# Genetic variation for harvest index in upland cotton (*G. hirsutum* L.)

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Cotton (*Gossypium* spp.) is an important cash crop and known for its diversified uses. *Gossypium hirsutum* is one of the most important natural textile fibres and a significant oilseed crop in the world.

In India, it is cultivated in three distinct agro - climatic zones of the Country.
In the northern zone where cotton is raised entirely under irrigation while in central and south zones it is predominantly a rainfed crop.

Approximately, 65 % of the India's cotton is produced under rainfed conditions. The productivity of Central zone is very low compared to South and North zones owing to larger rainfed area under cultivation.

**Though India has largest area planted to cotton (10.05 m. ha) and first in production (351 lakh bales) productivity is very low (568 kg lint/ha) *i.e.*, far below the world average of 788 kg/ha (Anonymous 2016).**

In view of this, for improving productivity there is a need to understand how under limited rainfall maximum yield can be achieved using relative determinancy of cotton plant.

**Improved cotton varieties, hybrids and Bt cotton currently grown in India**

Cotton (*Gossypium hirsutum*) is a major fibre crop of global importance and has high commercial value.

It is the world's leading natural fibre crop and second most important oil seed crop. In India, all the four species of cultivated cotton (*Gossypium hirsutum*, *G. barbadense*, *G. arboreum* and *G. herbaceum*) are grown.

**Tetraploids:** *Gossypium hirsutum* **(2n = 52),** *Gossypium barbadense* **(2n = 52)**
**Diploids:** *Gossypium arboreum* **(2n = 26),** *Gossypium herbaceum* **(2n = 26)**

Improved cotton varieties = 207
Development of hybrids: 95
Bt hybrids released - 1060

**In India, hybrid cotton was cultivated on about 40% of total cotton area before introduction of Bt hybrids during the year 2002.**

**Presently above 90 % area is under Bt hybrids**


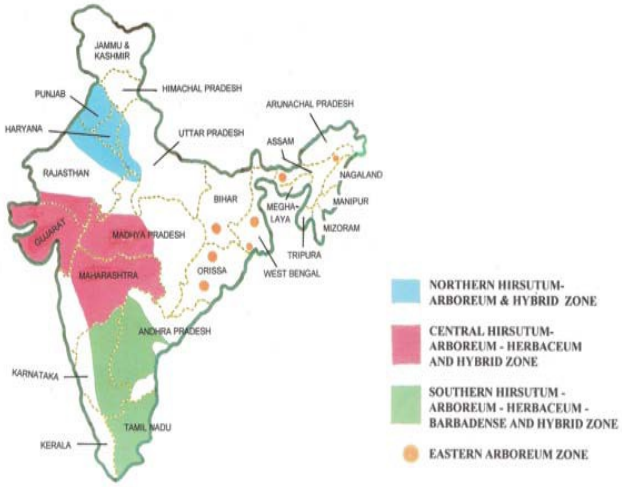


**Figure : Zonal Map of India showing distribution and zones**
**Source: CICR, nagpur**

| Zone | Area lakh ha 2016 | Production Lakh bales of 170 kg | Productivity |
|---|---|---|---|
| North zone | 11.96 | 40.4 | 668 |
| South Zone | 23.13 | 84.20 | 691 |
| Central Zone | 68.05 | 195.35 | 512 |
| Odisa | 1.36 | 2.95 | 375 |
| Others | 0.50 | 2.00 | - |
| Total | 105.00 | 324.9 | 568 |
| World | | | 788 |
| | | Loose 26.10 | |
| | Grand total | 351.00 | |

Harvest index describes plant capacity to allocate biomass (assimilates) to reproductive parts. In cotton (*Gossypium* spp.), it is the ratio of harvested product (lint and seed) to the above ground plant dry weight or biomass (stem, leaves and fruits). The harvest index is an important trait for cotton breeding programme under rainfed conditions. In this direction, efforts were made at ICAR – CICR, Nagpur, India for developing breeding lines of upland cotton with improved plant type and better fibre properties.

During the year 2016-17 an experiment was conducted comprising 14 advanced breeding lines along with four released varieties for evaluation of yield components and fibre properties under rainfed conditions.

The biomass (stems, leaves and fruits) was collected at the time of harvesting at 150 days after sowing.

Lint samples were prepared from each advanced breeding lines and released varieties for testing fibre properties using HVI at Ginning Training Centre, ICAR-CIRCOT, Nagpur.

