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Agronomic Performance Sugar Beet (*Beta vulgaris* L.) in Egypt Using Inorganic, Organic and Biofertilizers

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FIELD experiments were conducted at the Experimental Farm of Environmental Agricultural Sciences Faculty, Arish University, El-Arish, North Sinai Governorate, during the two growing seasons of 2014/2015 and 2015/2016, the experimental design was split-plot in (RCBD) with three replications. The main plots were devoted to forms of nitrogen and biofertilizer treatments in sub-plots. The main objective to evaluate four nitrogen forms, biofertilizer and their interactions on some growth criteria of sugar beet (*Beta vulgaris* L.). Results revealed that, urea treatment achieved the highest (LAI) and (RGR) in the first season (CGR) in the second season, whereas ammonium nitrate achieved the highest (CGR) in the first season and (LAI) and (LAD) in the second season. Urea treatment inclusion in seeds with ntrobin application resulted the highest values of (LAI), (CGR) and (LAD) and in the first season. Ammonium sulphate treatment with (phosphorin + ntrobin) obtained the highest (NAR) in the first season. Ammonium sulphate treatment with phosphorin obtained the highest (RGR) in the first season. Ammonium nitrate treatment with phosphorin obtained the highest (LAD) in the second season. Finally, results concluded fertilizing sugar beet plants with ammonium sulphate 100 kg N/fad and inoculated with biofertilizer (ntrobin 600 gm/fad) increased the growth rate sugar beet plants under sandy soil conditions.

Keywords: Randomized complete block design (RCBD), Biofertilizer**,** *Beta vulgaris* L.*,* Leaf area index (LAI)**,** Relative growth rate (RGR)**,** Crop growth rate (CGR)**,** Leaf area duration (LAD)**,** Net assimilation rate (NAR).

Introduction

Sugar beet is considered one of the most familiar sugar crops it is a temperate crop; however, it can be grown in a wide range of climatic conditions. Sugar beet contains sucrose up to 21% (Memon et al., 2004). Sugar yield per unit area is mostly depends on root yield and sugar ratios of the roots. Sugar beet yield potential depends upon several factors viz., temperatures at the critical growth stages soil moisture, and availability of essential nutrients and solar radiation intercepted by plant canopy. All these are the main factors limiting sugar beet yield and quality. Sugar beet root yield varied between 5000-9000 kg/ha (Faddan (fad) = 0.42 hectare (ha)) and sugar content varied between 12 and 16% according to growing conditions and climate changes (Turgut, 2012). Sugar beet (*Beta vulgaris* L.) is an important sugar crop, it covers approximately 35% of global needs of sugar, and it is widely cultivated in arid and semi-arid regions (Wu et al., 2013). Global production of sugar beet in 2014 amounted 266.8 million tons with area of 4.47 million ha^{-1} with an average root yield of 59.6 ton/ha (FAOSTAT, 2016). European Union, USA and Russia are the three largest sugar beet producers in the world. In Egypt, although it is a new sugar crop, the total production of sugar beet in 2016 was about 13,323,369 tons with area 254,991 ha-1 with an average root yield of 52.3 ton/ha^{-1} (ha=2.38 fad). Sugar beet produced 1.255 million tons of sugar represented about 50% from the local production (FAOSTAT, 2016). Egypt suffers from a gap between production and consumption of sugar which reaches nearly to one million ton (Abu Zaida, 2014). So, Researchers are pressing hard to narrowing this gap through increasing both axis, horizontal and vertical expansion. Although this vision is difficult to follow in ancient lands,

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but a gleam of light is coming from achieved it in the new cultivated area. The most constrains facing new reclaimed area is low soil fertility and saline soil and irrigation water (Mohamed, 2014). The last three decades showed a gradual increase in sugar beet cultivation in Egypt. This is a way of minimizing the gap between production and consumption of sugar. The importance of sowing sugar beet is not only confined to sugar production, but also to its wide adaptability to grown in poor, saline, alkaline and calcareous soils. Also, increasing sugar productivity could be achieved through developing appropriate new technical package for growing sugar beet that included management agronomic practices to improve yield and quality of sugar beet (*Beta vulgaris* L.) such as fertilization programs, which are the most important factors that affect the quantity and quality (Azzazy et al., 2007). Monreala et al. (2007) stated that the highest values of quality parameters were achieved from the lowest level of nitrogen application (30 kg N/ha). Meanwhile, Abou Zeid & Osman (2005), Seadh (2008); El-Sarag (2009); and Attia et al., (2011) found that bacterial inoculation of sugar beet seeds caused insignificant increases in either root quality or growth parameters, while significant increase was registered in root and sugar yields/fed. There is high potential for using sugar beet to reducing the imported sugar from abroad. Among several crops, Sugar beet (Beta vulgaris L.) is one of successful crop in North Sinai due to its tolerability to high salinity in the soil and irrigation water. The new reclaimed land around El Salam Canal (650.000 feddan) are promising area for cultivation strategic crops such as sugar beet. Also, byproduct can be produce from sowing sugar beet, there is the crop residue after extracting sugar in factories, this is used as untraditional source for feeding large animals, sheep and goat in North Sinai. In addition, there is some secondary industrial products leaves and roots residue of sugar beet which can increase farmer's income, from these residues secondary products can be produced, Such as alcohol, forages and other products. Nitrogen is one of the limiting factors, among others essential nutrients, because few soils contain sufficient amount of nitrogen in an available form for plant absorption, So, nitrogen had become an important role for grown most crops to obtained maximum yield and quality (Abd El-Razek,2012). Most of the soil applied chemical fertilizers leach down below the root zone or into the ground water, which pollute the ground water and causing problems Further, an imbalanced continuous use of synthetic fertilizers may result in micronutrient deficiencies, which is becoming a major constrain for productivity, stability and sustainability of soil health. Thus, the advantages need to be integrated use of inorganic, organic and biofertilizers in order to make optimum use of each and achieve balanced nutrient management for optimum crop growth (Selim & Al-Jawhara, 2017).

