American-Eurasian J. Agric. & Environ. Sci., 11 (6): 929-937, 2011
ISSN 1818-6769

Stability Parameters of Cane Yield and its Components under Various Planting Dates and Interrow Spacing for Ten Sugarcane Genotypes (*Saccharum spp*)

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Abstract: The present study was carried out at El-Mataana Agricultural Research Station Farm, Qena Governorate, Upper Egypt Region during two successive plant cane crops (2006/2007 and 2007/2008 growing seasons) to study stability parameters of cane yield and its components for ten sugarcane genotypes under three planting dates (February 20th, March 20th and April 20th) and three inter-row spacing (80, 100 and 120 cm). The experiment was carried out in a randomized complete blocks design with three replications in split - split plot system. The harvesting date was after 12 months from planting. The ten sugarcane genotypes were used G.84-47, G95-19, G95-21, G98-24, G.98-28, G.99-103, G.99-165, Ph.8013, Mex.2001-80 and G.T.54-9 variety (check variety).The results showed that in both seasons, number of millable cane, stalk weight, cane yield and sugar yield of the sugarcane genotypes differed and were affected significantly by planting date, inter-row spacing, genotypes and their interactions. Furthermore, in both seasons, the results indicated that the February 20th planting date was the best for sugarcane crop since it recorded the highest values for number of millable cane stalk weight and cane yield. Planting at 80 cm inter-row spacing recorded the highest values for number of millable cane and cane yield while planting at 120 cm recorded the highest values for stalk weight. G95-21 genotype recorded the highest values for number of millable, while G99-103 genotype recorded the highest values for the other studied traits. Also, the planting date revealed that most of the studied genotypes recorded the highest means when they planted at Feb. 20th and at 80 cm interspacing for most studied traits, while March 20th planting date for sugar yield and 120 cm. distance between cane rows for stalk weight. The combined analysis of variance for environment (E), genotypes (G) and GE interactions was highly significant for all studied traits. The joint regression analysis of variance revealed highly significant differences among genotypes, environments as well as genotype x environment interactions for all studied traits. The results showed highly significant mean squares due to pooled deviation. The genotypes Ph.8013 and G.98-28 for number of millable cane, Ph.8013, G.98-28 and Mex.2001-80 for stalk weight, Ph.8013, G.98-28, Mex.2001-80 and G98-24 for cane yield and genotypes Ph.8013, Mex.2001-80 and G98-24 for sugar yield were considered specially adapted to unfavorable environments (April 20th planting date and 120 cm inter-row spacing). However, the most desirable genotype for number of millable cane was G95-21 while G.99-103 was the best for the other studied traits.

Key words: Sugarcane genotypes · Yield and its components · Planting date · Inter-row spacing · Stability analysis

INTRODUCTION

Cane yield and its components are the most important traits in sugar cane production, which stalk weight and number of millable cane are the two primary components of cane yield. The differences in these traits among sugar cane genotypes due to their differences in genetic constitution and response to the environmental factors in which they grown. These traits were widely studied by Nassar *et al.* [1], El-shafai and Ismail [2], Manjunath *et al.* [3], Abo El - Ghait [4] and El-Sogheir and Abd El Fattah [5]. Planting date and interrow spacing could be the main environmental factors affecting cane yield and its components traits. The reliability of

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sugarcane genotype performance across planting date, interrow spacing and years should be taken in consideration in sugarcane breeding program. Most of sugarcane genotypes are adapted to a broad range of environmental conditions, especially planting dates and interrow spacing while others are more limited in their potential distribution. There are genotypes perform similarly regardless of the cane and sugar yield level under wide range of planting dates, inter-row spacing and years and other whose performance is directly related to the cane and sugar yield potential of the used planting dates, inter-row spacing and years. The information on adaptability and performance stability of genotypes over environments is important for national policy in crop production. Stable yield of a genotype means that its rank relative to other genotypes remains unchanged in a given set of environments. Most genotypes when tested under different environmental conditions differ in their performance and consequently it becomes difficult to recognize a genotype is relatively stable in its performance under different environmental conditions. Researchers need a statistic that provides a mean square of stability or consistency of performance across a range of environments, particularly one that reflects the contribution of each genotype to the total GE interaction. In regression analysis the stable genotype was defined as one which has high and stable in production concerning mean performance over environments ($\bar{x}$), stability regression coefficient of unity (bi = 1.0) and deviation from regression mean square equal to zero ($S^2d = 0$) and hence an ideal genotype would have both a high average performance over a wide range of environments together with stability parameters as defined by Eberhart and Russell [6]. The response of genotypes to variable productivity levels among environments provides an understanding of the environmental stability of performance. An understanding of sugarcane genotypes stability across various environments representing the combinations of various planting dates, inter-row spacing and years should be encountered in sugarcane breeding program. The objective of this investigation was to study the performance and stability parameters of ten sugarcane genotypes grown at three planting dates, three interrow spacing and two seasons.

