Effect of the application of molasses and vinasses on the yield and quality of sugar beet and soil fertility

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Abstract

Beet sugar industry in the tropics and subtropics is growing as an important component of sugar production. In Egypt, sugar beet has acquired more importance and becoming an important source of refined sugar. Large amounts of beet sugar byproducts are produced resulting in environmental pollution.

The surface application of molasses has significantly increased root yield, and the highest root yields were produced from either the control treatment and the application of 150 L/fed. of molasses to the soil surface. The highest root yield values were produced from the Belino variety under the control treatment and the Kawimera variety under the surface application of 150 L/ fed. of molasses. Surface application of molasses at the rate of 150 L/ fed. resulted in the highest sugar content. The highest values of the quality index, recoverable sugar (RS%) and recoverable sugar yield (RSY) from the Belino and Kawimera varieties were produced from the surface application of 150 L/ fed. of molasses. Meanwhile, the foliar application of vinasses at the rate of 4% (v/v) resulted in the lowest values of quality index, recoverable sugar% and recoverable sugar yield. The lowest values of Na%, K% and α-amino N% from both varieties resulted from the surface application of 150 L molasses. Moreover, the highest values of the quality index (QZ), recoverable sugar (RS%) and recoverable sugar yield were produced from the surface application of 150 L/ fed. of molasses. Compared to the control treatment, applying molasses at the rate of 150 L/ fed. improved the available N, P and K as well as the organic matter, calcium and magnesium contents in the soil after sugar beet harvest. The data indicate that molasses is a promising organic soil amendment that enhances sugar beet yield and yield-related traits through improving the physical and chemical properties of the soil. Besides, the application of beet sugar molasses can improve sugar beet quality through improving juice quality by reducing impurities content that retard sugar extraction.

Keywords: Sugar beet; Sugar yield; Juice quality; Soil amendment; Soil fertility

Introduction

Sugar beet is the most important sugar crop that can be grown commercially in a wide variety of temperate regions. Beet sugar industry in the tropical and subtropical regions, which are mostly developing countries including Egypt, is growing as an important component of sugar production (Abo-Elwafa et al. 2013; Abo-Elwafa et al. 2006; Abou-Elwafa 2010). Recently, extensive efforts have been made to cultivate and adapt sugar beet in the tropical and subtropical countries in order to replace or supplement the sugar production from sugarcane which is dominating the industry for the following reasons; i) less crop irrigation requirement of sugar beet, which is a decisive determinant of sustainable cultivation in dry regions. Further, studies showed that root and sugar yields were not significantly reduced as low as 70% of optimum crop irrigation requirements, ii) sugar beet has a shorter growing season (5-6 months) compared to sugarcane which is approximately 12 months, and iii) sugar beet could be a possible solution as tolerant crop of soil alkalinity or for newly reclaimed soils which are common in tropical and subtropical areas, that are not suitable for sugarcane or other crops (Abou-Elwafa et al. 2020; Alotaibi et al. 2021; Mawusi 2004; Nasr and El-Razek 2008). Additionally, cultivation of sugar beet in developing countries could be a profitable for farmers in two ways; 1) by diversification of their incomes by enabling them to grow an additional cash crop, and 2) supply sugar factories with additional raw material to the sugar cane that will extend the crashing period (Abou-Elwafa et al. 2020; Balakrishnan and Selvakumar 2009; Mandere et al. 2010).

In Egypt, sugar beet has acquired more importance and becoming an important source of refined sugar. Total sugar beet cultivated area is more than 600,000 feddans, producing about 20 million Mt of sugar beets with an average sucrose content of about 18% (www.fao.org). Improving the physical and chemical properties of the soil is essential for sustainable cultivation and production of sugar beet in Egypt. Different approaches have been reported for successful, low cost and effective improvement of the physicochemical soil properties (Cha-um and Kirdmanee 2011; Ding et al. 2020; Jesus et al. 2015). The application of beet sugar molasses, the residual syrup from sugar beet processing, to the soil surface could enhance the physical and chemical properties of the soil (El-Tokhy et al. 2019).

