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Using Different Types of Fertilization for Increasing Sugar Beet Growth under Sandy Soil Conditions

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Abstract

Four nitrogen forms and four biofertilizer were application as well as their interactions on growth analysis of sugar beet (*Beta vulgaris* L). The important results could be summarized as follow. Urea treatment achieved maximum increase in Leaf Area Index were 69.71, 81.32 and 166.54 at 120, 140 and 160 day in the 1st season, respectively, The highest one was 160.6 in the 2nd also was ammonium nitrate application at 160 days. Urea treatment inclusion in seeds with ntrobin application resulted the highest values of leaf area index (LAI), crop growth rate (CGR) and leaf area duration (LAD) and in the 1st season. A slight increase was 0.03 g/week in this case was found due to urea treatments as compared with the others treatment at the period from Relative growth rate (RGR_3) in the 1st season. Ammonium nitrate treatment achieved the maximum values from Crop Growth Rate was 39.16 g/day in (CGR_1), 93.24 and 13.5 g/day in (CGR_2) and (CGR_3) from urea treatment at the 1st season. The highest net assimilation rate was 0.66 g/dm.week achieved by ntrobin as compared the others treatment whereas, the lowest one 0.11 g.dm /week with the phosphorin**e** application. Ammonium sulphate treatment with (phosphorin + ntrobin) obtained the highest net assimilation rate (NAR) in the 1st season. The highest values from leaf area duration were 0.11, 0.19 and 0.15 dm^2/week achieved with urea and ntrobin in the 1st season at (LAD_2), (LAD_3) and (LAD_4). Ammonium nitrate treatment with phosphorin obtained the highest leaf area duration (LAD) in the 2nd season. Generally, it could be recommended that fertilizing sugar beet plants variety Ymer with nitrogen forms inoculated with biofertilizer (ntrobin 600gm/fed) increased the growth of sugar beet plants under sandy soil conditions.

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Introduction

World sugar production depends upon two main crops sugar cane and sugar beet. The percentage of recovered sugar out of cane and beet amount is about 70% and 30% of total world production of sugar, respectively. Sugar is considering a strategic commodity in many countries over the world. It comes after wheat from the strategic view for many countries in Africa, Europe, America and Australia. Sugar beet crop occupies ranked second in the production of sugar in the world. Egypt suffers from a gap between the consumed and produced sugar which reaches nearly one million ton [1].

So, Researchers are pressing hard to narrowing the gap between production and consumption through increasing horizontal and vertical expansion. As, it is difficult to increase the horizontal expansion in the old valley, so, that it is promising to try to cultivate this strategic crop in the newly reclaimed lands. These lands are characterized as sandy saline soil and high salinity irrigation water [2].

Also, the economic way of increasing sugar productivity could be achieved through developing appropriate new technology package for sugar beet crop that includes agronomic management to improve yield and quality of sugar beet (*Beta vulgaris L.*) such as nitrogen fertilization, which are the most important factors that affect the quantity and type of crop [3].

The last three decades showed a gradual increase in sugar beet cultivation in Egypt. This is considered one of the important national targets to minimize the gap between production and consumption of sugar.

The importance of sugar beet crop to agriculture is not only confined to sugar production, but also to its wide adaptability to grown in poor, saline, alkaline and calcareous soils. The crop is annual planting during the winter season from September till mid- November, and is highly adapted to grow in moderate saline soils especially in newly reclaimed land which has water shortage. There is high potential for using sugar beet to reducing the imported sugar from abroad [4].

Sugar beet (*Beta vulgaris L.*) is growing in North Sinai, because it is tolerant to high in the soil and water salinity. Around El Salam Canal (650.000 fed) is promising for the new reclaimed land cultivated with strategic crops such as sugar beet. The demand of sugar beet is showed the gap between production and consumption. Nitrogen in many cases is a limiting factor because few soils contain sufficient nitrogen in an available form. So, nitrogen rate had become an important role for growers to obtained maximum yield and quality [5]. Sugar beet growers cultivate sugar beet plants with unsuitable nitrogen levels. Biofertilizer can be generally defined as preparations containing live or latent cells of efficient strains of nitrogen fixation, phosphate solubility and silicate decomposers used for application to soil with the objective of acceleration certain microbial processes to augment the extent of the availability of nutrients in a form which can be easily assimilated by plants [5].

The aim of this investigation studies the effect of nitrogen fertilization, organic 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), EL-Arish, Arish University, North Sinai Governorate during two successive winter seasons of 2014-15 and 2015-16 sugar beet (*Beta vulgaris* c.v. Ymer). This cultivar was obtained from Sugar Crops Research Institute, Agric., Research Center, Ministry of Agriculture, Egypt. The experiment 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) and four biofertilization treatments (Without, ntrobin 600gm/fed, Phosphorine 300 gm/fed and ntrobin + Phosphorine by rate 1:1). The previous crop was sugar beet and gaur in the first and second seasons, respectively, the experimental design was randomized complete block design (RCBD) with three replications. The main plots were devoted to source of nitrogen and biofertilizer treatments in sub-plots. Plot area was 8 m^2 (1/500 fed^{-1}) containing 4 rows of 4 m length (50 cm between rows and 25 cm between plants).

