Response of Some Sugarcane Cultivars to Nitrogenous Fertilization and Micronutrients on Productivity and Quality

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ABSTRACT: Two filed experiments were carried out in the experiment farm of Faculty of Agriculture Aswan Egypt, during 2014 and 2015 growing seasons. The objective of this study was to investigate the response of some sugarcane cultivars to nitrogenous fertilization and micronutrient on productivity and quality. Experimental design was spilt spilt plot with three replicates. The results could be summarized as follows: Giza 9 variety at the four sampling dates had higher cane length, number of tillers/plant, number of internode/plant, leaf area index and cane diameter, also, cane girth, sugar cane, Brix (TSS%), sucrose (%), purity (%) and commercial cane sugar % (CCS%). Addition, nitrogen fertilizer at rate of 200 kg N/fed, resulted in a significant increment in growth characters, yield and quality of sugarcane plants in both seasons. Significant variations were recorded between the tested foliar micronutrient treatments for growth characters, yield and sugarcane quality. The effective treatments for growth characters, yield and quality were obtained for Giza 9 variety and adding 200 kg N/fed in both seasons. The highest values of all growth characters, yield and quality were obtained by Giza 9 variety with using the application of 200 kg N/fed and mixture of Zn +Fe treatment.

Keywords: sugarcane cultivars, nitrogenous fertilizer, micronutrient, growth, yield and quality.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a commercial crop grown in tropical and sub-tropical regions for sugar production in climates ranging from hot dry environment near sea level to cool and moist environment at high elevations (Plaut *et al.,* 2000). Apart from the main product, sugar, it produces many valuable co-products such as alcohol used by pharmaceutical industry and as fuel, bagasse for paper and chip board and press mud as a rich source of organic nutrients for crop production (Kumar *et al.,* 1996 and Legendre *et al.,* 2000).Thrives best a temperature above 20℃ and requires a period of about 8 to 24 months to reach maturity (Nazir, 2000). Sugarcane is a major cash crop in Egypt, which not only provides man stay to sugar industry but also, row materials to many allied industries for alcohol and chip broad manufacturing (Naqvi, 2005).

Nitrogen is essential for vigorous vegetative growth and development, yield and quality in sugarcane. It is a constituent of plant cell components e.g. amino acids and nucleic acids and its deficiency inhibits plant growth, reduction in leaf area, thus causes a decrease in photosynthesis hence suppressing yield and quality (Taiz and Zeiger, 2002 and Sreewarome *et al.,* 2007). Application of N fertilization is mandatory in intensive sugarcane cultivation which requires a high amount of nitrogen as a nutrient to produce high biomass (Thornburn *et al*., 2005). Excess N and low N uptake cause retarded growth phase and decreases photosynthetic capacity of leaves thus causing shorter internodes (Martin, 1994). For many locations the depletion of plant available soil N over time justifies the need for split application of yearly total N rate (Wiedenfeld, 1995).

Micronutrients can be applied directly into the soil or by foliar application. Foliar application has many advantages such as less application rate, even distribution of nutrients and immediate response of plant to applied material. It also, performs better where; soil alkalinity and permeability are more which leads to leaching of nutrients. Foliar application of nutrients is useful where the nutrients are fixed up to in the soil and thereby not available for absorption by the roots. Foliar application of zinc sulphate and iron sulphate increases cane yield (Chandra, 2005 and Boklar and Sakurai, 2005). The aim of this study was to examine the response of some sugarcane cultivars to nitrogenous fertilization and micronutrients on productivity and quality.

MATERIALS AND METHODS

The present study was carried out at the experimental farm Kom-Omb-Aswan, Egypt, sugarcane is grown in the belt 32°N and 24°S, during the two successive growth seasons of 2014 and 2015 seasons to study the response of some sugarcane cultivars to nitrogenous fertilization and micronutrients on productivity and quality. The main physical and chemical properties of cultivated soil before planting and also, its content of some macro and micronutrients were determined according to the methods described by Page *et al.* (1982) as shown in Table (1)

Table (1). Some Physical and chemical properties of the experimental soil in 2014 and 2015 seasons.

