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SHORT NOTE [NOTA CORTA]

COMBINING ABILITY ESTIMATES FOR OIL CONTENT, YIELD COMPONENTS AND FIBRE QUALITY TRAITS IN COTTON (*G. hirsutum*) USING AN 8 × 8 DIALLEL MATING DESIGN

[ESTIMADOS DE HABILIDAD COMBINATORIA PARA CONTENIDO DE ACEITE, PRODUCCIÓN Y CARACTERES DE CALIDAD DE LA FIBRA DEL ALGODÓN (*G. hirsutum*) EMPLEANDO UN DISEÑO DE CRUZAS DIALÉLICO 8 × 8]

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SUMMARY

Eight cotton parental lines (CSH 7106, 3 HS, B 58-1290, 23 ES, 23 K, F 1861, VCH (F) and RS 810) were used in an 8 × 8 diallel mating design to obtain 56 F1 hybrids for combining ability analysis. The analysis revealed significant general combining ability (GCA) and specific combining ability (SCA) effects for all the traits measured except lint index, seed index and fiber strength. Preponderance of non-additive gene action was observed for oil content, ginning outturn, 2.5% span length and micronaire and preponderance of additive gene action was obtained in seed yield, boll weight, fiber elongation and oil content. Significant GCA effects were observed for RS 810 for seed yield, and 2.5% span length, for 3 HS and B 58-1290 for boll weight, and CSH 7106 for oil content. Parental lines VCH (F), RS 810 and B 58-1290 were found to be a good general combiner for seed yield and parental lines CSH 7106 and VCH (F) for oil content. Some promising hybrids showing positive significant SCA effect for seed yield were 23 ES × 23 K, F 1861 × VCH (F). For oil content crosses 23 K × RS 810, B58-1290 × F1861, CSH 7106 × 23 ES and 3 HS × VCH (F) showed significant SCA effects.

Key words: Additive; non- additive; gene action; GCA; SCA; hybrids.

RESUMEN

Ocho líneas parentales de algodón (CSH 7106, 3 HS, B 58-1290, 23 ES, 23 K, F 1861, VCH (F) y RS 810) fueron empleadas en un diseño de cruzamiento dialélico 8 × 8 para obtener 56 F_1 híbridos para análisis de habilidad combinatoria. Se encontró un habilidad combinatoria general (GCA) y habilidad combinatoria específica (SCA) para todos los caracteres medidos excepto los índices de fibra, semilla y fortaleza de la fibra. Se observó preponderancia de acción genética no aditiva para el contenido de aceite, producción al desmoteado, 2.5% longitud y micronaire y una preponderancia de acción genética aditiva en producción de semilla, elongación de la fibra, contenido de aceite y peso del fruto de algodón. La línea RS 810 tuvo efectos SCA para producción de semilla y longitud a 2.5%, las líneas 3 HS y B58-1290 para el tamaño del fruto de algodón y la línea CSH 7106 para el contenido de aceite. Las líneas VCH (F), RS 810 y B 58-1290 fueron en general buenas opciones para combinación para la producción de semilla y las líneas CSH 7106 y VCH (F) para el contenido de aceite. Algunos híbridos mostraron SCA positiva para la producción de semilla (23 ES × 23K, F 1861 × VCH (F). Para el contenido de aceite, las cruzas 23 k × RS 810, B58-1290 × F1861, CSH 7106 × 23 ES y 3 HS × VCH (F) mostraron SCA.

Palabras clave: Aditividad; no aditividad; acción génica; híbridos; habilidad combinatoria general; habilidad combinatoria específica.

INTRODUCTION

Cotton plays an important role in providing fiber and cottonseed oil for human consumptions. For improvement in such an important crop, the most important prerequisite is the selection of suitable parents, with good combining ability. Parents with good combining ability would be useful for hybrid development to exploit heterotic gene combination or for use in pedigree breeding to develop inbred lines with favour gene combination to improve yield, oil content and fiber quality traits. Combining ability analysis helps in identification of parents with high general combining ability (GCA) and parental combinations with high specific combining ability (SCA) effects. To aid in the selection of parental combinations with relatively better agronomic performance than expected based on the average performance of the parental lines.

