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Egypt. J. Soil. Sci. Vol. **60**, No. 3, pp. 335- 347 (2020)

Egyptian Journal of Soil Science
http://ejss.journals.ekb.eg/

Role of Organic Food Wastes on Soil Fertility, Growth and Yield of Stevia Crop

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A FIELD experiment was conducted at the Experimental farm, Soils and water Department, Faculty of Agric., Al-Azahar Univ., Assuit, Egypt, during two successive growing seasons of 2018 and 2019. The study aims to assess the influence of organic food wastes (Eggshell, Banana peels, Green pea peels and Potato peels) are sources of some nutrients and Soybean protein isolate as a source of nitrogen on the soil fertility, growth parameters, yield and quality of stevia plant under drip irrigation system. The result showed positive increase in all growth parameters and yield of sativa plant as well as improving soil properties by adding organic food wastes. The most effective treatment was the combination of C_4 treatment (50% organic-N from isolated soy protein, 12.5% banana peels, 12.5% eggshell, 12.5% green pea peels and 12.5% potato peels). The highest total chlorophyll value of 4.48 and 3.61 mg/g fresh weight in the 1st and 2nd cutting, respectively in the 1st season were obtained under C_4 treatment. The corresponding values were 4.89 and 4.02 mg/g fresh weight in the 2nd season. The highest values of dry leaf yield 843 kg plot^{-1} and biological yield 1.60 kg plot^{-1} were noticed under C_2 treatment in the 2nd cut in the first season. In the second season, the corresponding values were 1242 and 2.19 kg plot^{-1} resulted from C_4 treatment in the 2nd cut. The highest values of protein content 10.73 and 13.72% in 1st and 2nd cut, respectively were realized under C_4 treatment in the 1st season. The corresponding values were 15.0 and 18.11% for C_4 treatment in the 2nd season. In the 1st season, the highest values of stevioside content were 8.49 and 8.98 % in the 1st and 2nd cut for C_4 and C_2, respectively. In the 2nd season, the highest values of stevioside content were 9.69 and 10.05 % in the 1st and 2nd cut for C_2 treatments, respectively. Available N in C_0 treatment Control (without applied fertilizers) had the lowest values of both seasons compared to the C_4 treatment that had the highest values of both forms in both seasons. The overall results suggest that organic food wastes combination could be advised to grow stevia plant and improving soil properties of Egypt.

Keywords: Stevia, Stevioside, Soybean protein, Banana, Green pea, Potato peels, Drip irrigation

Introduction

Stevia plant (*Stevia rebaudiana* Bertoni) is an herbaceous and perennial plant and native plant to Paraguay is a member of family Asteraceae. Steviosides, a white crystalline compound isolated from stevia is 300 times sweeter than sugar the two main glycosides are stevioside 10% and rebaudioside A 4 % of the dry weight of the leaves (Dzyuba 1998 and Yadav et al. 2010). The chemical compound obtained from stevia is considered to be the best alternative source of sugar especially for diabetes patients. So, the expanding in planting stevia will helping in decrease the gap between the production and consumption in the sugar in Egypt as well as used alternative source of sugar especially for diabetes patients (Allam et al., 2001).

Egypt is considered one of the most important agricultural and agro-industrial countries in

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DOI: 10.21608/ejss.2020.34458.1368

Received: 4/7/2020; Accepted: 17/8/2020

the Middle East. The agricultural products are provided for many industrial food such as frozen vegetables, potato and sweets factories. These factories produce many food wastes such as green pea, banana, potato peels and eggshell. These wastes contain many important nutrients N, P and K that could be absorbed by plants and increase soil fertility in the long term that might represent an alternative fertilizer sources instead of mineral fertilization which has harmful effect on human health (Castro et al. 2009). Nitrogen nutrient an essential constituent is recognized as one of the most limit nutrients for stevia growth, Maheshwar (2005) reported that various N is applied to the stevia which is short day plant were effective vegetative growth, productivity, quality and yield. In addition, the fertilization of N, P and K increases the yield and nutrients content of stevia (Das et al. 2007). Numerous researchers shed light on using organic food wastes in agriculture plays an important role in recycling essential plant nutrients, sustaining soil security as well as protecting the environment from unwanted hazards (Hoornweg and Bhada-Tata, 2012), and its explained importance to the soil properties that increase soil fertility and thus increase crop growth, yield and quality (Ding et al. 2020). Also, Hossain et al. (2017) reported that organic wastes have a great positive impact on the physical, chemical, and biological soil properties as well as increase the growth and yield of crops.

