# COMPARATIVE STUDY OF COTTON GENOTYPES FOR YIELD AND PHYSIO-BIOCHEMICAL TRAITS UNDER IRRIGATED AND RAINFED CONDITION

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***ABSTRACT***

***The present study in which twenty G. hirsutum L. genotypes in irrigated and rainfed condition with a view to find out promising genotypes against water stress for seed cotton yield. The trial was conducted in a split plot design, replicated thrice for two years (2012-13 and 2013-14) at Main Cotton Research Station, Navsari Agricultural University, Surat. ANOVA revealed that on pooled basis, plant height, relative water content, biomass and seed cotton yield were significantly lower under stress condition. Various indices for water stress tolerance were computed for plant height stress index (PHSI), dry matter stress index (DMSI), yield stability index (YSI) and stress susceptibility index (SSI) for various genotype were ranged from 80.4-101.1, 78.8-101.3, 82.6-99.0 and 0.1-2.1 respectively. Two genotypes GSHV-162 and H-1454/12 were found to be promising and also exhibited higher seed cotton yield under stress condition. Genotypes CSH-111, ARBH-2004 and BGDS-802, BHL -2413 and CA-105 may be used for future drought tolerant breeding programme.***

***KEY WORDS: Cotton, Drought, Rainfed, Stress, Index, Yield***

## INTRODUCTION

Cotton plays a significant role in Indian economy. Millions of people are supported directly and indirectly by the farms that grow it, the manufacturing concerns that process it, and the domestic and international marketing activities that distribute cotton products. India is the only country where all the four cultivated species of cotton are grown on commercial scale and covers cultivated area about 12.7 mha. It occupies second position in production with 400 mt among all cotton producing countries, next to China (Anonymous, 2014-15). But dominant cotton cultivation is done in semi-arid regions and mainly grown in rainy season.

In the rainfed areas, the cotton yield is strongly dependent on the date of onset of monsoon. The crop is also exposed to drought as well as flood. Both of these reduce crop yields depending upon the stage of growth. Drought is an abiotic stress; it has drastic effect on plant growth and crop productivity (Quisenberry, *et al*., 1985). Guinn and Mauney, 1984 reported that water stress decreased seed cotton yield due to decreased in flowering and boll retention. During last two decades significant efforts have been taken to develop drought tolerant cotton lines. Majority of techniques, however, use laboratory experiments for selection of tolerant lines which cannot be translated well under variable field environments. These approaches generally suggest testing of germplasm under stress and non-stress conditions and ranking genotypes for drought tolerance or susceptibility on the basis of reduction in yield (Blum, 1988). Due to large scale genotypic variability for drought tolerant characteristics in cotton, it has become necessary to evaluate more and newly developed genotypes. Considering the situation, it is strongly needed for scientific community to evaluate the performance of strains / varieties of irrigation condition to rainfed condition. The present experiment was conducted for comparative study of promising cotton (*G. hirsutum* L.) genotypes for seed cotton yield and physio-biochemical parameters under irrigated and rainfed condition to find out suitable genotypes for rainfed condition.

## MATERIALS AND METHODS

A complete set of 20 promising genotypes of *G. hirsutum* L. was sown at Main Cotton Research Station, Navsari Agricultural University, Surat. The trial was conducted in a split plot design, replicated thrice for two years (2012-13 and 2013-14). Each entry was planted in a single row of 7.2 m length and spaced at 1.20 m apart. Plant to plant distances was 45 cm. All recommended agronomical practices and plant protection measures were adopted as and when required. Five plants were randomly selected from each replication per genotype for recording observations on plant height (cm), biomass (g) and seed cotton yield (g/plant). Relative Water Content (RWC) was calculated by using formula: RWC = FW - (DW/TW) - DW x 100 described by Turner (1986), while proline content was estimated as per standard method of Bates *et al*. (1973) and Thimmaih (2009). The mean value was used and subjected to statistically analysis. PHSI (Plant height stress index), DMSI (Dry matter stress index) and yield Stability Index was calculated as per Saensee *et al.* (2012). Stress Susceptibility Index (SSI) was calculated as described by Fischer and Maurer (1978).

## RESULTS AND DISCUSSION

Recorded observations were partitioned in two groups; (I) Growth, development and other physiological indices, and (II) Seed cotton yield. The pooled data presented in Table 2 for plant height, RWC, proline content, biomass and seed cotton yield as well as in Table 3 for PHSI, DMSI, yield, yield stability index and stress susceptibility index.