## Morpho-vegetative traits:

•Plant height (cm), Leaf shape, Leaf size, Leaf colour, Stem nodes number, Stem node length

•Number of monopodia

•Number of sympodia

## Phenological traits:

•Node number of first vegetative/monopodial branch

•Node number of first fruiting/sympodial branch

•Date of first flower (DFF): number of days from sowing to appearance of first flower.

•Date of first open boll (DFOB): number of days from sowing to opening of the first boll.

•Boll maturation period, vertical flowering interval, horizontal flowering interval,

## Yield components:

•Boll weight (g), Boll Number, Boll locule number, Seed surface ($cm^2$/seed)

•Seed index (g)

•Lint index (g)

•Ginning outturn (%)

•Lint yield (g)

## Fibre quality traits:

•Upper half mean length (mm), Uniformity index (%)

• Micronaire, Fibre bundle strength (g/tex), Elongation (%)

Table 1Mean values of seed cotton yield, yield components and fibre properties of advanced breeding lines

| Sl. No. | | PH | NM | NS | NNFSB | NB. | BW | GP (%) | SI (g) | UHML (mm) | UI (%) | MIC | FS (g/tex) | E (%) | HI | SCY (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CNH 7012-13 | 115.4 | 2.1 | 16.6 | 7.9 | 22.5 | 4.5 | 32.6 | 9.7 | 29.0 | 84.0 | 5.1 | 28.3 | 5.5 | 0.3 | 44.9 |
| **2** | **CNH 09-4** | **71.7** | **1.1** | **13.6** | **4.1** | **18.9** | **4.6** | **33.4** | **10.5** | **30.7** | **85.5** | **3.2** | **35.3** | **5.4** | **0.5** | **71.5** |
| 3 | CNH 09-62 | 82.4 | 2.0 | 16.5 | 6.5 | 22.2 | 3.6 | 34.3 | 9.2 | 28.0 | 83.5 | 4.1 | 32.5 | 5.3 | 0.3 | 37.9 |
| 4 | CNH 2-2 | 74.3 | 1.6 | 14.8 | 5.9 | 17.0 | 4.6 | 34.7 | 10.5 | 31.1 | 84.5 | 3.7 | 31.4 | 5.6 | 0.4 | 36.3 |
| **5** | **CNH 09-9** | **73.7** | **1.4** | **14.4** | **5.9** | **21.9** | **4.8** | **33.3** | **9.2** | **30.0** | **84.0** | **4.5** | **28.9** | **5.4** | **0.6** | **59.1** |
| 6 | CNH 09-7 | 65.7 | 1.3 | 12.7 | 5.0 | 14.5 | 4.2 | 34.1 | 9.1 | 31.3 | 85.5 | 4.0 | 31.2 | 5.1 | 0.5 | 47.4 |
| **7** | **CNH 09-77** | **94.5** | **1.9** | **16.4** | **6.8** | **20.8** | **5.1** | **35.3** | **10.2** | **29.5** | **83.5** | **3.9** | **30.3** | **5.5** | **0.6** | **67.1** |
| 8 | CNH 09-78 | 105.4 | 2.0 | 20.1 | 7.8 | 22.1 | 5.0 | 34.2 | 10.9 | 29.3 | 84.5 | 4.1 | 30.4 | 5.4 | 0.2 | 36.1 |
| 9 | CNH 10-6-1 | 127.8 | 1.4 | 21.9 | 7.5 | 25.4 | 4.4 | 35.6 | 11.3 | 31.6 | 85.5 | 4.6 | 32.7 | 6.0 | 0.3 | 66.4 |
| 10 | CNH 12-12-4 | 111.6 | 2.9 | 13.6 | 8.4 | 23.6 | 4.5 | 31.5 | 9.6 | 30.3 | 84.5 | 4.0 | 28.6 | 5.8 | 0.3 | 55.5 |