Keeping in consideration the previous researches that previously mentioned, the present study is aimed to evaluation the effect of nitrogen fertilization, forms and biofertilizer on growth rate of sugar beet crop under conditions of North Sinai.

Materials and Methods

Two field experiments were carried out at the Experimental Farm, Faculty of Environmental Agricultural Sciences (FEAS), Arish University, EL-Arish, North Sinai Governorate during two winter seasons of 2014/2015 and 2015/2016. Physical and Chemical analyses of the experimental soil are shown in Table 1. Sugar beet multi germ sugar beet cultivar seeds c.v. Ymer, were sown on the 5th October in the first and second seasons (at rate of 4 kg fad^{-1}). Seeds were obtained from Sugar Crops Research Institute, Agric., Research Center, Ministry of Agric, Egypt. Chemical analyses of the irrigation water in seasons 2014/2015 and 2015/2016 are illustraded in Tables 2 and 3, respectively. Treatments included 16 treatments were the combination between four forms of nitrogen (olive pomace 1.54% N, ammonium nitrate 33.5% N, ammonium sulphate 20.6% N, urea 46.5% N). Chemical analysis of 1000 gram olive pomace used in the study is illusterted in Table 4. Four biofertilization treatments (Without, ntrobin 600 gm/fad, phosphorine 300 gm/fad and ntrobin+phosphorine by rate 1:1). The previous crop was guar in the first and second seasons, respectively and the experimental design was split-plot in randomized complete block design (RCBD) with three replications. Plot area was 8 m^2 (1/500 fad^{-1}) containing 4 rows of 4 m length (50 cm between rows and 25 cm between plants). After one month, the plants were thinned to two plants per hill, and then were singled to one plant per hill after 45 days from sowing. Organic fertilization (olive pomace) treatment was added at a rate of 10 kg per plot after sowing. The study aimed to examine

the effect of nitrogen forms and biofertilizer on growth rate under sandy soil conditions. Ntrobin and phosphorin (example - phosphorin is a combined microbial fertilizer having free living nitrogen fixing bacteria and P solubilizing *Bacillus megaterium*). Biofertilization treatments were added (150 g/kg seed) for the biofertilization mixed with sugar solution after that mixed with seed, then left one hour in shading place and sowing in land just one time according to recommendations of Ministry of Agriculture, Egypt. Nitrogen in four forms of ammonium nitrate, urea and ammonium sulphate was supplied at a rate of 100 kg N fad^{-1} at 45, 60, 75, 90 days from sowing. All used treatments were shown in Table 5.

TABLE 1. Physical and chemical analyses of the experimental soil during 2014/2015 and 2015/2016 seasons.

Soil properties	**Season**	**Season**
	2014/2015	**2015/2016**
Coarse sand %	60.28	58.26
Fine sand %	19.66	17.74
Silt %	11.39	14.36
Clay %	8.67	9.64
Soil texture	Loamy sand	Loamy sand
Organic matter %	0.21	0.22
Chemical analysis in extraction soil		
a) Cations (mq/L)		
Ca++	3.01	3.03
Mg++	2.22	2.21
Na+	3.82	3.75
K+	0.45	0.51
b) Anion (mq/L)		
HCO3	2.12	2.11
Cl-	2.23	2.17
SO4	3.27	3.33
CaCO3 %	1.78	1.79
EC (ds/m) (1:5)	0.95	0.95
pH (1:2.5)	8.2	8.15

TABLE 2. Chemical analysis of the irrigation water in season 2014/2015.

pH	EC		Soluble ions (mq/L)							
			Cations					Anions		
	$d.sm^{-1}$	ppm	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	Hco_3^{-}	Co_3^{--}	So_4^{--}
6.6	5.49	3500	17.22	19.17	19.29	.31	37.51	5.21	-	13.27

TABLE 3. Chemical analysis of the irrigation water in season 2015/2016.

pH	EC		Soluble ions (mq/L)							
			Cations					Anions		
	$d.sm^{-1}$	ppm	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	Hco_3^{-}	Co_3^{--}	So_4^{--}
6.6	5.5	3514	19.21	18.87	14.87	2.14	39.51	2.41	-	13.09

TABLE 4. Chemical analysis of 1000 gram olive pomace used in the study.

Cu g/kg	Zn g/kg	Mn g/kg	Fe g/kg	Mg g/kg	Ca g/kg	K g/kg	P g/kg	N g/kg	C/N ratio	EC (ds/m)	pH (1:10)	organic matterg/ kg	Dry matter %
0.24	0.40	0.38	1.4	3.8	9.2	7.29	0.58	166	28.2	3.2	6.8	8489	49.6

TABLE 5. The experiment treatments.

Main plot	Sub plot
Organic (olive pomace)	Without biofertilizer (control)
(1.54% N)	Nitroginbiofertilizer (ntrobin 600gm/fad)
(6.5 ton/fad)	Phosphat biofertilizer (phosphorine 300 gm/fad)
	Nitroginbiofertilizer + phosphat biofertilizer by rate 1:1
Urea (46.5% N)	Without biofertilizer (control)
(100 kg N/fad)	Nitrogin biofertilizer (ntrobin 600 gm/fad)
	Phosphat biofertilizer (phosphorine 300 gm/fad)
	Nitrogin biofertilizer + phosphat biofertilizer by rate 1:1
Ammonium nitrate	Without biofertilizer (control)
(33.5% N)	Nitrogin biofertilizer (ntrobin 600gm/ fad)
(100 kg N/fad)	Phosphat biofertilizer (phosphorine 300 gm/fad)
	Nitrogin biofertilizer + Phosphat biofertilizer by rate 1:1
Ammonium sulphate (20.6% N)	Without biofertilizer (control)
(100 kg N/fad)	Nitrogin biofertilizer (ntrobin 600 gm/ fad)
	Phosphat biofertilizer (phosphorine 300 gm/fad)
	Nitrogin biofertilizer + phosphat biofertilizer by rate 1:1

Drip irrigation system was used. The experiment site was irrigated immediately just after seeding and thereafter, irrigation every 3 days by underground saline water (3500 ppm) pumped from a well from sowing was applied. All The other cultural practices were practiced as recommended for cultivation in North Sinai sugar beet. Before commencement experiments, samples of soil sites and irrigation water were taken analysis according the methods described by Richard (1954).

