

RESPONSES OF SOME SUGARCANE VARIETES TO APPLIED OF ETHREL RIPENER ON QUALITY AND PRODUCTIVITY.

ABSTRACT

The study was conducted at the Agricultural Research Station in Shandaweel, Sohag Governorate, Egypt. (latitude of 26.33° N and longitude of 31.41° E) in 2020/2021 and 2021/2022 seasons, to evaluate the effect of three concentrations of the chemical ripener "Ethrel" (0.6, 0.8 and 1.0 liter/fed) sprayed on the leaves, in addition to control treatment (without spraying) on yield and quality of two sugarcane varieties [the commercial variety (G.T. 54-9) and the promising one (G. 2004-27) in addition to (G. 2005-47) genotype]. A randomized complete block design was used in a split-plot arrangement was used. The results showed that sugarcane varieties differed markedly in all studied traits. G.T. 54-9 variety superior in stalk diameter and sugar yield/fed in both seasons as well as cane yield/fed in the 1st one, while, G.2004-27 variety recorded the highest stalk and most number of millable canes/fed in both seasons as well as cane yield/fed in the 1st season, and the other hand, G.2005-47 genotype was superior in brix, sucrose, purity and sugar recovery% in both seasons. Results showed that adding 1.0 liter/fed from Ethrel spray to cane leaves caused an increase in brix, sucrose, purity and sugar recovery% as well as sugar yield/fed compared to untreated treatment (control). On the contrary, the treatments with Ethrel concentrations led to a decrease the height and diameter of the stalk as well as cane yield. However, the increase (%) in quality and sugar yield was more than the decrease in cane yield. Therefore, Ethrel added led to an increase in quality and sugar yield with higher concentrations of Ethrel. 1.0 liter/fed "E3". Under conditions of this work, it was found that growing all studied sugarcane varieties and sprayed by 1.0 l/fed of Ethrel ripener can be recommended to get the maximum production of sugar.

Key word: Chemical ripener, Sugarcane varieties, Ethrel, Cane yield.

INTRODUCTION

Sugarcane ripening is the process of sucrose accumulation in stalk, sugar productivity is affected significantly by cane yield and quality traits at harvest. Improving sugar

yield is the ultimate goal of sugarcane researchers all over the world. Many researchers are currently seeking to genetically modify sugarcane varieties that give a high yield of millable cane to increase their sucrose content so to increase the economic return of its cultivation.

In Egypt, the commercial cane variety 'G.T.54-9' occupies most of the area planted with sugarcane (**Sugar Crops Council, annual report 2022**). Although many studies showed an improvement in juice quality of some sugarcane varieties in the past, however, the emergence of new sugarcane varieties necessitated work of studies that provide modern information, so this study was conducted to evaluate sugarcane varieties for chemical ripener under local conditions of Sohag Governorate. Recently, Sugar Crops Research Institute produced many promising varieties of sugarcane, most prominent of which is G.2004-27 variety, which is characterized by high production of cane yield, but it is slightly lower than the commercial cane variety 'G.T.54-9' in sucrose% content. From this point of view, this work was conducted with the aim of increasing the sugar content of this variety and other varieties grown in the experiment. In this respect, many studies and researches were carried out to evaluate sugarcane varieties for productivity and juice quality traits and significant variables among varieties were reported by **El-Geddawy, et al. (2012); Makhoulf et al. (2016); El-Bakry, (2018); Gadallah and Mehareb(2020); Ali et al. (2022)** and **Hussein et al. (2023)**

Some countries are currently pursuing use of chemical compound spray as ripeners to increase the concentration of sucrose in cane. One of these compounds is Ethrel (active substance is isophane), which is used in horticultural cultivations to ripen many fruits. As for using it as a ripener on canes, when it is sprayed on the plant, ethylene is released to help increase the storage of sucrose because ethylene is one of the ripening hormones in the plant. Ethrel has been used as a means of accelerating maturation and increasing sugar content of sugarcane cv. Adding ethrel as a chemical ripener primarily aims to enhance the quality of juice, raise its sucrose content, and consequently boost the output of sugar. Numerous investigations and studies have demonstrated that using chemical ripeners on sugarcane improves the quality of the juice and increases sugar yield, including **Leite, et al.(2009); Al-Mubarak and Al-Chalabi(2011); Abo-El-Hamd et al. (2013) ; Van Heerden et al. (2015) and Ayele et al. (2021)**, who discovered how sugarcane responded to chemical ripeners added to it to raise its sugar content.

