ALLEVIATION OF SALT-STRESS ON SUGAR BEET (*BETA VULGARIS* L.) USING MOLASSES, HUMIC, AND NANO-CACO$_3$

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Abstract. The impact of soil application (control (C), molasses (M) and humic acid (HA)) and foliar applicllation treatments (C, HA, M and lithovit Boron (LB)) on sugar beet (*Beta vulgaris* L.) growth, yield, and quality under saline conditions were studied. A field experiment was conducted in Oct. 2017 and 2018 at Tamrfayah village (31°22’ N, 31°12’ E), Kafr El-Shiekh Governorate, Egypt. Soil or foliar application treatments increased leaf area index (LAI), dry weight plant^{-1}, root weight, length and diameter, root yield (t/ha), gross sugar%, extractable white sugar%, juice purity%, and sugar yield (t/ha) of sugar beet compared to C. The inverse was true in K, Na, K + Na, α-amino nitrogen (meq/100 g), loss sugar (%), and quality for root juice. Adding M to soil along with foliar spraying with LB produced the maximum average increase of two season at about leaf area 53.67%, dry weight 18.56%, root diameter 7.88%, root weight (g plant^{-1}) 23.89%, root yield (t/ha) 29.8%, gross sugar (%) 9.29%, extractable white sugar (%) 14.97%, Juice purity (%) 4.93%, sugar yield (t/ha) 47.55 compared to C (Soil application) × C (Foliar application) treatment. The highest values of K 6.84 and 7.33, Na 2.47 and 2.53, and K + Na 9.32 and 9.85 meg/100 g of sugar beet were obtained with the C (Soil application) × C (Foliar application) treatment.
Keywords: *biofertilizer, lithovit, fulvic, salinity, Nano fertilizer,*

Introduction

Sugar beet (*Beta vulgaris* L) has become a prospective crop for sugar production in Egypt. The annual output reaches 11 million tons from a cultivated area 219 thousand hectares (FAO, 2018).

Abiotic stress, such as salinity, can be considered a limit factor for increasing crop yield. The alleviated adverse effect of salt stress on crop physiology and growth through nano-fertilizer (Sassine et al., 2020), molasses (El-Tokhy et al., 2018), and humic acid (Khaled and Fawy, 2011) are practical approaches.

The industrial process of sugar production results in by-products like molasses, a dark brown viscous liquid. Molasses contains varying humic, fulvic, and amino acids, which promote nutrient uptake efficiency and soil biological activity (Samavat and Samavat, 2014). Srivastava et al. (2012) found that beet molasses is high in mineral elements such as N, P, K, Ca, and micronutrients. It increases the abundance of nutrients and organic matter in the soil (Li et al., 2020). Soil and foliar applications of molasses increased beet root yield and sugar content (%) (Şanli et al., 2015). (Li et al., 2020) indicated that foliar application of molasses soluble increased the seed of rapeseed yields up to 20% compared to chemical fertilizer only treatment.

Humic substances, including humate potassium and fulvic acid, have a stimulating effect on plant growth and microbial activities (Canellas and Olivares, 2014). The

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humic soil application (12% of humic acids, 3% of fulvic acids) induced more intensive growth and a positive influence on beetroot and sugar content yield than the control (Wilczewski et al., 2017). The humic treatment application exceeded the control treatment in sucrose, refined sugar, root yield, and sugar yield (Rassam et al., 2015).

Nano-fertilizers, such as Lithovit® (Boron 05), contain nano-CaCO3, a carbonate that decomposes in the leaf stomata to calcium oxide (CaO) and carbon dioxide (CO2), increasing photosynthesis rate (Beinșan et al., 2014). The product contains boron, which is necessary for plant development through the structural integrity of the cell wall, sugar translocation, physiological functions such as carbohydrates and nitrogen metabolism, the formation of amino acid, and plant hormones (Marschner, 2012; Nyomora et al., 2000; Rawashdeh and Sala, 2013). Besides, iron is essential for electron transport systems of mitochondria and chloroplasts (Rochaix, 2011) and many vital enzymes in the photosynthetic system (Rout and Sahoo, 2015). Lithovit® contains magnesium, the central core of the chlorophyll molecule (Nawaz et al., 2020); silica plays a vital role in increased tolerance in plants against abiotic stress like deficit and salinity stresses balancing nutrients uptake (Alsaeedi et al., 2019). Lithovit foliar application improves the growth and yield of cotton (Attia et al., 2016), maize (Gigel and Florin, 2017), barley (Szczepanek, 2017), and stevia (Soliman et al., 2018).

The study aimed to evaluate the effect of soil application (control, molasses, and humic acid) and foliar application (humic, molasses and lithovit) treatments in combinations on sugar beet growth, yield, and quality under salinity soil and water conditions.

Material and methods

An experiment was established on 6 Oct. 2017 and 10 Oct. 2018 at the field of Qaryah_No. 1 at Tarfayah village (31°22’ N, 31°12’ E), Kafr El-Shiekh Governorate, in Northern Egypt. Rice was the previous crop.

Table 1 shows the chemical study of the experimental soil (0-30 cm) using (Black et al., 1965). Clay was the soil texture. The soil salinity level was mild to high (Abrol et al., 1988).

Table 1. *Chemical analysis of the experimental soil (0-30 cm) in 2017/18 and 2018/19 seasons*

Seasons	PH (2.5:1)	EC (dS.m-1)	OM (%)	(meq. L^{-1})							Available (ppm)		
				Ca++	Mg++	K+	Na+	HCO3	CL-	SO4-	Fe	Zn	Mn
2017/18	8.6	8.8	1.1	6.5	6.4	0.4	68	8.7	69.3	6.33	5.4	0.68	3.9
2018/19	8.2	7.9	0.98	6.2	7.3	0.6	79	8.2	65.3	5.33	4.9	0.76	3.2

*pH determined in soil suspension 1:2.5
**Ec determined in soil paste extract

The water source was drainage effluent mixed with canal water before application. The irrigation water was EC 2.01 dS m^{-1}, and SAR 5.5 (mmol L^{-1})$^{1/2}$, whereas the classification of degree of restriction on use was slight to moderate (Ayers and Westcot, 1985).

