

Effect of Planting Material and Row Spacing on Sugarcane Yield and Quality

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Abstract

Field experiment was conducted at Al-Majaar Al-Kabher south Iraq to determined the effect of two planting materials (Whole Stalk and billet) and four row spacing (1.25 , 1.50 , 1.75 and 2 m) on sugar cane *Saccharum officinarum* L. yield and quality for crop yield and subsequent ratoon crop cycle for year 2007 and 2008, respectively. Cane yield and its attributes responded differently to different planting material and row spacing. Planting whole stalk on narrow row 1.25 and 1.50m gave higher cane yield (80.4 and 78.5 t/ha, respectively) than billet planting on the same row spacing (53.8 and 63.2 t/ha, respectively). Planting whole stalk on narrow rows gave higher stalk no./m² (18.2 and 17.9 stalk/m² for 1.25 and 1.50m row spacing, respectively) than billet planting (15.3 and 15.4 stalk/m² for 1.25 and 1.75m row spacing respectively). Ratoon crop cycle gave also higher cane yield and stalk no./m² when planted whole stalk compare to billet planting. Planting whole stalk gave higher stalk height than billet planting in only crop yield cycle. Reduced row spacing from 2 to 1.25 resulted in increased stalk height and reduced stalk diameter in plant cane and subsequent ratoon crop cycle. The two planting materials prove to be similar in yield quality in crop yield crop cycle but in the first ratoon billet planting gave 0.9% higher in pol% cane than whole stalk planting. Reduced row spacing increased pol% cane and purity% in sugarcane plant cane and ratoon crop cycle. This result showed that improvement of sugarcane production in Iraq could be achieved as first step by manipulating the current cultural practices.

Introduction

The Iraq fields of sugarcane nearly 30 thousand hectare located at Al-Majaar Al-Kabber south of Iraq. The fields supply sugarcane as raw material for the factory near by the field. The production of sugarcane has been observed to decline and not fulfill the production capacity of the factory. There are many uses for sugar thus there is high demand for sugar specially with fast growing population. In order to increase production per unit area improved cultural practices need to be adopted. Among these cultural practices selecting planting material and the desirable row spacing. Use billet planting has been for long time in the sugarcane production in Iraq. The billets are the whole stalk cut to pieces 40 to 45 cm long containing 3 to 4 buds each, are placed in the opened furrow and covered with soil. There are several concerns about billet planting. By cutting the stalk of cane into smaller pieces, environmental stresses survival (such salinity and cold winter) and spring growth is frequently decrease due to less available stored carbohydrates and possible stalk damage caused by the intense cutting process (Benda *et al.*,1978). Reduced temperature a here in winter, reaching to freezing and salinity are a major concern for production sugarcane in south Iraq. Hoy *et al.*(2004) reported that in Louisiana winter survival is a problem due to saturated soil and reoccurring freezing temperature are the reasons for high planting rate. Yin and Ho (1997) reported that in subtropical area stalk rot is major concern and become more severe when seed-cane is exposed to environmental stress. Ryan *et al.*(2005) compared billet planting to whole at three planting date. They found the whole stalk planting out-yield billet by 2.9 and 4.5 tons/acre in planting dates August 2000 and October 2000, respectively. Hsu *et al.*(1981) reported in tropical area (Hawaii) that whole stalk planting had consistently higher yields than planting billet. Another cultural practice need to be considered for improving sugarcane production in south Iraq is row spacing. Row spacing can affect growth and development of sugarcane in many ways. Tiller growth in sugarcane constitutes the major economic yield. Singels and Smith (2002) found that tiller population demonstrated a linear

increase of 4.29 tillers/m² with decrease in row spacing also they found that radiation use efficiency increased with decreased row spacing resulted in high dry matter production. Nguyen *et al.*(1997) reported from Hochi Minh-Vietnam that narrowing the row distance from 150 to 90 cm led to increase in biomass yield without affecting brix or extraction rate of juice. They also reported that number of plants/m² increased from 4.4 to 6.8 and from 6.2 to 8.7 plant/m² by decreasing row spacing from 150 to 90 cm for year 1994 and 1995, respectively.