Seeds were sown at rate of 4 kg fed^{-1} on the fifth October in the first and second seasons. 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 97.26 kg fed^{-1} after sowing. The chemical analysis of olive pomace was shown in Table 1. Biofertilization treatments were added for mixing with seeds. Nitrogen in four doses form of ammonium nitrate, urea and ammonium sulphate were added at a rate of 100 kg N fed^{-1} at 60,75,90,105 days from sowing. All used treatments were shown in Table 2.

Drip irrigation system (4 L/hr) 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 sugar beet. Samples of the experimental soil mixture were taken before sowing of sugar beet for chemical and physical analysis of [8] in Table 3. Chemical analysis of irrigation water is showed in Tables 4 and 5 for both seasons.

Average monthly of some meteorological data for Sinai (El-Arish region) during sugar beet growth duration (October – April) in two growing seasons of 2014/2015 and 2015/2016 are shown in Table 6.

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 [12].Plants were separated into roots and tops to determine the following characters.

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 [13] as the following formulae:

- Leaf area index (LAI) = leaf area (dm^2/plant)/plant ground area (dm^2).
- Leaf area duration (LAD) = (LA_2 - LA_1) * (T_2- T_1). $dm.^2$/week
- Relative growth rate (RGR) = Loge W2 – Loge W1 / (T2 –T1) . g.g/week
- Net assimilation rate (NAR)= (W_2- W_1) (Loge A_1- Loge A_2)/ (A_2 – A_1)(T_2-T_1). $g.dm^{-2}$.week
- Crop growth rate (CGR) = (W_2 – W_1) / (T_2- T_1). g/ week

Where .W_1, A_1 and W_2, A_2 refer to dry weight for top or root (g) and leaf area, respectively at time T_1 and T_2 (day or week).

Statistical Analysis

Experimental design was randomized complete block design. Data analyses using SAS [14] .Not statistically significant between the means followed by the same alphabetical letters at the 0.05 level of significance according to [15].

Results and Discussion

The main objective of this chapter in the study is to show and explain the obtained results and their responses to the effect of nitrogen fertilizer forms, biofertilization treatments and their interaction in term of growth of sugar beet at different growth stages at 120,140, 160 and 180 days in 2014/2015 and 2015/2016 successive seasons.

Growth Analysis

Leaf Area Index.

Leaf Area Index in response to nitrogen forms, biofertilization treatments and their interaction at 120, 140, 160 and 180 days during 2014/2015 and 2015/2016 seasons are marked down in Tables 7, 8.

Data listed in Table 7 that nitrogen treatments had significant effect on Leaf Area Index in the two seasons except at 180 day in 1st season and 120, 140 and 180 days in 2nd season. Urea treatment achieved maximum increase in Leaf Area Index were 69.71, 81.32 and 166.54 at 120, 140 and 160 day in the 1st season, respectively, The highest one was 160.6 in the 2nd also was ammonium nitrate application at 160 days. Whereas, the lowest leaf area index was 66.29 and 117.11 with olive pomace at 140 and 160 days in 1st season respectively, and was 128.8 with the olive pomace in the 2nd season at 160 day. Such increase in this trait may be returned to the role of nitrogen in

Table 1. Chemical analysis of Olive pomace used in the study adopted from [6].

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

Table 2. show the experiment treatments adopted from [7].

Organic (Olive pomace)	Without biofertilizer (Control)
(1.54%N)	Nitrogin biofertilizer (ntrobin 600gm/fed)
(97.26 kg N / fed)	Phosphat biofertilizer (Phosphorine 300gm/ fed)
	Nitrogin biofertilizer + Phosphat biofertilizer by rate 1:1
	Without biofertilizer (Control)
Urea (46.5% N)	Nitrogin biofertilizer (ntrobin 600gm/ fed)
(100kg N / fed)	Phosphat biofertilizer (Phosphorine 300gm/ fed)
	Nitrogin biofertilizer + Phosphat biofertilizerby rate 1:1
	Without biofertilizer (Control)
Ammonium nitrate	Nitrogin biofertilizer (ntrobin 600gm/ fed)
(33.5% N)	Phosphat biofertilizer (Phosphorine 300gm/ fed)
(100kg N / fed)	Nitrogin biofertilizer + Phosphat biofertilizer by rate 1:1
	Without biofertilizer (Control)
Ammonium sulphate (20.6% N)	Nitrogin biofertilizer (ntrobin600gm/ fed)
(100kg N / fed)	Phosphat biofertilizer (Phosphorine 300gm/ fed)
	Nitrogin biofertilizer + Phosphat biofertilizer by rate 1:1

Table 3. Chemical analyses of the irrigation water in season 2014/2015 adopted from [9].

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 4. Chemical analyses of the irrigation water in season 2015/2016 adopted from [10].

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 5. physical and Chemical analyses of the experimental soil during the two seasons adopted from [11].

Soil properties	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	
Organic matter %	0.21	0.22
Chemical analysis in extraction soila) Cations (mq/l)		
Ca^{++}	3.01	3.03
Mg^{++}	2.22	2.20
Na^{+}	3.82	3.75
K^{+}	0.45	0.51
b) Anion (mq/l)		
Hco^{-}	2.12	2.11
Cl^{-}	2.23	2.17
So_4^{--}	3.27	3.33
$CaCO_3$ %	1.78	1.79
EC (ds/m) (1:5)	0.95	0.95
pH (1:2.5)	8.20	8.15

Table 6. Maximum and minimum values of temperature and relative humidity and rain full in 2014/2015 and 2015/2016 seasons.