Large quantities of sugar beet industrial byproducts are produced from beet sugar factories, resulting in environmental pollution. Molasses is the residual syrup from the processing of sugar beet which no more sugar be crystallized by conventional means. Beet molasses contained about17% water, 66% sucrose, 1% fructose, 1%glucose, 6% glycine betaine, 8% amino acids, 0.3% sterols, 0.5 % phospholipids and 0.2% wax (Tantawy 2007). Vinasses is a byproduct of the fermentation of molasses to for example alcohol, yeast, citric acid and monosodium glutamate. During the fermenting process nearly all of the sugar in the molasses is detracted. According to this process the proportion of all original ingredients is changed. Thus, ridding of vinasses is a problematic environmental challenge for the industry. Several solutions have been proposed involving the re-utilization of vinasses in various technical fields. The application of a mixture of filter cake and molasses exhibited insignificant effects on soil ECe, SAR and ESP after the harvesting of sugar beet (Aljabri et al. 2021). The percentage of Na removed from the soil at the end of the experiment was estimated as 51% (Amer 2015). Additionally, all plant growth aspects such as plant height, leaf area, plant fresh and dry weights of tomato irrigated with saline water with an EC of 2000, 3000 and 4000 ppm were improved in response to the application of beet molasses at rates of 200 and 300 kg/ fed. Among treatments, beet molasses at a rate of 200 kg/ fed. recorded the highest significant effect in mitigating salinity negative effects (El-Tokhy et al. 2019).

The current study hypothesizes that because of their high calcium content molasses and vinasses could efficiently improve the physical and chemical properties of the soil and consequently enhance sugar beet yield and quality. The present study aimed to; i) evaluate the surface application of molasses and vinasses as a soil amendment and nutritional supplements on sugar beet yield and quality, and ii) evaluate the foliar application of molasses and vinasses as nutritional supplements on sugar beet yield and quality.

Materials and methods

Plant materials and experiments

The current study was conducted at the Research Farms of Dakahlia Sugar Company, Belqas, Daqhlia, Egypt (31° 15' N, 31° 25' E, 764 m asl) during the 2018/2019 growing season. Two commercial sugar beet cultivars, i.e., Kawimera and Belino were used. Planting was performed on September 15, 2018, and harvest was performed on April 15, 2019. Seeds were sown by hand at 10 cm distance in a 10.5 m^2 plot consists of 6 rows of 3.5 m in length, with a distance of 50 cm between rows. Furrow irrigation was implemented.

The experiment was designed in a three-replicate randomized complete block design (RCBD) in a split-plot design. The main plots were allocated to nine fertilization treatments, i.e., 1) the control treatment (CT): N, P and K fertilizers were applied as locally recommended for sugar beet cultivation and production. In Brief, nitrogen was applied at the rate of 200 kg/ fed. in the form of urea (46.5% N) in two equal doses (with second irrigation after thinning, and with the third irrigation). Super phosphate (15.5%

P_2O_5) at the rate of 200 kg/ fed. was applied at soil preparation. Potassium sulfate (50% K_2O) was added at the rate of 75 kg/ fed. with the first irrigation, 2) 75 L/ fed. of molasses applied with the irrigation water at three equal doses at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, 3) 150 L/ fed. of molasses applied with the irrigation water at three equal doses at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, 4) 2% (v/v) molasses solution applied as a foliar spray at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, 5) 4% (v/v) molasses solution applied as a foliar spray at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment. 6) 75 L/ fed. of vinasses applied with the irrigation water at three equal doses at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, 7) 150 L/ fed. of vinasses applied with the irrigation water at three equal doses at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, 8) 2% (v/v) vinasses solution applied as a foliar spray at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment, and 9) 4% (v/v) vinasses solution applied as a foliar spray at 4, 6 and 8 weeks after sowing in addition to half of the N, P and K fertilizers added to the control treatment. All other agronomical practices were performed as locally recommended for sugar beet cultivation and production.

Analysis of soil physiochemical properties.

The chemical and physical properties of the experimental soil were analyzed before sowing and after harvest. Composite representative soil samples were taken from the 0–30 cm surface layer of the experimental soil before sowing. After harvest, soil samples were collected from each plot, and a composite sample was made up from each treatment. The soil samples were air-dried, crushed and sieved to pass through a 2 mm. Some physical and chemical properties of the soil were determined according to Burt (Burt 2004). The soil pH was measured in 1:2.5 soil to water suspension using a digital pH meter. The electrical conductivity (EC) was estimated using the salt bridge method (Burt 2004). The available soil nitrogen was extracted by 2 M potassium chloride and then the nitrogen in the extract was determined using micro-kjeldahl method (Burt 2004). The spectrophotometer set at a wavelength of 550 nm was employed to measure the available P in the soil extracted using 0.5 M sodium bicarbonate solution at pH 8.5 (Olsen 1954). The flame photometry was used to measure the potassium in the soil after extraction using the ammonium acetate procedure at pH 7.0 (Jackson 1973). The available potassium was extracted by ammonium acetate method and was measured by flame photometry (Burt 2004). The soil organic matter (OM) was measured using the Walkley–Black method (Jackson 1973). The main chemical and physical properties of the experimental soil are shown in Table 1.

