Pure Appl. Biol., 6(1): 153-158, March, 2017
http://dx.doi.org/10.19045/bspab.2017.60008

Research Article

Genetic studies in upland cotton (*Gossypium hirsutum* L.) for earliness and yield contributing traits

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Citation

Sabir Hussain Kaleri, Arshad Ali Kaleri, Abdul Wahid Baloch, Shah Nawaz Mari, Sajid Hussain Kaleri, Naila Gandahi, Wajid Ali Jatoi, Tanweer Fatah Abro and Mohsin Khan. Genetic studies in upland cotton (*Gossypium hirsutum* L.) for earliness and yield contributing traits. Pure and Applied Biology. Vol. 6, Issue 1, pp153-158. http://dx.doi.org/10.19045/bspab.2017.60008

Received: 10/11/2016 Revised: 09/01/2017 Accepted: 14/01/2017 Online First: 18/01/2017

Abstract

The current experiment was conducted to evaluate the genetics for earliness and yield traits in upland cotton (*Gossypium hirsutum* L.) during Kharif season 2013 at Cotton Section, Agriculture Research Institute, Tandojam. The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of fifteen genotypes in which ten F_1 were developed from five parents crossed in a 5 x 5 diallel matting design for days to 1st flower, bolls formed at 90 days after planting, bolls opened at 90 days after planting, plant height (cm), sympodial branches plant^{-1}, bolls plant^{-1}, boll weight (g) and seed cotton yield plant^{-1} (g). The genotypes were significantly different ($P \leq 0.05$) for days to 1st flower, bolls formed at 90 days after planting, bolls opened at 90 days after planting, plant height, sympodial branches plant^{-1}, bolls plant^{-1} and seed cotton yield plant^{-1}. Among the genotypes, Sindh-1, CRIS-134 and Shahbaz were best general combiners for days to 1st flower, bolls formed at 90 days after planting, bolls opened at 90 days after planting, plant height, sympodial branches plant^{-1}, bolls plant^{-1}, boll weight and seed cotton yield plant^{-1}. The F_1 hybrids Sadori x Sindh-1, Shabaz x Haridost, Sadori x CIM-496 were best specific combiners for all the characters studied. The F_1 hybrids Shahbaz x Sindh-1, Sadori x Sindh-1, Sadori x Haridost and Sadori x CIM-496 gave higher heterotic effects for all the studied traits.

Keywords: Earliness; Diallel; Seed cotton yield; Upland cotton; Earliness traits

Introduction

Cotton occupies a unique position in Pakistan's agrarian economy. Efforts on various aspects of the crop have been under way to increase overall production of the country. Cotton is principal component of Pakistan's economy owing to its 69% share in foreign exchange earning, 7.5% value addition in agriculture and 1.6% in GDP. It contributes about 78% in domestic oil

production. It is a powerful source for our economic growth because it plays an efficient role in enhancing the national economy by earning a huge share of the total foreign exchange. It enhances textile exports of cotton with made items like raw cotton, cotton yarn, bed wear, towels, cotton cloths and synthetic fabrics knit wear and readymade garments to foreign countries and embrace more than $7.3 billion to the national economy which is around two thirds of the country's export earnings [1]. Cotton breeders hence are very keen in determining the genetic potential of their inbred parents in hybrid combinations for two reasons. First is that, inbred parents be identified which form good individuals in specific combinations, which is commonly referred as specific combining ability (SCA) of the inbred parents. Second purpose is, to locate those inbred lines which perform very well when crossed with a series of other inbred parents referred as general combining ability (GCA) of the parents. Thus, former types of inbreds are useful for hybrid cotton development, whereas later types are desirable for hybridization and selection from segregation populations. The primary objectives of this study were to determine the genetic potential in upland cotton cultivars, such information can usefully be subjugated in articulating efficient selection program for synthesis and development of new cotton genotypes with improved traits for earliness and seed cotton yield.