Traditionally sugarcane production in Iraq uses billet planting with 1.5 row spacing. Thus the objective of this research to determined if whole stalk with different row spacing (from the traditional) could help in improving sugarcane production under south Iraq environment conditions.

Materials and Methods

This study was conducted at the Sugarcane Research Station located in the fields of the General Company for Sugar Production at Al-Majaar Al-Kabber south of Iraq. Physical and chemical characteristics of the soil are presented in Table (1).

Table (1). Physical and chemical properties of the soil

Depth cm	pH	E.C ds/m	O.M. g/kg	Texture	K ppm	NO ₃ ⁻¹ ppm	NH ₄ ⁺¹ ppm	P ⁻¹ ppm
0.25	7.2	4.5	9.2	Silty loam	3.6	14	16	0.12
0.50	7.5	4.4	4.9	Silty clay loam	2.4	13	16	0.14

The experiment was set to study the effect of two planting materials (billets and whole stalk) and four row spacing (1.25, 1.50, 1.75 and 2m) on yield and quality of plant cane (first year) and first ratoon (second year).

They variety (C 0.976) planted on 15th of October year 2007. The experiment design was randomized complete block where eight (2 × 4) treatments combination were set in factorial arrangement with three replicates. The planting material billets were 43-45 cm in length while whole stalk length ranged from 1.8m. There were 24 experiment plot each plot content 4 rows of planted sugarcane, each five meter long. All plots received the recommended cultural practices for successful stand establishment and growth which have been used in the area, these include fertilizer irrigation, weeding and pest control. The plant cane crop was harvested on 10th of December while ratoon crop was harvested on 20th of November. All harvest was done by hand. The whole plant of the middle rows from each plot were cut at ground level. The stalks then separated. Measurement were taken on the following characteristics: Stalk No./m², stalks height; stalk diameter; and cane yield. The quality measurements were pol% cane, brix% cane and purity% .

The data collected were subjected to analysis of variance technique and least significant differences (LSD) test at (p<0.05) was used to compare treatment mean according to Gomez and Gomez (1984).

Results and Discussion

Cane yield and its attributes responded differently to different planting material and spacing. There was a significant planting material by row spacing interaction for stalk no./m² and cane yield in the plant cane crop yield cycle indicate that the effect of planting material was not consistent at different row spacing. Reduced row spacing to 1.25 and 1.50m gave higher stalk no./m² for the whole stalk planting (18.2 and 17.9 stalk/m², respectively) compared to billet planting (15.3 and 15.4 stalk/m², respectively (Table 2). The high number of stalk/m² for whole stalk material may be due to large number of viable buds on whole stalk and compared to billet material with few buds planted in area having combined stresses of salinity and low winter temperature (Table 1) could result in lower survival percentage and cause lower stand establishment.

Table (2). Stalk number/m² and cane stalk yield as affected by treatment combination for cane yield crop cycle

Planting material	Row spacing, m									
	1.25	1.50	1.75	2	Mean	1.25	1.50	1.75	2	Mean
	Stalk no./m ²					Cane yield t/ha				
Whole stalk	18.2	17.9	13.3	12.4	15.4	80.4	78.5	60.1	54.3	68.3
Billet	15.3	15.4	12.8	12.1	13.9	53.8	63.2	60.3	55.1	58.1
Mean	16.8	16.6	12.4	12.1		67.1	70.8	60.2	54.7	
L.S.D (0.05)	Planting material = N.S Row spacing = 2.7 Interaction = 3.82					Planting material = 4.8 Row spacing = 6.9 Interaction = 9.75				

In plant cane crop cycle planting whole stalk on 1.25 and 1.50m gave the highest can yield (80.4 and 78.5 t/ha, respectively) (Table 2). This high sugarcane yield of whole stalk when planted on narrow rows may be due to high stalk no./m² (Table 2) and planting in narrow rows could have faster canopy closure and higher leaf area leading to produce high photosynthate. Similar result reported by Bull and Mcleod (2000) and Hoy *et al.*(2004).

Beside its lower yield than planting whole stalk, billet planting gave no consistent result across different row spacing in such that planting on 1.50 and 1.75 row spacing, billet planting gave higher yield than planting on 1.25 and 2 (63.2 and 60.3 t/ha compared to 53.8 and 63.2 t/ha, respectively) (Table 2).

