Theor Appl Genet (1987) 74:310–316

Interrelationships among stabilities of important agronomic traits in sugarcane*

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Received September 25, 1986; Accepted March 27, 1987
Communicated by G. S. Khush

Summary. The stability-variance statistic, $\hat{\sigma}_i^2$, measures the contribution of the i^{th} genotype to genotype x environment interaction. In addition to the knowledge of cultivar stability for an agronomic trait, information on whether stability of one trait can be used to predict stability of another should be useful to breeders. Three separate groups of data, respectively involving CP 79 series, CP 80 series, and CP 81 series experimental clones of sugarcane (*Saccharum* spp.) were used in this study. Rank-correlation coefficients (r_s) between ranks of genotypes for $\hat{\sigma}_i^2$'s for paired traits indicated in both plant-cane and ratoon crops that stability of tons per hectare of sugar can be predicted from the stability of tons per hectare of cane (THC) and also, to a lesser extent, from the stability of stalk number. The stability of THC also can be reasonably well predicted from the stability of stalk number. Brix stability may give some indication of the stabilities for percentage sucrose and sugar concentration (SC). The $\hat{\sigma}_i^2$'s for percentage sucrose and SC were almost identical in the CP 79 and CP 81 series (r_s varied from 0.93, $P<0.01$, in plant-cane crop for CP 79 series to 0.98, $P<0.01$, in plant-cane crop for CP 81 series). Whether correlations were based on $\hat{\sigma}_i^2$'s estimated across locations within crops or across crops, the magnitude of r_s was about the same. Means of various traits were not correlated with their respective $\hat{\sigma}_i^2$'s (for CP 81 series), indicating that identification and selection of high-yielding sugarcane genotypes with a relatively high degree of stability of performance across test environments should be possible.

Key words: Stability variance – Genotype x environment interaction – Adaptation – *Saccharum* – Sugarcane

Introduction

The stability-variance parameter estimate (or statistic), $\hat{\sigma}_i^2$, developed by Shukla (1972) measures the contribution of each genotype to genotype x environment (GE) interaction and may aid in selecting stable cultivars. Thus far, only a few studies have employed this statistic for evaluating stability of cultivars for individual traits such as yield (Casler and Hovin 1984; Eagles and Frey 1977; Kang and Miller 1984). Shukla's method (1972) provides additional information on stability by allowing use of a covariate of, usually but not limited to, fertility and cultural practices at different locations to remove heterogeneity variance (nonadditivity) from the GE interaction. The remainder of GE interaction variance can be partitioned into components assignable to each cultivar ($\hat{s}_i^2$ statistic). Kang and Miller (1984) reported on the use of the $\hat{s}_i^2$ statistic for obtaining additional information on cultivar stability in sugarcane (*Saccharum* spp.) for four traits.

In addition to the stability of cultivars for an agronomic attribute, it is worthwhile to know whether stability of one trait is correlated with stability of other trait(s). If stability-variance of two traits were reasonably well and positively correlated, concurrent selection for stability of two traits would be possible. Depending

* Cooperative investigation of the Univ. of Florida, Everglades Research and Education Center, Belle Glade, FL, USA; Louisiana Agricultural Experiment Station, LSU Agricultural Center, Baton Rouge, LA, USA; and Sugarcane Field Station, Canal Point, FL, USA. The field work reported in this study was done when the senior author was affiliated with the University of Florida. Florida Agric. Exp. Stns. Journal Series No. 5933

Table 1. Analyses of variance for stalk number, stalk weight, Brix, sucrose, sugar concentration (SC), tons per hectare of cane (THC) and tons per hectare of sugar (THS) for plant-cane (PC) and ratoon (RT) crops for CP 79, CP 80, and CP 81 series of experimental clones, and for germination for CP 81 experimental clones

