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Partial Replacement of Nitrogen Fertilizer with Algae Extract for Enhancing Sugar Beet Productivity and Quality under Different Plant Densities

Elham A.Badr, Gehan A. Amin, Magda H. Mohamed and D.M. Sabra*
Field Crops Research Department, Agricultural and Biological Research Institute, National Research Centre, 33 El Bohouth St., Giza, Egypt. P.O. 12622

RECENTLY, there has been a rapid increase in the use of nitrogen fertilizers to increase the production of sugar beet crops, despite their negative impact on the environment and human health, and their higher cost. Therefore, the aim of the research is to partially replace nitrogen fertilizers with algae extract.

Two field experiments were conducted in the Experimental and Production Station of the National Research Center in Nubaria, Beheira Governorate, Egypt. Sugar beet (*Beta vulgaris* var. Ras poly) was grown in sandy soil with a sprinkler irrigation system to study the effect of different planting densities and foliar application with algae extract and nitrogen on yield, yield components and quality characteristics throughout the winter seasons in 2019/2020 and 2020/2021. The combined studies showed that nitrogen fertilizer+foliar application of algae extract and planting density had a significant impact on growth parameters. Decreasing planting density from 50000 plants/fed to 40000 or 30000 plants/fed.(hectare = 2.4 fed) significantly increased root length, root diameter and fresh root weight/plant. The highest values of growth characters measured by less plant density 30000 plant/fed and 100 kg/N+ 1.5 g/L algae extract. At the greatest plant density (50000 plants/fed.), the top, root, and sugar production (ton/fed.) exhibited the highest value, whereas at the lowest plant density (30000 plants/fed.), the lowest value was recorded. The maximum percentages of sucrose, purity, and extractable sugar were achieved by applying 80 kg of nitrogen per fed, plant density (50000 plants/fed) and spraying 2.5 g/L of spirulina extract on beets.

Keywords: Sugar beet**,** planting density, algae extract, quality parameters.

Introduction

Sugar beet (*Beta vulgaris L.*) is the second crop for sugar production in Egypt after sugar cane. Provide over 30% of the world's total output, and they are easily adaptable to many climatic variables, such as climate (El Hag Mohammad et al., 2015). As a potential supplemental crop for expanding local sugar production in Egypt, sugar beet offers various benefits. It is classified as an industrial crop since it is used to make a variety of products such as alcohol, fodder, and a variety of other items.In recent years, sugar beet crops have gained popularity as a winter crop in local crop rotations, both in fertile soils and in less fertile, salty, astringent, and calcareous soils.It might also be economically farmed in recently reclaimed soils. Planting density, plant dates, nitrogen fertilization, and bio-fertilization are all significant agricultural strategies for increasing sugar beet yield. For all field crops, but particularly for sugar beet, the planting density is regarded as one of the most crucial variables. Growing, yielding, and root quality are all positively impacted by it. Maximizing sugar beet productivity and quality can be accomplished by employing optimal planting density, which is regarded as a critical element influencing sugar beet production and quality. In this respect (El-Ghareib et al., 2012) and (El-Hity et al., 2014) revealed that

*Corresponding author mail: deyaa_nrc@yahoo.com
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planting densities of 48000, 46666, 42000, 56000, and 52000 plants/fed yielded the maximum root, top, and sugar yields/fed, root length and diameter, fresh weight/plant, sucrose (%), and purity (%), respectively. On the other hand, sugar beetroot planted at a density of 28000 plant/fed yielded the greatest values for fresh weight /plant, root length, and diameter (Sarhan et al., 2012). Furthermore, Varga et al. (2015) found that average root weight were lower with smaller intra-row spacing (13 and 15 cm) than with greater intra-row spacing (17 and 19 cm). Additionally, (Yasin 2017) came to the conclusion that dense planting of 42000 plant/fed led to the maximum root yield/fed, however, root yield characteristics and sugar loss in molasses (SLM%) were impacted by reducing planting density to 33600 and 28000 plant/fed. Sugar beet cultivation techniques including variety, planting date, and population density have an impact on its composition. A vital economic crop across the world is sugar beet. Additional crop management strategies are needed to maintain the production of this crucial commodity. The wide -leaved crop also acts as a soil conditioner, particularly in recently farmed soils that have low organic matter and water-holding capacity, as well as high leaching of nutrients that result in symptoms of macro and micronutrients deficiencies. (Shafeek et al., 2013). Nitrogen nutrition has a substantial impact on root sugar beet production and quality, with a lack of nitrogen causing a significant loss in root yield and excess nitrogen causing a considerable decrease in sucrose content of the root and excessive leaf growth (Zaki et al 2018). Algae extract is regarded as a significant source of nourishment for sustainable agriculture, particularly in recently recovered soil, due to its organic and biodegradable nature. Chemical examination of algae extract has shown a number of plant growth regulators, including auxins and cytokinins, in various concentrations (Zhang & Ervin, 2004). Algae extract therefore encourages plant vegetative growth and root establishment as well as root elongation. Algae extract applied topically has been shown to have a wide range of beneficial benefits, including increased nutrient absorption, improved crop production and quality, and increased resilience to frost and stressful environmental conditions.A significant increase in the weights of roots both fresh and dried, total biomass, yield component, photosynthetic pigments, and hormones that stimulate growth are all brought about by algae, which were once thought to be a significant group of microorganisms capable of fixing atmospheric nitrogen (Ghalab& Salem, 2001). By increasing the quantities of total carbohydrates, starch, amino acids, and protein, the functional activity leads to an expansion of the photosynthetic apparatus (Raupp & Oltmanns, 2006 and Yassen et al., 2007). Spirulina platensis is a strong source of potassium and also includes significant levels of Ca, Cu, Fe, Mg, Mn, P, and Zn, which helps plants absorb and accumulate these elements. This also explains why most crops, especially those cultivated in semi-arid and desert environments, have significantly increased vegetative growth and yield, along with their components' levels of nitrogen, phosphate, and protein in the leaves and chlorophyll content. (Abd El-Mawgoud et al., 2010 and Marrez et al., 2014).

