J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (6): 215 - 222 , 2017

Effect of Mineral Nitrogen Fertilization and Compost on Stevia Yield and its Profitability.

Basma R. A. Rashwan[1] and H. Ferweez[2]
[1] Soil, Water and Environ. Res. Inst., Agric. Res. Center, Giza, Egypt.
[2] Food Sci. and Techno. Dept. ,Fac. Agric. New Valley, Assiut University, Egypt.

ABSTRACT

Stevia (*Stevia rebaudiana Bertoni*) was recently introduced to Egyptian agriculture in order to produce a natural sweetener (Steviol glycosides) instead of sugar (Sucrose) to cover some of the lack of sugar production, which reached annually about 0.8 million ton. So, a field experiment was carried out at Mallawi Agriculture Research Station , Minia Governorate , Egypt, during two successive seasons (2014 and 2015) to study the effect of different levels of mineral N fertilization and compost on yield and its quality of stevia (*Stevia rebaudiana Bertoni)* under Middle Egypt conditions. The experimental design was a split plot in three replicates and the main plot were devoted N fertilizer levels (40, 60 and 80 kg N fed^{-1}) while compost levels (0, 3 and 6 ton fed^{-1}) were allocated in the sub plot. The obtained results revealed that N fertilizer level and/or compost level had a significant effect on plant height (cm) , fresh and dry leaves weight (g plant^{-1}) , N, P& K contents of stevia leaves and N uptake kg fed^{-1}, dry leaves yield kg fed^{-1} , stevioside (St %), rebaudioside A (Rb%), stevioside yield (kg/fed) and rebaudioside A yield (kg fed^{-1}), the remained nutrients (N,P & K (ppm) and OM %) in the soil post-harvest of stevia in two growing seasons, except P% of leaf in the 2nd season for N fertilization. A significant interaction was scored between N fertilizer level and compost rate with regard to plant height (cm) , fresh and dry leaves weight (g plant^{-1}) , N % of stevia leaves and N uptake kg fed^{-1} , dry leaves yield kg fed^{-1} , stevioside (St %), rebaudioside A (Rb%), stevioside yield (kg fed^{-1}) and rebaudioside A yield (kg fed^{-1}) of stevia in the two growing seasons. From the present study , it may be concluded that the application of 60 kg mineral N fertilizer + 6.0 ton compost fed^{-1} was the best treatment for improving the yield and quality of stevia and is advisable to achieve the highest values of rebaudioside A (298.99 and 297.74 kg fed^{-1}) ,and net profit of stevia.

Keywords: Stevia, N fertilizer, compost, stevioside%, and rabaudioside A.

INTRODUCTION

Stevia (*Stevia rebaudiana Bertoni)* has been widely cultivated in the world for the sweet deterrence glycosides that are mainly contained in its leaves. In Egypt, the gap between sugar production (2.5 million ton) and consumption (3.3 million ton) represents a serious problem, since it was estimated to be 0.8 million ton. Nowadays, attention is concentrated upon using Stevia in food industries, in order to close the gap between the sugar production and consumption.

Stevia plant was recently introduced to Egyptian agriculture in order to produce a natural sweetener than can cover some of the lack of sugar production. It is expected that in the Egyptian agricultural environment; one feddan of Stevia may produce up to 400 kg of Stevia sugar, annually. Taking the sweetening powder of the Stevia sugar into consideration; these 400 kg of stevia are equivalent to about 80000 sweetening units. Note that one feddan of "Sugar cane" produces about 5000 sweetening units and one feddan of "Sugar beet" produces about 3500 sweetening units. A sweetening unit is equivalent to the sweetness of one kilogram of sucrose Alaam, (2007). Dossier, (1999) reported that Stevia sweeteners and extracted products which are commonly used as non-nutritive and high-intensity sweeteners in beverages, foods and medicines. The leaves naturally contain a complex mixture of eight sweet diterpene glycosides, including stevioside, steviolbioside, rebaudiosides (A, B,C, D, E) and dulcoside A.

The increasing consumption of sugar (sucrose) has resulted in several nutritional and medical problems, such as obesity. Therefore, low caloric sweeteners have been investigated to substitute sugar. An important class of low caloric sugar substitutes is known as high intensity sweetener, this is at least 50 - 100 times sweeter than sucrose Jaroslav *et al.,*(2006).

Fertilizers play an important role in increasing crop production. The main macronutrients present in inorganic fertilizers are nitrogen, phosphorus, and potassium which influence vegetative and reproductive phase of plant growth.

Nutrient content, solubility, and nutrient release rates Organic fertilizer are typically lower than inorganic fertilizers and thus inorganic fertilizers are preferred over organic fertilizers. However, in the developing countries the high prices of fertilizers is affecting the incorn of farmers. A comparative study on effect of chemical fertilizers and bio-fertilizers was done on growth and biochemical parameters in Stevia rebaudiana Var Bertoni. The results indicated that chemical treatment increased plant growth when compared to control. Therefore, it is necessary to evaluate and develop a balanced fertilization strategy that combines the use of chemical, organic or biofertilizer.

Composts are prepared by biological degradation of plant and animal residues under controlled and aerobic conditions (Patil, 2010). Rashwan *et al*., (2017) concluded that the application of compost at 2.0 ton/fed was the best treatment for improving the yield and quality of stevia (Stevia rebaudiana Bertoni) with 3rd cutting and is advisable because it is achieved the highest value of rebaudioside A (102.80 kg fed-1). The use of biofertilizer or compost are favorable to minimize the environmental problems , caused by the chemical ones . This work carried out to assess the effect of different levels of nitrogen fertilization and compost on yield and quality of stevia (Stevia rebaudiana Bertoni) under Middle Egypt conditions.