MATERIALS AND METHODS

The present investigation was carried out at El-Mataana Agricultural Research Station Farm, Qena Governorate,Upper Egypt Region during two successive growing seasons (2006/2007 and 2007/2008) to evaluate the performance and stability of ten sugarcane genotypes under three planting dates and three inter-row spacing. The harvesting date was after 12 months from planting. The ten sugarcane genotypes are G.84-47, G.95-19, G.95-21, G.98-24, G.98-28, G.99-103, G.99-165, Ph.8013 and Mex.2001/80 and G.T.54-9. The commercial variety (G.T.54-9) was used as a check variety. The three planting dates were February 20th, March 20th and April 20th in 2006/2007 and 2007/2008 seasons, respectively. The three inter-row spacing were 80, 100 and 120cm. The experimental design was a split-split plot with three replications. The planting dates were allocated at random in the main plots while the inter-row spacing was randomly distributed in the sub-plots and the sugarcane genotypes were randomly assigned to the sub-sub plots. The experimental unit area was 60m^2 (12m x 5m) and consisted of 15rows of 5m long at 80 cm inter-row spacing,12 rows of 5 m long at 100 cm inter-row spacing and 10 rows of 5 m long at 120 cm inter-row spacing. Each row was planted with 12 of three budded cane sets. The recommended cultural practices of sugarcane were adopted throughout the tow growing seasons 2006/2007 and 2007/2008. The ten sugarcane genotypes used and their parents are presented in Table 1.

Daily minimum and maximum temperature degrees (°C) and humidity at the experimental site were recorded and the monthly means are presented in Table 2. The following traits at each harvest date were recorded i.e. number of millable cane /feddan (one feddan =4200 m^2) was calculated on plot basis, stalk weight (kg) (was determined by the cane weight of the plot and dividing it by its number of millable cane, cane yield ton/fed (was calculated on plot basis and sugar yield (ton/fed.) (Was calculated according to the formula described by Yadav and Sharma [7].

Statistical Analysis

Analysis of Variance: The collected data were subjected to proper statistical analysis of randomized complete blocks design according to the procedures outlined by Snedecor and Cochran [8]. The comparison among means was done using LSD at 0.05 level of probability.

Stability Analysis: was carried out using Eberhart and Russell model [6].

$$Y_{ij} = \mu_I + B_i I_j + \partial_{ij}$$

Where:

Y_{ij}: Is the genotype mean of the ith genotype at the jth environment (i=1, 2.... n)

Table 1: pedigree of the studied sugarcane genotypes

No.	Genotypes	Pedigree	Origin
1	G.T.54-9	[(N.Co 310 X F. 337/925	Taiwan
	(check variety)	(P.SA32 X F.861)]	
2	G.98-28	C34-33 X??	Egypt
3	Ph 8013	CAC 71-312 X Phil. 64-2227	Philippine
4	G.99-165	Cp.76 -1306 X Q.76-1053	Egypt
5	G.99-103	US. 74-3 X Cp. 76-1053	Egypt
6	G.84-47	N.Co.310 X??	Egypt
7	G.95-19	Sp.79-2278 X Sp. 80-1043	Egypt
8	G.95-21	Sp. 79-2278 X Sp. 80-1043	Egypt
9	Mex.2001-80	Sp.71-6180 X Mex.79-431	Mexico
10	G.98-24	C. 34-33 X??	Egypt

Table 2: Average monthly meteorological data for Qena Governorate during 2006- 2008

	2006			2007			2008		
	Temperature °C			Temperature °C			Temperature °C		
Month	Max	Min	Humidity %	Max	Min	Humidity %	Max	Min	Humidity %
January	24.7	4.3	43	22.5	8.5	47.9	23	5.4	52
February	27.6	5.6	52	24	8.4	47.1	25.5	7	42
March	30.6	9	41	31.7	14.5	30	29.5	10.6	34
April	34.2	13.3	20	28.9	14.2	28.6	34.8	15.7	26
May	38.3	18.9	29	35.4	21.2	18.9	38.7	20	22
June	41.8	21.8	9	42.9	26.5	14.3	41.1	23	23
July	40.9	23.9	31	40.3	26.6	19.6	40.6	23.6	26
August	41.4	21.3	34	40.2	25.9	21.8	40.7	23.4	27
September	40.2	18.7	40	41.5	26.4	22.1	38.6	21.5	32
October	36.1	14.9	31	37	21.7	29.6	35.3	17.5	40
November	28.4	7.6	47	27	13.7	43.2	29.6	12.1	47
December	24.1	3.8	48	42.1	10.3	48.2	24.6	7.2	53

Source: Central Laboratory for agricultural Climate, Agricultural Research Center, Giza, Egypt

μ_i: Is the mean of the ith genotype over all environments.

$B_iI_{¼}$: Is the regression coefficient that measures the response of the ith genotype to varying environments.

