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Integrated Effect of Inorganic and Organic Nitrogen Sources on Growth and Yield of Roselle (*Hibiscus sabdariffa* L.)

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Abstract

The pot experiment was conducted in summer season of 2017 at Assiut Governorate, Egypt, to study the influence of compost and different rates of inorganic nitrogen on growth and chemical composition roselle as well as yield. The studied treatments include the application of recommended dose of N as T_1= urea, T_2= compost, T_3= 75% urea + 25 % compost and T_4 = 50% urea +50% compost. Plants treated with the combination of mineral nitrogen and organic fertilization gave the highest significant values of growth parameters, i.e., plant height, as well as fresh and dry weight of leaves, chlorophyll, carotenoids, N, P and K contents in leaves tissues. While the application of full dose in the inorganic form gave the moderate values compared to the untreated plant. The maximum sepals yield was obtained from the 100% of N from compost treatment which increased the fresh and dry weight of sepals by 228.75 and 138.96% above the un-treated soil. Generally it is concluded that roselle sepals yield and quality can be improved through the treatment of 100% composted and application of 50 % urea + 50 % compost improved the growth and yield of roselle also increased the available N nutrients in the soil as well as the macronutrients concentrations. Therefore, this treatment could be recommended to obtain economical yield with satisfactory quality and to improve the soil fertility under the conditions of the studied area.

Keywords: *Urea, compost, sepals, chlorophyll, carotenoids.*

Introduction

Medicinal plants are used throughout the world, and the regulations defining their proper use, such as identification of the correct species and page verification of the presence, purity and concentration of the required chemical compounds, are widely recognized (Palhares, *et al*., 2015). The global market of herbal medicines products is estimated at $83 billion US and continues to grow (WHO, 2011). Medicinal plants considered among the promising crops which can increase Egypt income from foreign currency (Mohamed, 2012). However, the value of its exports is estimated at about 6.6% of the total value of the Egyptian agricultural exports representing around 0.39% of the total crop-area. Egypt has a lot of ingredients that help medical and aromatic plants to be flourished, such as climate and the availability of productive factors such as manpower, proper soil and availability of reclaimed land areas (Mostafa, 2016). The roselle plant is one of the most important medical and aromatic plants in Egypt (Mohamed, 2012; Mostafa, 2016).

Roselle (*Hibiscus sabdariffa* L.), family *Malvaceae*, is known commonly as Karkade. It is also known under other different names in different countries viz roselle, razelle, sorrel, red sorrel, Jamaica sorrel, Indian sorrel, Guinea sorrel, sour-sour, and queens land jelly plant (Moroton, 1987). It is an important crop in tropical and sub-tropical regions (El Naim *et al.,* 2017). The roselle plant can be found in almost all warm countries such as India, Saudi Arabia, Malaysia, Indonesia, Thailand, Philippines, Vietnam, Sudan, Egypt and Mexico (Rao, 1996 and Chewonarin *et al.,* 1999). Roselle is mainly cultivated to be consumed and the main producers of roselle blossoms are Egypt, Sudan, Mexico, Thailand and China (Naturland, 2004).

Organic amendments hold great promise as an excellent source of both macro and micro nutrients. Organic manures provide organic acids which help in dissolving soil nutrients and make in available for plants (Rajasekaran *et al*., 2015; Mondal *et al*., 2015; Sharma and Chaubey, 2015; Saeed *et al.,* 2015). Chemical fertilizers are expensive and due to low purchasing power of farmers, particularly in developing countries, farmers cannot apply fertilizers in balanced proportion, which resulted in low yield (Ahmad, 1999). Under such condition, integrated use of chemical and organic N sources can play an important role to sustain soil fertility and crop yield (Tandon, 1998; Lampe, 2000).