Months	2014/2015					2015/2016				
	Temperature (°C)			*RH (%)	Rain mm/day	Temperature (°C)			*RH (%)	Rain mm/day
	Max.	Min.	Mean			Max.	Min.	Mean		
Oct.	28.8	16.6	26.5	85.7	4.4	28.8	16.6	22.7	72	4.4
Nov.	24.2	12.1	18.15	79.8	12.9	25.7	12.3	19	70	10.6
Dec.	20.5	8.8	14.65	85.3	20	20.5	8.8	14.65	71	20
Jan.	18.9	7.6	13.25	72	25.9	19.2	8.5	13.85	70	19
Feb.	19.5	7.9	13.7	70	13.9	19.9	9.1	14.5	69	2.4
Mar.	21.5	9.6	15.55	70	15.8	21.3	18.8	20.05	67	3.2
Apr.	25.5	12	18.75	66	5.1	23.7	13.3	18.1	67	3.8

Source. Central Laboratory for Agricultural Climate ARC, Ministry of Agriculture, Egypt. *RH = Relative humidity

Table 7. Effect of nitrogen forms on Leaf area index after 120, 140, 160 and 180 days from sowing in 2014/2015 and 2015/2016 seasons.

Seasons / Treatments	2014/2015				2015/2016			
	Days from sowing (DAS)							
	120	**140**	**160**	**180**	**120**	**140**	**160**	**180**
Olive pomace	50.48[b]	66.29[b]	117.1[b]	140.5	37.95	47.83	128.8[b]	131.5
Urea	69.71[a]	81.32[a]	166.5[a]	164.8	44.24	96.14	149.9[a]	248.9
Ammonium nitrate	65.19[ab]	72.67[ab]	138.1[ab]	212.3	58.57	68.13	160.6[a]	244.7
Ammonium sulphate	66.76[ab]	80.39[a]	140.2[ab]	176.6	42.84	73.66	139.1[ab]	248.3
significance	*	*	*	**NS**	**NS**	**NS**	*	**NS**

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. where **(**NS= not significant & * = significant & ** =high significant**).**

increasing number of leaf and blade width per plant.

In other words nitrogen fertilizers certainly stimulating growth and increasing leaf area index per plant. These results generally are in good agreement with those stated by [16, 17, 18, and 19].

Regarding the effect of biofertilization treatments the data in Table 8 cleared that had significant effect of biofertilization treatments on leaf area index in the 1st season except at 120 days and insignificant effect in 2nd season except at 160 days. The results showed that ntrobin application achieved maximum increase in leaf area index was 86.24, 160.7 and 225.5 in 140, 160 and 180 days in the 1st season, respectively, the highest leaf area index was 195.5 in the 2nd at 160 days. Whereas, the lowest leaf area index was 113.52 and 131.59 with control application at 160 and 180 days in 1st season respectively, the lowest 121.5 one in the 2nd season was control treatment applied at 160 days. The increase in leaf area index as a result of biofertilization treatments may be referred to their effect on nitrogen fixation and the uptake of nutrients hence increased sugar beet growth and development. These findings are in fully accordance with results of [20, 21, 22, and 23].

With regard to the effect of the interaction between nitrogen forms and biofertilization treatments on leaf area index were significant in the 1st season whereas, it were insignificant effect in 2nd season except at 160 days. The highest values from leaf area index were 87.70, 97.84, 224.05 and 306.21 achieved with urea treatment and ntrobin in the 1st season at 120, 140, 160 and 180 days, respectively, The highest values 238.90 from leaf area index was in 2nd season were produced with urea and phosphorine interaction at 160 days (table 9).

Crop Growth Rate (CGR) g/day

Means of crop growth rate (CGR) in g/day in response to nitrogen forms, biofertilization treatments and their interaction at (CGR_1), (CGR_2) and (CGR_3) during 2014/2015 and 2015/2016 seasons are marked down in Tables 10, 11 and 12.

Crop growth rate (g/day) was significantly affected by nitrogen forms in the two seasons only (Table 10). Ammonium nitrate treatment achieved the maximum values from Crop Growth Rate was 39.16 g/day in (CGR_1), 93.24 and 13.5 g/day in (CGR_2) and (CGR_3) from urea treatment at the 1st season. The maximum value from Crop Growth Rate was 15.41, 17.08 and 5.17 g/day in the 2nd season from urea treatment. The results generally are in good agreement with those stated by [24, 25, and 26].

Data in Table 11 excreted that biofertilization treatments had a significant effect on crop growth rate at the 1st season and 2nd season except at (CGR_2) in the 2nd season. As seems to appear from data that the ntrobin treatment gave the maximum values were 39.10 and 99.06 g/day in the 1st season at (CGR_1) and (CGR_2)**.** However, and was 11.26 and 10.81 g/day in the 2nd season at (CGR_1) and (CGR_3) respectively, in the end of the growth period at (CGR_3) the highest value was 14.18 g/day showed with phosphorine treatment in 1st season. Generally, biofertilization treatments exhibited slight improvement in Crop Growth Rate in all planting dates in the two seasons. This effect of biofertilization on enhancing growth of sugar beet plants was expected. These results are in harmony with those supported by [27, 28, and 29].

