Evaluation of *Gossypium herbaceum* germplasm race *Wightianum* under different sowing dates in the central cotton zone of India

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Introduction

- Cotton, popularly known as 'White Gold', is important commercial fiber crop in India. Cotton has long history and evolved in India millions of years ago.
- **6000 BC** Mehrgarh, Now Pakistan: *G. arboreum*
- **3500 BC** Tehaucan valley, Mexico: *G. hirsutum*
- **2700 BC** Mohenjodaro, Indus valley: *G. herbaceum*
- **2500 BC** Huaca Preita Peru: *G barbadense*
- The genus *Gossypium* comprises of 51 species, among them 6 are tetraploids and 45 are diploids (*G. ekmanianum* Wittmack, AD6)

The magic of Dhaka muslins

❖ **Suleiman the Arab traveler wrote in the 9th century that cotton fabrics in Rahmi (now, Bangladesh) are so fine and delicate that they pass through a signet ring.**

❖**Dhaka Muslin yarn was one of the finest ever heard of 345-356 counts. Andhra Khadi work women spin 70 -100 counts yarn with 15 mm cotton, which will yield only 12s counts yarn in machine spinning.**

- **India is the only country in the world growing all the four cultivated species of cotton and successfully exploiting heterosis through cultivation of intra and inter specific hybrids.**
- **India is the ancient home of *Gossypium arboreum* L. races *bengalense, cernuum* and *indicum* and also *wightianum* of *G. herbaceum* (Hutchinson *et al.*1947)**
- **Diploids possess highly desirable traits such as stress, disease tolerance and adaptive features (Samba Murthy *et al*.1994)**

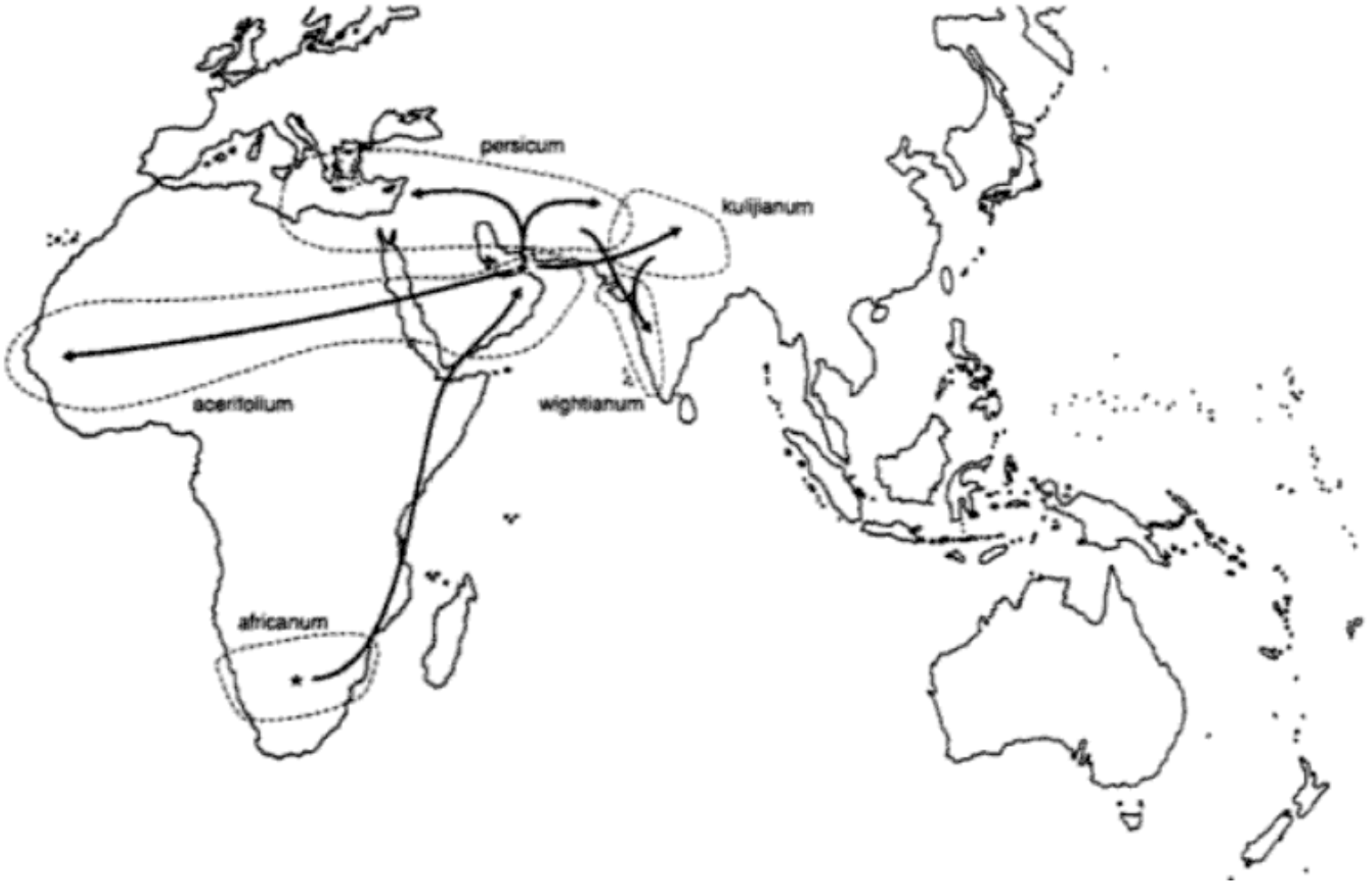
Diploid species of genus Gossypium

G. arboreum	*G. herbaceum*
Geographic distribution as was done	Till 1937 geographic distribution was not done as in case of arboreum
Three varieties	
Typicum	Typicum
Neglectum	Fruitescens
Cernum	Africanum
Geographic races (6) *Soudanense, Indicum, Burmanium, Cernum, Bengalense, Sinense*	Geographic races (5) *Persicum, kuljianum, acerifolium, wightianum, africanum*
Hutchinson and Ghose (1937) ; Silow, 1944	

	Races	Region wise distribution
1.	*G. herbaceum race persicum*	Iran, Baluchistan, Afghanistan, Turkmenistan, Iraq, and Mediterranean region
2.	*G. herbaceum race kuljianum*	Western China and adjacent regions of erstwhile Russia
3.	*G. herbaceum race acerifolium*	Arabia , Ethiopia, North Africa and Gambia
4.	*G. herbaceum race wightianum*	Western India and Persia
5.	*G. herbaceum race africanum*	South – east Africa (Zimbabwe, Mozambique , Swaziland and Transvaal) lowland

Source : Cotton monograph, 1980

Distribution of *G. herbaceum* races



(Silow, 1944 ; Hutchinson , 1949 ; 1950)

Cotton breeding work in herbaceum

Gujarat	**The Govt. Agriculture research station was set up as Surat as early as in 1896. Talod, Bharuch, Charodi, Junagarh**
Karnataka	**Improvement of Kumptas cotton in the northern part of Mysore State was begun in 1905 at Dharwad, Arbhvi, Siruguppa**
Progress made for Early type, Less incidence of pink boll worm, Escape from late drought, Erect, Compact	
Africannum	**Drought resistance (South East Africa)**
Acerifolium	**Drought resistance (Saudi Arabia)**
Kuljianum	**Drought resistance, Early maturity (China & Russia)**
Persicum	**Drought resistance (Baluchistan)**
Wightianum	**Drought resistance (India)**
Linking races between B group of wild races (anamalum & trifolium)	

GUJARAT (14)

Varieties / hybrid	Year of released	Yield (q/ha)	Duration (Days)	Ginning (%)	MHL (mm)	Spinning counts	Adaptability
Wagad 8	1930	6 R	230	37	19	14	Waged area
Vijay	1943	4.5 R	220	39	21	24	Middle Gujarat
Kalyan	1947	6 R	220	39	20	20	North Gujarat
Vijalpa	1952	5 R	220	36	22	26	South Gujarat
Digvijay	1956	6 R	170	39	23	38	Middle Gujarat
V 797	1966	8 R	160	39	22	30	Waged Zone
Sujay	1971	6 R	250	40	24	35	Middle Gujarat
G. Cot 11 (1449)	1979	10 R	140	38	24	37	South & Middle Gujarat
G. Cot 13	1981	8 R	190	39	23	30	Waged area
G.Cot 15	1989	16 R	150	38	22	30	Mathio Tract
G. Cot 17	1995	11 R	210	37	23	40	Middle Gujarat
G.Cot 19	1997	11 R	140	34	23	30	Mathio Tract
G. Cot 21	1998	11 R	215	42	22	30	Waged area
G. Cot 23	2000	13 R	200	39	22	30	Rainfed area

