58.18
	2 Years Average		**4232**	-	-	-	**3777**	-	-	
2005-06	VT-2	Multan	4350	4153	3922	4005	-	-	-	
		Khanewal	4489	4021	3842	3962	-	-	-	
		Average	**4420**	**4087**	**3882**	**3984**	-	-	-	83.47
	2 Years Average		**4490**	-	**3978**	**4134**	-	-		
2006-07	VT-2	Multan	4016	3815	-	3148	-	-	-	-
		Khanewal	3820	3640	-	3059	-	-	-	-
		Average	**3918**	**3728**	-	**3104**	-	-	-	87.64
	2 Years Average		**4169**	**3907**		**3544**	-	-	-	-
	% increase over		-	**6.7**	**12.9**	**17.6**	**12.0**	**10.7**	**16.9**	-

ZONAL VARIETAL TRIALS

CIM-534 was also evaluated in Zonal Varietal Trials at Government farms as well as with the progressive growers in different ecological zones for the year 2005-06 (Table-2a), in which CIM-534 gave 2.3% and 2.6% increase over CIM-496 and CIM-506 at twenty locations. While during the year 2006-07 again CIM-534 gives 2.7% and 4.5% increase over CIM-496 and CIM-506 for seed cotton yield (Table-2b) at twenty different locations.

Table-2(a). Yield performance of CIM-534 in Zonal Varietal Trial at farmers' fields during 2005-2006

Sr. No	Name of growers/locations	Varieties& Seed cotton yield kgha^{-1}		
		CIM-534	CIM-496	CIM-506
1	Mian Abdul Rasheed, Mian Pur	3505	3700	3605
2	Malik Manzoor Ahmad, Basti Malook	3610	3505	3470
3	Malik M. Mushtaq, Rawan	3500	3470	3480
4	Khuda Bux, 19-Kasi, Multan	3580	3520	3511
5	Tariq Mahmood Bhutta, 6-Faiz, Multan	3667	3651	3622
6	Mian Abbas Qureshi, Kot Addu	3810	3770	3725
7	Mian M. Mahbub Qureshi, Kot Addu	3775	3780	3715
8	Brig.® G.M. Khan, T. Gurmani	4017	3870	3790
9	PSC Farm, 86-87, Khanewal	4010	3925	3900
10	Ch. M. Akram, Basti Malook	3560	3520	3530
11	Mian Saeed Akhtar, 41-R, Khanewal	3599	3550	3540
12	Ch. Rehmat Ali, 88/10-R, KWL	3677	3640	3600
13	Mian M Naeem, Mailsi	3440	3450	3400
14	Haji Allah Ditta, Kukar Hatta	3690	3641	3651
15	Sh. Zaheer Ahnmad, Burewala	3555	3515	3594
16	Ch. Sher Bahadar, 225/EB Burewala	3370	3310	3340
17	Mr. M. Hanif, 108/7-R, Sahiwal	3015	2470	2530
18	Ch. Ramzan Ahmad, Hasilpur	3862	3800	3810
19	G. Mustafa Chatta, Uch Sharif	3450	3460	3402
20	Ch. M. Ikram, R.Y. Khan	4201	4000	4100
	Average	**3660**	**3577**	**3567**
	% increase over		**2.3**	**2.6**

Table-2(b). Yield performance of CIM-534 in Zonal Varietal Trial at farmers' fields during 2006-2007

Sr. No	Name of growers/locations	Varieties& Seed cotton yield kgha^{-1}		
		CIM-534	CIM-496	CIM-506
1	Haji Tariq Mahmood Bhutta, 6-Faiz, Multan	4025	3880	3750
2	Ch. Ghohar Ali, Makhdum Rasheed	3517	3471	3500
3	Ch.. Muhammad Hanif 108/7R, Sahiwal	3018	3111	3016
4	Ch. Muhammad Saddiq, 17/11R, Sahiwal	3217	3024	3167
5	Mr. Khuda Bux, 19 Kasi, Multan	4060	3880	3790
6	Mr. Muhammad Saleem, Jalla Arian, Lodhran	3516	3440	3390
7	Mian Mehboob Qureshi, Kot Addu	3720	3800	3610
8	Mian Abbas Qureshi, Kot Addu	3470	3500	3370
9	Mr. Muhammad Tahir, Lodhran	3990	3790	3670
10	Ch. Muhammad Akram, Lodhran	3260	3150	3162
11	Mr. Shahid Manzoor Khanpur	3515	3523	3413
12	Ch. Rehmat Ali, 88/10-R, KWL	3016	2825	2800
13	Mr. Aleem Ahmad Khan, Tounsa	3760	3540	3340
14	Sh. Zaheer Ahmad, Burewala	3565	3400	3440
15	Ch. Sher Bahdar 255/EB, Burewala	3138	3017	3110
16	Haji Allah Ditta, Kukar Hatta	3160	3060	2925
17	Ch. Ramzan Ahmad, Hasilpur	3951	3750	3800
18	Mr. Ghulam. Mustafa Chatta, Uch Sharif	3790	3800	3670
19	Ch. M. Ikram, R.Y. Khan	4260	4140	4070
20	Jamil-ur-Rehman Bazdar, Rajanpur	4070	3990	3900
	Average	**3601**	**3505**	**3445**
	% increase over		**2.7**	**4.5**

REGIONAL ADAPTABILITY TRIALS

National Coordinated Varietal Trials

CIM-534 was included in National Co-ordinated Varietal Trials for two years i.e., 2004-05 and 2005-06. The yield data for the year 2004-05 given in Table-3 indicated that, in Faisalabad region CIM-534 out yielded the commercial variety yielding 2233 kg ha^{-1} compared with the standard variety CIM-499 (1969kg ha^{-1}).

On the basis of average of all the locations in Punjab CIM-534 again gave higher yield (2956 kg ha^{-1}) compared with standard variety CIM-499 (2535 kg ha^{-1}).

CIM-534 was also included in NCVT during 2005-06. The yield data presented in Table 3(a) revealed that on the basis of average of 9 locations of the Punjab, CIM-534 gave higher yield (3072 kg ha^{-1}) compared with 2818 kg ha^{-1} of the standard variety CIM-499.

Table-3. Yield Performance of new strains in National Coordinated Varietal Trial at different locations during 2004-2005

FAISALABAD ZONE

Code No.	Varieties	Location & yield kg ha^{-1}				
		NIAB, FSD	CRS, Sahiwal	CRI, FSD	NIABGE FSD	Average
V-1	CIM-496	2175	2154	2271	3001	2400
V-2	CRIS-460	2657	3124	1217	2434	2358
V-3	FH-115	2848	1831	2023	2627	2332
V-4	NIAB-884	4093	1832	2276	3144	2836
V-5	MJ-7	3924	2514	1953	2353	2686
V-6	**CIM-534**	**2826**	**1939**	**1862**	**2306**	**2233**
V-7	CRIS-461	3274	3270	1421	2755	2680
V-8	FH-2000	1917	2765	1285	2272	2060
V-9	NIAB-98	3162	2803	1902	3734	2900
V-10	H-151-F2	2949	3380	1494	2220	2511
V-11	**CIM-499**	**2198**	**1293**	**1862**	**2522**	**1969**
V-12	TH-41/83	1671	2083	875	2251	1720
V-13	BH-162	2994	2298	2005	3297	2649
V-14	PB-899	2399	2766	1556	2441	2291
V-15	Neelum-NS-11	4384	2299	1661	1857	2550
V-16	SLH-279	2859	4022	1417	2264	2641
V-17	NIBGE-2	2063	3089	2096	3469	2679
V-18	MNH-700	2736	1831	1247	2625	2110
	CD 5%	806.7	194.9	610.0	144.4	

MULTAN ZONE (2004-05)