∂_{ij}: Is the deviation from regression of the ith genotype at the jth environment and $I_{¼}$ is the environmental index obtained as the mean of all genotypes at the jth environment minus the grand mean.

$$[I_j = (\sum i\ Y_{ij}/\nu)-(\sum i \sum j\ Y_{ij}/\nu n),\ \sum j\ I_j=0]$$

Eberhart and Russell 1966 [6] proposed that the ideal variety is one that has three characteristics as follows: Regression coefficient significantly different from zero (b≠0) and not significantly different from unity (*b* = 1). Minimum value of the deviation from regression, i.e., (S^2d =0). High performance with a reasonable range of environments.

The regression coefficient (bi) was used to determine the adaptation of tested genotypes according to Finlay and Wilkinson [9] as follow genotypes which their (bi) less than unity is adapted to stress environments while these which their (bi) more than unity is adapted to favorable environments.

RESULTS AND DISCUSSION

Genotype Performance and Analysis of Variance: Combined analysis of variance of the genotypes over eighteen environments presented in Table 3 indicated that mean squares of environments, genotypes and their interactions were highly significant for number of millable cane, stalk weight, cane yield and sugar yield. The results indicated that the genotypes interacted differently with the environments. Similar results were obtained by El-Shafai and Ismail [2], Ahmed [10], Alexander and Mathew [11], Ramdoss *et al.* [12], Mahmoud [13], Mishra *et al.* [14], Lesllie and Lesllie [15], Ryan *et al* [16], Viator *et al.* [17], Ahmed *et al.* [18] a.d Sewa-Ram *et al.* [19]. Data presented in Tables 4, 5, 6 and 7 showed that planting dates, interrow spacing, genotypes and all their interactions among them had significant effect for all studied traits, except the effect of planting date on number of millable cane which was not significant in the first season only. For sugar yield the effect of planting dates was insignificant in the second season, in addition the interaction between planting dates and inter-row spacing was insignificant in both seasons. In both seasons, delaying planting from February 20th to April 20th reduced all studied traits (Tables 4-7). However, the highest sugar yield was recorded in March 20th in both seasons. These results are in agreement with those reported by Alexander and Mathew [11], Eweida *et al.* [20], Ramesh and Mahadevaswamy [21], El-Gergawy and El-Shafai [22] and Mohamed and El-Taib [23].

In both seasons, increasing the distance between cane rows led to decrease all studied traits. The results showed that 80 cm interrow spacing was the best among tested interrow spacing for all studied traits, except planting at 100 cm interrow spacing in the second season April 20th which recorded the highest value for sugar yield trait. The same results were reported by El-Shafai and Ismail [2], Ramdoss *et al.* [12], Mishra *et al.* [14], Lesllie and Lesllie [15], El-Geddawy *et al.* [24] and Sundra [25].

In both seasons, the results revealed that G 84-47 and G 95-19 genotypes were superior than G.T. 54-9 (the check variety) in number of millable cane. Meanwhile, G 99-103 genotype was superior to G.T. 54-9 for the other studied traits. These results were in harmony with those obtained by Ahmed [10], Mahmoud [13], Sewa-Ram *et al.* [18], Taha *et al.* [26] and Shafshak *et al.* [27]. The results revealed that all studied traits at both seasons (Tables 4-7) decreased by increasing inter-row spacing at all tested planting dates and all genotypes recorded the highest performance at February 20th and 80 cm. inter-row spacing except G.T 54-9 which recorded the highest number of millable cane at March 20th planting date and the same variety (G.T 54-9) recorded the highest number of millable cane at 100 cm inter-row spacing at the second season. For the stalk weight, in both seasons all genotypes showed high performance when they were planted at February 20th and 120 cm inter-row spacing, except the genotypes G 99-165 and G 98-24 which gave the same stalk weight in February 20th and March 20th. Also, G 98-24 genotype recorded the same stalk weight at 120 cm at the second season under both Feb. 20th and March 20th planting dates; while G99-103 genotype recorded the highest values for stalk weight and cane yield at both seasons. However, sugar yield of all studied genotypes showed the highest values in March 20th planting date in both seasons, except G 98-28 and G 95-19 genotypes which recorded the highest sugar yield in February 20th planting date. These results are in accordance with the results obtained by Ryan *et al.* [16], Viator *et al.* [17] and Ahmed *et al.* [19], Jadhav *et al.* [28] and Arumugam *et al.* [29].