Karnataka (15)

	Released varieties	Year	Yield (q/ha)	IC No.
1.	Dharwad-1	1918	--	IC- 371109
2.	1A LB	1919	--	IC-371256
3.	Dharwad-2	1920	--	IC- 371165
4.	1027 ALF	1923	--	IC-371296
5.	Jayawant	1928	6 R	IC-371153
6.	Western-1	1930	3 R	IC- 371250
7.	BD - 8	1938	--	IC-371095

Karnataka (15)

Released varieties		Year	Yield (q/ha)	IC No.
8.	Wagotar	1942	- -	IC-371249
9.	Selection - 69	1942	2.5 R	IC- 371199
10.	Suyog	1945	--	IC- 371236
11.	Jayadhar	1950	4 R	IC- 371152
12.	Suyodhar	1963	3 R	IC-371235
13.	Raichur-51	1968	3 R	IC-371179
14.	DB-3-12	1979	4 R	IC - 371098
15.	DDhC-11	2009	4 R	IC-371213

Hybrids (4)

Varieties / hybrid	Year of release	Yield (q/ha)	Duration (Days)	Ginning (%)	MHL (mm)	Spinning counts	Adaptability	
DH – 7	1985	15 R	190	22	37	30	Gujarat	hA
G. Cot. DH – 9	1988	15 R	190	34	28	40	Gujarat State, M.P	hA
DDH - 2	1992	12 R	180	34	22	20	South Zone	hA
Pha - 46	1996	12R	190	30	26	30	MAU	hA

hA = *herbaceum* x *arboreum*

KARNATAKA

Varieties / hybrid	Year of release	Yield (q/ha)	Duration (Days)	Ginning (%)	MHL (mm)	Spinning counts	Adaptability
Jayawant	1928	6 R	230	28	21	26	Raichur and Gulbarga
Western 1	1930	3 R	190	29	21	24	Karnataka
Selection 69	1942	2.5 R	230	30	20	20	South & Central K K
Jayadhar	1950	4 R	180	30	23	30	Karnataka
Suyodhar	1963	3 R	180	28	22	35	Karnataka
Raichur- 51	1968	3 R	200	34	21	26	Karnataka
DB – 3 - 12	1979	4 R	170	33	22	30	North East Karnataka

Level of heterosis for seed cotton yield

Hybrids	Maximum level of heterosis (%) over		
	MP	BP	SP
G. hirsutum x G. hirsutum	301.1	268.9	138.4
G. hirsutum x G. barbadense	222.7	72.4	54.4
G. barbadense x G. barbadense	127.7	110.9	-
G. arboreum x G. arboreum	224.0	134.1	73.7
G. arboreum x G. herbaceum	222.6	208.6	124.2
G. herbaceum x G. herbaceum	63.0	43.0	-

G. herbaceum improvement for fibre quality

Variety	Release	Yield Q/ha	GOT	2.5% SL (mm)	Counts	Duration
Jayadhar	1950	10	39	20.2	30	220-240
Digvijay	1956	10	39	23.1	24	220-260
Raichur 51	1968	5	31	20.5	24	210-250
Sujay	1972	6	39	23.5	34	230-260
G Cot 11	1979	10	39	23.9	24	190-230
G Cot 13	1981	10	39	23.0	30	170-210
DH 3-12	1983	8	34	21.5	24	170-190
G Cot 17	1996	14	37	25.5	30	160-180
Raghavendra	1997	12	36	25.0	25	180-190
G Cot 21	1998	15	42	23.6	30	210-220
G Cot 23	2000	13	39	22.0	30	190-200

Inter specific desi hybrids *G. herbaceum* x *G. arboreum*

Hybrid	Release	Yield Q/ha	GOT	2.5% SL (mm)	Counts	Duration
DH 7	1983	20	36	21.5	24	200-220
DDH 2	1986	19	32	23.5	30	180-200
DH 9	1988	21	34	28.0	40	200-220
Pha 46	1996	17	32	26.0	40	180-200

Varieties of G. herbaceum

In Gujarat, G. Cot. 21 and G. Cot. 23 were released to retrieve this situation as they often possess yield potential of 700 - 800 kg / ha lint under rainfed conditions as against state average of 392 kg / ha and 567 kg / ha of *G. herbaceum* and hybrids, respectively.

- **In Karnataka, Jayadhar and Renuka (DB-3-12) was released for dry land area and 2 lakh hectare area under cultivation.**
- **Need envisaged to identify *G. herbaceum* genotypes for dry land area under rainfed condition of central cotton growing area and Vidharbha region of Maharashtra.**

Why *G. herbaceum ?*

Advantages

- **Genotypes of *G. herbaceum* are suitable for rainfed areas**
- **Immune to CLCV and BB and resistant to sucking pests and comparatively tolerant to bollworm complex**
- **Tolerance to salinity / drought / water stress / wind and heat**
- **Suitable for Denim culture that requires coarse, strong and clean stretchable fibres**
- **Needs low cost of cultivation**
- **Enormous bio-diversity for unexploited area which is vulnerable to day to day climate change**

- **Weak traits like undesirable plant frame, Long duration, Smaller boll size, Stage specificity of water stress, Quality attributes like trash. No well established seed production system. Species is under vanishing stage and neglected**

- ***G. herbaceum*** **is has been neglected and cultivated only 1 % of total cotton growing area despite having wider scope for development but the best species for harsh weather conditions.**
- **Cotton likely to be pushed out, unless extra-early varieties are developed that can fit in these cropping systems, and thus increase cotton production and sustain productivity.**
- **Extra-early varieties (110 - 120 days) escape end-of-season drought and heat stresses in addition to fitting the crops in available short windows of these cropping systems.**
- **Water deficits (drought) and low soil fertility (poor plant nutrition) are considered to be major abiotic stress limitations for production**

Why *G. herbaceum* was not adapted ?

- Adaptive performance of *G . herbaceum* was not studied in depth for central zone especially in rainfed cotton growing area of Maharashtra
- Large assemblage of germplasm was not extensively evaluated
- But scenario changed in 2013, 99% of India's cotton area is under American Bt cotton and hardly 1% of area are under Desi cotton

Change in species composition

At the time of independence, these Asiatic cottons were grown to the extent of 97 per cent of the total cotton growing area in India (65% under G. *arboreum* and 32% under G. *herbaceum*)

Species	% of total cotton area				
	1947	1990	2000	2007	2015
G. arboreum	80	30	16	10	4
G. herbaceum	**17**	**10**	**8**	**4**	**<1**
G. hirsutum	3	50	72	85	95
G. barbadense	-	10	4	1	<1

- **Bt hybrids threatened by high incidence of pests and use of pesticides**
- **Bt hybrids break the resistance of pink boll worm and they are highly susceptible to sucking pest.**
- **High incidence of insect pests -resulting into huge economic loss and stagnation in yield.**
- **Muslin was once the pride of West Bengal with demand for these high count fabrics coming from all corners of the world. Sadly, this industry was crushed by British policy during the Raj.**
- **Unbelievable but true, an amazing fact is that, even now Andhra Khadi work women spin 100 counts yarn with Gossypium arboreum coarse fiber of 15 mm length, which would otherwise yield only 12s counts yarn in machine spinning**

Breeding to improve performance of *Gossypium herbaceum* for adaptation to climate change in Central India

PI : Dr. D.V. Patil
Sr. Scientist (Plant Breeding)

Co-PI: Dr. Punit Mohan
Principal Scientist (Economic Botany)

Duration : 5 years

Objectives

To identify breeding lines of *G. herbaceum* with early maturity type and estimate the genetic variability for morpho – economic traits

To identify genetically distinct genotypes of *G. herbaceum* adapted to climate change and enhance productivity of cotton growing tract in central India and local conditions

Introduction

Maharashtra region is one of the most important cotton growing areas of India where cotton seed sowing initiated during June. Adverse meteorological conditions such as shifting of monsoon and 4 - 5 days long gap in precipitations during June affect seed germination drastically. Presence of sufficient soil moisture in field during seed sowing protects costly seeds from failure of germination and avoids repeated sowing.

