RESPONSES OF SOME SUGARCANE VARIETES TO APPLICATION OF ETHREL RIPENER WITH RESPECT TO THEIR 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 the 2020/2021 and 2021/2022 planting seasons, to evaluate the effects 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 tow 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 the 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, on the other hand, G.2005-47 genotype was superior in brix, sucrose, purity and sugar recovery% in both seasons. The results also showed that adding 1.0 liter/fed of Ethrel spray to the cane leaves caused an increase in brix, sucrose, purity and sugar recovery% as well as sugar yield/fed, compared to the untreated (control). On the contrary, the treatments with Ethrel concentrations led to a decrease in 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 addition led to an increase in quality and sugar yield at concentration of 1.0 liter/fed "E3". Under conditions of this work, it was found that growing all studied sugarcane varieties and spraying them with 1.0 l/fed of Ethrel ripener can be recommended for the maximum sugar production.

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

INTRODUCTION

Sugarcane ripening is the process of sucrose accumulation in the 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 so as to increase their sucrose content as well as increase the economic returns from their 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 studies that provide modern information, so this study was conducted to evaluate the response of sugarcane varieties to chemical ripeners 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 this of variety and other varieties grown in the experiment. In this respect, many studies and researches carried out to evaluate sugarcane varieties for productivity and juice quality traits as well as significant variables among varieties were reported by **El-Geddawy, *et al.* (2012); Makhlouf *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 compounds as ripeners to increase the concentration of sucrose in cane. One of these compounds is Etheril (active substance is isophone), 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 plants. Ethrel has been used as a means of accelerating maturation and increasing sugar content of sugarcane cultivars. Adding ethrel as a chemical ripener is primarily aimed at to enhancing the quality of juice, raising of sucrose content, and consequently boosting the output of sugar. Numerous investigations and studies have revealed that using chemical ripeners on sugarcane improves the quality of the juice and increases sugar yield, including the report of **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.**

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Thus, the goal of this study was to determine which sugarcane cultivars will yield the highest sugar content and how they will respond to application of Ethrel as a chemical ripener. It also aimed at understanding how artificial ripeners like Ethrel affect the ripening process or sucrose accumulation during sugarcane harvesting, which would be essential knowledge for the farmers in figuring out when to harvester sugarcanes.

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 planting seasons. The 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- $Ethrel_1$ "E_1" at 0.6 liter/fed. 2- $Ethrel_2$ "E_2" at 0.8 liter/fed. 3- $Ethrel_3$ "E_3" at 1.0 liter/fed in addition to 4-control (without sprayed). A split plot design with three replicates was used. The main plots were devoted to sugarcane varieties, while, chemical ripener treatments were distributed in the sub plots, in both planting seasons. Sugarcane planting was carried out by seed-cutting within the last week of March and harvested after 12 months in both planting seasons. The optimum Ethrel application date was within the nin month of planting, so as not to effect the cane yield; Ethrel was sprayed on the 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 m^2 with 5 ridges of 1.2 m apart (to allow smooth passage during spraying) and 3.5 m length (1/200 from feddan), there was a space of two m between each experimental piece for ease of spraying. Fertilizers were applied at rate of 210 kg N; urea (46.5% N) was divided into two equal in both seasons after 60 and 90 days respectively after planting (after the 1^{st} and 2^{nd} hoeing, *i.e.*). Phosphorus fertilizer, as calcium super phosphate (15.5% P_2O_5) was added once during seed-bed preparation at a rate of 30 kg P_2O_5/fed. Potassium fertilizer as potassium sulphate (48% K_2O) was added at rate of 48 Kg/fed once with the 2^{nd} dose of N fertilizer. The other agronomical 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 on each sup-plot. The following measurements were taken: Stalk length (cm) measured from soil surface to the top visible dewlap and stalk diameter (cm) measured at the middle part of stalks. On the other hand a sample of 20 millable canes was taken from each experimental sub plot at each harvest to be analyzed for juice quality. Sugar traits, i.e., were determined according to the methods described by **A.O.A.O. (2005)**. Brix% (total soluble solids of juice) was determined by using a "Brix Hydrometer" folloing the procedure described by "The Chemical Control Lab" of Sugar and Integrated Industries Company **(Anonymous, 1981)**. Sucrose% was determined using a "Scracometer", **(A.O.A.C. 2005).**

Purity% was determined 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% in each of the 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 subjected to mechanical and chemical analyses following standard methods. 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 heighet, diameter and number of millable cane

Data in Table (1) showed that the tested sugarcane varieties in this study differed significantly from each other with respect to stalk highest,diameter and number of millable cane. The promising G. 2004-27 variety exhibited superiority in stalk highest and number of millable cane/fed, followed by commercial sugarcane variety G.T.54-9, with G. 2005-47 genotype, recording the shortest stalk in both planting seasons, while,the commercial variety G.T.54-9 had the widest thickness of cane stalk, in both planting 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 highestwas markedly affected by the Ethrel ripener concentrations sprayed in both seasons. However, the mean value of stalk diameter and number of millable cane hadsignificanteffectsonly in the 2nd planting season. Sup-plots that did not receive any application ofEthrel ripener had the tallest canes thickest plants and highest number of millable canes (Table 1). The decrease in stalk height when sprayed with Ethrel was probably due to reduction in internode elongation of the cane stalksresulting from the inhibition of GA20 to GA1 conversion process within the stalks**(van Heerden *et al* 2015).**These results are in harmony with those reported 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 revealed thatthe mean values ofnumber of millable canewere insignificantly affected by the interaction between the sugarcane varieties and Ethrel application in the planting season, while, the mean values ofthe stalk length and its diameter were significantly affected in the 2nd planting season only (Table 1).