Source of variation	df	Mean square															
		Stalk no.		Stalk wt (kg)		Brix (%)		Sucrose (%)		SC (g kg^{-1})		THC (t ha^{-1})		THS (t ha^{-1})		Germination (%)	
		PC	RT	PC	RT	PC	RT	PC	RT	PC	RT	PC	RT	PC	RT	PC	RT
CP 79 Series																	
Location (L)	3	14,746.4**	14,490.1**	0.42**	1.57**	104.0**	44.6**	153.3**	105.8**	8,628.5**	6,418.5**	24,818.2**	20,824.0**	153.4**	319.5**		
Replication within L	4	2,078.9**	6,762.7**	0.03	0.05	1.0	0.4	0.9	1.0	48.2	61.7	1,127.7	5,221.2**	10.3	49.9**		
Genotypes (G)	25	1,848.8**	4,902.3**	0.14**	0.09**	3.5**	2.7**	5.8**	5.6**	343.7**	333.6**	1,774.8**	3,182.0**	17.4**	32.4**		
L×G	75	602.0*	1,219.5**	0.04	0.04**	0.7*	0.7	1.0	1.1	69.0	70.3	877.6*	1,076.0*	8.7	12.0*		
Error	100	411.5	735.7	0.03	0.026	0.5	0.7	1.0	1.0	70.7	60.8	603.1	685.6	6.7	7.6		
CP 80 Series																	
Locations (L)	3	24,804.3**	40,999.4**	2.37**	0.38**	23.2**	47.5**	58.7**	85.3**	3,578.1**	4,779.0**	72,962.4**	33,228.7**	567.4**	182.7**		
Replication within L	4	776.8	1,260.4	0.05	0.07	0.5	4.2**	1.9	9.0**	132.3	527.8**	1,273.6	2,355.5*	13.3	11.8		
Genotypes (G)	22	2,627.9**	8,140.5**	0.40**	0.22**	4.8**	4.8**	6.2**	6.4**	331.6**	347.6**	2,693.7**	5,754.3**	23.5**	45.4**		
L×G	66	401.1	1,612.5**	0.06	0.04	1.0	0.7	1.4	1.4	80.6	91.4	986.9	1,876.9**	9.9	14.5**		
Error	87	418.0	722.3	0.05	0.04	1.0	0.6	1.4	1.2	81.6	78.7	951.5	911.9	8.6	7.1		
CP 81 Series																	
Locations (L)	2	60,292.0**	10,374.4**	0.54**	0.03	74.0**	26.4**	107.0**	23.4**	5,667.3**	1,043.7**	102,676.5**	9,642.6**	595.1**	103.8**	29.5**	26.9**
Replications within L	3	205.5	3,834.2**	0.03	0.35**	0.4	0.6	0.4	2.5	28.9	182.2*	652.8	9,327.8**	4.8	108.0**	0.3	11.0**
Genotype (G)	36	1,750.1**	2,574.8**	0.17**	0.12**	4.1**	3.8**	6.0**	6.1**	323.4**	340.4**	1,932.3**	1,617.2**	12.7*	17.9**	1.6**	3.5**
L×G	72	498.7**	710.0	0.06*	0.04	1.1*	1.2	1.9*	1.7*	108.8*	94.6	1,087.8**	734.3	11.8*	8.7	0.9*	1.4
Error	108	211.3	584.0	0.04	0.03	0.8	0.9	1.2	1.2	69.8	68.1	629.2	666.7	7.4	7.9	0.6	1.3

*, ** Significant at the 5% and 1% level of probability, respectively

upon the magnitude and sign of a correlation coefficient, appropriate selection strategies can be designed.

The main objective of the present investigation was to determine relationships as follows: $\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$, $\hat{s}_i^2$ vs. $\hat{s}_i^2$, and $\bar{x}$, i.e., mean vs $\bar{x}$ for pairwise combinations of important agronomic traits in sugarcane, especially, sugar concentration (SC) (g of sugar per kg of cane), tons per hectare of cane (THC), and tons per hectare of sugar (THS). The SC, THC, and THS are used as selection criteria for advancing sugarcane experimental clones from one selection stage to the next (Kang et al. 1983).