Cotton, an environmental sensitive crop, sowing date and genotypes selection are a key management component.

Thus, studies on sowing date effects and identification of suitable genotypes are needed for the regional development of diploid herbaceum genotypes.

However information on these aspects are limited where cotton can be grown successfully in the rainfed region of Maharashtra.

Hence germplasm of *G. herbaceum race Wightianum* were evaluated in two frame of sowing using paper tube nursery to identify suitable genotypes and interaction of sowing dates x genotypes enable to screen genotypes for further utilization in breeding program.

Develop drought tolerant varieties with adaptation to water stress to reap profitable yield in rainfed area of central zone in India.

Materials and Methods

Treatments

A part of base collection of *Gossypium herbaceum* germplasm consisting 582 accessions belonging to race *Wightianum* were raised in paper tubes tray nursery on 27th June and 28th July 2015 and 15 days old seedlings were transplanted (14th July and 12th August 2015) at main research farm of ICAR – CICR, Nagpur (*Latitude* = 21° 09' 23.58"N; *Longitude* = 79° 05' 16.99" E; *Altitude* = 312.42m amsl; Annual Rainfall = 1082.1mm; Number of rainy days = 54.5).

Seven seedlings of each genotype, accordingly 7 seeds x 582 genotypes x 2 sowing frame = 8148 seedlings were raised in paper tube tray nursery. Five seedlings of each genotype accordingly 5820 seedlings (5 seedlings x 582 germplasm x 2 set of sowing) were transplanted in the field with the spacing of 60cm x 30cm The experiment was conducted in augmented design and germplasm were distributed in twelve blocks with three standard checks (DDhC-11, G.Cot-25 and Jayadhar).

(MTS)





















Experimental details

Design : Augmented

No. of genotypes : 582

Sowing : Two frame (June & July)

Sowing in paper straw nursery:
27^{th} – 29^{th} June 2015 { 1^{st} set}

Date of transplanting :
10^{th} – 14^{th} July 2015

Sowing in paper straw nursery:
27^{th} – 28^{th} July 2015 { 2^{nd} set}

Date of transplanting :
10^{th} – 12^{th} August 2015

Checks : 3 (Jayadhar, DDhC – 11 & G.cot - 25)

Genotypes / block : 97 (Total blocks : 12)

Spacing : 60 cm x 30cm

Plants / plot / block / genotype : 5

Plot No. E 42 (Plot Area : 58.8m x 64m)






Materials and Methods

Cultural practices

Transplanted seedlings were planted as such along with paper tube in field so that there was no young root damage. Healthy and disease free seedlings were preferred for transplanting. After transplanting life saving irrigation was applied with the help of rose cane and seedlings were recovered from shock next day itself. Recommended package of practices were followed. Split doses of fertilizer at seedling establishment stage, after 30 and 60 days @ 50:50:80NPK kg/ha were applied. In order to avoid fungal and soil born diseases hand spray of Carbendanzim @ 200g in 200litre of water was applied after 3rd day of transplanting.

Data collection

Germination status of 582 *G. herbaceum* germplasm was recorded (DAS). Germinated seeds were observed from 3rd day onwards to till 13th day. Seedling vigour was recorded in seedling height and number of leaves till 15 days. Plant vigour of transplanted seedlings at 30 days interval to till the completion of plant life cycle (280 – 300 DAS) for morphological and yield contributing traits were recorded.

The yield component measurements were carried out at maturity. Mean of 5 plants for number of bolls per plant, boll weight (g) and seed cotton yield per plant (g) was recorded.

Data analysis

Seasonal variation and genotypes interactions: Two factor analysis of variance (Gomez and Gomez,1984).

Number of bolls per plant and boll weight was plotted against seed cotton yield per plant. Boll per plant Vs boll weight was plotted and regression equation was derived with R^2 value.

Planting dates, genotypes, blocks and planting dates x genotype interaction were used as fixed effects while the block x planting date interaction was used as a random effect (Chen and Wiatrak, 2010).

F – test corresponding to significant effects were conducted at 5 % and 1 % significance level.

Regression analysis between and boll number and boll weight and seed cotton yield was done and complied data was statistically analyzed using OPSTAT programme (Sheoran et al.1998).

Results

Sowing dates effect

Sowing dates had a significant influence between the genotypes across experiments on number of bolls, boll weight and yield per plant as genotypes influenced by environment.

Pooled mean of seed cotton yield per plant on two dates of sowing showed 58.90 % increase in July month crop of sowing than that of sown in June as observed by the higher number of bolls per plant.

- **Seasonal effect of two frames sowing was highly significant in relation to yield as 28th July showed higher yield /plant**

Performance *herbaceum* 582 genotypes in two dates of sowing

Characters			Check varieties					
			Jayadhar		G. Cot - 25		DDhC-11	
	S1	S2	S1	S2	S1	S2	S1	S2
Days to germination	5.56	5.44	7.8	6.6	7.6	6.3	8.3	6.7
Boll number	24.87	45.99	31.32	67.13	30.36	62.56	27.54	65.63
Boll weight (g)	2.01	2.53	2.31	2.83	2.03	2.77	1.99	2.71
Seed cotton yield / plant (g)	49.52	107.86	61.67	170.19	40.82	162.4	50.58	169.93

S1 = June sowing ; S2 = July sowing

	Boll numbers / plant			Boll weight (g)		Yield / plant (g)	
SV	df	MSS	F cal	MSS	F cal	MSS	F cal
Blocks	5	5.20	1.93NS	0.004	2.07NS	37.69	2.36 NS
Sowing dates (A)	1	6695.70	2486.96**	27.87	6950.37**	29701.56	1864.87**
Genotypes (B)	581	205.69	76.40**	0.82	205.84**	987.02	61.97**
SD x G	581	205.69	76.40**	0.82	205.84**	987.02	61.97*
Total treatments	1163	211.27	78.47**	0.83	211.64**	1011.71	63.52**
Error	5815	2.69	--	0.004	--	15.92	--
Total	6983	--	--	--	--	--	--
CD		P = 0.05*	P = 0.01**	P = 0.05*	P = 0.01**	P = 0.05*	P = 0.01**
Factor A (SD)		0.077	0.101	0.003	0.004	0.187	0.246
Factor B (G)		1.313	1.725	0.051	0.067	3.193	4.197
SD x G		1.857	2.440	0.072	0.094	4.516	5.935