Materials and Methods

Site Description: Two field experiments were conducted at the newly reclaimed lands that affiliated to National Research Centre and located at the East side of Cairo-Alexandria desert road, at Al-Emam Malek Village, North Tahrir, El-Beheira Governorate, Egypt, The farm is at a latitude of 30° 30′1.4″ N, a longitude of 30° 9′ 10.9″ E, and a 21m mean altitude above sea level. Through out winter seasons, sugar beet plants were cultivated on 14^{th} October in both investigated seasons (2019 and 2020/2021), to study the effect of different planting density and algae extract foliar application with in addation to nitrogen fertilization on yield, its components and quality characters of Sugar Beet (*Beta vulgaris* var. Ras poly) cultivar that obtained from Sugar Crops Research Institute, Agric., Research Center, Ministry of Agriculture, Egypt, that planted in a sandy soil under sprinkler irrigation system. There were three planting density of (50000, 40000 and 30000 plants/fed). Each planting density was conducted in a separate experiment. A split-plot design with three replicates, the planting density were used in main plotsand Algae extract (*Spirulina platensis*) were allocated in subplots, the algae extract was sprayed as foliar application at two filtrate concentrations; 120 kg/N, (control), 100kg/N +1.5g/L and 80 kg/N +2.5 g/L/200 liter water/fed). The plot area was 21.60 m^2 including 12 rows of 4m in length and 45cm between them, with 17cm hill spacing with one seed per hill. Phosphorus fertilizer was applied in the form of calcium super phosphate (15 % P_2O_5) at the rate of 200 kg/fed during soil preparation. Nitrogen fertilizer was applied as ammonium nitrate (33.5% N), Potassium fertilizer in the form of potassium sulfate (48%) was added at the rate of 48 kg K_2O/fed with the first dose of N. Other culture practice procedures were done as recommended. A multiple soil sample was gathered from the soil depth of (0-30 cm), air-dried, sieved by 2 mm sieve and analyzed. The physical and chemical properties of soil as illustrated in Table (1) were determined according to A.O.A.C. (2005). The meteorological data for the two growing seasons, which included monthly average values of maximum and minimum air temperature ^{o} C, relative humidity % and rainfall are presented in Table (2).

The Algae, Spirulina platensis and preparation for the study

S. platensis strain was isolated from Al-Khadra Lake, Wadi Al-Natroon, El-Baheira governorate, Egypt. Isolation, purification, Morphological identification and production to massive scale were performed at Algae Biotechnology Unit, National Research Center. Homogenate was prepared by a suspension of dry *S. platensis* in deionized water (in a ratio 1:10) and mixing (Thermomix TM5; USA) at 37 °C for 40 min. (500 rpm). The obtained solution was centrifuged for 20 min. (4600 rpm) (HeraeusMegafuge 40, rotor TX-750, Thermo Scientific, and Waltham, MA, USA). Supernatant was separated and treated as an algae filtrate (AF)—100%. Three samples were taken for determination of Macro minerals and trace elements by Algae Biotechnology Unit, National Research Center. Samples were irradiated, together with standard reference materials; two standard reference materials were used: the European Inter-Institutes Committee (CII) “Alfa-Alfa” and the Bureau Communautaire de Référence “Lucerna Flour”. Major components of the used algae filtrate are appeared in Table 3.

TABLE 1. Pre-treatment mechanical and chemical parameters of the soil experimental.