Random samples of five plants were taken from each sub plot after 120, 140, 160, 180 and 200 days from sowing which reflected the growth stages, i.e., initial, establishment, mid-season, late-season and ripening stages, respectively (Cooke & Scott, 1995). Plants were separated into roots and tops to determine the following characters:

Periodical studies

1- Leaf area (LA) (dm^2/plant): The disk method was followed using 100 disks of 1.15 cm diameter then total leaf area per plant was calculated according to blades dry weights (Brown et al., 1987).

2- Root dry weight/total dry weights (root + leaf), R/T.

3- Leaf dry weight/total dry weights (root + leaf), L/T.

4- Root fresh weight/root dry weights, Rfw/Rdw.

5- Leaf fresh weight/leaf dry weights, Lfw/Ldw.

6- Root/top ratio (root dry weight/leaf dry weight), Rdw/Ldw.

Growth analysis

The growth analysis, viz. leaf area index (LAI), leaf area duration (LAD) in dm^2/week, relative growth rate (RGR) in $g.g^{-1}d.^{-1}$, crop growth rate (CGR) in $g.day^{-1}$ and net assimilation rate (NAR) in $g.dm^{-2}.week^{-1}$ were computed according to Beedle (1993) as the following formulae:

1- Leaf area index (LAI) = Leaf area (dm^2/plant)/ plant ground area (dm^2).

2- Leaf area duration (LAD) = (LA2 - LA1) * (T2- T1), dm^2/week.

3) Relative growth rate (RGR) = Loge W2 – Loge W1/(T2 –T1), g/week.

4) Net assimilation rate (NAR) = (W2- W1) (Loge A1-Loge A2)/(A2 – A1) (T2-T1), $g.dm^{-2}$ week.

5) Crop growth rate (CGR) = (W2 – W1)/(T2-T1), g/week.

where: W1, A1 and W2, A2 refer to dry weight for top or root (g) and leaf area, respectively at time T1 and T2 (day or week).

Statistical analysis

The obtained data were computed and subjected to the proper statistical analysis of randomized complete block design by the General Linear Models (GLMs) procedures using SAS (SAS, 1994). The means followed by the same alphabetical letters were not statistically significant at the 0.05 level of significance according to the Duncan's multiple range test (1955).

Results and Discussion

Root fresh weight (g/plant)

Data in Table 6 revealed that, the effect of nitrogen forms had a significant effect on root fresh weight (g) at the different growth stages. The highest root fresh weight was 1435.1 g/plant was obtained at 180 day with ammonium sulphate at the first season. The same trend observed in the second season, where ammonium sulphate gave the highest root fresh weight was 525.41, 771.22 and 900.7 g/plant at 140,160 and 180 days, respectively. These results are explaining with those reported by El-Sayed & Yousif (2003), Ouda (2007) and Hellal et al. (2009). Concerning to biofertilization treatment (Table 6), ntrobin treatment gave the heaviest root fresh weight were 1420.3 and 942.5 g/plant in 180 day in both seasons. this increase in root fresh weight by biofertilization treatments may be due to the role of biofertilization in nitrogen fixation via free living bacteria which reduce the soil pH especially in the rhizosphere which led to increase the availability of most essential macro and micro-nutrients, consequently increase growth and root weight. These findings were in harmony with those reported by Suslow et al.(1979) and Bassal et al. (2001). The interaction between nitrogen forms and biofertilization treatments was significant at 140 and 160 days in the first seasons and 180 day in the second season (Table 6). The highest values of root fresh weight were 798.7 and 1325 g/plant were obtained from urea and ntrobin interaction in 140 and 160 days in the first season. Meanwhile, ntrobin under ammonium sulphate produced the best root weight 1179.4 g/plant in 180 day in the second season.

TABLE 6. Effect of nitrogen forms, biofertilization and the interaction on root fresh weight (g/plant) at different growth stages in 2014/2015 and 2015/2016 seasons.

Seasons		2014/2015				2015/2016			
Treatments		Days from sowing (DAS)							
		120	140	160	180	120	140	160	180
Nitrogen forms on root fresh weight (g/plant)									
Olive pomace		262.08	480.54	875	1077.2^{b}	258.35	321.66^{b}	527.19^{b}	537.5^{b}
Urea		270.13	582.58	1145.8	1425.0^{a}	247.97	461.25^{ab}	711.66^{ab}	896.5^{a}
Ammonium nitrate		228.13	526.46	1116.7	1352.8^{ab}	280.05	503.89^{a}	697.5^{ab}	825.8^{a}
Ammonium sulphate		240.83	544.17	1045.8	1435.1^{a}	324.3	525.41^{a}	771.22^{a}	900.7^{a}
Significance		NS	NS	NS	*	NS	*	*	*
Biofertilization on root fresh weight (g/plant)									
Control		228.13	512.21	916.7	1147.5^{b}	255.39	437.22	655.52	644.4^{b}
Ntrobin		283.75	522.79	1193.8	1420.3^{a}	285.86	488.05	670	942.5^{a}
Phosphorine		257.42	554.58	1120.8	1381.9^{b}	288.61	407.36	658.32	696.8^{ab}
(Ntro + Phosph)		231.88	544.17	952.1	1340.3^{b}	280.83	479.58	723.75	876.8^{ab}
Significance		NS	NS	NS	*	NS	NS	NS	*
The interaction between nitrogen forms and biofertilization on root fresh weight (g/plant)									
Olive pomace	Control	210.8	450.8^{b}	825.00^{b}	1188.9	206.3	277.2	500.6	438.30^{d}
	Ntrobin	307.5	568.3^{ab}	1141.7^{ab}	1235.6	278.4	380.6	595.4	614.40^{a-d}
	Phosphorine	294.1	590.7^{ab}	1300.0^{a}	955.6	276.6	333.3	508.3	455.00^{d}
	(Ntro + Phosph)	235.8	400.5^{b}	891.70^{b}	928.9	272	295.6	504.4	642.20^{a-d}
Urea	Control	191.6	465.8^{b}	1025.0^{b}	1300	208.5	283.3	637.8	624.40^{a-d}
	Ntrobin	292.5	798.7^{a}	1325.0^{a}	1506.9	310	599.4	786.1	1069.4^{a-c}
	Phosphorine	230	519.5^{ab}	1041.7^{b}	1527.8	248.3	457.8	748.9	1091.1^{ab}
	(Ntro + Phosph)	198.3	472.8^{b}	1216.7^{ab}	1405.6	225	504.4	912.2	801.10^{a-d}
Ammonium nitrate	Control	168.3	462.5^{b}	1083.3^{ab}	1105.6	259.9	339.4	634.4	502.80^{cd}
	Ntrobin	333.3	541.0^{ab}	1166.7^{ab}	1383.3	267.7	522.2	800	994.40^{a-d}
	Phosphorine	328	531.3^{ab}	1200.0^{ab}	1400	299.4	522.2	655.6	921.70^{a-d}
	(Ntro + Phosph)	253.8	556.3^{ab}	1016.7^{b}	1522.2	292.9	631.7	682.2	884.40^{a-d}
Ammonium sulphate	Control	155.8	502.5^{b}	425.00^{c}	1255.6	287.2	435.6	571.1	567.20^{b-d}
	Ntrobin	277.5	523.3^{ab}	1250.0^{ab}	1538.9	346.6	632.8	730	1179.4^{a}
	Phosphorine	277.5	557.5^{ab}	950.00^{b}	1522.2	330	528.3	745.6	786.10^{a-d}
	(Ntro + Phosph)	230.8	593.3^{ab}	875.00^{b}	1383.3	333.3	505	800	1070.0^{a-c}
Significance		NS	NS	*	**	NS	NS	NS	NS