Concerning to the effect of nitrogen forms and biofertilization treatments interaction on crop growth rate (CGR) g/day, interaction resulted in the highest values of crop growth rate was 131.6 g/day at (CGR_2) from urea with ntrobin in 1st season. However, the highest value was 32.23 g/day at (CGR_2) from urea with phosphorine treatment in 2nd season.

Relative Growth Rate (RGR) g/week.

Data collected display the effect of nitrogen forms, biofertilization treatments and their interaction at (RGR_1), (RGR_2) and (RGR_3) during 2014/2015 and 2015/2016 seasons are marked down in Tables 13, 14.

It is clearly seen that Relative growth rate (RGR) in g/week rate was insignificantly affected by nitrogen forms and bio fertilization treatments through both

Concerning to the effect of nitrogen forms in (Table 13), (RGR_3) only significant in the 1st season. A slight increase was 0.03 g/week in this case was found due to urea treatments as compared with the

Table 8. Effect of biofertilization on Leaf area index after 120, 140, 160 and 180 days from sowing in 2014/2015 and 2015/2016 seasons.

Seasons / Treatments	2014/2015				2015/2016			
	Days from sowing (DAS)							
	120	140	160	180	120	140	160	180
Control	55.80	69.39^{ab}	113.5^{b}	131.5^{b}	38.31	40.37	121.5^{b}	167.6
Ntrobin	71.55	86.24^{a}	160.7^{a}	225.5^{a}	43.04	76.69	195.5^{a}	294.2
Phosphorine	62.69	84.03^{ab}	158.2^{a}	191.9^{ab}	49.53	64.86	161.9^{ab}	209.5
(Ntro + Phosph)	62.13	71.02^{ab}	129.5^{ab}	145.2^{b}	51.64	47.50	125.2^{b}	260.1
significance	**NS**	*	*	*	**NS**	**NS**	*	**NS**

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 . where **(**Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant**)**.

Table 10. Effect of nitrogen forms on crop growth rate (CGR g/day) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015			2015/2016		
	CGR_1	CGR_2	CGR_3	CGR_1	CGR_2	CGR_3
Olive pomace	27.53^{b}	56.16^{b}	-33.79^{c}	-2.98^{d}	6.32^{b}	-4.48^{b}
Urea	33.10^{b}	93.24^{a}	13.50^{a}	15.41^{a}	17.08^{a}	5.17^{a}
Ammonium nitrate	39.16^{a}	83.41^{ab}	-26.07^{c}	12.76^{ab}	10.76^{ab}	-2.95^{b}
Ammonium sulphate	38.37^{a}	73.05^{b}	-4.17^{b}	3.11^{c}	10.82^{ab}	-0.46^{b}
significance	*	*	**	**	*	**

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.where **(**NS= not significant & * = significant & ** =high significant**)**.

Table 9. Effect of interaction between nitrogen forms and biofertilization on Leaf area index after 120, 140, 160 and 180 days from sowing in 2014/2015 and 2015/2016 seasons.

Treatments	Seasons	2014/2015				2015/2016			
		Days from sowing (DAS)							
		120	140	160	180	120	140	160	180
Olive pomace	Control	41.87^{b}	71.91^{ab}	110.8^{b}	95.15^{b}	37.54	71.62	96.39^{c}	130.6
	Ntrobin	55.41^{ab}	72.22^{ab}	172.6^{ab}	186.2^{ab}	43.25	75.42	132.4^{bc}	212.8
	Phosphorine	48.23^{ab}	93.24^{a}	164.5^{ab}	163.9^{ab}	49.43	73.70	178.4^{bc}	218.2
	(Ntro + Phosph)	56.45^{ab}	87.92^{ab}	112.9^{b}	116.5^{b}	38.89	78.42	142.07^{bc}	312.6
Urea	Control	62.12^{ab}	68.22^{ab}	115.1^{b}	147.3^{ab}	30.73	70.50	$119.0^{a\text{-}c}$	157.6
	Ntrobin	87.70^{a}	97.84^{a}	224.0^{a}	306.2^{a}	39.10	86.14	149.7^{bc}	270.4
	Phosphorine	68.55^{ab}	93.83^{a}	176.0^{ab}	229.7^{ab}	44.20	72.20	238.9^{a}	221.9
	(Ntro + Phosph)	64.47^{ab}	71.69^{ab}	151.0^{ab}	166.2^{ab}	36.72	78.43	153.1^{ab}	217.2
Ammonium nitrate	Control	52.45^{ab}	62.77^{ab}	120.3^{b}	132.9^{ab}	47.87	68.89	$117.5^{a\text{-}c}$	284.1
	Ntrobin	79.90^{a}	79.41^{ab}	134.2^{ab}	219.6^{ab}	48.43	75.06	$122.1^{a\text{-}c}$	310.9
	Phosphorine	66.86^{ab}	81.10^{ab}	152.6^{ab}	185.4^{ab}	68.50	76.84	$120.5^{a\text{-}c}$	428.7
	(Ntro + Phosph)	67.85^{ab}	67.43^{ab}	145.3^{ab}	168.3^{ab}	71.00	88.66	$118.6^{a\text{-}c}$	201.6
Ammonium sulphate	Control	62.08^{ab}	60.52^{b}	111.0^{b}	129.7^{ab}	32.25	68.09	$118.7^{a\text{-}c}$	116.1
	Ntrobin	83.18^{a}	65.50^{ab}	112.0^{b}	190.0^{ab}	37.85	71.56	140.2^{bc}	377.4
	Phosphorine	67.11^{ab}	67.97^{ab}	139.6^{ab}	188.7^{ab}	56.80	73.16	151.2^{bc}	259.4
	(Ntro + Phosph)	64.41^{ab}	71.21^{ab}	105.7^{b}	150.9^{ab}	50.80	85.64	$132.5^{a\text{-}c}$	207.0
significance		*	*	*	*	NS	NS	**	NS

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. where (Ntro + Phosp = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant).