The trial was a split-plot arrangement with three soil application substances as main plots, 0 (control), humic acid (12 kg ha^{-1}) and beet molasses (60 kg ha^{-1}), and four foliar

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application substances in sub-plot 0 (control), humic, molasses and Nano-boron. The experimental units were in three replications. As a foliar application, humic acid in 1 g/l, molasses 20 cm^3/l, and lithovit in 0.4 g/l were sprayed twice at 45 and 60 days after sowing (DAS).

Molasses level of the soil and foliar applications was determined as Şanli et al. (2015). Lithovit and humic acid levels were used as company products recommend.

A humic substance contains 85% humate potassium, 10% soluble potassium, and 5% fulvic acids. The source of molasses was *Daqahlia* Sugar & Refining Company Kalabshou – Zayan – Belkas/Daqahlia Governorate, Egypt. Chemical and physical analysis of sugar beet molasses was Brix 81%, Total sugar 47%, purity 58%, unfermentable sugar 0.43%, specific gravity 1.42 gm/cm^3, pH 8.2, and Ash 10.56% (Analyzed by Daqahlia Manufacturing Co.). Some mineral analysis for molasses was N 1.3%, P 0.25%, K 3.2%, Ca 0.6%, Mg 0.19%, Na 1.3% and S 0.4%. Lithovit® (Boron 05) is a natural fertilizer; dolomite is tribodynamically activated and micronized to levels of 10-20 microns. Lithovit® (Boron 05) contains 50% (CaCO3) calcium carbonate, 28% (CaO) calcium oxide, 9% SiO_2 silicon dioxide, 15.0% B boron, 1.8% MgO magnesia, 1.0% Fe iron and 0.02% Mn manganese. The source is Agrolink Agricultural Co., Egypt, manufactured in Germany by (Tribodyn, 2020).

Nitrogen fertilizer with a rate of 214 N ha $^{-1}$ in the form of Urea (46% N) was top-dressed in two equal splits at 35 and 70 days after sowing (DAS).

Supplying water to experiments was furrow irrigation. Light irrigation was given after ten days from sowing to ensure high seed emergence. Then, irrigation was carried out when 50 to 60% of the available soil moisture was depleted at 0-30 cm soil depth and was done at intervals of approximately 15 to 21 days depending on weather conditions and the amount of the effective rainfall. The seasonal water applied (irrigation water and effective rain) from sowing to harvesting were 5426 m^3 and 5595 m^3 in the first and second seasons.

The plot was 18 m^2 (3 × 6 m). Each plot had six ridges that were 50 cm apart and 6 m long. Seeds of the multigerm sugar beet cultivar “Cleopatra” were sown at 2-3 seeds per hill in hills 20 cm apart on one side of the ridge. Plants were hand thinned 35 days after sowing to one stable plant hill^{-1}. Plants were thinned by hand after thirty-five days from sowing to one healthy plant hill^{-1}. All plots received 119 Kg. ha^{-1} super phosphate triple (46% P_2o_5) before second ploughing and sulfate potassium (48% K_2O) after thinning in one dose at 60 Kg. ha^{-1}.

Beto 27.4% EC (a.i. Phenmedipham + ethofumesate + desmedipham) was applied at the rate of 1L/fed applied after 21 DAS for annual broad-leaved weed control. Select super 12.5% EC (a.i. Clethodim) was used at 1.19 L ha^{-1} on 24 DAS for annual grassy weed control.

At 180 DAS, five guarded plants were selected randomly from each plot to determine leaf area and dry weight of root and top plant^{-1}. The different plant fractions (leaf blade, petiole, and bulb) were oven-dried to a constant weight at 60 ° C. Leaf area (blades area) was measured by Portable Area Meter (Model LI-3000A). Leaf area of sample plants divided into a ground area of the sample to calculate the Leaf area index (LAI).

At harvest (210 DAS), the central area of three rows 9.5 m^2 avoids the border effect for top and root yield (Ton ha^{-1}). Ten guarded plants were taken randomly and screened for root and top yields/plant, root diameter (cm), and root length (cm).

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Gross sugar (total Sugar content%), K, Na, and α-amino-N in roots were analyzed using Daqahlia Sugar Co laboratory methods. Determination of the sugar content% (Pol%) in the juice was determined using an automatic saccharimeter on lead acetate, according to Le Docte (1927). A flame photometer measured the soluble non-sugar content, K and Na, in meq/100 g of beet according to Brown and Lilleland (1946). α-amino-N according was estimated by a spectrophotometer according to Cooke and Scott (1993).

$$\text{Alkalinity coefficient} = \frac{k + Na}{\alpha\text{-amino-N}} \quad \text{(Reinfeld et al., 1974)}$$

$$\text{Extractable white sugar} = Z_B = \text{Pol} - [0.343\ (K + Na) + 0.094\ N_{BI} + 0.29]$$

according to Harvey and Dutton (1993), where: Z_B = corrected sugar content (white sugar%), Pol = Gross sugar (total Sugar content%) and N_{BI} = α-amino-N determined by the “blue number” method. Loss sugar% = (Gross sugar – Extractable white sugar). Juice purity% was calculated by (Z_B/Pol).

Results

Leaf area, dry weight, root length, and root diameter of sugar beet were affected significantly by soil, foliar, and soil × foliar application interaction (*Table 2*). M (Soil application) treatment had the highest leaf area for 2017 and 2018 at about 3.56 and 5.35, respectively. The differences between M and HA treatments are not significant for LAI in 2017 (*Table 2*).

In terms of dry weight (g plant^{-1}), root length (Cm), and root diameter (Cm), M (Soil application) treatment had the highest values with insignificant differences with HA (Soil application) treatment compared to control (*Table 2*).

Data in *Table 2* show the foliar application of LB can significantly increase leaf area for first and second seasons at about 3.85 and 5.56, Dry weight 353.8 and 353.8 (g plant^{-1}), root length 30.03 and 31.24 cm, and root diameter 13.72 and 13.81 cm, respectively to the highest value compare with other treatments. In contrast, the control gave the lowest values.

LB (Foliar application) with M (Soil application) treatments gave the highest leaf area (*Fig. 1A*), dry weight (*Fig. 1B*), and root diameter (*Fig. 1D*) with an increase (50 and 57.34, 19.22 and 18.09 and 8.14 and 7.62%) in 2017 and 2018 seasons compared to C (Soil application) × C (Foliar application) treatment, respectively. HA (Soil application) and HA (Foliar application) combination caused the highest increase in root length of 24.39% in the first year and LB (Foliar application) with M (Soil application) treatments an increase of 16.54% in the second season in comparison with control C (Soil application) × C (Foliar application) treatment.

