Egypt. J. Agric. Res., 82 (1), 2004.

EFFECT OF ROW SPACING AND CUTTING SIZE ON CANE JUICE QUALITY ATTRIBUTES

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(Manuscript received 31 June 2003)

Abstract

Tow field experiments were carried out to investigate the effect of three levels of row distance as well as cutting size on Juice quality attributes "TSS, Brix, sucrose, reducing sugars, purity, sugar recovery and fiber percentages" of three promising sugar cane varieties.

The effects of row spacing and cutting size on all studied Juice quality attributes were not great enough to reach the significant level with the exception of the effect of row distance on fiber % in which the wider the row distance the higher the fiber % and vice versa. Varietal response to the studied factors varied greatly in respect to Juice quality parameters. Variety G. 85- 37 showed superiority in the TSS and inferiority in both purity and sugar recovery percentages when compared with the other two varieties. Meanwhile, variety F. 153 recorded the highest values of fiber and Brix % compared tc the other two varieties. The commercial variety (G. T. 54 - 9) showed superiority over the other two varieties in purity percentage. The first and second orders interactions effect on sugar recovery were significant.

INTRODUCTION

The chemical composition of cane Juice (Juice quality) plays an important and direct rule in the quantity of the extracted raw sugar. Meanwhile, the Juice quality parameters differ among varieties and are affected bythe agronomical practices . Bull (1975) found that close row spacing increased the stalk yield of the plant crop, reduced sucrose concentration and restricted the increase in sugar production. He added that sucrose level was less affected and sugar production was directly related to stalk weight. Irvine and Banda (1980) showed no significant effect of spacing on the sugar content of the cane but fiber % increased in cane with decreasing spacing. Nandihalli and Singh (1982) reported that sugar cane quality of Co. 1148 variety increased with row spacing from 45 cm to 90 cm. Moreover Irvene *et al.* (1984) found that the 0.6 m- v- fur-

row rows compared with 1.8 v- furrow rows had the higher yield of sugar but there were no differences in cane quality due to spacing treatments. Phogat *et al.* (1986) showed that row spacing (45 or 60 cm) and cultivars Co 7314 and Co 7717 had no significant effects on juice quality. Mandloi *et al.* (1989) reported that variety Co 6304 was superior than Co 1305 in respect to brix, sucrose, purity and sugar recovery % of sugar cane juice. Also, they found that spacing of 60 cm proved superior than 75 and 90 cm except in brix value and sugar recovery % in juice. Singh and Singh (1993) suggested that with sugar cane cv. Cos 8118. Bo 91, Cos 767, Cos 7918 and Cos 8009 planted in rows 60, 75 or 90 cm apart, sucrose content was not affected by spacing or cultivars, in the plant crop but was highest in Cos 767 (15.8%) and at 75 cm spacing (15.9%) in the ratoon crops. El-Gergawi *et al.* (1995) indicated that increasing rates of seed cuttings from one to double drills caused a reduction in TSS, sucrose and purity percentages especially in the first season and had no effect neither on purity in the second season nor on sugar yield in both seasons.

MATERIALS AND METHODS

Two field experiments were conducted in two successive seasons, i.e. 1994/ 95 and 1995/96 in Shandaweel Research Station, Agricultural Research Center, Souhag Governorate. The aim of this experiment is to investigate the influence of some agronomical factors (row distance, cane variety and cutting size) on the quality attributes of sugar cane juice. This experiment included 27 treatments representing the combination of three levels of each of the following factors:

a. Row distance; 100, 120 and 140 cm.
b. Cane variety; G-85-37, G.T. 54-9 and F. 153.
c. Number of buds on seed cutting; 2, 4 and 6 buds/seed cutting.