In the present study, a combining ability analysis was conducted to estimate the GCA effects of eight parental lines and SCA effects for 56 F1 hybrids developed from these parents with respect to oil content, yield components and fiber quality traits. Additionally, the study involved determining the gene action governing these quantitative traits and to fix favourable gene combinations for oil content, yield components and fiber quality traits in derived hybrids.

MATERIAL AND METHODS

The experimental materials used for this study comprised of eight parents from diverse lines of American cotton *viz.*, CSH 7106, 3 HS, B 58-1290, 23 ES, 23 K, F 1861, VCH (F) and RS 810. These parents were crossed in an 8 × 8 diallel mating design to develop 56 F1 hybrids. The parents and hybrids were planted in a randomized complete block design with three replication during the Kharif (growing season) in 2006 and 2007 at the research farm of the Division of Crop Improvement, Central Institute for Cotton Research, Nagpur. Individual plot consisted of a single row 6 m length with 0.6 m row spacing. Observations were recorded on five competitive plants for seed yield (g), boll weight (g), ginning outturn(%), seed index(g), lint index (g), 2.5 % span length (mm), fiber strength (g tex^{-1}), micronaire (µg $inch^{-1}$), fiber elongation (%) and oil content (%). Lint samples were sent to the Indian Agricultural Research Institute, New Delhi for analysis of four fibre quality traits:- fiber strength (g tex^{-1}), 2.5 % span length (mm), micronaire (µg $inch^{-1}$) and fiber elongation (%). Oil content in the intact delinted seeds (washed with acid to remove lint from seeds) was estimated by a non- destructive Nuclear Magnetic Resonance (NMR UK Oxford Instruments MQA 7005) method (4) using the Newport Analyzer.Combining ability analysis of the experimental data was done according to Model I and Method I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among parents and hybrids, indicating the presence of considerable amount of genetic variability. Genetic variation derived from the parents as compared to the hybrids was also significant for seed yield, bolls/plant, boll weight, oil content, and fiber elongation. Mean squares obtained from analysis of variance for GCA and SCA for all the characters under study were significant except lint index, seed index and fiber strength (Table 1) indicating the importance of both additive and non-additive gene effects in their expression. Ginning outturn, 2.5% span length and micronaire were not significant for SCA effect (Table 1). However, the magnitude of GCA variance was higher than SCA variance for seed yield, boll weight and fiber elongation indicating the importance of additive gene action for these characters. Tuteja *et al.* 2003 supported these findings.

Table 1. Analysis of variance for combining ability of ten traits in *G. hirsutum* involving 8 x 8 diallel mating design.

Source of variance	Df	Seed Yield (g)	Boll weight (g)	Ginning outturn (%)	lint Index (%)	Seed Index (g)	2.5% Span length (mm)	Fiber Elongation (%)	Micronaire (µg $inch^{-1}$)	Fiber Strength (g tex^{-1})	0il content (%)
GCA	7	587.77**	0.18**	1.62	0.05	0.14	0.67	0.06**	0.04	0.90	0.84**
SCA	28	505.03**	0.07*	1.94*	0.12	0.16	1.03**	0.03**	0.14**	1.68	2.22**
Reciprocal	28	544.70**	0.04	3.70**	0.17**	0.14	1.55**	0.03**	0.07**	1.77	1.37**
Error	126	138.52**	0.04	1.20	0.08	0.13	0.33	0.11	0.01	0.55	0.56
GCA/SCA		0.08	0.26	0.04	-0.04	-0.01	0.03	0.13	0.33	0.02	0.37

* Significant at 0.05, ** Significant at 0.01.