At both seasons, data showed that all studied genotypes recorded the highest number of millable cane (Table 4) at all tested planting dates at 80 cm inter-row spacing, while G.T 54-9 variety recorded the highest number of millable cane at 100 cm inter-row spacing at the second season. The genotype G 99-165 recorded the highest number of millable cane at 100 cm inter-row spacing at the second season at February 20th planting date. For stalk weight, all genotypes in both seasons revealed the highest stalk weight when they were planted at February 20th and 120cm inter-row spacing, except the genotypes G 99-165 and G 98-24 gave the same stalk weight in February 20th and March 20th (Table 5). Also, G 98-24 genotype recorded the same stalk weight at 120 cm at the second season under both February 20th and March 20th planting dates, while G99-103 genotype recorded the highest value for stalk weight at March 20th planting date and 120 cm inter-row spacing. For cane yield, G 99-103 recorded the highest cane yield at all tested inter-row spacing and G 99-165 recorded the lowest yield at all tested inter-row spacing at both seasons (Table 6). The genotype G 99-103 recorded the highest cane yield at February 20th planting date under 80 cm inter-row spacing. For sugar yield, in both seasons (Table 7), G 95-19 genotype gave the highest sugar yield at 100 cm in February 20th planting date and at 80 cm in February 20th and March 20th planting dates in the second season and it recorded the highest sugar yield at 100 cm in March 20th and April 20th planting dates in the first season and in April 20th in the second season.

Joint Regression Analysis: The joint regression analysis of variance for number of millable cane, stalk weight, cane yield and sugar yield, as shown in Table 8, revealed highly significant differences of E + (E x G) for these traits. This indicated that the environments and their interaction with genotypes played important role in determining cane yield and its components. Similar results were reported by Mohamed and El-Taib [30]. Mean squares of environments (linear) for cane yield and its components were highly significant, indicating differences between

Table 3: Mean squares of cane yield and its components of ten sugarcane genotypes under eighteen environments.

		MS			
SOV	df	Number of millable cane/fed	Stalk weight(kg)	Cane yield (ton/fed)	Sugar yield ton/fed
Rep (R)	2	41517132.62	0.0001	57.28	0.463
Environment (E)	17	1729102342.25**	0.115**	1783.09**	23.62**
Error (E)	34	16634541.55	0.002	30.00	0.76
Genotype (G)	9	509242880.59**	0.865**	2391.35**	26.80**
E x G	153	20064334.97**	0.004**	33.97**	0.88**
Error (G)	324	11927597.14	0.001	17.88	0.47

Table 4: Number of millable cane of ten sugarcane genotypes under three planting dates and three interrow spacing in season 2006/2007 (upper values) and season 2007/2008 (lower values).

		Genotypes										
Planting dates (D)	Row spacingcm	G.T.54-9	Ph 8013	G.98-28	G.99-165	G.99-103	G.84-47	G.95-19	Mex.2001-80	G.98-24	G.95-21	Mean
D1	80	59052	56808.5	54519.5	49829.5	57946	62090	60977	55916	59846.5	67417	58440.2
February 20th		45458	44380	45395	50844.5	55902	53658.5	51369.5	46679.5	54796	58940	50742.3
	100	48781.6	44732.8	47877.2	53933.6	52788.4	50853.6	56176.4	47594.4	46418.4	55812.4	50496.88
		46261.6	42212.8	45357.2	51413.6	50268.4	48333.6	53656.4	45074.4	43898.4	53292.4	47976.88
	120	36869	35882	34995.33	39008.67	40576.67	40224.33	39853.33	34468	40518.33	43176	38557.17
		34769	33782	32895.33	36908.67	38476.67	38124.33	37753.33	32368	38418.33	41076	36457.17
	Mean	48234.2	45807.77	45797.34	47590.59	50437.02	51055.98	52335.58	45992.8	48927.74	55468.47	49164.75
		42162.87	40124.93	41215.84	46388.92	48215.69	46705.48	47593.08	41373.97	45704.24	51102.8	45058.78
D2	80	58782.5	56896	52906	50158.5	56098	63035	65012.5	55478.5	54208	57662.5	57023.75
March 20th		44642.5	42931	44201.5	50085	55632.5	53746	49756	47008.5	52948	59885	50083.6
	100	52010	44382.8	43366.4	46130	49904.4	48529.6	52306.8	45670.8	46900	55272	48447.28
		49490	41862.8	40846.4	43610	47384.4	46009.6	49786.8	43150.8	44380	52752	45927.28
	120	40880	35602	34876.33	38084.67	37984.33	38838.33	37020.67	34878.67	38467.33	42282.33	37891.47
		38780	33502	32776.33	35984.67	35884.33	36738.33	34920.67	32778.67	36367.33	40182.33	35791.47
	Mean	50557.5	45626.93	43716.24	44791.06	47995.58	50134.31	51446.66	45342.66	46525.11	51738.94	47787.5
		44304.17	39431.93	39274.74	43226.56	46300.41	45497.98	44821.16	40979.32	44565.11	50939.78	43934.12
D3	80	54866	51625	51219	48163.5	56070	60070.5	61579	52461.5	53214	50967	54023.55
April 20th		43970.5	43554	42689.5	40614	51716	48475	48069	45013.5	52920	56920.5	47394.2
	100	49263.2	41969.2	42571.2	40773.6	47462.8	46351.2	48106.8	42750.4	45710	53225.2	45818.36
		46743.2	39449.2	40051.2	38253.6	44942.8	43831.2	45586.8	40230.4	43190	50705.2	43298.36
	120	39503.33	32664.33	33791.33	30788.33	37450	37585.33	34302.33	34461	36649.67	41447	35864.27
		37403.33	30564.33	31691.33	29855	35350	35485.33	32202.33	32361	34549.67	39344	33880.93
	Mean	47877.51	42086.18	42527.18	39908.48	46994.27	48002.34	47996.04	43224.3	45191.22	48546.4	45235.39
		42705.68	37855.84	38144.01	36240.87	44002.93	42597.18	41952.71	39201.63	43553.22	48990.9	41524.5
Overall mean	80	57566.83	55109.83	52881.5	49383.83	56704.67	61731.83	62522.83	54618.67	55756.17	58682.17	56495.83
		44690.33	43621.67	44095.33	47181.17	54416.83	51959.83	49731.5	46233.83	53554.67	58581.83	49406.7
	100	50018.27	43694.93	44604.93	46945.73	50051.87	48578.13	52196.67	45338.53	46342.8	54769.87	48254.17
		47498.27	41174.93	42084.93	44425.73	47531.87	46058.13	49676.67	42818.53	43822.8	52249.87	45734.17
	120	39084.11	34716.11	34554.33	35960.56	38670.33	38882.67	37058.78	34602.56	38545.11	42301.78	37437.63
		36984.11	32616.11	32454.33	34249.44	36570.33	36782.67	34958.78	32502.56	36445.11	40201.78	35376.52
	Mean	48889.74	44506.96	44013.59	44096.71	48475.62	49730.88	50592.76	44853.25	46881.36	51917.94	47395.88
		43057.57	39137.57	39544.87	41952.11	46173.01	44933.54	44788.98	40518.31	44607.53	50344.49	43505.8
LSD 0.05	D	R.S	D.R	V	D.V	R.V	D.R.V	--	--	--	--	--
	N.S	703.25	1218.04	1900.2	3291.24	3291.24	5700.6	--	--	--	--	--
	1879.58	1092.52	1892.3	1782.57	3087.5	3087.5	5347.7	--	--	--	--	--

