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EFFECT OF ROW DISTANCE AND CUTTING SIZE ON GROWTH CRITERIA OF TWO PROMISING SUGAR CANE VARIETIES AND THE COMMERCIAL VARIETY

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Abstract

The present study was carried out at Shandaweel Research Station, Sohag Governorate in 1994/1995 and 1995/1996 seasons to study the effect of row distance and cutting size on the growth criteria of three promising sugarcane varieties. A split plot experimental design with three replicates was used, where the main plots were assigned for row distances while the combination between varieties and cutting sizes were distributed in the sub- plots.

Results indicated that row distance affected significantly the number of cane stalks per meter as well as stalk diameter particularly at the late ages of growth. Meanwhile, the effect of row distance on germination %, stalk height, number of internodes and leaves/main stalk and chlorophyll content were not great enough to reach the significant level.

Concerning the influence of cuttings size, planting sugarcane by using 4- budded cutting attained in all cases, with few exceptions, the highest values of germination %, stalk dimensions, number of stalks/meter and number of internodes/main stalk.

The response of the studied varieties varied greatly from one variety to another. While the F. 153 variety showed superiority over the other two varieties in germination % and number of cane stalk/meter, variety G. 85- 37 produced the highest values of stalk diameter and stalk height. Meanwhile variety G. T. 54- 9 showed superiority over the other two varieties in number of internodes/main stalk.

INTRODUCTION

It is well known that all commercial sugar cane varieties are inter specific hybrids and consequently differ in their performance due to the great variation in their genetic make-up. Nowadays, several promising varieties of sugar cane has been developed by the Sugar Crops Research Institute. Therefore, it is of great importance to investigate the effect of the most common agronomical practices i. e. row distance and seed setts

size on the growth criteria of such promising sugar cane varieties.

In respect to cutting size effects, Panje (1971) using 3, 4 and 5 budded setts found that the 4 budded ones gave the highest germination % followed by that of 3 budded setts. On the other hand, cane plants arising from single budded setts are lacking in vigorous compared to those from the 3 budded setts (Lakshmikanthan, 1973).

Concerning the previous results on plant density, Bull (1975) showed that close row spacing promoted rapid development of stalk population and leaves cover. Irvine and Benda (1980) stated that plant weight and number of stalks decreased as row spacing decreased. Shih and Gascho (1980) found that stalk heights in the. 0.5 m row spacing were all greater and more erect than those in the 1.5 m row spacing. Similar findings were reported by El- Gergawi *et al.* (1995) who reported that the number of stems/ m increased with increasing planting density, while Romero *et al.* (1990) pointed out that stem density was greater with wide furrow. This work was initiated to investigate the influence of row distance and cutting size on the growth criteria of three promising sugarcane varieties.

MATERIALS AND METHODS

Two field experiments were carried out for two successive seasons, i.e. 1994/95 and 1995/96 in Shandweel Research Station, Agricultural Resarch Center, Sohag Governorate. The soil of the experiment was clay loam. Each experiment included 27 treatments representing the combinations of three levels of each of the following factors:

Row distances; 100, 120 and 140 cm.
Number of buds on seed cutting (cutting size); 2, 4 and 6 buds/seed cutting.
Sugarcane varieties; G –85 –37, G. T. 54- 9 and F- 153.

A split plot experimental design with 3 replications was used. Row distances were allocated in the main plots whereas, the combination between cane varieties and cutting sizes were distributed in the sub- plots. The sub- plot area was 42 m^2. Other agricultural operations were practiced as recommended in the region.

Data recorded:

The following data were recorded periodically:

1. Germination % was calculated after 15 days from planting and every 15 days up to 60 days from planting.
2. Main stalk dimensions:
   - Stalk height (cm), was measured from soil surface up to the top visible dewlap.
   - Stalk diameter (cm), was measured at the middle part of the middle internode of the stalk.

   The stalk dimentions were measured after 90 days from planting and every 30 days up to 270 days from planting as well as at harvest (340 days from planting)
3. Number of stalks/m was counted after two months from planting and every 30 days up to 150 days.
4. Chlorophyll content was determined in the field using chlorophyll meter (SPAD 501) after 60 days from planting and every 30 days up to 270 days as well as at harvest.
5. Number of green leaves and internodes per stalk were counted monthly after 3 months from planting up to 270 days as well as at harvest.