Parameter	Value		
	2014	2015	Unit
Mechanical Analysis			
Sand	52.12	53.00	%
Silt	22.00	23.00	%
Clay	22.88	24.00	%
Textural class	**Sandy Clay Loam**		
pH (1:2)	7.92	7.84	-
Ca Co_3	2.1	2.3	%
EC(1:2, water extract)	0.417	0.412	dS/m
O.M	1.65	1.55	%
Soluble cations			
Ca^{2+}	2.04	2.02	meq/l
Mg^{2+}	3.06	2.99	meq/l
Na^{+}	1.41	1.42	meq/l
K^{+}	0.71	0.70	meq/l
Soluble anions			
$HCO3^{-}$	5.4	5.2	meq/l
Cl^{-}	7.82	7.85	meq/l
SO_4^{2-}	0.79	0.77	meq/l
Available nutrients			
Nitrogen (N)	189.5	188.4	mg/kg
Phosphorus (P)	46.75	45.80	mg/kg
Potassium (K)	1000	1001	mg/kg

A split split plot design with three replicates was used in both seasons. Three cultivars (Giza 9 (V1), Giza 47 (V2) and Giza 49 (V3) were randomly assigned to the main plots, three nitrogen fertilizer levels (120, 160 and 200 kg N/fed) were allocated to sub plots and three micronutrients treatments (Zn, Fe and Zn +Fe) were randomly distributed in sub sub plots.

The experiment was laid out as split split plot with three replicates Net plot size was 4.5m x 8.0 m for 75 cm spaced trenches.

Fertilization

Fertilizers were applied at the rate of 115 kg P_2O_5/ha and 115 kg/ha K_2O, respectively. Phosphorus (single super phosphate 15.5% was applied at the time of sowing and SOP (sulphate Potash, 48 %K_2O). The amount of Zn and Fe was applied at 2kg Zn and 2kg Fe/fed. The foliar spray of 1/3rd dose of Zn and Fe and mixture Zn + Fe were applied 50 days after sowing and the remaining 2/3 was applied in two equal splits in 20 days intervals after the 1st spray. The sources of Zn and Fe were Zn SO_4-H_2O (35% Zn) and $FeSO_4$ - $7H_2O$ (19.5 % Fe), respectively.

Recorded data

A. Growth attributes

- Cane length (cm)
- Cane diameter (cm)
- Number of tillers/plant
- Number of internods/plant
- Leaf area index

B. Yield

- Cane girth
- Sugar yield (ton/ha) was determined by the following formula:

$$\text{Sugar yield (t/ha)} = \frac{Cane\ yield\ (t/ha)\ \text{X}\ CCS\%}{100}$$

C. Qualitative traits

- Brix %

  Ten cane randomly selected from every plot were crushed through a cane crusher and the juice was collected in glass jars. The reading brix (%) was recoded with brix hydrometer. Temperature of the juice was noted. These brix reading were corrected with the help of Schmitz table (Spancer and Meade, 1963).
- Sucrose in juice %

  With the help of parameter, pol reading of extracted juice of every treatment was recorded. Sucrose contents of cane juice were calculated with the help of Schmitz table (Spancer and Meade, 1963).
- Cane juice purity %

  Cane juice purity was determined at described by (Spancer and Meade, 1963).

$$\text{Cane juice purity (\%)} = \frac{Pol\ \%\ juice}{Brix\ \%\ Juice}\text{X}\,100$$

- P=Pol % in juice
- B= Brix % in juice
- F=Fiber % in juice (12.5%)
- Commerical cane sugar (CCS %) was determined by as per the method described by Meady and Chen (1997).

$$CCS\ \% = 3/2\ (1-\frac{F+S}{100})\ -1/2\ B(1-\frac{F+3}{100})$$

Where S = Sucrose percent in juice
All the data collected were subjected to statistical analysis of Varian ANOVA and (L.S.D.) values to test the differences among the standard treatments means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Growth attributes

All the studied growth characters were greatly increased by all treatments with significant differences in most cases.

Regarding sugarcane varieties effect on cane length at all sampling dates and number of tillers/plant, number of internode/plant, leaf area index and cane diameter in both seasons, data in Table (2) show highly significant difference among sugarcane varieties for growth attributes. The Giza 9 variety produced the greatest values of all traits in the two seasons of study. This superiority can be mainly attributes to the increase in their number of tillers/plant and leaf area index and consequently increased photosynthesis by plant. These results are in agreement with those obtained by Nazir (2000) and Naqvi (2005).