**PH - Plant height (cm), NM - No. of Monopodia, NS - No. of sympodia, NNFSB - number of node first sympodial branch, BN – Number of bolls per plant, BW – boll weight (g), SCY – Seed cotton yield per plant (g), UHML(mm), UI(%),MIC, FS(g/tex), E(%),HI – harvest index**

| Sl. No. | | PH | NM | NS | NNF SB | NB | BW | GP (%) | SI (g) | UHML (mm) | UI (%) | MIC | FS (g/tex) | E (%) | HI | SCY (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **11** | **CNH 12-4-2** | **103.8** | **2.7** | **16.9** | **8.0** | **16.1** | **4.7** | **29.6** | **11.5** | **31.1** | **85.5** | **4.8** | **29.6** | **5.7** | **0.3** | **56.5** |
| 12 | CNH 18-8-3 | 85.2 | 1.8 | 17.0 | 6.9 | 16.3 | 5.3 | 33.8 | 9.6 | 29.8 | 83.5 | 4.6 | 30.8 | 5.5 | 0.5 | 63.4 |
| 13 | CNH09-5 | 72.8 | 2.3 | 18.4 | 7.1 | 34.1 | 4.0 | 34.3 | 10.0 | 30.4 | 85.5 | 4.2 | 32.6 | 6.0 | 0.3 | 51.6 |
| 14 | CNH09-98 | 90.5 | 1.6 | 16.4 | 4.4 | 17.6 | 4.3 | 32.9 | 9.0 | 28.9 | 84.5 | 4.3 | 31.6 | 5.8 | 0.4 | 50.2 |
| **15** | **NH 615** | **89.9** | **1.4** | **15.3** | **6.4** | **28.3** | **3.6** | **36.2** | **9.0** | **30.2** | **82.5** | **3.7** | **31.2** | **5.7** | **0.5** | **61.0** |
| **16** | **LRA 5166** | **87.4** | **1.5** | **19.3** | **5.9** | **15.6** | **3.5** | **33.6** | **9.1** | **31.6** | **83.5** | **4.4** | **31.8** | **6.1** | **0.5** | **69.7** |
| **17** | **Suraj** | **81.3** | **1.8** | **18.0** | **5.5** | **31.0** | **4.2** | **31.8** | **10.0** | **32.2** | **83.0** | **4.3** | **33.1** | **6.2** | **0.5** | **84.8** |
| 18 | LRK 516 | 64.3 | 3.5 | 15.0 | 6.9 | 34.0 | 4.0 | 34.2 | 8.3 | 29.6 | 83.5 | 3.4 | 29.9 | 5.9 | 0.6 | 74.4 |
| | Mean | 88.7 | 1.9 | 16.5 | 6.5 | 22.3 | 4.4 | 33.6 | 9.8 | 30.2 | 84.3 | 4.1 | 31.1 | 5.6 | 0.4 | 57.4 |
| | C.V. | 8.3 | 27.1 | 9.7 | 20.2 | 23.5 | 11.3 | 3.9 | 9.6 | 3.9 | 1.4 | 14.5 | 5.4 | 5.7 | 18.2 | 16.1 |
| | Mean squares | ** | * | ** | NS | * | * | * | NS | NS | NS | NS | NS | NS | ** | ** |
| | C.D. 5% | 15.6 | 1.1 | 3.4 | - | 11.1 | 1.0 | 2.8 | - | - | - | - | - | - | 0.2 | 19.5 |

Table 2.Range, Phenotypic coefficient of variation (PCV), genetic coefficient of variation (GCV), components of variance and heritability of yield and yield components

| | PH | NM | NS | NB | BW | GP (%) | HI | SCY (g) |
|---|---|---|---|---|---|---|---|---|
| **Range** | | | | | | | | |
| **Maximum** | **127.8** | **3.5** | **21.9** | **34.0** | **5.3** | **36.2** | **0.6** | **84.8** |
| **Minimum** | **64.3** | **1.1** | **12.7** | **14.5** | **3.5** | **29.6** | **0.2** | **36.1** |
| **Var Genotypical** | **297.3** | **0.2** | **4.5** | **24.0** | **1.5** | **0.15** | **0.01** | **148.0** |
| **Var Phenotypical** | **351.8** | **0.5** | **7.0** | **51.5** | **3.3** | **0.38** | **0.01** | **233.6** |
| **GCV (%) Gnnotypic Coefficient of variability** | **19.4** | **27.0** | **12.8** | **21.9** | **3.8** | **8.82** | **24.5** | **21.1** |
| **PCV (%) Phenotypic Coefficient of variability** | **21.1** | **38.3** | **16.1** | **32.1** | **5.4** | **14.30** | **30.5** | **26.6** |
| **$h^2$ (Broad Sense)** | **0.85** | **0.5** | **0.6** | **0.46** | **0.4** | **0.38** | **0.64** | **0.6** |

Amongst the breeding lines, CNH 09-9 and CNH 09-77 recorded highest harvest index (HI) of 0.6 compared to CNH 09-78 and CNH 7012-13 which recorded harvest index of 0.2 and 0.3, respectively. Breeding lines CNH 10-6-1, CNH 12-12-4 and CNH 12-4-2 recorded harvest index of 0.3 which had plant height of 127.8, 111.6 cm and 103.8 cm, respectively.