Organic food wastes contain important nutrients and it would be more efficient to re-use them in agriculture the application of organic food wastes that probably improved the soil properties have a great positive impact on the physical, chemical, and biological soil properties, such as increased the organic matter, electric conductivity EC and nutrient availability of soil, such as available N, P and K contents as well as micronutrients were increased in soil (Zheljazkov et al., 2006; Fuentes et al., 2010; El-Sirafy et al., 2015; Farid et al., 2018; Faiyad et al., 2019). Also, Abou Hussien et al. (2020) reported that effect of both types of organic wastes applied (composts) significantly increased the soil content of all determined nutrients. On the other hand, soil pH, EC, available micronutrients were higher in the conventional system than in the organic system (Mai et al., 2015). In addition, they found that the sufficient the organic food wastes not only influence soil properties, but also play a great role in the growth and development of plants and thus improve agricultural productivity. Because it's a good source of plant nutrients (Zheljazkov et al., 2006; Fuentes et al., 2010; Mai et al., 2015; Faiyad et al., 2019 and Abou Hussien et al., 2020). Merwad (2017) mentioned that the combination of potassium feldspar and organic food wastes (Ch. M and FYM) with SDB on NPK-uptake, wheat plants growth, yield and available potassium in soil was a significant effect**.** Therefore, the objective of the current study evaluation and studying the effect of organic food waste as a source for nutrition of stevia plants and soil properties.

Materials and Methods

A field experiment was conducted at The Experimental Farm, Faculty of Agric., Al-Azahar Univ., Assuit, Egypt during two successive growing seasons of 2018 and 2019. The soil of the experimental site was silt loam of texture grade. Table 1 shows some physical and chemical properties of soil which were analyzed according to Carter and Gregorich (2007).

The study aims to assess the influence of organic food wastes and Soy protein as a source of nitrogen which was added in single dose at a rate of 150 kg N/fed. on the growth parameters, yield and quality of stevia plant (*rebaudiana Bertoni*) under drip irrigation. The chemical properties of the used organic food wastes were analyzed according to FAO (1980) and they are shown in Table 2.

chased from sugar Crops Research Institute, Agriculture Research Centre, Ministry of Agriculture, Giza, Egypt. Stevia seedlings were transplanted at a spacing of 30 cm between plants × 50 cm between rows on 21st and 25th March 2018 and 2019, respectively. The experiment was laid out in complete randomized design in three replications contains 18 plots for different combinations of isolated soy protein (ISP), banana peels (BP), eggshell (ES), green pea peels (GPP) and potato peels (PP) and they are listed in Table (3). The size of each plot was 3.5 m long x 3 m wide (10.5 m^2).

Growth parameters and yield

Stevia plants were harvested four months after transplanting for the first cut, whereas the second cut was at the flowering stage by standard cut 15 cm above soil surface during both seasons. Five plants per plot were selected randomly excluding plants from either end of the rows and edges for recording all growth parameters (plant height, branches number/ plant, fresh & dry plant weight, dry leaf weight, leaf area, total chlorophyll and dry matter). The leaf/stem rations were used for growth characterization. Also, biological yield, dry leaf yield and chemical composition (stevioside, protein, N, P and K-contents) were determined and recorded from each cut in each season.

TABLE 1. Some preliminary physical and chemical properties of the experimental site

Parameter		Values* 2018 season	Values* 2019 season
Particle size distribution	Sand (%)	49.30	50.25
	Silt (%)	30.40	31.43
	Clay (%)	20.30	18.32
Texture grade		Silt loam	Silt loam
Physical properties	Bulk density (g cm^{-3})	1.52	1.49
	FC (%)	25.89	26.67
	(%) WP	13.30	13.32
	AW (%)	13.29	13.35
Available nutrients (mg Kg^{-1})	N	23.68	30.15
	P	10.35	10.84
	K	89.78	95.76
Soluble ions (cmolc kg^{-1} soil)	Ca^{++}	0.71	0.79
	Mg^{++}	0.62	0.67
	Na^{+}	0.14	0.15
	K^{+}	0.16	0.17
	CO_3^{--}	---	---
	HCO_3^{-}	0.45	0.49
	Cl^{-}	0.61	0.66
	SO_4^{--}	0.55	0.62
Chemical properties	pH (Susp. 1:2.5)	8.19	8.06
	EC (dS m^{-1})(1:2.5)	0.925	0.948
	CEC ($cmol_c$ kg^{-1})	15.73	17.34
	OM (g kg^{-1})	14.8	19.3
	$CaCO_3$ (g kg^{-1})	12.2	13.2

*Each value in this Table is the mean of 3 values.

TABLE 2. Some chemical composition of organic food waste samples used in the study on dry weigh basis

Determination*		Isolated Soy protein (ISP)	Green pea peels (GPP)	Banana peels (BP)	Potato peels (PP)	Eggshell (ES)
Nutrients content (%)	N	15.36	2.93	1.88	1.99	0.95
	P	1.25	0.21	0.27	1.05	0.18
	K	0.12	0.65	3.04	2,32	0.07
pH (Susp. 1:10)		6.46	4.24	5.68	5.14	8.04
EC dS/m (Ext. 1:10)		2.715	3.342	13.867	6.683	1.078
Organic C (%)		38.07	36.30	37.11	34.62	1.79
Organic matter (%)		65.64	62.58	63.98	59.68	3.08
C/N Ratio		2.5:1	12.4:1	19.7:1	17.4:1	1.9:1
Bulk density (g/cm^3)		0.36	0.45	0.60	0.76	1.32

*Each value in this table is the mean of 3 replicates.

