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EFFECT OF SEED RATES AND NITROGEN FERTILIZATION LEVELS ON YIELD AND QUALITY OF SUGAR CANE

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ABSTRACT

Two field trails were carried out at El-Mattana Agricultural Research Station (Luxor Governorate) to study the performance of sugarcane G.84-47 variety grown as plant cane in 2008/2009 and 2009/2010 seasons and the 1st ratoon crops in 2009/2010 under two seed rates of 1.5 and 2.0 rows of cane cuttings (12600 and 16800) of three-budded cane cuttings, i.e. 37800 and 50400 buds/fed and three nitrogen fertilization levels of 150, 180 and 210 kg/fed, respectively. A split plot experimental design with four replications was used, where the main plots were assigned for seed rates while nitrogen levels were distributed in the sub plots.

The results showed that, seed rates differed significantly, where 50400 buds/fed recorded the highest values of stalk height, sucrose%, purity%, sugar recovery%, millable cane/fed, cane and sugar yields/fed in the plant cane and 1st ratoon crop, respectively. While, seed rate 37800 buds/fed recorded the highest values of stalk diameter, brix% and impurities% in the plant cane and 1st ratoon crops.

Increasing nitrogen fertilizer level up to 210 kg N/fed given to G.84-47 recorded the highest values of stalk height, number of millable cane/m^2 and cane yield, which increased sugar yield/fed. whereas, 180 kg N/fed recorded the highest mean values of stalk diameter, sucrose%, purity%, sugar recovery%.

The interaction between nitrogen levels 210 kg N/fed with 50400 buds/fed attained the highest mean values of cane and sugar yields (ton/fed) in the plant cane and 1st ratoon crop.

Under conditions of this work, adding 210 kg N/fed with seed rate 50400 buds/fed can be recommended to obtain the highest cane and sugar yields.

INTRODUCTION

Therefore this leads to save cane yield for sugar production and reduce the vast gab between sugar production and consumption which reached about 1.10 million ton. It is still imported annually **(**CCSC 2010). Crop density (number of drills of cane cuttings/furrow) and nitrogen fertilizer application rates could be the main environmental factors affecting sugarcane productivity and quality. Among all of agricultural factors, crop density number of cane cuttings/unit area and nitrogen fertilizer application levels can be considered the main environmental factors affecting sugarcane productivity and quality. Many investigators reported that cane yield increase when seeding rate increases to an optimum levels. El-Sogheir (1999) and Ahmed (2003) found that differed significantly in stalk length, diameter, number of millable cane/m^2 and cane and sugar yields/fed. While, sucrose%, purity% and sugar recovery% were insignificantly affected between three seeding rates of 25200, 37800 and 50400 buds/fed (1.0, 1.5 and 2.0 drill of cane seets). Drilling two rows of cane cutting exceeded the other two seed rate in stalk length, sugar recovery%, cane and sugar yields/fed. Avtar (2000), Garside *et al.* (2002) and Shahid *et al.* (2002) planted sugarcane at (27000, 50000, 62500, 70000, 75000 and 81000) double and/or three-budded setts/ha showed the highest cane (73.41 and 72.63 t/ha) and sugar (10.17 and 10.1 t/ha) yields with dense planting. El-Sogheir and Mohamed (2003), El-Geddawy *et al.* (2005) and Ismail *et al*. (2008) indicated that the highest seed rate of sugar cane (50400 buds/fed) gave the highest values of number of millable cane/fed, stalk height, brix%, sucrose%, sugar recovery%, cane and sugar yields/fed compared with the other seeding rates (25200 and 37800 buds/fed). Hasan *et al.* (2009) found that differed significantly in stalk height, diameter, brix%, sucrose%, reducing sugars%, sugar recovery%, millable cane yield/fed and recoverable sugar yield/fed between three seeding rates (1.5, 2.0 and 2.5 drills/fed) in both seasons and their combined, except purity% in the 1st season.