The collected data were subjected to the proper statistical analysis of split plot design 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

1. Germination percentage

Data presented in Table (1) show insignificant response of germination percentage in respect to row distance. These results were fairly true at the various germination stages. However, it is clearly shown that germination percentages of sugarcane cuttings rapidly increased from one stage to the next to reach the highest values after 60 days from planting. It is also clear that the most effective period on germination percentage lies between 15 and 30 days from planting where the values of germination percentage jumped up from 1% to 40% after 15 and 30 days respectively.

Concerning the effect of cutting size on germination percentage, results revealed that the highest values of germination percentage were attained by using 4-bud seed cutting. This effect was true at all germination stages, but reached the significant level at the age of 15 and 30 days from planting if compared to the 6-bud seed cutting. These results are in accordance with those reported by Panje (1971) who mentioned that for the 3,4 and 5 buded setts, the 4 budded setts gave the highest germination followed by the 3 budded setts. Meanwhile, Odda *et al.* (1989) showed that the highest density reduced shoot germination.

Moreover, data in Table (1) clearly show that the used cane varieties varied statistically in their germination percentage from one stage to another. Thus the F-153 and G85-37 varieties surpassed the commercial variety (G.T. 54-9) in the values of germination percentage in the last two stages i.e. 45 and 60 days from planting.

Table 1. Effect of row spacing and size of seed cuttings on germination percentage and stalks number/m of some sugar cane varieties.

(Combined analysis of seasons 1994/95 and 1995/96)

Treatment	Germination %				Stalks number/ m			
	Days after planting							
Row spacing (cm)	15	30	45	60	60	90	120	150
100	0.993 a *	39.52 a	52.59 a	62.65 a	8.018 a	19.86 a	23.73 b	22.23 c
120	1.206 a	39.31 a	51.54 a	61.31 a	8.058 a	19.1 a	25.66 ab	24.48 b
140	1.013 a	40 a	52.59 a	63.29 a	8.168 a	19.93 a	27.67 a	26.02 a
Cutting size								
2- bud	0.993 a	39.52 a	51.66 a	61.7 a	8.009 ab	19.48 a	24.7 b	23.52 b
4- bud	1.246 a	41.57 a	53.29 a	64.1 a	8.416 a	19.98 a	26.35 a	24.35 a
6- bud	0.986 b	36.32 b	51.78 a	61.44 a	7.849 b	19.25 a	26.01 a	24.87 a
Varieties								
F153	0.285 c	38.6 b	53.48 a	66.4 a	8.598 a	21.02 a	28.45 a	26.78 a
G85-37	1.303 b	42.67 a	55.03 a	64.83 a	8.48 a	19.13 b	23.97 b	22.68 b
G.T. 54-9	1.625 a	37.56 b	48.22 b	56.01 b	7.199 b	18.56 b	24.63 b	23.28 b

* Means followed by the same letter are not significantly different at 0.05.

2. Number of cane stalks/m:

The effect of row distance and number of buds of seed setts (seed cuttings) on the number of plants/m is illustrated in Table (1). Increasing row distance raised the number of cane stalks/ m, this observation was not clear when sugarcane seedling aged 60 and/or 90 days from planting. However a significant increment in number of cane stalks/ m was accompanied the increase in row distance at the later stages of growth (120 and 150 days). This finding may be due to the fact that sugarcane plants grown under wider rows have more appropriate conditions to produce more tillers, than those grown under higher dense plantation. These results are in agreement with those reported by Romero *et al.* (1990) who pointed out that stem density was greater with wide furrow. Moreover Panje (1971) reported that the maximum stalk numbers are produced approximately four months after planting.

As for, the effect of number of buds/seed sett on number of stalks/ m. results in Table (1) pointed out that number of buds/seed cutting significantly affected the number of stalks/m., particularly at the later two stages of growth. On the contrary it could be noticed that increasing the number of buds/seed cutting (longer cuttings) decreased the number of stalks/ m in the 1st period of growth (60 days from planting). This last finding may be due to the inhibition effect of the buds which affect the germination percentage and consequently affect the number of plants/ m. However as the plants grow up the dormant buds resumption their active growth and compensate this reduction in the number of stalks/ m in the 1st two periods of growth.