-Ntro + Phosph = Ntrobin + Phosphorine
-Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test
-NS= not significant, * = significant , ** =high significant.

Root dry weight (g)

Data in Table 7 showed that, nitrogen forms had a in significant effect on root dry weight (g) at most of growth stages in both season, the highest root dry weight was 369.20 g was obtained at 180 day, respectively, from urea compared with the other nitrogen treatments in the first season. On the other hand, in the second season ammonium nitrate gave the highest root dry weight 177.72 g 180 day, respectively, the increase in plant dry weight due to increasing nitrogen rate may be attributed to synergistic effect of nitrogen on vegetative growth, number and area of leaves as well as photosynthesis rate which increased dry matter accumulation and stored in root. These results are in line with those reported by Sobhy et al. (1999), Kandil et al. (2004), Osman (2005) and Saleh (2007). Data in Table 7, clear that root dry weight was insignificantly affected by biofertilization treatment in the different growth stages in both seasons, except at 120 day in the first season. The greatest values of root dry weight were 82.29 g in 120 day from ntrobin treatment, while the lowest value 67.88 g was achieved with control treatment. The same results were obtained by Mrkovack et al. (1997) and Abo EL-Goud (2000). In the two growing seasons, the interaction between nitrogen forms and biofertilizer types showed significant effect on root dry weight at 140, 160 and 180 days in first season and at 140 and 180 days in the second season (Table 7). In the first season, the highest means of root dry weight 449.1 g were produced from urea and ntrobin at 160 day. Where, ammonium nitrate and ntrobin gave the highest value of root dry weight was 228.07 g at 180 day in the second season.

Leaf fresh weight (g)

Means of leaf fresh weight (g) as affected by nitrogen forms, biofertilization treatments and their interaction at 120, 140, 160 and 180 days in 2014/2015 and 2015/2016 seasons are registered in Table 8, clear that leaf fresh weight was significantly affected by nitrogen forms at both seasons except 180 days in second season. The greatest values of leaf fresh weight were 652.08 and 480.00 g derived from urea application in both seasons at 160 days, respectively, this tendency was recorded by El-Sayed & Yousif (2003), Mousa (2004), Kozicka (2005), Ouda (2007) and Abdelaal & Tawfik (2015). They found that, increased using biofertilizers may be due to its role in nitrogen fixation via free living bacteria which reduce the soil pH especially in the rhizosphere which led to increase the availability of most essential macro and micro-nutrients as well as excretion some growth substances such as IAA and GA3 which plays an important roles in formation a large and active root system and therefore increasing nutrient uptake, which stimulating establishment and vegetative growth, hence increasing root and shoot fresh weights and also root length and diameter. Favilli et al. (1993) found that inoculation sugar beet seeds with *Azosperillium* accelerated the germination, seedling growth and optimum plant growth and increased root and sugar yield and reduce nitrogen fertilizer requirement during the growth season. Many investigators confirming this conclusion Badawi et al. (2004), Kandil et al. (2004) and Amin et al. (2013). As shown in Table 8, leaf fresh weight exposed significant differences among biofertilization treatments at 180 day in both seasons. treated soil with ntrobin caused significant increase in leaf fresh weight other biofertilization treatments and gave the highest values, which results were 670.66 and 337.08 g at 180 day in the first and second seasons, respectively. The lowest values in this terms were 407.78 and 253.96 were achieved with control at 180 days in the first and second seasons, respectively. This increase in leaf fresh weight by biofertilization treatments may be attributed to its effect upon nitrogen fixation, enhancing nutrient uptake and excretion some growth substances such as IAA and GA3 which improve growth and leaf canopy of sugar beet. Similar results were also corresponding by Ali (1996), Stajner et al. (1997), Mezei et al. (1998) and Medani et al. (2000). Concerning the effect of interaction between nitrogen forms and biofertilization types showed significant effect on leaf fresh weight except 120 day in both seasons, it was apparent that adding urea with ntrobin gave the highest leaf fresh weight were 808.3 and 579.44 g at 160 days in first and second seasons, as shown in Table 8.

TABLE 7. Effect of nitrogen forms, biofertilization and the interaction on root dry weight (g) at different growth stages in 2014/2015 and 2015/2016 seasons.