Results recorded in Tables (3 and 4) revealed that cane length at four sampling dates, also, number of tillers/plant, number of internode/plant, leaf area index and cane diameter (cm) significantly increased by increasing the rate of nitrogen fertilizer (200 kg N/fed) in both growing seasons. The highest increases in these growth characters were obtained by application of 200 kg N/fed. However, the lowest values were recorded by using 120 kg N/fed. It is evident that each increase in the rate of nitrogen fertilizer from 120 to 200 kg N/fed was accompanied by highly significant increased in all growth characters. Similar results were found by Wiedenfeld (1995) and Thorburn *et al.* (2005).

Different dates of nutrients show significant effect of all growth attributes during both seasons. However, the application of Zn +Fe produced the highest all growth attributes in both seasons. The findings of Khan *et al*. (1997) and Tunio *et al*. (2004) are in contrast with these results they reported that of the most micronutrient exhibited a positive of all growth attributes.

Tables (3 and 4) indicated that growth characters of sugarcane plants significantly affected by the nitrogenous fertilizer and micronutrients, as well as, their interactions.

Concerning the interaction effect, data in Tables (3 and 4) indicated that Giza 9 variety and application of 200 kg N/fed produced the highest cane length, number of tillers/plant, number of internode/plant, leaf area index and cane diameter (cm) in both seasons.

The results reported in Tables (3 and 4) indicated that the effective treatments for cane length of four sampling dates and number of tillers/plant, number of internode/plant, leaf area index and cane diameter were obtained from Giza 9 with foliar application of Zn +Fe treatment in both seasons.

Regarding the effect of interaction among sugarcane varieties, nitrogen fertilizer levels and micronutrients on all growth attributes characters in both seasons.

Table (2). Number of tillers/plant, Number of internode/plant, Leaf area index and Cane diameter as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	Number of tillers/plant		Number of internode/plant		Leaf area index		Cane diameter (cm)	
	2014	2015	2014	2015	2014	2015	2014	2015
A)Varieties								
Giza 9	4.76a	5.45a	20.30a	21.91a	8.53a	9.48a	2.47a	2.74a
Giza 47	4.20b	4.43b	18.36b	20.39b	8.07b	8.97b	2.38b	2.64b
Giza 49	3.46c	3.84c	16.24c	18.04c	7.25c	8.86c	2.26c	2.58c
LSD (0.05)	**0.42**	**0.48**	**1.02**	**1.04**	**0.40**	**0.45**	**0.05**	**0.04**
B)Nitrogen levels								
120	3.64c	4.01c	16.10c	17.88c	7.73c	8.53c	2.26c	2.51c
160	4.24b	4.70b	18.24b	20.28b	7.98b	8.87b	2.34b	2.62b
200	4.74a	5.28a	20.57a	22.18a	8.21a	9.11a	2.47a	2.75a
LSD (0.05)	**0.45**	**0.50**	**1.12**	**1.20**	**0.20**	**0.21**	**0.06**	**0.07**
C)Micronutrient								
Zn	3.68c	4.10c	15.71c	16.80c	7.13c	7.98c	2.21c	2.46c
Fe	4.17b	4.60b	18.12b	20.14b	7.92b	8.88b	2.34b	2.61b
Zn+Fe	4.67a	5.30a	21.06a	23.42a	8.88a	9.78a	2.60a	2.81a
LSD (0.05)	**0.45**	**0.48**	**1.15**	**1.30**	**0.60**	**0.70**	**0.09**	**0.11**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.

*: Significant at (0.05) probability level

Table (3). Cane length (cm) as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	2014				2015			
	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.
A)Varieties								
Giza 9	179.97a	200.13a	223.35a	247.17a	180.39a	210.70a	222.91a	241.04a
Giza 47	136.37c	151.16c	168.70c	186.86c	138.52c	173.35c	168.36c	187.08c
Giza 49	147.79b	165.07b	183.82b	203.78b	149.23b	187.09b	183.31b	203.41b
LSD (0.05)	**5.40**	**6.10**	**8.10**	**9.70**	**6.10**	**6.40**	**7.10**	**9.30**
B)Nitrogen levels								
120	140.24c	155.51c	173.08c	192.09c	141.15c	157.04c	173.39c	186.25c
160	155.97b	175.03b	192.92b	214.17b	156.79b	173.40b	192.30b	214.17b
200	169.31a	188.27a	209.41a	232.30a	170.29a	184.79a	208.10a	231.68a
LSD (0.05)	**4.70**	**5.20**	**7.10**	**10.20**	**5.01**	**5.60**	**6.80**	**9.80**
C)Micronutrient								
Zn	142.95c	158.84c	176.46c	195.99c	143.63c	158.82c	176.82c	189.73c
Fe	154.37b	172.57b	191.63b	213.12b	155.67b	171.28b	190.40b	211.82b
Zn+Fe	166.32a	186.40a	206.43a	250.69a	169.38a	186.60a	206.88a	230.47a
LSD (0.05)	**5.10**	**6.30**	**7.50**	**10.4**	**5.18**	**6.50**	**7.20**	**10.20**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.
*: Significant at (0.05) probability level
ns: not significant

Table (4). Interaction between three cultivars and N-levels on cane length (cm) at three sampling dates in 2014 and 2015 seasons.

