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COMBINING ABILITY ANALYSIS FOR YIELD CHARACTERISTICS IN SUGARCANE (*SACCHARUM* SP. COMPLEX)

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ABSTRACT

General and specific combining ability variances and their effects were studied for eight characters in line x tester mating design in sugarcane. Study indicated the predominance of additive gene action for cane height, cane hardness and brix. Nonadditive gene action was preponderant for number of millable canes per stool, number of internodes per cane, internode length and cane yield per stool. Among lines, Co 7201 for internode length, cane height, cane hardness and cane yield, and Co 7304 for brix were the good general combiners. IA 1141 was good male donor for millable canes, cane height and cane yield. Based on sca effects and mean performance three crosses, Co 7201 x Co 7314, Co 1148 x Co 6806 and Co 7304 x Co 7314 were found promising for cane yield. The present study revealed that potential donor for brix could be selected on the basis of gca effects of female parent.

Key words: *Saccharum* sp. *complex*, line x tester, combining ability.

Evaluation of combining ability of genotypes helps in identification of suitable parents for further exploitation. The general combining ability is based on additive gene action whereas, specific combining ability is dependent on non-additive type of gene action. Studies indicate that varieties good in per se performance, may not necessarily produce desirable progenies when used in hybridization. Hence, knowledge about combining ability of parents becomes more important. Further, studies have shown that sugarcane seedling progenies exhibit better variation for different characters in ratoon crop than the plant crop [1]. In the present investigation combining ability of seven varieties, therefore, has been studied for yield characteristics in ratoon crop of seedling generation for further utilization in sugarcane breeding programme.

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MATERIALS AND METHODS

The experimental material comprised of ratoon crop of seedling generation of 12 crosses developed from seven varieties in a line (3) x tester (4) mating design. Three-month-old seedlings were transplanted in randomized complete block design with four replications. The plot for each cross progeny had 20 seedlings per replication, transplanted at 60 cm distance in rows spaced 75 cm apart. Data on 12 plants per replication were recorded for number of millable canes per stool, number of internodes per stalk, internode length (cm), cane height (cm), cane thickness (cm), cane hardness (pressure in cm^2 by cone penetrometer), brix (degree), and cane yield per stool (kg). The combining ability analysis was carried out following Kempthorne [2] and the variances were estimated as per the method of Kempthorne and Curnow [3]. Additive (σ^2_A) and dominance (σ^2_D) genetic variance components and their standard errors were computed following Hogarth [4].

RESULTS AND DISCUSSION

Analysis of variance indicated that there were significant differences among the crosses for number of millable canes per stool, cane height, internode length, cane hardness, brix and cane yield (Table 1). The partitioning of variance due to crosses into its components revealed that there were differences among crosses due to lines (females) for cane thickness, cane hardness and brix. The differences due to testers (males) were also significant for number of millable canes and cane thickness. The interaction between lines and testers was significant for number of millable canes, internode length and cane yield. This showed that general combining ability was more important for cane thickness, cane hardness and brix and specific combining ability was predominant for internode length and cane yield. However, both general and specific combining ability variances were important for number of millable canes per stool.

A perusal of estimates of combining ability variances revealed that general combining ability (gca) was more important for cane height, cane thickness, cane hardness and brix. These results were in general agreement with earlier findings [4–6]. Specific combining ability variance was predominant for number of millable canes per stool, number of internodes per stalk, internode length and cane yield per stool. These results were in agreement with those of [7–9].