Similarly, Şanli et al. (2015) and Priyadarshani (2019) reported molasses increased leaf area, fresh plant weight, and root diameter and root weight of sugar beet. The results are in harmony with Badawi et al. (2013) and Nemeat-Alla et al. (2021), who reported that humic acid increased leaf area, root dry weight, length, and diameter of sugar beet.

A positive effect of lithovit on leaf area, chlorophyll, dry matter of tomato were reported by Sajyan et al. (2019).

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Table 2. *Leaf area index (LAI), dry weight, root length, and root diameter of sugar beet as affected by soil and foliar substances application in 2017 and 2018 seasons*

Treatments	LAI		Dry weight (g plant^{-1})		Root length (cm)		Root diameter (cm)	
	2017	2018	2017	2018	2017	2018	2017	2018
Soil application	0.005**	0.00**	0.044*	0.004**	0.00**	0.001 **	0.03*	0.02*
Molasses (M)	3.56 a	5.35 a	360 a	365.3 a	30.19 a	31.65 a	13.72 a	13.85 a
Humic (HA)	3.50 a	4.82 b	350.6 a	355.2 a	28.88 a	31.44 a	13.58 a	13.7 a
Control (C)	3.27 b	4.61 c	309.2 b	321.2 b	27.8 b	28.54 b	13.28 b	13.18 b
Foliar application	0.000**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
Control (C)	2.86 d	4.19 c	319.4 b	331.8 c	27.36 b	29.73 c	13.14 c	13.27 c
Humic (HA)	3.45 c	4.61 b	342.3 a	357 a	30.01 a	30.68 b	13.59 b	13.53 b
Molasses (M)	3.63 b	5.34 a	344.2 a	346 b	29.75 a	30.53 b	13.68 ab	13.71 a
Lithovit (LB)	3.85 a	5.56 a	353.8 a	354.3 a	30.03 a	31.24 a	13.72 a	13.81 a
Interaction	0.018*	0.001*	0.049*	0.04 *	0.03 *	0.047 *	0.033*	0.049*

*, ** and NS indicate $P < 0.05$, $P < 0.01$, and not significant, respectively. Means of each factor designated by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test

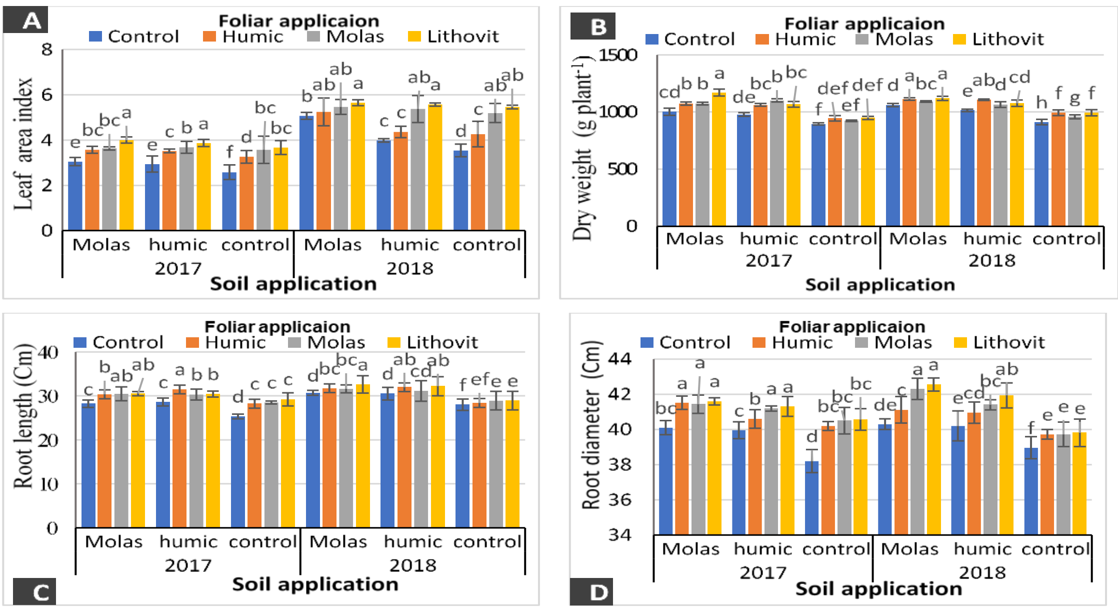

Figure 1. *Leaf area index (A), dry weight (g plant^{-1}) (B), root length (cm) (C), and root diameter (D) of sugar beet as affected by the interaction between soil and foliar application treatments in the 2017 and 2018 seasons*

As observed in *Table 3*, the soil application of M or HA increased the root weight (g plant^{-1}) significantly, top weight (g plant^{-1}), root yield (t/ha), and top yield (t/ha) of sugar beet compared to control. The maximum increase in root weight and root weight (T/ha) treated M (Soil application). There was an insignificant effect between M (Soil application) and HA (Soil application) in top weight (g plant^{-1}) and Top yield (T/ha).

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Data in *Table 3* showed that foliar application treatments had a significant effect on the root weight (g plant^{-1}), top weight (g plant^{-1}), root yield (t/ha), and top yield (t/ha). The root yield (t/ha) and top yield (t/ha) were higher on LB (Foliar application) treatment in both years. LB (Foliar application) gave the maximum root weight (g plant^{-1}) in 2018 and top weight (g plant^{-1}) in 2017. At the same time, there were insignificant differences between HA, LB, and M treatments for root weight in 2017 and top weight in 2018.

Under M (Soil application) treatment, LB (Foliar application) produced a maximum increase at about root weight (g plant-1) (21.34 and 26.45%), top weight (g plant^{-1}) (28.89 and 17.06%), root yield (t/ha) (28.36 and 31.25%) and top yield (t/ha) (28 and 25.15%) in 2017 and 2018, respectively more than C (Soil application) with C (Foliar application) (*Fig. 2A, B, C* and *D*).