Properties	Sand %	Silt %	Clay %	pH	OM %	$CaCo_3$	EC ds/m	Soluble N (ppm)	Av. P (ppm)	Ex. K (ppm)
2019/2020	92.05	3.9	4.1	8.30	0.25	4.8	0.30	8.1	0.29	10.02
2020/2021	91.20	3.7	5.1	8.15	0.34	2.9	0.36	7.65	0.35	13.65

TABLE 2. The data on maximum andminimum temperatures, relative humidity, andwind speed recorded from the local weatherstation at El-Nubaria Farmin 2019/2020 and 2020/2021 seasons.

Average Monthly for both seasons 2019/2020 and 2020/2021	T_{Max}	T_{Min}	RH %	Wind	Rain
Oct	28.67	19.77	60.43	3.23	2.2
Nov	25.90	11.95	55.50	3.43	2.3
Dec	22.15	12.23	63.61	3.57	5.4
Jan	19.85	8.75	60.71	3.48	17.6
Feb	20.12	9.45	61.58	3.65	18.9
Mars	25.**00**	11.27	51.74	4.28	7.37
April	29.55	15.22	48.34	4.39	4.5

T_{max}= Maximum air temperature degree , T_{min}= Minimum air temperature degree , RH= Average relative humidity (%), Rain= Average precipitation (mm/day), Wind= wind speed(m/s).

TABLE 3. Chemical composition of some macro and micro-nutrients of algaeextract bio fertilizer.

Elements	**%**						**ppm**			
	N	**P**	**K**	**Mg**	**Na**	**Ca**	**Fe**	**Zn**	**Mn**	**Cu**
Conc.	**11.2**	**1.65**	**0.88**	**0.22**	**0.01**	**0.33**	**1936**	**21**	**68**	**18**

Data Recorded: The outer two ridges were considered as a belt, while a plant of the 2nd ridge was used for growth analysis. The other ridges, 3*rd*, 4*th* and 5*th* were kept for determination of yield, yield components and technological quality. For determining growth analysis, a random sample of five plants was taken from each plot of every replication after 6 months (at harvest) from sowing during both seasons to determine the following parameters:

A- Growth characters:
1-Root(length (cm), diameter (cm),
2- Root (fresh weight and dry weight (g/plant)3-Top(fresh weight and dry weight (g/plant) photosynthetic pigments (chla, chl b and carotenoids (mg/g.fresh weight)

B- Yield components:
1- Root yield (ton/fed.)
2- Top yield (ton/fed.)
3- Sugaryield (ton/fed.)

C- Quality traits: Sucrose percentage was determined by using Sacharimeter according to Le-Docte (1927). Total Soluble Solids (TSS %) was determined by using digital referactometer. Juice purity percentage (%) was determined according to the method of Carruthers and Oldfield (1961).

Potassium (K) and Sodium (Na) were measured in the root dry weight at harvest time, by using the Flame photometer. α- amino nitrogen was also calculated by double beam filter photometry using the blue number method (Sheikh_Aleslami 1997).

Sucrose loss to molasses (SLM) = 0.343*(K+ Na) + 0.0393* α- amino N + 0.31

Extractable sugar % was calculated using the following equation according to (Cooke & Scott 1993):
Quality% (QZ%) = QZ = (ZB × 100)/ (α- amino N)

Statistical analysis:

The obtained data of the two seasons and their combined analysis were computed according to Snedecor and Cochran (1980). Combined analyses between two seasons were calculated according to McIntosh, M. S. (1983). The treatment means were compared by using the least significant difference (L.S.D) test (Waller and Duncan, 1969) at 5% level of significance.

Results and Discussion

A-Growth characters
A-1-Effect of Planting Densities:

The data presented in Table (4) showed that the examined planting densities had a substantial impact on root (length, diameter, fresh and dry weight) as well as top fresh and dry weight per plant (g). It could be concluded that, decreasing planting density from 50000 plant/fed to 40000 or 30000 plant/fed. significantly increased all studied growth characters. These results may explain that low planting density of 30000 plants/fed. minimize the inter competition between plants which led to high light use efficiency of solar radiation utilized by plants. In this connection, (Sarhan et al., 2012) studied the effect of planting density (46000, 35000 and 28000 plants/fed.) on sugar beet and they found that sowing sugar beet plants with low density (28000 plants/fed.) recorded the highest valuesof root length and diameter as well as fresh root weight/plant. Fig (1) show that the effects of plant density on photosynthetic pigments (Chla, Chlb and carotenoids) significant differences were observed among plant density. Decreasing planting density from 50000 to 40000 or 30000 plant/fed increasing photosynthetic pigments. These findings may provide an explanation for the low planting density of 30,000 plant/fed, which reduces plant competition and increases the amount of solar radiation that plants may use for light. There after high in the conversion of light energy to chemical energy and, as a result, high in the dry matter accumulation. The obtained results are in agreements with those noticed by Yasin (2017) and (Ehssan et al., 2019).