Code No.	Varieties	Location & yield kg ha^{-1}							Average Punjab
		CCRI Multan	CRS Multan	CRS Vehari	PSC KWL	CRS B. Pur	CRS RYK	Average	
V-1	CIM-496	4485	3398	3095	4089	2649	3274	3498	3059
V-2	CRIS-460	3656	2743	3261	2905	1896	4117	3096	2801
V-3	FH-115	4532	3577	3357	3911	2661	3328	3561	3069
V-4	NIAB-884	4094	3057	3378	4019	2811	3247	3434	3195
V-5	MJ-7	4351	3075	2355	3922	2177	2835	3119	2946
V-6	**CIM-534**	**4591**	**3479**	**2893**	**4154**	**2111**	**3400**	**3438**	**2956**
V-7	CRIS-461	3816	3254	2856	2825	2033	3499	3047	2900
V-8	FH-2000	3869	2923	2981	3078	2123	3229	3034	2644
V-9	NIAB-98	4201	3218	3101	3239	2482	3095	3223	3093
V-10	H-151-F2	3758	4303	3698	3013	2823	3588	3531	3123
V-11	**CIM-499**	**4290**	**2322**	**1890**	**3331**	**2183**	**3463**	**2913**	**2535**
V-12	TH-41/83	3587	2654	2287	2809	1854	2781	2662	2285
V-13	BH-162	4311	3326	3027	3341	2811	3220	3339	3063
V-14	PB-899	3482	3380	3095	3255	3050	3956	3370	2938
V-15	Neelum-NS-11	4507	3828	3027	4212	2248	3158	3497	3118
V-16	SLH-279	4430	2860	3900	3535	2661	3570	3493	3151
V-17	NIBGE-2	4165	3523	3324	3777	2811	3050	3442	3137
V-18	MNH-700	3936	3192	2704	3470	2309	3651	3210	2770
	CD 5%	168.1	623.8	472.9	130.9	599.1	347.7		

Table-3(a). Yield Performance of new strains in National Coordinated Varietal Trial at different locations during 2005-2006

FAISALABAD ZONE

Code No.	Varieties	Location & Yield Kg ha^{-1}				
		NIAB FSD	Sahiwal	CRI FSD	NIBGE	Ave
V-2	BH-162	4380	2574	2031	2335	2830
V-3	NIAB-884	5088	3190	2314	1577	3042
V-4	MJ-7	4860	3498	1962	2007	3082
V-5	TH-84/99	3794	2575	1930	1648	2487
V-6	FH-115	4058	3036	2105	1713	2728
V-7	NIAB-824	4956	3171	2240	2244	3153
V-8	MNH-789	3789	3959	1963	1859	2892
V-9	**CIM-534**	**4375**	**3383**	**2140**	**2234**	**3033**
V-10	FH-207	4362	3613	2114	2181	3068
V-11	CRIS-466	5091	3844	2166	1836	3234
V-12	MNH-786	3726	4313	1841	1425	2826
V-13	PB-899	5135	4136	2532	2126	3482
V-14	H-151-F2	4364	3960	2815	2299	3359
V-15	CRIS-461	4494	4036	2454	2227	3303
V-16	TH-35/99	4828	3921	2671	1704	3281
V-17	NIBGE-4	4319	3429	2143	2381	3068
V-18	**CIM-499**	**4548**	**2845**	**2267**	**2026**	**2921**
V-19	GH-99	4096	2345	1854	1206	2375
V-20	CIM-538	4855	2730	2478	1819	2970
	CD 5%	390.727	570.263	463.319	120.642	

MULTAN ZONE

Code No.	Varieties	Location & Yield Kg ha^{-1}						Punjab Ave
		CCRI Multan	CRS Multan	CRS Vehari	PSC Kwl	CRS R.Y.Khan	Ave	
V-2	BH-162	3515	2242	2623	2932	2131	2689	2751
V-3	NIAB-884	3534	1883	2757	3336	2275	2757	2884
V-4	MJ-7	3664	2452	2555	2878	2104	2731	2887
V-5	TH-84/99	2186	1206	2623	2717	1026	1952	2189
V-6	FH-115	3807	1994	2757	2852	2079	2698	2711
V-7	NIAB-824	3622	1923	3026	2340	2212	2625	2859
V-8	MNH-789	3697	3209	2858	2959	2267	2998	2951
V-9	**CIM-534**	**4719**	**2322**	**2858**	**3632**	**1986**	**3103**	**3072**
V-10	FH-207	4164	2491	2757	2771	2741	2985	3022
V-11	CRIS-466	3534	2162	3228	2932	2784	2928	3064
V-12	MNH-786	3485	3428	3329	3013	3102	3271	3073
V-13	PB-899	3554	2680	2757	3094	2903	2998	3213
V-14	H-151-F2	3837	2930	3161	3201	2856	3197	3269
V-15	CRIS-461	3559	2352	2791	2932	2702	2867	3061
V-16	TH-35/99	3357	2471	3295	2905	2541	2914	3077
V-17	NIBGE-4	4323	2491	2757	2905	1878	2871	2959
V-18	**CIM-499**	**3878**	**1893**	**2656**	**3013**	**2238**	**2736**	**2818**
V-19	GH-99	3161	384	2219	2986	1489	2048	2193
V-20	CIM-538	4226	2143	2556	3255	1933	2822	2888
CD 5%		124.064	586.092	639.017	165.258	608.166		

Director Cotton Research (DCR) Trials

DCR Trials

CIM-534 was evaluated in DGR Trials for two years i.e., 2004-05 and 2005-06 by the Punjab Government. The yield data for the year 2004-05 given in Table-4(a) revealed that on the basis of average of all 15 locations CIM-534 gave seed cotton yield of 2625 kg ha^{-1} which is higher than both standard varieties CIM-473 (2587 kg ha^{-1}) and FH-1000 (2379 kg ha^{-1}).

The yield data for the year 2005-06 given in Table 4(b) revealed that CIM-534 gave the higher yield (2024 kg ha^{-1}) compared with standard variety FH-901 (2008 kg ha^{-1}).

Table-4a. Yield performance of new strains (Kg ha^{-1}) in DGR Trial during 2004-2005