T – paired test for two dates of sowing

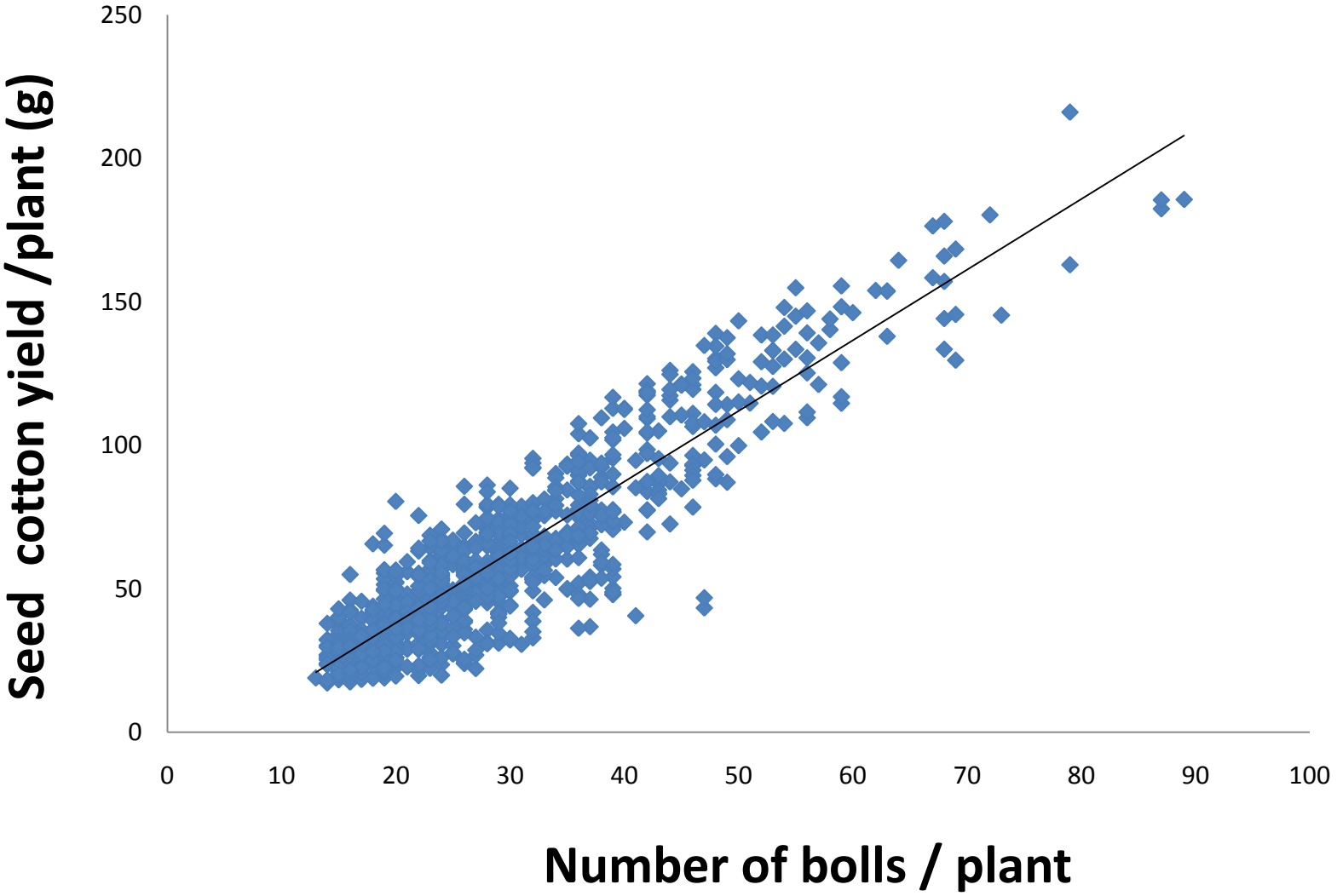
	BN		BW		Seed cotton yield/ plant	
	S1	S2	S1	S2	S1	S2
Mean ± SD	24.87 ± 9.64	45.99 ± 12.44	2.01 ± 0.30	2.53 ± 0.34	49.52 ± 24.64	107.86 ± 26.45
Variance	92.93	154.91	0.09	0.12	607.47	699.67
T - Statistic	61.37**		160.12**		48.47**	
T - Table (0.05) = 1.96 ; (0.01) = 2.57						

Yield Vs Number of bolls per plant

A significant effect on boll number due to sowing dates was observed as sowing dates and genotype interaction (SD x G) were significant. The mean of 582 germplasm for seed cotton yield was obtained for July month sowing (107.86g / plant) which was higher than that of June month sowing (49.52g / plant) showed 58.90 % increase in July month crop of sowing as observed by the higher number of bolls per plant. Similarly boll numbers / plant were higher (45.59) in July sowing as compared to June month sowing (24.87). Positive and significant correlation was observed between seed cotton yield and boll numbers. Using 1164 number of observations the regression equation was derived as $Y = 2.4605x - 11.097$ with $R^2 = 0.8377$ value.

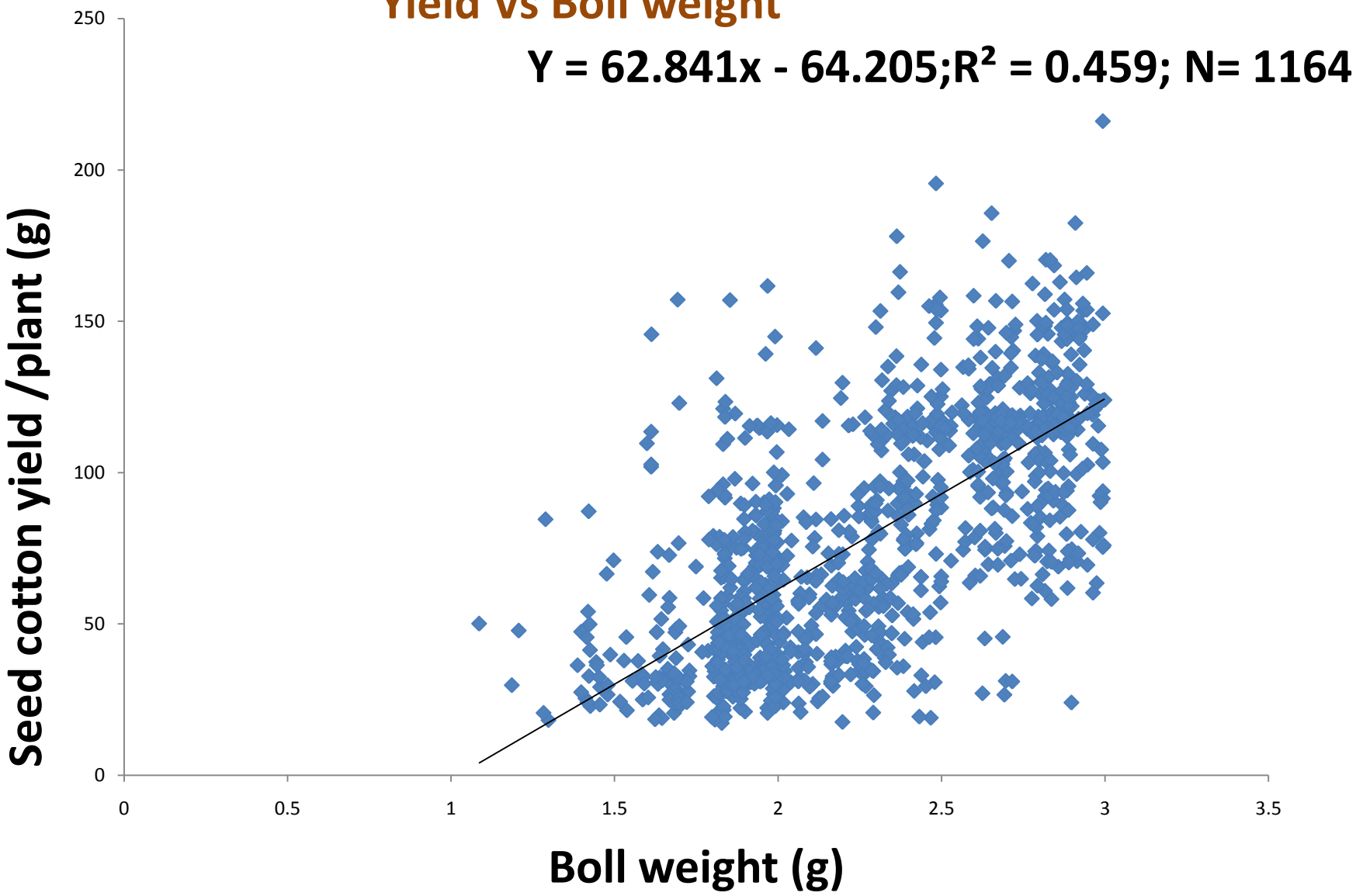
Yield Vs Number of bolls

$Y = 2.4605x - 11.097$; $R^2 = 0.8377$; N = 1164



Yield Vs Bolls weight

Sowing dates has significant effect on boll weight as genotype, sowing dates and their interaction (SD x G) were highly significant. The boll weight across planting dates and genotype ranged from 2.01 and 2.53 in June and July month sowing respectively. Increased boll weight resulted increased the seed yield of July month sowing as suggested by the significant relationship found between boll weight and seed cotton yield. The regression equation $Y = 62.841x - 64.205$ with $R^2 = 0.459$ showed positive and significant correlation between yield and boll weight.