Organic amendments besides supplying chemical fertilizer to the current crop, often leaves important part as residual effect on the succeeding crops in the system (Gaur, 1982). Nitrogen applied to previous crop had a remarkable effect on yield, fertilizer use efficiency and soil fertility. It is important that residual value of fertilizer nitrogen should be taken into account when applying fertilizer N to the succeeding crop (Shafi *et al*., 2012).

This study is guidance for studying the effect of inorganic and organic N combination on vegetative aspects, sepal yield and yield components of roselle plant.

Materials and Methods

Pot Experiment

Soil sample (0-30 cm) was collected from the Agricultural Experimental Farm of the Faculty of Agriculture, AL-Azhar University, Assiut, Egypt, which is located at 27° 12¯ 16.67˭ N latitude and 31° 09¯ 36.86˭ E longitude in 2017. The collected soil sample was sieved to pass through a 2 mm stainless steel sieve. Plastic pots, 40×40 cm, were filled with 20 kg of the studied soil. The current trail aims to investigate the response of roselle plants to a organic manure, mineral fertilizer and combination between organic and mineral fertilizer. Roselle (*Hibiscus sabdariffa* L.cv. Sabhia 17) seeds (obtained from the Horticultural Research Institute, Agricultural Research Center, Ministry of Agriculture, Giza, Egypt). Five seeds of roselle were sown in each pot on 15th April 2017 and after emergence the number of plants was thinned to two plants per pot. The plants were irrigated regularly to keep the soil moisture content near field capacity. The treatments are as follows: C without fertilizer, T_1= 100% of recommendation does from urea (46.5% N) at rate of 0.16 g/kg soil, T_2= 100 % compost (1.2 % N) at rate of 5.83 g/kg soil, T_3= 75% urea+ 25 % compost (0.12+1.46 g/kg soil) and T_4 = 50% urea+50% compost

(0.08+2.92 g/kg soil). Calcium superphosphate (15.5% P_2O_5) at rate of 0.2 g/kg soil and potassium sulphate (48% K_2O) at rate of 0.075 g/kg soil was added to the soil. The rate of mineral fertilization was added according to the Egyptian Ministry of Agriculture and Land Reclamation. However, P-fertilizer and organic fertilizer were added to the pots before the sowing and during soil preparation. Plant samples were collected at full blooming stage (26th August 2017) and at harvest stage (25th October 2017) and the plant growth parameters i.e., plant height, number of branches per plant, number of sepals per plant, fresh and dry weight of plant were recorded. All the collected samples were cleaned, washed with tap and distilled water, air dried, and then dried in oven at 70˚C until constant weight, ground and stored for chemical analysis. Representative dry samples were taken from each replicate for chemical analysis.

Analysis of physiochemical properties of the studied soil

Data in Table 1 and 2 shows some physical and chemical properties of the soil (0-30 cm depth) used in the experiment before swoing and some chemical characteristics of tested organic waste, receptivity. Particle-size distribution was carried out using the pipette method according to (Jackson, 1973). The pH of soil was measured in (1:2.5soil: water suspension) and the electrical conductivity (EC) was measured in (1:2.5) and (1:5) extracts in soil and organic waste, receptivity (Jackson, 1973). Soil organic matter was determined by wet oxidation method by $K_2Cr_2O_7$ 1N and H_2SO_4 (Baruah and Barthakur, 1997). Available nitrogen was extracted with 1% K_2SO_4 at a ratio of 1:5. Then, 20 ml of the extract were distilled with the addition of 1 g Devarda's alloy using a micro Kjeldahl's distilling unit into a flask containing 10 ml boric acid-mixed indicator solution until about 50 ml distillate in each flask was collected. After the distillation, available nitrogen (NH_4^+ + NO_3^-) content was determined in the distillate by titrating with standardized 0.01 N sulphuric acid (Jackson, 1973). The available soil phosphorus was extracted from 5 g of soil sample using 100 ml of $NaHCO_3$ method buffered at pH 8.5 according to Olsen *et al.* (1954). Phosphorus in the extract was determined using the phosphomolybdic acid and stannous chloride method and measured by spectrophotometer at 660 nm (Jackson, 1973). The available soil potassium was extracted from 5 g of soil sample using 50 ml by ammonium acetate 1 M at pH 7.0 and measured by flame photometer (Jackson, 1973). Total nitrogen was measured in soil samples by digestion using 20 ml of a mixture of 7: 3 ratio of sulfuric to perchloric acids, then 5 ml of digested sample were distilled with 20 ml of 40% sodium hydroxide using a micro Kjeldahl's distilling unit into an Erlenmeyer flask containing 10 ml boric acid-mixed indicator solution until about 50 ml distillate in each flask was collected. After distillation, total nitrogen content was determined in the distillate by titrating with a standardized 0.01 N sulphuric acid (Jackson, 1973). Total phosphorus was measured in the soil samples by digestion using 20 ml of a mixture of 7: 3 ratio of sulfuric to perchloric acids. Total calcium carbonate was determined by Collin's calcimeter according to Nelson, 1982. The values of field capacity and permanent wilting point (PWP) were determined using the pressure cooker and pressure membrane apparatus. A saturated undisturbed and disturbed soil samples were equilibrated at suction pressures of 0.33 and 15 bar, respectively, according to Shawky, 1967.