Sr. No.	Varieties	CRSS Sargodha	CRI FSD	NIAB FSD	Agri. Uni.FSD	CRS Sahiwal	ARS KWL	CRSS KWL	PSC KWL	CRS Vehari	CRS Multan	CCRI Multan	CRS Bahawal pur	ARS Bahawal nagar	CRI RYK	CRSS Khan pur	Average
1	FH-2006	1805	848	1794	1722	1435	2711	2022	2332	2400	2281	2943	1752	2613	2857	160	2072
2	FH-2000	2265	1542	2422	976	1854	2830	1854	2452	2800	2754	4174	2350	2562	2358	150	2323
3	FH-115	1895	1951	3379	2157	2093	2920	2238	3648	3500	3515	3923	3109	3586	2588	139	2816
4	NIAB-884	2243	2392	4216	1492	1375	2775	2752	3468	2700	2755	4296	2416	3484	2537	175	2712
5	MNH-732	2713	1689	2362	1297	1434	2512	2106	3050	2710	2755	4367	2488	3125	2627	111	2470
6	MNH-700	2433	1734	3199	2077	1615	2432	2333	3110	3235	2941	4313	2422	2767	2460	114	2579
7	MNH-768	1839	1792	3229	1888	1914	2472	2573	2691	3035	3644	4274	2547	2818	2652	145	2581
8	RH-510	1974	816	2033	1349	2093	1874	2010	2811	3035	3830	4536	2081	3740	2947	175	2460
9	SLH-279	2366	1650	3289	930	3647	2352	2776	3110	2510	3041	3870	2607	4150	3229	153	2732
10	VH-148	2288	2692	3468	2559	1854	2631	2692	3229	3750	2998	4525	2410	2920	2678	165	2837
11	BH-162	1828	1610	3498	2123	1495	2392	2357	3468	2710	2482	4161	2272	3228	2114	104	2496
12	BH-163	2108	1292	3259	1205	1255	2727	2154	3050	2525	3199	3515	2763	2920	2358	114	2396
13	**CIM-534**	**1928**	**1527**	**3110**	**1641**	**1855**	**2647**	**2393**	**3409**	**3030**	**3859**	**4612**	**2207**	**3330**	**2358**	**170**	**2625**
14	CIM-496	1553	2140	4156	2043	1615	2512	2668	3528	3575	3027	4553	2201	2669	2627	199	2684
15	RH-512	1929	1193	2272	1343	1913	2671	2213	3349	3040	2841	3991	2105	2971	2563	194	2366
16	NIAB-824	1817	1936	3289	1136	2511	2671	2932	3409	2910	2927	4221	2129	2766	2627	142	2588
17	ALSEEM I-H-151	2332	1835	3588	1744	2810	2352	2513	3289	3210	3544	3990	2691	3228	3524	129	2832
18	**CIM-473**	**2725**	**1422**	**3169**	**2295**	**2392**	**1634**	**2213**	**3169**	**2725**	**3199**	**3887**	**2045**	**2869**	**3396**	**168**	**2587**
19	**FH-1000**	**1615**	**1935**	**3558**	**1985**	**1795**	**1754**	**2572**	**3468**	**2740**	**2625**	**4125**	**2117**	**1998**	**2089**	**109**	**2379**
20	FH-2925	2893	1324	2781	1865	2219	1746	2369	3409	2150	3257	3220	2009	2152	3024	186	2407
21	NIBGE-2	1649	1565	2900	2204	2153	2368	2322	2990	3200	3357	4015	2242	2715	2294	155	2482
22	PB-843	2366	1138	2811	2123	2273	2145	2058	3229	3310	3443	3696	2344	3586	3203	262	2653
23	PB-899	2803	1791	3199	1917	3109	2488	2333	3528	3505	3371	4004	2440	2869	2716	139	2788
24	MJ-7	2196	1814	3708	2031	2392	2280	2273	3050	2705	3070	4290	2087	3791	1679	186	2603

Table-4b. DCR TRIAL IN PUNJAB DURING 2005-06 (YIELD Kg ha^{-1})

Sr.	Varieties	CRI	ARI	CRSS	CRSS	CRS	ARS	PSC	CRSS	CRS	CRS	ARS	ARS	CRSS	CRSS	CRI	CCRI	NIBGE	NIAB	Average
No.		FSD	FSD	Jhang	SGD	Sahiwal	KWL	KWL	KWL	Multan	B.Pur	B.Pur	Karore	K.Pur	T.Gur.	RYK	Multan	FSD	FSD	
V-1	SLH-284	2388	1488	329	1268	2126	2816	3407	2022	1700	861	1305	453	1006	2172	2723	3200	1323	4442	1946
V-2	PB-889	2543	1400	1384	1398	2179	3048	3346	1854	2072	969	1534	715	2406	1827	2099	3533	1229	4152	2094
V-3	NIAB-846	3037	1424	1038	1844	2232	2460	3468	2238	1089	538	1237	382	2083	1742	1674	2768	1248	4149	1925
V-4	FH-113	2946	3077	1401	1692	2397	2091	3468	2752	1939	789	1389	1280	2352	2733	2809	3056	1016	4751	2330
V-5	**CIM-534**	**2124**	**1407**	**519**	**1485**	**2020**	**3212**	**3346**	**2106**	**1368**	**825**	**1632**	**233**	**1523**	**1637**	**2034**	**4455**	**1297**	**5209**	**2024**
V-6	SLH-317	2448	1421	1453	1361	1914	2433	3526	2333	1660	789	1258	667	1738	2336	2212	3772	1091	4927	2074
V-7	VH-156	2872	1066	726	1464	2232	3246	3407	2573	1673	753	1297	400	1383	2450	1889	3272	963	3865	1974
V-8	H-151	2852	1986	2041	1735	2764	2781	3346	2010	2511	1076	1552	1440	2368	1146	2320	4107	881	4315	2291
V-9	CIM-538	2398	1697	311	1453	2126	2569	3468	2776	1434	502	1178	196	1437	1243	1459	4358	1112	3595	1851
V-10	FH-115	2296	1710	242	1323	1914	2228	3289	2692	1408	610	1316	231	1884	2273	1948	2279	1107	4001	1820
V-11	MNH-786	2285	1252	1436	1633	2073	2898	3407	2992	2657	897	1527	684	1921	2580	2562	3309	917	4497	2196
V-12	BH-162	2167	1401	536	1410	1861	2884	3407	2154	1554	502	1200	429	1706	2423	2212	2616	1090	2999	1808
V-13	FH-207	2197	1226	1159	1312	2126	2775	2988	2393	1249	574	1255	329	2637	2040	1927	3023	1181	4991	1966
V-14	VH-148	2338	2195	848	1833	2020	3649	3346	2668	1036	789	1474	338	1975	2470	2842	2936	934	4408	2117
V-15	MNH-789	1984	1091	917	1284	1967	2132	3346	2953	2524	861	1158	231	2223	2531	1932	3262	984	3843	1957
V-16	NIAB-884	2621	1414	657	1447	2285	2529	3827	2932	1329	538	942	284	2007	2370	1711	3451	943	4022	1962
V-17	BH-164	1855	1347	623	1312	2126	1968	2869	2513	691	359	1027	124	1937	2082	1389	1905	804	2679	1534
V-18	NIAB-824	2509	1367	1263	1622	2339	2911	3468	2213	1554	682	1151	604	2223	1800	2287	3212	1154	3824	2010
V-19	N-4	1641	1300	225	1632	2285	2105	3407	2572	1820	538	1107	217	1868	2050	1835	4489	1336	4276	1928
V-20	**FH-901**	**2743**	**1030**	**1159**	**1676**	**2126**	**2474**	**3407**	**2369**	**1833**	**718**	**1485**	**578**	**1937**	**2550**	**1943**	**3016**	**1141**	**3956**	**2008**
V-21	SLH-279	2391	1044	1142	1273	2020	2146	3346	2262	1368	897	1244	555	2099	2183	1997	3674	1347	4428	1968
V-22	MJ-6	2109	1198	917	1610	1807	2501	3526	1998	571	603	1045	180	1884	2047	1378	2435	953	4094	1714
V-23	RH-511	2330	1064	657	1182	1648	2125	3586	2333	1355	1077	1235	622	2115	2387	1744	2396	1063	3578	1805
V-24	MJ-7	2753	1508	1090	1578	2179	3526	3289	2273	1355	718	1355	320	1991	2387	1911	3046	854	4483	2034
LSD (0.05)		737	263	408	367	210	463	245	435	708	303	349	38	897	107	811	194	61	1043	

GINNING OUT TURN AND FIBRE CHARACTERS

CIM-534 had 40.1% ginning out turn 29.0mm staple length and prime mike of 4.5 ug inch^{-1}, 97.2 tppsi fibre strength, 1.02 maturity ratio and 48.4% uniformity ratio. CIM-534 had 2208 counts lea strength product (CLSP) value at 50 counts and falling in A grade (Table-6).

Two year's average of GOT% and other fibre traits reports of cotton sample collected by expert sub-committee of PSC on the eve of spot examination during the years 2004 and 2005.