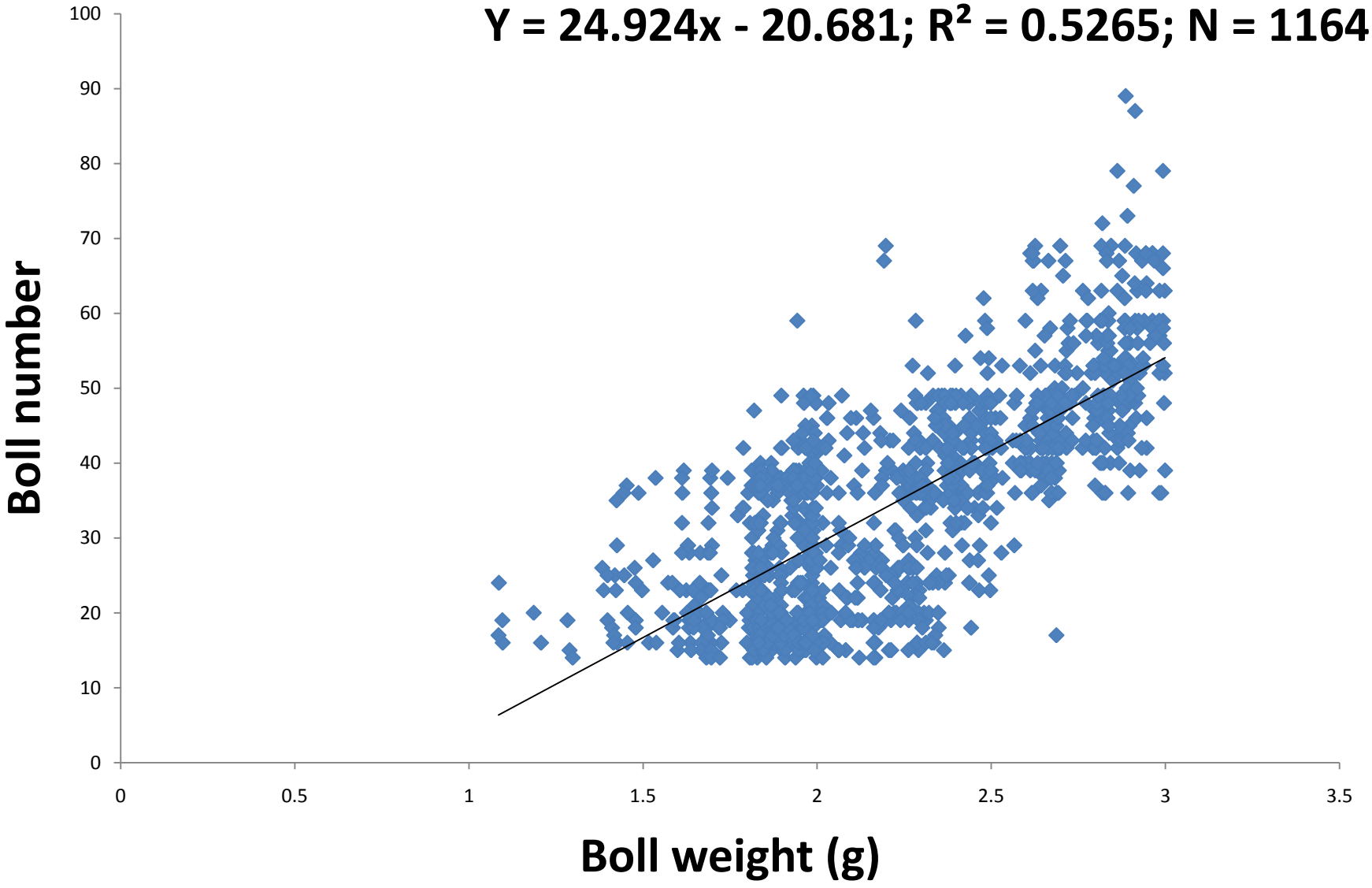

Yield Vs Boll weight
Y = 62.841x - 64.205;R² = 0.459; N= 1164
Seed cotton yield /plant (g)
250
200
150
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
Boll weight (g)

Boll number Vs Bolls weight

The significant interaction for boll number and boll weight was a result of changes in the magnitude of the differences of the means between experiments. The boll numbers and boll weight interaction resulted by the significant relationship Y = 24.924x - 20.681 with R^2 = 0.5265. The relationship between yield, boll number production and boll weight for 582 genotypes grown under both environments showed that there was direct correlation of yield between boll numbers and boll weight across genotypes. Better yield response was obtained in the July month sowing with the reference cultivars (DDhC – 11, G. Cot – 25 and Jaydhar) also.

Six genotypes *viz.* IC 371582, IC 371575, IC 371587, IC 371560, IC 371602 and IC 371437 significantly outperformed with seed cotton yield from 160 to 200 g / plant.

Boll number Vs Boll weight



Genotypes			Y/P (g)
1.	522	IC - 371582	164.43
2.	513	IC - 371575	165.92
3.	527	IC - 371587	168.36
4.	498	IC - 371560	176.41
5.	544	IC - 371602	182.4
6.	367	IC - 371437	203.48


IC 371437

Jayadhar

- Year of release : 1950
- Yield potential : 4q/ha
- Ginning out turn: 30.0%
- Duration : 180days
- Boll weight (g) : 2.0
- Fibre length (mm) : 23.0
- Strength (g/text): 30.0
- Spinnability : 30s count
- Adaptability : Karnataka

Early maturity traits and seed cotton yield

	Variables	Mean ± SD	Std. Error
V1	Days to germination	5.23 ± 1.74	0.29
V2	Plant height (cm)	134.05 ± 15.37	2.63
V3	Days for first squaring	59.38 ± 5.90	1.01
V4	Days to first flowering	67.17 ± 5.96	1.02
V5	Days to first boll opening	75.70 ± 6.28	1.07
V6	Percent first picking	67.21 ± 7.30	1.25
V7	Days to maturity	164.61 ± 15.84	2.71
V8	Number of bolls / plant	35.38 ± 11.03	1.89
V9	Boll weight (g)	2.14 ± 0.41	0.07
V10	Lint weight / boll (g)	0.99 ± 0.36	0.06
V11	Seed weight / boll (g)	1.23 ± 0.54	0.09
V12	Number of seeds / boll	17.64 ± 2.07	0.35
V13	100 seed weight (g)	6.18 ± 0.79	0.13
V14	Seed cotton yield / plant (g)	73.63 ± 29.32	5.02
	(Hearn, 1969; Jain, 1980; Babar et al., 2002)		

Relationship of early maturity traits and seed cotton yield

	Variables	Correlation with seed cotton yield	Direct path effect
V1	Days to germination	-0.589**	0.183
V2	Plant height (cm)	-0.420*	-0.005
V3	Days for first squaring	-0.463**	0.234
V4	Days to first flowering	-0.449**	0.314
V5	Days to first boll opening	-0.302NS	-0.028
V6	Percent first picking	0.697**	0.028
V7	Days to maturity	-0.287NS	0.063
V8	Number of bolls / plant	0.916**	0.811
V9	Boll weight (g)	0.507**	0.335
V10	Lint weight / boll (g)	0.210NS	-0.038
V11	Seed weight / boll (g)	0.257NS	-0.113
V12	Number of seeds / boll	0.140NS	0.009
V13	100 seed weight (g)	0.182NS	0.08

(Ray and Richmond, 1966; Jain, 1980; Godoy and Palomo, 1990; Khan et al., 2002)

Phenotypic variability in boll shape, size & opening

Relationship of early maturity traits

Variables		Correlation with percent first picking
V1	Days to germination	-0.758**
V2	Plant height (cm)	-0.597*
V3	Days for first squaring	-0.472**
V4	Days to first flowering	-0.496**
V5	Days to first boll opening	-0.391*

Correlation of days taken for germination, plant height, days to first squaring, days taken to first flower, days taken to open first boll with percent first picking was negative and significant which indicated that as the value of these morphological traits decrease the per cent first pick will increase.