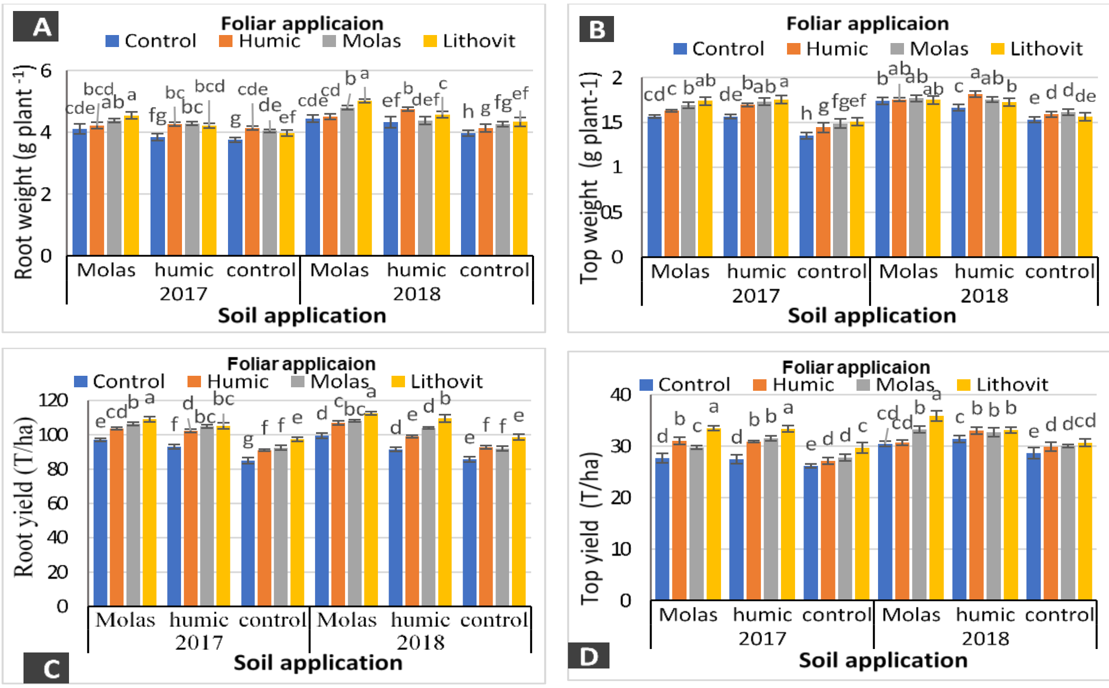

Figure 2. *Root weight (g plant^{-1}) (A), top weight (g plant^{-1}) (B), root yield (T/ha) (C), and top yield (T/ha) (D) of sugar beet as affected by the interaction between soil and foliar application treatments in the 2017 and 2018 seasons*

Such findings had also been pointed out by Priyadarshani (2019); Şanli et al. (2015) for molasses application in sugar beet. Similarly, Rehab et al. (2019) and Nemeat-Alla et al. (2021) for the effect of humic in sugar beet yield. These results are in coincidence with that reported by Artyszak et al. (2014) nano-caco$_3$ in sugar beet, Farouk (2015) lithovit in potato, and Sajyan et al. (2020) in pepper.

Gross sugar (%), Potassium (K) (meq/100 g), sodium (Na) (meq/100 g), K + Na (meg/100 g), α-amino nitrogen (meq/100 g), Alkalinity coefficient were significantly were affected by soil and foliar application in 2017 and 2018 (*Table 4*), except gross sugar (%) in 2017.

M (Soil application) gave the highest gross sugar (%) at 19.84 and 19.2% in the 2017 and 2018 seasons, respectively, which insignificant difference with HA (Soil

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application) treatment. The control (Soil application) treatment had the minimum gross sugar (%) of 18.42 in 2017 (*Table 4*). The control was 18.42% in 2018, with an insignificant difference with HA treatment.

Table 3*. Root weight (g plant-1), top weight (g plant-1), root yield (t/ha), and top yield (t/ha) of sugar beet as affected by soil and foliar substances application in 2017 and 2018 seasons*

Treatments	Root weight (g plant^{-1})		Top weight (g plant^{-1})		Root yield (T/ha)		Top yield (T/ha)	
	2017	2018	2017	2018	2017	2018	2017	2018
Soil application	0.00 **	0.00 **	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
Molasses (M)	1.43 a	1.56 a	0.552a	0.588a	82.56a	84.7a	24.18a	25.85a
Humic (HA)	1.38 b	1.50 b	0.563a	0.582a	80.42b	80.16b	24.44a	25.82a
Control (C)	1.32 c	1.39 c	0.483b	0.524b	72.57c	73.21c	21.97b	23.66b
Foliar application	0.00 *	0.00 **	0.01*	0.00**	0.00**	0.00**	0.00**	0.00**
Control (C)	1.30 b	1.41 c	0.498d	0.549b	72.78d	73.19d	21.52c	23.94d
Humic (HA)	1.40 a	1.48 b	0.529c	0.574a	78.54c	79.02c	23.54b	24.75c
Molasses (M)	1.41 a	1.49 b	0.546b	0.571a	80.35b	80.42b	23.54b	25.39b
Lithovit (LB)	1.42 a	1.54 a	0.557a	0.564a	82.42a	84.8a	25.54a	26.37a
Interaction	0.018 *	0.00 **	0.00 **	0.03*	0.04*	0.00**	0.00**	0.00**

*, ** and NS indicate P < 0.05, P < 0.01, and not significant, respectively. Means of each factor designated by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test

Table 4. *Gross sugar (%), Potassium (K) (meq/100 g), sodium (Na) (meq/100 g), K + Na (meg/100 g), α-amino nitrogen (meq/100 g), Alkalinity coefficient of sugar beet as affected by soil and foliar substances application in 2017 and 2018 seasons*

