RESEARCH ARTICLE

# New Earliness Index and Integration of Earliness Additive Genes in the New Genotype of Cotton (*Gossypium hirsutum* L.)

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**Received: 12 February 2017/Revised: 02 March 2017/Accepted: 13 April 2017**

**ABSTRACT**- Cotton (*Gossypium hirsutum* L.) is an important fiber crop in the world being used in the textile industry and over 90% of cotton grown in the world is upland cotton. An experimental design carried out for integration of earliness genes from sindose-80 in bulgare-557 during 2005 to 2016 in the Department of Botany, University of Pune-India and Agricultural Research Center of Tehran-Iran. The first cross carried out between sindose-80 and bulgare-557 in 2005 and after crossing five years selection was done among segregated population till to $F_5$. In 2011 the second cross carried out as a back cross between the new variety and sindose-80. Five years selection was also done after second cross. In 2016, the new earliness genotype compared with the five native and commercial cotton varieties in RCBD design. The criterion for earliness was a new earliness index of the combined picking and day (CPD), which has been presented as a new earliness index in this paper along with EFD and FFT indexes. Mean comparison of traits such as three earliness indexes, boll per plant, micronaire and yield showed priority of the new earliness genotype. Comparison of the three earliness indexes indicated priority by CPD index, which is combined by both time and weight to the two conventional indexes such as EFD and FFT which are showing time and weight affects in the earliness respectively.

**Key-words-** Cotton, Earliness, Genotype, *Gossypium hirsutum*, Indexes

## INTRODUCTION

Cotton is an important fiber crop in the world. Over 90% of cotton grown in the world is *G. hirsutum* L. or upland cotton, which is being used in the textile industry. Cotton also reputed as "Queen of the fiber plants". In order to increase its yield potential and decrease the growth limitations like temperature and cloudy weather, soil moisture, soil fertility level and pest pressure, it is desirable to utilize the available genetic variability to find the earliness variety of cotton. Earliness trait in cotton is controlled by additive gene effects and this model of inheritance in cotton is useful inthe development of pure lines, whereas dominance and epistatic effects can be used to exploit hybrid vigor. In upland cotton, various studies have been conducted to study the nature and magnitude of gene effects in the inheritance of different quantitative characters. [1].

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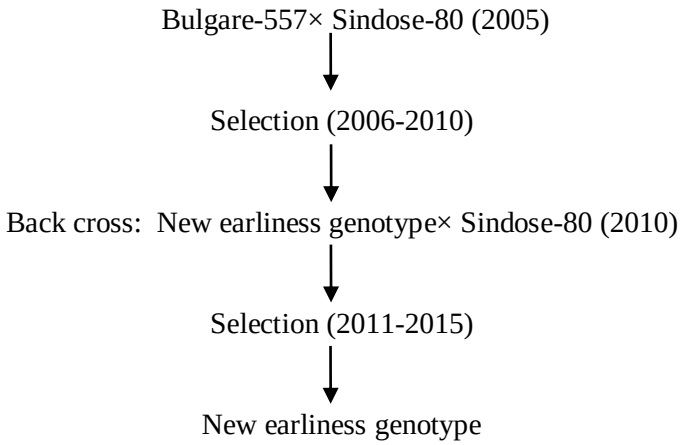
| | crossref DOI: 10.21276/ijlssr.2017.3.3.9 |

Involvements of both additive and non-additive gene effects have been reported in cotton by many workers [2].
Early maturity protects cotton from frost damage, insect and disease buildups, escape pink bollworm and fertilizer and insecticide application, soil moisture depletion, less number of irrigation, decreased higher quality and leave field for the next cultivation. Earliness is the shortest time to produce a profitable crop in cotton [3].
Cotton plant is in-determinant into habit and its boll maturation takes over a period of 80 days in the early flowering varieties which are associated with earliness. Plant breeders utilize percent open bolls to measure the relative maturity of cotton varieties. Environmental variations make comparisons between years difficult, on the other hands specific management decisions have defferential impacts on the diverse varieties or treatments. The morphology of a variety also can influence maturity [4]. Morphological traits that impact earliness includes root/shoot ratios and leaf shape [5]. Divided leaves allow sunlight to penetrate deeper into the canopy, which improves early boll set. Varieties with lower root/shoot ratios expend less carbohydrate on soil exploration which can enhance earliness if coupled to early [6].

## MATERIALS AND METHODS

An experimental project was done in the experimental field of Department of Botany, University of Pune-India and Agricultural Research Center of Tehran-Iran during 2005 to 2016. The first cross carried out between sindose-80 and bulgare-557 in 2005 and after crossing five years selection was done among segregated population till to $F_5$. In 2011, the second carried out as a back cross between the new variety and sindose-80. Five years selection was also done after the second cross. In 2016, the new earliness genotype compared with the five native and commercial cotton cultivars including; New earliness genotype, Sindose-80, Varamin, Oltan, Sahel and Arya, which were planted on 23 May 2016 in randomized complete block design (RCBD) with four replications. The row to row distance was maintained at 0.8 m, whereas plants within rows were thinned out to maintain a distance of 0.2 m between plants. Each treatment plot contained four rows 12 m lengths. All the agronomical, nutritional and plant protection requirements of the experiment were completed when needed.