MATERIALS AND METHODS

A field experiment was carried out at Mallawi Agriculture Research Station , Minia Governorate , Egypt, during the two successive seasons (2014 and 2015) to study the effect of different levels of N fertilization and compost on yield and quality of stevia (*Stevia rebaudiana Bertoni)* under Middle Egypt conditions. The experiment design was split plot in three replicates, main plots were devoted N fertilizer levels (40, 60 and 80 kg N fed^{-1}) and compost levels (0, 3 and 6 ton fed^{-1}) were allocated in the sub plots. The seedlings of stevia (*Stevia rebaudiana Bertoni*), Spanish cultivar, were purchased from the sugar crops research institute and grown in the experimental farm of Mallawi Agric., Res. Station , on the beds (120 cm) at the two sides. Stevia seedlings were transplanted at a spacing of 35 × 60 cm at 25th and 23th March 2014 and 2015, respectively. Stevia plants were harvested just prior to flowering stage when the concentration of steviol glycoside in the leaves was in the maximum level. Since glycoside synthesis is reduced at or just after flowering Kumar, *et al*.,(2014) ,leaving 10 cm up to ground level, periodically at 90 days (1st cutting or harvest), 140 days (2nd cutting or harvest) and 190 days (3rd cutting or harvest) of planting. Growth of stevia plants stops under the low temperatures, i.e. in winter season. Well decomposed compost (commercial compost namely Nile compost (plant residues) was incorporated into the soil before transplanting every year. Inorganic nutrients were applied at the time of transplanting utilizing ammonium nitrate (N 33.5%), calcium super phosphate (P_2O_5 15.5%), and Potassium Sulphate (K_2O 48%). Nitrogen was applied in three equal splits; first dose at the time of transplanting and the remaining second applied after the first harvest (90 day) and the remaining third applied after the second harvest (140 day), whereas, the full doses(Calcium super phosphate (15.5 % p_2O_5) at a rate of 150 kg fed^{-1}. Potassium sulphate (48%K_2O) at rates of 50 kg fed^{-1}) of phosphorus and potassium were applied at the time of transplanting composed. Samples of soils were analyzed using methods cited by Black *et al* (1965).

Table 1. Some physical and chemical properties of the experimental soil.

Properties	2014	2015	Properties	2014	2015
Particle size distribution (%)					
Sand (%)	8.62	8.03	pH	8.01	8.22
Silt (%)	53.18	52.55	EC	1.24	1.16
Clay (%)	38.20	39.43	Organic matter (%)	1.01	1.07
Soil texture	Silty clay loam				
Soluble cations (meq/L)			Soluble anions (meq/L)		
Ca^{++}	7.35	7.05	CO_3^{-}	---	
Mg^{++}	2.13	2.06	HCO^{-}	3.20	3.44
Na^{+}	3.21	3.23	Cl^{-}	4.14	4.08
K^{+}	0.20	0.25	SO_4^{-}	5.55	5.07
Available nutrients (mg kg^{-1})					
Available N		18.50		19.31	
Available K		155.50		159.82	
Available P		7.57		7.81	

EC(dsm^{-1}) soil-water extract ratio (1:5) **pH soil – water suspension ratio (1:2.5)**

Table 2. Some characteristics of compost.

Properties	OM (%)	Organic carbon (%)	pH (compost: water) suspension ratio (1:10)	E.C (compost: water) extract (1:10) .(dSm^{-1})	C:N	Total macronutrients (%)			Total micronutrients (ppm)			Weight of one m^3 (kg)
						N	P	K	Zn	Fe	Mn	
Values	32.75	29.20	7.85	6.9	14.6:1	2.00	0.22	0.85	54	810	204	500

Data recorded:_ Five plants of stevia / plots were selected randomly and cut at the ground level before flowering for recording the following:

Vegetative traits :

1-Plant height (cm). 2- Fresh leaves weight (g)/plant

3- Dry leaves weight (g)/plant. (the plants were dried in air oven at 60^{O}C).

Leaves nutrient status :

Stevia leaves samples were collected at 15 days interval followed by fertilizer treatment in the third and fourth leaf from the top to determine N P K from the different treatments . Leaves dried in a forced oven at 60°C till constant of weight; 0.2 gm of fine leaves powder was wet digested using sulphuric-perchloric acid mixture (1:1) as described by A.O.A.C (2000), to determine the total N, P and K in the acidic extract according to Jackson, (1967).

Yields:

Stevia plants of inner two ridges for each plot were harvested or cut from the bottom, leaving 10 cm up to ground level and weighed and converted for kg fed^{-1} to determine:

1. Fresh leaves yield (kg fed^{-1}).
2. Dry leaves yield (kg fed^{-1}).

Quality traits:

Quality traits of stevia in the two field experiments were determined as follows:

1. Stevioside of dry stevia leaves (St %) was estimated using the method described by A.O.A.C. (2000).
2. Rebaudioside A (Rb%) of dry stevia leaves was estimated using the method described by A.O.A.C. (2000).
3. Stevioside yield (St yield) of dry stevia leaves (kg fed^{-1}) was calculated by the formula as follows:

St yield (kg fed^{-1}) = dry stevia leaves yield (kg fed^{-1}) × Stevioside %of dry leaves.

4. Rebaudioside A yield (Rb A yield) of dry stevia leaves (kg fed^{-1}) was calculated by the formula as follows:

Rb A yield (kg fed^{-1}) =dry stevia leaves yield(kg fed^{-1}) × Rb A% of dry leaves.

Sweet glycosides extraction :

Harvest stevia leaves were collected from different treatments and dried at 60 °C in hot air oven for 48 h .Hundred milligrams of air-dried powdered leaves of stevia was macerated in methanol (10 ml) overnight and filtered. Plant material was re-extracted with same solvent twice (5ml each time) for 3 h each. the extractants were pooled together and concentrated up to dryness under reduced pressure. After defatting with n-hexane (2ml) thrice and vacuum drying , the extract was dissolved in 10 ml of HPLC grade acetonitrile and water (80 :20) mobile phase degassed for 5 min. and filtered through 0.45 µm filter . The filtrated was used for HPLC analysis. Standard stock solutions (1mg/ 2ml) of stevioside and rebaudioside A contents were calculated through high-performance liquid chromatography (HPLC). Data collected were subjected to Analysis of (ANOVA) Variance. The proper statistical of all data was carried out. Differences among treatments were evaluated by the least significant difference test (LSD) according to procedure out lined by Gomez & Gomez (1984). Significant of differences was defined at 5 percent level.