Table 10. Effect of nitrogen forms on crop growth rate (CGR g/day) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015			2015/2016		
	CGR_1	CGR_2	CGR_3	CGR_1	CGR_2	CGR_3
Olive pomace	27.53[b]	56.16[b]	-33.79[c]	-2.98[d]	6.32[b]	-4.48[b]
Urea	33.10[b]	93.24[a]	13.50[a]	15.41[a]	17.08[a]	5.17[a]
Ammonium nitrate	39.16[a]	83.41[ab]	-26.07[c]	12.76[ab]	10.76[ab]	-2.95[b]
Ammonium sulphate	38.37[a]	73.05[b]	-4.17[b]	3.11[c]	10.82[ab]	-0.46[b]
significance	*	*	**	**	*	**

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. where (NS= not significant & * = significant & ** =high significant).

Table 11. Effect of biofertilization on crop growth rate (CGR g/day) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015			2015/2016		
	CGR_1	CGR_2	CGR_3	CGR_1	CGR_2	CGR_3
Control	28.72[ab]	96.55[a]	-33.91[c]	11.23[a]	7.57	-7.21[c]
Ntrobin	39.10[a]	99.06[a]	-18.44[b]	11.26[a]	11.65	10.81[a]
Phosphorine	35.87[ab]	59.82[b]	14.18[a]	9.23[a]	13.07	-8.21[c]
(Ntro + Phosph)	30.48[ab]	64.44[b]	-12.37[b]	-3.42[b]	12.69	1.88[b]
significance	*	*	*	**	NS	**

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. where (Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant).

Table 12. Effect the interaction between nitrogen forms and biofertilization on crop growth rate in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015			2015/2016		
		CGR_1	CGR_2	CGR_3	CGR_1	CGR_2	CGR_3
Olive pomace	**Control**	25.51[ab]	22.76[b]	-60.95[b]	-0.75[ab]	8.42[ab]	-12.97[a-c]
	Ntrobin	26.50[ab]	97.57[ab]	-41.48[b]	9.99[ab]	12.83[ab]	0.06[a-c]
	Phosphorine	48.89[ab]	111.6[ab]	-7.02[b]	1.30[ab]	10.03[ab]	-8.78[a-c]
	(Ntro + Phosph)	52.60[a]	60.24[ab]	-25.71[b]	1.91[ab]	12.04[ab]	3.73[a-c]
Urea	**Control**	19.81[b]	51.46[ab]	-58.5[b]	3.50[ab]	3.00[ab]	-15.81[a-c]
	Ntrobin	41.99[ab]	131.1[a]	-17.98[b]	15.77[a]	9.39[ab]	16.43[a]
	Phosphorine	42.09[ab]	107.2[ab]	-24.4[ab]	20.36[a]	32.28[a]	10.25[a-c]
	(Ntro + Phosph)	36.78[ab]	75.02[ab]	-3.40[ab]	22.00[a]	23.67[a]	-22.69[bc]
Ammonium nitrate	**Control**	22.56[ab]	63.83[ab]	-24.72	4.58[ab]	0.97[b]	-24.92[c]
	Ntrobin	24.78[ab]	95.96[ab]	8.77[ab]	11.20[ab]	19.58[ab]	12.77[ab]
	Phosphorine	29.29[ab]	94.6[ab]	8.84[ab]	17.69[a]	17.83[ab]	5.13[a-c]
	(Ntro + Phosph)	33.54[ab]	79.25[ab]	-9.58	17.57[a]	4.67[ab]	5.16[abc]
Ammonium sulphate	**Control**	21.63[ab]	14.63[b]	-44.45	7.95[ab]	1.05[ab]	6.53[a-c]
	Ntrobin	26.87[ab]	93.61[ab]	79.32[a]	25.50[a]	4.83[ab]	7.42[a-c]
	Phosphorine	40.82[ab]	73.16[ab]	14.76[ab]	13.81[a]	9.03[ab]	20.17[a]
	(Ntro + Phosph)	43.10[ab]	43.25[ab]	4.36[ab]	18.81[a]	10.39[ab]	14.47[a]
significance		*	*	**	**	**	**

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. where **(**Ntro + Phosph = Ntrobin + Phosphorine & ns= not significant & * = significant & ** =high significant**).**

others treatment at the period from (RGR_3) in the 1st season. Similar results were supported by [30, 31, and 32].

On the whole, there were insignificant differences in biofertilization treatments over planting dates in the two seasons except (RGR_3) in both season, the highest value was 0.033, 0.091 g/week in (RGR_3) at two seasons in (Table 14). These results are in harmony with those supported by [33 and 34].

With regard to the effect of the interaction between nitrogen forms and biofertilization treatments on relative growth rate (RGR) were insignificant in both season except in (RGR_3). The highest values from relative growth rate were 0.19 g/week achieved with ammonium sulphate and phosphorine bio fertilizer in the 1st season. While, in the 2nd season was 0.17 g/ week with ammonium sulphate and ntrobin in (Table 15).