Comparison of the performance with released varieties of G. herbaceum

	Released varieties	Year	Yield (q/ha)	I C No.	Yield potential (q / ha)	Status
1.	Dharwad-1	1918	--	IC- 371109	4.30	--
2.	1A LB	1919	--	IC-371256	3.35	--
3.	Dharwad-2	1920	--	IC- 371165	3.24	--
4.	1027 ALF	1923	--	IC-371296	4.23	--
5.	Jayawant	1928	6 R	IC-371153	6.16	+ 0.16
6.	Waged 8	1930	6 R	IC-371247	2.89	- 3.11
7.	Western-1	1930	3 R	IC- 371250	4.41	+ 1.41
8.	BD - 8	1938	--	IC-371095	3.24	--
9.	Wagotar	1942	- -	IC-371249	3.81	--
10.	Selection - 69	1942	2.5 R	IC- 371199	3.96	+ 1.46
11.	Vijay	1943	4.5 R	IC - 371240	4.62	+ 0.12
12.	Suyog	1945	--	IC- 371236	3.86	--

Comparison of the performance with released varieties of *G. herbaceum*

	Released varieties	Year	Yield (q/ha)	I C No.	Yield potential (q / ha)	Status
13.	Kalyan	1947	6 R	IC - 371157	4.51	-1.49
14.	Jayadhar	1950	4 R	IC- 371152	5.93	+ 1.93
15.	Vijalapa	1952	5 R	IC- 371239	3.01	-1.99
16.	Digvijay	1956	6 R	IC- 371115	2.16	- 3.84
17.	Suyodhar	1963	3 R	IC-371235	3.84	+ 0.84
18.	V 797	1966	8 R	IC- 371238	5.97	- 2.03
19.	Raichur-51	1968	3 R	IC-371179	4.97	+ 1.97
20.	Sujay	1971	6 R	IC-371231	3.67	- 2.33
21.	G. Cot-11	1979	10 R	IC- 37102	5.37	- 4.63
22.	DB-3-12	1979	4 R	IC - 371098	4.16	+ 0.16
23.	G. Cot -13	1981	8 R	IC- 371135	2.99	- 5.01
24.	DDhC-11	2009	4 R	IC-371213	4.74	+ 0.74

Discussion

Mid – June sowing experienced warmer growing conditions compared to July sowing. High rainfall was received by August probably influenced the yield contributing traits and highest fruit retention.

Early and late sowing time shown that reproductive phase of early sown cotton genotypes coincides with the hot month's period, which caused serious short fall in the yield (Akhter et al. 2002; Arshad et al. 2007; Ali et al. 2011).

As observed in herbaceum species, early sown genotypes suffers due to dry spell during germination and initial growth stage period altered the plant architecture and serious short fall in the yield.

July month sowing resulted in higher translocation and mobilization photosynthates which were utilized in the production of more number of bolls and retention of squares. Probable reason may be the more number of bolls production in July sowing was resulted higher seed cotton yield than June month sowing due to more transformation of flower buds to full pods.

Discussion

Significant variation in pod number of cluster bean over different planting dates was found by Kalyani (2012) and Patil (2014).

Retention of squares (flower buds) and young bolls was higher in July sowing that allowing time to support growth of the same number of bolls as earlier sowings.

Favorable climate for more transformation of flower buds to full pods, boll weight over different planting dates was affected directly on seed cotton yield.

Increased number of bolls has increased the seed cotton yield suggested the significant relationship between number of bolls and seed cotton yield. (Bozbek, et al. 2006; Azhar et al. 1999; Rauf et al. 2004; Kilby et al. 2013 ; Kowsalya and Ravindran, 1996) and Larik et al. 1999).

Conclusions

The genetic potential of the germplasm, environmental conditions and management practices affected crop yield.

The data in the study showed positive linear relationship between boll numbers and seed cotton yield. Planting date showed a significant effect on seed cotton yield production. Hence efforts should select larger boll size (high boll weight) with high boll retention rates (number of productive bolls) indirectly linked with high lint percentage. Breeding should be therefore focus on increasing lint yield per boll, boll weight and high boll retention rates.

Six identified genotypes may be used in future breeding programmes. Varying sowing dates for herbaceum species in different production regions may offer opportunities to cotton growers of Maharashtra state helping to optimize yield and reduce risk associated with crop establishment when crops are sown too early.

Seven intra – specific herbaceum crosses

- **Yield performance**
- **boll numbers and shape**
- **IC – 371437 x Baluchistan – 1**
- **IC – 371437 x Jayadhar was better over MP**

IC – 371437
X
Baluchistan -1

Introgress breeding

- ***G. arboreum* x *G. herbaceum* was initiated to improve the fibre length**
- **Crossing and selfing of three crosses namely GVHV – 655 x PA – 740, GVHV – 655 x PA – 785 and GVHV – 655 x PA – 812 and their reciprocals were carried out.**
- **A total of 960 F1 seeds and 1145 selfed parental seeds were collected.**




Extra early type

Early type (Short duration): 140 – 160

Medium duration : 165 – 180

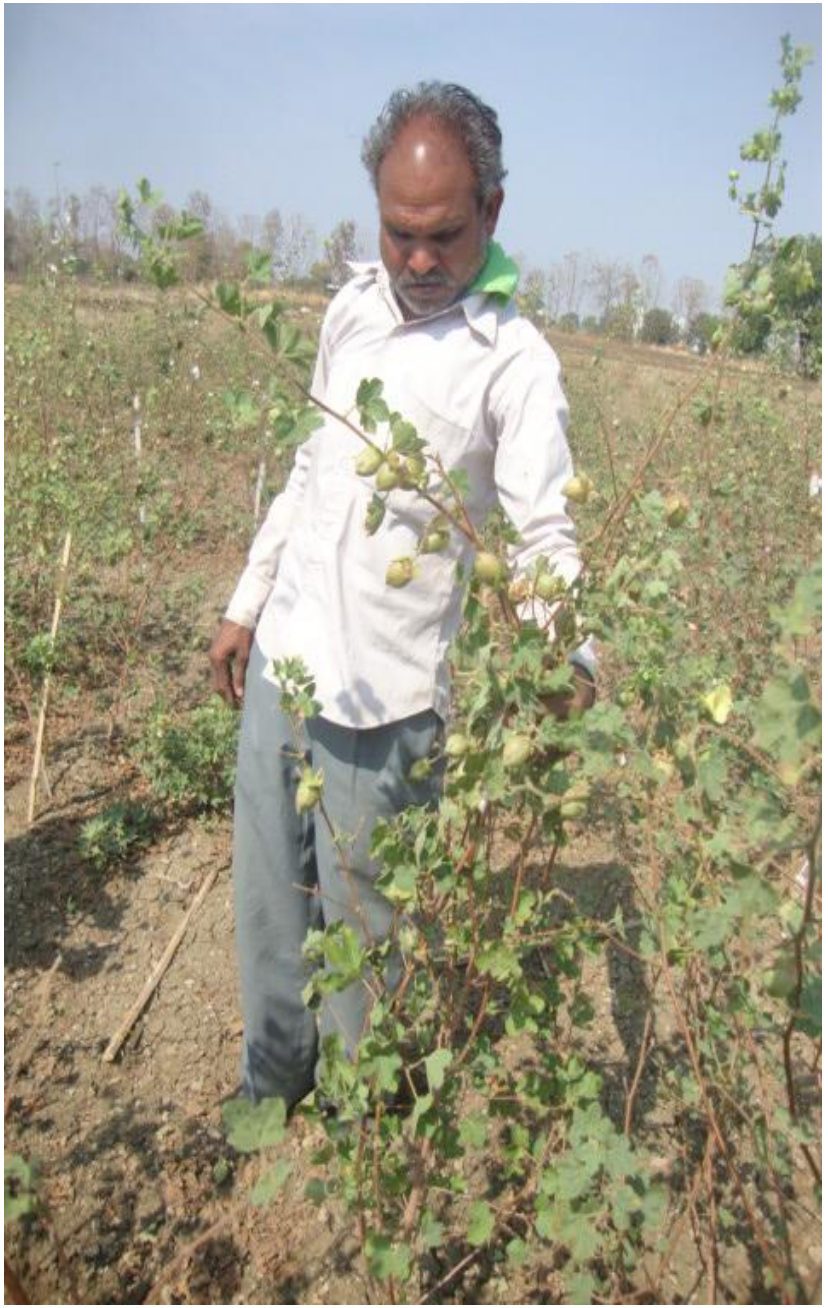
Long duration : 185 – 220

Extra early type : 120 - 130 (Ideotype)