The nature of genetic variance could be revealed by estimates of additive (σ^2_A) and dominance (σ^2_D) variance components [4]. The estimates of σ^2_A, were either significantly different from zero or larger than standard error for millable canes per stool, number of internodes, cane height and cane yield per stool which indicated the importance of additive genetic variance for these characters. Similarly estimate of σ^2_D showed the importance of

Table 1. Analysis of variance (mean squares) for combining ability and estimates of genetic components in sugarcane

Source	d.f.	Millable canes per stool (log x)	Inter-nodes per cane	Inter-node length	Cane height	Cane thick-ness	Cane hard-ness	Brix	Cane yield per stool
Replications	3	0.38**	43.40	7.70	0.83	36.187**	292.9**	33.838*	91.5**
Crosses	11	0.84**	54.43	20.19**	0.84**	1.515	176.1*	48.372**	106.5**
Lines	2	0.05	10.78	47.02	1.06	4.580**	504.6**	217.540**	247.8**
Testers	3	2.24*	95.32	5.47	1.83*	1.833*	93.5	15.452	207.2
Lines x testers	6	0.40*	48.54	18.61*	0.38	0.334	107.9	8.443	75.6**
Between plot error	33	0.07	31.42**	5.76**	0.23**	0.801**	79.9	8.435*	22.9
Within plot error	528	0.06**	11.71**	2.74**	0.11**	0.094**	52.5**	5.187**	15.2*
Pooled error	561	0.06	—	—	—	—	—	—	15.6
Gca variance	(σ^2_g)	0.01	0.03	0.05	0.006	0.007	1.1	0.443	0.3
Sca variance	(σ^2_s)	0.01	0.36	0.27	0.003	–0.010	0.6	0.001	1.1
$(\sigma^2_s / \sigma^2_g)^{0.5}$		1.23	3.65	2.43	0.731	—	0.7	0.018	1.9
Additive genetic variance	(σ^2_A)	0.03 ± 0.02	0.13 ± 0.13	0.30 ± 0.36	0.025 ± 0.017	0.065 ± 0.009	4.1 ± 3.8	2.276 ± 2.266	1.8 ± 1.82
Dominance genetic variance	(σ^2_D)	0.03 ± 0.02	1.43 ± 1.03	1.07 ± 0.81	0.012 ± 0.017	–0.039 ± 0.000	–2.3 ± 4.8	0.001 ± 0.020	4.4 ± 3.2
σ^2_A / σ^2_D		0.96	0.09	0.28	2.083	—	1.8	2276.00	0.4

*,**Significant at 5% and 1% levels, respectively.

dominance variance for millable canes per stool, number of internodes, length of internode and cane yield per stool. Relative importance of additive and dominance genetic variances based on absolute quantities revealed that former was more important than later for cane height, cane hardness and brix.

Within and between plot error variances were significant for all the characters studied except between plot variances for number of millable canes and cane yield per stool. The significance of above error variances indicated that there was considerable plant to plant variation among the progenies of the crosses which could have resulted from both genetic and nongenetic causes. As in the present findings, larger within plot error variance was also observed for several characters by Hogarth [6].

GCA EFFECTS

Among lines, Co 7201 showed significant positive gca effects for internode length, cane height and cane hardness (Table 2). This line also exhibited positive gca effects for brix and cane yield, the magnitudes of which were more than their standard errors. This indicated that Co 7201 was a good general combiner for the above characters. The parent, Co 1148 did not show significant gca effects for any character. Thus, it was not promising as female parent. The line Co 7304 had significant gca effects for brix which showed that it was a good combiner for brix.

Table 2. General combining ability effects of parents for different yield characteristics in sugarcane

Parent	Millable canes per stool	Inter-nodes per cane	Internode length	Cane height	Cane thick ness	Cane hard ness	Brix	Cane yield per stool
Lines								
Co 7201	–0.002	–0.265	0.583**	0.086*	0.113	1.775**	0.361	0.523
Co 1148	—0.015	0.195	–0.246	–0.039	0.014	–1.078	–0.198	–0.384
Co 7304	0.017	0.070	–0.337	–0.046	–0.127	–0.697	0.837**	–0.139
SE (gi)	0.020	0.404	0.172	0.034	0.123	0.633	0.209	0.419
SE (gi-gi)	0.028	0.572	0.244	0.049	0.175	0.895	0.296	0.5
Testers								
Co 7314	–0.090**	0.169	–0.047	0.001	0.059	0.890	0.476	–0.476
IA 1141	0.184**	0.923	0.189	0.149**	0.036	0.421	–0.274	1.232*
Co 6806	–0.036	–1.049*	0.124	–0.087*	–0.057	–0.168	–0.089	–0.365
Co A 7602	–0.058	–0.043	–0.226	–0.062	–0.044	–1.146	–0.113	–0.390
SE (gj)	0.023	0.467	0.199	0.040	0.142	0.731	0.242	0.483
SE (gj-gj)	0.032	0.660	0.281	0.056	0.201	1.034	0.342	0.684

*,**Significant at 5% and 1% levels, respectively.