Table 5 : Stalk weight of ten sugarcane genotypes under three planting dates and three interrow spacing in season 2006/2007 (upper values) and season 2007/2008 (lower values).

		Genotypes										
Planting dates (D)	Row spacingcm	G.T.54-9	Ph 8013	G.98-28	G.99-165	G.99-103	G.84-47	G.95-19	Mex.2001-80	G.98-24	G.95-21	Mean
D1February 20th	80	1.191.25	1.141.17	1.201.23	0.970.99	1.371.40	1.101.13	1.211.25	1.061.09	0.930.95	0.981.00	1.111.15
	100	1.381.41	1.201.23	1.281.31	1.021.05	1.421.46	1.171.20	1.261.30	1.101.13	1.001.02	1.001.02	1.181.21
	120	1.421.46	1.241.27	1.311.34	1.041.06	1.481.52	1.191.22	1.321.30	1.151.18	1.041.06	1.021.05	1.221.25
	Mean	1.331.37	1.191.22	1.261.29	1.011.04	1.431.46	1.151.18	1.271.30	1.101.13	0.991.01	1.001.02	1.171.20
D2March 20th	80	1.221.25	1.141.17	1.161.19	0.960.99	1.251.28	1.021.05	1.101.30	1.031.06	1.001.02	1.031.06	1.091.12
	100	1.331.37	1.181.21	1.221.25	1.041.07	1.371.40	1.051.08	1.201.30	1.081.10	1.041.06	1.091.12	1.161.19
	120	1.361.40	1.211.24	1.251.28	1.011.04	1.461.50	1.151.18	1.271.30	1.141.17	1.071.10	1.121.15	1.201.24
	Mean	1.311.34	1.181.21	1.211.24	1.001.03	1.361.39	1.081.10	1.191.30	1.081.11	1.041.06	1.081.11	1.151.18
D3April 20th	80	1.151.18	1.091.12	1.081.10	0.880.91	1.201.23	0.940.96	0.991.30	0.940.96	0.830.85	0.940.96	1.001.03
	100	1.201.23	1.101.13	1.171.20	0.940.96	1.231.26	0.950.98	1.061.30	1.001.03	0.920.94	1.031.06	1.061.09
	120	1.261.29	1.181.21	1.201.23	0.960.98	1.271.30	1.001.02	1.101.30	1.031.06	0.991.01	1.021.05	1.101.13
	Mean	1.201.23	1.121.15	1.151.18	0.930.95	1.231.26	0.960.99	1.051.30	0.991.02	0.910.94	1.001.02	1.051.08
Overall mean	80	1.181.23	1.121.15	1.151.18	0.940.96	1.271.30	1.021.05	1.101.30	1.011.04	0.920.94	0.981.01	1.071.10
	100	1.301.34	1.161.19	1.221.25	1.001.03	1.341.37	1.061.09	1.181.30	1.061.09	0.981.01	1.041.07	1.131.16
	120	1.351.38	1.211.24	1.251.28	1.001.03	1.411.44	1.111.14	1.231.30	1.111.14	1.031.06	1.051.08	1.181.21
	Mean	1.281.31	1.171.20	1.211.24	0.981.01	1.341.37	1.061.09	1.171.30	1.061.09	0.981.00	1.031.05	1.131.16
LSD 0.05	D	R.S	D.R	V	D.V	R.V	D.R.V	--	--	--	--	--
	0.021	0.015	0.025	0.019	0.033	0.033	0.057	--	--	--	--	--
	0.016	0.013	0.023	0.019	0.033	0.033	0.057	--	--	--	--	--