Materials and methods

Three separate groups of data, respectively involving CP 79 series, CP 80 series, and CP 81 series sugarcane experimental clones and checks, were used in the study. The experimental clones and check cultivar(s) were grown in a randomized complete block design with two replications at each of four locations (for CP 79 series and CP 80 series) or at three locations (for CP 81 series). Three of the four locations for CP 79 and CP 80 series tests were characterized as organic soil (histosol), and one location as sandy soil. Two of the three locations for CP 81 series tests were characterized as organic soil and one as sandy soil. The CP 79 series tests consisted of 25 experimental clones and check cultivar, 'CP 63-588'; the CP 80 series tests consisted of 21 experimental clones and check cultivars, CP 63-588 and 'CP 70-1133'; the CP 81 series tests consisted of 35 experimental clones and check cultivars CP 63-588 and CP 70-1133.

Planting was in the fall of 1980 for CP 79 series, in the fall of 1981 for CP 80 series, and in the fall of 1982 for CP 81 series by placing 10 stalks of cane, for each plot, in two rows 4.57 m long and 1.5 m apart. Cultural practices such as fertilizing, cultivating, and pest control varied across locations.

For the plant-cane crop of each series, number of millable stalks per plot was recorded in August of the year after planting. A 10-stalk sample was cut from each plot and weighed in October. The THC was calculated from plot size, stalk number, and mean stalk weight. The samples were milled and the crusher juice was analyzed for Brix (percentage soluble solids determined with a hydrometer) and percentage sucrose. Sugar concentration (SC) was calculated by using Arceneaux's (1935) modification of the Winter-Carp-Geerlig formula. The THS was calculated as (SC×THC)/1,000. For the three series, ratoon data were obtained. Germination rating (1 = up to 10% germination and 10 = 100% germination) was assigned in May 1983 to the CP 81 series clones.

Analyses of variance were done for each series. Within each series, the mean ($\bar{x}$) was calculated for each trait across locations, separately in the plant-cane and ratoon crops, and for the two crops combined.

Stability-variance statistics, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$, were computed for each clone in each CP series by using the computer program developed by Kang (1985). As in the case of means, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ for CP 79 and CP 80 series were determined across four locations separately for plant-cane and ratoon crops, and for both crops combined (i.e., across eight environments). The $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ for CP 81 series were determined across three locations separately for plant-cane and ratoon crops, and for both crops combined (i.e., across six environments).

Spearman's rank correlation coefficients (r_s) were determined using the SAS Institute guide (1982) as follows: between $\bar{x}$ of trait 1 and $\bar{x}$ of trait 2, between $\hat{\sigma}_i^2$ of trait 1 and $\hat{\sigma}_i^2$ of trait 2, and between $\hat{s}_i^2$ of trait 1 and $\hat{s}_i^2$ of trait 2, and so on for all possible pairwise combinations of various traits for plant cane (PC), ratoon (RT), and both crops combined (COM). Rank-correlation coefficients were also computed for $\bar{x}$ vs $\hat{\sigma}_i^2$ for each trait in the plant-cane and ratoon crop and both crops combined for CP 81 series. Ranks were assigned to clones for each statistic in a descending order, i.e., the highest value was given a rank of 1.

Results and discussion

Analyses of variance for the CP 79, CP 80, and CP 81 series experiments are presented in Table 1. Within each series, genotypes or clones displayed significant variation in each crop for all traits. Location x genotype (L×G) interaction was significant in both plant-cane and ratoon crops for stalk number and THC in CP 79 series. The L×G interaction was significant in CP 81 series for percent sucrose in both plant-cane and ratoon crops. For other traits in CP 79, CP 80, and CP 81 series, the L×G interaction was either not significant in both PC and RT or in only one crop, i.e., either PC or RT. The determination of stability-variance for those traits which had non significant L×G interaction is not necessary, but to study possible relationships among stabilities of various traits, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ were calculated for all traits.