Seasons		2014/2015				2015/2016			
Treatments		Days from sowing (DAS)							
		120	140	160	180	120	140	160	180
Nitrogen forms on on root dry weight (g/plant)									
Olive pomace		68.47^{b}	149.9	286	268.5^{b}	32.44	45.18^{b}	90.42^{b}	114.7^{b}
Urea		72.00^{b}	168.7	374.8	369.2^{a}	41.88	57.62^{ab}	121.7^{a}	169.6^{a}
Ammonium nitrate		88.60^{a}	154.2	345.6	355.9^{a}	36.62	65.66^{a}	116.5^{a}	177.7^{a}
Ammonium sulphate		76.70^{b}	154.8	325	341.3^{ab}	32.11	57.00^{ab}	108.7^{a}	157.8^{ab}
Significance		*	NS	NS	*	NS	*	*	*
Biofertilization on on root dry weight (g/plant)									
Control		67.88^{b}	144.7	294.7	292	34.39	51.01	104.9	133.9
Ntrobin		82.29^{a}	158.2	372.7	356.6	36.7	57.93	107.7	176.7
Phosphorine		77.95^{ab}	155.2	367.4	364.2	35.63	56.2	108.3	139.8
(Ntro + Phosph)		69.66^{ab}	169.5	296.5	322	36.33	60.33	116.4	169.4
Significance		*	NS	NS	NS	NS	NS	NS	NS
The interaction between nitrogen forms and biofertilization on on root dry weight (g/plant)									
Olive pomace	Control	64.95	139.2^{ab}	261.4^{ab}	228.8^{b}	25.26	39.98^{ab}	83.39	98.20^{b}
	Ntrobin	91.13	167.9^{ab}	432.5^{a}	285.2^{ab}	35.98	44.99^{ab}	93.65	126.7^{ab}
	Phosphorine	70.44	152.1^{ab}	268.7^{ab}	308.1^{ab}	32.97	52.46^{ab}	93.16	133.7^{ab}
	(Ntro + Phosph)	80.3	140.6^{ab}	337.5^{ab}	251.8^{ab}	34.25	43.32^{ab}	91.47	100.4^{b}
Urea	Control	57.68	114.7^{b}	324.0^{ab}	345.1^{ab}	28.99	34.65^{b}	106.8	158.6^{ab}
	Ntrobin	89.24	211.9^{a}	449.1^{a}	416.3^{a}	40.64	62.10^{ab}	121.3	210.4^{ab}
	Phosphorine	68.51	156.2^{ab}	337.8^{ab}	367.5^{ab}	29.76	65.83^{ab}	107.7	187.0^{ab}
	(Ntro + Phosph)	58.47	136.5^{ab}	388.3^{a}	385.0^{ab}	30.4	65.44^{ab}	130.3	122.6^{ab}
Ammonium nitrate	Control	52.3	139.9^{ab}	305.8^{ab}	288.0^{ab}	34	43.38^{ab}	97.69	102.9^{b}
	Ntrobin	94.24	167.6^{ab}	378.2^{a}	356.9^{ab}	38.78	79.96^{a}	127.3	228.0^{a}
	Phosphorine	101.4	148.2^{ab}	380.1^{a}	362.4^{ab}	37.92	70.34^{ab}	111.4	183.5^{ab}
	(Ntro + Phosph)	74.45	161.0^{ab}	318.2^{ab}	379.1^{ab}	35.82	68.98^{ab}	98.41	157.5^{ab}
Ammonium sulphate	Control	47.48	161.0^{ab}	148.8^{b}	266.9^{ab}	36.21	55.64^{ab}	105.2	122.0^{ab}
	Ntrobin	86.12	164.2^{ab}	398.5^{a}	388.6^{ab}	46.75	63.16^{ab}	130.3	205.6^{ab}
	Phosphorine	87.74	164.5^{ab}	321.1^{ab}	403.8^{ab}	41.81	55.76^{ab}	120.7	155.1^{ab}
	(Ntro + Phosph)	66.65	185.1^{ab}	275.4^{ab}	305.9^{ab}	42.78	55.94^{ab}	130.8	187.3^{ab}
Significance		NS	*	*	*	NS	*	NS	*

-Ntro + Phosph = Ntrobin + Phosphorine
-Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test
-NS= not significant, * = significant , ** =high significant.

TABLE 8. Effect of nitrogen forms, biofertilization and the interaction on leaf fresh weight(g) at different growth stages in 2014/2015 and 2015/2016 seasons.

