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POSSIBILITY OF COMMERCIAL UTILIZATION OF RESIDUAL HETEROSIS IN KENAF (*HIBISCUS CANNABINUS* L.)

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ABSTRACT

Combining ability and heterosis were studied in line × tester crosses between 24 female and 4 male parents for fibre yield in kenaf. The gca and sca variances showed that gene action was predominantly additive. The accessions, CPI-072111 and CPI- 78891 and the variety AMC-108 were good general combiners. None of the crosses showed significant positive sca effect for fibre yield. But eight crosses showed 30-40% heterosis over popular variety HC-583. In absence of male sterile line in kenaf, mannual production of hybrid seed and subsequent exploitation of heterosis becomes prohibitive due to high cost of F_1 seed production. Hence an attempt was made to study the extent of residual heterosis present in F_2 due to predominance of additive genes so that F_2 seeds may be utilized to get heterotic effect with lower cost of seed production as has been done in other crops. Fibre yield performance of two generations (F_1 and F_2) of selected cross combinations and two standard check varieties (HC- 583 and AMC-108) were studied and decline in yield from F_1 and F_2 was observed.

Results showed that three crosses each between one exotic germplasm and one indigenous variety retained substantial amount of residual heterosis in F_2 generation that may be exploited and utilized commercially with lower cost of seed production.

Key Words : Kenaf, *Hibiscus cannabinus*, residual heterosis

Kenaf (*H. cannabinus* L.) is one of the important bast fibre crops of the world and is mostly grown over a wide latitudinal range like 16° S to 41°N. This crop is adapted to a variety of cultural conditions and need only minimal management. Inspite of the economic importance of kenaf as a fibre crop, the improvement of this crop has till now been based on introduction, adaptation and pedigree selection followed by hybridization. In the recent past, exploitation of hybrid vigour and selection of parents on the basis of combining ability has been used as an important breeding approach to break the yield plateau. Development of high yielding F_1 hybrids for this crop primarily depends on the extent of heterosis for fibre yield and subsequent elaboration of an economical method of producing the hybrid seed. In the absence of male sterile line in kenaf, the cost of hybrid seed produced through hand emasculation and pollination becomes expensive. Hence, an attempt is made to study the extent of heterosis present in F_1 and residual heterosis in F_2 so that F_2 seeds may be utilized to get heterotic effect with lower cost of seed production. The result of such attempt are reported in this paper.

MATERIALS AND METHODS

Twenty-four diverse genotypes of different ecogeographic origin (DS\023H, DS\024H, DS\025H, BL\088H, C-1098, Ev.-41, Ev.-71, G-45, DS\005H, DS\021H, PI-189210, PI-318726, PI-329191, PI-343140, PI-343146, PI-343147, PI-376260, CPI-072111, CPI-072121, CPI- 072125, CPI-072175, CPI-78891, CPI-82388 and TAN\NY\025H) received from International Jute Organization and identified on the basis of fibre yield and other agromorphological characters like plant height, basal diameter, optimum growth habit and bristle free or less bristled typed, were crossed with three well adapted varieties viz. HC-583, MT-150, AMC-108 and one accession, CPI-072126, a best performer in India, Bangladesh and China under IJO Regional Collaborative Trial, as testers to produce 96 F_1s in line × tester mating design. All 96 hybrids and their 28 parents were grown together in randomized block design with three replications in the rainy season of 1996. Each plot had a single row of 3m length. The spacing was 30 cm between and 5-7 cm within rows. All the recommended cultural practices were followed. Ten randomly selected plants from each entry were harvested at 140 days crop age and fibre yield data were recorded after extraction and drying of fibre. Combining ability analysis was done according to Kempthorne [1] and Arunachalam [2]. The magnitude of heterosis was calculated over the ruling check varieties.

Eight cross combinations showing high heterosis ranging from 30-40% in F_1 were selected and F_2 seeds of these cross combinations along with the ruling check varieties. HC-583 and AMC-108, were grown in randomized block design with 6 replications in 1997. Plot size was 3 m × 1.5 m. Net plots were harvested and plot yield data were scored. The magnitude of residual heterosis was calculated as before.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences for fibre yield. The differences were significant among the lines, but nonsignificant among the testers for this character indicating reasonable amount of genetic variability among the lines of this crop. The lines vs. testers component was highly significant. The hybrids differed significantly. The differences among hybrids due to lines and testers were highly significant but non significant due to line × tester interaction for yield. A comparison of parents vs. hybrids revealed highly significant differences between

Table 1. Analysis of variance (mean squares), combining ability and variance components for fibre yield in kenaf

Source	df	Mean squares for fibre yield
Treatment	123	413.28**
1) Parents	27	518.10**
(a) Among lines	23	539.57**
(b) Among testers	3	31.52
(c) Lines vs. testers	1	1484.17**
2) Hybrids	95	348.17**
(a) Due to lines	23	643.30**
(b) Due to testers	3	1599.34**
(c) Due to lines × testers	69	195.39
Parents vs. hybrids	1	3768.81**
Error	246	169.97
$\frac{2\hat{\sigma}^2 gca}{2\sigma 2\, gca + \sigma^2 sca}$		226.51 0.84

**Significant at P = 0.01

parents and hybrids for the character studied indicating a substantial amount of hybrid vigour in the crosses. The magnitude of gca and sca variances (Table 1) indicated preponderance of additive type of gene action in the inheritance of this trait. But predominance of nonadditive gene action for fibre yield was reported earlier in a closely related species, *H. sabdariffa* var. *uttissima* [3]. Degree of dominance indicated partial dominance for this character. The estimation of gca effects of the parents (Table 2) revealed that the parents CPI-072111, CPI-78891 and AMC-108 were good general combiners for fibre yield. In general it was noted that the parents with high gca effect for fibre yield also gave food per se performance. This indicated that the parents could transmit their genetic potentiality to the offspring.

