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Heterosis Studies on within-boll yield traits in Upland Cotton (*Gossypium Hirsutum* L.)

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ABSTRACT

Cotton (Gossypium hirsutum L.) is the major source of fiber supplier to the entire world within boll several component traits were major determinants which contribute to increase lint and seed cotton yield. Very little information has been established on heterosis of these traits in cotton. Ten upland cotton genotypes were utilized for development of 45 F_1 hybrids in a half diallel manner. Parents and their F_1 progeny were evaluated in Randomized complete block design with two replications at ARS, Siruguppa during 2013-14. six within-boll yield components traits were analyzed and identified crosses GSHV 99/307 x ARB 904, GSHV 99/307 x Surabhi, GSHV 99/307 x H 1462 are exhibited potent desirable MP and BP heterosis for Boll size, Lint percentage, Lint mass per boll, Seeds per boll respectively.

***Key words**: Cotton, F_1 hybrids, Boll size, Lint percentage, Lint mass per boll*

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INTRODUCTION

India is one of the leading countries in the cotton production and consumption possesses long back history of its cultivation. The uniqueness of the country is cultivation of all four types of cotton species but maximum area under *Gossypium hirsutum* L due to its productive potential and large number of released varieties and hybrids.

The major concern of breeder is to improve the productive potentiality of genotype and achieved successfully in many crops including cotton by focusing only on direct selections such as number of bolls on unit land area and boll size for decades [1]. But there are several number of component traits within boll contributed for boll weight e.g. boll size, seeds number, boll number, seed weight, lint weight etc., A little attention has been made for selection of these basic traits mainly because of the difficulty in their measurement [1]. Within-boll yield components are the most basic determinants of seed cotton and/or lint yield in cotton [2].

The number of bolls produced on unit land area played a primary, lint yield produced on each seed as secondary and number of seeds per boll as tertiary role in the overall contribution to lint yield [2]. Heterosis breeding is most extensively used method for genetic improvement of cotton yield. By keeping in view the role of various yield contributing traits within boll. The present study was undertaken to predict the heterotic potential of 45 crosses for within-boll yield traits.

MATERIALS AND METHODS

Ten genetically diverse upland cotton genotypes *viz.,* GSHV 99/307, Pusa 9127, ARB 904, Surabhi, CCH 510, BS 277, BS 2170, H 1462, TSH 0250, TCH 1728 whose performance found to be consistent across locations with stable yield and good fibre quality traits. These 10 parents were crossed in 10 x 10 haf diallel during 2012-13 to generate 45 F_1 hybrids. The obtained F_{1s} and their parents were grown in experimental area of Agricultural Research Station Siruguppa (UAS, Raichur) in Randomized Complete Block Design with two replications in 2013-14. Spacing of 60 cm within and 90 cm between the rows with length of 6 meters has been followed. All standard agronomic and plant protection measure were taken to raise good crop.

Observations were recorded on five plants in each entry were selected randomly in each replication samples were ginned in laboratory to separate seed and lint fractions while rest of the measurements was done using formulas suggested by [3] follows below:

Boll size (BS) = (seed cotton weight (g)/boll number)

Lint percentage (LP) = (lint weight (g)/seed cotton weight (g)) x (100)

Lint mass per boll (LM/B) = (lint weight (g)/boll number)

Seed mass per boll (SM/B) = (seed weight (g)/boll number)

Seeds per boll (S/B) = boll size (100 – lint %)/seed index

Seed mass per seed (SM/S) = (seed mass per boll/seed number per boll)

Number of seed per boll was determined in accordance with [2] and heterosis over mid and better parent was carried out as per [4].