Among testers, IA 1141 had significant gca effects for number of millable canes, cane height, and cane yield. This indicated that IA 1141, an Indo-American hybrid clone, was good combiner for number of millable canes, cane height and cane yield. Ethirajan et al. [10] also reported that IA clones had good combining ability for number of tillers (millable canes) and ratooning ability. The testers Co 7314 and Co 6806 had significant negative gca effects for number of millable canes and cane height, respectively.

PROMISING CROSS COMBINATIONS

The perusal of specific combining ability effects and means of cross progenies for the characters revealed that the cross Co 7201 x Co 7314 was most promising for cane yield (Table 3). Based on sca effects alone the crosses Co 1148 x Co 6806 and Co 7304 x Co 7314

Table 3. Best crosses based on sca effects and per se performance in sugarcane

Character	Sca effect	Per se performance
No. of millable canes/stool	Co 7201 x Co 7314 Co 1148 x Co 6806 Co 7304 x Co 7314	Co 7304 x IA 1141 Co 1148 x IA 1141 Co 7301 x IA 1141 Co 1148 x Co 6806
Cane height	Co 7304 x Co 7314 Co 7201 x Co 6806	Co 7201 x IA 1141 Co 1148 x IA 1141 Co 7201 x Co 6806
No. of internodes/cane	Co 7201 x Co 7314	Co 7304 x IA 1141 Co 1148 x Co A 7602 Co 1148 x IA 1141 Co 7201 x Co 7314
Internode length	Co 7304 x Co 7314 Co 1148 x Co 6806	Co 7201 x IA 1141 Co 7201 x Co 6806 Co 7201 x Co A 7602 Co 7304 x Co 7314 Co 1148 x Co 6806
Cane thickness	Co 7304 x Co A 7602 Co 1148 x IA 1141	Co 7201 x Co 7314 Co 7201 x Co A 7602 Co 7201 x Co 6806 Co 7201 x IA 1141
Cane hardness	Co 1148 x IA 1141 Co 7304 x Co 7314	Co 7201 x Co 6806 Co 7304 x Co 7314 Co 7201 x Co 7314 Co 7201 x IA 1141
Brix	—	Co 7201 x Co 7314 Co 7304 x Co 7314 Co 7304 x Co A 7602 Co 7304 x Co 6806
Cane yield/stool	Co 1148 x Co 6806 Co 7201 x Co 7314 Co 7304 x Co 7314 Co 7201 x Co 6806	Co 7304 x IA 1141 Co 1148 x IA 1141 Co 7201 x IA 1141 Co 7201 x Co 7314

were also promising for cane yield. The cross Co 7201 x Co 7314 also had significant positive gca effect for number of millable canes per stool and the cross Co 7304 x Co 7314 had significant gca effect for internode length. Further, the cross Co 1148 x IA 1141 had considerable sca effect for cane yield per stool and cane hardness. However, the crosses involving Co 7304 as female parent had high mean brix. As discussed earlier, Co 7304 had also showed significant gca effect for brix. This indicated that Co 7304 was promising female donor for brix. These results were in agreement with the findings of Loh and Tseng [11] who reported that sucrose content in the progeny was largely dependent on female or seed parent. The results suggested that the potential donor for brix might be selected on the basis of gca effect of female parent.

From the above results it was obvious that Co 7304 is a promising donor for brix and cane yield. IA 1141 is a good male donor for number of millable canes and cane yield. The progenies of the crosses Co 7201 x Co 7314, Co 1148 x Co 6806, and Co 7304 x Co 7314 were promising for cane yield.

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