Net Assimilation Rate (NAR) (g/dm.week)

Net assimilation rate (NAR) in response to nitrogen forms, biofertilization treatments and their interaction at (NAR_1), (NAR_2), (NAR_3) and (NAR_4) during 2014/2015 and 2015/2016 seasons are marked down in (Tables 16). The Net Assimilation Rate (NAR) was insignificantly affected by nitrogen forms in both seasons in (Table 16). These results are in stand with those confirmed by [35,36,37 and 38].

Net assimilation rate (NAR) was insignificantly affected by biofertilization treatments through both seasons except at (NAR_1) in the 1st season (Table 17). The highest net assimilation rate was 0.66 g/dm.week achieved by ntrobin as compared the others treatment whereas, the lowest one 0.11 g.dm /week with the phosphorin**e** application. This may be due to the role of nitrogen in fixing more nitrogen and producing some growth substances that encourage plant growth and dry matter accumulation. These results are in harmony with those supported by [39 and 40].

With regard to the effect of the interaction between nitrogen forms and biofertilization treatments on net assimilation rate were significant in (NAR_3) in both seasons and (NAR_4) in the 1st season**.** However, the interaction between nitrogen forms and biofertilization treatments on net assimilation rate were insignificant (NAR_1) and (NAR_2) in both seasons and (NAR_4) in the 2nd season**.** The highest values from net assimilation rate were 1.34 g/dm.week achieved with ammonium sulphate and (ntrobin + phosphorine) at the 1st season. However, the interaction between the ammonium sulphate and ntrobin achieved the highest value 0.24 g/dm.week from net assimilation rate in the 2nd season (Table 18).

Leaf Area Duration (LAD dm^2/week)

Data in Tables 19 ,20 and 21 display the effect of nitrogen forms, biofertilization treatments and their interaction in (LAD_1), (LAD_2), (LAD_3) and (LAD_4) during 2014/2015 and 2015/2016 on Leaf Area Duration.

The leaf area duration was insignificantly affected by nitrogen forms treatments through both seasons except in (LAD_2), (LAD_3) in the 2nd season. The highest leaf area duration was 0.37 and 0.40 dm^2/week achieved due to urea as compared with the others treatment. However the lowest one was 0.24 and 0.26 dm^2/week with the olive pomace treatment. Similar results were supported by [41 and 42].

Concerning the effect of biofertilization treatments on leaf area duration, it showed an insignificant role at both seasons except in (LAD_4) in the 1st season. The highest leaf area duration was 0.66 dm^2/ week achieved with phosphorine treatment compared with the others treatment. However, the lowest one was 0.11 dm^2/week with the control treatment (Table 20). These results are in stand with those confirmed by [43,44 and 45].

With regard to the effect of the interaction between nitrogen forms and biofertilization treatments on leaf area duration (dm^2/week) were significant in 1st season except in (LAD_1)**.** However in the 2nd season were insignificant except in (LAD_1) and (LAD_4).The highest values from leaf area duration were 0.11, 0.19 and 0.15 dm^2/week achieved with urea and ntrobin in the 1st season at (LAD_2), (LAD_3) and (LAD_4). However, in the 2nd season the interaction between the ammonium sulphate and ntrobin achieved the highest value was 0.43 dm^2/week from (LAD_4), the interaction between the Ammonium Nitrate and Phosphorine achieved the highest value was 0.44 dm^2/week from (LAD_1) in (Table 21).

Table 13. Effect of nitrogen forms on relative growth rate (RGR g/week) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015			2015/2016		
	RGR_1	RGR_2	RGR_3	RGR_1	RGR_2	RGR_3
Olive pomace	0.160	0.161	-0.009[b]	-0.053	0.068	-0.009
Urea	0.180	0.234	0.036[a]	-0.053	0.090	-0.003
Ammonium nitrate	0.200	0.247	-0.050[b]	-0.049	0.075	-0.004
Ammonium sulphate	0.210	0.197	-0.075[b]	-0.041	0.062	-0.007
significance	**NS**	**NS**	*	**NS**	**NS**	**NS**

Table 14. Effect of biofertilization on relative growth rate (RGR g/week) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015			2015/2016		
	RGR_1	RGR_2	RGR_3	RGR_1	RGR_2	RGR_3
Control	0.150	0.175	-0.066[b]	-0.060	0.071	-0.003[b]
Ntrobin	0.200	0.253	-0.041[b]	-0.034	0.089	-0.010[b]
Phosphorine	0.220	0.217	0.033[a]	-0.055	0.056	0.091[a]
(Ntro + Phosph)	0.180	0.195	-0.024[b]	-0.048	0.080	-0.096[b]
significance	**NS**	**NS**	*	**NS**	**NS**	*

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. where **(**Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant**).**