Thus, the goal of this study was to determine which sugarcane cultivars yielded the highest sugar content and how they responded to Ethrel as a chemical ripener. It also sought to understand how artificial ripeners like Ethrel affected the ripening process or sucrose accumulation during sugarcane harvest, which would be essential knowledge for the farmers in figuring out when to harvest.

MATERIALS AND METHODS

Field experiment was conducted at Shandaweel Agricultural Research Station (latitude of 26.33° N, longitude of 31.41° E and altitude of 69m), Sohag Governorate, Egypt in 2020/2021 and 2021/2022 seasons. Experiment contained of 12 treatments that represented combinations among three sugarcane varieties were G.T. 54-9, known as C9 (the commercial variety). The promising one (G. 2004-27), commonly known as G4 and (G. 2005-47) genotype and spraying by concentrations chemical ripener (Ethrel "480 g/l. ethephon") were 1- Ethrel₁ "E₁" at 0.6 liter/fed. 2- Ethrel₂ "E₂" at 0.8 liter/fed. 3- Ethrel₃ "E₃" at 1.0 liter/fed in addition to 4-control (without sprayed). A split plot design with three replications was used. The main plots were devoted to sugarcane varieties, while, chemical ripener treatments were distributed in the sub plots, in both seasons. Sugarcane planting was carried out by seed-cutting in last week of March and harvested after 12 months in both seasons. The optimum application date was in late the nine month of planting, so as not to effect of cane yield; Ethrel was sprayed on cane plants using a knapsack sprayer, when spraying, the chemical ripener was mixed with 600 liters of water/fed and spraying was done in the early morning when the wind was calm. Plot area was 21 m² with 5 ridges of 1.2 m a part to allow passage during spraying and 3.5 m length (1/200 from feddan), each experimental piece separated by tow meters between them for ease of spraying. Fertilizers were applied at rate of 210 kg N, was added as urea (46.5% N) was divided into two equal in both seasons after 60 and 90 days from planting (after the 1st and 2nd hoeing, *i.e.*). Phosphorus fertilizer, at a rate of 30 kg P₂O₅/fed as calcium super phosphate (15.5% P₂O₅) was added once during seed-bed preparation. Potassium fertilization at rate of 48 Kg/fed as potassium sulphate (48% K₂O) was added once with the 2nd dose of N fertilizer. The other agricultural practices were done as recommended by Sugar Crops Research Institute, A.R.C.

At harvest (12 months after planting), data were recorded on 15 main stalks taken at random of each sup-plot. The following measurements were taken: Stalk length (cm)

was measured from soil surface to the top visible dewlap, stalk diameter (cm) was measured at the middle part of stalks. On the other hand a sample of 20 millable canes was taken at each harvest cutting for each experimental sub-plot to be analyzed for juice quality. Sugar traits were determined according to the methods described by **A.O.A.O (2005)**. Which is Brix% (total soluble solids of juice) by using a “Brix Hydrometer” according to the method described by "The Chemical Control Lab" of Sugar and Integrated Industries Company (**Anonymous, 1981**). Sucrose% using a “Scracometer”, according to (**A.O.A.C. 2005**). Purity% according to the formula = (sucrose% cm/ brix%) x 100. Sugar recovery% was calculated according to (**Yadav and Sharma 1980**) as follows: Sugar recovery% = [sucrose% - 0.4(brix% - sucrose %) × 0.73]. Quality parameters were used to estimate the sugar% sugarcane, which in turn was used to calculate the sugar yield/fed, sugar yield (tons/fed) was estimated according to the following equation: sugar yield (ton/fed) = (cane yield (ton/fed.) x sugar recovery %/100. Cane yield (tons/fed) was estimated from the middle rows which was converted into tons/fed.