TABLE 3. Treatments code and amount of combinations of organic food waste applied per plot

No.	Treatment code	amount of a mixture for organic food waste (Source of 100% organic-N plot^{-1})*
1	C_0	Control (without applied fertilizers)
2	C_T	Check treatment {Recommended dose of chemical NPK fertilizers at the (150 kg N, 60 kg P_2O_5 and 80 kg K_2O fed.$^{-1}$), added in the form of ammonium nitrate (33.5 % N), superphosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O)}. Ammonium nitrate was applied in three equal splits in each cutting. Superphosphate was applied at planting time. potassium sulphate was applied in two equal splits in each cutting. This was maintained for each cutting the crop during both seasons.
3	C_1	Combination$_1$ = (50 + 25 + 25 %) organic-N from isolated soy protein, eggshell and potato peels = (1.226, 9.867 and 4.712 kg plot^{-1}, respectively) and added during soil preparation for cultivation.
4	C_2	Combination$_2$ = (50 + 25 + 25 %) organic-N from isolated soy protein, eggshell and banana peels = (1.226, 9.867 and 4.987 kg plot^{-1}, respectively) and added during soil preparation for cultivation.
5	C_3	Combination$_3$ = (50 + 25 + 25 %) organic-N from isolated soy protein, eggshell and green pea peels = (1.226, 9.867and 3.232 kg plot^{-1}, respectively) and added during soil preparation for cultivation.
6	C_4	Combination$_4$ = (50 + 12.5 + 12.5 + 12.5 + 12.5 %) organic-N from isolated soy protein, eggshell, potato peels, banana peels and green pea peels = (1.226, 4.933, 2.356, 2.494 and 1.616 kg plot^{-1}, respectively) and added during soil preparation for cultivation.

*Each combination in this table with 3 replicates

Plant and soil analysis

Plant samples were collected after each cut and they were analyzed for stevioside using water/methanol extract analyzed by High Performance Liquid Chromatography (HPLC) as describe by Nishiyama et al. (1992) at the central unit for analysis and scientific services in National Research Centre Cairo, Egypt. The protein and NPK were analyzed using the content method described by Carter and Gregorich (2007). As well as, plant height was measured from the ground level to the top leaf by graduated tape meters. The leaf area measure by using disk method according to Radford (1967). The total chlorophyll by acetone extraction methods estimated by A.O.A.C. (2000), protein determined by using micro-Kyeldahl method Page et al. (1982). The plants samples were dried in a hot-air oven at 70°C until weights stability then recorded the dry weights. The leaf/stem ratio was calculated on dry weight basis by dividing leaf dry with stem dry of biological yield. Soil samples were collected after harvest and air-dried passed through a 2-mm sieve for chemical analysis. Soil organic-matter content, total & available N, and soil pH in suspension (1:2.5) were estimated following the standard procedures as described by Carter and Gregorich (2007).

Statistical analyses

Analysis of variance (ANOVA) was carried out using Proc Mixed of SAS package version 9.2 (SAS 2008) and means were compared by Duncan test at 5% level of significant Steel and Torrie (1981).

Results and Discussion

Changes of some chemical properties of the soil as results of and their combinations could be discussed as follows:

Soil Reaction (pH)

Data presented in Fig. 1 show that adding organic food waste to soil decreased the pH values compared to the control. The pH decreases may be due to the accumulation of organic acids during the decomposition of these materials in addition to the microbe's activity during both seasons, especially in C_4 treatment (combined isolated soy protein, eggshell, banana peels, green pea peels and potato peels). Zaman et al. (2017) indicated that the pH of the soil will reduce soil acidity due to organic material application. These results are in harmony with many workers explained the beneficial effects of adding combined of organic food waste on soil reaction and improving soil properties by (Zaman et al., 2015; Hossain et al., 2017; Zaman et al., 2018).

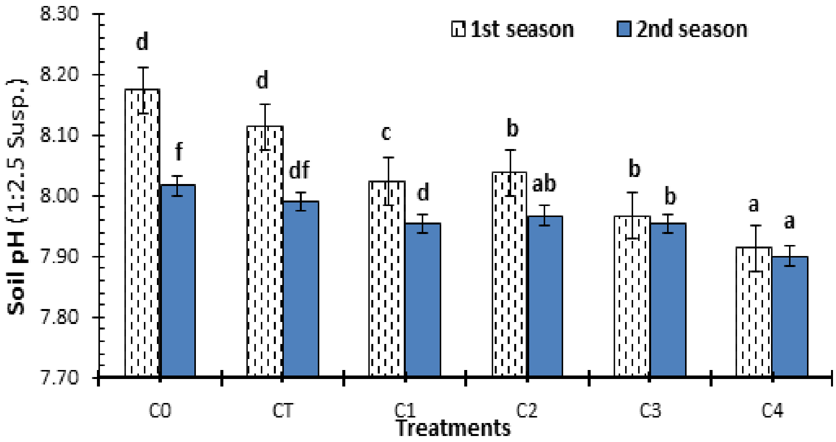

Fig. 1. Impact of organic food waste and their combination on soil pH at the end of the trial during both seasons