Nitrogen has pronounced effects on growth and physiological processes of sugar cane, even to the extent of causing large changes in the physiological and chemical traits of yields at harvest. Quality is a combination of all chemical and physical aspects of sugar cane which influence processing and hence yields of sugar and its product (Oldfield *et al.* 1979). Regarding the effect of nitrogen fertilizer levels, Babu *et al.* (2000) and Mahender *et al.* (2002) fertilized sugarcane with N rates of 75, 100, 125, and 150 % of the recommended dose (150 and 168 kg/ha). They found that produced higher cane yields (119.3 t/ha) with the application of 125 and 150% of the recommended N dose. Azzazy and El-Ham (2000), Shafshak *et al.* (2001), Ahmed (2003), Azzazy and El-Geddawy (2003) and Osman *et al.* (2004) found that application of 210 kg N/fed produced the highest values of stalk height, diameter, leaf area, number of millable cane/m^2, sucrose%, purity%, sugar recovery%, cane and sugar yields/fed, compared with the other application levels (120, 150 and 180 kg/fed), while, the application of 240 kg N/fed, gave the highest values of reducing sugars% and brix%. Azzazy *et al.* (2000) and Azzazy *et al*. (2005) they stated that there was a significant and gradual increases in stalk height, diameter, cane and sugar yields as N level were increased from 180 to 210 kg/fed for 1st and 2nd ratoons. While, sucrose%, purity% and sugar recovery% were statistically and negatively affected by increasing, N level 240 kg/fed in the 2nd ratoon only. Srinivas *et al.* (2003) and Patel *et al.* (2004) applied nitrogen fertilizer (0, 200, 250, 300 and 350 kg N/ha) to sugarcane. They reported that the increase in N rate 300 kg/ha resulted in the increase of millable cane length, number of shoots, number of millable canes, cane yield and sugar yield. Ismail *et al*. (2008) and El-Sogheir and Ferweez (2009) fertilized sugar cane with three nitrogen fertilization levels (186, 232.5 and 279 kg N/fed represent 8, 10 and 12 bags of Urea, 46.5% N). They found that increasing N levels up to 279 kg N/fed significantly increased number of millable cane, cane and sugar yields/fed in the plant cane and 1st ratoon crops, stalk diameter only in 1st ratoon crops, however, sucrose%, purity% and sugar recovery% were decreased, over the other two N levels. Ahmed *et al*. (2009) and Osman *et al.* (2010) found that increasing nitrogen fertilizer levels from 160 up to 240 kg/fed recorded the highest values of stalk length, diameter, number of millable cane/m^2, brix%, reducing sugars%, as well as, cane and sugar yields/fed. While, decreased significantly sucrose%, purity%, pol% and sugar recovery%.

The present study aimed at finding out the optimum seed rates and nitrogen levels to obtain the highest yields under El-Mattana representing the main area for growing sugar cane in Upper Egypt.

MATERIALS AND METHODS

Two field trails were carried out at El-Mattana Agricultural Research Station (Luxor Governorate) to study the performance of sugarcane G.84-47 variety grown as plant cane in 2008/2009 and 2009/2010 seasons and the 1st ratoon crops in 2009/2010 under two seed rates of 1.5 and 2.0 rows of cane cuttings (12600 and 16800) of three-budded cane cuttings, i.e. 37800 and 50400 buds/fed and three nitrogen fertilization levels of 150, 180 and 210 kg/fed, respectively. A split plot experimental design with four replications was used, where the main plots were assigned for seed rates while nitrogen levels were distributed in the sub plots. Plot area was 42 m^2, including 6 ridges of 1 m apart and 7 m long. The soil was fallow before planting sugarcane crop. Plant cane was planted in the 1st week of March and 1st ratoon crop raised in the 1st week of March. Both plant cane and 1st ratoon crop were harvested at age of twelve months. Soil physical and chemical properties of the experimental site were determined according to Jakson (1967) as shown in Table 1.

Table 1: Soil physical and chemical properties of the experimental site at El-Mattana

Particle size %			Soil texture	**E.C.ds/m	Soil pH*	Organic matter %	CaCO3 %
Sand	Silt	Clay	clay loam				
33.6	32.4	34.0		0.6	7.8	1.22	1.18

Soluble Cations (meq/L)				Soluble anions(meq/L)				Total available contents (ppm)		
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO3^{--}$	$HCO3^{-}$	Cl^{-}	$SO4^{--}$	N	P	K
2.2	2.1	2.1	0.2	0.2	1.8	2.0	2.6	12.1	5.20	320.0

***pH was measured in a soil – water suspension (1: 2.5).**
****EC = Electrical conductivity was measured in a soil – water extract (1: 5)**

Recommended NPK fertilizers were added at rates of 210 kg N (as urea 46.5% N/fed), 30 kg P_2O_5 (as calcium superphosphate 15.5% P_2O_5/fed) and 24 kg K_2O (as potassium sulfate 48% K_2O/fed). Nitrogen and potassium fertilizers were added in two equal doses. In the plant cane, the 1st N and potassium doses were applied two months after planting preceded with hoeing. In the 1st ratoon, the 1st N-dose and potassium were added one after month from harvesting the plant cane and after furrowing (ditching between rows of sugarcane) and earthing-up. The 2nd dose were added one month after the 1st one, for both cane crops. Phosphorus fertilizers was applied during seed bed preparation. The other agricultural practices were followed as recommended by Sugar Crops Research Institute.