Materials and methods

The study was conducted during Kharif season of 2013 at Cotton Section, Agriculture Research Institute, Tandojam in randomized complete block design with three replications to evaluate genetics for earliness in upland cotton (*Gossypium hirsutum* L.). The experiment was consisted of fifteen genotypes in which five were parents(P_1 = Shahbaz, P_2 = CIM-496, P_3 = Sindh-1, P_4 = Sadori, P_5 = Hari-Dost) and the rest were F_1 hybrids(C_1=ShahbazxCIM-496, C_2=Shahbaz x Sindh-1, C_3=Shahbaz x Sadori, C_4=Shahbaz x Haridost, C_5=CIM-496 x Sindh-1, C_6=CIM-496 x Sadori, C_7=CIM-496 x Haridost, C_8=Sindh-1 x Sadori, C_9=Sindh-1 x Haridost, C_{10}= Sadori x Haridost) were developed from a 5x 5 diallel matting design. Cotton seeds were sown by dibbling method, plant to plant and row to row distance was kept 30 and 75 cm, respectively.

Results and discussion

The study was conducted during Kharif season of 2013 at Cotton Section, Agriculture Research Institute, Tandojam in randomized complete block design with three replications. In context to evaluate genetics for earliness and yield related traits in upland cotton (*Gossypium hirsutum* L.).The experiment consisted of fifteen genotypes in which five were parents and the rest were F_1 hybrids in a 5 x 5 diallel matting design for days to 1st flower, bolls formed at 90 days after planting, bolls opened at 90 days after planting, plant height (cm), sympodial branches plant^{1}, bolls plant^{1}, boll weight (g) and seed cotton yield plant^{1} (g).The obtained mean squares from analysis of variances exhibited highly significant differences ($P \leq 0.05$) for all the studied traits among the assessed genotypes except that of boll weight, which was non-significant (Table 1). This reveals that examined genetic materials have value to be used in more breeding programs for the improvement of upland cotton in respect to fiber and yield. Kaleri *et al.*[2] also reported that a set Bt and non-Bt cotton genotypes differed highly significantly at $P \leq 0.01$ of probability level for plant height, 1st sympodial node number, 1st effective boll node number, sympodial branches plant^{-1}, bolls plant^{-1}, boll weight, seed index, micronaire value, staple length, ginning outturn percentage and seed cotton yield plant^{-1}.

Table 1. Mean squares from analysis of variance for various quantitative traits in upland cotton

Source of variation	Replication (D.F.=2)	Genotypes (D.F.=16)	Error (D.F.=32)
Days to 1st flower	3.45	210.13**	10.89
Bolls formed at 90 DAP	8.97	345.14**	8.31
Bolls opened at 90 DAP	15.14	210.00**	2.30
Plant height	30.35	398.89**	15.31
Sympodial branches plant^{-1}	4.38	24.30*	1.89
Bolls plant^{-1}	10.25	123.89**	15.60
Boll weight	3.95	15.60^{NS}	8.85
Seedcotton yield plant^{-1}	35.48	598.30**	14.31

*,** indicates significant level at 5 and 1% of probability level; NS= Non-significant

With regard to GCA effects, among the five parents, Shahbaz recorded maximum (2.89) GCA effects for days to 1st flower, followed by CIM-496 (1.60), while Sindh-1 recorded maximum (1.25) GCA effects for bolls formed at 90 DAP and also showed maximum (3.00) GCA for bolls opened at 90 DAP. Whereas, Haridost gave maximum (1.95) GCA effects for plant height, followed by CIM-496 (1.25) for same trait; parent Sadori recorded highest (1.90) GCA effects for sympodial branches plant^{-1} and also expressed the highest GCA effects (2.10) for seed cotton yield plant^{-1}. Sindh-1 recorded maximum GCA (1.30) effects for bolls plant^{-1} and CIM-496 gave the highest GCA (0.45) for boll weight (Table 2). Similarly, Abro *et al.* **[3]** showed that the variety Sadori proved to be best general combiner for plant height, number of bolls plant^{-1} and seed cotton yield.