Stalk number means for PC, RT, and both crops combined, in general, were reasonably well, positively correlated with the means of THC and THS in the three series (Tables 2 and 3). Stalk number is taken into consideration for advancing clones from one selection stage to the next as it is an important component of THC (Kang et al. 1983). A high significant, positive r_s between $\hat{\sigma}_i^2$'s of two traits indicated that the stability of one trait can be reliably predicted from that of the other trait. Stability of stalk number was positively correlated with that of THC and THS for both CP 79 and CP 80 series (Table 2) and for CP 81 series (Table 3), although no conscious selection, as was done for means, was made for stability. The rank-correlation coefficients for $\hat{\sigma}_i^2$ of stalk number vs $\hat{\sigma}_i^2$ of THC and of THS were correspondingly of the same magnitude as were those for $\bar{x}$ vs $\bar{x}$. Whether correlations were based on statistics estimated across four environments (PC or RT) or three environments (PC or RT) for CP 81 series or across both PC and RT, i.e., eight or six environments for each series, the magnitude of M_s was about the same. It is significant that stability of THC and THS can be predicted from the stability of stalk number to almost the same extent as mean performance of THC and THS can be predicted from the mean performance

Table 2. Rank correlation coefficients (r_S) between means ($\bar{x}$'s), estimated stability-variance statistics ($\hat{\sigma}_i^2$'s), and estimated stability-variance statistics following a covariate correction ($\hat{s}_i^2$'s) of pairwise combinations of seven traits in plants cane (PC), ratoon (RT), and both crops combined (COM) for CP 79 series and CP 80 series. [a] SC = Sugar concentration; [b] THC = tons per hectare of cane; and THS = tons per hectare of sugar

Statistics correlated	Crop	Trait	CP 79 series ($n=26$)						CP 80 series ($n=23$)					
			Stalk wt.	Brix	Sucrose	SC[a]	THC[b]	THS[b]	Stalk wt.	Brix	Sucrose	SC	THC	THS
$\bar{x}$ vs $\bar{x}$	PC	Stalk no.	−0.37	−0.11	−0.28	−0.32	0.77**	0.51**	−0.51*	0.49*	0.39	0.33	0.25	0.45*
	RT		−0.14	0.13	0.01	−0.03	0.89**	0.88**	−0.41	0.37	0.38	0.48*	0.80**	0.87**
	COM		−0.28	0.05	−0.05	−0.09	0.84**	0.77**	−0.41	0.40	0.33	0.39	0.53**	0.73**
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC		−0.17	0.21	0.00	−0.16	0.71**	0.61**	0.00	0.17	0.00	−0.01	0.48*	0.49*
	RT		−0.14	0.21	0.04	−0.08	0.51**	0.42*	−0.17	0.17	0.07	0.12	0.43*	0.63**
	COM		−0.03	0.37	0.03	−0.04	0.67**	0.69**	−0.04	−0.34	−0.54**	−0.51*	0.53**	0.40
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC		−0.16	0.06	−0.17	−0.21	0.51**	0.31	−0.25	−0.10	0.20	0.27	0.25	0.10
	RT		−0.19	0.04	−0.08	−0.19	0.39*	0.27	0.23	−0.05	0.15	0.36	0.45*	0.48*
	COM		−0.18	0.25	0.03	−0.07	0.53**	0.55**	−0.32	−0.06	0.23	0.34	0.35	0.32
$\bar{x}$ vs $\bar{x}$	PC	Stalk wt. (kg)		−0.10	0.09	0.15	0.26	0.39*		−0.65**	−0.60**	−0.58**	0.51*	0.36
	RT			−0.17	−0.18	−0.14	0.20	0.15		−0.53**	−0.49*	−0.65**	0.16	−0.06
	COM			−0.19	−0.11	−0.04	0.16	0.19		−0.63**	−0.51*	−0.58**	0.36	0.19
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC			−0.30	−0.15	−0.05	0.17	0.20		0.12	−0.22	−0.34	0.27	0.20
	RT			0.09	−0.10	−0.12	0.27	0.27		0.16	−0.21	−0.20	0.16	−0.22
	COM			−0.35	−0.21	−0.14	−0.09	0.03		0.27	0.01	−0.03	0.12	−0.07
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC			−0.22	−0.13	0.12	0.05	−0.04		−0.03	−0.38	−0.42*	0.23	0.37
	RT			0.29	0.13	0.16	−0.17	0.09		−0.06	0.00	0.34	0.53**	0.01
	COM			−0.36	−0.11	−0.05	−0.27	−0.23		0.33	−0.03	−0.12	0.06	−0.14
$\bar{x}$ vs $\bar{x}$	PC	Brix (%)			0.86**	0.78**	−0.25	0.21			0.92**	0.87**	−0.28	−0.01
	RT				0.88**	0.83**	0.02	0.17			0.67**	0.72**	0.02	0.26
	COM				0.88**	0.81**	−0.11	0.24			0.88**	0.84**	−0.25	0.12
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC				0.53**	0.28	0.16	0.22			0.77**	0.63**	0.10	0.18
	RT				0.61**	0.47*	0.33	0.39*			0.33	0.30	0.14	0.21
	COM				0.73**	0.59**	0.32	0.32			0.52**	0.53**	−0.11	−0.06
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC				0.39*	0.14	−0.09	0.04			0.67**	0.59**	−0.09	−0.10
	RT				0.61**	0.59**	0.12	0.20			0.39	0.31	0.24	0.18
	COM				0.74**	0.62**	0.39*	0.45*			0.44*	0.56**	0.13	−0.01
$\bar{x}$ vs $\bar{x}$	PC	Sucrose (%)				0.98**	−0.33	0.22				0.99**	−0.24	0.07
	RT					0.99**	−0.08	0.10				0.87**	0.04	0.33
	COM					0.98**	−0.20	0.17				0.95**	−0.23	0.20
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC					0.93**	−0.01	0.08				0.96**	−0.29	0.00
	RT					0.96**	0.09	0.21				0.70**	0.03	0.10
	COM					0.96**	−0.07	−0.03				0.81**	−0.23	−0.06
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC					0.89**	−0.03	0.04				0.98**	−0.33	−0.42*
	RT					0.97**	0.29	0.29				0.66**	0.23	0.04
	COM					0.94**	0.00	0.10				0.74**	0.25	0.05