ANOVA revealed that plant height was significantly reduced under rainfed condition. Plant height of genotypes CSH-111, RHC-0717, NDLH-1938, LRA-5166, BHL-2413, PH-1075, BS-279, BS-79 and G.COT-16 were significantly lower in rainfed condition over irrigated. The similar trends also reported in cotton by Soomro *et al*. (2011) and Memon *et al.* (2014) and in sunflower by Saensee *et al.* (2012). The relative water content (RWC) was significantly deviated for treatments, varieties and their interaction. The RWC was significantly reduced under stress condition over irrigated condition. The range of relative water content was 70.7 (BS-79) to 82.0 per cent (H-1454/12) under rainfed condition, while under irrigated condition, it was from 78.2 (SCS-793) to 87.9 percent (BS-79). The genotype SCS-793 showed lowest reduction in RWC due to stress followed by GBHV-177 and H-1462/12. The reduction of RWC due to stress condition is also observed by Malik *et al*. (1999), Siddique *et al*. (2000), Parida *et al*. (2007), Abdel-Kader *et al*. (2015) and Hafeez *et al*. (2015). Proline content was observed significant among treatments. The highest proline content was noticed by genotype GSHV 500 (0.038 %) followed by BHL-2413, BS-279 (0.036%) and GSHV-162, CA-105 (0.035 %) in rainfed condition.

Similar trend of proline content were found by Koutu *et al*. (2005) and Baraiya *et al*. (2009). The biomass was significantly decreased under stress condition. All genotypes observed significant difference for treatment except BHL -2413, H-1454/12, H-1462/12, SCS-793, CA -105 and BGDS-802. Reduction in biomass in various crop due stress were also reported by Specht *et al*. (2001), Mohammadian *et al*. (2005) and Petropoulos *et al*. (2008).

The significant reduction in seed cotton yield was observed due to stress condition. The genotypes RHC-0717 showed significantly higher reduction followed by BS-79 and PH-1075 under rainfed condition. Matthew *et al*. (2014), Memon *et al*. (2014), Abdel-Kader *et al*. (2015) and Volkan *et al*. (2015) also noticed that water stress leads to decrease in seed cotton yield. Genotypic difference was found significant for seed cotton yield. Genotype RHC-0717(113 g) recorded significantly the highest yield per plant in irrigated condition followed by BS-279 (103.6 g), GSHV-162 (101.5g). However, GSHV-162, RHC-0717, H-1454/12 and BS-279 showed significantly the highest (>10% of Avg. yield under stress) yield per plant in rainfed condition. Similar works for yield component were done by Baraiya *et al*. (2011).

Various indices for water stress tolerance were computed and the data for plant height stress index (PHSI), dry matter stress index (DMSI), yield stability index (YSI) and stress susceptibility index (SSI) for various genotypes are presented in Table 3. PHSI, DMSI and YSI decreased as water stress increase in cotton. Genotype GSHV-162 was found to be promising for drought tolerant as it expressed lower stress susceptibility index (0.3), higher proline content (0.035 per cent) with higher seed cotton yield per plant (99.3 g) and it was followed by H-1454/12 with lower stress susceptibility index (0.2), proline content (0.033 per cent) with higher seed cotton yield per plant (91.2 g). Whereas, genotypes CSH-111, ARBH-2004, BGDS-802, BHL-2413 and CA-105 also registered low stress susceptibility index, higher proline content, but possessed low seed cotton yield and may be used for future drought tolerant breeding programme.

## CONCLUSION

From overall discussion it concluded that genotypes GSHV-162 and H-1454/12 found promising under rainfed condition for seed cotton yield, while genotypes CSH-111, ARBH-2004 and BGDS-802, BHL -2413 and CA-105 may be used for future drought tolerant breeding programme.

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**Table 1: Temperature, relative humidity and rainfall data of two seasons**

| Month | 2012 -13 | | | | | 2013-14 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature ($^0$C) | | R.H. | Rainfall (mm) | Rainy Days | Temperature ($^0$C) | | R.H. | Rainfall (mm) | Rainy Days |
| | Max. | Min. | | | | Max. | Min. | | | |
| June | 34.9 | 27.5 | 68.3 | 86 | 4 | 32.6 | 27.64 | 75.5 | 104.5 | 21 |
| July | 32.1 | 26.9 | 80.5 | 185.6 | 12 | 29.7 | 27.3 | 84.7 | 154.9 | 25 |
| August | 31.7 | 26.2 | 80.3 | 119.6 | 11 | 30.9 | 27.3 | 81.3 | 12.6 | 20 |
| September | 31.6 | 25.3 | 80.6 | 376.2 | 15 | 32.3 | 27.0 | 83.1 | 119.1 | 13 |
| October | 35.5 | 22.2 | 59.5 | 13.6 | 3 | 33.8 | 25.9 | 74.2 | 22.2 | 3 |
| November | 33.3 | 17.8 | 52.9 | -- | -- | 34.0 | 22.2 | 57.1 | -- | -- |
| December | 32.7 | 19 | 51.1 | -- | -- | 31.6 | 18.2 | 56.3 | -- | -- |
| January | 30.9 | 16.5 | 78.1 | -- | -- | 30.2 | 19.2 | 59.1 | 15.6 | 1 |
| February | 33.3 | 19.9 | 60.7 | -- | -- | 31.7 | 21.2 | 55.7 | -- | -- |
| Avg. | 32.9 | 22.4 | 68 | -- | -- | 31.9 | 24.0 | 69.7 | -- | -- |
| **Total** | | | | **781** | **45** | | | | 1793.9 | 83 |