Organic Matter (OM)

The lowest OM percentage was realized in the control treatment (C_0) in both seasons. On the other hand, the C_2 and C_4 treatments recorded the highest OM values in the 1st and 2nd season, respectively. This might be due to the C_2 treatment contains high percentage of organic-N from isolated soy protein, banana peels and green pea peels (50+25+25%, respectively) and the C_4 treatment contains the all combination of Organic-N from isolated soy protein, banana peels, eggshell, green pea peels and potato peels (50+12.5+12.5+12.5+12.5%, respectively). This might be due to the slow decomposition ratios of the materials that contain high amount of fiber such as banana and green pea peels (Zaman et al., 2018).

In addition, the C_2 treatment (banana and green pea peels) have the highest C/N ratio which resulted in the narrowest different between the OM % in both seasons that induce immobilization of N (Wan et al., 2014). Also, a remarkable decrease of OM percentages were found in both C_1 and C_3 treatments especially in the1st season which could be attributed to the lowest pH values. Moreover, the soil buffering capacity might resist the changes in soil reaction. Generally, it was observed that the OM percentages of the 2nd season for all treatments were higher than those of the 1st one. This might be due to increasing the microbial activity and the residual effect of the previous season. Similar results in soil and stevia have been reported by (Fuentes et al., 2010; El-Sirafy et al., 2015; Hossain et al., 2017; Zaman et al., 2018; Farid et al., 2018; Faiyad et al., 2019 and Abou Hussien et al., 2020).

Total and Available Nitrogen

Data presented in Table 4 indicate that the total and available N in C_0 treatment had the lowest values of both forms compared to the C_4 treatment that had the highest values of both forms in both seasons. This might be due to that the C_4 treatment contain ISP which has high percentage of nitrogen beside it also contain different combinations of organic food waste which have high content of fibre which provide the soil by nitrogen through mineralization by microbial activity as the time proceeded (El-Sirafy et al., 2017). Similar results were found by El-Sirafy et al. (2015); Hossain et al. (2017); Zaman et al. (2018); Faiyad et al. (2019) and Abou Hussien et al. (2020).

Stevia plant growth parameters

Plant height

Data in Table 5 show the effect of organic food waste and their combination on plant height, branch number/plant and the total chlorophyll. The results showed a positive increased in sativa plant height due to the application of different organic food waste and their combination over the control treatment (without fertilizer). The fertilization sativa plant with 100% NPK of the recommended dose realized the taller plant height (43.33 and 49.69 cm in the 1st and 2nd cut, respectively) compared to the control treatment (28.67 and 34.67 cm in the 1st and 2nd cut, respectively) in the first season. The C_4 treatment (organic-N from isolated soy protein, banana peels, egg shell, green pea peels and potato peels) realized a plant height of 40.00 and 44.67 cm in the 1st and 2nd cut, respectively in the first season compared to control. While in the second season the plant height value of 53.0 cm resulted from C_4 treatment in 2nd cut compared to that of 34.67 cm resulted from control and that of 51.67 cm resulted from chemical fertilization 100% NPK of the recommended dose.

TABLE 4. Impact of organic food waste combination fertilization on organic matter, total nitrogen and available of soil N at the end of the trials during two seasons 2018-2019

Treatments	O.M (%)		Total-N (mg\kg)		Avail-N (mg\kg)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
C_0	0.98^{f}	1.81^{j}	884^{h}	1045^{f}	85^{g}	106^{i}
C_T	1.26^{e}	1.83^{j}	1488^{g}	3055^{e}	112^{f}	131^{gh}
C_1	1.57^{c}	2.17^{fg}	1658^{fg}	3055^{e}	121^{fe}	121^{ih}
C_2	2.08^{a}	2.31^{cbd}	2820de	3133^{e}	152^{f}	149^{gf}
C_3	1.64^{c}	2.28^{ced}	1945^{g}	4308^{d}	116^{f}	134^{gfh}
C_4	2.28^{b}	2.46^{a}	3290^{dc}	5562^{ba}	177^{ba}	233^{b}
Means	1.62	2.14	2014.17	3359.67	120.50	145.67

C = Control, CT = Check Treatment, C_1 = Combination1, C_2 = Combination2, C_3 = Combination3, C_4 = Combination4 Mean of (n=3) ± Standard Deviation, within column followed by the same letters are not significantly different according to Duncan`s multiple range test (P < 0.05).