Table 1. Basic physical and chemical properties of the experimental soils.

Parameters	Control	75 L molasses	150 L molasses	75 L vinasses	150 L vinasses
Sand (%)	30	35	34	33	33
Silt (%)	33	30	31	31	31
Clay (%)	37	35	36	36	36
Texture	Clay loam				
$CaCO_3$ (%)	5.0	5.9	5.8	5.2	5.5
pH (1:2.5 suspension)	7.38	7.40	7.28	7.45	7.66
ECe (dS m^{-1})	3.2	2.99	2.95	3.01	3.2
Ca^{2+} (meq L^{-1})	25.22	31.78	34.23	27.12	27.64
Mg^{2+} (meq L^{-1})	20.75	23.19	25.44	21.09	20.87
K^{+} (meq L^{-1})	1.40	1.54	1.81	1.44	1.51
Organic matter (%)	1.34	1.61	1.65	1.45	1.45
Available N (ppm)	28	44	49	30	33
Available Olsen P (ppm)	18	19	22	16	17
Available K (ppm)	360	366	387	350	360

Chemical characterization of molasses and vinasses.

Molasses is a byproduct viscous syrup resulted from sugar beet or sugarcane manufacturing. Vinasse is an organic liquid byproduct generated from the sugar beet or sugarcane ethanol fermentation industry. Chemical characterization of molasses and vinasses are presented in Table 2.

Statistical analysis

Experiments were designed in a three-replicates randomized complete block design (RCBD) in a split-plot design. The Proc Mixed of SAS 130 package version 9.2 was used to perform analysis of variance (ANOVA) and Fisher's least significant difference (LSD) of significantly different treatments.

Table 2. Chemical composition of molasses and vinasses produced from beet sugar processing.

Parametres	Molasses	Vinasse
PH	8.5	4.38
Brix (%)	79.0	13.5
Total sugar (%)	48.5	3.25
Ash (%)	13.10	2.73
N (%)	1.66	0.431
P (%)	0.012	0.016
K (%)	5.68	0.750
Ca (%)	0.297	0.195
Mg (%)	0.232	0.070
Na (%)	0.169	0.100
Density (g/cm^2)	1.47	1.05

Results

Effect of the application of beet sugar byproducts on sugar beet yield

Root yield exhibited high significant difference ($P<0.01$) in response to either the surface and foliar application of both molasses and vinasses (Table 3). The surface application of molasses has significantly increased root yield, and the highest root yields were produced from either the control treatment and the application of 150 L of molasses to the soil surface (Table 4). Meanwhile, the lowest root yield values were produced from the application of either molasses or vinasses as a foliar spray (Table 4). Varieties did not exhibit significant differences ($P>0.05$) in root yield. The interaction between varieties and the application of beet sugar byproducts revealed highly significant differences on root yield. The highest root yield values (46.93 and 46.25 ton/fed.) were produced from the Belino variety under the control treatment and the Kawimera variety under the 150 L molasses surface application (Table 4).

Table 3. Analysis of variance of evaluated traits indicated as P-values.

Source of Variance	Sucrose	Na	K	α-amino N	QZ	RY	RS%	RSY	SL%	SLY
Treatments	0.000	0.000	0.808	0.024	0.000	0.000	0.000	0.000	0.004	0.000
Varieties (V)	0.428	0.702	0.754	0.366	0.367	0.331	0.401	0.473	0.444	0.310
T×V	0.002	0.090	0.069	0.486	0.028	0.308	0.003	0.001	0.182	0.196

Effect of the application of beet sugar byproducts on beet juice quality parameters