The estimate of GCA (Table 2) revealed that parents 3 HS and B 58-1290 were good general combiners for boll weight and parent RS 810 was a good general combiner for seed yield and 2.5% span length. For oil content, parents CSH 7106 and 23 K were good general combiners. For most of the traits, GCA effects were not significant or were negative for the eight parents. Specific combining ability variances were higher than GCA variances for all the characters (except seed yield, boll weight and fiber elongation) as shown by their lower ratios (Table 1), which would indicates predominance of non-additive gene action (dominant or epistasis) in the inheritance for these traits (Sprague and Tatum 1942); Ahuja and Dhayal 2007) reported non-additive gene action for these traits. Baloch *et al.* 1997; Hassan *et al*., 1999 and 2000) and Ahuja and Tuteja (2003) also reported the presence of non-additive gene action for fiber length, fiber strength and micronaire value.

Based on the SCA effects presented in Table 3 most of the hybrid combinations having high SCA effects are between geographically diverse parents. Joshi & Dhawan (1966) reported high SCA effects when genetic diverse parents were used in hybrid combinations. Of the 56 hybrids, five for seed yield, ginning outturn, 2.5% span length, fiber strength: four for lint index, fiber elongation, oil content; three for micronaire and one for boll weight showed significant positive SCA effects (Table 4). At least one positive combiner was included in most of the crossess for all characters studied except lint index and fiber elongation. Similar results were reported for seed yield, boll number and boll weight by Ahuja and Tuteja 2000; Potdukhe *et al*., (2003); Wankhede *et al*., (2008). However Ahuja *et al*., (2007) reported non-significant SCA effects for fiber elongation. Studies by Punitha *et al*., (1991) and Shakeel *et al*., *(*2001) revealed that boll number, boll weight and seed yield were influenced by the non-additive genes action. Non-additive gene action fiber length, fiber strength and micronaire have been reported by Holla., (1986), Baloch *et al*., (1997) and Hassan *et al*.,1999 and Hassan *et* al., 2000.

The results of this study would suggest that heterosis breeding was suitable for all the characters including fibre properties. In most of the traits, reciprocal crosses showed significant effects (Table 1) suggesting selection of a desirable female parents would be important in hybridization programs Such combinations may give desirable transgressive segregants and these could be utilized for the development of improvemed genotypes, if additive gene effects are present with complementary epistatic effects. Most of the hybrids in this study were crosses of good × poor, average x poor and poor x poor parents for seed yield which indicates the involvement of additive and non – additive gene action for this character. Verma *et al*. (2004) also was reported additive and non-additive gene action for this character. High SCA effect of any cross does not necessarily depend upon the GCA effects of the parents involved. The superiority of the cross may be due to complementary gene action, which can be exploited in the subsequent generations.

Table 2**.** Estimate of GCA effects of eight parents for ten characters in an 8 x 8 diallel mating design in *G.hirsutum.*

Parents	Characters									
	Seed yield (g)	Boll weight (g)	Ginning outturn (%)	Lint Index (g)	Seed index (g)	2.5% Span length (mm)	Fiber Elongation (%)	Micronaire (µg inch^{-1})	Fiber Strength (g tex^{-1})	0il content (%)
CSH 7106	-10.70**	-0.09	-0.44	-0.05	0.04	-0.15	-0.10*	0.01	0.24	0.64**
3 HS	-2.36	0.10*	0.07	-0.06	-0.14	-0.27*	-0.04	-0.06	-0.50**	-0.43*
B58-1290	3.21	0.17**	0.30	0.05	-0.01	0.01	-0.02	-0.03	-0.10	-.025
23 ES	2.73	0.09	0.25	-0.02	-0.11	0.05	0.05	0.02	0.20	-0.46**
23 K	-2.53	-0.07	-0.18	-0.03	-0.01	0.12	-0.01	-0.02	-0.01	0.62*
F 1861	-2.18	-0.13**	-0.25	-0.03	0.14	0.01	-0.02	0.08	-0.04	0.11
VCH (F)	1.44	0.00	-0.20	-0.01	0.03	-0.15	-0.02	-0.05	0.13	0.03
RS 810	10.30**	-0.06	0.46	0.10	0.04	0.40**	0.30	0.06	0.08	0.04

Table 3**.** Five top crosses of SCA effect for seed oil content, yield components and fibre quality characters.