TABLE 5. Impact of organic food wastes and their combination on plant height, branches number/ plant and total chlorophyll of stevia plant during 2018 and 2019 growing seasons.

Treatments	Plant height (cm)		branches No./ plant		Total chlorophyll (mg/g f.w)	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
	1st season (2018)					
C_0	28.67c	30.02c	20.67d	22.67d	2.29b	1.96c
C_T	36.33a	40.67a	32.33b	33.41b	3.26a	3.31bc
C_1	32.00b	35.33b	27.33c	30.00c	1.90a	1.95c
C_2	40.00a	44.67a	33.67cb	34.34cb	4.09a	4.36ba
C_3	34.33b	35.67b	29.87cb	30.95c	2.43b	2.41ba
C_4	43.33a	49.67a	37.00a	39.33a	4.48a	4.51a
Means	35.78	40.11	29.28	31.83	3.27	2.71
	2nd season (2019)					
C_0	30.00d	31.67d	21.12d	23.35d	2.53b	2.26b
C_T	38.67cb	41.22a	33.83a	35.76a	3.35a	3.42a
C_1	35.00cd	36.93d	30.47c	32.00c	2.19b	2.25b
C_2	44.68a	47.03a	34.00ba	35.00ba	4.46a	4.33a
C_3	37.00cb	38.05d	31.17bc	31.95b	2. 65b	2.72a
C_4	47.67a	51.84c	40.19a	42.24a	4.52a	4.58b
Means	40.67	44.95	36.00	41.50	3.56	3.07

C = Control, CT = Check Treatment, C1 = Combination1, C2 = Combination2, C3 = Combination3, C4 = Combination values followed by the same letters are not significantly different according to Duncan`s multiple range test (P < 0.05).

Branch number/ plant

Regarding branch number/ plant, the highest value of 37.00 and 39.33 in the1st and 2nd cut, respectively in the 1st season were obtained under C_4 treatment compared to control one (Table 5). The corresponding values were 41.00 and 47.00 in the 2nd season. This might be due to the increasing of N through adding food waste which increase division cells (Meristematic tissues) of plant and increase branch number, leaf area and leaf stem. Also, similar results were reported by Zaman et al. (2018).

Total chlorophyll

The highest total chlorophyll value of 4.48 and 3.61 mg/ g fresh weight in the1st and 2nd cut, respectively in the 1st season were obtained under C_4 treatment compared to control one (Table 5). The corresponding values were 4.89 and 4.02 mg/ g fresh weight in the 2nd season. The increase in total chlorophyll content might be due to the role of nitrogen in increasing plant growth and this lead to increase the green pro-plastids and secondary meristems tissues that cause an increase in the total chlorophyll content. Also, the important role of organic food waste in improving soil chemical and physical properties as well as increasing N, P and K soil content that reflects on the total chlorophyll content. This results in a good line with those obtained by Achiba et al. (2010) and Blanchet et al. (2016).

Leaf area

In the first seasons (2018), the highest leaf area of 1393 and 1227cm^2/ plant in the 1st and the 2nd cut, respectively were resulted from C_4 and C_1 treatment, respectively (Table 6). Regarding the second season, the highest leaf area of 1573 and 1725 cm^2/ plant were obtained from C_1 treatment in the 1st and the 2nd cut, respectively compared to control treatment (777 and 1016 cm^2/ plant in the 1st and the 2nd cut, respectively). In this study, the leaf area was greater than that obtained by Zaman et al. (2015b) which was 1126 cm^2/ plant. The increase in leaf area might be due to the role of organic food west that contain high amount of N (Table 2) which will help in formation a new cell and make large vegetative growth. Also, the organic waste improved the root activity and enhanced the photosynthesis rates that reflect on the leaf area. This result in harmony with that obtained by El-Sirafy et al. (2017) whom reported that nitrogen encourage cell division.

Dry matter

Also, result in Table 6 show a positive increase in dry matter of sativa plant due to fertilization by different organic food wastes over control and chemical fertilizer. The highest dry matter value of 31.22% / plant was obtained from C_4 treatment in the 1st cut and 32.25 % / plant in 2nd cut in the first season compared to that of control (20.06 and 20.36% / plant in the 1st and 2nd cut, respectively. In the second season, the highest dry matter value was resulted from C_T treatment (recommended dose of chemical NPK) 1st cut and C_4 treatment in the 2nd cut (32.25% / plant). The positive increase in dry matter as a result of application different organic food waste and their combination may be attributed to NPK treatment contains high N% (Table 2) and N form protein which participated causing dry matter accumulation. In addition, phosphorus has an important role in energy to transport many nutrients whereas K has many biochemical processes. This result in the same trend with those obtained by El-Sirafy et al. (2017) whom explained the role of NPK in many processes which led to dry matter accumulation.