The criterion for earliness is a new earliness index of combined picking and day (CPD), which has been presented as a new earliness index in this paper evaluated along with conventional indexes such as early flowering days (EFD) and fraction of first picking to the total seed cotton yield (FFP). Mean comparison of study traits are earliness, staple length (mm), micronaire (gr/inch), fiber bundle strength (gr/tex), lint (%) (G.O.T), boll weight (gr), bolls/Plant, yield/hec (Kg), uniformity ratio (%), staple elasticity (%) and monopodia branch.

A procedure of the CPD earliness index, which has been measured, as follows:

The criteria and indexes which have been calculated for the evaluation of earliness were early flowering days on the basis of days from germination to first flowering (EFD), old criterion as fraction of first picking to the total seed cotton yield (FFP) and the new combined earliness index of picking and day (CPD) which is combined by both days of picking and weight of seed cotton picking as weighted new earliness index.

**Earliness Index (CPD) =**

$$\left\{\frac{P_1}{P_1+P_2+\cdots\ldots\ldots+P_n}\right\} \times \left\{\frac{Number\ of\ days\ to\ last\ picking}{Number\ of days\ to\ first\ picking}\right\}$$

Where ($P_1$, $P_2$, Pn) being the weight of seed cotton picked during first and second and n is the total number of pickings.

All the fiber quality traits were studied by putting the 20-30 grams sample of lint in a latest computerized High Volume Instrument (HVI) in the fiber technology laboratory of Cotton Research Institute of Iran.

## RESULTS AND DISCUSSION

Analysis of variance (ANOVA) which has been done adopting Snedecor and Cochran [7]; Steel and Torrie [8] procedures shown significant differences and genetic variation among the cultivated cultivars and varieties for studied traits such as early flowering days on the basis of days from germination to first flowering or early flowering days (EFD), fraction of first picking to the total seed cotton yield (FFP) and combined picking and day (CPD) as three indexes for earliness, staple length (mm), micronaire (gr/inch), fiber bundle strength (gr/tex), lint% (G.O.T), boll weight (gr), bolls/Plant, yield/hec (Kg), uniformity ratio (%), staple elasticity (%) and non-significant for monopodia branch (Table 1).

**Table 1:** Mean squares from ANOVA for various traits in cotton cultivars

| SOV | DOF | MS | F-Value | Prob | CV |
|---|---|---|---|---|---|
| **Earliness (EFD)** | 5 | 121.03** | 189.40 | 0.0000 | 1.71% |
| **Earliness (FFT)** | 5 | 474.966** | 13.81 | 0.0000 | 7.1% |
| **Earliness (CPD)** | 5 | 6011.79** | 111.46 | 0.0001 | 5.77% |
| **Staple length (mm)** | 5 | 98.651** | 66.14 | 0.0000 | 4.14% |
| **Micronaire (gr/inch)** | 5 | 2.713** | 33.78 | 0.0000 | 6.11% |
| **Fiber bundle strength (gr/tex)** | 5 | 126.185** | 73.46 | 0.0000 | 4.60% |
| **Lint% (G.O.T)** | 5 | 19.919** | 24.09 | 0.0000 | 2.48% |
| **Boll weight (gr)** | 5 | 1.492** | 11.88 | 0.0001 | 6.67% |
| **Bolls/plant** | 5 | 14.445** | 4.62 | 0.0094 | 16.23% |
| **Yield/hec (Kg)** | 5 | 1179174* | 3.30 | 0.0331 | 16.62% |
| **Uniformity ratio (%)** | 5 | 15.373* | 3.79 | 0.0200 | 2.42% |
| **Staple elasticity (%)** | 5 | 0.11* | 2.96 | 0.0460 | 2.73% |
| **Monopodia branch** | 5 | 0.367ns | 1.74 | 0.1869 | 34.46% |

**Varieties: 1= New earliness genotype, 2 = Sindose-80, 3 = Varamin, 4 = Oltan, 5 = Sahel, 6 = Arya,**

***, ** = Significant at 0.05 and 0.01 probability levels, respectively**

Duncan's mean comparison [9] shown that new earliness genotype allocated itself the first ranking of the most studied traits like earliness, micronaire, boll/plant and yield. Three types of indexes were used and evaluated for earliness in this paper. Two out of three were belong to the conventional method including early flowering days (EFD) and fraction of first picking to the total seed cotton yield (FFP) [10] and the third one was the new earliness index which was combined from picking and day (CPD) or was made by both days to picking and weight of seed cotton picking as a new weighted and combined earliness index. In the new index weight and time play the vital role and because of this mean comparison of EFD, FFT and CPD affected the ranking of study cultivars. Table 2 shows the actual ranking of the cultivars for earliness by means of CPD method to the EFD and FFT methods. Comparison of the three earliness indexes indicated priority by CPD index, which is combined by both time and weight to the two conventional indexes such as EFD and FFT that showing separated time and weight affects in earliness respectively (Table 3).