A split plot design with three replications was used . Row distances were allocated in the main plots, whereas, the combination between cutting sizes and cane varieties were distributed in the sub plots. The sub- plot area was 42 m^2. Planting dates were on the 1^{st} week of April in both seasons. The recommended dose of NPK/fed (210 kg N, 30 kg P205 and 48 kg K20) was added as commonly practiced by sugar cane farmers of Upper Egypt. The normal agricultural practices needed for growing sug-

ar cane plants were followed. At harvest a sample of 30 stalks was taken at random for chemical analysis, and the following data were recorded .

1. TSS % in the 3rd, 6th, 9th, 12th, 15th internode using the "hand refractometer"
2. Brix percentage was determined in the laboratory using the Brix Hydrometer standardized at 20°C .
3. Sucrose percentage was determined by using Saccharemeter according to the method mentioned in the AOAC (1995).
4. Purity percentage was calculated using the following equation:
   Apparent purity = (Sucrose %) x100 / Brix %
5. Sugar recovery percentage was calculated as follows:
   Sugar recovery = { S - 0.4 (B-S) } x 0.73 .
   Where : B = Brix %, S = Sucrose %.
6. Reducing sugars percentage was determined in the extracted juice of cane according to Chemical Control in Egyptian Production Factories (Anonymous, 1981).
7. Fiber percentage was determined according to Pleskhow (1976) method in the basal, middle and terminal internodes of the stalk.

Statistical analysis:

The collected data were subjected to the proper statistical analysis according to the procedure outlined by Snedecor and Chocran (1981). To compare between means, Duncan multiple range test was used according to Duncan (1955).

RESULTS AND DISCUSSION

The Effect of row distance and cutting size on juice quality attributes of some promising sugar cane varieties will be discussed under the following topics:

1. Total soluble solids percentage (TSS %)

Data presented in Table (1) show the effect of row spacing and cutting size on the percentage of total soluble solids (TSS %) at 270 days from planting and at harvest for certain internodes of the studied sugar cane varieties. The results obtained cleared that the effect of row spacing on the TSS% values in the measured internodes

was insignificant. However, this effect was only significant at the age of 270 days in the 12th internode and at harvest with the 3rd internode. The insignificant effect of row spacing on TSS% has been reported by Singh *et al.* (1982) who found no applicable effect on juice quality due to row spaces.

The effect of number of buds/seed cutting on TSS % was simillar to the effect of row spacing where in the most of the various internodes; the differences between the TSS % values were not great enough to reach the level of significance. However, it could be noticed that using the 4 budded cuttings attained somewhat superiority in respect to TSS % compared with the other cuttings i.e. 2 and/or 6 buds/seed cutting.

Table 1. Effect of row spacing and seed cutting size on total soluble solids percentage (TSS%) of some sugar cane varieties.

(Combined analysis of seasons 1994/ 1995 and 1995/ 1996)

Treatments	T.S.S %									
	3rd internode		6th internode		9th internode		12th internode		15th internode	
Row spacing (cm)	270	Harvest	270	Harvest	270	Harvest	270	Harvest	270	Harvest
100	18.89 a *	22.81 b	19.04 a	22.26 a	18.80 a	22.26 a	18.66 a	22.40 a	16.46 a	21.95 a
120	18.69 a	22.86 b	18.29 b	21.39 a	18.44 a	21.96 a	17.17 b	21.86 a	16.23 a	21.63 a
140	18.89 a	23.46 a	18.66 ab	22.28 a	18.41 a	22.23 a	17.49 b	22.03 a	16.85 a	21.59 a
Cutting size										
2- bud	18.66 a	22.83 a	18.79 a	21.90 a	18.62 a	22.11 a	17.87 a	21.80 a	16.45 ab	21.31 b
4- bud	18.91 a	23.11 a	18.59 a	22.06 a	18.69 a	22.28 a	18.15 a	22.28 a	16.85 a	22.07 a
6- bud	18.90 a	13.19 a	18.60 a	21.97 a	18.33 a	22.06 a	17.29 b	22.21 a	16.25 b	21.78 ab
Varieties										
F. 153	18.91 b	22.61 b	18.64 b	21.90 b	18.27 b	22.06 a	17.90 a	21.88 b	16.10 b	21.55 b
G. 85- 37	19.25 a	23.83 a	18.98 a	22.45 a	18.89 a	22.37 a	18.11 a	22.50 a	17.01 a	22.17 a
G.T 54- 9	18.32 c	22.69 b	18.36 b	21.58 b	18.49 b	22.01 a	16.43 b	21.90 b	16.43 b	21.43 b

* Means followed by the same letter are not significant.