TABLE 6. Impact of organic food waste and their combination on leaf area, leaf/stem ration and dry matter of stevia plant during 2018 and 2019 growing seasons

Treatments	Leaf area (cm^2 plant^{-1})		Leaf/stem ration		Dry matter (% plant^{-1})	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
	1st season (2018)					
C_0	542c	890b	57.50a	56.42a	20.06c	20.36c
C_T	1166a	1225a	55.43a	56.63a	26.20bac	26.45b
C_1	597c	857b	57.54a	55.76a	24.69bc	26.61b
C_2	1165a	1227a	55.36a	52.73b	31.04a	32.25a
C_3	845b	1085a	56.10a	52.59b	28.74ba	29.20ba
C_4	1393b	1175a	52.12a	52.07b	31.22a	31.58a
Means	951.33	1076.52	55.68	54.37	26.99	27.74
	2nd season (2019)					
C_0	777d	1016d	52.79a	52.82b	20.78b	21.23c
C_T	1490a	1653a	54.41a	54.42ba	30.77a	34.53a
C_1	1573d	1725c	51.93a	52.58b	26.85ba	28.00b
C_2	1161ba	1463ba	54.03a	54.68ba	28.02b	28.64b
C_3	1267c	1476b	54.14a	54.27ba	25.43ba	25.79b
C_4	1337b	1607ba	55.98a	56.63a	29.31a	33.73a
Means	1267.53	1490.00	53.88	54.23	26.86	28.65

Values followed by the same letters are not significantly different according to Duncan`s multiple range test (P < 0.05).

Fresh weight

Mean value of fresh weight of stevia plant as affected by different fertilizer source of organic food wastes are presented in Table 7. The results indicate that there was a positive significant effect of organic food wastes in both seasons. In the 1st season, the highest fresh weight values of 91.81 and 101.96 g/ plant in the 1st and 2nd cut, respectively were realized under C_T treatment and values of 100.81and121.11 g/ plant in the 1st and 2nd cut, respectively were obtained from C_4 treatment (Table 7). The corresponding values were 87.47and 100.60 g/ plant for C_T treatment and they were 100.90 and 120.69 g/ plant for C_4 treatment in the 2nd seasons. Also, the highest dry plant and dry leaf weights of 29.62 and 15.62 g/ plant in the 2nd cut, respectively were observed from C_2 treatment in the 1st season compared to those (11.58 and 6.52 g/ plant) control. In second season the highest dry plant and dry leaf weights resulted from C_T and C_4 treatment. The enhancement effect of using NPK fertilizer and combination of organic food waste on fresh weight, dry plant and dry leaf weights of stevia plant might be attributed to the nutritional balance which is accomplished through enforcement them where N helping in forming new cells and produced a large vegetative growth that will reflected on all growth parameters. These results are in harmony with those obtained by Singh et al. (2015) and Hossain et al. (2017) whom reported that organic wastes have a great positive impact on soil physical, chemical, and biological properties as well as stimulate plant growth.

Dry leaf yield and biological yield

The data in Table 8 shows the effect of organic food waste and their combination on dry leaf and biological yields. The result revealed a positive increase in dry leaf yield and biological yield. The highest values of dry leaf yield (843 kg plot^{-1}) and biological yield (1.60 kg plot^{-1}) were noticed under C_2 treatment in the 2nd cut in the first season compared to those under control (352 and 0.78 kg plot^{-1} respectively). In the second season, the corresponding values were 1242 and 2.19 kg plot resulted from C_4 treatment in the 2nd cut compared to those of the control treatment (432 and 1.02 kg plot^{-1}, respectively). The positive increase in both dry leaf yield and biological yield by the application of different organic food waste and their combination may be attributed to the role of organic food waste in improve soil physical and chemical properties, increase biological activity, increase organic matter as well as nutrient availability (NPK). These effects increased soil fertility and subsequently increase the growth and yield of sativa plant. These findings confirmed by those obtained by Hossain et al. (2017) and Maniruzzaman et al. (2017).

TABLE 7. Impact of organic food waste and their combination on fresh plant, dry plant and dry leaf weights of stevia plant during 2018 and 2019 growth seasons

Treatments	Fresh weight (g plant^{-1})		Dry weight (g plant^{-1})		Dry leaf (g plant^{-1})	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
			1st season (2018)			
C_0	53.11d	56.93d	10.66c	11.58d	6.13c	6.52c
C_T	91.81a	101.96a	24.88a	26.41b	13.80a	14.82a
C_1	63.05c	74.98c	17.69b	21.80c	10.08b	12.18b
C_2	76.94b	91.84b	26.13a	29.62a	14.45a	15.62a
C_3	76.25b	88.47b	24.39a	25.83b	13.21a	13.94ba
C_4	87.47a	100.60a	25.27a	27.74ba	13.30a	14.46a
Means	74.77	85.80	21.50	23.83	11.83	12.92
			2nd season (2019)			
C_0	65.62d	71.36d	13.63d	15.13d	7.18d	7.99d
C_T	100.81a	121.11a	30.98a	41.82a	16.83a	22.79a
C_1	81.07c	94.29c	21.72c	26.35c	11.94c	13.58c
C_2	96.98ba	115.10ba	27.44ba	32.59b	14.85ba	17.13b
C_3	93.04b	112.97b	23.80bc	28.83c	13.16bc	15.13c
C_4	100.90a	120.69a	29.43a	40.64a	16.44a	22.99a
Means	89.74	105.92	24.50	30.89	13.40	16.60

Values followed by the same letters are not significantly different according to Duncan`s multiple range test ($P < 0.05$).