Concerning the number of stalks/m of the different varieties, it is obviously shown that variety F153 attained a superiority over the other two varieties (Table 1). The pronounced effect of varieties in this trait is mainly due to gene-make up effect. This finding is in agreement with those showed by El-Sayed (1996) who found that variety F153 produced a significantly higher number of stalks/m after 105 days as well as after 195 days from planting compared to variety G.74-96. Similar findings were observed by Mohamed and Ahmed (2002).

3. Stalk diameter:

Data in Table (2) show the effect of the studied factors on stalk diameter of sugarcane plant at different growth stages as well as at harvest. The obtained results revealed that there was no significant effect of the used row width on stalk diameter up to 130 days from planting. However, the next period of growth and up to harvest the values of stalk diameter positively responded to the increase in row width, i.e. the wider the row the thicker stalk diameter. The increase in stalk diameter under the wider row spacing could be due to the low competition between plants on the environmental elements i.e. nutrients, soil moisture,... etc, consequently plants grow much better than the closely spaced ones. On the contrary Romero *et al.* (1990) stated that stem diameter did not differ between furrow types but El-Gergawi *et al.* (1995) and El- Shafai (1996) reported that sugarcane plants grown by planting 1.5 drill had thicker stalks than those planted by double drills at all growth stages.

Concerning, the effect of buds number/ seed sett (cutting size), data in Table (2) point out that planting by 4-budded seed setts mostly produced the highest values of stalk diameter.This finding may be due to the fact that the appropriate number of buds/seed sett improve the sprouting process of cane shoot and in turn germination percentage (Table 1). However, at harvest differences between 4 and 6-bud/seed setts were insignificant in stalk diameter.

In respect to stalk diameter of the studied varieties, the data presented in Table (2) indicate that sugar cane variety G. 85-37 produced thicker stalks than the two other varieties i.e. F. 153 and G.T. 54-9. This result indicated that in addition to the effect of agronomical practices, gene make-up broadly affected growth properties, the fewer the number of stalks in sugar cane stool, the better growth and vigourus stalks. This finding is in agreement with Nafei (1993) who found that sugarcane variety G.T. 54-9 was superior in stalk thickness compared with variety G. 68-88.

4. Stalk height:

The effect of row spacing and number of buds/seed cutting on plant height of some sugarcane varieties at different growth stages are shown in Table (3). It is clearly shown that plant height was insignificantly affected by the used row distances. Howev-

er, it could be noticed that there was a negligible increases in plant height as the row distance decreased. This result is in line with that reported by Shih and Gascho (1980) who pointed out that stalk height in the 0.5 m row spacing was greater than that in the 1.5 m row spacing. Moreover, El-Gergawi *et al.* (1995) revealed that increasing plant density in terms of raising plant drill significantly increased stalk height.

Table 2. Effect of row spacing and size of seed cuttings on stalk diameter (cm) of some cane varieties.

(Combined analysis of seasons 1994/95 and 1995/96)

Treatment	Stalk diameter							
	Days after planting							
Row spacing (cm)	90	120	150	180	210	240	270	Harvest
100	1.629 a *	2.045 a	2.543 a	2.709 b	2.805 a	2.898 C	2.921 c	2.982 b
120	1.651 a	2.004 a	2.515 a	2.66 a	2.92 b	2.976 B	2.997 b	3.03 b
140	1.657 a	2 a	2.539 a	2.819 a	2.969 a	3.047 a	3.078 a	3.111 a
Cutting size								
2- bud	1.605 b	1.973 b	2.487 c	2.714 a	2.852 b	2.935 c	2.959 c	2.98 b
4- bud	1.671 a	2.046 a	2.581 a	2.793 a	2.911 a	2.978 b	3.006 b	3.006 a
6- bud	1.662 a	2.031 a	2.53 b	2.787 a	2.931 a	3.008 a	3.031 a	3.079 a
Varieties								
F.153	1.472 c	1.787 b	2.34 b	2.56 b	2.725 c	2.811 c	2.836 b	2.871 b
G.85-37	1.783 a	2.23 a	2.647 a	2.884 a	3.003 a	3.07 a	3.087 a	3.139 a
G.T. 54-9	1.683 b	2.032 a	2.61 a	2.85 a	2.967 b	3.041 b	3.073 a	3.114 a

* See table No. 1.