The soil of the experimental area was sand clay loam (21.5 and 21.7% sand), (29.3 and 28.8 % silt) and (49.2 and 49.5 % clay), and contained (N: 94 and 110), (P: 18 and 19) and (K: 917 and 950) ppm available N, P, K with pH 7.55 and 7.60, in both seasons respectively.

The collected data were statistically analyzed according to (**Gomez and Gomez 1984**) using the computer "MSTAT-C" statistical analysis package described by (**Freed, et al. 1989**). The least significant differences (LSD) at 0.05 level of probability were calculated to compare the differences among means of treatments according to (**Snedecor and Cochran 1981**).

RESULTS AND DISCUSSION

1. Stalk height, diameter and number of millable cane

Data in table (1) cleared that the tested varieties differed significantly with respect to stalk height, diameter and number of millable cane. Promising G. 2004-27 variety exhibited the superiority in stalk height and number of millable cane/fed greater followed by commercial sugarcane variety G.T.54-9 compared to G. 2005-47 genotype, which recorded shortest stalk in both seasons, while, the commercial variety G.T.54-9 had the widest thickness of cane stalk, in both seasons. The variance between the two cane varieties in this trait may be due to their gene make-up. These findings are

in line with those reported by **El-Bakry, (2018);Gadallah and Mehareb, (2020); Ali et al. (2022)**and **Hussein et al. (2023)**.

The results also pointed out that cane stalk highest was markedly affected by the used Ethrelripen concentrations in both seasons, however, the mean value of stalk diameter and number of millable cane had significantly affected only in the 2nd season. Sup-plots that did not receive any application Ethrelripen concentration (unsprayed) had the tallest, thickness plants and number of millable cane. The decrease in stalk height when sprayed by Ethrel probably due to the reduction of internode elongation of cane stalk resulted from inhibiting of gibberellic acid GA20 to GA1 conversion process within stalk (**van Heerden et al 2015**). These results are in harmony with those found by **Leite, et al. (2009); Al-Mubarak and Al-Chalabi (2011); Abo-El-Hamd et al. (2013) ;Van Heerden et al. (2015) and Ayele et al. (2021)**,

The results cleared the mean values of number of millable cane was insignificantly affected by the interaction between sugarcane varieties and Ethrel treatments in the 1st and 2nd season, while, The mean values of stalk length and its diameter were significantly affected in the 2nd season only.

Table 1: The impact of Sugarcane varieties, Ethrelripen, and their interactions on stalk length, diameter and number of millable cane in 2021/2022 and 2022/2023 seasons

Treatments	Stalk highest (cm)		Stalk diameter (cm)		No. of Millable cane (1000/fed)		
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	
Sugarcane varieties (A)							
G.T. 54-9	308.7	304.6	2.58	2.52	41.525	42.516	
G. 2005-47	294.7	290.0	2.54	2.48	40.242	40.553	
G. 2004/27	313.3	309.5	2.57	2.50	41.675	42.630	
LSD at 0.5 level	2.3	2.8	0.02	0.02	0.397	0.180	
Ethrelripen concentrations (B)							
Control	309.6	309.7	2.57	2.54	41.228	42.219	
0.6 L/fed (E1)	307.2	304.7	2.56	2.51	41.142	41.935	
0.8 L/fed (E2)	305.0	299.1	2.56	2.49	41.178	41.768	
1.0 L/fed (E3)	300.3	292.0	2.55	2.46	41.041	41.678	
LSD at 0.5 level	2.0	2.6	NS	0.01	NS	0.190	
Interactions (A x B)							
G.T. 54-9	Control	313.3	313.3	2.59	2.56	41.573	42.767
	0.6 L/fed (E1)	310.3	309.0	2.58	2.53	41.510	42.443
	0.8 L/fed (E2)	307.3	298.7	2.57	2.51	41.513	42.383
	1.0 L/fed (E3)	303.7	297.3	2.57	2.48	41.380	42.230
G. 2005-47	Control	297.7	296.7	2.55	2.52	40.237	40.883
	0.6 L/fed (E1)	297.3	292.7	2.55	2.50	40.220	40.634
	0.8 L/fed (E2)	295.3	290.3	2.55	2.47	40.270	40.400
	1.0 L/fed (E3)	288.3	280.3	2.50	2.44	40.240	40.297