RESULTS AND DISCUSSION

Heterosis is expressed as percentage increase (+) or decrease (-) in the mean value of concern trait (Table1) over the mid parent and better parent referred as *relative heterosis* and *heterobeltiosis* respectively. All the six traits under study showed significant positive MP except SM/B and SM/S were in significant negative MP. The highest MP heterotic potential was noticed for LP at 25.66%, then accompanied by S/B, BS at 10.80% and 8.57% respectively. Many of the 45 crosses had significant and positive MP for above mention three traits. Hybrid combinations (Table 2) expressed highest heterotic increase in seed mass per seed (SM/S) in Surabhi x CCH 510 (92%), Lint mass per boll (LM/B) in GSHV 99/307 x ARB 904 (56.05%), Seeds per boll (S/B) in GSHV 99/307 x H 1462 (46.53%), Boll size (BS) in GSHV 99/307 x ARB 904 (45.92%), Seed mass per boll (SM/B) in Surabhi x CCH 510 (37.16%), Lint percentage (LP) in ARB 904 x H 1462 (13.40%) respectively. These results were in agreement with previous findings of [1] for seed number per boll, seed mass per boll, Lint percentage [5] and Lint mass per boll [3]. Increase in the number of seed per boll is considered to be desirable trait to increase the surface area for lint production inside the boll [6] [1].

Table 1 The heterosis over *better parent* or *mid-parent* of six within-boll yield components

Traits	Hpm (F_1) (%)				Hpb (F_1) (%)			
	Average	Range	+N	-N	Average	Range	+N	-N
BS	8.57**	-39.57 to 45.92	31 (17)	14 (5)	2.64**	-37.42 to 34.90	25 (11)	20 (5)
LP	25.66**	-12.26 to 13.40	25 (17)	20 (17)	-1.00**	-12.88 to 19.55	15 (6)	30 (8)
LM/B	1.55**	-34.22 to 56.05	32 (17)	13(4)	13.94**	-33.86 to 42.69	40 (19)	5 (1)
S/B	10.80**	-31.75 to 46.53	34 (20)	11(3)	3.51**	-37.40 to 41.59	28 (21)	17 (13)
SM/B	-21.34**	-59.63 to 37.16	5 (4)	40 (36)	-31.94**	-61.73 to 20.76	3 (1)	42 (38)
SM/S	-26.92**	-68.89 to 92.00	6 (4)	39 (33)	-39.41**	-73.44 to 70.79	3 (2)	42 (35)

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

BS: Boll size, LP: Lint percentage, LM/B: Lint mass per boll, S/B: Seeds per boll, SM/B: Seed mass per boll, SM/S: Seed mass per seed, Hpm (F_1): F_1 heterosis over mid-parent, Hpb(F_1): F_1 heterosis over the better parent, +N: number of hybrids with positive heterosis, number in parentheses indicates the combinations contributing to significant positive heterosis, -N: number of hybrids with negative heterosis, number in parentheses indicates the combinations contributing to significant negative hetesosis.

Significant positive heterosis over better parent was observed for boll size, lint mass per boll and seeds per boll while significant negative BP heterosis was noticed for seed mass per boll and seed mass per seed (SM/S) (Table 1). However, these traits showed wide range of variation. More number of hybrids exhibited positive significant BP heterosis for seeds per boll (21), then followed by lint mass per boll (19), boll size (11) and lint percentage (6) respectively. Hybrids (Table 2) ARB 904 x H 1462, Surabhi x BS-277, Surabhi x H 1462 manifested maximum increase in lint mass per boll and lint percentage over the better parent[1]. Higher lint percentage is mainly contributed by higher lint mass per boll with increase in number of medium sized seeds [7]. Under high temperature regimes the usefulness of increased seed number per boll and seed mass per boll are the important traits as suggested by [8] at the time of studying various seed related trait.

In this study, we identified GSHV 99/307 x ARB 904, GSHV 99/307 x Surabhi, GSHV 99/307 x H 1462 are the potential crosses which had a desirable MP and BP heterosis for Boll size, Lint percentage, Lint mass per boll, Seeds per boll suggesting heterosis breeding is useful for development of these traits. Our results were in close agreement with various earlier researchers and also disagreement with many others. This variation arises due to difference in the type of genetic material used for study and effect of environmental factors on expression of various quantitative characters.