In respect to the effect of bud's number per seed cutting on stalk height, the present data pointed out that increasing the buds number/seed cutting i.e. 4 and/or 6 buds/ seed cutting increased stalk height significantly compared with planting by 2-budded seed. This result was true at the various growth stages. However, differences between the 4 and 6 buds/seed cutting were not great enough to reach the level of significance. Similar findings were reported by Shih and Gascho (1980. who showed that stalk height increased with increasing planting density

Concerning, the stalk height of the different varieties , data illustrated in Table (3) show that stalk length varied significantly among used varieties, sugarcane varieties G85-37 and G.T. 54-9 attained supperiority in stalk height over F. 1503 variety at all growth stages. At harvest, the superiority of these two varieties attained 9.48% and 9.79% increment in stalk length over F. 133 variety. These differences between the used varieties mainly due to gene make-up effect. This result is in agreement with that found by El-Sayed (1996) who showed that variety F. 153 produced taller stalks compared to variety G.74-96. Varietal difference are also reported by Mohamed and Ahmed (2002).

Table 3. Effect of row spacing and number of buds per seed cutting on stalk height (cm) of some sugar cane varieties.

(Combined analysis of seasons 1994/95 and 1995/96)

Treatment	Stalk height (cm)							
	Days after planting							
Row spacing (cm)	90	120	150	180	210	240	270	Harvest
100	41.82 a *	110.14 a	192.14 a	238.75 a	265.14 a	286.52 a	292.64 a	294.54 a
120	42.41 a	109.06 a	184.22 a	234.12 a	265.07 a	283.56 a	290.44 a	291.36 a
140	43.16 a	108.99 a	187.11 a	232.76 a	262.06 a	284.42 a	290.6 a	290.7 a
Cutting size								
2- bud	40.67 b	106.92 b	186.44 a	232.75 a	261.68 ab	280.41 b	286.12 b	286.6 b
4- bud	44.47 a	111.47 a	187.37 a	236.73 a	266.42 a	288.02 a	294.82 a	294.23 a
6- bud	42.25 ab	109.8 ab	189.64 a	236.15 a	264.17 a	286.09 a	292.72 a	295.77 a
Varieties								
F.153	33.61 c	92.65 c	172.23 c	217.51 b	243.39 b	267.2 b	272.49 b	274 b
G.85-37	48.5 a	120.85 a	198.87 a	244.68 a	273.87 a	293.92 a	300.84 a	301.84 a
G.T. 54-9	45.29 b	114.7 b	192.37 b	243.44 a	275.02 a	293.39 a	300.34 a	301.76 a

* See table No. 1.

5. Number of leaves/main stalk:

Data presented in Table (4) indicate that number of leaves/main stalk were not greatly affected by row distance. However, at advanced stages of growth i.e. 210, 240, 270 days and at harvest there is partial increment in leaves number/main stalk under 100 cm row spacing. This increase in number of leaves per main stalk reached the significant level only at harvest. This finding may be due to the fact that plants grown under narrow space become taller than those grown under wide space (Table3); These results are in accordance with those found by Irvine and Benda (1980) who noticed that the Leaf Area Index (LAI) of sugar cane varieties almost increased from the widest to the closest spacing.

It is obviously shown that in the early 5-growth stages, growing sugar cane plants by using 6-budded setts attained the highest values of leaves number/main stalk (Table 4). However at the last two stages of growth i.e. 240 and 270 days as well as at harvest 4-buded setts attained the highest leaves number/main stalk. Results in Table (4) also show significant differences among the studied cane varieties in number of leaves per main stalk. In spite of sugar cane variety G.85-37 produced the highest values in stalk height (Table 3), it recorded the lowest values of number of leaves/main stalk. This result could throw some lights around the fact that the increase in stalk height could be due to internode elongation rather than increase in the number of internodes. This means that the increase in number of leaves is not necessary accompanied to the increase in stalk height.