Table-5. Two year summary of fibre test report

Variety	Year	G.O.T. (%)	Staple length (mm)	Micronaire	Fibre strength (g/tex)
CIM-534	2005-06	41.6	28.9	4.1	-
	2006-07	39.6	29.0	4.7	29.5
	Two year average	**40.6**	**29.0**	**4.4**	**29.5**
NIBGE-2	2005-06	37.1	29.2	4.9	-
	2006-07	35.3	28.0	5.1	29.1
	Two year average	**36.2**	**28.6**	**5.0**	**29.1**
MNH-786	2005-06	39.2	27.0	5.0	-
	2006-07	38.1	27.4	5.1	30.8
	Two year average	**38.7**	**27.2**	**5.1**	**30.8**

Table-6. Summary of salient characteristics of CIM-534

Sr. No.	Characters	Varieties				
		CIM-534	CIM-496	NIAB-111	CIM-506	CIM-499
1.	Yield of seed cotton (kg ha^{-1})	4169	3907	3978	3544	3777
2.	Ginning out turn (%)	40.1	41.4	36.1	38.7	40.1
3.	Staple length (mm)	29.0	29.1	29.6	28.5	29.5
4.	Micronaire value (µg inch^{-1})	4.5	4.8	4.4	4.6	4.5
5.	Fibre strength (tppsi)	97.2	92.6	92.2	101.1	94.9
6.	Maturity ratio	1.02	1.06	0.99	1.03	0.98
7.	Uniformity ratio (%)	48.4	48.0	47.7	48.2	47.8

PLANT CHARACTERS

The data of plant characters i.e., plant height, number of monopodial and sympodial branches, maximum boll weight, average boll weight and number of bolls per plant presented in Table-7 indicated that on an average of two years, CIM-534 had 138 cm plant height, 1.6 and 29.0 monopodial and sympodial branches per plant, respectively. It possessed 3.9g maximum boll weights, 3.5g average boll weight and 44.0 bolls plant^{-1}.

Table-7. Plant Characters Of Cim-534 Recorded During 2004 And 2005

Year	Trial	CIM-534	CIM-496	CIM-506	NIAB-111
Plant height (cms)					
2004	VT-2	129	-	111	115
2005	VT-2	148	152	131	157
Average		**138**	**152**	**121**	**136**
No. of monopodial branches plant^{-1}.					
2004	VT-2	1.4	1.4	5.2	4.7
2005	VT-2	1.7	1.4	5.0	5.2
Average		**1.6**	**1.4**	**5.1**	**5.0**
No. of sympodial branches plant^{-1}.					
2004	VT-2	28	-	21	26
2005	VT-2	30	28	23	23
Average		**29**	**28**	**22**	**25**
Boll weight (g) {average of good bolls}					
2004	VT-2	3.6	-	3.8	3.9
2005	VT-2	3.9	4.0	3.7	3.8
Average		**3.9**	**4.0**	**3.8**	**3.9**
Average boll weight (g).					
2004	VT-2	3.5	3.2	3.4	3.5
2005	VT-2	3.4	3.2	3.3	3.4
Average		**3.5**	**3.2**	**3.4**	**3.5**
No. of bolls plant^{-1}					
2004	VT-2	45	-	42	39
2005	VT-2	42	41	40	38
Average		**44**	**41**	**41**	**39**

Entomological studies

Entomological studies on CIM-534 were conducted by the Entomology Section of Central Cotton Research Institute, Multan in host plant resistant trial to assess its tolerance level against jassid, whitefly, thrips and bollworm damage compared with commercial varieties CIM-496 and NIAB-111. Data on pest population under un-sprayed conditions shown in Table-8 indicated that the new variety CIM-534 has about equal level of tolerance against sucking insects and bollworm as that of commercial varieties CIM-496 and NIAB-111.

Table-8. Reaction of CIM-534 to sucking pests and bollworm damage at Central Cotton Research Institute, Multan during 2004-2005

Varieties	No. of insects/leaf			% bollworm damage	
	Jassid	Whitefly	Thrips	Spotted	Pink
CIM-534	2.14	0.72	0.76	7.67	52.0
CIM-496	2.62	0.77	0.62	8.26	53.0
NIAB-111	2.51	0.76	0.74	7.81	58.0

Pathological studies

Pathological studies of CIM-534 relating to cotton leaf curl virus (CLCuV) were conduced by the Pathology Section of Central Cotton Research Institute, Multan. The result of field screening of CIM-534 in National Coordinated Varietal Trials during 2004-2005 is given in Tabel-9. The data presented in this table showed that at CCRI Multan disease incidence ranged from 42.6% to 84.3%. At Cotton Research Station, Vehari all the cultivars showed high susceptibility to CLCuV ranging from 73.5% to 100%.

Table-9: Incidence of cotton leaf curl virus on new strains in National Coordinated Varietal Trials at CCRI., Multan & CRS, Vehari during 2004-2005

Strains	Location /CLCuV (%)		Average
	Multan	Vehari	
CIM-496	49.79	87.0	68.4
CRIS-460	45.62	93.8	69.7
FH-115	50.72	93.3	72.0
NIAB-884	54.20	95.0	74.6
MJ-7	48.25	92.5	70.4
CIM-534	**45.36**	**88.5**	**66.9**
CRIS-461	54.33	95.5	74.9
FH-2000	65.31	92.8	79.1
NIAB-98	60.99	96.3	78.6
H-151-F2	50.14	92.5	71.3
CIM-499	84.30	98.5	91.4
TH-41/83	49.62	97.0	73.3
BH-162	66.28	96.5	81.4
PB-899	52.97	94.3	73.6
Neelum NS-11	42.56	73.5	58.0
SLH-279	51.68	93.3	72.5
NIBGE-2	43.42	74.5	59.0
MNH-700	61.88	100.0	80.9

Agronomic studies

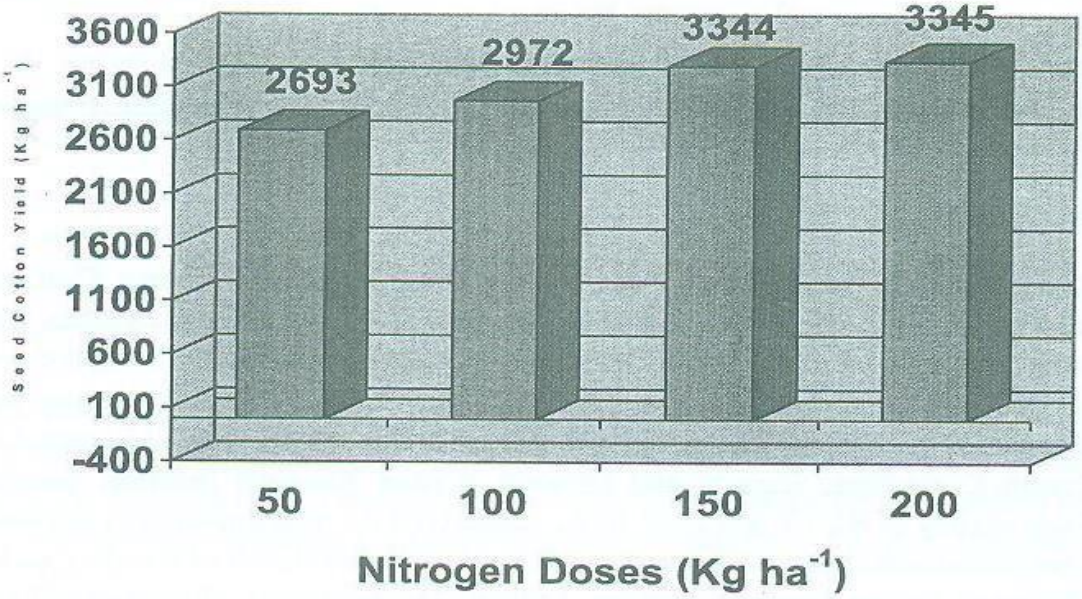
Fertilizer trial

The yield performance of CIM-534 was tested under four nitrogen levels i.e., 50, 100, 150 and 200 kg. N ha^{-1}. Data given in Fig-I indicated that CIM-534 gave highest yield of seed cotton (3344 kg ha^{-1}) with application of 150 kg N/ha. The yield was lowest in case of 50 kg N/ha^{-1} (2693 kg ha^{-1}). The differences between 150 and 200 kg N/ha were non-significant.