Table 15. Effect the interaction between nitrogen forms and biofertilization on relative growth rate in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015			2015/2016		
		RGR_1	RGR_2	RGR_3	RGR_1	RGR_2	RGR_3
Olive pomace	**Control**	0.15	0.08	-0.08[ab]	-0.64	0.78	0.01[ab]
	Ntrobin	0.27	0.27	-0.11[b]	-0.44	0.14	0.03[ab]
	Phosphorine	0.23	0.26	-0.04[ab]	0.01	0.78	0.05[ab]
	(Ntro + Phosph)	0.17	0.16	-0.04[ab]	-0.60	0.80	0.14[ab]
Urea	**Control**	0.10	0.11	-0.08[ab]	-0.73	0.10	-0.23[b]
	Ntrobin	0.22	0.28	-0.07[ab]	-0.68	0.96	0.12[a]
	Phosphorine	0.24	0.29	-0.04[ab]	-0.50	0.87	0.07[ab]
	(Ntro + Phosph)	0.25	0.23	-0.01[ab]	-0.22	0.76	-0.14[ab]
Ammonium nitrate	**Control**	0.12	0.18	-0.05[ab]	-0.70	0.10	-0.23[b]
	Ntrobin	0.13	0.28	0.01[ab]	-0.39	0.65	0.12[a]
	Phosphorine	0.17	0.26	-0.02[ab]	-0.58	0.79	0.03[ab]
	(Ntro + Phosph)	0.22	0.25	0.02[ab]	-0.31	0.57	0.04[ab]
Ammonium sulphate	**Control**	0.11	0.05	-0.11[b]	-0.58	0.49	-0.08[ab]
	Ntrobin	0.15	0.26	0.04[ab]	-0.27	0.75	0.17[a]
	Phosphorine	0.24	0.19	0.19[a]	-0.53	0.77	-0.40[ab]
	(Ntro + Phosph)	0.24	0.13	0.01[ab]	-0.74	0.70	0.09[ab]
significance		**NS**	**NS**	*	**NS**	**NS**	**

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. where **(**Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant**)**.

Table 16. Effect of nitrogen forms on net assimilation rate (NAR) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015				2015/2016			
	NAR_1	NAR_2	NAR_3	NAR_4	NAR_1	NAR_2	NAR_3	NAR_4
Olive pomace	0.36	0.48	-0.04	0.17	-0.08	0.08	-0.12	0.56
Urea	0.47	0.61	-0.16	0.40	0.25	0.20	0.04	0.69
Ammonium nitrate	0.39	0.67	-0.02	0.19	0.15	0.17	0.01	0.70
Ammonium sulphate	0.41	0.49	-0.13	0.50	0.04	0.12	0.08	0.75
significance	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

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. where **(**NS= not significant & * = significant & ** =high significant**).**

Table 17. Effect of biofertilization on net assimilation rate (NAR) in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015				2015/2016			
	NAR_1	NAR_2	NAR_3	NAR_4	NAR_1	NAR_2	NAR_3	NAR_4
Control	0.33	0.47	-0.12	0.25^{b}	0.09	0.09	-0.05	0.35
Ntrobin	0.41	0.67	-0.04	0.66^{a}	0.19	0.16	-0.10	0.71
Phosphorine	0.49	0.56	-0.13	0.11^{b}	0.16	0.16	-0.15	0.82
(Ntro + Phosph)	0.40	0.54	-0.06	0.23^{b}	-0.08	0.15	-0.11	0.83
significance	**NS**	**NS**	**NS**	*****	**NS**	**NS**	**NS**	**NS**

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. where **(**Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant**).**

Table 18. Effect of interaction between nitrogen forms and biofertilization on net assimilation rate in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015				2015/2016			
		NAR_1	NAR_2	NAR_3	NAR_4	NAR 1	NAR 2	NAR_3	NAR 4
Olive pomace	Control	0.33	0.16	-0.18[b]	0.09[bc]	-0.06	0.15	-0.01[ab]	0.59
	Ntrobin	0.58	0.67	-0.26[b]	0.17[bc]	0.15	0.20	-0.21[ab]	0.71
	Phosphorine	0.58	0.70	-0.09[b]	0.43[abc]	0.04	0.24	-0.35[b]	0.82
	(Ntro + Phosph)	0.37	0.40	-0.12[b]	0.90[ab]	0.02	0.21	0.10[ab]	0.66
Urea	Control	0.23	0.28	-0.06[b]	0.04[bc]	0.05	-0.01	-0.16[ab]	0.18
	Ntrobin	0.46	0.69	-0.12[b]	0.16[bc]	0.29	0.14	0.22[ab]	0.43
	Phosphorine	0.43	0.82	0.04[b]	0.32[bc]	0.26	0.32	0.18[ab]	1.23
	(Ntro + Phosph)	0.45	0.65	-0.08[b]	0.21[bc]	0.39	0.25	-0.22[ab]	0.94
Ammonium nitrate	Control	0.29	0.48	-0.05[b]	-0.18[c]	0.07	0.01	-0.30[ab]	0.23
	Ntrobin	0.29	0.72	0.06[b]	0.15[bc]	0.15	0.27	0.21[ab]	1.08
	Phosphorine	0.38	0.77	0.06[b]	0.36[bc]	0.17	0.17	0.08[ab]	0.56
	(Ntro + Phosph)	0.47	0.72	-0.15[b]	0.35[bc]	0.23	0.03	0.07[ab]	0.39
Ammonium sulphate	Control	0.24	0.15	-0.25[b]	-0.01[bc]	-0.89	-0.09	-0.12[ab]	0.15
	Ntrobin	0.33	0.87	0.12[b]	0.53[abc]	0.17	0.06	0.24[a]	0.85
	Phosphorine	0.54	0.56	0.63[a]	0.13[bc]	0.26	0.14	0.02[ab]	0.67
	(Ntro + Phosph)	0.54	0.38	0.04[b]	1.34[a]	0.13	0.12	0.19[ab]	1.32
significance		NS	NS	*	*	NS	NS	*	NS

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. where (Ntro + Phosph = Ntrobin + Phosphorine & NS= not significant & * = significant & ** =high significant).