G. 2004/27	Control	317.7	319.0	2.56	2.53	41.873	43.007
	0.6 L/fed (E1)	314.0	312.3	2.57	2.49	41.697	42.727
	0.8 L/fed (E2)	312.3	308.3	2.57	2.49	41.750	42.520
	1.0 L/fed (E3)	309.0	298.3	2.57	2.46	41.503	42.507
LSD at 0.5 level		NS	2.8	NS	0.02	NS	NS

2. Juice quality traits

The tested sugarcane varieties differed markedly in quality traits (brix, sucrose, purity and sugar recovery%). The results in Table (2), manifested that G.2005- 47 sugarcane genotype had the highest values of all quality traits. On the contrary, variety G.2004-27 recorded the lowest values in both seasons. It was noted from same table that the difference between G.T.54/9 and/or G.2005/47 is less than 1% in sugar recovery%. The differences between the studied varieties in quality may be due to the variations among varieties in gene make-up. These results are in accordance with that obtained by **El-Bakry, (2018); Gadallah and Mehareb, (2020); Ali et al. (2022) and Hussein et al. (2023).**

Table 2: The impact of Sugarcane varieties, Ethrelripeners, and their interactions on the percentages of brix, sucrose, purity, and sugar recovery in 2021/2022 and 2022/2023 seasons

Treatments	Brix %		Sucrose %		Purity %		Sugar recovery %		
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	
Sugarcane varieties (A)									
G.T. 54-9	21.28	23.12	18.21	19.79	85.58	85.62	11.67	12.61	
G. 2005-47	22.78	23.34	19.52	20.04	85.70	85.87	12.46	12.79	
G. 2004/27	20.58	21.46	17.17	17.90	83.42	83.40	10.75	11.17	
LSD at 0.5 level	0.12	0.23	0.12	0.21	0.15	0.14	0.09	0.13	
Ethrelripeners concentrations (B)									
Control	21.03	21.76	17.65	18.30	83.89	84.03	11.10	11.50	
0.6 L/fed (E1)	21.21	22.70	18.03	19.27	84.97	84.86	11.47	12.19	
0.8 L/fed (E2)	21.96	22.68	18.74	19.41	85.32	85.53	11.95	12.37	
1.0 L/fed (E3)	21.97	23.41	18.78	20.01	85.42	85.43	11.98	12.71	
LSD at 0.5 level	0.07	0.17	0.09	0.16	0.20	0.13	0.08	0.11	
Interactions (A x B)									
G.T. 54-9	Control	20.80	22.67	17.55	19.07	84.40	84.12	11.11	11.95
	0.6 L/fed (E1)	20.88	22.79	17.81	19.47	85.29	85.41	11.39	12.38
	0.8 L/fed (E2)	21.48	22.97	18.52	19.92	86.25	86.73	11.95	12.86
	1.0 L/fed (E3)	21.95	24.04	18.96	20.72	86.36	86.22	12.33	13.25
G. 2005-47	Control	22.09	22.18	18.75	18.93	84.87	85.33	11.88	12.05
	0.6 L/fed (E1)	22.38	23.27	19.21	20.06	85.85	85.85	12.30	12.85
	0.8 L/fed (E2)	23.13	23.63	19.89	20.29	85.99	86.19	12.72	12.93
	1.0 L/fed (E3)	23.50	24.27	20.22	20.90	86.07	86.11	12.93	13.33
G. 2004/27	Control	20.21	20.44	16.65	16.89	82.39	82.64	10.31	10.48
	0.6 L/fed (E1)	20.38	21.67	17.07	18.05	83.76	83.32	10.74	11.25
	0.8 L/fed (E2)	20.79	21.80	17.38	18.24	83.59	83.67	10.89	11.41
	1.0 L/fed (E3)	20.95	21.94	17.58	18.42	83.94	83.96	11.06	11.55