Of the 96 crosses, none showed significantly positive sca effect for fibre yield (Table 3). However, 8 crosses showed 25-26 gm/plant fibre yield in F_1 and 30-40% heterosis over the check variety HC-583, the current Indian elite variety. Among these 8 crosses, maximum yield, 25 q/ha, was obtained from F_2 generation of three cross combinations viz. CPI-072121 × MT-150, PI- 343147 × AMC-108 and PI-343147 × HC-583. It was interesting to note that the rank of the cross (PI-343147 × AMC-108) and that of the two check varieties were same in both generations.

Table2. Mean performance of parents and general combining ability (gca) effects for fibre yield in kenaf

Parent	Fibre yield	
	Mean (gm/plant)	gca effects
Lines:		
DS/023H	21.23	–14.93
DS/024H	16.97	–4.18
DS/025H	6.63	4.65
BL/088H	17.47	–12.43
C-108	13.87	–29.76
Evarglade 41	22.57	13.24
Evarglade 71	15.80	–0.76
G-45	9.40	–18.68
DS/005H	14.33	25.74
DS/021H	19.16	0.90
PI-189210	14.73	17.57
PI-318726	18.50	–11.93
PI-329191	10.10	–46.76
PI-343140	14.20	–34.43
PI-343146	16.97	–7.26
PI-343147	20.50	29.40
PI-376260	21.10	21.24
CPI-072111	17.80	–1.01
CPI-072121	21.80	44.90**
CPI-072125	16.40	13.49
CPI-072175	19.83	–15.01
CPI-78891	18.27	12.15
CPI-82388	14.83	38.40*
TAN/NY/025H	16.07	–24.51
SE (gi) lines ±		16.83
Testers :		
HC-583	19.23	4.49
MT-150	20.73	–0.90
AMC-108	20.29	16.08*
CPI-072126	20.57	–19.67*
SE(gi) testers ±		6.87

*, **Significant at P = 0.05 and 0.01, respectively

Table 3. Fibre yield performance of some selected crosses in F1 and F2, their specific combining ability (sca) effects and percentage increase over check varieties for fibre yield in kenaf

Sl. No.	Cross/Check variety	F1					F2			
		Sca effects	Fibre yield (gm/plant)	Rank	% increase over		Fibre yield	Rank	% increase over	
					HC-583	AMC-108	(q/ha)		HC-583	AMC-108
1	DS/005 × HC-583	24.10	25.27	6	31.41	25.10	20.94	8	5.65	3.71
2	PI-343147 × HC-583	22.76	25.50	4	32.61	26.24	25.19	3	27.09	24.76
3	PI_343147 × AMC-108	23.83	26.77	2	39.21	32.52	25.35	2	27.90	25.56
4	CPI-072121 × HC-583	20.93	26.87	1	39.73	33.02	23.76	5	19.88	17.68
5	CPI-072121 × MT-150	10.99	25.33	5	31.72	25.40	25.43	1	28.30	25.95
6	CPI-072125 × AMC-108	24.75	25.27	6	31.41	25.10	23.96	4	20.89	18.67
7	CPI-82388 × MT-150	14.82	25.07	8	30.37	24.11	23.53	6	18.72	16.54
8	CPI-82388 × CPI-072126	38.58	25.57	3	32.97	26.58	21.29	7	7.42	5.45
9	HC-583 (Check variety)	-	19.23	10	-	-	19.82	10	-	-
10	AMC-108 (Check variety)	-	20.29	9	-	-	20.19	9	-	-

All the cross combinations performed better in F_2 and the range of heterosis over standard check variety HC-583 varied from 5.65% to 28.30% and over AMC-108 it varied from 3.71% to 25.95%. It appeared that in F_1 maximum expression of heterosis (39.73% over HC-583 and 33.02% over AMC-108) was exhibited by CPI-072121 × HC-583. The same cross exhibited 19.88% over HC-583 and 17.68% over AMC-108 residual heterosis in F_2 generation. The second best performing hybrid PI-343147 × AMC-108 exhibited 39.21% over HC-583 and 32.52% over AMC-108 in F_1 generation. In F_2 generation the same cross exhibited 27.90% over HC-583 and 25.56% over AMC-108 residual heterosis. The next hybrid showing 31.72% over HC 583 and 25.40% over AMC-108 in F_1, exhibited 25.40% over HC-583 and 25.43% over AMC-108 in F_2 generation. This indicated that the inbreeding depression for fibre yield from F_1 to F_2 of these crosses were minimum. This behaviour was quite expected because fibre yield in kenaf was predominantly controlled by additive gene action as revealed by the gca effects of the parents of these crosses. These crosses showing low inbreeding depression and significantly high mean values in F_2 than those of the ruling check varieties, could be utilized for commercial plantation as advocated in *Pisum* and *Brassica* [4, 5]. Judged from this angle it was clear from the result that these crosses retained substantial amount of residual heterosis present in F_2 generation of these desirable crosses might be commercially exploited with lower cost of seed production. The F_2 populations of these crosses were uniform with regard to stem colour, leaf shape and plant height as the parents were chosen on the basis of uniform agromorphological characters.

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