Table 2. General combining ability (GCA) of the parents for earliness and yield traits in upland cotton

Genotypes	Shahbaz	CIM-496	Sindh-1	Sadori	Haridost	S.E.(gi)
Days to 1st flower	2.89	1.60	0.89	-2.60	-1.78	0.10
Bolls formed at 90 DAP	-0.45	-0.90	1.25	0.35	-0.25	0.05
Bolls opened at 90 DAP	1.15	2.80	3.00	-4.80	-2.15	0.78
Plant height	-2.05	1.25	-2.25	0.90	1.95	0.65
Sympodia plant^{-1}	-1.90	0.85	0.85	1.90	-1.10	0.45
Bolls plant^{-1}	-1.70	0.65	1.30	0.35	-1.60	0.32
Boll weight	0.02	0.08	0.45	0.10	-0.65	0.005
Seedcotton yield plant^{-1}	1.90	-2.80	0.80	2.10	-1.80	1.10

Regarding SCA effects, Shahbaz x Sindh-1 gave the higher (3.45) SCA effects for days to 1st flower and bolls formed at 90 DAP, while Sindh-1 x Sadori recorded high (3.45) SCA effects for boll opening at 90 DAP, followed by Shahbaz x Haridost (2.67). However, Shahbaz x Sadori produced high (5.60) SCA effects for plant height, followed by CIM-496 x Sindh-1 (3.90) SCA effects for same trait and Sindh-1 x Sadori gave the higher SCA effects (3.89,8.90,1.00 and15.98) for sympodial branches plant^{-1}, bolls plant^{-1}, boll weight and seed cotton yield plant^{-1}, respectively among the ten

crosses (Table 3). Similar to our findings, Baloch *et al.* [4] reported SCA estimates for hybrids FH-901 x CIM-506, which expressed maximum effects for ginning outturn percentage (4.00) and micronaire value (0.33); NB-999 x CIM-497 for earliness (5.29) and staple length (1.69) and FH-901 x CIM-497 (16.17) for plant height.

Table 3. Specific combining ability (SCA) effects of the F_1 hybrid for earliness and yield traits in upland cotton

Genotypes	Days to 1st flower	Bolls formed at 90 DAP+	Bolls opened at 90 DAP	Plant height	Sympodial branches plant-1	Bolls plant-1	Boll weight	Seed cotton yield plant-1
Shahbaz x CIM-496	1.20	2.90	-1.00	1.90	0.90	2.89	-0.34	3.56
Shahbaz x Sindh-1	3.45	3.45	-0.05	3.45	0.67	3.45	-0.20	4.50
Shahbaz x Sadori	-2.68	1.67	1.05	5.60	-1.20	-4.65	0.25	-2.87
Shahbaz x Haridost	-0.80	2.78	2.67	3.89	0.98	-2.80	0.45	-4.56
CIM-496 x Sindh-1	2.34	-2.12	0.65	3.90	1.90	-1.40	0.42	-3.59
CIM-496 x Sodri	-3.09	0.89	0.85	2.86	-2.76	2.40	0.45	4.89
CIM-496 x Haridost	2.36	2.00	1.20	-1.80	-1.65	1.65	-1.90	6.56
Sindh-1 x Sodri	-1.90	2.85	3.45	-2.44	3.89	8.90	1.00	15.98
Sindh-1 x Haridost	1.43	1.65	-1.35	1.00	-1.30	2.56	0.60	-10.67
Sadori x Haridost	1.90	1.05	1.90	1.68	0.80	3.45	-0.67	3.56
S.E (si)	1.89	0.68	0.86	1.45	0.80	1.77	0.35	2.38

Taking heterotic effects which is mentioned in Table 4 and 5, Shahbaz x Sindh-1 manifested maximum (8.80% and 5.18%) of relative and better parent heterosis for days to 1st flower; Shahbaz x Haridost gave the maximum (26.15%) relative heterosis and Shahbaz x CIM-496 gave higher (3.69%) better parent heterosis for bolls formed at 90 DAP and Shahbaz x CIM-496 disclosed maximum (20.97%and 18.74%) relative and better parent heterosis for plant height. CIM-496 x Haridost recorded highest (38.46 and 35.00%) relative and mid parent heterosis, followed by Sindh-1 x Haridost (19.13% and 6.59%) and Shahbaz x Sindh-1 (12.43% and 11.69%) relative and better parent heterosis for sympodial branches plant^{-1}, respectively and Shahbaz x Haridost gave maximum (41.61% and 40.48%) relative and better parent heterosis for bolls plant^{-1}, Sindh-1 x Haridost gave the higher (17.65% and 11.50%) relative and better parent heterosis for boll weight and Shahbaz x Sadori regarded higher (42.91% and 33.61%) relative and better parent heterosis for seed cotton yield plant^{-1}.Similar results were obtained by [1, 5, 6] for carrying out similar research segments to estimate hybrid vigour in cotton.