**Table 2: Response of growth parameters of cotton genotypes under irrigated and rainfed condition (Pooled results)**

| Genotypes (V) | Plant Height (cm) | | | RWC (%) | | | Proline Content (%) | | | Dry Biomass (g/plant) | | | Seed Cotton Yield (g/plant) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RF | IR | Mean | RF | IR | Mean | RF | IR | Mean | RF | IR | Mean | RF | IR | Mean |
| CSH-111 | 104.8 | 109.5 | 107.2 | 76.8 | 80.9 | 78.8 | 0.029 | 0.026 | 0.028 | 216.2 | 226.6 | 221.4 | 79.2 | 81.8 | 80.5 |
| ARBH-2004 | 104.1 | 105.7 | 104.9 | 77.7 | 82.1 | 79.9 | 0.031 | 0.028 | 0.029 | 191.1 | 200.1 | 195.6 | 70.8 | 72.1 | 71.4 |
| GSHV-162 | 129.2 | 130.0 | 129.6 | 79.4 | 85.7 | 82.6 | 0.035 | 0.032 | 0.033 | 292.1 | 310.7 | 301.4 | 99.3 | 101.5 | 100.4 |
| RHC-0717 | 123.0 | 127.9 | 125.5 | 78.6 | 85.7 | 82.2 | 0.033 | 0.029 | 0.031 | 281.7 | 322.3 | 302.0 | 94.5 | 113.2 | 103.8 |
| NDLH-1938 | 100.3 | 107.0 | 103.6 | 73.2 | 81.0 | 77.1 | 0.033 | 0.032 | 0.032 | 227.5 | 237.1 | 232.3 | 71.6 | 77.3 | 74.4 |
| LRA-5166 | 109.7 | 116.0 | 112.9 | 76.7 | 84.0 | 80.4 | 0.032 | 0.029 | 0.030 | 253.7 | 275.0 | 264.4 | 87.6 | 90.3 | 88.9 |
| BHL-2413 | 97.5 | 108.0 | 102.7 | 75.1 | 81.2 | 78.1 | 0.036 | 0.032 | 0.034 | 225.6 | 232.0 | 228.8 | 72.4 | 74.7 | 73.5 |
| IH-70 | 106.0 | 108.7 | 107.4 | 76.4 | 83.5 | 80.0 | 0.031 | 0.031 | 0.031 | 197.2 | 217.0 | 207.1 | 67.1 | 78.2 | 72.6 |
| H-1454/12 | 113.9 | 112.9 | 113.4 | 82.0 | 86.1 | 84.0 | 0.032 | 0.028 | 0.030 | 283.0 | 279.0 | 281.0 | 91.2 | 92.4 | 91.8 |
| H-1462/12 | 100.0 | 101.2 | 100.6 | 77.6 | 81.5 | 79.6 | 0.033 | 0.032 | 0.033 | 248.0 | 254.1 | 251.1 | 81.0 | 83.3 | 82.2 |
| SCS-793 | 100.9 | 103.9 | 102.4 | 76.6 | 78.2 | 77.4 | 0.033 | 0.028 | 0.031 | 202.5 | 205.6 | 204.1 | 71.7 | 73.0 | 72.3 |
| PH-1075 | 106.9 | 112.0 | 109.5 | 73.8 | 81.3 | 77.6 | 0.031 | 0.028 | 0.030 | 234.0 | 262.6 | 248.3 | 69.6 | 82.5 | 76.1 |
| BS-279 | 103.4 | 119.1 | 111.3 | 76.1 | 84.1 | 80.1 | 0.036 | 0.032 | 0.034 | 270.5 | 323.5 | 297.0 | 93.3 | 103.6 | 98.5 |
| CA-105 | 104.2 | 105.0 | 104.6 | 77.5 | 82.4 | 80.0 | 0.035 | 0.034 | 0.034 | 241.9 | 244.6 | 243.2 | 80.4 | 81.2 | 80.8 |
| HAG-805 | 117.5 | 120.9 | 119.2 | 77.3 | 83.6 | 80.5 | 0.033 | 0.031 | 0.032 | 221.7 | 268.9 | 245.3 | 89.1 | 94.0 | 91.5 |
| GBHV-177 | 111.7 | 114.2 | 113.0 | 79.0 | 82.1 | 80.5 | 0.034 | 0.030 | 0.032 | 258.3 | 270.7 | 264.5 | 87.5 | 92.6 | 90.0 |
| GJHV-500 | 105.0 | 107.4 | 106.2 | 76.3 | 82.9 | 79.6 | 0.038 | 0.033 | 0.036 | 233.3 | 252.1 | 242.7 | 82.0 | 89.2 | 85.6 |
| BGDS802 | 106.3 | 108.4 | 107.4 | 76.8 | 82.6 | 79.7 | 0.034 | 0.031 | 0.032 | 241.9 | 237.7 | 239.8 | 80.4 | 82.5 | 81.4 |
| BS-79 | 96.6 | 121.1 | 108.8 | 70.7 | 87.9 | 79.3 | 0.031 | 0.028 | 0.030 | 195.0 | 295.5 | 245.3 | 81.6 | 96.1 | 88.9 |
| G.COT-16 | 95.6 | 101.8 | 98.7 | 73.0 | 83.0 | 78.0 | 0.031 | 0.028 | 0.029 | 197.7 | 248.3 | 223.0 | 76.6 | 87.9 | 82.2 |
| Mean | 106.8 | 112.0 | | 76.5 | 83.0 | | 0.033 | 0.030 | | 235.6 | 258.2 | | 81.3 | 87.4 | |
| | C.D.@5% | | | C.D.@5% | | | C.D.@5% | | | C.D.@5% | | | C.D.@5% | | |
| T | 4.8 | | | 1.9 | | | 0.001 | | | 7.9 | | | 2.6 | | |
| V | 14.5 | | | 3.9 | | | 0.004 | | | 44.3 | | | 15.2 | | |
| T x V | NS | | | 5.5 | | | NS | | | 21.6 | | | 7.8 | | |
| Y x T | NS | | | NS | | | NS | | | NS | | | NS | | |
| CV (%) | 7.4 | | | 6.4 | | | 11.0 | | | 7.7 | | | 8.6 | | |