The main factors of sugar beet juice quality are sucrose content (Pol%), Na%, K% and α-amino N% which affect juice quality and thereby the extractable sugar and losses. The application of beet sugar byproducts exhibited highly significant differences on sucrose content, Na%, K% and α-amino N% (Table 3). Surface application of molasses at the rate of 150 L/ fed. resulted in the highest sugar content (Table 4), indicating the efficiency of beet sugar molasses as a soil amendment in promoting sucrose accumulation. The lowest values of Na%, K% and α-amino N% from both varieties resulted from the surface application of 150 L molasses (Table 4). The interaction between application of beet sugar byproducts and varieties significantly affected sucrose content, Na%, K% and α-amino N. The highest sugar content (19.22% and 19.27%) from the Belino and Kawimera varieties, respectively, resulted from the surface application of 150 L molasses. The application of 4% (v/v) vinasses as a foliar spray on the Belino variety resulted in the lowest sugar content (14.63%; Table 4). The lowest Na, K and α-amino N contents produced from both Belino and Kawimera varieties in response to the surface application of 150 L/ fed. of molasses (Table 4).

Effect of the application of beet sugar byproducts on beet quality, sugar yield and .

Table 4. Effect of the application of molasses and vinasses juice quality parameters of sugar beet.

Variety	Treatment	Sucrose%	Na (%)	K (%)	α-amino N (%)	QZ (%)
Belino	Control	18.03±0.35	7.51±0.11	3.09±0.06	4.09±0.07	76.42±0.33
	M75L	18.19±0.19	7.25±0.14	3.09±0.03	4.08±0.04	76.73±0.53
	M150L	19.22±0.27	6.79±0.02	3.07±0.08	3.97±0.06	77.88±0.49
	M2%	16.70±0.30	7.20±0.30	3.09±0.12	4.17±0.17	74.77±1.32
	M4%	16.23±0.38	7.37±0.24	3.11±0.09	4.18±0.15	73.66±1.18
	V75L	17.40±0.20	7.19±0.12	3.09±0.06	4.21±0.06	75.83±0.29
	V150L	17.47±0.06	7.14±0.03	3.08±0.03	4.20±0.04	76.04±0.10
	V2%	16.30±0.36	7.12±0.02	3.10±0.02	4.23±0.02	74.46±0.58
	V4%	14.63±1.10	7.05±0.03	3.09±0.03	4.22±0.02	71.56±2.16
Mean		17.13±1.32	7.18±0.19	3.08±0.06	4.09±.07	75.37±1.98
Kawimera	Control	18.60±0.62	7.20±0.09	3.12±0.03	4.06±0.04	77.35±0.77
	M75L	17.95±0.13	7.17±0.17	3.11±0.08	4.09±0.03	76.99±0.11
	M150L	19.27±0.25	6.89±0.06	3.04±0.05	3.91±0.01	78.49±0.18
	M2%	16.63±0.45	7.34±0.09	3.16±0.06	4.16±0.06	74.24±0.73
	M4%	15.60±1.25	7.37±0.12	3.12±0.02	4.04±0.08	70.73±2.25
	V75L	16.67±0.42	7.24±0.14	3.14±0.05	4.28±0.32	74.64±0.70
	V150L	17.00±0.10	7.18±0.02	3.15±0.05	4.10±0.05	75.58±0.18
	V2%	16.60±0.26	7.19±0.03	3.18±0.01	4.12±0.03	74.89±0.43
	V4%	15.90±0.78	7.38±0.25	3.16±0.04	4.18±0.10	73.17±0.77
Mean		17.02±1.41	7.20±0.15	3.08±.05	4.12±0.09	75.12±2.35
$LSD_{0.05}$		0.40	0.13	0.04	0.10	0.83

Table 5. Effect of the application of molasses and vinasses root and recoverable sugar yields and sugar losses of sugar beet.