TABLE 8. Impact of organic food wastes and their combination on dry leaf, biological yields of stevia plants during 2018 and 2019 seasons.

Treatments	Dry leaf yield (kg plot^{-1})		Biological yield (kg plot^{-1})		Biological yield over control (%)	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
			1st season (2018)			
C_0	331c	352c	0.74c	0.78d	00.00c	00.00c
C_T	745a	800a	1.34ba	1.43ba	44.66a	45.51a
C_1	545b	658b	1.06b	1.18c	30.01b	32.09b
C_2	780a	843a	1.41a	1.60a	45.45a	51.17a
C_3	714a	753ba	1.32ba	1.40b	42.45a	43.81a
C_4	718a	781a	1.36a	1.50ba	44.91a	48.04a
Means	638.83	697.83	1.21	1.32	34.58	36.77
			2nd season (2019)			
C_0	388d	432d	0.98c	1.02d	00.00c	00.00e
C_T	909a	1230a	1.67a	2.26a	40.86a	54.67a
C_1	645c	734c	1.24b	1.42c	20.70b	28.18d
C_2	802ba	925b	1.48ba	1.76b	33.66a	41.75b
C_3	710bc	817c	1.29b	1.56c	23.65b	34.32c
C_4	888a	1242a	1.59a	2.19a	37.61a	53.34a
Means	723.67	896.67	1.38	1.70	26.08	35.38

Values followed by the same letters are not significantly different according to Duncan`s multiple range test ($P < 0.05$).

Protein content

Protein and stevioside content of stevia plant as affected by different fertilizer source of organic food wastes are presented in Table 9. The results indicate that there was a positive significant effect of organic food wastes in both seasons on protein and stevioside content of stevia plant. The highest values of protein content (10.73 and 13.72% in 1st and 2nd cut, respectively) were realized under C_4 treatment in the 1st season. The corresponding values were 15.0 and 18.11% for C_4 treatment in the 2nd season.

The increase in protein content may be due to the direct increase in nitrogen content in stevia leaves plant. These results were similar to those obtained by Uçar et al. (2018).

Stevioside content

The data in Table 9 shows the effect of organic food wastes and their combination on stevioside content of stevia leaf. The result revealed a positive increase in stevioside content of stevia leaf. In the 1st season, the highest values of stevioside content were 8.49 and 8.98 % in the 1st and 2nd cut for C_4 and C_2 treatments, respectively. In the 2nd season, the highest values of stevioside content were 9.69 and 10.05 % in the 1st and 2nd cut for C_2 treatment, respectively. The increase in the stevioside content may be due to the accumulation of potassium in the leaves which result from addition of organic food residues (banana and potato peels) during the stages of plant development. Also, it may be particularly concentrated in the late stage of growth. It is noticed that the greater the leaf area the higher the rate of photosynthesis which increase potassium accumulation in the leaves (Mostafa 2019).

It could be concluded that stevia plant was grown well under the environmental conditions of Upper Egypt. Also using organic food wastes as alternative source instead of chemical fertilizer could reduce human health risks and reduced the production cost as well as increasing soil fertility in the long term. Stevia leaves contain a large amount of stevoside, so it can be used as a safe natural sweetener for diabetics and produce sweets.

TABLE 9. Impact of organic food wastes and their combination on protein content and stevioside content during 2018 and 2019 seasons

Treatments	Protein content (%)		Stevioside content (%)	
	1st cut	2nd cut	1st cut	2nd cut
		1st season (2018)		
C_0	3.35e	5.16e	3.83e	3.89f
C_T	8.65 b	10.36a	8.23a	8.73b
C_1	4.20d	4.38d	5.00d	5.14e
C_2	8.77b	11.29c	7.46b	8.98a
C_3	7.37c	8.40b	5.34c	5.57d
C_4	10.73a	13.72c	8.49a	7.77c
Means	7.26	8.88	5.35	6.68
		2nd season (2019)		
C_0	8.00bc	8.83c	4.17f	4.53f
C_T	12.50a	12.78a	9.48b	9.78b
C_1	8.12c	8.96c	5.74e	5.95e
C_2	13.25c	15.98c	9.69a	10.05a
C_3	11.57b	13.55b	6.03d	6.25d
C_4	15.00c	18.11c	8.27c	8.55c
Means	11.40	13.03	7.23	7.51

Values followed by the same letters are not significantly different according to Duncan`s multiple range test ($P < 0.05$).