LSD at 0.5 level	0.13	0.29	0.16	0.28	0.34	0.22	0.13	0.19
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Regarding the concentrations of Ethrelripeners in same table (2) revealed significantly effect on quality traits in both seasons. Treatment Ethrel 3 (E3) gave the highest values for brix, sucrose, purity and sugar recovery% in both seasons. Insignificant variance was detected in brix, sucrose and sugar recovery% when they were spraying with concentrations E2 and/or E3 in the first season. In both seasons, the difference in purity% between the same concentrations (E2 and/or E3) was insignificant. These results are in harmony with those found by **Leite, *et al.* (2009)**; **Al-Mubarak and Al-Chalabi (2011)**; **Abo-El-Hamd *et al.* (2013)** ; **Van Heerden *et al.* (2015)** and **Ayele *et al.* (2021)**.

Data in the same Table pointed to a substantial influence on quality traits (brix, sucrose, purity and sugar recovery percentages) due to the interaction between sugarcane varieties and Ethrel treatment in both seasons. The highest brix, sucrose, and sugar recovery% was recorded by planting G.2005/47 variety and its sprayed Ethrel at a concentration of 1.0 L/fed (E3) in the 1st and 2nd seasons, while the highest purity% was recorded by planting G.T.54-9 variety and its sprayed Ethrel at a concentration of 1.0 L/fed in both seasons. Insignificant variance was detected in brix, sucrose, and sugar recovery% between G.T.54-9 and G.2005-47 varieties when they were sprayed with concentrations of 1.0 L/fed (E3), in the 2nd season. While, there is no significant difference in juice purity% between G.T.54-9 and G.2005-47 varieties when sprayed with the three concentrations of Ethrel in both seasons.

3. Cane and sugar yields ton/fed

The results in Table (3) pointed out that the tested varieties differed significantly with respect to cane and sugar yields/fed. The promising variety G. 2004-27 (G. 4) and commercial variety G.T.54-9 (C9) exhibited the superiority in cane yield over the other variety G. 2005-47 in both seasons, without any significant difference between the two varieties G. 2004-27 and/or G.T.54-9 in cane yield/fed in the 2nd season. Moreover, the highest sugar yield/fed was recorded by G.T.54-9 variety, in both seasons without any appreciable variance between the two varieties G.T.54-9 and G. 2005-47 in sugar yield in the 1st season. In the 1st one, G.T.54-9 and G.2004-27 varieties produced increase in cane yield by 3.706 and 3.456 tons/fed over those gained from G.2005-47 genotype, respectively, in contrast, the increase in cane yield

was 4.928 and 4.952 tons/fed, successively, in the 2nd one. These results are probably due to the same tendency of stalk length, diameter and number of millable canes (Table 1), which was obtained by the two varieties C9 and/or G4. On the other hand, the data in Table 3 shows the superiority of the sugarcane variety GT.54-9 in sugar production/fed, followed by the G.2005-47 genotype over the other variety G.2004-27 in both seasons. The increase in sugar yield/fed was associated with the increase in cane yield/fed and sugar recovery% (Tables 1 and 2), which is considered the main component of sugar yield. Such varietal differences were reported by **El-Bakry, (2018)**; **Gadallah and Mehareb, (2020)**; **Ali et al. (2022)** and **Hussein et al. (2023)**.