(continued overleaf)

Table 2 (continued)

$\bar{x}$ vs $\bar{x}$	PC	SC (g kg^{-1})	−0.32	0.23	−0.22	0.07
	RT		−0.11	0.07	0.06	0.38
	COM		−0.19	0.16	−0.21	0.23
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC		−0.16	−0.03	−0.33	−0.08
	RT		0.00	0.15	0.39	0.48*
	COM		−0.17	−0.09	−0.08	0.15
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC		0.00	−0.03	−0.34	−0.46*
	RT		0.21	0.23	0.67**	0.55**
	COM		−0.05	0.03	0.38	0.30
$\bar{x}$ vs $\bar{x}$	PC	THC (t ha^{-1})		0.78**		0.87**
	RT			0.97**		0.93**
	COM			0.88**		0.78**
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC			0.95**		0.40
	RT			0.92**		0.61**
	COM			0.92**		0.76**
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC			0.66**		0.68**
	RT			0.90**		0.50*
	COM			0.90**		0.81**

*, ** Significant from zero at the 5 and 1% levels of probability, respectively

of stalk number. Since stalk number of experimental clones can be estimated during the growing season, it should be possible to have an assessment of stability of those clones relative to THC and THS prior to harvest.

Stalk weight means were not highly correlated with those of other traits for CP 79 series, but were negatively correlated with means of Brix, percent sucrose and SC for CP 80 series (Table 2). Stalk weight $\bar{x}$ had a small positive relationship in the plant-cane crop with the $\bar{x}$ of THS for CP 79 series and with the $\bar{x}$ of THC for CP 80 (Table 2) and CP 81 series (Table 3). Stalk weight stability cannot be used reliably to predict the stability of other traits in any crop as indicated by a lack of correlation between $\hat{\sigma}_i^2$'s for stalk weight and those for other traits in CP 79 and CP 80 series. Only a small but significant r_s was detected between $\hat{\sigma}_i^2$'s for stalk weight and those for THC in the CP 81 series (Table 3) in PC and both crops combined ($r_s = 0.37$, $P < 0.05$, and 0.34, $P < 0.05$, respectively).

The Brix $\bar{x}$'s, $\hat{\sigma}_i^2$'s, and $\hat{s}_i^2$'s were positively correlated with the corresponding statistic for percent sucrose and SC (Tables 2 and 3). Stability of percentage sucrose and SC can be reasonably well predicted from the stability of Brix. Percentage sucrose showed the highest correlations with the corresponding statisitics for SC (Tables 2 and 3). These high correlations were not unexpected since SC and percentage sucrose are essentially the same trait. The $\bar{x}$ and stability of SC can be well predicted, respectively from $\bar{x}$ and stability of percent sucrose.