Variety	Treatment	RY (t fed^{-1})	RS (%)	RSY (t fed^{-1})	SL (%)	SLY (t fed^{-1})
Belino	Control	46.93±2.44	16.04±0.35	7.13±0.33	2.99±0.01	1.40±0.07
	M75L	44.63±1.20	15.32±0.21	6.84±0.26	2.87±0.03	1.28±0.03
	M150L	45.31±1.86	16.26±0.29	7.61±0.22	2.79±0.02	1.34±0.06
	M2%	17.76±0.22	13.72±0.37	2.44±0.09	2.98±0.10	0.53±0.01
	M4%	15.76±0.60	13.23±0.41	2.09±0.14	3.01±0.08	0.47±0.02
	V75L	26.09±0.82	14.43±0.20	3.76±0.10	2.97±0.01	0.78±0.02
	V150L	28.19±1.93	14.50±0.06	4.09±0.27	2.97±0.02	0.84±0.06
	V2%	16.64±0.58	13.36±0.36	2.22±0.10	2.94±0.01	0.49±0.02
	V4%	16.43±0.80	11.71±1.10	1.92±0.16	2.93±0.00	0.48±0.02
Mean		28.63±8.47	14.14±1.32	4.20±2.30	2.96±0.04	0.85±0.39
Kawimera	Control	45.47±1.62	15.64±0.62	7.10±0.06	2.96±0.02	1.35±0.05
	M75L	44.91±1.28	15.03±0.13	6.75±0.18	2.91±0.01	1.31±0.04
	M150L	46.25±1.19	16.33±0.24	7.55±0.08	2.78±0.01	1.26±0.03
	M2%	16.80±0.96	13.62±0.44	2.29±0.10	3.01±0.02	0.51±0.03
	M4%	16.25±1.05	11.63±1.24	1.89±0.26	2.97±0.02	0.48±0.03
	V75L	26.86±0.77	13.65±0.38	3.67±0.03	3.01±0.06	0.81±0.01
	V150L	28.80±1.01	14.06±0.09	4.05±0.12	2.94±0.01	0.85±0.03
	V2%	16.99±0.93	13.65±0.27	2.32±0.15	2.95±0.01	0.50±0.03
	V4%	17.81±0.22	12.89±0.73	2.30±0.11	3.01±0.06	0.54±0.01
Mean		28.90±8.26	14.06±1.43	4.21±2.31	2.97±0.04	0.86±0.39
$LSD_{0.05}$		1.32	0.41	0.36	0.03	0.03

Effect of beet sugar byproducts on soil chemical properties

The application of molasses and vinasses has affected the contents of organic matter, calcium and magnesium contents, the available N, P and K in the soil after harvest (Table 1). Compared to the control treatment, applying molasses at the rate of 150 L/ fed. increased the available N, P and K as well as the organic matter, calcium and magnesium contents in the soil after sugar beet harvest. Furthermore, all applied beet sugar byproducts influenced the pH degree and the electrical conductivity (EC) value (Table 1).

Discussion

The application of molasses to the soil surface significantly enhanced root yield in both varieties. This action of molasses in enhancing root yield could be attributed to its high calcium content that dramatically improves soil physical and chemical properties and hence enhances sugar beet growth (Abejehu 2015; Moda et al. 2015; Prado et al. 2013). Besides, molasses the presence of polysaccharides in molasses might enhance plant growth and soil microorganisms which release some regulators that promote plant growth and yield (Honma et al. 2012).

The significant increase in sugar content in response to the application of molasses to the soil surface may be due to the presence of high calcium content in the molasses which is antagonized with sodium ions and enhance soil aggregation which improves soil properties, plant growth and yield (Miller and Smith 2010). Furthermore, the high sugar content produced from the application of 150 L/ fed. of molasses to the soil surface could be ascribed to the enhanced plant growth that leads to partitioning more photo assimilates in the roots (Hosseini et al. 2019; Koch et al. 2019; Lemoine et al. 2013; Sowiński 1999). Furthermore, the reduction in Na, K and α-amino-N contents in root juice in response to the application of molasses to the soil surface might be due to that the presence of an excess of Ca^{2+} and Mg^{2+} ions that led to a reduction in the absorption of Na^+ and K^+ and therefore affected membrane permeability to control Na and K absorption (Wakeel 2013). Besides, soil amendments (such as molasses application) can cause contradictory impacts on phytoavailability and mobilization of elements depending on the type of elements and amendments (Shaheen et al. 2017).

The application of molasses to the soil amendments enhanced beet roots quality and recoverable sugar yield (RSY).

These results might be due to the high root yields produced from the application of molasses. The high contents of calcium and magnesium in molasses affect the bioavailability and immobilization of Na and K by reducing soil pH and increasing the availability of exchangeable soil Ca and Mg through the antagonistic actions. The antagonistic actions have multiple effects on improving the soil physical and chemical properties, maintaining soil quality and enhancing plant growth and consequently yield (Bhuiyan et al. 2015; David 2007; Hasanuzzaman et al. 2014).