Table 6: Cane yield of ten sugarcane genotypes under three planting dates and three interrow spacing in season 2006/2007 (upper values) and season 2007/2008 (lower values).

Planting dates (D)	Row spacingcm	Genotypes G.T.54-9	Ph 8013	G.98-28	G.99-165	G.99-103	G.84-47	G.95-19	Mex.2001-80	G.98-24	G.95-21	Mean
D1February 20th	80	70.0656.98	64.5951.77	65.5255.85	48.375056	79.1978.44	68.2460.47	74.0364.05	59.1850.60	55.3552.00	65.7258.90	65.0257.96
	100	67.1165.26	53.7552.02	61.1859.43	55.0753.85	75.1573.40	59.2757.74	70.9669.49	52.2550.78	46.3944.96	55.7554.57	59.6958.15
	120	52.3350.64	44.6043.05	45.7944.15	40.4939.29	60.2658.63	47.8946.57	52.7551.24	39.7638.26	41.9140.76	44.2143.15	47.0045.57
	Mean	63.1757.63	54.3148.95	57.5053.14	47.9747.90	71.5370.16	58.4654.93	65.9161.59	50.4046.55	47.8845.91	55.2352.21	57.2453.90
D2March 20th	80	71.4955.74	65.0450.39	61.5652.71	48.5349.67	70.0971.22	64.4056.37	71.3655.92	57.3049.83	53.9754.08	59.4263.41	62.3255.93
	100	69.4167.71	52.5950.79	52.9351.13	47.8446.35	68.2066.37	51.0549.65	62.9461.41	49.1547.64	48.5747.12	60.1758.91	56.2954.71
	120	55.8854.37	43.0041.50	43.4541.86	38.5237.30	55.6853.90	44.8343.46	46.8445.31	39.7538.30	41.2239.88	47.1746.00	45.6344.19
	Mean	65.5959.27	53.5447.56	52.6548.57	44.9644.44	64.6563.83	53.4349.83	60.3854.21	48.7345.26	47.9247.02	55.5956.11	54.7551.61
D3April 20th	80	63.1151.84	56.5048.88	55.1347.10	42.6336.84	67.0463.52	56.4546.66	60.9848.84	49.4943.37	44.2645.08	48.0655.04	54.3648.72
	100	58.8657.23	46.2144.58	49.7948.07	38.2536.80	58.3256.61	44.2242.91	51.2249.77	42.9141.41	41.8140.51	54.7953.56	48.6447.14
	120	49.8448.38	38.4636.95	40.5739.06	29.4429.31	47.6246.12	37.4236.25	37.7336.25	35.5034.19	36.2135.02	42.3541.25	39.5138.28
	Mean	57.2752.48	47.0543.47	48.5044.74	36.7834.32	57.6655.42	46.0341.94	49.9744.95	42.6339.66	40.7640.20	48.4049.95	47.5044.71
Overall mean	80	68.2254.85	62.0450.35	60.7451.88	46.5145.69	72.1171.06	63.0354.50	68.7956.27	55.3247.93	51.1950.39	57.7359.12	60.5754.20
	100	65.1363.40	50.8549.13	54.6352.88	47.0545.67	67.2265.46	51.5250.10	61.7060.22	48.1046.61	45.5944.20	56.9055.68	54.8753.33
	120	52.6851.13	42.0240.50	43.2741.69	36.1535.30	54.5252.88	43.3842.09	45.7744.27	38.3336.92	39.7838.55	44.5843.47	44.0542.68
	Mean	62.0156.46	51.6446.66	52.8848.82	43.2442.22	64.6263.13	52.6448.90	58.7653.59	47.2543.82	45.5244.38	53.0752.75	53.1650.07
LSD 0.05	D	R.S	D.R	V	D.V	R.V	D.R.V	--	--	--	--	--
	3.64	1.18	2.03	2.33	4.04	4.04	6.99	--	--	--	--	--
	2.10	1.66	2.88	2.18	3.77	3.77	6.54	--	--	--	--	--

Table 7: Sugar yield of ten sugarcane genotypes under three planting dates and three interrow spacing in season 2006/2007 (upper values) and season 2007/2008 (lower values).

