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Research Article

GENETIC EVALUATION OF COTTON GENOTYPES FOR DROUGHT AND YIELD PARAMETERS

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Abstract: The aim of the present investigation is evaluation of twenty genotypes of American cotton (*Gossypium hirsutum*) for estimating the genetic variability, heritability and genetic advance besides, yield and yield components and drought tolerance trails during *kharif* 2016-17. The data revealed statistically significant variation regarding seed cotton yield (kg/ha) (1883.35) and boll per plant (44.0). Genotype, GSHB-185 was noticed maximum (3.85g) boll weight per plant. The data regarding drought tolerance parameters was shown that the highest value of chlorophyll a and total chlorophyll was found in genotype TCH- 1199 and relative water content in the genotype TSH-327. The highest value for Chlorophyll stability was recorded in genotypes L-1060. However, the estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were found high for number of bolls plant^{-1} and boll weight (g) and drought tolerance parameters *viz*., chlorophyll b, leaf water potential, chlorophyll a and photosynthesis rate. The high heritability estimates were observed for yield and yield components *viz*., seed cotton yield plant^{-1}, bolls plant^{-1} and boll weight and drought tolerance traits *viz*., relative water content, proline content, total chlorophyll and leaf water potential. Genetic analysis revealed that promising genotypes JK- 4 and TCH 1199 led as tolerant genotypes and could be used in future yield improvement for drought tolerance with high yield potential. This study will be useful for the development of new drought tolerant verities for enhancing cotton yield.

Keywords: Cotton, drought tolerance, heritability, genetic evaluation, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV)

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Introduction

Cotton is a very important fibre crop at globally economic importance. Cotton plays a significant role in Indian economy through Agriculture, Industrial development as well as regarding employment generation. India has reached at first rank in area, second in production but fourth position in productivity of cotton crop. In India, crop occupy an area of 118.81 lakh ha with a production of 352.0 Lakh bales and productivity of 503 kg/ha. The major cotton growing states are Gujrat, Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Hariyana. Madhya Pradesh, has achieved the first rank in area 5.47 lakh hectares with 17.0 Lakh bales production and 559 (kg/ha) productivity [1]. Add references serially only in number [1]. Development of more efficient genotypes for high seed cotton yield coupled with tolerance to drought in cotton requires thorough understanding of drought tolerance and yield component trails which directly or indirectly influence the yield. Information on the magnitude of genetic variability for the desirable physiological trails of cotton crop has great value to plant breeders, since cotton is mostly grown as rain-fed crop. Besides genetic variability, heritability and genetic advance also play a vital role for the improvement of (genetic gain) any character. With the view of review and literature, the very little information is available particularly on physiological traits that are contributing towards drought tolerance. The objective of this study was to study the magnitude of performance of different genotypes for variability, heritability and genetic advance mainly of drought tolerance traits, besides yield and yield components in cotton.

Materials and Methods

The experimental was laid down at Regional Agriculture Research Station, RVSKVV, Khandwa, during *kharif* 2016-17. It was consisted of 20 diverse genotypes (*Gossypium hirsutum* L.), *viz,* RS-2835, GSHV-185,GISV-310,CPD-1601,CPD-1602,ARBH-1601,TSH-324,TSH-327,L-1060,L-1384, L-799,PH-1071, AR-9108,RB-616,RB-617,RB-610, RCH-1202,RCH-1217,TCH-1199 and JK-4. The experiment conducted in a randomized block design with three replications with recommended agronomical practices to maintain the crop in favorable condition. Each genotype was grown in five rows of six meters length with spacing of 60 cm between rows and plant with in the rows. Recommended agronomical and plant protection measures were taken up to maintain the crop in favorable condition. Five competitive plants were chosen at random from each genotype in each replication for recording observations on plant height (cm), number of sympodia plant^{-1}, Number of bolls plant^{-1}, boll weight (g), Seed cotton yield ha^{-1} in addition to the drought tolerance trails *viz*. relative water content (RWC), chlorophyll a, chlorophyll b, total chlorophyll and chlorophyll stability. Proline content in cotton plant is one of the most important parameters governing drought and temperature tolerance [2]. The analysis of the recorded data was calculated by Steel and Torrie [3 to assess the cotton genotypes for seed cotton yield per plant and its other components. Mean data of the five plants were subjected to analysis variance by adapting the procedure described by Panse and Sukhatme, [4]. The Genetic advance as percent were estimated by genotypic coefficient of variation and phenotypic coefficient of variation, heritability, using the procedures suggested by Bozokalfa *et al*., [5]. Leaf water potential (LWP) was measured as by Turner [6] and photosynthetic rate was recorded by using IRGA system (Infra-red Gas analyzer).