Recorded data:

1. Vegetative characters: at harvest, a sample of 10 millable canes from each sub plot was taken at random and the following data were recorded:

1. Stalk height (cm), which measured from soil surface to the top point of visible dewlap.
2. Stalk diameter, which was measured at the middle part of stalk.

II. Cane and sugar yields (ton/fed): Each sub plot was harvested, topped and cleaned from trash, weighed to estimate the following characters:

1. Cane yield (tons/fed) was calculated.
2. Sugar yield (tons/fed) was estimated according to the following equation:
   Raw sugar yield (ton/fed) = cane yield (ton/fed) x sugar recovery%.
3. Number of millable canes/fed were counted.

III. Juice quality traits: a sample of 20 millable cane stalks was collected immediately after harvest, stripped and squeezed then juice was extracted using 3- rool lab mill, filtrated and weighed to determine the following quality traits as described by A.O.A.C. (2005): Juice extraction%, was calculated using the following equation: Juice extraction% = juice weight x 100/stalk weight. Juice extraction% about 58-60% from cane weight.

1. Brix% was determined using, Brix Hydrometer standardized at 20^{o}C.
2. Sucrose%, was determined using "Saccharemeter" according to A.O.A.C. (2005).
3. Purity%, was calculated as follows:

Purity% = sucrose% / brix% x 100, where: brix%, was determined using brix Hydrometer standardized at 20 C^{0}.

4. Impurities%, i.e. sodium and potassium were determined using "Flame Photometer" as described by Page (1982). α-amino nitrogen was determined according to the method of Carruthers *et al*. (1962).
5. Sugar recovery%, was calculated according to Yadav and Sharma (1980).

Sugar recovery% = {Sucrose - 0.4 (brix – sucrose) 0.73}.

Data were statistically analyzed according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSION

Effect of seed rates.

The obtained results in Table 2 showed that seed rates had a significant influence on stalk height, diameter, brix%, sucrose%, purity%, sugar recovery%, millable canes/fed, cane yield, sugar yield and impurities%, i.e. nitrogen, sodium and potassium% in plant cane in both seasons and 1st ratoon crops.

Planting sugar cane using 50400 buds/fed recorded higher mean values of stalk height, sucrose%, purity%, sugar recovery%, millable canes/fed, cane and sugar yields/fed in plant cane and 1st ratoon crop compared with 37800 buds/fed. On the contrary, 37800 buds/fed led to higher mean values of stalk diameter, brix% and impurities% i.e. nitrogen%, sodium% and potassium% in plant cane in both seasons and 1st ratoon crop over those given by 50400 buds/fed. The increase in cane yield was strongly related to the higher number of millable canes/fed and stalk performance, i.e. stalk height at harvest. These results clearly indicate that cane yield/fed was governed by stalk weight rather than stalk diameter. The number of millable canes/fed played also a role in the expected cane yields/fed. Moreover, the increase in cane yields/fed was not on the expense of sucrose accumulation, sugar recovery% and hence sugar yields/fed which followed the same trend of cane yields/fed. This intensive competition was compared by a sufficient increase in number of miilable cane in plant cane in both seasons and 1st ratoon and hence could account for the increase of both cane and sugar yields/fed.

Table 2: Effect of seed rates on growth, quality traits and yields at harvest.

Seed rate	Stalk traits		Quality traits				No. of	Yields		Impurities		
No. of buds/fed	SH	SD	Brix	Suc%	Pur%	SR%	MC	CY	SY	N	Na	K
Plant cane (2008/2009 1st season)												
37800	268.15	3.25	22.64	17.56	77.56	11.13	42.10	44.33	4.93	1.40	0.780	2.45
50400	273.16	3.10	21.25	18.11	85.22	12.46	43.17	45.75	5.70	1.37	0.745	2.16
F. test	*	*	*	*	*	*	*	*	*	*	*	*
Plant cane (2009/2010 2nd season)												
37800	271.10	3.27	22.95	17.37	75.69	11.15	38.15	40.75	4.54	1.42	0.785	2.34
50400	278.15	3.05	21.85	18.35	83.98	11.85	45.16	47.33	5.61	1.25	0.775	2.18
F. test	*	*	*	*	*	*	*	*	*	*	*	*
1st ratoon cane (2009/2010 1st ratoon season)												
37800	257.19	3.02	22.82	17.41	76.29	10.39	39.19	44.74	4.65	1.96	0.718	3.12
50400	265.12	2.94	21.36	18.18	85.11	11.76	41.15	45.85	5.39	1.73	0.682	2.95
F. test	*	*	*	*	*	*	*	*	*	*	*	*

SH = stalk height (cm), SD = stalk diameter (cm), Suc% = sucrose%, SR% = sugar recovery%, Pur% = purity%, MC = No. of millable cane/fed, CY = cane yields (ton/fed), SY = sugar yields (ton/fed), N% = nitrogen%, Na% = sodium%, K% = potassium%.