Planting dates (D)	Row spacingcm	Genotypes G.T.54-9	Ph 8013	G.98-28	G.99-165	G.99-103	G.84-47	G.95-19	Mex.2001-80	G.98-24	G.95-21	Mean
D1February 20th	80	8.096.66	7.515.65	8.025.69	5.125.70	8.627.51	7.625.97	8.166.73	6.415.83	6.535.57	7.445.76	7.356.10
	100	7.807.14	6.035.54	7.005.53	6.426.09	8.896.80	6.435.37	8.877.12	6.345.46	5.455.30	6.055.37	6.935.97
	120	6.865.71	5.825.55	5.724.66	4.704.89	6.865.64	6.105.45	6.576.71	4.774.66	5.345.12	5.214.47	5.795.29
	Mean	7.586.50	6.455.58	6.915.29	5.415.56	8.126.65	6.725.59	7.866.85	5.845.32	5.775.33	6.235.20	6.695.79
D2March 20th	80	9.586.62	8.385.82	6.836.66	6.176.63	8.488.04	8.466.99	8.847.15	7.456.39	6.936.84	6.847.89	7.806.90
	100	9.338.26	6.726.36	7.015.03	6.205.88	8.706.58	6.346.31	8.426.42	6.885.68	6.744.99	7.436.86	7.386.24
	120	7.015.51	5.334.76	5.084.19	4.844.56	7.185.93	5.764.97	6.115.54	5.294.31	5.264.24	6.205.19	5.814.92
	Mean	8.646.80	6.815.65	6.315.29	5.745.69	8.126.85	6.856.09	7.796.37	6.545.46	6.315.36	6.826.64	6.996.02
D3April 20th	80	7.376.55	6.505.22	6.125.45	4.704.27	7.167.96	7.285.66	6.876.32	5.505.31	5.345.97	5.846.74	6.275.95
	100	6.837.65	5.886.19	5.146.43	4.814.94	6.967.13	5.115.38	5.325.92	5.035.32	4.665.42	6.706.97	5.646.14
	120	5.576.50	4.184.72	4.525.29	3.543.81	6.055.82	4.344.19	4.524.78	4.274.63	4.354.85	4.875.12	4.624.97
	Mean	6.596.90	5.525.38	5.265.73	4.354.34	6.736.97	5.575.08	5.575.67	4.945.09	4.785.41	5.806.28	5.515.68
Overall mean	80	8.356.61	7.465.56	6.995.93	5.335.53	8.097.83	7.796.20	7.966.73	6.455.85	6.276.13	6.716.80	7.146.32
	100	7.987.69	6.216.03	6.385.66	5.815.64	8.186.84	5.965.69	7.546.49	6.085.49	5.625.24	6.736.40	6.656.12
	120	6.485.90	5.115.01	5.114.72	4.364.42	6.705.80	5.404.87	5.735.68	4.784.54	4.984.73	5.434.92	5.415.06
	Mean	7.606.73	6.265.53	6.165.44	5.175.20	7.666.82	6.385.59	7.076.30	5.775.29	5.625.37	6.296.04	6.405.83
LSD 0.05	D	R.S	D.R	V	D.V	R.V	D.R.V	--	--	--	--	--
	0.586	0.176	0.365	N.S	0.633	0.633	N.S	--	--	--	--	--
	N.S	0.270	0.363	0.468	0.630	0.630	N.S	--	--	--	--	--

Table 8: The joint regression analysis variance for number of millable cane, stalk weight, cane yield and sugar yield traits

SOV	df	MS Number of millable cane/fed.	Stalk weight (kg)	Cane yield (ton/fed)	Sugar yield ton/fed
Genotypes (G)	9	573133125.30**	0.837**	2391.37**	26.81**
Env. + (G x Env.)	170	208351576.20**	0.022**	208.88**	3.16**
Env. (linear)	1	29584164162.30**	2.85**	30311.42**	401.83**
G x Env. (linear)	9	42299075.40**	0.03**	136.35**	0.98*
Pooled deviation	160	34093200.70**	0.004**	24.82**	0.79**
Pooled error	324	11927597.49	0.001	2391.37	26.81

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Table 9: Mean performance ($\bar{x}$) and stability parameters for ten sugarcane genotypes under eighteen environments for both number of millable cane and stalk weight traits.