Results and Discussion

The data indicated that the presence of wide range of variability for yield and yield components [Table-1]. The plant height varied from 78.66 to 136.33 cm in JK-4 and TSH-324.

Table-1 *Genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as percent of mean in twenty genotypes of (Gossypium hirsutum L.) for yield and yield components*

SN	Genotype	SCY (kg/ha)	Plant Ht. (cm)	Boll/plant	Boll Wt.(g)	Sympodia/plant	No .of nodes / plant
1	RS-2835	1511.82	108.43	29.50	3.42	24.00	28.44
2	GSHV-185	1547.78	113.00	32.11	3.85	24.00	29.00
3	GISV-310	1329.56	117.88	27.44	3.50	24.00	29.66
4	CPD-1601	1331.42	104.44	30.89	3.25	23.50	27.89
5	CPD-1602	1306.33	101.78	34.22	3.23	23.00	28.22
6	ARBH-1601	1163.57	107.11	25.98	3.20	22.50	29.44
7	TSH-324	897.21	136.33	24.50	2.50	21.00	28.78
8	TSH-327	1767.20	127.78	38.00	3.50	21.00	32.00
9	L-1060	822.14	116.11	22.55	3.59	19.50	30.00
10	L-1384	875.80	112.88	23.00	2.50	20.00	29.55
11	L-799	1018.14	118.11	40.89	2.70	21.50	30.66
12	PH-1071	1430.15	129.66	31.00	3.78	23.50	31.99
13	AR-9108	1732.23	118.44	36.11	3.00	22.00	25.78
14	RB-616	1652.71	116.11	27.11	2.90	23.50	30.77
15	RB-617	1309.02	113.22	32.55	3.40	21.44	26.33
16	RB-610	1189.07	121.33	26.11	3.31	22.00	30.44
17	RHC-1202	1689.41	120.66	36.00	3.70	24.50	32.11
18	RHC-1217	1693.62	113.77	24.55	3.73	24.50	29.00
19	TCH-1199	1832.88	111.55	41.67	3.60	25.70	28.77
20	JK-4	1883.35	78.66	44.00	3.80	25.50	27.64
	mean	1399.2	114.4	31.4	3.3	22.8	29.3
	S Em ±	54.92	6.85	1.65	0.17	1.09	0.72
	CD (0.05%)	157.27	19.60	4.73	0.48	3.12	2.05
	GCV	40.67	16.91	35.16	21.15	12.29	9.94
	PCV	41.23	19.84	36.32	22.85	14.82	10.80
	Heritability	97.28	72.69	93.71	85.64	68.82	84.67
	GA	669.9	770.81	251.24	1.01	16.22	17.5

Table-2 *Genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as per cent of mean in genotypes of (Gossypium hirsutum L.) for drought tolerance parameters*