Character	Range of SCA	Crosses	SCAvalue
Seed yield (g)	-1.20 to 34.64	23 ES × 23 K	34.64**
		F1861 × VCH (F)	30.44**
		F1861 × RS810	22.08**
		F1861 x23 K	18.93**
		3HS × VCH (F)	16.74**
Boll Weight (g)	-0.05 to 0.38	F1861 x VCH(F)	0.38**
		3 HS × RS 810	0.15
		B 58-1290 × 23 ES	0.14
		CSH 7106 × B 58-1290	0.10
		CSH 7106 ×3 HS	0.07
Ginning outturn (%)	-1.41 to 1.98*	3HS x RS 810	1.98**
		CSH 7106 x 23 K	1.36*
		B 58-1290 x F 1861	1.29*
		CSH 7106 × 3 HS	1.23*
		23 ES x VCH (F)	1.15*
Lint Index (g)	-0.07 to 0.54	CSH 7106 x 23 K	0.54**
		23 ES x VCH (F)	0.33*
		CSH 7106 x 3 HS	0.33*
		F 1861 x VCH (F)	0.27*
		23 K x VCH (F)	-0.38
Seed Index (g)	-0.92 to 0.51	CSH 7106 × 23 K	0.51
		F 1861 × VCH(F)	0.30
		23 K × RS 810	0.22
		CSH 7106 ×3 HS	0.22
		CSH 7106 x RS 810	0.13

CONCLUSIONS

Some promising hybrids showing positive significant SCA effect for seed yield were 23 ES × 23 K, F 1861 × VCH (F). For oil content crosses 23 K × RS 810, B58-1290 × F1861, CSH 7106 × 23 ES and 3 HS × VCH (F) showed significant SCA effects. Selection of plants showing harmonious combinations of desirable traits can be conducted if genetic variation is the result of additive gene effects. These hybrids could produce desirable seggregants and can be exploited successfully for cotton improvement.

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Table 4. Five top crosses for SCA for seed oil content, yield components and fibre quality characters.

Character	Range of SCA	Crosses	SCA value
2.5%Span length (mm)	-0.28 to 1.39**	B58-1290 x 23 K	1.39**
		B 58-1290 x CSH 7106	1.13**
		3 HS x F 1861	1.07*
		VCH (F) x CSH 7106	1.03*
		CSH 7106 x VCH(F)	0.92*
Fiber Elongation (%)	-2.75** to 3.81**	CSH 7106 × 23 K	3.81**
		CSH 7106 × F1861	2.85**
		CSH 7106 × 3HS	2.35**
		CSH 7106 × 23 ES	2.10**
		B58-1290 × VCH(F)	1.60
Micronaire (µg/inch)	-0.03 t0 0.64**	CSH7106 × 3HS	0.64**
		B 58 -1290 × VCH (F)	0.36**
		CSH 7106 × 23ES	0.29**
		23 K × VCH (F)	-0.30**
		B 58-1290 × F1861	-0.28**
Fiber Strength (g tex^{-1})	-0.69 to 1.69**	B58-1290 × 23 K	1.69**
		CSH 7106 × 3HS	1.48**
		CSH 7106 × F1861	1.21*
		23 K x VCH (F)	0.99*
		3 HS × F 1861	0.96*
Oil content (%)	-0.02 to 1.31**	B 58 1290 × 23 ES	1.31**
		B58-1290 × F1861	1.28**
		CSH 7106 × 23 ES	1.09*
		3 HS × VCH(F)	1.08*
		23 ES x VCH (F)	-0.97*

* Significant at 0.05, ** Significant at 0.01

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