**Table 2:** Duncan's mean comparison of traits in cotton cultivars

| **Earliness (EFD)** | | | **Earliness (FFT)%** | | | **Earliness (CPD)** | | | **Staple length (mm)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 53.75 | A | 1 | 94.81 | A | 1 | 182.7 | A | 4 | 32.63 | A |
| 5 | 45.50 | B | 2 | 91.00 | AB | 2 | 167.3 | B | 3 | 32.53 | A |
| 4 | 45.25 | B | 5 | 82.94 | AB | 4 | 109.3 | D | 5 | 31.75 | A |
| 3 | 44.50 | B | 4 | 81.92 | AB | 3 | 108.6 | D | 1 | 30.38 | A |
| 2 | 42.00 | C | 3 | 81.36 | B | 5 | 103.5 | D | 2 | 30.25 | A |
| 1 | 41.00 | C | 6 | 63.32 | C | 6 | 74.25 | E | 6 | 19.60 | B |
| **Micronaire (gr/inch)** | | | **Fiber bundle strength (gr/tex)** | | | **Lint% (GOT)** | | | **Boll weight (gr)** | | |
| 6 | 6.175 | A | 4 | 32.45 | A | 5 | 38.36 | A | 5 | 5.960 | A |
| 2 | 4.925 | B | 3 | 32.28 | A | 1 | 38.20 | A | 3 | 5.747 | A |
| 4 | 4.375 | BC | 5 | 31.37 | AB | 3 | 37.42 | A | 2 | 5.645 | AB |
| 3 | 4.30 | C | 2 | 29.02 | B | 2 | 37.17 | A | 4 | 5.327 | AB |
| 5 | 4.10 | C | 1 | 28.52 | B | 4 | 36.61 | A | 1 | 4.899 | BC |
| 1 | 3.950 | C | 6 | 17.55 | C | 6 | 32.33 | B | 6 | 4.325 | C |
| **Bolls/plant** | | | **Yield/hec (Kg)** | | | **Uniformity ratio (%)** | | | **Staple elasticity (%)** | | |
| 1 | 14.09 | A | 1 | 4305 | A | 3 | 84.93 | A | 5 | 7.25 | A |
| 4 | 11.66 | AB | 3 | 3939 | AB | 4 | 84.80 | A | 3 | 7.10 | AB |
| 3 | 10.98 | AB | 4 | 3917 | AB | 2 | 84.05 | A | 6 | 7.10 | AB |
| 6 | 10.46 | AB | 2 | 3355 | AB | 5 | 83.93 | A | 4 | 7.07 | AB |
| 2 | 9.550 | B | 5 | 3222 | BC | 1 | 82.65 | AB | 2 | 7.87 | B |
| 5 | 8/600 | B | 6 | 2853 | C | 6 | 79.70 | B | 1 | 6.80 | B |

Table 3 shows that the EFD index is the only timely index and FFT index is only weighted index, but the new index or CPD has been affected by both time and weight.

**Table 3:** Indexes comparison

| Index | Ranking | | | | | |
|---|---|---|---|---|---|---|
| **EFD** | 1 | 2 | 3 | 4 | 5 | 6 |
| **FFT** | 1 | 2 | 5 | 4 | 3 | 6 |
| **CPD** | 1 | 2 | 4 | 3 | 5 | 6 |

## CONCLUSIONS

It is concluded that comparison of the three mentioned formulas shows the effects and playing roles of both weight and time in the CPD accurate index, despite of the only weight and time effect on FFT and EFD respectively. Comparison of different cotton cultivars in the inappropriate condition of cotton growth like different soil moisture, soil fertility level, pest pressure, temperature and cloudy weather can affect earliness criteria which are controlled by adding quantitative genes despite of dominant qualitative genes. For this reason application of the accurate index like CPD for determination of earliness in cotton can be illustrate genetic effect of earliness very well and also separate the effect of management and environmental effects which are playing as suppressing genetic effects.

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**How to cite this article:**

Hosseini G: New Earliness Index and Integration of Earliness Additive Genes in the New Genotype of Cotton (*Gossypium hirsutum* L.). Int. J. Life Sci. Scienti. Res., 2017; 3(3): 1016-1019. DOI:10.21276/ijlssr.2017.3.3.9

**Source of Financial Support:** Nil, **Conflict of interest:** Nil