6. Chlorophyll content:

Results in Table (5). indicat that chlorophyll content of sugar cane leaves was not significantly affected by row distances. It is also noticed that the values of chlorophyll content of sugarcane leaves decreased as the plants tended toward maturity to reach the lowest value at harvest. The highest chlorophyll content were recorded at 90 days from planting.

Concerning the effect of cutting size in terms of number of buds/seed cutting, the results obtained showed that cutting size had no significant influence on chlorophyll content at the first seven growth stages or up to 240 days from planting. Mean-

while at 270 days and at harvest planting cane by using 6- budded cutting attained a significant effect on chlorophyll content in sugar cane leaves. The results also cleared that the promising variety G.85-37 was distinguished by significant increase in chlorophyll content at the most growth stages or at the 1st six growth stages (up to 210 days from planting). At later stages of growth the F 153variety attained the highest values of chlorophyll content in sugar cane leaves.

Table 4. Effect of row spacing and number of buds per seed cutting on number of green leaves per plant of some sugar cane varieties.

(Combined analysis of seasons 1994/95 and 1995/96)

Treatment	Number of green leaves/ plant							
	Days after planting							
Row spacing (cm)	9	120	150	1800	210	240	270	harvest
100	11.17 a *	12.23 a	13.9 a	15.18 a	16 a	14.24 a	12.87 a	11.34 a
120	11.22 a	12.32 a	13.91 a	14.2 a	15.5 a	13.8 a	12.66 a	10.9 b
140	11.02 a	12.22 a	14.01 a	15 a	15.5 a	13.73 a	12.43 a	10.86 b
Cutting size								
2- bud	10.97 b	12.06 b	13.83 a	14.93 a	15.56 b	14.09 a	12.6 b	11.08 a
4- bud	11.16 ab	12.28 ab	13.91 a	15.04 a	15.52 b	13.85 a	12.9 a	11.17 a
6- bud	11.27 a	12.42 ab	14.08 a	15.12 a	16.02 b	13.83 a	12.45 a	10.86 a
varieties								
F.153	11.08 b	12.57 a	14.15 a	15.24 a	15.91 a	14.34 a	13.15 a	11.50 a
G.85-37	10.96 b	11.7 b	13.4 b	14.33 b	15.12 b	12.81 b	11.51 b	10.44 b
G.T. 54-9	11.37 a	12.5 a	14.27 a	15.53 a	16.8 a	14.62 a	13.92 a	11.16 a

* See table No. 1.

7. Number of internodes/main stalk:

The obtained results revealed insignificant effects on number of internodes per main stalk due to row spacing (Table 6). These results were true throughout the vari-

ous growth stages. At harvest there was somewhat increase in number of internodes/ main stalk by increasing plant density, but this increase was not great enough to reach the significant level.

Concerning the influence of number of buds/ seed cutting on the number of internodes, results showed that this trait was not significantly affected by the number of buds/seed cutting. On the country, El- Gergawi *et al.* (1995) revealed that increasing the rates of seed cutting increased the number of internodes per plant.

Table 5. Effect of row spacing and number of buds per seed cutting on chlorophyll content (SPAD units) of some sugar cane varieties.

(combined analysis of seasons 1994/95 and 1995/96)

Treatment	Chlorophyll content (SPAD units) Days after planting								
Row spacing (cm)	60	90	120	150	180	210	240	270	harvest
100	34.63 a *	35.86 a	31.67 a	29.2 a	29.2 a	27.18 a	26.83 a	24.01 a	21.61 b
120	34.04 a	35.97 a	32.32 a	29.29 a	29.92 a	27.31 a	25.79 a	24.11 a	22.48 a
140	33.89 a	36.12 a	32.1 a	28.9 a	29.76 a	27.48 a	26.36 a	24.93 a	22.01 a
Cutting size									
2- bud	34.16 a	36.29 a	32.28 a	29.15 a	29.4 a	26.97 a	26.26 a	24.02 a	21.62 b
4- bud	34.59 a	36.03 a	32.02 a	29.15 a	29.85 a	29.21 a	26.29 a	23.57 b	22.19 a
6- bud	33.82 a	35.64 a	31.79 a	28.9 a	30 a	27.78 a	26.42 a	25.28 a	22.29 a
Varieties									
F.153	34.0 b	36.18 b	31.14 b	28.45 b	28.88 b	26.94 b	27.65 a	25.61 a	23.14 a
G.85-37	35.84 a	39.02 b	35.66 a	31.89 a	32.53 a	29.44 a	26.44 b	25.45 a	22.79 b
G.T. 54-9	32.72 b	32.79 c	29.29 c	26.91 c	27.84 b	25.58 c	24.88 c	21.99 b	20.17 c

* See table No. 1.