SN	Genotype	Chlorophyll (a)mg/gm of fresh leaves	Chlorophyll-(b) mg/gm of fresh leaves	Total Chlorophyll mg/gm of fresh leaves	Chlorophyll Stability	Proline content µmoles/gm tissue	Relative water content in %	Photosynthesis rate (µ mol m^2 s^{-1})	Leaf water Potential (-bar)
1	RS-2835	0.52	0.55	1.93	67.70	18.29	49.11	15.11	12.50
2	GSHV-185	0.55	0.51	1.90	79.37	20.33	53.41	12.07	13.00
3	GISV-310	0.60	0.66	1.70	78.70	19.97	54.66	13.33	16.10
4	CPD-1601	0.90	1.21	1.99	75.67	17.00	53.00	14.35	15.83
5	CPD-1602	0.50	0.95	1.66	77.11	18.47	55.00	16.07	16.33
6	ARBH-1601	0.78	1.53	2.20	75.33	19.29	54.33	15.33	15.50
7	TSH-324	0.49	0.88	1.86	81.50	12.50	53.78	12.00	23.10
8	TSH-327	0.88	1.60	2.10	68.00	22.67	61.33	18.00	18.27
9	L-1060	0.47	0.83	1.73	84.33	12.00	58.33	9.00	24.50
10	L-1384	0.45	0.81	1.66	83.50	12.50	51.22	11.20	25.50
11	L-799	0.50	1.07	1.43	79.00	14.00	57.67	10.20	21.50
12	PH-1071	0.60	0.89	1.80	78.41	19.32	54.93	14.07	14.50
13	AR-9108	0.65	1.88	2.10	68.50	21.00	52.67	17.40	10.78
14	RB-616	0.47	0.99	2.02	78.74	20.50	54.37	16.00	15.00
15	RB-617	0.60	0.93	1.87	77.07	17.50	52.33	12.99	16.50
16	RB-610	0.55	1.11	1.84	77.70	16.50	55.67	10.82	16.70
17	RHC-1202	0.65	1.16	2.00	80.44	19.70	53.52	16.40	15.50
18	RHC-1217	0.66	1.03	2.00	78.41	20.67	55.00	14.73	14.50
19	TCH-1199	1.12	1.25	2.21	67.50	22.00	59.33	18.44	9.32
20	JK-4	0.80	0.90	2.20	67.00	23.52	56.96	19.10	9.20
	Mean	0.64	1.04	1.91	76.20	18.39	54.83	14.33	16.21
	S Em±	0.07	0.14	0.06	2.38	0.88	0.55	0.94	1.36
	CD	0.19	0.39	0.16	6.82	2.51	1.58	2.69	3.89
	GCV	46.86	55.21	18.54	12.05	31.66	8.92	33.93	47.92
	PCV	50.20	59.73	19.24	13.21	32.73	9.09	35.79	50.08
	Heritability	87.16	85.42	92.87	83.21	93.61	96.34	89.90	91.58
	GA	0.18	0.68	0.25	173.62	69.82	49.32	48.70	125.08

The maximum seed cotton yield 1883.35kg/ha was recorded in JK-4 followed by (1832.88), (1767.20) in TCH-1199 and TSH-327 respectively, while, minimum (822.14) in L-1060 was recorded. The maximum boll per plant (44.0) in JK-4 followed by (41.67) and (40.89) in TCH-1199 and L-799 respectively, while, minimum (22.55) in L-1060 was recorded. The maximum boll weight (3.85) was noticed in GSHB-185 followed by JK-4 (3.80) PH-1071 (3.78), while, minimum was recorded in L-1384 (2.50). The highest number of sympodia (25.70) in TCH-1199 was followed by (25.50) and (24.50) in JK-4 and both RCH-1202 and RCH-1217 respectively, while, minimum (19.50) in L-1060 was recorded. The highest number of nodes were found in RHC-1202 (32.11) followed by TSH-327 (32.00) and PH-1071 (31.99), while, minimum was recorded in AR-9108 (25.78). Out of these twenty genotypes of cotton, only four genotypes *viz*., JK-4, TCH-1199, AR-9108 and TSH-327 were found significantly superior and at par with RHC-1217 followed by RHC-1202 and RB-616. However, the seed cotton yield was noticed in L-1060 followed by L-1384 and TSH-324. Similar results were reported by Valarmathi and Jehangir [7].