As for the varietal effect on TSS%, The G.83-37 variety showed significant superiority in the TSS % over the other two varieties. This result assured that TSS % is mainly affected by gene make-up. This result is in agreement with that reported by Nafei (1993) who showed that the average of TSS % revealed insignificant response to G.T. 54-9 or G.68-88 in two season.

2. Fiber percentage:

Results in Table (2) indicate clearly the fact that the percentage of fiber gradually increased from the terminal part of the stalk toward the basal part. The effect of row distance on fiber percentage was very clear, the narrower the row distance the lower the fiber percentage and vice versa. This finding may be due to the wider row distance the stronger the stalk growth consequently the higher fiber percentage. On the contrary El-Sayed (1996) found that planting density had no significant effect on fiber percentage of the cane stalk.

In respect to the varietal effect on fiber percentage of sugar cane plants, results in Table (2) reveals that sugar cane varieties differed greatly among themselves in respect to fiber percentage. This observation was true for the various studied intemodes. F. 153 variety recorded the highest values of fiber percentage compared with the other two varieties G-85-37 and G.T. 55-11-9. This finding is completely in line with that found by El-Sayed (1996) who mentioned that F. 133 variety significantly contained higher fiber percentage than G. 7496 variety.

Table 2. Effect of row spacing and number of buds per seed cutting on fiber percentage at harvest of some sugar cane varieties.

(Combined analysis of seasons 1994/ 1995 and 1995/ 1996)

Treatments	Fiber percentage		
Row spacing (cm)	Terminal internode	Middle internode	Basal internode
100	9.288 c*	9.944 c	10.819 c
120	9.847 b	10.513 b	11.338 b
140	10.188 a	10.826 a	11.897 a
Cutting size			
2- bud	9.757 a	10.415 a	11.247 a
4- bud	9.806 a	10.438 a	11.48 a
6- bud	9.75 a	10.431 a	11.48 a
Varieties			
F. 153	10.347 a	11.111 a	12.518 a
G. 85- 37	9.493 b	10.139 b	10.757 b
G. T. 54- 9	9.472 b	10.033 b	10.778 b

* See table 1.

3. Brix and reducing sugars percentages:

Data in Table (3) shows that neither brix (B%) nor reducing sugar percentages (RS%) were affected by the used row spacing. It is worth mentioning that the values of these two prameters were almost equally under the different levels of row spacing. These results are in accordance with those found by Irvine *et al.* (1984) who stated that there were no significant differences in cane quality due to row spacing.

Concerning, the influence of cutting size on both brix and reducing sugars percentages. The data illustrated that B% were insignificantly affected by the used cutting size. However R.S.% showed a significant response to the used cutting size, planting by 6-budded setts attained the lowest values of RS %.

In respect to the varietal effect on the percentages of brix and reducing sugars it could be noticed that varieties F. 153 and G.85-37 recorded significant increment in respect to B% over the commercial variety G.T. 54-9. These results support the results obtained for the percentages of (TSS) which revealed that G. 85 - 37 variety surpassed significantly the other two varieties in TSS. This finding is in line with that reported by Mandloi *et al.* (1989) Who pointed out that sugarcane variety Co. 6304 was superior than Co.1305 in respect to brix % of sugar cane juice. Once more, results in Table (3) showed that differences between the three varieties under investigation in respect to RS% were not great enough to reach the level of significance. These results are in harmony with those reported by El-Sayed (1996) who indicated that no significant differences were observed in R.S. % among his tested varieties.