Treatments		2014				2015			
Varieties	N-levels KgN/fed	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.
Giza 9	120	169.13	191.56	216.15	236.59	191.56	212.85	217.65	262.50
	160	180.60	203.14	226.13	250.80	202.72	226.70	250.67	285.55
	200	197.42	205.67	230.77	255.37	206.23	229.88	254.67	284.89
Giza 47	120	120.64	134.97	149.87	166.23	135.28	149.59	166.20	184.69
	160	138.37	152.45	169.14	188.83	152.46	167.70	186.03	209.44
	200	151.14	168.07	186.75	207.50	168.88	186.13	207.75	230.54
Giza 49	120	10.86	141.66	157.59	174.41	144.26	157.42	174.90	194.31
	160	148.34	148.50	183.16	203.53	164.82	182.78	203.50	226.11
	200	167.62	188.72	209.70	232.69	187.74	209.72	232.94	258.70
LSD (0.05)		**5.50**	**6.30**	**8.30**	**10.50**	**6.30**	**6.50**	**7.60**	**10.10**

B. Yield and Qualitative characters

Data in Tables (5 and 6) showed that Giza 9 variety was significantly superior in yield and Qualitative characters i.e. cane girth, cane yield, Brix percentage of TSS%, sucrose %, purity % and commercial sugar (CCS%) than the other two sugarcane varieties Giza 47, Giza 49 varieties. Differences in these traits among sugarcane varieties under study may be due to differences in their genetic make and to response to environmental factors affecting development processe and ability to uptake the available nutrients. These results are in harmony with those obtained by Sharma *et al.* (2002) and Wilson

and Leslie (1997).The obtained results given in Tables (5 and 6) showed, clearly, that nitrogen fertilizer levels exhibited significant effect on all estimated traits during the two cropping seasons of the study. Notably increasing nitrogen fertilizer level resulted in a significant increase in cane girth, cane yield (ton/ha), Birx percentage (TSS %), sucrose %, purity % and CCS%. These findings might be attributed to more adsorption of nutrition which reflect more growth substance more cell division and enlargement more tissues and organs and plant elongation. Also, the nitrogen fertilizer may increase the synthesis of endogenous phytohormones which cause the formation of big active root system which allow more nutrients uptake. The previous results agreed more or less with the findings obtained by Yadava (1991), Wiedenfeld (1995) and Pratop *et al.* (1996). Effect of Fe + Zn treatments on sugarcane are presented in Tables (5 and 6). Data cleared that application of all treatments caused marked increases in yield and qualitative characters. The highest values of cane girth, cane yield (ton/ha), Brix percentage (TSS %), sucrose %, Purity % and CCS % by foliar application of mixture Zn +Fe in both seasons. Similary, Dhanascharan and Bhuvaneswari (2004), noticed that Zinc and iron or in combination significantly increased Purity (%) of cane juice, sucrose (%) and Brix (TSS %). Similar results were obtained by Sharma *et al.* (2002) and Raskar and Bhai (2004).All first and second order interaction on yield and quality were significant in both seasons, Tables (5 and 6). Generally, Giza 9 variety with application of 200 kg N/fed and mixture of Zn +Fe treatment gave the best growth characters, yield and quality for sugarcane under Aswan conditions.

Table (5). Cane girth and cane yield (ton/ha) as affected by three varieties, nitrogen levels and micronutrients during 2014 and 2015 seasons.