Sowing Date Trial

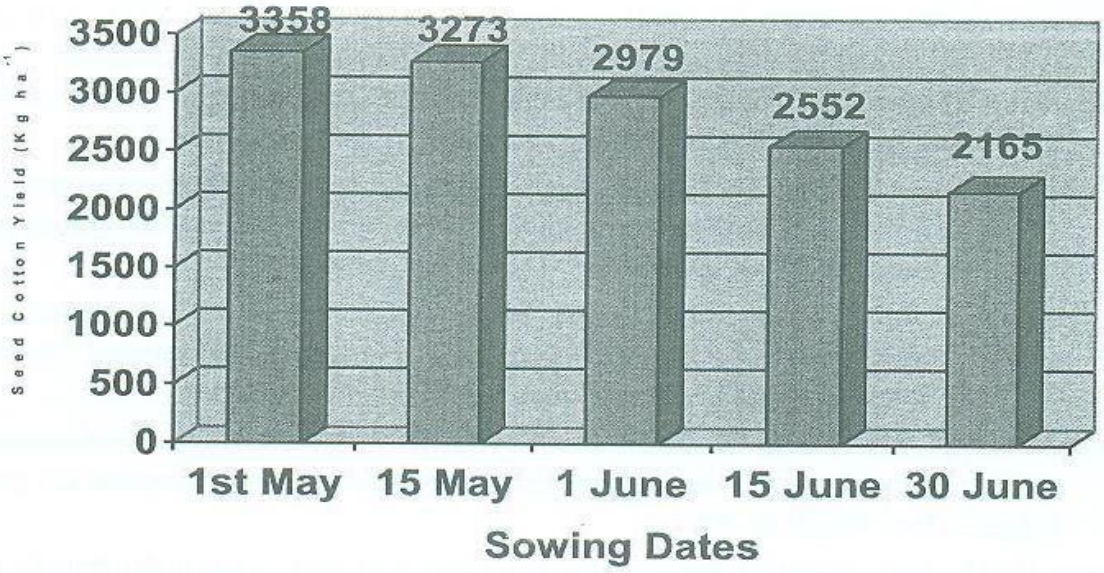
The data in Fig-2 showed that variety CIM-534 gave the highest yield of seed cotton (3358 kg ha^{-1}) in the sowing date on May, 01 followed by 3273 kg ha^{-1}) of sowing date May 15th. The yield successively declined in sowing done from 15th June and onward.

Fig. 1. YIELD PERFORMANCE OF CIM-534 UNDER DIFFERENT DOSES OF NITROGEN



LSD5% = 136.11

Fig. 2 YIELD PERFORMANCE OF CIM-534 UNDER DIFFERENT SOWING DATES



LSD5% = 134.23

SALIENT CHARACTERS OF CIM-534

1. It possesses good yield potential.
2. It has excellent fibre characteristics
3. It has higher lint percentage.
4. It is heat tolerant, early maturing and suitable for timely planting of wheat.
5. It is drought tolerant and has wider adaptability.
6. It is hairy and tolerant to the attack of jassid.
7. It has big boll size and very good opening.
8. Due to excellent fibre characteristics it has the ability to spin on higher count.

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Makhp-36 A

EFFECTS OF POTASSIUM NUTRITION ON PHOTOSYNTHETIC RATE AND GROWTH ATTRIBUTES ON COTTON (*Gossypium hirsutum L.*) UNDER IRRIGATED CONDITIONS

M. I. Makhdum[1], M. Ashraf[2], H. Pervez[3] and Shabab-ud-Din[1]

ABSTRACT

Development of a cotton (Gossypium hirsutum L.) crop is a full-season process involving a complex balance between vegetative and reproductive allocation. To understand better cotton plant for various physiological processes in response to potassium (K) nutrition, a field study was conducted under irrigated conditions. The treatments were consisted of (a) four cultivars (CIM-448, CIM-1100, Karishma, S-12), and (b) four K-rates (0, 62.5, 125.0, 250.0 K kg ha^{-1}). The experiment was laid out at silt loam soil on Miani soil series (fine silty, Calcaric Ccambisols, mixed Hyperthermic, Fluventic Haplocambids) at Central Cotton Research Institute, Multan, Pakistan. Plants were collected sequentially at five stages of growth, viz; first flower bud, first flower, peak flowering, first boll split and maturity. Net assimilation rate (NAR), crop growth rate (CGR) and relative growth rate (RGR) increased with concurrent increasing levels of K-rates. The values of NAR, CGR and RGR declined gradually as the season progressed. Leaf area duration (LAD) and leaf area ratio (LAR) were significantly affected by K-nutrition. The cultivars under test showed positive correlation co-efficient for K-rates with NAR, CGR, RGR, LAD and LAR.

Key words: Gossypium hirsutum L.; Potassium nutrition; Crop growth rate., Relative growth rate., Net assimilation rate; Leaf area duration.

INTRODUCTION

The quantitative analysis of plant growth have been found useful tool to determine genotypic environment interaction of plants. Several investigators (Bhagsari and Brown, 1986; Pettigrew et al. 1993) reported that growth analysis and their physiological parameters of cotton are functions of many factors such as varieties, management practices, nutritional status, insect control practices, soil types and other environmental factors.

Pholosynthesis plays an important role in cotton production (Wullschleger and Oosterhuis, 1990a). The increase in dry weight of crop depends primarily on the balance between photosynthesis and respiration called as net photosynthesis (net assimilation rate). The economic yield of crop

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depends on distribution of dry matter so produced by net photosynthesis between vegetative and reproductive organs. The earlier studies have shown a strong relationship between leaf nitrogen (N) concentration and photosynthesis (Wullschleger and Oosterhuis 1990b), which appears to be associated with the large fraction of leaf N associated with photosynthetic enzymes (Shiraiwa and Sinclair, 1993). With progression of the season, both leaf N and canopy photosynthesis declined due to leaf aging (Zhu and Oosterhuis, 1992). The decline in leaf N and photosynthetic capacity can be major limitations to cotton productivity as the yield of cotton is strongly influenced by photosynthesis (Wullschleger and Oosterhuis, 1990c).

Canopy photosynthesis also describes the photosynthetic activity per unit ground cover and combines genotype efficiency, leaf morphology and canopy architecture (Wells et al. 1986). Leaf area ratio (LAR) and leaf area duration (LAD) represent an integration of leaf area over ground coverage and its persistence in time. Once the exponential phase of canopy leaf area development is completed, individual leaves begin to senese, if not balanced by production of new leaves, contribute to a decline in canopy photosynthesis. (Kelly and Davies, 1988). Among various physiological processes influenced by nutrition, LAD and LAR have great relevance in understanding the process of yield formation. The other physiological processes such as relative growth rate (RGR) and crop growth rate (CGR) are the products of photosynthetic efficiency and leaf area ratio. Mauney (1986) reported that these indices of agricultural productivity are greatly affected by light, temperature, mineral nutrients and moisture. The contribution of leaf sensescence to declining canopy photosynthesis and to carbon availability for yield have been identified as a potential limitation in crop production (Wallschleger and Oosterhuis, 1992).

The N requirement and photsynthesis of cotton crop has been studied by various researchers (Wullschleger and Oosterhuis, 1990a; Oosterhuis et al. 1983), but information is lacking on potassium nutrition and canopy photosynthesis. A key to improving the efficiency of cotton productivity is to understand the influence of K on canopy photosynthesis and growth characteristics. Therefore, the objectives of this research were to determine effects of potassium nutrition on some physiological processes in irrigated cotton grown under an arid environment.