4. Purity, sucrose and sugar recovery percentages:

Purity percentage (P%) and sugar recovery percentage (SR %) are considered ones of the very important juice parameters which play a direct rule in the quantity of the extracted raw sugar. The obtained data revealed that juice purity percentages were insignificantly affected by row spacing as well as by cutting size. This finding is in line with that found by El-Sayed (1996) who mentioned that planting density had no significant effect on purity percentage. As to, the influence of varieties on juice purity percentage, it could be noticed that G.T. 54-9 variety attained a superiority over the other two varieties i.e. F153 and G.85-37.Differences between varieties in juice purity per-

centages has been reported by Mahajan *et al.* (1991) who stated that sugar cane variety Co. 7717 had greater purity percentage than Co. 1148. It is worth mentioning that sugar cane variety G.T. 54-9 attained a greater purity percentage compared to the other two varieties, this finding may be due the low fiber percentage (Table 2) and the low TSS % (Table 3).

In respect to the effect of the studied factors on sucrose %, results revealed that sucrose % does not affected significantly by any of these factors. Results pointed out that all effects of the interactions between the studied factors on juice purity and sucrose percentages at harvest were not significant, these findings indicated that each factor acted independently in affecting these two traits.

Concerning the effect of the studied factors on sugar recovery percentage (SR%), results in Table (3) revealed that sugar recovery percentages were significantly responded to the used row spacing. The highest sugar recovery percentage was recorded under the closest row spacing i.e. 100 cm apart between rows. This finding could be due to the fact that plants grown under narrow spaces become thinner than those grown under wider spaces, consequently its juice become more concentrated and in turn attain high sugar recovery.

As for the effect of cutting size on sugar recovery percentage. Results showed that this trait was not significantly affected by cutting size. However it was significantly affected by sugar cane varieties where F. 153 and G.T. 54-9 varieties produced significant increases in sugar recovery percentage over the other variety (G.85-37). This increment amounted to be 0.352% and 0.243% over G.85-37 variety. This result is in agreement with that found by El-Sayed (1996) who found that F.153 variety recorded higher values of sugar recovery percentage over G.74-96 variety.

Interactions:

In respect to the interaction effects between the studied three factors on sugar recovery percentage. It could be noticed that, the first order interactions between row spacing and cutting size as well as between varieties and cutting size were significant in their effect on this trait. The highest value of sugar recovery percentage (12.49%) was recorded with the combination between 100 cm apart row spacing, and 4-budded/

seed cutting, meanwhile, the 2- budded seed cutting produced the highest value of sugar recovery with 140 cm row spacing.

Concerning varieties x row spacing interaction, results showed that (Tables 5 and 6) variety F.123 produced the highest value of sugar recovery with the 100 cm row spacing, while variety G.T.54-9 produced the highest sugar recovery % with the 140 cm row spacing.

Table 3. Effect of row spacing and number of buds per seed cutting on the percentages of brix, reducing sugars, purity, sucrose and sugar recovery of some sugar cane varieties.

(Combined analysis of seasons 1994/ 1995 and 1995/ 1996)

Treatments / Row spacing (cm)	Brix %	Reducing sugar %	Purity %	Sucrose %	Sugar recovery %
100	22.24 a*	0.37 a	85.72 a	19.06 a	12.35 a
120	21.84 a	0.39 a	84.59 a	18.47 a	11.76 c
140	22.24 a	0.38 a	85.19 a	18.94 a	12.19 b
Cutting size					
2- bud	22.7 a	0.39 ab	85.23 a	18.81 a	12.08 a
4- bud	21.35 a	0.40 a	85.48 a	19.90 a	12.12 a
6- bud	22.29 a	0.36 b	84.79 a	18.43 a	12.10 a
Varieties					
F. 153	23.32 a	0.37 a	85.92 b	18.97 a	12.25 a
G. 85- 37	22.58 a	0.37 a	83.02 c	18.87 a	11.90 b
G. T. 54- 9	21.43 b	0.39 a	86.63 a	18.56 a	12.15 a

* See table 1.