***RF=Under rainfed condition, IR=Under irrigated condition***

**Table 3: Response of various stress indexes of cotton genotypes under irrigated and rainfed condition (Pooled results)**

| Genotypes | Plant Height Stress Index (PHSI) | Dry Matter Stress Index (DMSI) | Yield/Plant Under Stress Condition | Yield/Plant Under Irrigated Condition | Yield Stability Index (YSI) | Stress Susceptibility Index (SSI) |
|---|---|---|---|---|---|---|
| CSH-111 | 95.8 | 95.0 | 79.2 | 81.8 | 96.4 | 0.4 |
| ARBH-2004 | 98.8 | 94.5 | 70.8 | 72.1 | 97.6 | 0.3 |
| GSHV-162 | 99.4 | 94.0 | 99.3 | 101.5 | 97.6 | 0.3 |
| RHC-0717 | 96.1 | 86.1 | 94.5 | 113.2 | 82.6 | 2.1 |
| NDLH-1938 | 94.2 | 96.4 | 71.6 | 77.3 | 93.3 | 0.9 |
| LRA-5166 | 94.3 | 91.7 | 87.6 | 90.3 | 96.5 | 0.4 |
| BHL-2413 | 90.8 | 97.7 | 72.4 | 74.7 | 96.9 | 0.4 |
| IH-70 | 97.9 | 90.4 | 67.1 | 78.2 | 85.0 | 1.8 |
| H-1454/12 | 101.1 | 100.5 | 91.2 | 92.4 | 98.5 | 0.2 |
| H-1462/12 | 98.8 | 97.8 | 81.0 | 83.3 | 97.1 | 0.4 |
| SCS-793 | 97.2 | 98.5 | 71.7 | 73.0 | 98.4 | 0.2 |
| PH-1075 | 95.1 | 88.1 | 69.6 | 82.5 | 83.6 | 1.9 |
| BS-279 | 87.0 | 84.0 | 93.3 | 103.6 | 90.1 | 1.2 |
| CA-105 | 99.5 | 99.2 | 80.4 | 81.2 | 99.0 | 0.1 |
| HAG-805 | 97.3 | 82.4 | 89.1 | 94.0 | 94.2 | 0.7 |
| GBHV-177 | 97.6 | 94.3 | 87.5 | 92.6 | 93.1 | 0.8 |
| GJHV-500 | 97.5 | 92.0 | 82.0 | 89.2 | 90.9 | 1.1 |
| BGDS802 | 98.1 | 101.3 | 80.4 | 82.5 | 97.0 | 0.4 |
| BS-79 | 80.4 | 67.4 | 81.6 | 96.1 | 83.5 | 2.0 |
| G.COT-16 | 93.8 | 78.8 | 76.6 | 87.9 | 85.8 | 1.7 |
| Mean | 95.5 | 91.5 | 81.3 | 87.4 | 92.8 | 1.0 |

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