Table 1: The impact of Ethrel ripener on Sugarcane varieties, with respect to their stalk length, diameter and number of milliable cane in 2021/2022 and 2022/2023 planting seasons

Treatments	**Stalk Height (cm)**		**Stalk Diameter (cm)**		**No. of Millable Canes (1000/fed)**	
	1st season	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd 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**
Ethrel ripener concentrations sprayed on the sugarcane varieties (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**
Effects/ 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 all the juicequality traits(brix, sucrose, purity and sugar recovery%) determined in this study (Table 2). Variety G.2005- 47 sugarcane genotype had the highest values of all the juice quality traits, while variety G.2004-27 recorded the lowest values in both seasons (Table 2). It was noted from the same table that the difference between G.T.54/9 and/orG.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 their gene make-up. These results are in accordance with those reported by **El-Bakry(2018), Gadallah and Mehareb(2020), Ali *et al.* (2022)**and **Hussein *et al*. (2023).**

Table 2: The impact of Sugarcane varieties, Ethrel ripener, 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 %**	
	1st season	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd 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**
Ethrel ripener concentrations sprayed on the sugarcane varieties (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/Effects (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**

The concentrations of Ethrel ripener sprayed on the sugarcane varieties had significantly high effect on the juice quality traits in both planting seasons (Table 2). Treatment E3 gave the highest values for brix, sucrose, purity and sugar recovery% in both [planting seasons. However, an insignificant variance was detected in brix, sucrose and sugar recovery% when the the sugarcane varieties were treated as in with E2 and/or E3 in the first planting season (Table 2). In both panting seasons, the difference in purity% between the same concentrations (E2 and/or E3) was insignificant (Table 3). These results are in harmony with those of **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).**

Results in Table 2 also pointed to a substantial influence on quality traits (brix, sucrose, purity and sugar recovery percentages) due to the interaction between sugarcane varieties and concentrations of Ethrel applied in both planting seasons. The highest brix, sucrose, and sugar recovery% were recorded in the variety G.2005/47 sprayed with Ethrel at concentration of 1.0 L/fed (E3) in the 1st and 2ndplanting seasons, while the highest purity% was recorded in the variety G.T.54-9 sprayed with Ethrel at concentration of 1.0 L/fed in both planting seasons (Table 2). Insignificant variance was detected in brix, sucrose, and sugar recovery% between varieties G.T.54-9 and G.2005-47 sprayed with Ethrel at concentration1.0 L/fed (E3), in the 2ndplanting season, while, there was no significant difference in the juice purity% between varieties G.T.54-9 and G.2005-47 sprayed with the three concentrations of Ethrel in both planting seasons in this study (Table 2).

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 superiority in cane yield over the variety G. 2005-47 in both planting seasons, without any significant difference between the varieties G. 2004-27 and/or G.T.54-9 in cane yield/fed in the 2nd season (Table 3).Moreover, the highest sugar yield/fed was recorded by G.T.54-9 variety, in both planting seasons without any appreciable variance between the two varieties G.T.54-9 and G. 2005-47 in sugar yield in the 1st planting season. In the 1st planting season, varieties G.T.54-9 and G.2004-27 exhibited increase in cane yield by 3.706 and 3.456 tons/fed over those of variety G.2005-47, respectively. In contrast, the increase in cane yield was 4.928 and 4.952tons/fed, successively, in the 2nd planting season. These results were probably due to the reasons adduced for the parameters in Table , for varieties C9 and/or G4. On the other hand, the data in Table 3 showed the superiority of variety GT.54-9 in sugar production/fed, followed by the variety G.2005-47 over variety G.2004-27 in both planting seasons. The increase in sugar yield/fed was associated with the increase in cane yield/fed and sugar recovery% (Tables 1 and 2), which are considered the main components 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 , Ethrel ripener, and their interactions on cane and sugar yields in 2021/2022 and 2022/2023 seasons

Treatments		Cane yield (ton/fed)		Sugar yield (ton/fed)	
		1st season	2nd season	1st season	2nd 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**
Ethrel ripener concentrations sprayedon the sugarcane varieties(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/Effects (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 the significant effects of Ethrel application on the sugarcane varieties in both Planting seasons. The control treatment had the highest yield of cane/fed compared to those that were sprayed with different concentrations of Ethrel in both planting seasons. The results showed a significant effect of spraying Ethrel at a concentration of E3 (1.0 L/fed)on sugar yield treatments in both Planting seasons. Spraying Ethrel at concentrations0.6, 0.8 and 1.0 L/fed resulted in an increase in sugar yield to the tune of 0.148, 0.379 and 0.384 tons/fed respectively in the 1stplanting season, compared to the control. The corresponding effect of spraying Ethrel at the same concentrations in the second planting season yielded 0.293, 0.342 and 0.460 tons/fed, , compared with the control. These results are in agreement with those of **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 interaction between the concentrations of Ethrel ripener sprayed and the sugarcane varieties subjected to these treatments, the results indicated that the cane and sugar yields (ton/fed) were significantly affected in both planting seasons, with the highest cane yield/fed recorded in the unsprayed sugarcane variety G.T.54-9 in both planting seasons. There was no significant difference between varieties G.T.54-9and/or G. 2004-27 in cane yield when they were sprayed with Ethrel at concentration 1.0 liter/fed (E3) in the 1stplanting season. In terms of the sugar yield, G.T.54-9 attained the highest sugar yield/fed when sprayed with ripener Ethrel concentration 1.0 liter/fed (E3) in the two planting seasons.

Under conditions of this work, it was found that growing all the sugarcane varieties under this study in combination with spraying them with of Ethrel ripener at concentration 1.0 L/fed can be recommended for maximum sugarcane production.

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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