Table 19. Effect of nitrogen forms on leaf area duration (dm^2/week) in 2014/2015 and 2015/2016 seasons.

Treatments	**2014/2015**				**2015/2016**			
	LAD_1	**LAD_2**	**LAD_3**	**LAD_4**	**LAD_1**	**LAD_2**	**LAD_3**	**LAD_4**
Olive pomace	0.04	0.06	0.10	0.08	0.29	0.24^b	0.26^b	0.22
Urea	0.05	0.08	0.14	0.11	0.29	0.37^a	0.40^a	0.23
Ammonium nitrate	0.05	0.09	0.11	0.10	0.36	0.35^a	0.39^a	0.30
Ammonium sulphate	0.05	0.07	0.10	0.10	0.31	0.34^a	0.37^{ab}	0.30
significance	**NS**	**NS**	**NS**	**NS**	**NS**	*	*	**NS**

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. where **(**NS= not significant & * = significant & ** = high significant**).**

Table 20. Effect of and biofertilization on leaf area duration (dm^2/week) in 2014/2015 and 2015/2016 seasons.

Treatments	**2014/2015**				**2015/2016**			
	LAD_1	**LAD_2**	**LAD_3**	**LAD_4**	**LAD_1**	**LAD_2**	**LAD_3**	**LAD_4**
Control	0.33	0.47	-0.06	0.11^b	0.08	0.09	-0.05	0.35
Ntrobin	0.41	0.67	-0.12	0.25^b	0.19	0.16	-0.10	0.71
Phosphorine	0.49	0.56	-0.04	0.66^a	0.16	0.16	-0.15	0.82
(Ntro + Phosph)	0.40	0.54	-0.13	0.23^b	0.09	0.15	-0.11	0.83
significance	**NS**	**NS**	**NS**	*	**NS**	**NS**	**NS**	**NS**

Table 21. Effect the interaction between nitrogen forms and biofertilization on leaf area duration (dm^2/week) in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015				2015/2016			
		LAD_1	LAD_2	LAD_3	LAD_4	LAD_1	LAD_2	LAD_3	LAD_4
Olive pomace	**Control**	0.04	0.06^{cd}	0.07^{b}	0.06^{b}	0.22^{b}	0.23	0.24	0.16^{d}
	Ntrobin	0.05	0.09^{a-d}	0.13^{ab}	0.10^{ab}	0.25^{ab}	0.26	0.28	0.21^{b-d}
	Phosphorine	0.05	0.09^{a-c}	0.12^{ab}	0.09^{ab}	0.27^{ab}	0.24	0.26	0.23^{b-d}
	(Ntro + Phosph)	0.05	0.07^{b-d}	0.08^{b}	0.08^{b}	0.25^{ab}	0.24	0.29	0.28^{b-d}
Urea	**Control**	0.05	0.07^{cd}	0.09^{b}	0.08^{b}	0.22^{b}	0.32	0.34	0.20^{cd}
	Ntrobin	0.06	0.11^{a}	0.19^{a}	0.15^{a}	0.31^{ab}	0.33	0.38	0.24^{b-d}
	Phosphorine	0.06	0.10^{ab}	0.15^{ab}	0.11^{ab}	0.28^{ab}	0.43	0.44	0.26^{b-d}
	(Ntro + Phosph)	0.05	0.08^{b-d}	0.11^{ab}	0.10^{ab}	0.28^{ab}	0.44	0.47	0.23^{b-d}
Ammonium nitrate	**Control**	0.04	0.06^{cd}	0.09^{b}	0.09^{ab}	0.28^{ab}	0.29	0.32	0.22^{b-d}
	Ntrobin	0.06	0.08^{b-d}	0.13^{ab}	0.11^{ab}	0.31^{ab}	0.34	0.40	0.34^{a-c}
	Phosphorine	0.05	0.07^{b-d}	0.12^{ab}	0.10^{ab}	0.44^{a}	0.40	0.36	0.30^{a-d}
	(Ntro + Phosph)	0.06	0.08^{b-d}	0.11^{b}	0.09^{ab}	0.39^{ab}	0.39	0.48	0.36^{ab}
Ammonium sulphate	**Control**	0.05	0.06^{cd}	0.09^{b}	0.08^{b}	0.22^{b}	0.27	0.28	0.22^{b-d}
	Ntrobin	0.06	0.07^{b-d}	0.12^{ab}	0.11^{ab}	0.26^{ab}	0.29	0.42	0.43^{a}
	Phosphorine	0.05	0.06^{d}	0.11^{b}	0.11^{ab}	0.36^{ab}	0.37	0.35	0.26^{b-d}
	(Ntro + Phosph)	0.05	0.06^{cd}	0.09^{b}	0.09^{b}	0.41^{ab}	0.44	0.45	0.31^{a-c}
significance		**NS**	*	*	*	*	**NS**	**NS**	**

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.where **(**Ntro + Phosph = Ntrobin + Phosphorine & ns= not significant & * = significant & ** =high significant**).**

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