Table 4. Effect of the interaction between row spacing and cutting size on sugar recovery percentage.

Cutting size	Row spacing cm		
	100	120	140
2- bud	12.19 ab*	11.64 c	12.42 a
4- bud	12.49 a	11.70 c	12.15 ab
6- bud	12.37 ab	11.94 bc	11.99 bc

* See table 1.

Table 5. Effect of the interaction between row spacing and varieties on sugar recovery percentage.

Varieties	Row spacing cm		
	100	120	140
F. 123	12.69 a*	11.6 e	12.47 ab
G. 85- 37	12.21 bc	11.76 de	11.47 de
G. T. 54- 9	12.15 bcd	11.92 cde	12.36 ab

* See table 1.

Table 6. Effect of row spacing x cutting size x cane varieties interaction on sugar recovery percentage.

varieties	Cutting size	Row spacing cm		
		100	120	140
F. 153	2- bud	12.79 a*	11.67 cdef	12.31 abc
	4- bud	12.88 a	11.27 ef	12.47 abc
	6- bud	12.39 abc	11.88 bcde	1.61 ab
G. 85- 37	2- bud	12.1 abcd	11.08 f	12.16 abcd
	4- bud	12.56 ab	11.85 bcde	11.67 cdef
	6- bud	1.87abcde	12.34 abc	11.39 def
G. T. 54- 9	2- bud	11.68 cdef	12.17 abcd	12.79 a
	4- bud	11.94 bcde	11.99 bcde	12.32 abc
	6- bud	12.83 a	11.61 cdef	11.97 bcde

* See table 1.

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تأثير مسافة التخطيط وطول عقلة الزراعة علي صفات جودة عصير قصب السكر

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تضمن البحث تجربة حقلية أجريت في موسمي ٩٤/ ١٩٩٥، ٩٥/ ١٩٩٦ بمحطة البحوث الزراعية بشندويل بهدف دراسة تأثير ثلاثة مستويات من كل من عرض الخط (مسافات التخطيط) وطول عقلة الزراعة (عدد البراعم علي العقلة) علي صفات جودة العصير لثلاثة أصناف من قصب السكر.

- أوضحت النتائج بشكل عام عدم تأثر النسبة المئوية لكل من المواد الصلبة الذائبة الكلية والبركس والسكريات المختزلة ودرجة النقاوة بطول عقلة الزراعة وكذلك بعرض الخط بينما تباينت الأصناف معنويا فيما بينها في هذه الصفات حيث تفوق الصنف جيزة ٨٥/٣٧ علي الصنفين الآخرين في نسبة المواد الصلبة الذائبة كما تفوق الصنفين F 153 وجيزة ٨٥/ ٣٧ علي الصنف جيزة تايوان ٥٤/ ٩ في النسبة المئوية للبركس كما حقق الصنف التجاري جيزة تايوان ٥٤/ ٩ تفوقا في النسبة المئوية للنقاوة علي الصنفين الآخرين . كما لم يكن للتفاعلات بين العوامل المدروسة تأثير معنوي.
- دلت النتائج علي أن النسبة المئوية للألياف تنخفض بنقص مسافة التخطيط بينما لم تتأثر بطول العقلة، وسجل الصنف F 153 أعلي نسبة ألياف مقارنة بالصنفين الآخرين.
- أظهرت النتائج تفوق الزراعات الضيقة (١٠٠ سم) عن غيرها في النسبة المئوية لنتائج السكر بينما لم يكن لطول العقلة تأثير علي تلك الصفة. كما تفوق الصنفين F153 والصنف التجاري جيزة تايوان ٥٤/ ٩ في هذه الصفة علي الصنف جيزة ٨٥/ ٣٧ .