A-2-Effect of nitrogen fertilizer with foliar application of algae extract

Data in Table 4 and Fig(1) show that nitrogen fertilizer and Spirulina extract significantly affected photosynthetic pigments, root (diameter and length) and (fresh and dry) weights/plant of the root and foliage in both seasons. In comparison to the other levels (i.e., control and 2.5g/L), spraying beet plants with Spirulina extract1.5 g/L+100 kg/N or 2.5 g/L+80 kg/N increased the levels of photosynthetic pigments and root thickness as well as fresh weight of leaves and roots. The significant impact of algae extract may be attributed to its capacity to raise cell membrane permeability and promote plant efficiency in nutrient absorption, which is directly connected to leaf chlorophyll concentration. Additionally, the presence of cytokinins in algae extract may contribute to its ability to delay the ageing of leaves by slowing down the breakdown of chlorophyll. Algae extract also functions as a bio-regulator, influencing the balance of plant respiration and photosynthesis (Raupp & Oltmanns, 2006, Yassen et al., 2007, Enan et al., 2016, Elham et al.,2017 and Alice et al., 2019).

A-3-The interaction effect of plant density and nitrogen fertilizer with foliar application of algae extract

Growth character traits were strongly influenced by the combination of nitrogen, plant density, and foliar application of algae extracts. Were reacted to the increase in foliar Spirulina extract level, but that the response was highly magnitude by plant density (30000 plants/fed.), according to the results in Table (4) and Fig. (2). Given that algae extract contains cytokines that stimulate physiological processes and raise total chlorophyll in plants, which influences photosynthesis and the synthesis of compounds that will favorably affect growth characteristics, it is plausible that the maximum value of growth characteristics, as measured by less plant density (30000 plant/fed), will result from this extract. And100 kg/N+ 1.5 g/L algae extract is the result of this (Enan et al., 2016 and ELSayed et al.,2018).

TABLE 4. Effect of plant density and nitrogen fertilizer with foliar application of algae extract on growth characters of Sugar beet (combined two seasons).

Treatments		Root				Top	
		Length (cm)	**Diameter (cm)**	**Fresh wt. (g/plant)**	**Dry wt. (g/plant)**	**Fresh wt. (g/plant)**	**Dry wt. (g/plant)**
50000 Plant/fed.		32.44	12.81	910.33	110.3	475.73	58.57
40000 plant/fed.		35.45	13.48	1004.92	128.34	527.97	70.47
30000 plant /fed.		36.33	14.7	1106.58	139.51	539.39	72.78
L.S.D 5%		**0.67**	**0.40**	**5.13**	**3.11**	**8.70**	**1.4**
Nitrogen fertilizer with foliar application of algae extract							
80 kg/N+ 2.5 g/L		32.20	12.94	983.90	119.20	489.33	61.85
100 kg/N +1.5 g/L		34.46	13.96	1015.57	128.38	524.10	69.44
120 kg/N (control)		37.57	14.09	1022.35	130.57	529.66	70.53
L.S.D 5%		**0.71**	**0.42**	**4.56**	**2.35**	**3.14**	**1.20**
50000 plant/fed.	80 kg/N+ 2.5 g/L	32.65	11.71	894.86	110.96	473.85	52.15
	100 kg/N +1.5 g/L	33.19	11.93	909.94	116.87	488.01	57.65
	120 kg/N (control)	33.69	12.43	924.74	118.73	500.23	61.26
40000 plant/fed.	80 kg/N+2.5g/L	34.42	13.15	980.19	120.91	504.34	62.96
	100 kg/N +1.5 g/L	34.77	13.83	997.86	123.52	515.47	66.25
	120 kg/N (control)	34.91	13.94	1017.52	127.51	528.84	68.05
30000 plant/fed.	80 kg/N+ 2.5 g/L	35.74	14.19	1090.07	128.84	533.53	73.80
	100kg/N +1.5 g/L	36.48	15.70	1120.30	140.51	541.15	80.85
	120 kg/N (control)	36.85	16.08	1129.99	146.64	543.83	82.48
L.S.D 5%		**0.89**	**0.83**	**10.23**	**3.20**	**5.55**	**1.22**