The data indicate presence of wide range of variability for Physiological and biochemical parameters [Table-2]. The highest Chlorophyll a content (1.12 mg g^{-1} fresh weight) in (TCH-1199) was followed by (0.90) and (0.88) in CPD-1601 and TSH-327 respectively, while, minimum (0.45) in L-1384 was recorded. The highest Chlorophyll b content (1.88 mg g^{-1} fresh weight) in (AR-9108) was followed by (1.60) and (1.25) in TSH-327 and TCH-1199 respectively, while, minimum (0.51) in GSHV-185 was recorded. The highest total chlorophyll content (2.21 mg g^{-1} fresh weight) in (TCH-1199) was followed by (2.20 mg g^{-1} fresh weight), (2.20 mg g^{-1} fresh weight) in JK-4 and ARBH-1601 respectively, while, minimum (1.43 mg g^{-1} fresh weight) in L-799 was recorded. Similar results were reported by Reddy and Ratnakumari [8]. The Chlorophyll stability index was maximum in L-1060 (84.33) and minimum in JK-4 (67.00).The highest proline content was found in JK-4 (23.52 µ moles/g m tissue) followed by TSH-327 (22.67) and TCH-1199 (22.00), while, minimum was recorded in L-1060 (12.00). Similar results were reported by Bates *et al*., [9]. (1975). The highest relative water content was found in TSH-327 (61.33 %) followed by TCH-1199 (59.33) and L-799 (57.67), while, minimum was recorded in RS-2835 (49.11). The highest photosynthetic rate was found in JK-4 (19.10 µ mol m^2 s^{-1}) followed by TCH-1199 (19.10) and TSH-327 (18.00), while, minimum was recorded in L-1060 (9.0). The highest Leaf water potential (9.20-bar) in (JK-4), followed by 9.32) and (10.78) in TCH-1199 and AR-9108 respectively, while, minimum (25.50) in L-1384 was recorded. Similar finding was also reported by Koutu *et al*., [10].

Estimates of genetic parameters

The estimates of genotypic (GCV) and phenotypic (PCV) coefficients of variations, respectively for seed cotton yield (40.67, 41.23), number of bolls $plant^{-1}$ (35.16, 36.32) and boll weight (g) (21.15, 22.85) showed relatively high coefficients of variation [Table-1]. Similar results were reported by Sankarpandian *et al*. [11], Valarmathi and Jehangir [12], Rao and Reddy [2] (2001); Ahuja and Tuteja [13] (2000) and Reddy and Ratnakumari [8]. (2004).The drought tolerance traits considerable variations viz., chlorophyll b (55.21, 59.73), leaf water potential (47.92, 50.08), chlorophyll a (46.86, 50.20) and photosynthesis rate (33.93, 35.93) was observed that indicating the greater scope for further improvement through selection [Table-2], especially when the objective is to isolate genotypes specifically suitable for rainfed situation. The estimates of PCV were higher than GCV. The differences in values of GCV and PCV were low values for no. of nodes, sympodia per plant and plant height indicating less influence of environment in the expression of these traits. These results indicate that there was ample scope for improving these traits by practicing simple selection as considerable amount of variation were present in the material. The information on estimates of genotypic coefficient of variation gives the idea of total variation available for a particular trait. However, it does not provide information on the relative amount of heritable variation. This information can be obtained by estimating the heritability. High heritability estimates were observed for yield and yield components [Table-1] *viz.* seed cotton yield $plant^{-1}$ (97.28), bolls $plant^{-1}$ (93.71) and boll weight (85.64). The drought tolerance traits [Table-2] *viz*., relative water content (96.34), proline content (93.61), total chlorophyll (92.87) and leaf water potential. High heritability indicates the effectiveness of selection based on phenotype but do not necessarily mean a high genetic gain for either a particular trait. The heritability estimates includes dominance epistasis as well as additive genetic variance Paul, [14]. Swarup and Chaugale [15]) indicated that a high value of heritability is not always an indicator of high genetic gain. Hence, consideration of both high heritability and high genetic advance are crucial for the improvement (genetic gain) of any character. Leaf water potential, proline content and relative water content showed high heritability estimates and high genetic advance [8].

Conclusion

High heritability coupled with high genetic advance showed that these characters are governed by additive gene action. Chlorophyll b and no. of nodes showed low heritability as well as low genetic advance suggesting the involvement of non-additive gene action in the inheritance of this trait. Further improvement in this trait can be achieved through heterosis breeding.

Application of research: If the variability, heritability and genetic advance are considered together for seed cotton yield plant-1, Bolls plant-1, boll weight plant-1 chlorophyll b, leaf water potential and proline content may be the best reliable for yield and drought tolerance in American cotton and that could be exploited through selection for improvement these characters for developing high yielding cotton varieties/hybrids possessing drought tolerance.

Research Category: Genetic analysis

Abbreviations:
TSH-327-Cotton Research Station, Srivilliputtar
TCH- Tamil Nadu Agricultural University, Coimbatore

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