Conclusion

Stevia plant was cultivated successfully in Upper Egypt, under the environmental conditions of area. Using of organic food waste increased soil fertility as the long term. Using organic food waste as alternative for chemical fertilizer reduced health risks to humans and reduced the production cost of the crop. Generally, food waste can be used in production some crops because its contain the nutrients. Stevia leaves contain a large amount of stevoside, so it can be used as a safe natural sweetener for diabetics and produce sweets. The result showed that the (C_4) treatment which contain (50 + 12.5 + 12.5 + 12.5 + 12.5 %) organic-N from isolated soy protein, banana peels, eggshell, green pea peels and potato peels combination (C_2) treatment which contain (50+25+25%) organic- N from isolated soy protein, eggshell and banana peels respectively, have a clear impact in increasing the production of Stevia plant.

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دور المخلفات الغذائية العضوية على خصوبة التربة و نمو ومكونات محصول الأستفيا

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أجريت تجربة حقلية في المزرعة التجريبية لقسم الأراضي و المياه، كلية الزراعة، جامعة الأزهر (فرع أسيوط)، أسيوط ، مصر خلال موسمين زراعيين على التوالي لعامي ٢٠١٨ و ٢٠١٩م. تهدف الدراسة إلى تقييم تأثير مخلفات التصنيع الغذائي العضوية (قشور ثمار الموز والبطاطس والبازلاء الخضراء و البيض) كمصدر لبعض العناصر الغذائية وكذلك البروتين المعزول من فول الصويا كمصدر للنيتروجين على خصوبة التربة ، و على نمو ، محصول و جودة نبات الأستيفيا تحت نظام الري بالتنقيط. أظهرت النتائج زيادة إيجابية في جميع الصفات المدروسة كقياسات النمو ومكونات محصول نبات الأستفيا وأيضاً أظهرت تحسين في خواص التربة وذلك لإضافة جميع المخلفات العضوية محل الدراسة. حيث كانت المعاملة الأكثر فعالية هو خليط (50٪ N-عضوي من بروتين الصويا المعزول و ١٢,٥٪ قشور الموز و ١٢,٥٪ قشر البيض و ١٢,٥٪ قشور البازلاء الخضراء و ١٢,٥٪ قشور البطاطس) والتي رمزها (C_4). وتم الحصول على أعلى قيمة الكلوروفيل ٤,٤٨ و٣,٦١ مليجرام/ جم من الوزن الطازج في الحشة الأولى والثانية على التوالي في الموسم الأول وكانت القيم المقابلة ٤,٨٩ و ٤,٠٢ ملجم/جرام من الوزن الطازج في الموسم الثاني تحت المعاملة (C_4) . وقد لوحظت أعلى قيم لمحصول الأوراق الجافة (٨٤٣ كجم/ حشة) والمحصول البيولوجي (١,٦٠ كجم حشة) تحت (٥٠ + ٢٥ + ٢٥٪) عضوي- N من بروتين الصويا المعزول وقشور الموز والبازلاء الخضراء خلال المعاملة (C_2) في الحشة الثانية في الموسم الأول. بينما فى الموسم الثاني ، كانت القيم المقابلة ١٢٤٢ و ٢,١٩ كجم ناتجة عن المعاملة (C_4) في الحشه الثانية. وكذلك تم تحقيق أعلى قيم للمحتوى البروتين (١٠,٧٣ و ١٣,٧٢٪ في الحشة الأولى والثانية على التوالي) كانت القيم المقابلة ١٥,٠ و ١٨,١١٪ تحت المعاملة ((C_4 في الموسم الأول و الثاني على التوالي. وبالنسبة لصفة الاستيفيوسيد في الموسم الأول ، كانت أعلى قيم ٨,٤٩ و ٨,٩٨٪ في الحشة الأولى والثانية بالتوالي تحت المعاملة (C_4) ثم تلتها المعاملة (C_2) على التوالي. بينما في الموسم الثاني، كانت أعلى قيم لمحتوى ستيفيوسيد هي ٩,٦٩ و ١٠,٠٥٪ في الحشة الأولى والثانية على التوالي فى المعاملة (C_2). و كانت قيمة N الميسر فى التربة في المعاملة C_0 (بدون الأسمدة) هي أدنى قيم فى كلا الموسمين مقارنة بمعاملة C_4 التي أعطت أعلى قيم فى كلا الموسمين. ولذا توصي الدراسة بأستخدام خليطة المعاملة C_4 لما لها تأثير أيجابي في جميع صفات نمو ومحصول نبات الأستيفيا, وكذلك تحسن جميع صفات التربة نظراً لاحتواء هذه المعاملة على مادة عضوية وعناصر غذائية ضرورية للنباتات الأمر الذي يؤدي الي التقلل من تلوث البيئة بسبب تراكم هذه المخلفات الغذائية فى حالة عدم أستخدام واستغلالها كمصدر لتغذية وتسميد النباتات.