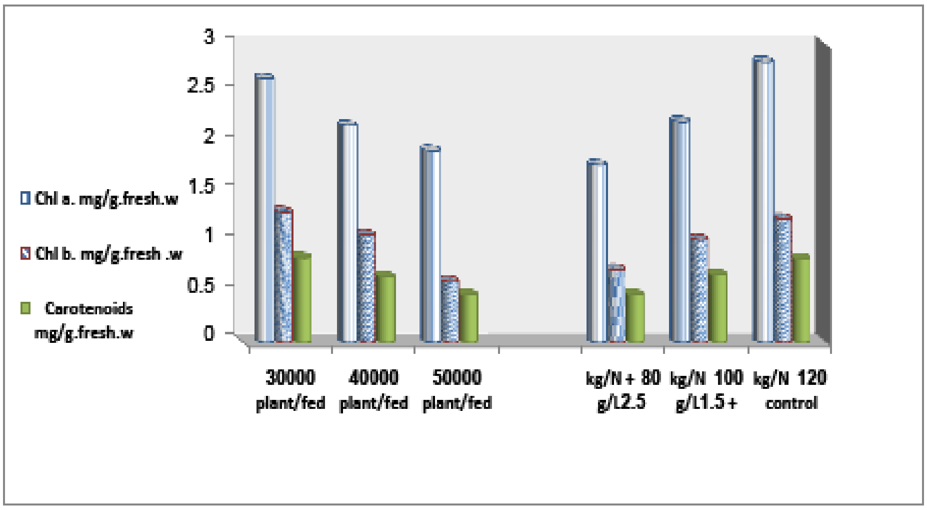

Fig. 1.The effect of plant density and nitrogen fertilizer with foliar application of algae extract on photosynthetic pigments in Sugar beet.

L.S.D at 5% for chla (plant density):0.50chl b :0.35 carotenoids:014
L.S.D at 5% for chla (nitrogen +foliar of algae):0.40chl b :0.25 carotenoids:0.10.

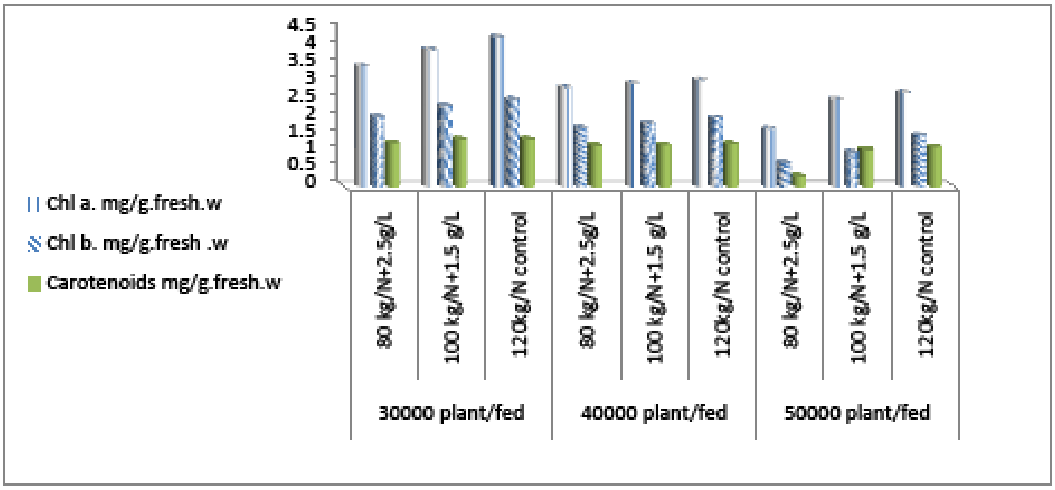

Fig 2. the interaction effect of plant density and nitrogen fertilizer with foliar application of algae extract on photosynthetic pigments in Sugar beet.

L.S.D at 5% for chla: 1.53chl b: 0.75 carotenoids: 0.56.

B-Yield and yield components:

B-1- Effect of Planting Densities:Fig(1)

Plant density was significant effect on yield and its components. The highest value of top, root and sugar yield (ton/fed.) Table 5 at highest plant density (50000 plants/fed.), while the lowest value top, root and sugar yield at lowest plant density (30000 plants/fed.). It seems that increased plant density did not compensate for the reduction in dry matter accumulation and root weight accompanying plant density. It could be concluded that, decreasing planting density from 50000 plants/fed. to 40000 or 30000 plants/fed. significantly increase droot length, root diameter and fresh root weight/plant. These results may explain that low planting density of 30000 plants/fed minimize the inter competition between plants which led to high light use efficiency of solar radiationutilized by plants. In turn high in the conversion of light energy to chemical energy and consequently high accumulation of dry mater and increase of yield and its attributes. A similar result was obtained by Elham (2006) who found that plant density of 50000 plant/fed. produced the highest root and sugar yield compared to the low density 30000 plant/fed**.** Also, the obtained results are in agreements with those noticed by El-Ghareib et al., (2012), El-Hity et al., (2014) and Yasin (2017).