The THC $\bar{x}$'s, $\hat{\sigma}_i^2$'s, and $\hat{s}_i^2$'s were generally highly correlated with those of THS (Tables 2 and 3), as were those of stalk number. The $\bar{x}$'s and stability of THS can be well predicted from those of THC. Both SC and THC are the direct components of THS. However, the $\bar{x}$, $\hat{\sigma}_i^2$, and $\hat{s}_i^2$ of SC were not respectively correlated with those of THS. Therefore, from stability standpoint, THC appeared to be more useful than SC.

Significant and reasonably high correlations between $\hat{\sigma}_i^2$'s of any two traits should be important, but those involving SC, THC, THS, percent Brix, percent sucrose, and stalk number were of special significance since these traits are involved directly or indirectly in the decision-making process for advancing clones from one selection stage to the next. Percent Brix and percent sucrose are involved in the calculation of SC (Arceneaux 1935; Kang and Miller 1984), and stalk number is a component of THC. Germination rating $\bar{x}$'s, $\hat{\sigma}_i^2$'s, and $\hat{s}_i^2$'s were not well correlated with those of any of the other traits (Table 3). Germination stability, therefore, cannot be used to predict stability of other traits reported here. The $\hat{s}_i^2$'s of any two traits were generally less correlated than $\hat{\sigma}_i^2$'s, indicating that after the variation due to heterogeneity was removed, the relative stability of clones for various traits changed

Table 3. Rank-correlation coefficients (r_S) between means (X's), stability-variance statistics ($\hat{\sigma}_i^2$'s), and stability-variance statistics following a covariate correction ($\hat{s}_i^2$'s) of pairwise combinations of eight traits in plants-cane (PC), ratoon (RT), and both crops combined (COM) for CP 81 series $n=37$. [a] SC = Sugar concentration; [b] THC = Tons per ha of cane and THS = tons per ha of sugar; [c] within trait indicates $\bar{X}$ and $\hat{\sigma}_i^2$ correlated were for the same trait