Breeding lines CNH 09-4 and CNH 09-7 recorded harvest index of 0.5.

The released variety LRK 516 had recorded HI of 0.6 followed by NH 615, LRA 5166 and Suraj with HI of 0.5 indicating the importance of plant architecture while selecting desirable plant type for improving yield per plant under rainfed situations.

The varieties LRK 516, NH 615, LRA 5166 and Suraj had recorded plant height of 64.3 cm, 89.9 cm, 87.4 cm, and 81.3 cm, respectively.

Table 3. Correlation coefficients of seed cotton yield and yield components

| | Height | Mo. | Sym. | Boll no. | Boll wt. | HI | SCY |
|---|---|---|---|---|---|---|---|
| **Height** | **G** | 0.11 | 0.52* | -0.18 | 0.32 | -0.61** | -0.19 |
| | **P** | 0.14 | 0.55* | -0.01 | 0.17 | -0.55* | -0.07 |
| **Mo.** | **G** | | -0.05 | 0.41 | -0.51 | -0.33 | -0.03 |
| | **P** | | -0.05 | 0.41 | -0.35 | -0.12 | 0.04 |
| **Sym.** | **G** | | | 0.23 | -0.03 | -0.45 | 0.04 |
| | **P** | | | 0.17 | -0.01 | -0.44 | 0.10 |
| **Boll no.** | **G** | | | | -0.45 | 0.02 | 0.47* |
| | **P** | | | | -0.26 | -0.04 | 0.24 |
| **Bwt.** | **G** | | | | | 0.09 | -0.16 |
| | **P** | | | | | 0.02 | -0.04 |
| **HI** | **G** | | | | | | 0.66** |
| | **P** | | | | | | 0.61** |

Plant height had significant positive correlations with number of sympodia and negative correlations with harvest index. Boll number per plant had significant positive correlations at genotypic level with seed cotton yield. Harvest index had significant positive genetic and phenotypic correlations with seed cotton yield. The results suggest that there is strong association between harvest index and seed cotton yield.

Thus selection of relatively determinate and fully indeterminate parents in breeding programme generates large amount of variability for plant type suitable for rainfed situations.

| | India | Australia, Brazil, Turkey, China |
|---|---|---|
| Cultivars | Hybrids | Pure-line varieties |
| Crop Duration days | 160-240 | 150-160 |
| Flowering-fruiting days | 80-160 | 60-100 |
| Plant population /ha | 11,000 | 160,000 |
| Bolls/plant | 20-100 | 5-7 |
| Number of pickings | 3-5 | 1 |
| Sowing and picking | Manual | Mechanised |
| Labourers employed per hectare | 100 to 120 | 1-10 |
| Harvest index (seed-cotton v/s plant-bio-mass) | 0.2-0.4 | 0.4-1.0 |
| Lint % in seed cotton (Ginning %) | 32-34 | 38-44 |
| Plant architecture | Bushy | Erect-compact |
| Plants in meter row | 1 to 2 | 10 |
| Seed rate kg/ha | 2 | 12 |
| Seed production | Cumbersome | Easy |
| Pink bollworm infestation in long duration crop | High | low |
| Non-Bt seeds in bolls | present | absent |
| Bollworm resistance risk | High | low |
| Area lakh ha | 119 | 224 |
| Average lint yield kg/ha | 500 | >1500 |

*Ref.Dr. K.R. Kranthi.* Unlearn A Few And Learn Some New*(Part-1).* Cotton Association of India Cotton Ststistics & News 2016-17 No. 43 24th January, 2017 Published

# Early maturity variety identified for rainfed conditions - CNH 09-7


CNH 09-7
11.16.2016 10:02

Early maturity line - CNH 09-9


CNH09-9
UHML (mm)- 27.2
BS (g/tex) - 26.6
UI(%)- 84
EI%- 4.6
MIC (µg/in) - 3.5
11.16.2016 10:01


11.16.2016 10:03
CNH 09-77


Determinate plant type

Indeterminate plant type



**(NH 615 × SUVIN) G-21-19-619 SP 8**

# Fig 1.Fruiting sites on a cotton plant