B-2-Effect of nitrogen fertilizer with foliar application of algae extract

The relationship between foliar algae extract application and nitrogen fertilization had a significant impact on all production characteristics. The results in Table (5) demonstrated that they responded to an increase in nitrogen fertilization level, but only to a large extent when 120 kg/N was added. As a result, the highest yield characteristics. It also gave the same results using 100 kg/N and foliar spraying with algae extract at 1.5 g/L. Therefore, foliar spraying led to a reduction in the nitrogen fertilization rate from 120 to 100. Except for sugar yield, spraying beets with 1.5 g/L Spirulina extract and adding 100 kg N/fed., yielded higher results.It is appropriate to note that the quality of sugar beets is a complex cycle that is influenced by a number of factors (Elham et al. 2017). For responsible sugar production, the specialized character of sugar beetroot is essential. It specifically depends on the beet's artificial organization. The primary factor affecting sugar beetroot preparation is its substance production. To increase the amount of extractable sugar, sugar factories need beetroot with high Sucrose concentrations and low concentrations of melassigenic chemicals (Thalooth et al., 2020).

B-3-The interaction effect of plant density, nitrogen fertilizer with foliar application of algae extract

Table (5) shows that the nitrogen fertilization levels were increased from 80 to 100 and 120 kg N/fed all yield segments collectively increased. Of all the considered yield components, sugar beetroot plants that were prepared with 120 kg N/fed., of provided the most significant estimates**.** After the highest level of nitrogen fertilization with crucial contrasts and association with various levels, use of 100 kg N/fed+1.5 g/L foliar spraying with algae extract. Led to the finest discoveries. While the plants that received nitrogen fertilization (80 kg N/fed.+1.5 g/L foliar spraying with algae extract.) were the ones that obtained the most decreased ones. But that the response was highly magnitude by plant (50000 plant/fed.). The data in Table (5) demonstrate that the production of sugar beet was positively impacted by increasing plant density from 30 to 50 thousand plants fed. The lowest values of the interaction of plant density (30000 plant/fed.), nitrogen and foliar application with algae extract (80kg/N/fed.+2.5g/L). Similar results were obtained by Elham (2006) discovered that a plant density of 50000 plant / fed generated the maximum root and sugar output when compared to a low density of 30000 plant/fed. Abd El- Kader (2005) discovered that a plant density of 56000 plant/fed gave the maximum root and sugar production when compared to a low density of 33600 plant/fed. Also, the obtained results are in agreements with those noticed by El-Ghareib et al., (2012), El-Hity et al., (2014) and Yasin (2017).

IV. Quality parameters:

Regarding the effect of plant densities on sugar beetroot plant quality measures, significant variations were found (Table 6). In the treatment with 50000 plant density, the maximum values of sucrose, purity, extractable sugar, N, K, and α-amino N were observed. Put another way, the increased plant density from had a good impact on all the earlier traits. Conversely, the maximum quantity of sugar lost to molasses was 6.01 under a density of 30000 plants. This outcome is in line with earlier studies by (Ismail and Allam 2007). Masri (2008), Entessar et al. (2015), and Heba (2017) noted that increasing plant density from 87500 to 100000 plants ha-1 had a favorable effect in this regard and considerably boosted the production of sugar, sucrose content, purity, and extractable sucrose.. Wider plant spacing, they said, invariably produced less sugar. According to Khaiti (2012), when plant populations declined and the gap rate rose, low-quality plants grew and the amount of non-sugar content rose, which in turn raised the amount of extractable sugar content and, ultimately, the yield of recoverable sugar. These outcomes might be the result of improved nutrient utilization and maximal light absorption, which led to improved leaf growth.The interaction between nitrogen fertilizer with foliar application of algae extract significantly effect on sucrose (%), purity (%) and extractable sugar (%). The highest values of sucrose (%), purity (%), and extractable sugar (%) were obtained by spraying beets with 2.5 g/L of spirulina extract and adding 80 kg of nitrogen per fed, according to Table (6). In the meantime, foliar application of algae extract and nitrogen fertilization had no significant influence on alpha-amino-N, K%, Na%, and sugar lost molasses (SLM %). These finding are in agreement with that mentioned by (Enan et al., 2016).

TABLE 5. Effect of plant density and nitrogen fertilizer with foliar application of algae extract on yield and its compounds of Sugar beet (combined two seasons).