Analysis of the chemical composition of the experimental soil after harvest revealed that all the application of molasses as a soil amendment promotes calcium and potassium contents in the soil compared to the control treatment. These results indicate that molasses can cause antagonistic effects on the element mobilization and phytoavailability depending on the type of element. The impact of the application (1%) of several low-cost soil amendments and environmental wastes on the mobilization, immobilization availability and uptake of some nutrients in the long-term sewage effluent irrigated sandy soils. The increased contents of Ca^{2+} and Mg^{2+} in the experimental soil in response to the application of molasses might due to the high content of both elements in the molasses. Likewise, the high K content observed in the soil after harvest is due to high K content in the molasses (Hussain et al. 2013; Kemi Idowu and Adote Aduayi 2007; Miller and Smith 2010; Momayezi et al. 2010).

Conclusions

The current study represents beet sugar molasses as an efficient soil amendment that has great potential for use in conservation agriculture. Beet sugar molasses could be applied as a soil amendment and substitute for inorganic nitrogen and phosphorus fertilizers. Molasses is a promising organic soil amendment that greatly enhances sugar beet yield and yield-related traits through improving the physical and chemical properties of the soil. Furthermore, the application of beet sugar molasses as a soil amendment can improve sugar beet quality through improving juice quality by reducing impurities content that retard sugar extraction.

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الملخص العربي

تأثير إضافة المولاس والفيناس على المحصول والجودة في بنجر السكر وخصوبة التربة

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تعتبر صناعة سكر البنجر من الصناعات الواعدة في المناطق الاستوائية وشبه الاستوائية كعنصر مهم في إنتاج السكر في تلك المناطق. فعلى سبيل المثال فقد اكتسب بنجر السكر أهمية أكبر وأصبح المصدر الأول لانتاج للسكر في مصر. من ناحية أخرى فإن صناعة سكر البنجر ينتج عنها كميات هائلة من منتجات الثانوية التي تؤدي إلى تلوث البيئة.

في هذه الدراسة تم دراسة تأثير المعاملة بكلا من المولاس (سائل بني لزج غامق ناتج ثانوي من عملية البلورة النهائية لتصنيع السكر) والفيناس (ناتج ثانوي من عملية تخمير المولاس الى إيثانول) سواء بالاضافة الى الأرض مع مياه الري أو من خلال الرش الورقي على المحصول والجودة في بنجر السكر وكذلك على خصوبة التربة. أظهرت النتائج أن إضافة المولاس مع مياه الري بمعدل 150 لتر/ فدان أدت إلى زيادة معنوية في محصول الجذور. كما كان لإضافة المولاس مع مياه الري بمعدل 150 لتر/ فدان تأثير معنوي على زيادة معامل جودة العصير والنسبة المئوية للسكر القابل للاستخلاص ومحصول السكر القابل للاستخلاص (طن/ فدان). فيما تم الحصول على أدنى قيم من معامل جودة العصير والنسبة المئوية للسكر القابل للاستخلاص ومحصول السكر القابل للاستخلاص من الرش الورقي للفيناس بمعدل 4٪. كما أظهرت الدراسة أن إضافة المولاس مع مياه الري بمعدل 150 لتر/ فدان أدت إلى إنخفاض النسبة المئوية للشوائب التي تعيق استخلاص السكر (الصوديوم والبوتاسيوم والألفا أمينو نيتروجين).

وبالمقارنة مع معاملة الكنترول (بدون اية إضافات أو رش)، أدت إضافة المولاس مع مياه الري بمعدل150 لتر/ فدان إلى زيادة محتوى التربة من النيتروجين والفوسفور والبوتاسيوم وكذلك المواد العضوية والكالسيوم والمغنيسيوم بعد حصاد بنجر السكر. تشير البيانات إلى أن إضافة المولاس إلى التربة يعد تحسيناً عضويًا

واعدًا للتربة مما يؤدي إلى زيادة محصول بنجر السكر من خلال تحسين الخصائص الفيزيائية والكيميائية للتربة. بالإضافة إلى ذلك فإن إضافة المولاس مع مياه الري يمكن أن يؤدي إلى تحسين جودة بنجر السكر من خلال تحسين جودة العصير عن طريق تقليل محتوى الشوائب التي تعيق استخلاص السكر.