- **Speed of germination, speed in plant growth, yield**
- **Limited boll numbers and compact type**
- **Medium - bold size boll**
- **Escape end-of-season drought**
- **Less management practices**
- **Fitting in rainfed target environment**

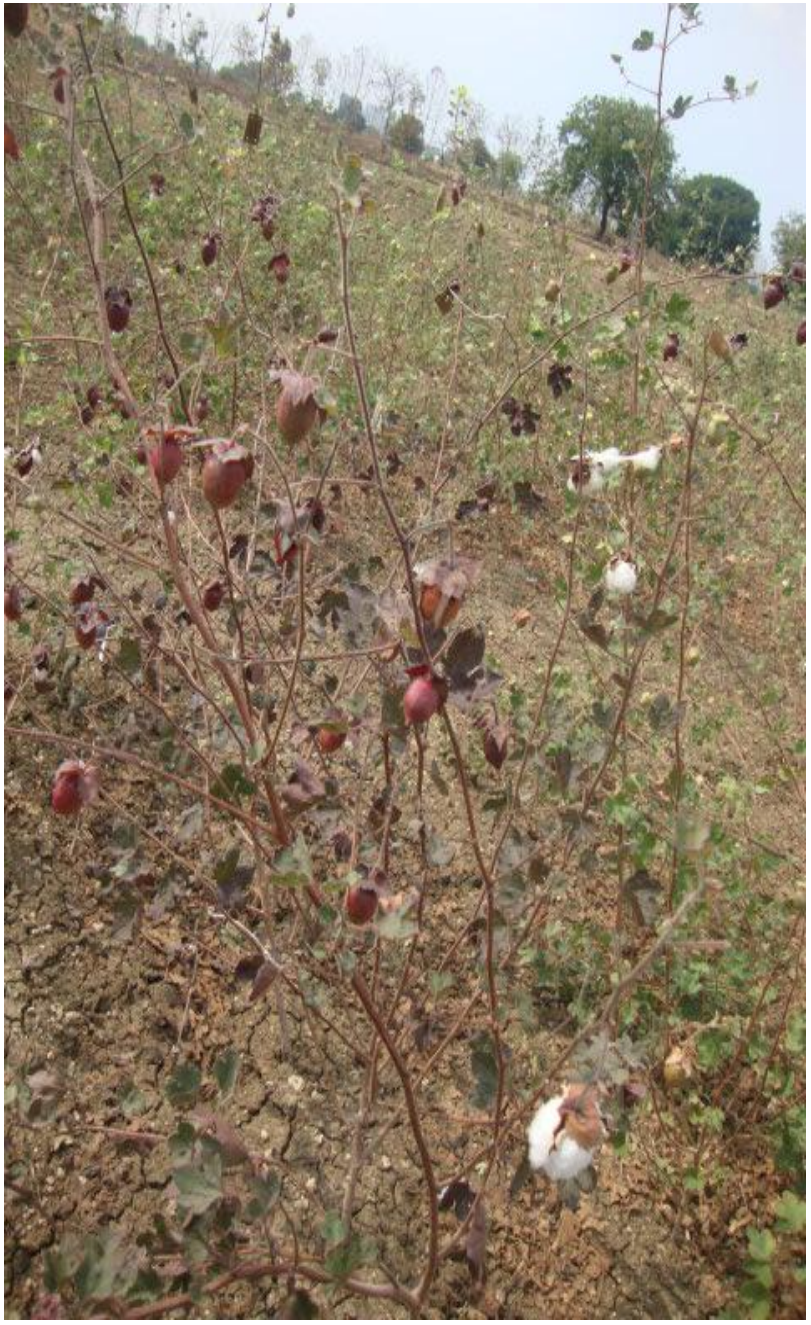
Genotypes survived in soil moisture stress and crack conditions

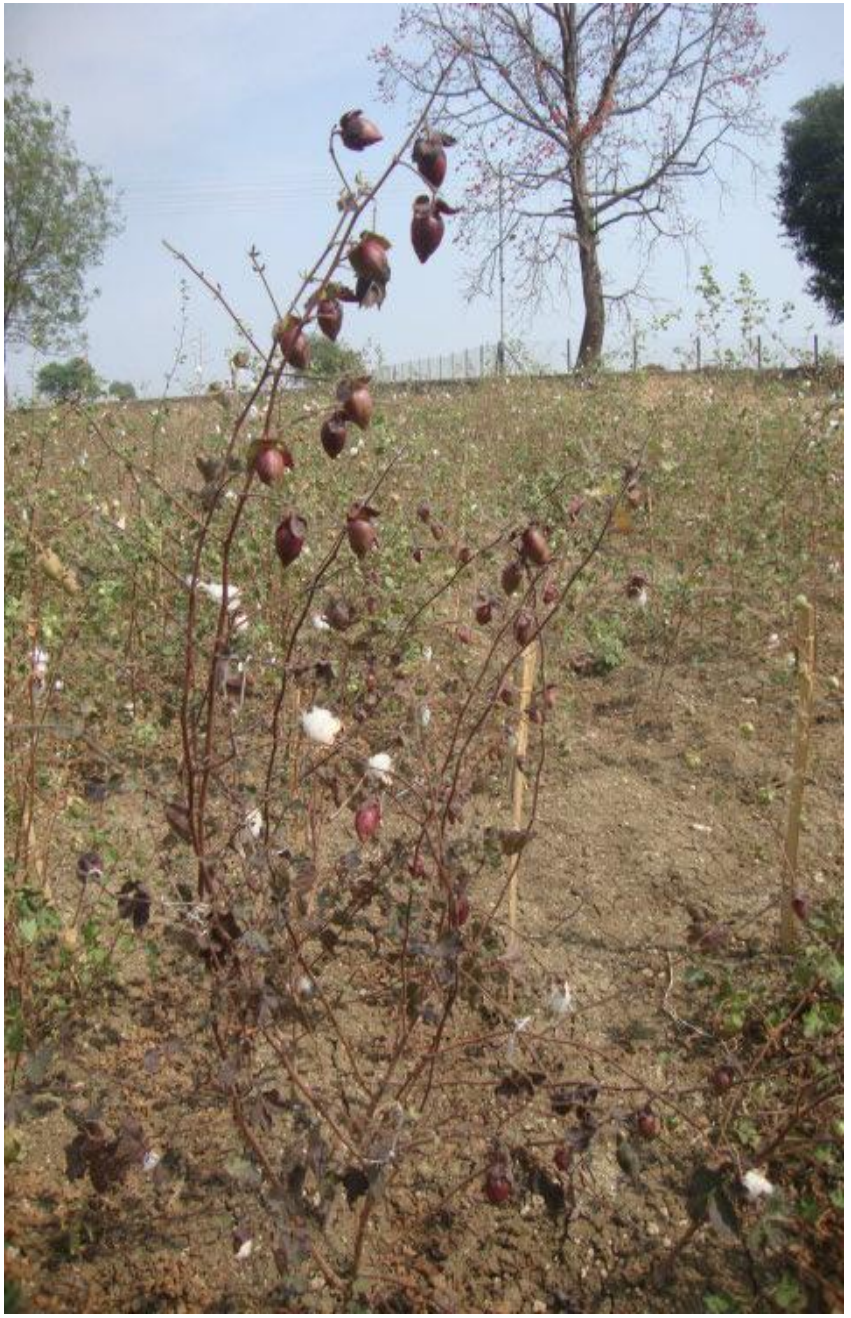
Stay green and with stand at high temperature (40^{O}C) and moisture stress condition (IC 371156)



Dwarf type

Absent extra floral nectaries on leaves on G-522





Area and Production of Desi cotton in India

Years	*G. arboreum*		*G.herbaceum*	
	Area (m ha)	Production (m ton)	Area (m ha)	Production (m ton)
1947- 48	**2.79**	**0.253**	**1.39**	**0.109**
1989 - 90	1.28	0.217	0.98	0.130
2013 -14	**1.17**	**0.129**	**0.58**	**0.064**