Treatments		Root				Top	
		Length (cm)	Diameter (cm)	Fresh wt. (g/plant)	Dry wt. (g/plant)	Fresh wt. (g/plant)	Dry wt. (g/plant)
50000 Plant/fed.		32.44	12.81	910.33	110.3	475.73	58.57
40000 plant/fed.		35.45	13.48	1004.92	128.34	527.97	70.47
30000 plant /fed.		36.33	14.7	1106.58	139.51	539.39	72.78
L.S.D 5%		**0.67**	**0.40**	**5.13**	**3.11**	**8.70**	**1.4**
Nitrogen fertilizer with foliar application of algae extract							
80 kg/N+ 2.5 g/L		32.20	12.94	983.90	119.20	489.33	61.85
100 kg/N +1.5 g/L		34.46	13.96	1015.57	128.38	524.10	69.44
120 kg/N (control)		37.57	14.09	1022.35	130.57	529.66	70.53
L.S.D 5%		**0.71**	**0.42**	**4.56**	**2.35**	**3.14**	**1.20**
50000 plant/fed.	80 kg/N+ 2.5 g/L	32.65	11.71	894.86	110.96	473.85	52.15
	100 kg/N +1.5 g/L	33.19	11.93	909.94	116.87	488.01	57.65
	120 kg/N (control)	33.69	12.43	924.74	118.73	500.23	61.26
40000 plant/fed.	80 kg/N+2.5g/L	34.42	13.15	980.19	120.91	504.34	62.96
	100 kg/N +1.5 g/L	34.77	13.83	997.86	123.52	515.47	66.25
	120 kg/N (control)	34.91	13.94	1017.52	127.51	528.84	68.05
30000 plant/fed.	80 kg/N+ 2.5 g/L	35.74	14.19	1090.07	128.84	533.53	73.80
	100kg/N +1.5 g/L	36.48	15.70	1120.30	140.51	541.15	80.85
	120 kg/N (control)	36.85	16.08	1129.99	146.64	543.83	82.48
L.S.D 5%		**0.89**	**0.83**	**10.23**	**3.20**	**5.55**	**1.22**

TABLE 6. Effect of plant density and nitrogen fertilizer with foliar application of algae extract on quality traits of sugar beet (combined two seasons).

Treatments	Meq/100g Sugar beet			%			
	Na	K	α-aminoN	Sucrose	Purity	Sugar loss of molasses	Extractable sugar
50000 plant/fed.	2.11	4.25	2.03	17.56	86.98	3.09	16.38
40000 plant/fed.	2.01	4.06	1.88	16.02	86.62	5.30	14.96
30000 plant/fed.	1.94	3.42	1.83	15.32	86.13	6.01	14.8
L.S.D 5%	0.03	0.07	0.81	0.21	0.98	0.02	0.11
80 kg/N+ 2.5 g/L	1.95	3.82	1.80	16.63	89.02	4.1	16.00
100 kg/N +1.5 g/L	2.00	3.91	1.93	16.40	86.40	4.89	15.92
120 kg/N (control)	2.10	4.00	2.00	15.85	84.27	5.41	14.23
L.S.D 5%	0.31	0.02	0.94	0.05	0.25	0.42	0.31

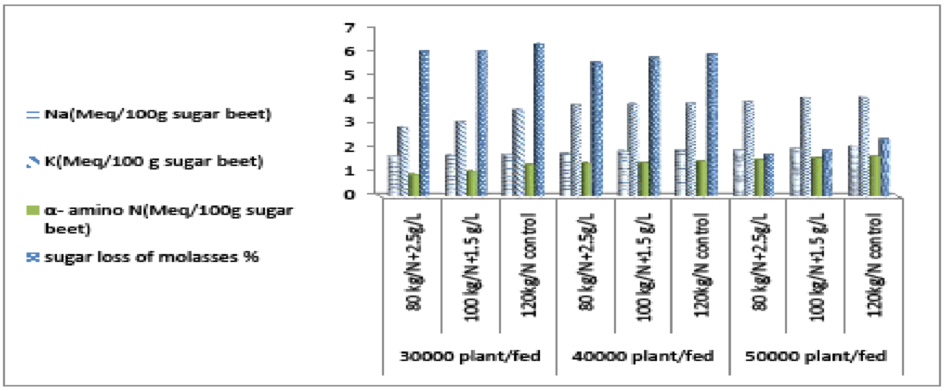

Fig. 3.The interaction effect of plant density and nitrogen fertilizer with foliar application of algae extract on quality of sugar beet

LSD at 5% Na 0.40 K 0.19 α- amino N 0.20 sugar loss of molasses % 0.003

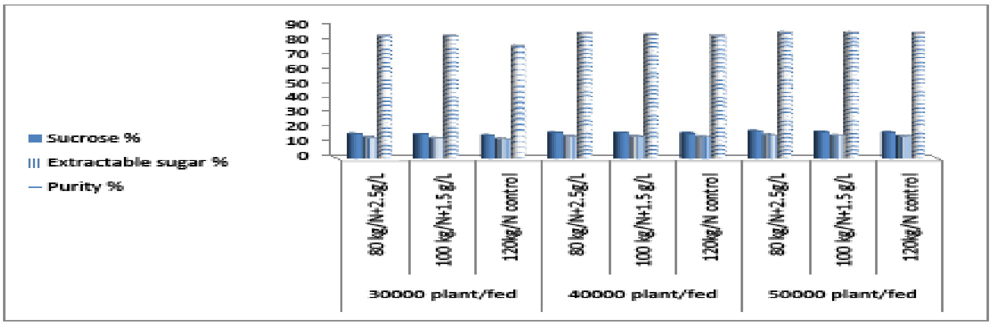

Fig. 4. The interaction effect of plant density and nitrogen fertilizer with foliar application of algae extract an quality of sugar beet.