Treatments	Gross sugar (%)		K (meq/100 g)		Na (meq/100 g)		K + Na (meg/100 g)		α-amino nitrogen (meq/100 g)		Alkalinity coefficient	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Soil application	0.00 **	0.00 **	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00 **	0.00 **	0.00**	0.00**
Molasses (M)	19.84a	19.2a	6.59b	6.9b	2.16b	1.94b	8.75b	8.83b	2.82b	2.08b	3.11b	4.31a
Humic (HA)	19.63a	18.92ab	6.45c	6.93b	2.14b	1.55c	8.59b	8.48b	2.7b	2.08b	3.18a	4.13b
Control (C)	19.1b	18.42b	6.73a	7.02a	2.43a	2.43a	9.2a	9.46a	3.21a	2.33a	2.86c	4.12b
Foliar application	0.00 *	0.00 **	0.01*	0.00**	0.00**	0.00**	0.00**	0.00**	0.00 *	0.00 **	0.01*	0.00**
Control (C)	19.11c	18.58c	6.7a	7.26a	2.31a	2.08a	9.02a	9.32a	2.99a	2.56a	3.03bc	3.65c
Humic (HA)	19.61b	18.72b	6.68a	6.75c	2.21c	1.97b	8.89b	8.75c	2.9b	2.22b	3.07ab	3.94b
Molasses (M)	19.46b	18.75b	6.45b	7.04b	2.18c	1.94bc	8.64c	8.99b	2.88bc	1.96c	3.01c	4.6a
Lithovit (LB)	19.91a	19.33a	6.52b	6.75c	2.26b	1.9c	8.84b	8.63d	2.86c	1.91c	3.08a	4.55a
Interaction	0.17 NS	0.00 **	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00 *	0.01*	0.00**	0.00**

*, ** and NS. Indicate P < 0.05, P < 0.01, and not significant, respectively. Means of each factor designated by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test

The control (Soil application) treatment accounted for the highest potassium (k) (meq/100 g), sodium (Na) (meq/100 g) and K + Na (meg/100 g) of sugar beet among soil application for 2017 and 2018 at about 6.73 and 7.02 (meq/100 g), 2.43 and 2.43 (meq/100 g) and 9.2 and 9.46 (meg/100 g), respectively. C (Soil application) treatment obtained the highest α-amino nitrogen in 2017 and 2018 with (3.21 and 2.33 meq/100 g, respectively). In contrast, C (Soil application) treatments recorded the lowest alkalinity of 2.86 and 4.12 in the first and second seasons, while the difference between C and HA was non-significant in 2018 (*Table 4*).

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Data in *Table 4* showed that the highest gross sugar (%) among the foliar treatments for 2017 and 2018 was recorded in the M (Foliar application) with 19.91 and 19.33%, respectively. C (Foliar application) treatment significantly exceeded other spray treatments in 2017 and 2018 at potassium (k) 6.7 and 7.26 meq/100 g, sodium (Na) 2.31 and 2.08 meq/100 g, and K + Na 9.02 and 9.32 meg/100 g of sugar beet.

C (Soil application) treatment obtained the highest α-amino nitrogen in 2017 and 2018 with 2.99 and 2.56 meq/100 g, respectively. In contrast, C (Soil application) treatments recorded the lowest alkalinity of 3.03 and 3.65 in the first and second seasons.

The Alkalinity coefficient was higher in LB (Foliar application) treatment 3.08 in 2017 and M (Foliar application) 4.55 in 2018.

The data in *Figure 3A* show that the Foliar application and Soil application treatments' interaction was insignificant on gross sugar (%) in 2017. The highest gross sugar (%) values, 19.86%, were obtained with M (Soil application) × LB (Foliar application) treatment in 2018. In *Figure 3B, C, D*, the maximum values of potassium (k) 6.84 and 7.33 meq/100 g, sodium (Na) 2.47 and 2.53 meq/100 g, and K + Na 9.32 and 9.85 meg/100 g of sugar beet in 2017 and 2018 were obtained with the C (soil application) × C (Foliar application) treatment.

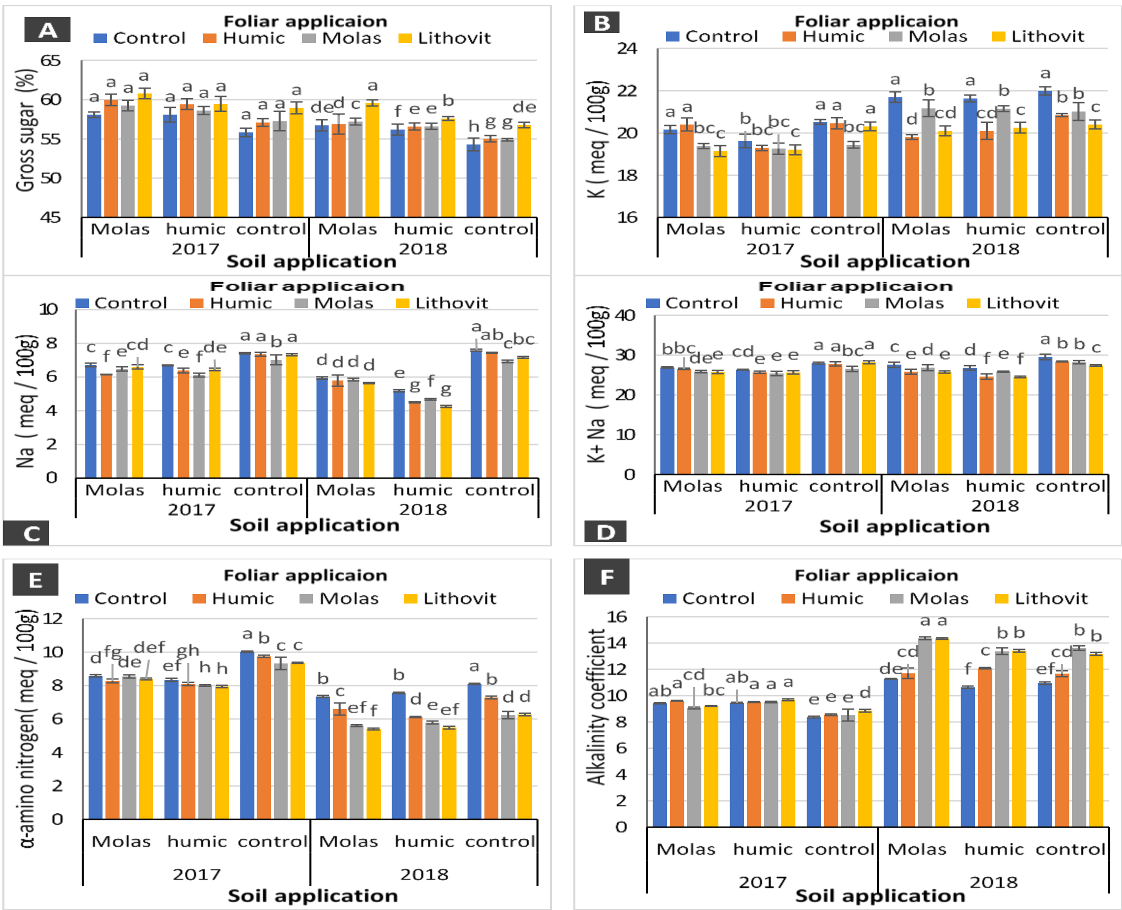

Figure 3. *Gross sugar (%) (A), K (meq/100 g) (B), Na (meq/100 g) (C) and K + Na (meg/100 g) (D), α-amino nitrogen (meq/100 g) (E), Alkalinity coefficient (F) of sugar beet as affected by the interaction between soil and foliar application treatments in the 2017 and 2018 seasons*