RESULTS AND DISCUSSION

I-Vegetative traits

Data in Table (3) and Fig. (1)show that N fertilizer level and/or compost level had a significant effect on plant height (cm) , fresh and dry leaves weight (g plant^{-1}) of *Stevia rebaudiana Bertoni* in the two growing seasons. It could be concluded from the results that the increase in N fertilizer level from 40 to 60 and 80 kg N fed^{-1} or compost from 0.0 to 3.0 and 6.0 ton fed^{-1} led to increasing plant height, fresh and dry leaves weight (g plant^{-1}) of *Stevia rebaudiana Bertoni* in the two seasons. Similar results were obtained with those reported by Khanom *et al.,*(2008) and Umesha, *et al.,*(2011) and Dushyant *et al.*, (2014) who mentioned that vegetative values in stevia have been very much influenced by the application of inorganic and organic nutrients.

Table 3. Effect of compost and N fertilization on plant height (cm), Fresh leaves weight (g)/ plant and Dry leaves weight (g)/ plant of stevia plant during 2014 and 2015 seasons.

Nitrogen fertilizers (A)	Season 2014				Season 2015			
	Compost (ton fed^{-1}) (B)							
	0	3	6	Mean	0	3	6	Mean
	Plant height (cm)							
Control (80 kg N fed^{-1})	69.3	71.0	74.3	71.6	70.0	71.7	75.0	72.2
(60 kg N fed^{-1})	55.4	66.8	76.3	66.2	57.3	65.0	77.3	66.5
(40 kg N fed^{-1})	38.2	43.5	46.0	42.6	37.3	42.4	45.4	41.7
Mean	54.3	60.4	65.5	60.1	54.9	59.7	65.9	60.1
LSD $_{5\%}$	A= 2.6 B=1.6 AB=2.7				A= 2.3 B=1.3 AB=2.3			
	Fresh leaves weight (g)/ plant							
Control (80 kg N fed^{-1})	261.3	261.3	257.3	260.0	269.3	269.3	265.3	268.0
(60 kg N fed^{-1})	237.3	243.3	271.3	250.7	242.3	248.3	279.3	256.7
(40 kg N fed^{-1})	210.3	216.3	222.3	216.3	213.3	219.3	225.3	219.3
Mean	236.3	240.3	250.3	242.3	241.7	245.7	256.7	248.0
LSD $_{5\%}$	A= 2.61 B=7.31 AB=12.71				A= 2.63 B=7.32 AB=12.74			
	Dry leaves weight (g)/ plant							
Control (80 kg N fed^{-1})	75.8	78.7	82.7	67.5	74.0	77.1	81.1	66.3
(60 kg N fed^{-1})	70.8	75.2	84.7	76.9	69.3	73.3	82.7	75.1
(40 kg N fed^{-1})	66.3	67.5	68.7	79.1	65.1	66.3	67.6	77.4
Mean	70.9	73.8	78.7	74.5	69.5	72.1	77.1	73.0
LSD $_{5\%}$	A= 1.70 B=0.30 AB=0.46				A= 1.12 B=0.04 AB=0.07			

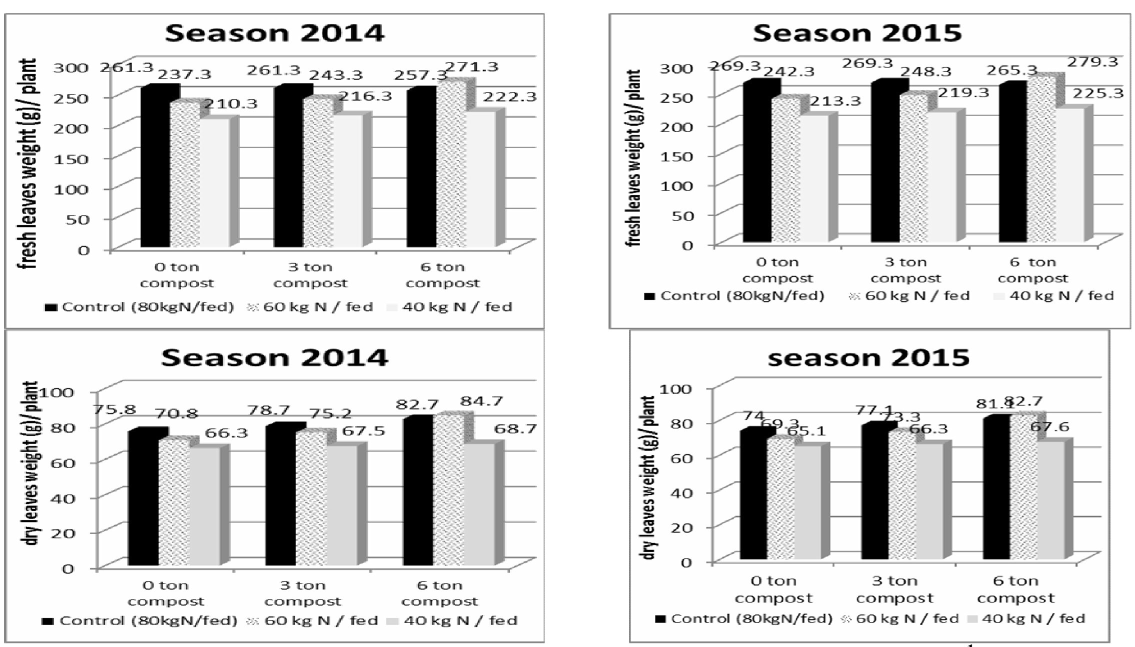

Fig 1. Effect of compost and N fertilization levels on fresh and dry leaves weight (g plant^{-1}) of stevia plant during 2014 and 2015 seasons.