LSD at 5% sucrose % 0.33 Extractable sugar % 0.18 purity % 1.11

The interaction effect of plant density and nitrogen fertilizer with foliar application of algae extract

The interaction between plant density and nitrogen fertilizer with foliar application of algae extracts significantly affects all studied characters in quality in sugar beet. According to the findings in Fig (3&4), the highest values of sucrose %, purity % and extractable sugar % by plant density (50000 plant /fed) spraying beets with 2.5 g/L Spirulina extract, and adding 80 kg N/fed.(19 % ,86.78% and 16.13 %) and less lost sugar loss of molasses (1.75%). Meanwhile alpha-amino-N, K% and Na%, not significant effect by plant density,foliar application with algae extract and Nitrogen fertilization.These results support the information provided by (Enan et al., 2016).

Conclusion

This study presented the incredible impact that plant density and nitrogen fertilizer with foliar application of algae extract on yield and quality of sugar beet.When applied as a foliar application spirulina extract, can contribute to the supply of plant nutrients and substitute nutrients. On the results of this study, it can be recommended to 80 kg N/fed with foliar spray 2.5 g/L algae extract and plant density (50000 plant/fed) give the maximum percentages of sucrose, purity, and extractable sugar

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الاستبدال الجزئي للسماد النتروجيني بمستخلص الطحالب لتحسين إنتاجية وجودة بنجر السكر تحت كثافات نباتية مختلفة

إلهام عبد المنعم بدر، جيهان عادل أمين، ماجدة محمد حسنين، ضياء الدين محمد صبره
قسم بحوث المحاصيل الحقلية، معهد البحوث الزراعية والبيولوجية، المركز القومي للبحوث، ٣٣ ش البحوث، الدقي، الجيزة، مصر

شهدت الآونة الأخيرة زيادة سريعة في استخدام الأسمدة النيتروجينية لزيادة إنتاج محصول بنجر السكر، رغم تأثيرها السلبي على البيئة وصحة الإنسان، وارتفاع تكلفتها. لذلك يهدف البحث إلى استبدال الأسمدة النيتروجينية جزئياً بمستخلص الطحالب لتقليل الأضرار الناتجة عن استخدامها وخفض تكلفة الإنتاج وزيادة تحسين محصول وجودة بنجرالسكر بزراعتة تحت كثافات نباتية مختلفة.

اجريت تجربتين حقليتين بمحطة التجارب والإنتاج التابعة للمركز القومى للبحوث بالنوبارية، محافظة البحيرة. حيث تمت زراعة بنجر السكرصنف (*Beta vulgaris* var. Ras poly) في تربة رملية تحت نظام الري بالرش لدراسة تأثير كثافات الزراعة المختلفه والتسميدالنيتروجينى مع الرش الورقي بمستخلص الطحالب على المحصول ومكوناته وصفات الجودة خلال شتاء موسمى ٢٠٢٠/٢٠١٩ و ٢٠٢١/٢٠٢٠. وأظهرت النتائج أن التغذية الورقية مستخلص الطحالب+التسميد النيتروجينى والكثافة النباتيه كان لها تأثير معنوي على صفات النمو. ادى انخفاض الكثافة الزراعية عن ٥٠٠٠٠ نبات/فدان. إلى ٤٠٠٠٠ أو ٣٠٠٠٠ نبات/فدان الى زيادة كبيرة في طول الجذر وقطر الجذر ووزن الجذر الطازج/النبات. ووجد ان أعلى قيمة لصفات النمو سجلت مع أقل كثافة نباتية ٣٠٠٠٠ نبات/فدان و ١٠٠ كجم/نيتروجين + 1.5 جم/ لتر مستخلص الطحالب. بينما وجد عند أعلى كثافة نباتية (٥٠٠٠٠ نبات/فدان)، أظهر أعلى قيمة لإنتاج محصول العرش والجذور والسكر (طن/فدان) ، بينما عند اقل كثافة نباتية (٣٠٠٠٠ نبات/فدان)، سجلت اقل القيم. تم تحقيق أعلى نسب للسكروز والنقاوة والسكر القابل للاستخلاص من خلال إضافة 80 كجم نيتروجين للفدان تحت كثافة نباتية (٥٠٠٠٠ نبات/فدان) مع الرش بمعدل 2.5 جم/لتر من مستخلص طحالب الاسبيرولينا على نبات البنجر.