Seasons		2014/2015				2015/2016			
Treatments		Days from sowing (DAS)							
		120	140	160	180	120	140	160	180
Nitrogen on leaf fresh weight (g/plant)									
Olive pomace		266.0^{b}	314.2^{b}	564.5^{ab}	434.1^{ab}	295.0^{b}	297.3^{b}	305.0^{b}	204.4
Urea		314.3^{a}	376.1^{a}	652.0^{a}	488.3^{ab}	370.1^{ab}	448.3^{a}	480.0^{a}	295.6
Ammonium nitrate		347.5^{a}	365.3^{ab}	597.9^{ab}	531.6^{a}	400.8^{a}	445.8^{a}	458.4^{a}	362.3
Ammonium sulphate		358.7^{a}	320.6^{ab}	487.5^{b}	513.6^{a}	396.2^{a}	455.0^{a}	395.2^{ab}	309.7
Significance		*	*	*	*	*	*	*	NS
Biofertilization on leaf fresh weight (g/plant)									
Control		291.0^{b}	326.6	506.2	407.7^{b}	334.1	381.3	385.1	253.9^{b}
Ntrobin		357.0^{a}	348.6	652	670.6^{a}	394.5	415.5	438.4	337.0^{a}
Phosphorine		320.4^{a}	374	635.4	533.8^{b}	372.5	427.9	427.9	312.2^{ab}
(Ntro + Phosph)		318.1^{a}	327	508.3	519.4^{b}	360.9	421.6	387.2	268.8^{ab}
Significance		*	NS	NS	*	NS	NS	NS	*
The interaction between nitrogen forms and biofertilization on leaf fresh weight(g/plant)									
Olive pomace	Control	230.8	329.1^{ab}	450.0^{ab}	312.2^{b}	264.4	271.4^{c}	275.5^{c}	166.6^{d}
	Ntrobin	290	416.6^{ab}	625.0^{ab}	452.2^{ab}	355.5	337.2^{bc}	331.6^{bc}	229.4^{cd}
	Phosphorine	250.8	407.5^{ab}	716.7^{a}	534.4^{ab}	281.7	301.1^{c}	319.9^{bc}	215.0^{d}
	(Ntro + Phosph)	292.5	341.3^{ab}	466.7^{ab}	437.8^{ab}	278.3	279.4^{c}	292.7^{c}	206.8^{d}
Urea	Control	274.1	309.1^{ab}	500.0^{ab}	422.2^{ab}	332.7	398.8^{a-c}	406.6^{a-c}	250.0^{b-d}
	Ntrobin	327.5	426.6^{a}	808.3^{a}	606.7^{a}	417.2	535.0^{ab}	579.4^{a}	303.6^{a-d}
	Phosphorine	332.5	417.0^{ab}	683.3^{ab}	580.0^{ab}	364.4	399.4^{a-c}	408.3^{a-c}	308.3^{a-d}
	(Ntro + Phosph)	323.3	318.6^{ab}	616.7^{ab}	447.8^{ab}	366	460.0^{a-c}	525.5^{ab}	320.5^{a-d}
Ammonium nitrate	Control	275	293.3^{ab}	550.0^{ab}	374.4^{ab}	351.6	367.7^{a-c}	427.7^{a-c}	244.4^{cd}
	Ntrobin	405	342.0^{ab}	625.0^{ab}	561.1^{ab}	427.7	558.8^{a}	448.3^{a-c}	397.7^{a-c}
	Phosphorine	342.5	339.6^{ab}	625.0^{ab}	584.4^{ab}	436	407.7^{a-c}	466.0^{a-c}	414.4^{ab}
	(Ntro + Phosph)	367.5	307.5^{ab}	591.7^{ab}	503.3^{ab}	387.7	448.8^{a-c}	491.6^{a-c}	392.5^{a-c}
Ammonium sulphate	Control	335	282.5^{b}	350.0^{b}	496.7^{ab}	351.6	421.6^{a-c}	363.7^{a-c}	328.8^{a-d}
	Ntrobin	405.8	306.6^{ab}	550.0^{ab}	561.1^{ab}	377.6	440.0^{a-c}	382.7^{a-c}	238.3^{cd}
	Phosphorine	355.8	313.0^{ab}	516.7^{ab}	485.6^{ab}	407.7	452.2^{a-c}	415.5^{a-c}	427.2^{a}
	(Ntro + Phosph)	338.3	355.0^{ab}	533.3^{ab}	511.1^{ab}	447.7	506.1^{ab}	418.8^{a-c}	244.4^{cd}
Significance			NS	*	*	*	NS	**	**

-Ntro + Phosph = Ntrobin + Phosphorine

-Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test

-NS= not significant, * = significant , ** =high significant.

Leaf dry weight (g)

Data presented in Table 9, clear that significant effect of nitrogen forms on leaf dry weigh (g) in four growing stage at the two studied seasons. The greatest value of leaf dry weight was 70.70 and 159.02 g was achieved from ammonium sulphate application at 120 and 160 days, respectively in first season. However, in the second season ammonium nitrate gave the greatest values of leaf dry weight. This result in accordance with that found by Zalat (2002), NemeatAlla (2004), Kandil et al. (2004) and Saleh (2007). Concerning the effect of biofertilization treatments on leaf dry weight (g), it showed a significant role in the two seasons (Table 9). Thebiofertilization treatments had a variable trend with respect to leaf dry weight, where the highest values were 90.29, 158.09 and 111.46 g at 140, 160 and 180 days from ntrobin, respectively, in the first season. However, 55.18 g at 180 day in the second season were produced due to inoculate seeds with ntrobin fertilizer. Ntrobinbio fertilization treatment caused noticeable increase in leaf dry weight over the biofertilization treatment. This favorable increase in leaf dry weight owing to ntrobin biofertilization treatments may be returned to the role of fixing more soil nitrogen and producing some growth substances that encourage plant growth and dry matter accumulation. These results are in stand with those confirmed by Stajner et al. (1997), Abo EL-Goud (2000) and Saleh (2007). Concerning to the effect of interaction between nitrogen forms and bio fertilization treatments on leaf dry weight, it was significant in the two seasons except at 160 days in the second season as appear from Table 8. The highest means 209.2 g were obtained from ammonium sulphate treatment with ntrobin at 160 days in the first season otherwise, the lowest leaf dry weight in 120 day. However, the best leaf dry weight was 75.13 g in the second season was achieved when adding ammonium nitrate with ntrobin at 140 day. On the other hand, the lowest leaf dry weight at 180 days.

Root / top ratio (root dry weight / leaf dry weight)

Data in Table 10 showed that, the root dry weight / leaf dry weight percent at different growth stages at 120, 140, 160 and 180 days as affected by nitrogen forms, biofertilization treatments and their interaction during the seasons of 2014/2015 and 2015/2016. Data in Table 10 listed that, nitrogen treatments had insignificant effect on root dry weight/ leaf dry weight percent in the two seasons except at 120 days in both season. The highest root dry weight/leaf dry weight percent was 2.32 at 140 days in the first season and 1.57 at 120 days in the second season were produced with the ammonium sulphate application in both seasons, respectively. These results were alleged with the previous results obtained by Nemeat-Alla (2004), Osman (2005), El-Sheref (2006) and EL-Geddawy et al. (2008). Regarding the effect of biofertilization treatments the data in Table 10 cleared that, had insignificant effect of biofertilization treatments on root dry weight/ leaf dry weight percent in both season except at 120 days in second season. The results showed that the combination between the ntrobin and phosphorine application achieved the maximum 1.52 root dry weight / leaf dry weight percentage in the second season. This result is in accordance with those found by Bassal et al. (2001) and Kandil et al. (2004). Regarding the effect of the interaction between nitrogen forms and biofertilization treatments on root dry weight / leaf dry weight percent was significant in the first season except at 120 and 160 days whereas, it was insignificant effect in second season except at 120 and 180 days. The highest values from root dry weight / leaf dry weight percent were 1.70 achieved with olive pomace treatment and phosphorine as biofertilizer at 120 day and 3.57 achieved with ammonium sulphate treatment and ntrobin as biofertilizer types in 160 days in the first season, respectively. The highest values 3.68 and 4.80 from root dry weight / leaf dry weight percent in second season were produced with ammonium sulphate and ntrobin at 120 days, ammonium nitrate and phosphorine interaction at 180 day (Table 10).