A significant interaction was scored in Table (3) and Fig. (1) between N fertilizer level (A) and compost (B) with regard to plant height (cm) , fresh and dry leaves weight (g plant^{-1}) of *Stevia rebaudiana Bertoni* in the two growing seasons. The highest values of plant height (76.3 and 77.3 cm),fresh (271.3 and 279.3 g plant-[1]) and dry leaves weight (84.7 and 82.7 g plant^{-1}) were recorded with 60 kg N fed^{-1}+ 6 ton compost fed^{-1} treatment in the two growing seasons ,respectively. This result might be due to that the release of nutrients from compost and their absorption by plants and remineralization of immobilized N require time, which has become imperative to sustain high nutrient supply for greater productivity. These findings are in the same trend with those obtained by Das *et al.* (2009), Khaled & Fawy (2011) and Kumar , *et al.* (2012 and 2013) who noticed that combined application of chemical fertilizer and compost increased the plant height and fresh and dry leaves weight (g plant-1) of stevia.

2-Plant nutrient status:

N,P&K% in leaves of stevia after 15 days from planting.

Results in Table (4) and Fig (2) showed that N, P, K contents of stevia leaves and N uptake kg fed^{-1} of stevia were significantly affected by N fertilization level and/or compost in the two growing seasons, except P% and K% of leaf in the 2nd season for N fertilization . When N fertilizer level increased from 40 to 60 and 80 kg N fed^{-1} or compost level from 0 to 3 and 6 ton fed^{-1} increased N%, P%, K% and N uptake kg fed^{-1} of stevia leaves . The aforementioned findings correlated with those recorded by Gupta, *et al*. (2011) , Khaled & Fawy (2011) ,Kumar *et al,*. (2012 and 2013) and Yami *et al* ., (2015)who reported the same results. A significant interaction was showed in Table (4) and Fig. (2) between N fertilizer level (A) and compost (B). The highest values of N content (1.687 and 1.707 %) and N uptake (93.22 and 94.51 kg fed^{-1}) of stevia leaves were recorded with 60 kg N fed^{-1}+ 6 ton compost fed^{-1} treatment in two growing seasons ,respectively. Such results are in the same line with those found by Kumar , *et al*. (2012 and 2013) who revealed that the increase in N % of stevia leaf by compost application might be due to enhancement in N availability by shifting the equilibrium between the forms of N from relatively exchangeable N to soluble N forms in the soil.

Table 4. Effect of compost and N fertilization on N, P, K% and N Uptake kg fed^{-1} of fresh stevia leaves during 2014 and 2015 seasons.

Nitrogen fertilizers (A)	Season 2014				Season 2015			
	Compost (ton fed^{-1}) (B)							
	0	1	2	Mean	0	1	2	Mean
N % of fresh stevia leaves								
Control (80 kg N fed^{-1})	1.617	1.643	1.637	1.632	1.610	1.637	1.650	1.632
(60 kg N fed^{-1})	1.570	1.617	1.687	1.624	1.597	1.603	1.707	1.635
(40 kg N fed^{-1})	1.457	1.513	1.553	1.508	1.467	1.527	1.583	1.526
Mean	1.548	1.591	1.626	1.588	1.558	1.589	1.647	1598
LSD $_{5\%}$	A= 0.038 B=0.020 AB=0.035				A= 0.017 B=0.021 AB=0.036			
P % of fresh stevia leaves								
Control (80 kg N fed^{-1})	0.21	0.22	0.23	0.22	0.20	0.22	0.23	0.22
(60 kg N fed^{-1})	0.19	0.20	0.23	0.21	0.20	0.20	0.26	0.22
(40 kg N fed^{-1})	0.16	0.15	0.16	0.16	0.18	0.17	0.19	0.18
Mean	0.19	0.19	0.21	0.20	0.19	0.20	0.22	0.21
LSD $_{5\%}$	A= 0.018 B=0.014 AB=NS				A= NS B=0.021 AB=NS			
K % of fresh stevia leaves								
Control (80 kg N fed^{-1})	1.89	1.97	1.96	1.94	1.89	1.95	1.97	1.94
(60 kg N fed^{-1})	1.79	1.89	2.09	1.93	1.81	1.90	2.08	1.93
(40 kg N fed^{-1})	1.46	1.59	1.67	1.57	1.49	1.62	1.69	1.60
Mean	1.71	1.82	1.91	1.81	1.73	1.82	1.92	1.82
LSD $_{5\%}$	A= 0.122 B=0.063 AB=NS				A= 0.133 B=0.058 AB=NS			
N Uptake kg fed^{-1} of fresh stevia leaves								
Control (80 kg N fed^{-1})	86.00	88.35	89.03	87.79	85.74	87.89	89.72	87.79
(60 kg N fed^{-1})	79.73	85.00	93.22	85.98	80.99	84.22	94.51	86.57
(40 kg N fed^{-1})	61.81	69.14	75.40	68.78	62.14	69.58	76.72	69.48
Mean	75.85	80.83	85.88	80.85	76.29	80.56	86.99	81.28
LSD $_{5\%}$	A= 2.12 B=1.45 AB=2.52				A= 1.08 B=1.43 AB=2.48			

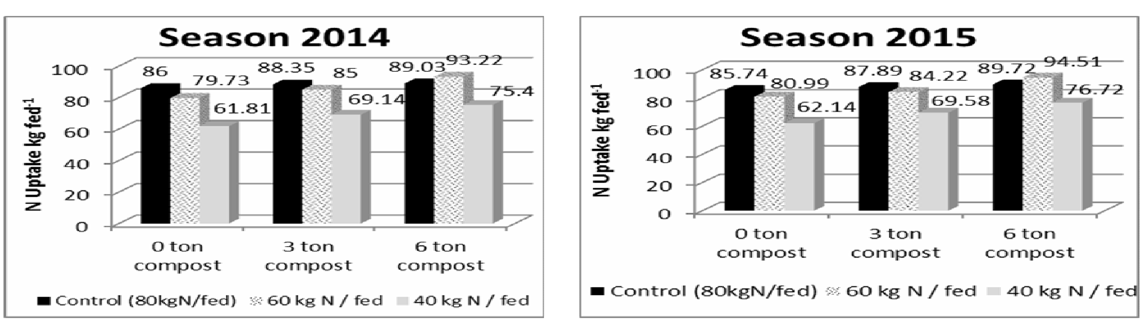

Fig 2. Effect of compost and N fertilization levels on N Uptake kg fed^{-1} of stevia plant during 2014 and 2015 seasons.