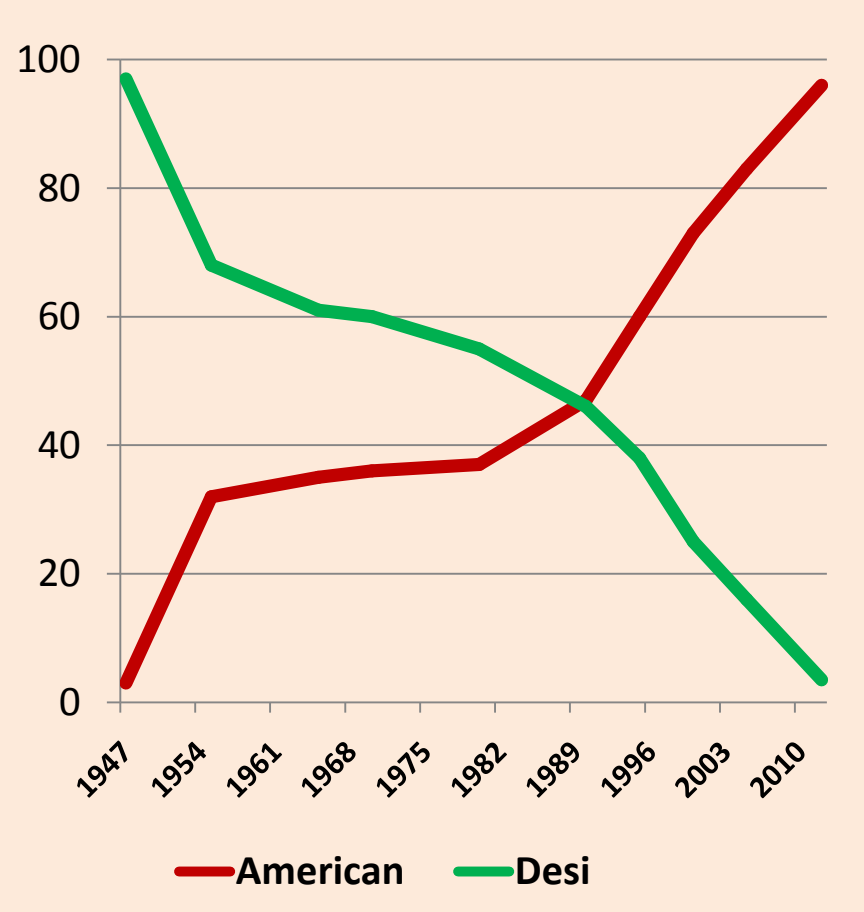
ICAC, 2015

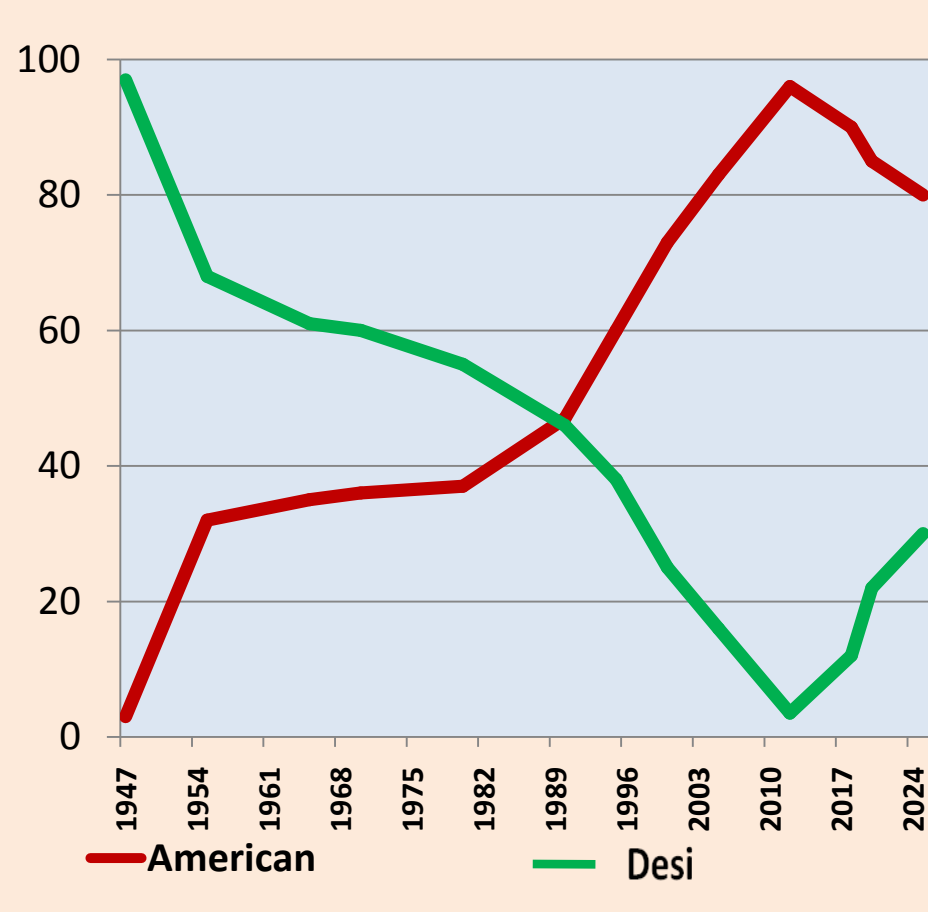
The idea of reintroducing improved (desi cotton) in different cotton tracts has tremendous potential for improving yields, reducing cost of production and minimizing environmental hazards and hence is a sustainable option.

What we need is the right genotype for the right purpose at the right place

Can scenario change in future?

Cotton area in India since Independence (in per cent)





Yield >1500 kg/ha

	Kg lint/ha
Australia	2443
China	1633
Brazil	1508
Turkey	1639
Mexico	1600
Israel	1800

India 510 kg/ha

Area (2015 - 16)

CZ (G, MS, MP): 75.10 lakh ha

MS : 41.90 lakh ha

Vidharbha : 15 lakh ha

Production (2015 - 16)

CZ (G, MS, MP): 186.35 lakh bales of 170 kg

MS : 71.25 lakh bales

Vidharbha : 30 lakhs bales

Productivity (2015 - 16)

CZ (G, MS, MP): 467 kg/ha

MS : 342 kg/ ha

Vidharbha : 325 lakh ha

Year	% Bt area
2004	22
2005	57
2006	82
2007	91
2008	91
2009	96
2010	96
2011	96
2012	97
2013	97

Source : CCI, 2013

Why Desi Cotton

Desi cotton evolved to tolerate and resists to a wide range of adverse environmental conditions

Inherently *G. herbaceum* varieties naturally produce short staple, coarse, high water absorbing fibre.

Desi species are so sturdy that they acclimatize fast and grow easily in any climatic condition. Grow well in marginal soils and sub optimal conditions

Desi species are good yielders and require least inputs to obtain better yields as compare to American cotton

The robust nature of the Desi cotton make it easy to adopt organic cultivation

Market for Desi cotton

If Desi cotton is used, the domestic demand in India itself is estimated to be at least 20 lakh bales per year.

Besides the Indian market, there is enormous export potential to USA, Japan and EU.

It is estimated that the demand for absorbent cotton is growing at the rate of 10 percent per annum across the world

In next 5 years, 30 - 35 lakh bales will be required to fulfill the domestic market itself.

K.R. Kranthi (2013)

Conventional	Breakthrough
Long duration 180-240 days	Short duration 140-160 days
Short staple Desi 22 mm	Long staple Desi 32 mm
Low density crop 66,000 plants/ha	High density planting 1,68,000 plants/ha
High cultivation cost Rs 75,000/ha	Low cultivation cost Rs 30,000/ha
Moderate net returns Rs 15,000/ha	High net returns 45,000/ha
High chemical inputs	Low chemical inputs

REVIVAL OF LIVELIHOODS ESP. OF WOMEN

TRADITIONAL SKILLS & KNOWLEDGE KEPT ALIVE

DECENTRALISED PROCESSES; LOCAL, DISTRIBUTED ECONOMY

BRAND INDIA

SYMBOL OF SOCIETY

ENVIRONMENTAL CONSERVATION

NOT-FOR-PROFIT SOCIAL ENTERPRISE

Wide scope for the improvement

Revival of diploid cotton for the development of Nation

Make in India with desi cotton as brand name

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Thank you