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Figure 3E shows the highest values of α-amino nitrogen was obtained by C (soil application) × C (Foliar application) in 2017 and 2018. HA (Soil application) × M (Foliar application) treatment gave the lowest values of α-amino nitrogen in 2017, while M (Soil application) × LB (Foliar application) for α-amino nitrogen in 2018 gave the minimum values.

Under HA (Soil application) with LB (Foliar application) in *Figure 3F*, the alkalinity coefficient had the highest values in 2017, while M (Soil application) × M (Foliar application) treatments gave the maximum value in 2018. C (Soil application) × C (Foliar application) showed the lowest value of alkalinity coefficient in 2017 and HA (Soil application) × C (Foliar application) in 2018. At M (Soil application) × LB (Foliar application) treatment gave the maximum value of extractable white sugar in 2017 and 2018.

The results also agree with (Rahimi et al., 2020; Rassam et al., 2015); Rehab et al. (2019), who use humic acid in sugar beet. Also, molasses improve the chemical and quality of tomato (El-Tokhy et al., 2018); and onion (Mahmoud et al., 2020). Similar results for nano caco$_3$ in sugar beet (Artyszak et al., 2014).

Loss sugar (%), Extractable white sugar (%) and Juice purity (%), and Sugar yield (t/ha) were significantly were affected by soil and foliar application in 2017 and 2018 (*Table 5*).

Data in *Table 5* showed that C (Soil application) treatment obtained the highest sugar loss (%) in 2017 and 2018 with 3.73%. In contrast, C (Soil application) treatments recorded the lowest extractable white sugar (%), 80.45 and 79.82%, Juice purity (%) 15.36 and 14.85%, and Sugar yield (t/ha) 11.43 and 10.91 in the first and second seasons.

Table 5. *Loss sugar (%), extractable white sugar (%) and juice purity (%) and Sugar yield (t/ha) of sugar beet as affected by soil and foliar substances application in 2017 and 2018 seasons*

Treatments	Loss sugar (%)		Extractable white sugar (%)		Juice purity (%)		Sugar yield (t/ha)	
	2017	2018	2017	2018	2017	2018	2017	2018
Soil application	0.00**	0.00**	0.00 **	0.00 **	0.00**	0.00**	0.00**	0.00**
Molasses (M)	3.56b	3.52b	82.12a	81.67 a	16.36a	15.68a	13.59a	13.24a
Humic (HA)	3.49c	3.39b	82.23a	82.09 a	16.15a	15.54a	13.45a	12.86a
Control ©	3.73a	3.73a	80.45b	79.82 b	15.36b	14.85b	11.43b	10.91b
Foliar application	0.00**	0.00**	0.00 *	0.00 **	0.00**	0.00**	0.01*	0.00**
Control (C)	3.67a	3.74a	80.81d	80.02 d	15.44c	14.91c	11.56c	11.05d
Humic (HA)	3.61b	3.49b	81.56c	81.36 b	16b	15.31b	13.08b	12.73b
Molasses (M)	3.52d	3.52b	81.89b	81.05 c	15.94b	15.25b	13.16b	12.47c
Lithovit (LB)	3.57c	3.44c	82.15a	82.34 a	16.45a	15.96a	13.5a	13.11a
Interaction	0.00**	0.00**	0.00 **	0.00 **	0.00**	0.00**	0.02*	0.00**

*, ** and NS. Indicate $P < 0.05$, $P < 0.01$, and not significant, respectively. Means of each factor designated by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test

Extractable white sugar (%) was the highest with HA (Soil application) treatment, while M (Soil application) gave the highest Juice purity (%) and Sugar yield (t/ha). The M and HA treatments were static par in Extractable white sugar (%), Juice purity (%) and Sugar yield (t/ha).

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The loss of sugar% was higher in values of 3.67 and 3.74% in C (Foliar application) in 2017 and 2018. LB (Foliar application) treatment gave the maximum value of extractable white sugar (%) 82.15 and 82.34%, Juice purity (%) 16.45 and 15.96%, and Sugar yield (t/ha) 13.5 and 13.11% in the first and second seasons (*Table 5*).

As shown in *Figure 4A*, the highest loss sugar values were obtained by C (Soil application × C (Foliar application) in 2017 and 2018. HA (Soil application) × M (Foliar application) treatment gave the lowest values of loss sugar in 2017, while HA (Soil application) × LB (Foliar application) for loss sugar in 2018 gave the minimum values.

Data in *Figure 4B* showed that at M (Soil application) × LB (Foliar application) treatment gave the maximum value of extractable white sugar in 2017 and 2018. LB (Foliar application) with M (Soil application) treatments gave the highest Juice purity (%) and Sugar yield (t/ha) in the 2017 and 2018 seasons (*Fig. 4C* and *D*). C (Soil application) × C (Foliar application)) the combination caused the lowest Juice purity (%) and Sugar yield (t/ha) in the 2017 and 2018 seasons.

These results are in agreement with Şanli et al. (2015) for molasses application in sugar beet. Similar, humic acid treatment in sugar beet (Rahimi et al., 2020; Rassam et al., 2015); Rehab et al. (2019.