Treatments	Cane girth (cm)		Cane yield (ton/ha)	
	2014	2015	2014	2015
A)Varieties				
Giza 9	2.35a	2.61a	163.32a	180.95a
Giza 47	2.15b	2.39b	151.46b	167.74b
Giza 49	2.09c	2.32c	137.15c	153.12c
LSD (0.05)	**0.04**	**0.06**	**9.40**	**9.60**
B)Nitrogen levels				
120	2.12c	2.29c	141.54c	153.59c
160	2.25b	2.44b	148.56b	165.96b
200	2.35a	2.60a	165.97a	187.11a
LSD (0.05)	**0.06**	**0.08**	**6.70**	**7.90**
C)Micronutrient				
Zn	2.10c	2.32c	138.22c	153.53c
Fe	2.19b	2.42b	149.54b	166.12b
Zn+Fe	2.32a	2.58a	164.84a	179.77a
LSD (0.05)	**0.07**	**0.08**	**8.90**	**8.50**
Interaction				
AxB	*	*	*	*
AxC	*	*	*	*
BxC	*	*	*	*
AxBxC	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.

*: Significant at (0.05) probability level

Table (6). Total soluble solids (TSS), Sucrose content and juice Purity (%) and Commercial cane sugar (CCS%) as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	Brix (TSS %)		Sucrose (%)		Purity (%)		Commerical cane sugar (CCS %)	
	2014	2015	2014	2015	2014	2015	2014	2015
A)Varieties								
Giza 9	20.14a	22.39a	13.70a	15.15a	77.62a	86.61a	12.25a	13.56a
Giza 47	18.13b	20.14b	13.44b	14.93b	60.56b	69.91b	11.89b	12.27b
Giza 49	16.29c	18.12c	12.73c	14.23c	52.30c	58.13c	9.62c	10.75c
LSD (0.05)	**1.02**	**1.10**	**0.50**	**0.45**	**7.10**	**9.50**	**0.50**	**0.60**
B)Nitrogen levels								
120	17.39c	19.33c	12.75c	14.17c	59.99c	66.26c	10.48c	11.59c
160	18.36b	20.45b	13.37b	14.82b	62.30b	71.27b	10.95b	12.23b
200	18.86a	20.98a	13.86a	15.33a	69.46a	76.27a	11.45a	12.77a
LSD (0.05)	**0.45**	**0.48**	**0.47**	**0.45**	**6.10**	**5.50**	**0.45**	**0.48**
C)Micronutrient								
Zn	17.88c	19.85c	12.39c	13.77c	65.51c	66.47c	10.52c	11.13c
Fe	18.20b	20.20b	13.23b	14.70b	63.91b	71.26b	10.96b	12.23b
Zn+Fe	18.54a	20.60a	14.39a	15.90a	66.56a	76.40a	11.97a	13.39a
LSD (0.05)	**ns**	**ns**	**0.70**	**0.80**	**ns**	**5.10**	**0.55**	**0.60**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	ns	ns	*	*	*	*	*	*
BxC	ns	ns	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.
*: Significant at (0.05) probability level
ns: not significant

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الملخص العربي

إستجابة بعض أصناف القصب للتسميد النتروجيني والعناصر الصغري علي الإنتاجية والجودة

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أجريت تجربتان في بالمزرعة البحثية بكلية الزراعة جامعة أسوان= مصر، خلال موسمي ٢٠١٤، ٢٠١٥ لدراسة إستجابة بعض أصناف قصب السكر للتسميد النيروجيني والعناصر الصغري علي الإنتاجية والجودة، صممت التجربة بإستحدام القطع المنشقة مرتين في ثلاث مكرارت.

ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١. أعطي الصف جيزة ٩ عند ٤ عينات أعلي طول لنبات القصب فقط وعدد الأفرع /نبات، عدد العقد/نبات، دليل المساحة الورقية، قطر قطر العود أيضاً، مصول العود(طن)، المواد الكلية الكلية، السكروز، النقاوة، القيمة الأقتصادية للسكر.

٢. إضافة التسميد النيتروجين عند معدل ٢٠٠ كجم نيتروجين/فدان أنتج معنوية لصفات الخضرية والمصول وجودة نباتات قصب السكر في كلا الموسمين.

٣. سجلت لأختلافات معنوية بين إضافة العناصر الصغري المختبرة للصفات الخضرية والمحصول وجودة قصب السكر.

٤. المعاملات المتأثرة لصفات الخضرية ، المحصول والجودة تحصل عليها من الصنف جيزة ٩ مع إضافة ٢٠٠ كجم نتروجين/فدان في كلا الموسمين.

٥. أعلي قيم لجميع الصفات لجميع الصفات الخضرية والمحصول والجودة تحصل عليها بواسطة أفضل نباتات قصب السكر جيزة ٩ مع إستخدام إضافة ٢٠٠ كجم نيتروجين/فدان وخليط من معاملات Zn +Fe.