Table 1. Some physical and chemical properties of representative soil sample (0-30 cm depth) before sowing

Properties	Unit	0-30 cm
Sand	%	53.5
Silt	%	22.3
Clay	%	24.2
Texture		Sandy clay loam
Field capacity	v%	30
Witling point	v%	21.6
$CaCO_3$	%	1.5
pH (1:2.5 suspension)		8.14
EC (1:2.5 extract)	dS m^{-1}	0.92
Organic matter	g kg^{-1}	6.0
Total N	mg kg^{-1}	1000
Total P	mg kg^{-1}	300
Total K	mg kg^{-1}	400
Available N	mg kg^{-1}	55
Available Olsen P	mg kg^{-1}	8.5
Available K	mg kg^{-1}	98.5

Each value represents a mean of three replicates.

Table 2. Some chemical characteristics of tested organic waste

Properties	Unit	Compost
pH (1:2.5 suspension)		7.5
EC(1:5 extract)	dS m^{-1}	5.9
Organic matter	g kg^{-1}	330
Total N	mg kg^{-1}	12000
Total P	mg kg^{-1}	7000
Total K	mg kg^{-1}	8700

Each value represents a mean of three replicates.

Plant sample analysis

Plant samples were taken and washed with deionized water, oven-dried at 70°C, mill ground and kept for chemical analysis. Dried grounded plant material of 0.2 g was digested using 10 ml of a mixture of 7: 3 ratio of sulfuric to perchloric acids (Jackson, 1973). Total nitrogen was measured in the digested sample by distilled with 20 ml of 40% sodium hydroxide using a micro Kjeldahl's distilling unit (Jackson, 1973). Total phosphorus was measured in the extract by using the chlorostannous, ammonium –molybdate method while K was measured in the extract by using flame photometer (Jackson, 1973).

The photosynthetic pigments; chlorophyll a (Chl-a), chlorophyll b (Chl-b), total chlorophyll (Chl a+b), and carotenoid contents were assessed following the modified protocol of Lichtenthaler (1987). Briefly, 100 mg of fully expanded fresh leaf was extracted with 10 ml ethyl alcohol (95%) in a test tube and kept in darkness until the sample's color was completely turned into white. Chl-a and Chl-b concentrations were measured by spectrophotometer at 663 and 644 nm, respectively. Carotenoid concentration was also determined spectrophotometrically using the same plant extract at 452 nm. The blank was 95% ethyl alcohol.