	Number of millable (cane/fed)			Stalk weight (kg)		
Genotypes	Mean	bi	S²di	Mean	bi	S²di
G.T.54-9 (check variety)	45973.65	0.850	33128374.56**	1.297	1.221	0.002**
G.98-28	41822.26	0.975	11171174.86	1.179	0.653	0.001
Ph 8013 (Philippine var.)	41773.17	0.926	5155960.80	1.222	0.892	0.001
G.99-165	41357.75	0.931	196618487.40**	1.009	1.106	0.011**
G.99-103	47329.32	1.008	10905291.19	1.356	1.344	0.003**
G.84-47	47332.21	1.126*	8228274.86	1.077	1.161	0.004**
G.95-19	47690.87	1.271**	16776661.98	1.184	1.424	0.002**
G.95-21	42686.28	1.011	3507320.12	1.073	0.897	0.00
Mex.2001-80 (Mexican var.)	45744.41	0.925	21028174.57*	0.991	0.865	0.004**
G.98-24	51131.21	0.977	34412286.38**	1.039	0.437	0.007**
Mean	45284.11	--	--	1.143	--	--

*, ** significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Table 10: Mean performance ($\bar{x}$) and stability parameters for ten sugarcane genotypes under eighteen environments for both cane yield and sugar yield traits.

	Cane yield (ton/fed)			Sugar yield (ton/fed)		
Genotypes	Mean	bi	S²di	Mean	bi	S²di
G.T.54-9 (check variety)	59.24	0.855	47.93**	7.17	1.115	1.05**
G.98-28	49.15	0.960	21.25	5.90	0.996	0.67
Ph 8013 (Philippine var.)	50.85	0.986	10.04	5.80	1.019	0.71
G.99-165	42.73	0.908	31.33*	5.18	0.783	1.06**
G.99-103	63.88	1.228*	25.95	7.24	1.046	0.65
G.84-47	50.77	1.132	19.02	5.99	1.102	0.86*
G.95-19	56.17	1.439**	20.50	6.69	1.297	0.96*
G.95-21	45.54	0.937	3.34	5.53	0.975	0.13
Mex.2001-80 (Mexican var.)	44.95	0.713	18.94	5.49	0.815	0.44
G.98-24	52.91	0.842	49.94**	6.16	0.850	1.34**
Mean	51.61	--		6.11	--	--

*, ** significant and highly significant at 0.05 and 0.01 probability levels, respectively.

environments and their considerable influence on all studied traits. It is also important to mention that the linear component of genotype - environment interaction was highly significant for all studied traits. Therefore, it could be preceding in the stability analysis [6]. This indicated that the relative ranks of the genotypes differed from one environment to another. The significance of pooled deviation indicates that the genotypes differed considerably with respect to their stability for all studied traits. Similar results were obtained by Sanjeev - Kumar *et al*. [31].

Stability Parameters: For each genotype, mean performance over environments ($\bar{x}$), the stability regression coefficient (bi) and deviation from regression (S^2d) as presented in Table 9 for number of millable cane and stalk weight and (Table 10) for cane yield and sugar yield. The stable genotype was defined as one which has a regression coefficient of 1.0 and deviation from regression mean square equal to zero. The regression coefficients (bi) of genotypes Ph.8013, G.98-28, G.99-103 and G95-21 for number of millable cane, while genotypes Ph.8013, G.98-28 and G95-21 for stalk weight (Table 9), in addition to genotypes Ph 8013, G 98-28, G 84-47, G95-21 and Mex.2001/80 for cane yield and also genotypes Ph.8013, G.98-28, G.99-103, G 95-21 and Mex.2001/80 for sugar yield (Table 10), were insignificant from unity and the deviation from regression (S^2d) were also insignificant from zero, indicating that these genotypes considered stable for such trait. Meanwhile, the other tested genotypes for such trait were unstable; since their S^2d were significantly differ from zero according to Eberhart and Russell [6]. Similar results were obtained by Sanjeev - Kumar *et al*. [31], Khatod *et al*. [32], Hapase *et al*. [33], Sanjeev -\ Kumar *et al*. [34] and Khatod *et al*. [35].

The genotypes Ph.8013 and G.98-28 for number of millable cane and genotypes Ph 8013, G 98-28 and G 95-21 for stalk weight (Table 9), in addition to genotypes Ph 8013, G.98-28, G 95-21 and Mex.2001/80 for cane yield and also, genotypes G98-28, G 95-21 and Mex.2001/80 for sugar yield (Table 10) were considered specially adapted to unfavorable environment late planting date (April 20th) and un-optimum inter-row spacing (120 cm) because the regression coefficients of these genotypes were less than one (bi < 1). Our results are in agreement with those obtained by Ghosh and Singh [36]. The other studied genotypes i.e., G.99-103 and G 95-21 for number of millable cane, G 84-47 for cane yield; and Ph 8013 and G.99-103 for sugar yield gave (bi) values more than unity (bi > 1) and could be well adapted to optimum planting dates (Feb. 20th

and March 20th) and optimum interrow spacing (80 cm.). The present results confirm the findings of Hapse *et al.* [33]. The most desirable genotypes based on the three stability parameters ($\bar{x}$, bi and S^2d) were G.95-21 for number of millable cane and G.99-103 for the other studied traits because they had desired performance among all studied genotypes, bi did not differ significantly from unity and least deviation from regression. Similar results were reported by Manjunath *et al.* [3], Khatod *et al.* [32] and Mattias [37].

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