Conclusion

Results concluded that, there was positive effect of nitrogen and biofertilizerfor sugar beet production, and fertilizing sugar beet plants with ammonium sulphate 100 kg N/ fad and inoculated with biofertilizer (ntrobin 600 gm/fad) increased the growth rate sugar beet plants under sandy soil conditions.

TABLE 9. Effect of nitrogen forms, biofertilization and the interaction on leaf dry weight (g) at different growth stages in 2014/2015 and 2015/2016 seasons.

Seasons		2014/2015				2015/2016			
Treatments		Days from sowing (DAS)							
		120	140	160	180	120	140	160	180
Nitrogen forms on on leaf dry weight (g/plant)									
Olive pomace		51.18^{b}	73.29	137.1^{b}	92.28	40.84^{b}	39.63^{b}	46.12^{b}	28.98^{b}
Urea		66.02^{ab}	88.16	110.8^{b}	90.49	54.08^{ab}	54.16^{ab}	65.12^{a}	44.54^{ab}
Ammonium nitrate		65.96^{ab}	85.41	136.6^{b}	113.4	57.34^{a}	57.78^{a}	65.77^{a}	53.27^{a}
Ammonium sulphate		70.70^{a}	77.45	159.0^{a}	109.6	50.37^{ab}	58.89^{ab}	53.82^{ab}	48.03^{ab}
Significance		*	NS	*	NS	*	*	*	*
Biofertilization on on leaf dry weight (g/plant)									
Control		57.26	73.61^{b}	116.9^{b}	82.50^{b}	46.01	49.46	55.5	38.49^{b}
Ntrobin		71.47	90.29^{a}	158.0^{a}	111.4^{a}	51.13	52.83	51.73	55.18^{a}
Phosphorine		63.48	82.84^{ab}	150.3^{ab}	106.9^{ab}	52.04	55.97	61.89	39.71^{b}
(Ntro + Phosph)		61.65	77.57^{ab}	118.2^{b}	104.8^{ab}	53.45	52.19	59.72	46.43^{b}
Significance		NS	*	*	*	NS	NS	NS	*
The interaction between nitrogen forms and biofertilization on leaf dry weight (g/plant)									
Olive pomace	Control	42.57^{b}	74.78^{ab}	108.8^{bc}	64.23^{b}	34.90^{b}	36.02^{d}	47.14	24.59^{c}
	Ntrobin	54.42^{ab}	77.70^{ab}	169.3^{ab}	97.25^{ab}	51.70^{ab}	45.40^{b-d}	83.39	34.40^{bc}
	Phosphorine	49.21^{ab}	104.5^{ab}	163.2^{a-c}	104.7^{ab}	37.44^{ab}	40.55^{cd}	46.91	28.57^{c}
	(Ntro + Phosph)	58.56^{ab}	95.60^{ab}	107.0^{bc}	102.8^{ab}	39.32^{ab}	36.57^{d}	48.94	28.37^{c}
Urea	Control	57.14^{ab}	71.86^{b}	115.6^{bc}	76.16^{ab}	43.45^{ab}	46.66^{b-d}	51.99	37.15^{bc}
	Ntrobin	70.29^{ab}	96.79^{ab}	115.5^{bc}	103.6^{ab}	62.91^{a}	50.44^{a-d}	58.23	46.76^{a-c}
	Phosphorine	70.70^{ab}	97.62^{ab}	165.2^{a-c}	97.76^{ab}	50.71^{ab}	68.44^{ab}	74.43	45.68^{a-c}
	(Ntro + Phosph)	65.95^{ab}	75.37^{ab}	145.9^{a-c}	84.34^{ab}	59.29^{ab}	51.11^{a-d}	70.44	48.56^{a-c}
Ammonium nitrate	Control	52.58^{ab}	65.53^{b}	124.9^{a-c}	80.99^{ab}	47.47^{ab}	48.73^{a-d}	59.8	38.16^{bc}
	Ntrobin	78.95^{ab}	84.68^{ab}	139.1^{a-c}	113.1^{ab}	63.00^{a}	75.13^{a}	62.83	69.83^{a}
	Phosphorine	64.76^{ab}	85.56^{ab}	143.4^{a-c}	113.8^{ab}	60.49^{ab}	48.87^{a-d}	67.22	60.18^{ab}
	(Ntro + Phosph)	67.57^{ab}	72.22^{ab}	138.7^{a-c}	129.0^{a}	58.41^{ab}	58.39^{a-d}	70.65	58.08^{ab}
Ammonium sulphate	Control	63.34^{ab}	68.78^{b}	81.20^{c}	100.7^{ab}	42.72^{ab}	53.29^{a-d}	47.99	34.65^{bc}
	Ntrobin	82.24^{a}	161.0^{a}	209.2^{a}	130.5^{a}	42.46^{ab}	58.01^{a-d}	52	56.67^{ab}
	Phosphorine	69.27^{ab}	73.41^{ab}	128.4^{a-c}	112.7^{ab}	59.54^{ab}	57.11^{a-d}	59.03	36.93^{bc}
	(Ntro + Phosph)	67.95^{ab}	78.80^{ab}	118.2^{bc}	111.2^{ab}	56.79^{ab}	67.16^{a-c}	56.29	50.71^{a-c}
Significance		*	*	**	*	*	**	NS	**

-Ntro + Phosph = Ntrobin + Phosphorine

-Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test

-NS= not significant, * = significant , ** =high significant.