Table 4. Heterotic effects for various traits in upland cotton genotypes

Genotypes	Boll formed at 90 days		Boll opened at 90 days		Plant height		Sympodial branches plant^{1}	
	H	HB	H	HB	H	HB	H	HB
Shahbaz x CIM-496	10.26	3.69	-10.01	-14.29	20.97	18.74	19.41	3.90
Shahbaz x Sindh-1	0.01	-11.28	-14.30	-26.43	20.77	14.14	12.43	11.69
Shahbaz x Sadori	12.20	-0.82	30.43	18.39	4.35	-4.55	-13.37	-11.69
Shahbaz x Haridost	26.15	-2.09	23.90	19.96	-0.69	-14.45	16.79	3.90
CIM-496 x Sindh-1	-15.86	-20.95	-54.20	-69.34	-0.68	-13.07	6.79	-6.55
CIM-496 x Sodri	-4.28	-10.42	-47.40	-40.50	7.73	3.66	13.86	-2.51
CIM-496 x Haridost	16.04	-13.76	-17.80	-28.50	6.23	-1.14	38.46	35.00
Sindh-1 x Sodri	-6.02	-5.64	-19.65	-20.39	-16.40	-21.78	11.54	8.74
Sindh-1 x Haridost	17.53	-16.11	-64.98	-75.01	-29.31	-29.74	19.13	6.59
Sadori x Haridost	19.08	-15.21	-58.44	-70.17	-25.74	-25.74	11.42	-2.51

H= Mid-parent heterosis; HB= Better parent heterosis

Table 5. Heterotic effects for various traits in upland cotton genotypes

Genotypes	Bolls plant^{1}		Boll weight		Seed cotton yield plant^{1}	
	H	HB	H	HB	H	HB
Shahbaz x CIM-496	-5.13	-6.98	-5.62	-6.73	29.27	17.46
Shahbaz x Sindh-1	33.81	18.75	-3.08	-4.71	27.70	6.27
Shahbaz x Sadori	27.51	6.49	1.00	0.00	42.91	33.61
Shahbaz x Haridost	41.61	40.48	1.08	-5.72	36.36	28.74
CIM-496 x Sindh-1	21.81	10.01	-5.37	-5.86	-35.70	-41.72
CIM-496 x Sodri	-19.75	-31.90	-12.31	-14.19	-19.30	-30.96
CIM-496 x Haridost	1.95	0.77	-11.15	-16.21	7.32	-7.38
Sindh-1 x Sodri	-20.00	-25.41	4.07	1.32	4.62	-17.46
Sindh-1 x Haridost	1.40	-9.38	17.65	11.50	17.08	-6.92
Sadori x Haridost	2.88	-13.52	16.79	7.92	35.27	33.86

H= Mid-parent heterosis; HB= Better parent heterosis

Conclusion

All the genotypes were highly significant for most of the traits, however, boll weight was non-significant. Among the genotypes Sindh-1 and Shahbaz were best combiners for days to 1st flower, bolls formed at 90 days after planting, bolls opened at 90 days after planting, plant height, sympodial branches plant^{1}, bolls plant^{1}, boll weight and seed cotton yield plant^{1}. Among the F_1 hybrids the crosses Sadori x Sindh-1, Shabaz x Hari dost, Sadori x CIM-496 were best specific combiners for all the characters studied. The F_1 hybrids Shahbaz x Sindh-1, Sadori x Sindh-1, Sadori x Hari dost and Sadori x CIM-496 recorded higher heterotic effects for all the traits.

Authors' contributions

Conceived and designed the experiments: SN Mari, Performed the experiments: SH Kaleri & AA Kaleri, Analyzed the data: AW Baloch & AA Kaleri, Contributed reagents/

materials/ analysis tools: SH Kaleri & AA Kaleri, Wrote the paper: AA Kaleri.

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