Yields of stevia :

Data in Table (5) showed that dry leaves yield kg fed^{-1} of stevia were significantly affected by N fertilization level and/or compost in the two growing seasons. When N fertilizer level increased from 40 to 60 and 80 kg N fed^{-1} or compost level from 0 to 3 and 6 ton fed^{-1} increased dry leaves yield kg fed^{-1} of stevia. The aforementioned findings correlated with those recorded by Das, *et al*. (2007) and Rashwan *et al* (2017).A significant interaction was obtained in Table (5) between N fertilizer level (A) and compost (B) with regard to dry leaves yield kg fed^{-1} of stevia in the two growing seasons. It could be revealed from the results that application of 60 kg N fed^{-1} + 6 ton compost fed^{-1} given the highest value of dry stevia leaf yield (5527, 5537kg fed^{-1}) in both seasons,respectively. These results are in a good accordance with those reported by Das, *et al*. (2007) and Rashwan *et al* (2017).

Table 5. Effect of compost and N fertilization on dry leaves yield kg fed^{-1} of stevia during 2014 and 2015 seasons.

Nitrogen fertilizers (A)	2014 season				2015 season			
	Compost (ton fed^{-1}) (B)							
	0	3	6	Mean	0	3	6	Mean
Control (80 kg N fed^{-1})	5319	5376	5440	5378	5326	5340	5438	5378
(60 kg N fed^{-1})	5078	5258	5527	5287	5073	5253	5537	5288
(40 kg N fed^{-1})	4244	4569	4845	4555	4237	4557	4846	4547
Mean	4880	5067	5273	5074	4878	5060	5274	5071
LSD (5%)	A= 38.1 B=27.9 AB= 48.3				A= 42.0 B=26.6 AB= 46.1			

Quality parameters of stevia:

Production of more dry leaf biomass with higher steviol glycosides (St and Rb) is the main criterion for performance. Data in Table (6) and fig (3) showed that When compost level increased from 0 to 3 and 6 ton fed^{-1} led to an increase in stevioside (St %), rebaudioside A (Rb%), stevioside yield (kg fed^{-1}) and rebaudioside A yield (kg fed^{-1}) of stevia leaves . While N fertilizer level at 60 kg N fed^{-1} achieved the highest value of stevioside (St %), rebaudioside (Rb%), stevioside yield (kg fed^{-1}) and rebaudioside A yield (kg fed^{-1}) of stevia in both seasons. Such data confirmed the previous reports of Rashwan *et al* (2017).

A significant interaction was recorded in Table,(6)and Fig (3) between N fertilizer level (A) and compost (B) with regard to rebaudioside A (Rb%), stevioside yield (kg fed^{-1}) and rebaudioside A yield (kg fed^{-1}) of stevia in both seasons. It could be revealed from the results that application of 60 kg N fed^{-1} + 6 ton compost fed^{-1} given the highest values of Rb A% (4.41 and 5.38%), stevioside yield (609.77 and 611.00 kg fed^{-1}) and Rb A yield (298.99 and 297.74 kg fed^{-1}) of stevia in both seasons ,respectively.

Table 6. Effect of compost and N fertilization on Steviside %, rebaudiside A%, Steviside yield kg fed^{-1} and rebaudiside A yield kg fed^{-1} of stevia plant during 2014 and 2015 seasons.

Nitrogen fertilizers (A)	Season 2014				Season 2015			
	Compost (ton fed^{-1}) (B)							
	0	3	6	Mean	0	3	6	Mean
	Steviside %							
Control (80 kg N fed^{-1})	9.97	9.50	9.47	9.31	9.00	9.60	9.53	9.38
(60 kg N fed^{-1})	10.33	10.33	11.03	10.57	10.27	10.43	11.03	10.58
(40 kg N fed^{-1})	8.93	9.47	9.87	9.42	8.93	9.33	9.70	9.29
Mean	9.41	9.77	10.12	9.77	9.27	9.79	10.09	9.75
$LSD_{5\%}$	A= 0.44 B=0.36 AB=NS				A= 0.24 B=0.35 AB=NS			
	rebaudiside A%							
Control (80 kg N fed^{-1})	4.38	4.82	4.46	4.55	4.32	4.08	4.50	4.54
(60 kg N fed^{-1})	4.41	5.03	5.41	4.95	4.46	5.07	5.38	4.97
(40 kg N fed^{-1})	3.92	4.22	4.34	4.16	3.90	4.15	4.27	4.11
Mean	4.24	4.69	4.73	4.55	4.23	4.67	4.71	4.54
$LSD_{5\%}$	A= 0.104 B=0.104 AB=0.179				A= 0.253 B=0.101 AB=0.176			
	Steviside yield kg fed^{-1}							
Control (80 kg N fed^{-1})	476.98	510.76	514.73	500.82	479.32	515.51	518.11	504.31
(60 kg N fed^{-1})	524.71	543.29	609.77	559.26	520.75	548.04	611.00	559.93
(40 kg N fed^{-1})	379.11	432.47	478.87	430.15	374.44	425.34	470.02	423.27
Mean	460.29	495.51	534.46	496.74	458.17	496.30	533.31	498.84
$LSD_{5\%}$	A= 25.73 B=17.14 AB=29.70				A= 14.42 B=16.59 AB=28.74			
	rebaudiside A yield kg fed^{-1}							
Control (80 kg N fed^{-1})	232.82	259.14	242.41	244.79	230.25	257.94	244.49	244.23
(60 kg N fed^{-1})	223.78	264.46	298.99	262.41	226.41	266.13	297.74	263.43
(40 kg N fed^{-1})	166.48	192.94	210.50	189.97	165.10	189.28	206.76	187.05
Mean	207.69	238.84	250.63	232.39	207.25	237.78	249.66	231.57
$LSD_{5\%}$	A= 7.02 B=5.30 AB=9.17				A= 13.33 B=5.21 AB=9.02			

These results are in good accordance with those reported by Das, *et al*. (2007);Gupta, (2010) ; Kumar , *et al.,* (2012 ,2013 and2014) and Rashwan *et al* (2017) who indicated that production of leaf biomass along with higher steviol glycosides is the main criteria for technologist. They reported that glycoside content in stevia was greater in those plants which was supplied with compost due to improve root activity and they added that Rb is responsible for sweetness in stevia leaves ,so higher Rb is desirable and stevia crop give economically viable yield up to 4-5 years.