The results of the first ratoon crop cycle for stalk no./m² and cane yield were similar to the main effect of plant cane crop result but with lower magnitude in such planting whole stalk give higher stalk no./m² (14.1) than billet planting (10.7) (Table 4). Cane yield also was higher when planting whole plant (63.1 t/ha) than billet planting (45.9 t/ha) (Table 3).

Table (3). Effect of treatment on cane yield and its attribute for first ratoon crop cycle

Treatment				
Planting material	Stalk no./m₂	Cane yield t/ha	Stalk height m	Stalk diameter cm
Whole stalk	14.1	63.1	2.1	2.04
Billet	10.1	45.9	2.0	2.20
L.S.D (0.05) Row spacing m	1.56	5.8	NS	NS
1.25	15.6	61.4	2.3	1.68
1.50	14.0	61.0	2.3	1.80
1.75	10.5	48.1	2.0	2.10
2	9.6	47.6	1.8	2.61
L.S.D (0.05)	2.4	9.3	0.3	0.73

In the first ratoon crop cycle planting on narrow rows of 1.25 and 1.50m gave higher stalk no./m₂ (15.6 and 14.0 stalk/m₂ respectively) than wider spacing 1.75 and 2 (10.5 and 9.6 stalk/m₂ respectively) (Table 3). Sugarcane yield also was higher and they were 61.4 and 61.0 t/ha for rows spacing 1.25 and 1.50m, respectively compared to 48.1 and 47.6 t/ha for 1.75 and 2m, respectively (Table 3).

The results showed that planting whole stalk gave higher stalk height (2.6m) compared to billet planting (1.8m) in the plant cane crop (Table 4). Reduced row spacing from 2 to 1.25m increased plant height from 1.8 to 2.4m (Table 4). Reduce row spacing from 2 to 1.25m reduced stalk diameter from 2.51 to 1.85m in plant cane and from 2.61 to 1.68 in the first ratoon crop (Table 4).

The two planting materials (billet and whole stalk) in plant cane proved to be similar in yield quality : pol% cane , brix% cane and purity% (Table 5). While in the first ratoon crop, billett planting gave 0.9% higher pol% than whole stalks planting (Table 5). Planting materids had similar brix% cane this may lead to the billets planting to have 3.9% increased in purit% comparing to whole stalk planting (Table 5).

Table (4). Effect of treatment on sugarcane stalk height and stalk diameter for cane yield crop cycle

Treatment	Plant cane	
Planting material	Stalk height m	Stalk diameter cm
Whole stalk	2-6	2.18
Billet	1.8	2.24
L.S.D (0.05)	0.7	NS
Row spacing m	Stalk height m	Stalk diameter cm
1.25	2.4	1.85
1.50	2.3	2.21
1.75	2.3	2.31
2	1.8	2.51
L.S.D (0.05)	0.5	0.35

The result for plant cane crop showed reduced row spacing to 1.50 and 1.25m increased pol% cane to 15.8 and 16.3%, respectively compared to 14.8 and 14.9% for row spacing 1.75 and 2m, respectively (Table 5).

Row spacing had in consistent effect on brix% cane in such that planting on 1.75m gave the lowest brix% (16.7) while the other row spacing had no significant differences (Table 5). Planting at 2 gave the lower purity percentage (79.7) while other row spacing had no significant differences (Table 5). In first ratoon crop cycle similar trend were found but with lower magnitude. Planting on 1.25 and 1.50m gave similar pol% cane of 12.2 and 12.3, respectively and that was higher than planting on 1.75 and 2m (Which gave 10.6 and 11.5% pol, respectively) (Table 5). Also purity% of row spacing 1.25 and 1.50m were higher than planting on 1.75 and 2m and that was due to lower brix% cane and high pol% cane of narrow planting row (Table 5).