MATERIALS AND METHODS

A field experiment was conducted at Central Cotton Research Institute, Multan, Pakistan. Meteorological data for crop season are given in Table 1. The soil samples were collected before imposition of fertilizer treatments at planting time. The analyses soil samples were carried out according to the prescribed methods (Ryan et al., 2001). The soil was silt loam having alkaline in reaction (8.3 pH). The soil contained 0.67% organic matter, 7.2 mg kg^{-1} available-P and 80 mg kg^{-1} exchangeable-K in the top and 0 to 30 cm profile. The soil is moderately calcareous, weakly structured and developed in an arid sub-tropical continental climate in the areas of sub-recent flood plains. The soil is alluvium of mixed mineralogy with smectites and mica being dominant clay minerals followed by kaolinites and chlorites with various degrees of weathering. The soils belong to Miani soil series and classified as Calcaric Cambisols and fine silty, mixed

Hyperthermic Fluventic Haplocambids according to FAO (1990) and USDA Soil Classification (1998) systems, respectively.

The treatments consisted of (a) four cultivars (CIM-448, CIM-1100, Karishma, S-12); and (b) four potassium fertilizer rates (0.62.5, 125, 250 K kg ha^{-1}). The design of the experiment was split plot (main: cultivars, and sub-plot: K-doses. Crop was planted at a spacing of 75 cm between rows and 30 cm between plants in the rows. Crop also received 22 P kg ha^{-1} as triple superphosphate at planting and 150 N kg ha^{-1} as urea in three split doses, i.e. planting, flowering and peak flowering. The whole quantity of potassium and phosphorus was applied at the time of seedbed preparation and incorporated in the upper plough layer. Stomp-330E, 2.5 L ha^{-1} as pre-emergence herbicide was applied to control weeds. Crop was kept free from insect pest attack through regular sprays of common pesticides. Crop received normal irrigation and standard production practices of the area throughout the season.

The measurement on growth analysis was carried out through sequential harvests taken at five stages of growth, viz; first flower bud [at 28 days after planting (DAP)], first flower (at 61 DAP), peak flowering (at 94 DAP), first boll split (at 125 DAP) and maturity (at 153 DAP). The plants were brought to laboratory and partitioned into leaves, stalks and fruit. The material was dried in forced-air oven at 70 °C to a constant weight. Total dry weight per unit land area was recorded according to Hunt (1978). The growth parameters were calculated by following formulae of Radford (1967). Data were subjected to statistical analysis according to methods of Montgomery (1997).

RESULTS

Data for net assimilation rate (NAR) differed due to cultivars (Cv), and K-doses (D) and significant interaction between CvxD during the season (Table 1). The values of NAR differed significantly among the four cotton cultivars. Cultivar CIM-448 maintained the maximum NAR followed by Karishma>CIM-1100>and S-12 during the season. The NAR was the highest at first flower bud and then declined gradually as the season progressed in all cultivars. There was negative correlation co-efficient ($r = -0.93^{**}$) between NAR and stages of crop growth. The relationship could be described by an equation ($Y= 0.0063x^2-1.768x+135.73$). The addition of K-fertilizer caused significant increase in NAR during the season, the higher the soil K-level, the higher the NAR. After attaining the highest NAR at first flower bud stage, it declined with the age of crop in all the soil applied K-levels. The significant interaction between cultivar and K-dose during growth period depicted that genetic variation existed amongst them in response to K-fertilization (Table-1). Cultivar CIM-448 and Karishma were more efficient in utilizing K-nutrient compared in cvs. CIM-1100 and S-12.

Data for crop growth rate (CGR) differed significantly due to cultivars and K-doses and significant interaction between cultivars and K-doses (Table-1). The CGR continued to increase from first flower bud stage to first boll split stage and then declined at maturity. There was positive correlation co-efficient ($r= 0.49^{**}$) between CGR and stages of crop growth. The relationship could be described by an equation ($-7E-06x^3 + 0.0012x^2 -0.0012116–0.0003x+0.3662$). Cultivars

differed significantly in their CGR values. Cultivars CIM-1100 and CIM-448 maintained that almost similar CGR compared to cvs. Karishma and S-12. Cultivar CIM-1100 maintained CGR at an average of 3.97 compared to cv. S-12 at 2.51. The CGR increased with concurrent increase in K-fertilizer levels during the season. The maximum CGR (3.71) was maintained in crop fertilized with 250 kg K ha^{-1} and minimums to 3.12 under K-unfertilized crop. Moreover, there were significant interaction between cultivars and K-doses during growth period.

Data for relative growth rate (RGR) differed significantly because of cultivars and K-doses and significant interaction between cultivars and doses (Table-1). The values of RGR were higher at first flower bud stage and then declined gradually with advancement in age. There was negative correlation co-efficient (r= -0.57**) between RGR and stages of crop growth. The relationship could be described by an equation ($Y= -4E-07x^3 + 0.0001x^2 - 0.0157x + 0.6125$). The RGR values were increased under varying levels of K-fertilizers during first flower bud stage and then showed consistency during the later stages of growth. Moreover, the interaction between cultivar and K-doses demonstrate the wide variations in genetic make–up of various cultivars. (Table 1).

Data for leaf area duration (LAD) differed significantly due to cultivars and K-doses and significant interaction between cultivars and doses (Table-2). The values of LAD continued to increase from first flower bud stage to first boll split stage and then declined at maturity. The LAD was 21 at first flower bud and rose to 71 at first boll split and then declined to 42 at maturity. Cultivars differed greatly in their LAD values. The leaves of cvs CIM-448 and CIM-1100 endured for a longer period compared to cvs. Karishma and S-12. The persistence of leaves increased with increasing levels of K-fertilizer (Table 2). The crop fertilized with 250 K kg ha^{-1} retained leaves for a longer period compared to K-unfertilized treatment. Cultivars CIM-448 and CIM-1100 retained their leaves for a longer period than those of cvs. Karishma and S-12 under varying levels of K-fertilizer.

Data for leaf area ratio (LAR) showed similar trend to that of LAD (Table 2). The LAR increased gradually from first flower bud stage to first boll split and then declined at maturity. Cultivars differed significantly amongst themselves in their LAR values. Cultivar S-12 had higher LAR compared to other cultivars. The addition of K-fertilizer caused significant increase in LAR with increasing levels of K-fertilizer.

The various physiological traits showed positive significant correlation ($p<0.01$) between cultivars and K-rates in terms of various physiological parameters (Table 3)

DISCUSSION

The increase in net assimilation rate (NAR), crop growth rate (CGR), and relative growth rate (RGR) resulted due to enhanced translocation of nitrogen to leaves in the presence of sustained supply of K+ under varying K-levels (Mengel et al., 1976; Oosterhuis, 1990). The reason being that there is a great need for sufficient availability of K+ in soil- plant continuum to meet abrupt demand of K+ for boll development. The values of RGR declined under zero K-rate

treatment. These results clearly indicate that rate of remobilization of nutrient reserves varies with the nutrient status of the plant. This form of the relationship between RGR and plant nutrient concentration can vary depending upon whether a plant's external supplies or internal reserves of a particular nutrient are more limiting (Burns et al., 1997). Different researchers (Rosolem and Mikkelsem, 1991; Wullschleger and Oosterhuis, 1990b) found that bolls are the major sink for K+ during the reproductive development. In earlier studies, (Lauchli and Pflunger 1978; Wakhloo, 1980) reported that K movement in the plant is directed towards the meristematic zones of leaves and stems. Distribution and redistribution of assimilates in the plant are facilitated by the high mobility of K^+ in the plant and depended on the K+ supply to the root. The data for increase in persistence of leaves (leaf area duration) and leaf area ratio are supported by those of (Mengel et al., 1976; Oosterhuis et al., 1997) that addition of K-fertilizer resulted in increased uptake of N, which helped in longer persistence of leaves.