Chemical Properties of Soil post-harvest.

In the end of experiment, some chemical properties of the soil have changed in comparison with the previous conditions before planting. The present results in this work (Table,7) clarified that nitrogen fertilizer level and/or compost had a significant effect on the remained nutrients i.e. N,P, K and OM % , in the soil after harvest .

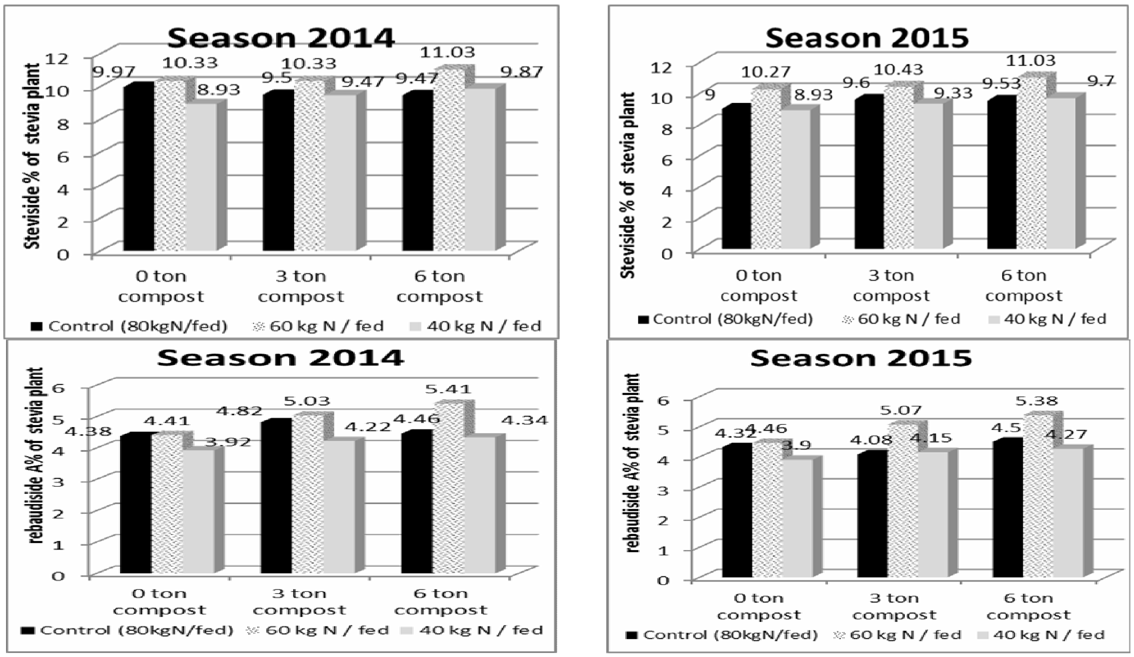

Fig 3. Effect of compost and N fertilization on stevioside yield (kg fed^{-1}) and rebaudioside A yield (kg fed^{-1}) of stevia plant during 2014 and 2015 seasons.

Table 7. Effect of compost and N fertilization on available soil N, P, K (ppm) and Organic matter content after harvest during 2014 and 2015 seasons.

Nitrogen fertilizers (A)	Season 2014				Season 2015			
	Compost (ton fed^{-1}) (B)							
	0	3	6	Mean	0	3	6	Mean
	N (ppm)							
Control (80 kg N fed^{-1})	18.65	19.14	19.35	19.05	18.71	19.20	19.39	19.54
(60 kg N fed^{-1})	18.58	19.20	20.12	19.30	18.65	19.25	20.18	19.36
(40 kg N fed^{-1})	18.18	18.69	19.00	18.62	18.20	18.71	19.03	18.65
Mean	18.47	19.01	19.49	18.99	18.52	19.05	19.53	19.18
LSD $_{5\%}$	A= 0.121 B=0.074 AB=0.128				A= 0.122 B=0.078 AB=0.135			
	P (ppm)							
Control (80 kg N fed^{-1})	8.18	8.66	8.75	8.53	8.22	8.66	8.73	8.54
(60 kg N fed^{-1})	8.57	8.35	8.90	8.61	8.59	8.41	8.89	8.63
(40 kg N fed^{-1})	7.91	8.00	8.27	8.06	7.86	7.94	8.27	8.02
Mean	8.22	8.34	8.64	8.40	8.22	8.34	8.63	8.40
LSD $_{5\%}$	A= 0.093 B=0.074 AB=0.080				A= 0.169 B=0.076 AB=0.132			
	K (ppm)							
Control (80 kg N fed^{-1})	160	164	167	163	159	162	165	162
(60 kg N fed^{-1})	158	162	171	163	157	162	169	163
(40 kg N fed^{-1})	156	161	164	160	154	161	163	159
Mean	158	162	167	162	156	161	166	161
LSD $_{5\%}$	A= 1.97 B=1.83 AB=3.17				A= 3.24 B=1.56 AB=2.70			
	Organic matter (%)							
Control (80 kg N fed^{-1})	1.15	1.21	1.24	1.20	1.17	1.22	1.24	1.21
(60 kg N fed^{-1})	1.13	1.18	1.25	1.19	1.14	1.18	1.27	1.19
(40 kg N fed^{-1})	1.08	1.17	1.19	1.15	1.07	1.17	1.19	1.14
Mean	1.12	1.19	1.23	1.18	1.13	1.20	1.23	1.18
LSD $_{5\%}$	A= 0.02 B=0.01 AB=0.02				A= 0.02 B=0.01 AB=0.02			

A significant interaction was recorded in Table,(7) between N fertilizer level (A) and compost (B) with regard to the remained nutrients i.e. N,P, K and OM % , in the soil postharvest in both seasons. It could be revealed from the results that application of 60 kg N fed^{-1} + 6 ton compost fed^{-1} recorded the highest values of the remained nutrients i.e. N (20.12 and 20.18 ppm), P(8.90 and 8.89 ppm), K (170.67 and 169.33 ppm) and OM % (1.25 and 1.27 %) in the soil postharvest in both seasons ,respectively. In general, it is assumed that such changes are related to status of the previous nutrient in the soil and its adsorption by the plant. But, it is assumed that the organic material, such as compost, that contains high content of different nutrients, which is applied before planting, has been able to provide much nutrients in the soil.