Table (5). Effect of treatment on quality of sugarcane for cane crop and first ratoon crop cycle

Treatment	Pol% cane	Brix% cane	Parity%	Pol% cane	Brix% cane	Purty%
Plant material	Cane crop			First ratoon		
Whole stalk	15.4	18.7	82.5	11.2	16.1	69.4
Billet	15.6	18.4	85.8	12.1	16.5	73.3
L.D.S (0.05)	NS	NS	NS	0.7	NS	2.4
Row spacing m						
1.25	16.3	19.1	85.2	12.2	14.8	82.4
1.50	15.5	19.4	82.9	12.3	15.9	77.8
1.75	14.8	16.7	88.4	10.6	17.2	61.5
2	14.9	18.9	79.7	11.5	17.5	65.7
L.S.D (0.05)	0.6	1.8	6.1	0.5	1.2	3.2

Conclusion

The results of this research work demonstrate that improvement of sugarcane productivity under south conditions could be possible by manipulating the traditional cultural practices. It was found that planting the whole stalk instead billet planting increased yield by 26.6 and 15.3 t/ha when planted on narrow rows of 1.25 and 1.50m, respectively (Table 2). Since mechanization is minimum, reduced row spacing found increased yield and number of stalk and plant height (Table 2 and 4). Sugarcane quality was similar between the two planting material but there was slight reduction in pol% cane in first ratoon crop cycle when whole stalk planting material used (Table 5). However, high cane yield when planting whole stalk in both crop cycles could compensate for any reduction to pol% cane. Thus with increasing salinity in soil and other environmental stress in the area, it would be worthwhile considering planting whole stalk on narrow row as first step toward improvement of sugarcane productive under south Iraq environmental conditions.

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تأثير أنواع التقاوي والمسافات بين خطوط على حاصل السكر ونوعيته

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الخلاصة

تم إجراء تجربة حقلية في منطقة المجر الكبير جنوب العراق لغرض تحديد تأثير نوعين من التقاوي (سوق كاملة وقطع من الساق) وأربعة مسافات بين خطوط (1.25، 1.50، 1.75 و 2 م) على حاصل ونوعية قصب السكر *Saccharum officinarum* L. في حاصل الغرس وحاصل الحلفة الأولى للسنوات 2007 و 2008 على التوالي. وجد من النتائج أن حاصل القصب ومكوناته استجابة لاختلاف نوعية التقاوي ومسافات بين خطوط. وجد أن زراعة السيقان وهي كاملة في مسافات خطوط قليلة 1.25 و 1.50م أعطت أعلى حاصل (84.4 و 78.5 طن/هكتار على التوالي) مقارنة بزراعة قطع من الساق على نفس مسافات الخطوط (حيث أعطت 53.8 و 63.2 طن/هكتار على التوالي). زراعة السيقان وهي كاملة أعطت أعلى عدد ساق/م² (حيث أعطت 18.2 و 17.9 ساق/م² عند الزراعة على مسافات 0.5 و 1م على التوالي) مقارنة عند زراعة قطع من الساق (حيث أعطت 15.3 و 15.4 ساق/م² عند زراعة على مسافة 1.25 و 1.50م على التوالي). ووجد من النتائج أن عدد السيقان/م² في الخلفة الأولى كان عالي أيضا عند زراعة السيقان وهي كاملة مقارنة بقطع من الساق. كذلك زراعة السيقان وهي كاملة أعطت أعلى ارتفاع نبات مقارنة بزراعة قطع من الساق فقط في حاصل الغرس. تقليل المسافات بين خطوط الزراعة من 2 الى 1.25م أدت الى زيادة ارتفاع النبات وتقليل قطر الساق في حاصل الفرس والحلفة الأولى.

ثبت من الدراسة أن زراعة سوق كاملة وقطع من الساق أعطت نوعية حاصل متشابهة في حاصل الغرس لكن في حاصل الحلفة الأولى وجد أن هناك 0.9% زيادة في نسبة السكر (Po1% cane) عند زراعة قطع من الساق. تقليل المسافات بين خطوط أدى الى زيادة نسبة السكر (Po1% cane) ونسبة النقاوة في حاصل الغرس وحاصل الخلفة الأولى.

ومن هذه الدراسة تبين أن بالإمكان تحسين إنتاجية محصول قصب السكر في العراق وذلك عن طريق تغيير العمليات الزراعية التقليدية كخطوة أولى.