Table 2. Heterotic potential of various F_1 upland cotton hybrids for within-boll yield components

Crosses	BS		LP		LM/B		S/B		SM/B		SM/S	
	Hpm	Hpb	Hpm	Hpb	Hpm	Hpb	Hpm	Hpb	Hpm	Hpb	Hpm	Hpb
GSHV 99 x PUSA 9127	22.43*	24.98**	3.52*	2.27	26.76**	27.82**	11.07*	3.70	-20.46**	-30.08**	-29.44**	-41.52*
GSHV 99/307 x ARB 904	45.92**	32.53**	7.69**	2.81	56.05**	32.97**	32.06**	12.85**	-45.41**	-55.49**	-61.35**	-72.04**
GSHV 99/307 x Surabhi	28.57*	15.98*	5.19**	-0.89	35.23**	42.69**	23.17**	37.46**	-33.81**	-53.86**	-46.22**	-68.54**
GSHV 99/307 x CCH 510	6.01	0.54	-0.09	-0.70	5.95	13.18	0.63	0.12	-2.39*	-4.74	-2.99	-4.86
GSHV 99/307 x BS 277	10.33	5.60	1.42	-0.20	12.01	19.49*	15.82*	8.78*	-28.78**	-40.54**	-39.54**	-51.99**
GSHV 99/307 x BS 2170	11.35	5.17	9.16	3.65	21.88*	23.59*	3.59	-5.76*	-27.71**	-38.88**	-32.13**	-46.84**
GSHV 99/307 x H 1462	30.35**	34.90**	3.80*	0.77	35.17**	29.20**	46.53**	39.07**	-44.22**	-52.48**	-62.40**	-69.31**
GSHV 99/307 x TSH 0250	15.01*	19.29*	-0.38	-1.90	14.52	11.22	18.31*	9.18*	-26.62**	-40.58**	-39.60**	-53.98**
GSHV99 / 307 x TCH 1728	22.53**	16.62*	-0.01	-0.51	22.49*	31.87**	26.04**	19.87**	-27.64**	-31.28**	-42.90**	-48.28*
Pusa 9127 x ARB 904	27.35**	13.00	-2.77*	-8.24*	22.89*	3.69	18.09*	7.32*	-25.77**	-32.02**	-38.34**	-48.22*
Pusa 9127 x Surabhi	7.39	16.07*	-0.12	-1.91	7.41	13.85	-1.38	-9.65*	-7.61*	-20.47**	-7.71	-24.68
Pusa 9127 x CCH 510	16.52*	8.42	0.43	-1.37	17.19*	24.22*	22.73**	15.13**	-24.58**	-35.08**	-39.46**	-50.59**
Pusa 9127 x BS 277	13.07	6.19	-8.76**	-11.27**	3.41	9.45	42.50**	41.59**	-21.91**	-26.47**	-45.18**	-48.07*
Pusa 9127 x BS 2170	9.39	1.36	-4.95*	-10.77**	4.46	5.06	-6.58	-20.09**	17.50**	-10.47	16.06	-20.36
Pusa 9127 x H 1462	22.94**	4.45	-0.39	-4.42	22.39*	15.96*	28.25**	30.54**	-35.65**	-37.95**	-49.81**	-48.80**
Pusa 9127 x TSH 0250	21.86**	23.21**	-2.61*	-5.23**	18.65*	14.24	21.17**	19.66**	-34.10**	-40.14**	-45.69**	-51.22**
Pusa 9127 x TCH 1728	10.86	3.50	-12.26**	-12.88*	-2.68	3.97	4.82	2.79	-10.42**	-17.46**	-14.72	-22.81
ARB 904 x Surabhi	21.48**	6.05	2.47*	2.81	24.54*	9.03	33.01**	13.02*	-35.30**	-42.14**	-53.84**	-64.19**
ARB 904 x CCH 510	12.19*	-6.50	2.33*	-1.73	13.86	12.39	10.04	-5.57*	-30.47**	-44.37**	-40.98**	-57.81**
ARB 904 x BS 277	6.46	-5.80	2.94*	-3.89	8.87	12.39	13.63	3.61	-42.58**	-45.36**	-50.21**	-50.57**