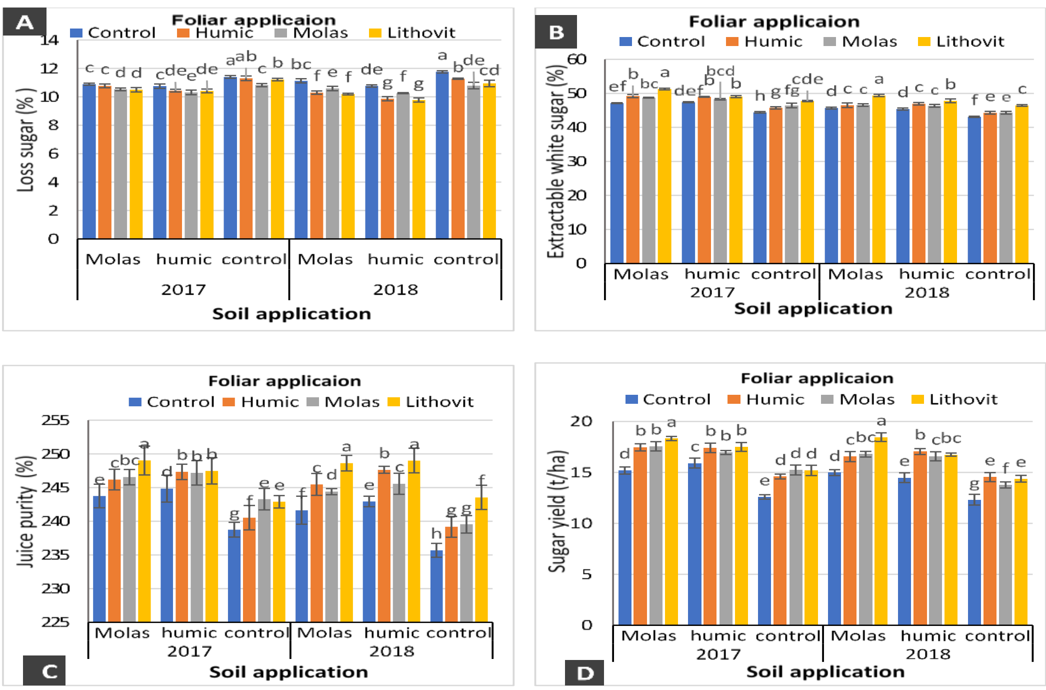

Figure 4. *Loss sugar (%) (A), Extractable white sugar (%) (B), Juice purity (%) (C), and Sugar yield (t/ha) (D) of sugar beet as affected by the interaction between soil and foliar application treatments in the 2017 and 2018 seasons*

Discussion

High salt stress showed an inhibitory effect on the growth and yield of sugar beet (Khorshid et al., 2018; Tahjib-UI-Arif et al., 2019). In the field experiments conducted to observe the soil application treatments (C, M, and HA) in combination with the foliar application (C, HA, M, and LB) for improving growth and yield of sugar beet and alleviate the harmful effects of saline water irrigation and soil.

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LAI, dry weight (g plant-1), root length (Cm), and root diameter (Cm) were enormously improved by M foliar or soil application compared to C treatment. Molasses contains large amounts of mineral elements K, N, P, Ca, Mg, Na, and S necessary for plant growth and development from the chemical composition of M in material and methods. Molasses include humic, fulvic, and amino acids, enhancing physical and chemical properties, biological activity, and soil fertility (Samavat and Samavat, 2014). Şanli et al. (2015) reported that molasses increased by 25% average root weight than control. Molasses soil application was higher than foliar application. Priyadarshani (2019) indicated that leaf area, fresh plant weight, and root diameter were increased in treatment contain molasses amended by soil. (Ramana et al., 2002) found that molasses increased total chlorophyll content, crop growth rate, total dry matter of groundnut. Li et al. (2020) concluded that molasses could encourage the root system, vigor, and nutrient usage in rapeseed planting. The increased weight and yield of the top and root plants was linked with improved LAI plant parameters, dry weight (g plant^{-1}), root length and root diameter. Şanli et al. (2015) recorded a noticeable improvement in root weight, root yield, and biological yield for foliar molasses.

In sugar beet, humic acid applied to the soil or foliar had a significant impact on LAI, dry weight (g plant^{-1}), root length (Cm), and root diameter (Cm) as compared to the control treatment. The humic compound contains organic matter and fulvic acid increase soil physicochemical properties and biological structure (Alsaeedi et al., 2019), enhances nutrients uptake (Gharib et al., 2011), improves cell membrane permeability of plants (Khaleda et al., 2017). Humic has the hormone-like activity response that may stimulate cell division and differentiation that enhance growth under salinity stress (Ouni et al., 2014), regulate the photosynthetic rate and cell elongation, and improve the water use efficiency (Zhang et al., 2013). Ali et al. (2020) indicated that HA increased root length, total dry weight, shoot length of sorghum in salinity soil. The HA foliar applications enhanced chlorophyll content and leaf area index (Khodadadi et al., 2020). Exogeneous fulvic acid on sugar beet gave the most outstanding root length values, root diameter, and root weight (Kandil et al., 2020). Kandil et al. (2020) in sugar beet that fluvic acid gave the maximum root weight (g)/plant, root yield (t/fed), and Top yield (t/fed), and Khodadadi et al. (2020) indicate that humic increased root yield (T/ha) of sugar beet. Rehab et al. (2019) found that humic acid foliar application gave the highest root and top yield (T/ha) of sugar beet. In past studies, foliar application of humic increased root yield (T/ha) of sugar beet (Rassam et al., 2015).

The foliar application of lithovit improved the growth and yield of sugar beet. Lithovit increases CO2 level inside the leaf intercellular, thereby improving photosynthesis (Bilal, 2010). It contains Mg, Ca, Fe, and Si, promoting effect through increased chlorophyll and carotenoid pigments. This compound improved weight and water content of plant parts cause better water movements in plants under salinity stress (Issa et al., 2020). In the previous study, nano-calcium had the promoting effect on plant growth, such as leaf area and plant dry weight of green bean plants and Ca and Si, mitigated salinity’s negative impact (Gomaa et al., 2017). Lithovit enhanced chlorophyll content, leaf area, and dry matter of tomato in saline soil (Sajyan et al., 2019).

Lithovit@B is rich in boron. B foliar significantly increased the leaf area, root weight, length, and diameter of sugar beet (Kandil et al., 2020; Pirzad et al., 2019). The foliar application treatments with LB effectively enhanced root weight (g plant-1), root yield (t/ha), and top yield (t/ha) because of improving growth parameters like LAI, dry weight (g plant-1), root length, and root diameter. The positive effects of LB foliar

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application on root and shoot dry weight and pepper yield inform Sajyan et al. (2020). The mean yield of tomato is superior under the LB foliar application (Becherescu et al., 2017). The micronized marine calcite (CaCO3) compound increases the leaves and root yield of sugar beet (Artyszak et al., 2014).