Table 3 : The impact of Sugarcane varieties , Ethrelripeners, and their interactions on cane and sugar yields in 2021/2022 and 2022/2023 seasons

Treatments		Cane yield (ton/fed)		Sugar yield (ton/fed)	
		1 st season	2 nd season	1 st season	2 nd season
Sugarcane varieties (A)					
G.T. 54-9		57.263	58.693	6.681	7.396
G. 2005-47		53.557	53.765	6.670	6.876
G. 2004/27		57.013	58.717	6.127	6.556
LSD at 0.5 level		0.122	0.217	0.050	0.062
Ethrelripeners concentrations (B)					
Control		56.518	58.106	6.264	6.669
0.6 L/fed (E1)		55.974	57.232	6.412	6.962
0.8 L/fed (E2)		55.594	56.739	6.643	7.011
1.0 L/fed (E3)		55.490	56.157	6.648	7.129
LSD at 0.5 level		0.078	0.199	0.047	0.070
Interactions (A x B)					
G.T. 54-9	Control	57.807	59.838	6.432	6.718
	0.6 L/fed (E1)	57.233	58.893	6.516	7.241
	0.8 L/fed (E2)	56.828	58.240	6.791	7.219
	1.0 L/fed (E3)	56.715	57.800	6.993	7.363
G. 2005-47	Control	54.033	54.610	6.418	6.283
	0.6 L/fed (E1)	53.550	53.700	6.586	6.900
	0.8 L/fed (E2)	53.378	53.548	6.789	6.924
	1.0 L/fed (E3)	53.267	53.103	6.887	6.985
G. 2004/27	Control	57.713	59.368	5.951	6.222
	0.6 L/fed (E1)	57.140	58.903	6.135	6.624
	0.8 L/fed (E2)	56.817	58.530	6.190	6.676
	1.0 L/fed (E3)	56.380	57.967	6.234	6.695
LSD at 0.5 level		0.135	0.345	0.081	0.121

Data in Table (3) revealed that cane yield/fed was significantly affected by Ethrel treatments, in both seasons. The control treatment (unspraying) had the highest yield of cane/fed compared to those that were sprayed with Ethrel concentrations in both

seasons. The results exhibited a significant effect on sugar yield due to the use of Ethrel treatments at a concentration of E3 (1.0 L/fed) in both seasons. Using Ethrel concentrations E1, E2 and E3 (0.6, 0.8 and 1.0 L/fed) resulted in getting increase in sugar yield amounted to 0.148, 0.379 and 0.384 tons/fed, in the 1st season, respectively, compared to the check (un-sprayed), corresponding to 0.293, 0.342 and 0.460 tons/fed, in the 2nd one, successively, compared with the un-sprayed sub-plots. These results are in agreement with those found by **Leite,et al.(2009)**; **Al-Mubarak and Al-Chalabi(2011)**;**Abo-El-Hamd et al. (2013)** ;**Van Heerden et al. (2015)** and **Ayele et al. (2021)**.

Concerning the effect of interaction between Ethrelripeners treatments x sugarcane varieties, data indicated that cane and sugar yields ton/fed were significantly affected in both seasons, where the highest cane yield/fed was recorded by planting sugarcane varieties G.T.54-9 with control (unsprayed) in both seasons. There was no significant difference between these varieties G.T.54-9 and/or G. 2004-27 in cane yield when they were sprayed by any Ethrel concentrations 1.0 liter/fed (E3) in the 1st season. Regarding sugar yield, the commercial sugarcane variety G.T.54-9 attained the highest sugar yield/fed with treatment of ripenerEthrelunder the of concentration of E3 (1.0 liter/fed) in both seasons.

Under conditions of this work, it was found that growing all sugarcane varieties under study combined with sprayed by 1.0 L/fed of Ethrelripeners can be recommended to get the maximum production of sugar.

CONCLUSION

Utilizing chemical ripeners to enhance sucrose accumulation throughout the mature months is a well researched topic. Among these chemicals, Ethrel has emerged as a potentially effective option due to its low cost and few health risks. Additionally, assessing these compounds' performance in particular cultural contexts and with promising types is crucial. By producing high-quality canes, technologies for differentiating between cane kinds and employing inexpensive, safe chemical management techniques would maximize sugar recovery. To improve the output of sugar in commercial cane growing in Egypt, further research is required to properly utilize chemical ripener technology.

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