Seed rates differences in the recorded traits could be attributed to the different response and competition among different number of cane plants emerged as a result of using different number of planting materials, i.e. different number of cane cuttings and bud/fed. The increase of stalk height could be attributed to a possible increase in the proportion of invisible solar radiation caused by mutual shading (Chang 1974). The increase of stalk diameter in case of using lower number of planting materials (37800 buds/fed) may be attributed to the great inter-plant competition for light and nutrients as well as mutual shading in case of higher seeding rate (50400 buds/fed). These radations have an effect on brix%, sucrose%, sugar recovery% and purity% (Chang 1974). These findings coincide with those reported by Ahmed (2003) and Ismail *et al*. (2008).

II. Effect of nitrogen fertilization levels:

Results in Table 3 revealed that the applied nitrogen levels differed significantly in their effect on stalk height, diameter, brix%, sucrose%, purity%, sugar recovery%, number of millable canes/fed, cane, sugar yields/fed and impurities%, i.e. nitrogen, sodium and potassium% in plant cane and 1st ratoon crops.

Adding 150 kg N/fed recorded the highest averages of brix% and impurities% whereas, adding 180 kg N/fed recorded the highest averages of stalk diameter, sucrose%, purity% and sugar recovery%. Application of 210 kg N/fed recorded the highest averages of stalk height, number of millable canes/fed and sugar yields/fed in the plant cane in both seasons and 1st ratoon crops. These results may be due to the role of nitrogen in building up plant organs through the synthesis of proteins. Moreover, integral is an part of the chlorophyll molecule and is conductive for higher sugar accumulation through its role in the photosynthesis process. The increase in cane yield was probably related to the higher number of millable canes/fed and stalk performance, i.e. stalk height and diameter at harvest. The increase in sugar yield may be due to that application of 180 kg N/fed was superior, also, for cane yield and quality traits, i.e. sucrose and sugar recovery%. These findings coincide with those Azzazy *et al*. (2005) and Ismail *et al*. (2008).

Table 3: Effect of nitrogen levels on growth, quality traits and yields at harvest.

Nitrogen kg N/fed Levels	Stalk traits		Quality traits				No. of MC	Yields		Impurities		
	SH	SD	Brix%	S%	Pur%	SR%		CY	SY	N%	Na%	K%
Plant cane (2008/2009 1st season)												
150	272.17	3.06	22.46	16.16	71.95	11.60	41.45	44.00	5.10	1.51	0.795	2.47
180	278.18	3.30	22.00	19.13	86.95	12.05	42.12	44.70	5.39	1.43	0.772	2.25
210	288.15	3.21	22.37	18.16	81.18	11.74	44.17	46.91	5.51	1.46	0.784	2.36
LSD at 5%	1.15	0.05	0.07	0.01	0.12	0.09	0.03	0.85	0.11	0.01	0.001	0.01
Plant cane (2009/2010 2nd season)												
150	270.16	2.89	22.82	16.25	71.21	11.33	41.15	43.20	4.78	1.36	0.710	2.51
180	281.15	3.10	22.10	19.72	89.23	11.70	43.93	45.50	5.32	1.31	0.674	2.32
210	301.14	2.96	22.45	18.74	83.47	11.14	45.75	47.90	5.34	1.33	0.689	2.43
LSD at 5%	1.15	0.04	0.20	0.12	0.88	0.10	0.95	0.85	0.09	0.02	0.002	0.02
1st ratoon cane (2009/2010 1st ratoon season)												
150	260.10	2.87	22.59	17.19	76.10	10.93	41.85	44.73	4.89	2.03	0.812	3.10
180	270.17	3.00	21.75	18.90	86.90	11.07	42.00	44.74	4.95	1.76	0.764	2.23
210	276.18	2.97	22.46	16.90	75.24	11.23	44.95	47.43	5.33	1.93	0.796	2.81
LSD at 5%	0.12	0.01	0.09	0.15	0.25	0.02	1.07	1.15	0.16	0.02	0.001	0.02

SH = stalk height (cm), SD = stalk diameter (cm), Suc% = sucrose%, SR% = sugar recovery%, Pur% = purity%, MC = No. of millable cane/fed, CY = cane yields (ton/fed), SY = sugar yields (ton/fed), N% = nitrogen%, Na% = sodium%, K% = potassium%.