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Table 1: Effect of potassium fertilization on net assimilation rate, crop growth rate and relative growth rate in four cotton cultivars

Cultivar	Net assimilation rate ($mg\ dm^{-2}\ d^{-1}$)				Crop growth rate ($g\ m^{-2}\ d^{-1}$)				Relative growth rate ($g\ g^{-1}\ d^{-1}$)			
	[kg K ha^{-1}]				[kg K ha^{-1}]				[kg K ha^{-1}]			
	0	62.5	125	250	0	62.5	125	250	0	62.5	125	250
First flower bud												
CIM-448	96	97	100	103	0.91	1.14	1.20	1.29	0.43	0.49	0.52	0.56
CIM-1100	84	85	87	90	0.99	1.13	1.16	1.19	0.40	0.49	0.50	0.52
Karishma	96	99	101	103	1.04	1.15	1.17	1.24	0.45	0.50	0.51	0.54
S-12	65	74	77	80	0.84	0.88	0.97	1.00	0.36	0.38	0.42	0.43
LSD ($p<0.05$) Cultivar	4.15**				0.05**				0.02**			
Dose	3.61**				0.04**				0.02**			
Interaction	5.21**				0.07**				0.03**			
First flower												
CIM-448	60	61	63	65	3.80	4.05	4.39	4.47	0.077	0.078	0.078	0.078
CIM-1100	52	54	55	58	3.52	3.67	3.87	4.03	0.060	0.063	0.065	0.066
Karishma	57	60	61	62	3.20	3.39	3.58	3.83	0.059	0.060	0.062	0.062
S-12	37	43	43	47	3.11	2.48	2.52	2.83	0.053	0.058	0.058	0.058
LSD ($p<0.05$) Cultivar	0.23**				0.14**				0.003**			
Dose	0.14**				0.12**				0.002**			
Interaction	0.20**				0.16**				0.005**			
Peak flowering												
CIM-448	24	24	26	26	5.17	5.51	5.67	6.10	0.031	0.032	0.032	0.032
CIM-1100	16	18	19	20	3.63	3.72	3.91	4.13	0.028	0.028	0.028	0.028
Karishma	18	20	22	23	4.72	5.75	6.07	6.37	0.033	0.035	0.036	0.036
S-12	15	16	17	18	2.75	3.03	3.32	3.40	0.030	0.030	0.031	0.031
LSD ($p<0.05$) Cultivar	0.08**				0.18**				0.001**			
Dose	0.08**				0.22**				0.001**			
Interaction	0.17**				0.44**				0.002**			
First boll split												
CIM-448	14	19	21	22	539	5.63	5.77	6.20	0.020	0.021	0.021	0.021
CIM-1100	13	15	16	17	8.05	8.79	8.83	9.14	0.026	0.027	0.027	0.027
Karishma	14	17	20	22	3.19	3.66	3.80	3.96	0.018	0.019	0.019	0.020
S-12	12	13	15	16	3.29	3.46	3.69	3.92	0.021	0.021	0.021	0.022
LSD ($P<0.05$) Cultivar	0.07**				0.42**				0.0003**			
Dose	0.06**				0.36**				0.0002**			
Interaction	0.13**				0.63**				0.0005**			
Maturity												
CIM-448	13	13	14	16	2.40	2.71	2.91	3.12	0.018	0.018	0.018	0.018
CIM-1100	12	13	14	14	2.35	2.42	2.78	2.80	0.017	0.017	0.017	0.017
Karishma	12	13	14	14	2.16	2.29	2.38	2.63	0.017	0.017	0.017	0.018
S-12	9	10	10	11	2.17	2.34	2.70	2.93	0.019	0.019	0.020	0.020
LSD ($p<0.05$) Cultivar	0.54**				0.23**				0.0004**			
Dose	0.22**				0.20**				0.0001**			
Interaction	0.43**				0.41**				0.0003**			

N.B. Since the two sources of K did not differ significantly, data for both were pooled.
** =significant at the 0.01 level

Table 2: Effect of potassium fertilization on leaf area duration and leaf area ratio in four cotton cultivars.

Cultivar	Leaf area duration (day) [kg K ha^{-1}]				Leaf area ratio [kg K ha^{-1}]			
	0	62.5	125	250	0	62.5	125	250
a) First flower bud								
CIM-448	20.8	22.2	23.6	24.7	0.012	0.013	0.013	0.013
CIM-1100	21.7	22.9	24.0	24.6	0.012	0.013	0.013	0.013
Karishma	18.3	18.6	19.7	20.4	0.010	0.010	0.010	0.010
S-12	18.4	18.9	19.5	20.1	0.013	0.013	0.013	0.013
LSD (p<0.05)	Cultivar		0.52**			0.0008**		
	Dose		0.51**			0.0007**		
	Interaction		1.01**			0.001**		
First flower								
CIM-448	31.0	39.2	43.0	48.0	0.017	0.016	0.016	0.016
CIM-1100	33.0	35.0	37.0	40.0	0.017	0.016	0.016	0.016
Karishma	23.0	28.0	33.0	34.0	0.016	0.016	0.016	0.016
S-12	25.0	29.0	32.0	35.0	0.021	0.021	0.020	0.020
LSD (p<0.05)	Cultivar		2.09**			0.0018**		
	Dose		1.58**			0.0013**		
	Interaction		3.16**			0.002**		
Peak flowering								
CIM-448	52.3	56.2	65.8	79.1	0.022	0.022	0.022	0.022
CIM-1100	56.2	62.7	68.4	80.4	0.020	0.020	0.020	0.024
Karishma	45.1	50.4	57.2	67.6	0.021	0.022	0.024	0.026
S-12	46.2	47.9	53.5	60.5	0.030	0.032	0.033	0.033
LSD (p<0.05)	Cultivar		1.35**			0.0016**		
	Dose		1.12**			0.0011**		
	Interaction		0.24**			0.0013**		
First boll split								
CIM-448	57.5	63.9	75.6	99.2	0.023	0.025	0.026	0.033
CIM-1100	64.5	74.5	81.2	101.7	0.023	0.025	0.026	0.020
Karishma	47.3	56.4	67.8	87.0	0.021	0.023	0.028	0.033
S-12	50.0	54.7	64.6	75.6	0.032	0.035	0.039	0.041
LSD (p<0.05)	Cultivar		1.29**			0.0013**		
	Dose		0.85**			0.0009**		
	Interaction		1.70**			0.0018**		
Maturity								
CIM-448	41.0	48.0	51.0	63.0	0.018	0.019	0.022	0.027
CIM-1100	32.0	43.0	47.0	54.0	0.018	0.020	0.021	0.025
Karishma	28.0	32.0	36.0	39.0	0.018	0.020	0.022	0.027
S-12	30.0	33.0	40.0	43.0	0.025	0.026	0.031	0.033
LSD (p<0.05)	Cultivar		1.94**		0.0008*			
	Dose		1.09**		0.0008*			
	Interaction		4.49**		0.001**			

N.B. Since the two sources of K did not differ significantly, data for both were pooled.
** = significant at the 0.01 level

Table 3: Correlation coefficient (r) between K-rates and various physiological processes in four cotton cultivars

Parameters	Cultivar				Averaged across cultivars
	CIM-448	CIM-1100	Karishma	S-12	
Net Assimilation rate ($mg\ dm^{-2}\ d^{-1}$)	0.94**	0.92	0.89**	0.87**	0.37*
Crop Growth Rate ($g\ m^{-2}\ d^{-1}$)	0.99**	0.95**	0.92**	0.96**	0.36*
Relative Growth Rate ($g\ g^{-1}\ d^{-1}$)	0.79**	0.82**	0.85**	0.89**	0.58**
Leaf Area Duration (day)	0.99**	0.99**	0.98**	0.98**	0.78**
Leaf Area Ratio	0.92**	0.94**	0.83**	0.85**	0.42*

**= significant at the 0.01 level.

THE BRAZILIAN COTTON PRODUCTION MODEL

The Prime Minister of Pakistan while receiving a presentation in the meeting of the National Textile Strategy Committee (NTSC) in December, 2006 had inter alia directed that the Brazilian model of increase in cotton production be studied for implementation in the country. Accordingly, the MINFAL constituted a two member team comprising the Vice President, PCCC and the Director, Central Cotton Research Institute, Multan to visit Brazil in order to study the Brazilian Cotton Production System and the interventions made there for enhancing the cotton productivity and to examine possibility of its replication in Pakistan. The visit was accordingly carried out from 9th June to 17th June, 2007. The report so prepared is epitomized in this note - Editor.