Data in Table (6) cleared that sugar cane varieties statistically differed in their effect on the number of internodes/main stalk. The commercial variety G.T. 54-9 attained the highest values of internodes number/main stalk, this difference is mainly due to varietal gene make-up.

Table 6. Effect of row spacing and number of buds per seed cutting on number of internodes per plant of some sugar cane varieties.

(combined analysis of seasons 1994/95 and 1995/96)

Treatment	Number of internodes/ main stalk					
	Days after planting					
Row spacing (cm)	150	180	210	240	270	harvest
100	10.96 a *	13.86 a	15.79 a	17.31 a	17.94 a	21.17 a
120	11.15 a	13.87 a	15.79 a	17.21 a	17.74 a	20.86 a
140	11.11 a	13.98 a	16.01 a	17.28 a	17.18 a	20.86 a
Cutting size						
2- bud	10.94 a	13.88 a	15.52 b	16.99 b	17.62 a	20.71 a
4- bud	1088 a	13.83 a	15.96 ab	17.33 ab	17.90 a	20.04 a
6- bud	11.39 a	14.01 a	16.06 a	17.48 a	17.97 a	20.93 a
varieties						
F.153	10.82 b	113.61 b	15.64 b	16.98 b	17.57 b	20.98 ab
G.85-37	10.85 b	13.45 b	15.35 b	16.90 b	17.45 b	20.38 b
G.T. 54-9	11.54 a	14.65 a	16.56 a	17.92 a	18.47 a	21.33 a

* See table No. 1.

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تأثير عرض الخط وطول عقلة الزراعة على صفات النمو لصنفين واعدين والصنف التجارى من قصب السكر

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أقيمت تجربة حقلية باستخدام تصميم القطاعات المنشقة مرة واحدة بمحطة البحوث الزراعية بشندويل في موسمي ١٩٩٥/٩٤، ١٩٩٦/٩٥ بهدف دراسة تأثير ثلاثة مسافات للتخطيط وثلاثة أطوال من عقل الزراعة علي صفات النمو لثلاثة أصناف من قصب السكر وهى الصنف التجارى GT54-9 وصنفين واعدين: G85-37؛ F153.

أظهرت النتائج أن نسبة الإنبات لم تتأثر معنويا بمسافات التخطيط (عرض الخط) بينما زاد عدد السيقان بالمتر بزيادة عرض الخط، تفوق الصنف ف ١٥٣ علي الصنفين الآخرين في كل من نسبة الإنبات وعدد النباتات بالمتر.

أوضحت النتائج أن صفتي طول الساق وكذلك عدد السلاميات للساق الرئيسي لم يتأثرا معنويا بعرض الخط بينما تأثرا معنويا بطول عقلة الزراعة وتفوق الصنف التجاري جيزة تايوان ٥٤/ ٩ علي الصنفين الآخرين في صفة عدد السلاميات للساق الرئيسي.

أظهرت النتائج أن صفتي قطر الساق وعدد الأوراق علي الساق الرئيسي لم يتأثرا معنويا بمسافات التخطيط في الأعمار الأولي، بينما أظهر التخطيط الضيق (١٠٠ سم) تفوقا في صفة عدد الأوراق علي الساق في الأعمار المتقدمة وعلي العكس أظهر التخطيط الواسع (١٤٠ سم) تفوقا في سمك قطر الساق.

لم يتأثر محتوي الكلوروفيل بعرض الخط وكذلك بطول عقلة الزراعة ولكن أظهر الصنف جيزة ٨٥/ ٣٧ تفوقا علي الصنفين الآخرين في تلك الصفة.