Interactions effects:

Results in Table 4 showed that the interaction effect between seed rates and nitrogen levels significantly differed on sugar recovery%, cane and sugar yields/fed in the 1st plant cane and 1st ratoon crops. The highest mean value of sugar recovery% was obtained by the application of 180 kg N/fed and planting sugar cane by 50400 buds/fed. Using 50400 buds/fed for planting sugarcane with the application of 210 kg N/fed recorded the highest cane and sugar yields/fed.

Table 4: Interaction effect between seed rates x nitrogen levels on quality and yields at harvest.

Plant cane (2008/2009 1st season)									
Nitrogen	**Sugar recovery%**			**Cane yield (tons/fed)**			**Sugar yield (tons/fed)**		
Levels x	**Nitrogen fertilization levels (kg/fed)**								
Seed rates	**150**	**180**	**210**	**150**	**180**	**210**	**150**	**180**	**210**
37800	11.00	11.27	11.13	43.00	44.15	45.83	4.73	4.98	5.10
50400	12.20	12.83	12.35	45.00	45.25	48.00	5.49	5.81	5.93
LSD at 5%	0.46			0.75			0.29		
1st ratoon cane (2009/2010 1st ratoon season)									
37800	10.33	10.48	10.35	43.35	44.27	46.61	4.48	4.64	4.82
50400	11.53	11.65	12.10	44.10	45.20	48.24	5.08	5.27	5.84
LSD at 5%	0.38			0.69			0.25		

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تاثير معدل التقاوى ومستويات التسميد النيتروجينى على محصول وجودة قصب السكر.

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معهد بحوث المحاصيل السكرية - مركز البحوث الزراعية - جمهورية مصر العربية

أقيمت تجربتان حقليتان بمحطة بحوث المطاعنة بمحافظة الاقصر خلال ٢٠٠٩/٢٠٠٨ و٢٠١٠/٢٠٠٩ (كقصب غرس) و٢٠١٠/٢٠٠٩ (كخلفة اولى) لدراسة تأثير معدلين للتقاوى (٣٧٨٠٠ و ٥٠٤٠٠ برعم/فدان) وثلاث مستويات من التسميد النيتروجينى (١٥٠ ، ١٨٠ و٢١٠ كجم ن/فدان) على محصول الغرس والخلفة الاولى للصناف جيزة ٨٤-٤٧. إستخدم تصميم القطع المنشقة مرة واحدة فى اربع مكررات حيث وزع معدلى التقاوى فى القطع الرئيسية ووزعت مستويات التسميد النيتروجينى فى القطع الشقية. اوضحت النتائج ما يلى:

- اختلفت معدلى التقاوى معنويا فى تاثيرهما على ارتفاع الساق وقطره وعدد العيدان القابلة للعصير/فدان و%للبركس و%للسكروز و%لناتج السكر و%للنقاوة ومحصولى العيدان والسكر/للفدان و%للشوائب (نيتروجين–صوديوم–بوتاسيوم). - أدت زيادة معدل التقاوى الى ٥٠٤٠٠ برعم/فدان الى زيادة ارتفاع الساق وعدد العيدان القابلة للعصير/فدان و%للسكروز و%لناتج السكر و% للنقاوة ومحصولى العيدان والسكر بينما تفوق المعدل الاقل ٣٧٨٠٠ برعم/فدان فى القطر و%للبركس و%للشوائب.
- ادت زيادة مستوى التسميد النيتروجينى الى ٢١٠ كجم/فدان الى زيادة ارتفاع الساق وعدد العيدان القابلة للعصير ومحصولى العيدان والسكر/للفدان. بينما ادت اضافة ١٨٠ كجم/فدان الى الحصول على اعلى قيم لقطر الساق و%للسكروز و%للنقاوة و%لناتج السكر فى محصولى الغرس والخلفة الاولى على التوالى.
- كان التفاعل بين معدلى التقاوى ومستويات التسميد الازوتى تاثيرا معنويا على النسبة المئوية لناتج السكر ومحصولى العيدان والسكر فى الموسم الاول للقصب الغرس والخلفة الاولى.
- يمكن التوصية بزراعة الصنف جيزة ٨٤-٤٧ بالمطاعنة بمعدل تقاوى ٥٠٤٠٠ برعم/فدان مسمدا باضافة ١٨٠ كجم/ن للفدان للقصب الغرس و٢١٠ كجم ن/للفدان للخلفة الاولى للحصول على أعلى محصول عيدان وسكر.

قام بتحكيم البحث

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