The cotton sector of Brazil has transformed itself and recovered its market position, turning the country from net importer into one of the world's largest cotton exporters in a relatively short period of time. Cotton production in Brazil in the past few years has significantly improved to 1.44 million metric tons estimated in 2006-07 from 0.85 million metric tons produced in 2002-03 – an increase of 69%. This increase is attributable to both the larger area brought under cotton crop and the yield enhancement. The area under the crop during the last five years increased from 0.735 million hectares in 2002-03 to 1.079 million hectares in 2006-07. The hectare yield in 2006-07 is estimated at 1,334 kgs per hectare as against 1,153 kgs in 2002-03. Thus, the cotton area in Brazil over the last five years has increased by 47%, whereas the yield improved by 16%. The cotton system that helped the country in attaining rapid growth in cotton production may be epitomized as under:

I. Brazilian Cotton Production Model

i. Shifting of cotton production from south to Cerrado areas covering the States of Mato Grosso, Goias and Bahia.
ii. Transformation from family management model to business management model for cotton production (number of farmers reduced from 24,000 to 1,000).
iii. Heavy doses of various inputs, particularly fertilizers and pesticides.
iv. Huge investment on machinery and equipment.
v. Zero-tillage or minimum tillage cultivation on approximately 75% of the area.
vi. Use of high yielding cotton varieties having average boll weight of five to six grams (Bt. cotton cultivation was not officially allowed so far, but the government was reportedly considering to allow Bollguard –I cultivation from next season).
vii. Government's income support programs for producers.
viii. Cotton classification at ginnery level for quality control (every bale produced in the ginning factory is first classified manually and subsequently tested/classified by the High Volume Instrument).
ix. Despite significant growth in cotton production in recent past, the cotton growing community is faced with the problems on account of US$ / REAL exchange rate, increasing cost of

production, competition with sugar cane and the serious threat of cotton boll weevil, which was in fact the main reason for driving cotton cultivation out of the south and up into the central-western region of Brazil.

II. Lessons to be Learnt

Having gone through the measures taken in Brazil for rapid growth in cotton production and its quality, it appears that for a similar growth in Pakistan under the prevailing conditions, the following areas relating to cotton R&D and marketing system should be given focused attention on priority:

1. Bridging the Yield Gap

In Brazil, the average yield of cotton from farm to farm do not vary as widely as in Pakistan, where the yield difference on small and progressive farmers' fields is much conspicuous and, therefore, resulting in low national average. The present level of national average yield (719 kgs as compared to 1334 kgs/ha in Brazil) may, however, be improved significantly by focusing primarily upon the following factors:

i. Adequate availability of certified seeds of approved varieties (Availability at present is 65%, but its use is still less).
ii. Balanced use of fertilizers (Subsidy on Phosphate and Potash fertilizers may continue for few years so that the farmers become used to it).
iii. Optimum Plant Population (38-40,000 plants/ha in Pakistan vis-à-vis 80 -90,000 plants in Brazil).
iv. Early introduction of Genetically Modified Cottons for Bollworms and CLCV control (using both locally developed or imported technologies).
v. Technology transfer through electronic and print media (Traditional extension services have not delivered).

2. Cotton in New Areas

The most significant development in cotton system in Brazil has been shifting of cotton cultivation from south to new areas in mid-west. As for Pakistan, the cotton area in the provinces of the Sindh and the Punjab can perhaps be increased only marginally, whereas vast potential areas are available in the provinces of Balochistan and NWFP. The following measures may thus be considered for bringing new fertile lands under cotton cultivation :

i) Bringing at least five lac acres under the cotton crop in Balochistan and NWFP during the next three years.
ii) Cotton can successfully be introduced at the left and right bank of the Mirani Dam in Balochistan (the government have recently approved a project for the purpose).
iii) In view of the setting up of sugar mills in D.I. Khan district, the efforts are required to

introduce cotton in other potential areas of Noushera, Mardan and Karak , etc in NWFP.

iv) A national policy / decision is required to discourage setting up of sugar mills in potential cotton growing areas in all the four provinces.

3. Improving Quality of Cotton

There is custom ginning in Brazil and the lint cotton produced passes through a classification system for quality assessment. In order to ensure a similar quality control mechanism in Pakistan, the following actions in addition to measures already taken by the government seem highly desirable:

i. Amendment in Cotton Control Act making marking of grade on each bale as mandatory.

ii. Mandatory use of lint cleaners already installed in the ginning factories and timely replacement of gin saws.

iii. Implementation of the cotton standardization and grading system through private sector companies in accordance with the provisions of the Pakistan Cotton Standardization Ordinance, 2002.

iv. Buying and selling of seed cotton and lint cotton by the private sector stakeholders on the basis of grade and staple rather than variety and station.

v. Promotion of instrumental evaluation of raw cotton using High Volume Instrument.

4. Cotton Research

The cotton research in the country has yielded several improvements over the years, particularly in respect of the staple length, mike, ginning out turn (GOT) and early maturity etc. However, for better yield per hectare as compared to that of Brazil, the research establishments inter alia need to address the following issues on priority :

i) Developing heat resistant varieties in order to avoid shedding of flowers and bolls which otherwise could add significantly to the production.

ii) The cotton bolls weight in the country is presently between 2.5 to 3.0 grams as against 5-6 grams in Brazil. Hence, the cotton breeders need to concentrate on developing larger sized / weight bolls (for this purpose the germ plasm brought from the Brazil may also be utilized by the research institutes).

iii) NIBGE (Faisalabad) and CEMB (Lahore) should expedite developing genetically modified cotton varieties in collaboration with the national and provincial cotton research establishments.

III. Tail piece

The cotton production prospects in Pakistan are bright to meet the future demand of the growing textile sector. The focused attention on the above referred measures may lead the country to following targets envisaged under Cotton Vision 2015, even earlier:

1. Cotton Production:	20.70 Million Bales (from current volume of 13 million bales).
2. Cotton Yield / hectare	1,060 kgs (from current average yield of 719 kgs/ha).
3. Mill Consumption of Cotton:	20.10 Million Bales (from 14 million bales consumed in 2005-06).
4. Exportable Cotton Surplus:	0.60 Million Bales (from about 0.30 million bales in 2006-07).
5. Improved Yarn Recovery Rate through clean / contamination free cotton production :	92% (from current average of 84%).

The higher production of cleaner cotton would thus result in the following advantages:

1. Assured supply of cleaner, uniform, graded and contamination free cotton to the domestic textile industry.
2. Higher recovery rate, hence more yarn.
3. Improved reputation of Pakistan's cotton and its products in the world market.
4. Substantial additional foreign exchange earning through better unit values.