TABLE 10. Effect of nitrogen forms, biofertilization and the interaction on root dry weight / leaf dry weight at different growth stages in 2014/2015 and 2015/2016 seasons.

Treatments		Days from sowing (DAS)							
		120	**140**	**160**	**180**	**120**	**140**	**160**	**180**
Nitrogen forms on root dry weight / leaf dry weight									
Olive pomace		1.34 a	1.75^{b}	2.29	3	0.79^{b}	1.03	2.17	3.88
Urea		1.22^{b}	1.79^{b}	2.42	3.57	0.72^{b}	1.1	1.85	4.04
Ammonium nitrate		1.03^{b}	2.10^{ab}	2.52	3.3	0.63^{b}	1.14	1.72	5.69
Ammonium sulphate		1.58^{a}	2.32^{a}	2.5	3.2	1.57^{a}	1	2.42	3.89
Significance		*	*	NS	NS	*	NS	NS	NS
Biofertilization on root dry weight / leaf dry weight									
Control		1.21	1.95	2.53	3.18	0.76^{b}	1.18	2.03	3.07
Ntrobin		1.22	1.78	2.24	2.96	0.74^{b}	1.03	2.13	3.75
Phosphorine		1.1	2.21	2.46	3.3	0.69^{b}	0.92	1.87	6.7
(Ntro + Phosph)		1.24	2.01	2.51	3.63	1.52^{a}	1.16	2.12	3.95
Significance		NS	NS	NS	NS	*	NS	NS	NS
The interaction between nitrogen forms and biofertilization on root dry weight / leaf dry weight									
Olive pomace	Control	1.47^{ab}	1.79	2.14^{bc}	2.98	0.70^{b}	1.01	2.14	2.67^{b}
	Ntrobin	1.46^{ab}	1.51	2.62^{a-c}	3.03	0.68^{b}	1.07	1.92	4.48^{b}
	Phosphorine	1.70^{a}	2.17	2.67^{a-c}	2.63	0.90^{b}	1.03	2.29	4.73^{b}
	(Ntro + Phosph)	1.68^{a}	1.55	2.27^{a-c}	3.35	0.87^{b}	1.02	2.32	4.18^{b}
Urea	Control	0.78^{b}	1.73	1.33^{c}	2.62	0.72^{b}	0.71	1.44	3.09^{b}
	Ntrobin	1.02^{ab}	1.55	2.20^{a-c}	3.76	0.65^{b}	1.22	1.9	4.39^{b}
	Phosphorine	0.78^{b}	1.97	2.74^{ab}	3.75	0.58^{b}	1.04	2.2	3.97^{b}
	(Ntro + Phosph)	1.37^{ab}	1.89	2.89^{ab}	4.14	0.92^{b}	1.45	1.85	4.05^{b}
Ammonium nitrate	Control	0.99^{ab}	1.75	2.20^{a-c}	2.79	0.57^{b}	0.9	1.56	1.55^{b}
	Ntrobin	1.30^{ab}	2.06	2.64^{a-c}	3.51	0.69^{b}	1.44	2	3.65^{b}
	Phosphorine	1.44^{ab}	2.33	2.68^{a-c}	3.28	0.64^{b}	0.91	1.68	4.80^{a}
	(Ntro + Phosph)	1.15^{ab}	2.28	2.54^{a-c}	3.6	0.63^{b}	1.32	1.62	2.77^{b}
Ammonium sulphate	Control	0.79^{b}	2.23	1.73^{bc}	2.46	0.62^{b}	0.84	2.08	2.91^{b}
	Ntrobin	1.07^{ab}	2.31	3.57^{a}	3.39	3.68^{a}	1.04	2.74	3.66^{b}
	Phosphorine	1.22^{ab}	2.39	2.37^{a-c}	3.53	1.04^{b}	1.09	2.18	4.19^{b}
	(Ntro + Phosph)	0.92^{b}	2.33	2.34^{a-c}	3.42	0.94^{b}	1.05	2.68	4.78^{b}
Significance		*	NS	**	NS	*	NS	NS	*

-Ntro + Phosph = Ntrobin + Phosphorine

-Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test

-NS= not significant, * = significant , ** =high significant)

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الأداء الزراعي لبنجر السكر في مصر باستخدام الاسمدة المعدنية و العضوية والمخصبات البيولوجية

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أجريت تجربتان حقليتان بالمزرعة البحثية بكلية العلوم الزراعية البيئية بالعريش خلال موسمي الزراعة 2014-2015 و2015-2016 بهدف دراسة تأثير أربعة اشكال للأسمدة النيتروجينية وهى تفل الزيتون (1.54%N)، سلفات نشادر (20.6%N)، نترات نشادر (33.5%N)، يوريا (46.5%N) وتم الإضافه بمعدل إضافة 100 كجم نيتروجين/الفدان على أربعة دفعات، وأربع معاملات من التسميد الحيوى وهي بدون تسميد ، نتروبين (600 جم/الفدان)، فسفورين (300 جم/الفدان)، مخلوط من النتروبين والفسفورين بمعدل ١:١، حسب توصيات مركز البحوث الزراعية على النمو والمحصول والجودة لبنجر السكر(صنف يمر) واستخدم تصميم قطاعات كاملة العشوائية في ثلاث مكررات. أظهر التسميد باليوريا أعلى قيم لدليل مساحة الأوراق فى الموسم الأول، والمعدل المطلق للنمو وفترة بقاء المسطح الأخضر فى الموسم الثانى وكذلك أعطى التفاعل بين إضافة اليوريا ومعاملة النتروبين تأثير معنويا لدليل مساحة الاوراق ومعدل النمو المطلق و مدة بقاء المسطح الأخضر عند معظم مراحل النمو خلال الموسم الأول بينما إضافة اليوريا مع الفسفورين أعطت أعلى قيم لدليل مساحة الأوراق ومعدل النمو المطلق فقط فى الموسم الثانى وكذلك أعطت إضافة سلفات النشادر مع مخلوط من النتروبين والفسفورين أعلى قيم لصافى معدل التمثيل الضوئى فى الموسم الأول .