Excessive Na in the salinity soil has detrimental effects on plant growth and physiology. Low gross sugar in control compared to other soil and foliar application treatments in saline soil may be ascribed to the dilution of sucrose in root through increased water content and also, gave low quality (high K meq/100 g, Na meq/100 g, and K + Na meg/100 g cause the high Na concentration (Tsialtas and Maslaris, 2009). The high a-amino-N compounds may be found as impurities in plants' storage roots under saline conditions, resulting from osmotic adjustment (Brown et al., 1987). The lowest value in control treatment may be due to the more significant amounts of a-amino-nitrogen than other treatments.

The highest value of loss sugar and the lowest means Extractable white sugar (%) and Juice purity (%) and Sugar yield (t/ha) for control compared to other soil application or foliar application treatments. It might be due to increasing K, Na, and α-amino nitrogen in juice roots, which causes troubles during juice purification and crystallization and, in turn, decreased purity and decreased extraction of white sugar (%).

Molasses has elements like K, P, S, Ca, and Mg. Molasses also contains different amounts of humic and fulvic acids and amino acids exhibiting hormone-like activity (Samavat and Samavat, 2014). molasses containing glycine betaine material are compatible solutes in osmotic adjustment and increased the net photosynthesis of water-stressed tomato plants (El-Tokhy et al., 2018). Şanli et al. (2015) concluded that foliar or soil application of molasses increased sugar content (%). Molasses treatments increased sugar yield by 2.9 t/ha compared to control (Şanli et al., 2015).

HA increased the uptake of P, K, Mg, Na, Cu, and Zn, so mitigate the saline's negative effect (Khaled and Fawy, 2011). (Rahimi et al., 2020; Rassam et al., 2015); Rehab et al. (2019) reported that humic application gave greater white sugar (%) than control while humic treatment was lower in α-amino nitrogen% and sodium% than control. (Rehab et al., 2019). El-Hassanin et al. (2016) reported that foliar application of humic acid increased extractable white sugar, purity, and sugar beet yield. Applying humic acid improved the percentage of sucrose and refined sugar compared with the control (Rassam et al., 2015). Fulvic foliar application increased the sugar yield and the portions of sucrose, TSS, and purity of the sugar beet plants (Kandil et al., 2020).

Lithovit® (Boron 05) contains nano-CaCO$_3$, 15.0% B boron, 9% SiO2, and other nutrients like Fe, Mg, and Mn. In a past study, the positive effects of marine calcite (containing CaCO3 and silicon mainly) foliar fertilization in lower Na and K, on the other hand, gave higher sugar beet content (Artyszak et al., 2014). Lithovit treatments gave the lowest sodium contents and recorded the highest sugar content (%) in the tomato fruits compared to control (Sajyan et al., 2018; Tantawy et al., 2014). (Rehab et al., 2019) indicated that foliar application of boron improved sugar and reduced Na and K. Lithovit improved the total soluble solids and soluble sugar concentrations compared to control in potato tubers (Farouk, 2015). The marine calcite (containing CaCO3 and silicon mainly) foliar resulted in increased content of refined sugar (%) and technological sugar yield (t/ha) (Artyszak et al., 2014). (Shallan et al., 2016) indicated that lithovit increased the total Soluble Sugars in leaves of cotton.

The integration of M (Soil application) treatment with LB (Foliar application) produced a maximum increase at LAI, root weight (g plant-1), top weight (g plant^{-1}),

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root yield (t/ha) and top yield (t/ha). Jiang et al. (2012) indicated that increased tillering, chlorophyll and yield relative to traditional fertilization through the amendment of condensed molasses soluble (CMS) in sugarcane resulted in enhanced physical and chemical soil characteristics. CMS application benefits crop productivity and physical soil structure enhancement and a rise in the biological activity of beneficial microorganisms (Wynne and Meyer, 2002). The CMS enhanced plant biomass, root vigour, and the superoxide dismutase function of the rapeseed shoot (Li et al., 2020). Molasses are rich in mineral elements and used as K sources due to their elevated levels. It also has critical other advantages, such as soil organic growth and nitrification-related microbial behaviour (Turner et al., 2002). According to Pujar (1995), foliar application of molasses improved Zn, Cu, Fe, and Mn uptake in corn and wheat.

LITHOVIT® or nano-CaCO3 is a carbon foliar fertilizer (Bilal, 2010), which increases CO2 concentration and stimulates light-saturated photosynthesis in C3 plants (Ainsworth and Rogers, 2007). Maswada and Abd El-Rahman (2014) demonstrated that using lithovit on wheat under natural or salinity stress significantly increased growth parameters, photosynthetic pigments, ion contents, yield, and components. Under salinity stress, Lithovit increased leaf area, dry matter, and total chlorophyll content of tomato (Sajyan et al., 2019). Lithovit foliar application greatly improved potato growth parameters (i.e. plant height, branch number per plant, shot fresh and dry weights, and leaf area per plant), potato tuber number and overall tuber yield per plant (Farouk, 2015).

Lithovit product contains B, silica, and Fe. Compared to the control treatment, foliar fertilization with marine calcite (Calcium carbonate (CaCO3) and silicon) improved root yield, leaf yield, and biological sugar output of sugar beet. Simultaneously, a beneficial influence on the technical quality of the roots was discovered. It resulted in a substantial decrease in alpha-amino-nitrogen content, as well as a reduction of potassium and sodium content (Artyszak et al., 2014). Pirzad et al. (2019) found that boron foliar application resulted in the highest yield of the root, sugar, and white sugar contents but decreased impurities (Na, K, and -amino-N) and molasses sugar percentage.

Conclusions

M could enhance the growth, yield, and quality of sugar beet under saline water and soil. Lithovit demonstrated the most significant advantages for biological and technical sugar yields. As a result, LB may be used as an agricultural fertilizer in the cultivation of sugar beet. In summary, the findings indicated that using an environmentally friendly Nano Caco3 foliar fertilizer (lithovit) and molasses soil fertilizer (by-products industrial process of sugar production) is beneficial for sugar beet development in saline soil and water. A long-term study for molasses and lithovit is needed to clarify product efficiency, optimal doses, application time and the methods used to improve the efficiency of the used product for different crops.

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