Economics of stevia productivity at different levels of N fertilizer and compost:

From the data in Table (8) it is obvious that the total return per fed was markedly increased by 39.47 and 29.71% and net profit by 43.88 and 32.98 % with applying N fertilizer at 60 and 80 kg fed^{-1} compared with 40 kg fed^{-1} ,while total return per fed was markedly increased by 14.87 and 20.57% and net profit by 16.31 and 22.54 % with applying compost at 3 and 6 ton fed^{-1} compared with the control (0.0 ton compost fed^{-1}) respectively. In addition , dry leaves yield in ton / 1000 m^3 increased by 16.20 and 18.17 % and rebaudioside A yield in ton / 1000 m^3 by 39.47 and 32.98 % with applying N fertilizer at 60 and 80 kg fed^{-1} compared with 40 kg fed^{-1}, while total return per fed was markedly increased by 3.79 and 8.10% and net profit by 16.31 and 22.54 % with applying compost at 3 and 6 ton fed^{-1} compared with the control(0.0 ton compost fed^{-1}) respectively.

Table 8. Some economics of stevia productivity per faddan under N Fertilizer level and compost rates.

Items	Nitrogen Fertilization level			Compost rate		
	40 kg/fed.	60 kg /fed.	80 kg /fed.	0 ton/fed.	3 ton/fed.	6 ton/fed.
Costs (L.E.)**						
Variable costs**: i.e. irrig., ferti.. etc	50000.00	50150.00	50300.0	50000.0	50300.00	50600.0
Fixed costs:**						
Overhead			100.00			
Rental value			7000.00			
Total costs:	57100.00	57250.00	57400.00	57100.00	57400.00	57700.00
Productivity (in kilogram/fed):						
Dry leaves yield	4551	5288	5378	4879	5064	5274
Rebaudiside A yield	188.51	262.92	244.51	207.47	238.31	250.15
Prices (L.E./ kilogram)** :						
Rebaudiside A yield			3000			
Total Return (L.E./fed.):						
Rebaudiside A yield	565530	788760	733530	622410	714930	750450
Net profit (L.E.)	508430	731510	676130	565310	657530	692750
Return-cost ratio	8.90	12.78	11.78	9.90	11.46	12.01
Quantity of water m^3 / fed / year :			7000.00			
Dry leaves(kg)/1000m^3	650.14	755.43	768.29	697.00	723.43	753.43
Rb A (kg)/1000m^3	26.93	37.56	34.93	29.64	34.04	35.74
Net-profit(L.E.)/1000m^3	72632.86	104501.00	96590.00	80758.57	93932.86	98964.29

*** L.E. = Egyptian pound. . 1 kg N = 7.50 L.E 1 ton compost = 300 L.E**

CONCLUSION

From the present study , it may be concluded that the application of 60 kg N fertilizer + 6.0 ton compost fed^{-1} was the best treatment for improving yield and quality of stevia and is advisable because it is achieved the highest value of rebaudioside A (298.99 and 297.74 kg fed^{-1}) , total return and net profit and of stevia in both seasons ,respectively under Middle Egypt conditions.

REFERENCES

A.O.A.C(2000):Official Methods of Analysis. Association of Official Agricultural Chemists 14th Benjamin Franklin Station, Washington D.C.U.S.A. pp. 490-51

Alaam A.I., (2007): Sugar crops council: Future view. The Proceeding of Thirty-eight Annual Conference, Egyptian Sugar Expertese Society Hawamdia, Egypt.

Black, C.A.M (1965): Methods of Soil Analysis" Part to A. S. A. Madison, Wisconsin, U. S.A

Das , K.R. ; R.Dang ; T.N. Shivananda ; N.Sekerogla (2007): Influence of biofertilizer on the biomass yield and nutrient content in Stevia Rebaudiana Bert.grown in India subtropic . J.Medicinal plant research , 1(1): 5-8.

Das , K.R. ; R.Dang ; T.N. Shivananda ; N.Sekerogla (2009): Effect of biofertilizers on the nutrient avalability in soil in relation to growth , yield and yield attributes of Stevia Rebaudiana.Archives of Agronomy and soil Sci.,55:359-366.

Dossier, A.,(1999) :Applications for using stevioside, extracted are refined from *Stevia rebaudiana Bertoni* leaves, as a sweetener. SCF Thirty-eight Annual Conference, Egyptian Sugar Expertese Society

Dushyant, S.; S. Maji; S. Kumar ; A.K. Maurya and K.R. Meena (2014): Efficacy of organic manures on growth , yield and biomolecules of stevia (Stevia Rebaudiana Bert.) . J. Crop Weed , 10(1): 107-110.

Gomez , K. A. and Gomez, A. A., (1984): Statistical Procedures for Agricultural Research (Second Edition.) John Wiley&Sons, Inc., New York, PP. 680.

Gupta ,M.; S.Bisht ; B.Singh ; A. Gulati and R. Tewari(2011): Enhanced biomass and sreviol glycosides in stevia rebaudiana treated with phosphate solubility bacteria and rock phosphate . Plant Growth Regulation . 65:449-457 .

Jackson, M.L. (1967): Soil chemical analysis. Prentice-Hall, Inc, Englewood Cliffs, NJ, USA

Jaroslav P, Barbora H, Tuulia H (2006): Characterization of *Stevia rebaudiana* by comprehensive two-dimensional liquid chromatography time-of-flight mass spectrometry. J. Chromatogr._doi: 10. 1016/J. Chroma 04.050.

Khaled , H. and H. Fawy (2011): Effect of different levels of K-Humateon the nutrient content , plant growth and soil properties under conditions of salinity . Soil & Water Res. 6(1): 21-29.