Statistics correlated	Crop	Trait	Stalk no.	Stalk wt.	Brix	Sucrose	SC[a]	THC[b]	THS[b]	Germination
$\bar{X}$ vs $\bar{X}$	PC	Stalk No.		−0.39*	−0.06	−0.03	0.00	0.66**	0.65**	0.24
	RT			−0.32*	0.09	0.03	−0.01	0.70**	0.65**	0.76**
	COM			−0.44**	0.00	−0.02	−0.05	0.69**	0.70**	0.71**
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC			0.10	−0.07	−0.12	−0.07	0.74**	0.62**	0.30
	RT			−0.10	0.15	0.11	0.09	0.57**	0.48**	0.00
	COM			0.06	0.13	0.03	0.03	0.66**	0.52**	0.59**
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC			0.18	−0.05	0.02	0.05	0.50**	0.25	0.15
	RT			0.18	0.16	−0.04	−0.10	0.53**	0.52**	−0.04
	COM			0.19	0.47**	0.28	0.23	0.58**	0.57**	0.48**
$\bar{X}$ vs $\bar{X}$	PC	Stalk wt. (kg)			−0.26	−0.27	−0.27	0.37*	0.10	0.13
	RT				−0.14	−0.12	−0.12	0.26	0.20	−0.30
	COM				−0.26	−0.24	−0.22	0.27	0.10	−0.20
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC				0.17	0.29	0.30	0.36*	0.28	0.08
	RT				−0.08	0.14	0.17	0.24	0.24	−0.28
	COM				0.54**	0.59**	0.59**	0.34*	0.40*	−0.04
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC				0.07	0.23	0.31	0.44**	0.20	−0.20
	RT				−0.29	−0.06	0.06	0.12	0.10	−0.07
	COM				0.24	0.43**	0.42**	0.33*	0.32*	0.05
$\bar{X}$ vs $\bar{X}$	PC	Brix (%)				0.97**	0.95**	−0.35*	0.27	−0.36*
	RT					0.95**	0.93**	0.03	0.35*	0.20
	COM					0.96**	0.95**	−0.19	0.25	−0.01
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC					0.94**	0.90**	−0.08	0.29	−0.13
	RT					0.71**	0.58**	0.21	0.27	−0.11
	COM					0.78**	0.71**	0.11	0.20	0.05
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC					0.78**	0.63**	0.09	0.16	−0.42**
	RT					0.61**	0.49**	0.10	0.22	−0.005
	COM					0.75**	0.64**	0.23	0.26	0.11
$\bar{X}$ vs $\bar{X}$	PC	Sucrose (%)					0.99**	−0.31	0.33*	−0.34*
	RT						0.99**	0.00	0.33*	0.12
	COM						1.00**	−0.21	0.26	−0.06
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC						0.98**	−0.05	0.24	−0.11
	RT						0.97**	0.22	0.37*	−0.07
	COM						0.98**	0.13	0.33*	−0.10
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC						0.94**	0.29	0.01	−0.37*
	RT						0.96**	0.02	0.07	−0.19
	COM						0.97**	0.23	0.32*	−0.05
$\bar{X}$ vs $\bar{X}$	PC	SC ($g\ kg^{-1}$)						−0.28	0.34*	−0.33*
	RT							−0.04	0.30	0.09
	COM							−0.22	0.24	−0.08
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC							−0.04	0.28	−0.13
	RT							0.16	0.32*	−0.09
	COM							0.14	0.34*	−0.11
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC							0.28	−0.04	−0.33*
	RT							−0.01	0.05	−0.24
	COM							0.25	0.35*	−0.12
$\bar{X}$ vs $\bar{X}$	PC	THC ($t\ ha^{-1}$)							0.73**	0.33*
	RT								0.90**	0.54**
	COM								0.80**	0.54**
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC								0.69**	0.24
	RT								0.92**	−0.11
	COM								0.83**	0.35*

(continued overleaf)

Table 3 (continued)

Statistics correlated	Crop	Trait	Stalk no.	Stalk wt.	Brix	Sucrose	SC[a]	THC[b]	THS[b]	Germination
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC								0.42**	0.05
	RT								0.82**	0.16
	COM								0.82**	0.20
$\bar{X}$ vs $\bar{X}$	PC	THS								0.12
	RT	(t ha^{-1})								0.48**
	COM									0.56**
$\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$	PC									0.18
	RT									−0.14
	COM									0.12
$\hat{s}_i^2$ vs $\hat{s}_i^2$	PC									0.19
	RT									0.16
	COM									0.12
$\bar{X}$ vs $\hat{\sigma}_i^2$	PC	Within	−0.24	0.17	−0.09	−0.05	−0.07	−0.10	0.07	−0.26
	RT	trait[c]	0.11	0.01	0.04	0.18	0.19	−0.12	0.04	−0.07
	COM		−0.10	0.16	−0.16	−0.07	−0.05	−0.20	−0.23	−0.35*

*, ** Significant at the 5 and 1% level of probability, respectively

differentially. Therefore, the $\hat{s}_i^2$ statistic may not be as practical to use as the $\hat{\sigma}_i^2$ statistic in predicting stability of a trait from that of another trait.

The lack of a significant correlation between $\bar{x}$'s and $\hat{\sigma}_i^2$'s for all eight traits in Table 3 was noteworthy, especially where the $\bar{x}$ vs $\bar{x}$ and $\hat{\sigma}_i^2$ vs $\hat{\sigma}_i^2$ relationships for the two traits involved were significant. This indicated that the $\bar{x}$'s and $\hat{\sigma}_i^2$'s were independent of each other and that it should be possible to indentify and select high-yielding cultivars with a relatively high degree of stability across environments.

We concluded that stability of certain traits can be reasonably well predicted from the stability of other trait(s), and that measurements of stability of various traits from four or three test environments were as precise as from eight or six test environments. Such knowledge should enable sugarcane breeders to determine whether or not concurrent selection for stability can be made for two or more traits.

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