ARB 904 x BS 2170	-4.41	-20.70	0.83	0.26	-3.51	-10.48	-15.18*	-32.94**	2.57	-26.38**	1.83	-36.20*
ARB 904 x H 1462	27.99**	14.91	13.40**	11.45**	44.85**	25.18**	27.12**	13.74**	-59.63**	-61.73**	-68.89**	-73.44**
ARB 904 x TSH 0250	40.98**	26.90**	6.14**	2.85	49.08**	31.33**	45.22**	33.48**	-49.12**	-49.57**	-65.21**	-67.76**
ARB 904 x TCH 1728	16.65*	-2.48	-1.32	-6.24*	13.94	13.50	27.38**	13.74**	-25.91**	-36.99**	-43.85**	-56.46**
Surabhi x CCH 510	-13.02	-17.01*	4.26*	-0.20	-9.54	0.55	-28.46**	-29.29**	37.16**	20.76*	92.00**	70.79**
Surabhi x BS- 277	10.03	5.95	11.91**	8.17*	22.87*	36.37**	4.62	-2.35	-17.45*	-24.15*	-22.00*	-32.68*
Surabhi x BS - 2170	-19.95*	-26.02**	9.12**	19.55**	-12.80	-1.80	-11.16	-36.36**	-9.47	-1.34	1.19	28.80*
Surabhi x H 1462	19.25*	23.20**	10.39**	8.14*	31.72**	30.24**	14.59	8.07	-42.18**	-45.64**	-49.92**	-55.42**
Surabhi x TSH 0250	-39.57**	-37.42**	8.74**	5.04*	-34.22**	-33.86**	-31.75**	-37.40**	-25.15**	-33.58**	7.53	-11.48
Surabhi x TCH 1728	7.66	2.31	1.64	-3.73	9.10	22.27*	15.78*	9.42*	-27.88**	-31.89**	-37.70**	-37.75*
CCH 510 x BS - 277	-13.41*	-12.00	-1.53	-2.51	-14.73	4.16	-12.55	-7.01*	-32.83**	-45.01**	-24.47**	-40.87*
CCH 510 x BS - 2170	-4.23	-3.88	2.77*	-1.85	-1.59	14.54	-13.27	-21.45**	33.76**	15.44	50.08*	19.25
CCH 510 x H 1462	-0.92	-8.24	4.37*	1.93	3.19	13.55	12.34	7.14*	-21.94*	-34.82**	-31.34**	-44.80*
CCH 510 x TSH 0250	-0.13	-7.32	-0.71	-1.64	-0.92	10.68	5.76	-1.94	-16.37*	-33.54**	-22.98*	-42.10*
CCH 510 x TCH 1728	-1.05	-1.34	-0.81	-1.61	-1.86	17.87*	2.89	5.95*	-13.93*	-35.33**	-16.75*	-44.38*
BS 277 x	-5.63	-4.45	0.75	-2.85	-4.96	10.45	-5.95	-19.12**	-7.63	-32.44**	-9.78	-39.86*
BS 277 x H 1462	-22.45**	-27.50**	0.06	-1.31	-22.51*	-14.87	-0.15	-1.24	-24.32**	-26.16**	-24.24*	-26.87*
BS 277 x TSH 0250	-13.84*	-19.28*	-1.84	-1.90	-15.42*	-5.66	5.37	3.40	-28.55**	-31.24**	-32.27**	-35.98*
BS 277 x TCH 1728	-3.78	-2.57	-5.16	-7.13*	-8.72	12.33	8.81	7.38*	-34.08**	-42.50**	-39.55**	-47.86*
BS 2170 x H 1462	10.19	1.61	10.39**	7.89*	21.88*	26.89**	10.08	-4.44	-37.25**	-53.37**	-47.09**	-64.07**
BS 2170 x TSH 0250	-1.04	-8.55	0.29	-3.35	-0.45	5.31	0.30	-15.09**	-9.06	-35.07**	-18.24	-47.00*
BS 2170 x TCH 1728	-4.90	-4.91	-6.47**	-11.61**	-11.05*	4.33	-5.12	-17.48**	31.06**	6.26	30.47*	-4.78
H 1462 x TSH 0250	22.78**	22.49**	1.30	-0.15	24.37*	23.65*	20.50**	16.98**	-23.73**	-28.30**	-36.88**	-42.29**
H 1462 x TCH 1728	8.32	-0.09	-0.54	-3.90	7.42	19.17*	29.51**	29.23**	-37.71**	-44.48**	-51.92**	-57.22**
TSH 0250 x TCH 1728	7.90	-0.26	-4.83*	-6.74*	2.52	15.46*	15.68*	12.05**	-12.88	-26.45**	-25.22*	-38.47*

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