Khanom, S., Saha, B.K., Islam, M.T. and Chowdhury, M.A.H. (2008): Influence of organic and inorganic fertilizers on the growth, leaf yield, chlorophyll and protein contents of stevia grown in different types of soil. *Progressive Agric.* 19 (1): 23-31.

Kumar, R.; S.Sharma ; K.Ramesh ; R. Prasad ; V.L.Pathania ; B. Singh and R.D.Singh (2012) : Effect of agro-techniques on the performance of natural sweetener stevia (stevia rebaudiana) under Western Himalayan conditions . India J. Agronomy . 57:74-81.

Kumar, R.; S.Sharma and R. Prasad (2013) : Yield , nutrient uptake and quaity of stevia as affected by organic sources of nutrient . Communications in Soil Sci. and plant analysis.44:3137-3149.

Kumar, R.; S.Sharma and S. Sood (2014) : Yield components , high interception and marker compound accumulation of stevia (Stevia rebaudiana Bertoni) as affected by planting materials and plant density under Western Himalayan conditions . Archives of Agronomy and soil Sci.,10:1-15.

Patil ,N.M.(2010): Biofertilizer effect on growth protein and carbohydrate contents in stevia Rebaudiana Var. Bertoni . Recent Research in Science and Technology , 2(10): 42-44.

Rashwan, Basma. R. A., Reem. M. Abd- El Raouf, Nagwa R. Ahmed1 and H.Ferweez (2017): Efficacy of k-Humate, Compost and Biofertilizer application as well as cutting number on yield and Quality of Stevia (*stevia rebaudiana Bertoni*) as natural sweetener. Assiut J. Agric. Sci., 48 (1) 251-268.

Umesha K., G.R. Smitha*, B.S. Sreeramu and A.A. Waman, (2011): Organic manures and bio-fertilizers effectively improve yield and quality of stevia (Stevia rebaudiana)Journal of Applied Horticulture, 13(2): 157-162,

Yami Zahida Rashid, Mudasir Rashid, Suhail Inamullah, Souliha Rasool and Fayaz Ah. Bahar(2015): Effect of different levels of farmyard manure and nitrogen on the yield and nitrogen uptake by stevia (*Stevia rebaudiana* Bertoni). Afr. J. Agric. Res 8 (29) 3941-3945.

تأثير التسميد النيتروجيني المعدني و الكمبوست علي محصول الاستيفيا وربحيته

بسمة رشوان احمد رشوان[1] و حسين فرويز محمد حسن[2]

[1] قسم تغذية النبات ، معهد بحوث الأراضي، المياه والبيئة ، مركز البحوث الزراعية ،جمهورية مصر العربية .

[2] قسم علوم وتكنولوجيا والاغذية ، كلية الزراعة بالوادي الجديد، جامعة اسيوط ، جمهورية مصر

دخل حديثا نبات الاستيفيا للزراعة المصرية لينتج مادة تحليه طبيعة (جليكوسيد الاستيفيوسيد والذى تصل حلاوته الى اكثر من 300 مرة عن حلاوة السكر) مما يجعله كبديل للسكر يستطيع ان يغطى جزء من النقص فى انتاج السكر (سكر السكروز) الذى يصل سنويا الى حوالى 0.8 مليون طن . لهذا الشأن أقيمت تجربة حقلية بمحطة البحوث الزراعية بملوى ،محافظة المنيا ،مصر خلال موسمين زراعيين 2014 و 2015 لدراسة تأثير مستويات مختلفة من التسميد النتيروجينى المعدنى والكمبوست على ناتج ، جودة وربحية نبات الاستيفيا ، وكان تصميم التجربة قطع منشقة مرة واحدة فى ثلاث مكررات ووزعت مستويات التسميد النيتروجينى { كنترول (80 كجم نتروجين) ، 60 و40 كجم نتروجين / فدان } فى القطع الرئيسية و معدلات الكمبوست {صفر (كنترول) ، 3.0و 6.0 طن/ فدان } فى القطع المنشقة .أوضحت النتائج المتحصل عليها الأتى : 1 – أحدث كل من مستوى التسميد النيتروجينى المعدنى و معدل الكمبوست تاثير معنوى على ارتفاع النبات (سم)، وزن الاوراق الطازجة والجافة / نبات ، ، النسب المئوية للنيتروجين والفوسفور والبوتاسيوم فى الاوراق الطازجة وكمية النيتروجين الممتص (كجم/ فدان) ، النسب المئوية لكل من الاستيفيوسيد و الريباديوسيد أ فى الاوراق الجافة، نواتج كل من الاوراق الجافة ،الاستيفيوسيد والريباديوسيد أ (كجم/ فدان) وكذلك العناصر الغذائية (النيتروجين ،الفوسفور والبوتاسيوم (كجزء فى المليون) و%المادة العضوية المتبقية فى التربة بعد الحصاد في كلا الموسمين الزراعيين عدا % الفوسفور فى الاوراق الطازجة للتسميد النيتروجينى المعدنى فى الموسم الثانى . 2 - وجد تفاعل معنوى بين مستوى التسميد النيتروجينى المعدنى و معدل الكمبوست على ارتفاع نبات الاستيفيا (سم) ، وزن الاوراق الطازجة والجافة / نبات ، ، النسب المئوية للنيتروجين فى الاوراق الطازجة وكمية النيتروجين الممتص (كجم/ فدان) ، النسب المئوية لكل من الاستيفيوسيد و الريباديوسيد أ فى الاوراق الجافة، نواتج كل من الاوراق الجافة ،الاستيفيوسيد والريباديوسيد أ (كجم/ فدان) وكذلك العناصر الغذائية (النيتروجين ،الفوسفور والبوتاسيوم (كجزء فى المليون) و%المادة العضوية المتبقية فى التربة بعد الحصاد في كلا الموسمين الزراعيين . 3- ظهر من هذة الدراسة إن استخدام 60 وحدة نيتروجين معدنى + ٦ طن الكمبوست للفدان كان المعاملة الأفضل تحت ظروف التجربة لان هذة المعاملة حققت القيمة الاعلى لناتج الريباديوسيد أ (289.99 و 297.74 كجم / فدان) فى الموسمين الزراعيين على التوالى ، وكذلك اعلى عائد وصافى ربح .