Total anthocyanin (TAC) and total flavonel (TF) were extracted from 1 g of the dried sepals by adding 10 ml of 85:15 ratio of ethanol (9٦%) and HCl 1.5 M. Then the sample was transferred to 50 ml beaker, covered and kept overnight in the refrigerator at temperature of 4 C^o. The solutions were made up to 50 ml. Absorption of solution was measured by spectrophotometer at wavelength 535 nm for TAC and 374 nm for TF. The method was modified by Lee and Francis (1971).

TAC (mg / 100 g dry weight) = (A535 × V × 100) / (98.2×W).

TF (mg / 100g) = (A374 × V × 100) / (76.5×W).

Where V = total volume extract in ml, W= weight sample (in grams).

The calculation of the nutrient use efficiency was assessed according to (Baligar *et al.,* 2001; Mosier *et al*., 2004; Dobermann, 2005). The nutrient use efficiency can be expressed by several agronomic indices such as agronomic efficiency (AE) in kg crop yield increase per kg of applied nutrient. These indices were calculated as follow: nitrogen use efficiency (NUE) was calculated according to the following equation.

$$\text{NUE (mg sepals/mg N)} = \frac{\text{(fresh sepals weight at applied N mg/pot)}}{\text{(amount of nitrogen applied mg N/pot)}}$$

Agronomic efficiency of applied nitrogen (AEN) was calculated according to the equation:

$$\text{AEN(mg/mgN)} = \frac{\text{(fresh sepals weight at applied N mg/pot - fresh sepals weight at control mg/pot)}}{\text{(amount of nitrogen applied mg N/pot)}}$$

Data analysis

The experimental design was Randomized Complete Block Design with four replicates. The Analysis of Variance (ANOVA) and Duncan multiple range tests at 5% level of probability were used to test the significance of differences between the treatments. Statistical data analyses were performed using Costat software (Steel and Torrie, 1986).

Results and Discussion

Effect of fertilizer on the growth of roselle plants

The data in (Table 3) show some growth parameters of roselle plants at full blooming and harvest stages. The recoded growth character including, fresh and dry biomass, plant height, root length, number of sepals and branches. Data showed that both of organic and inorganic fertilizers significantly (P<0.05) increased the recoded growth parameters of roselle plants in the full blooming and harvest stages. The treatment of 50% urea +50% compost increased the fresh and dry biomass, plant height, root length, number of sepals and branches by 156.84, 135.37, 95.00, 76.05, 191.11 and 318.88% respectively above of control. That is might be due to the increase in N content of the applied from urea fertilizer. This is in agreement with (Ojetayo *et al.,* 2011 and Okunlola and Adeona, 2016) who observed an increase in the growth parameters with applied fertilizer types, which might be due to the effective use of applied fertilizer at this rate by the plants. Also, the presence of other nutrient elements like P in the organic fertilizer used seems to increase the absorption of N which promotes vegetative reproduction (Jones *et al.,* 1991). The results may be due to the role of NPK in forming important molecules of phospholipids, nucleotides, nucleic acid and certain coenzymes, which play an important role in plant metabolism and thus increased growth thus was confirmed by (Kadu *et al.,* 2009 and Hassan *et al.,* 2015). Organic manure usually enhances seedling growth and plant development and increases productivity of a wide variety of crops (Canellas *et al.,* 2000). The humic materials of organic manure produced auxin-like effects on plants (Muscolo *et al*., 1999).

Table 3. Effect of organic and inorganic treatments on the growth of roselle plants (at blooming stage)

Treatments	FW	DW	PH	RL	NS	NB
C	195.1^{e}	45.8^{e}	70.0^{e}	14.2^{c}	9.0^{e}	9.0^{e}
T1	371.1^{c}	75.5^{c}	113.6^{c}	25.0^{a}	16.3^{c}	22.2^{c}
T2	322.8^{d}	67.5^{d}	98.3^{d}	20.0^{b}	13.0^{d}	18.0^{d}
T3	437.8^{b}	95.6^{b}	127.0^{b}	25.0^{a}	21.2^{b}	32.0^{b}
T4	501.1^{a}	107.8^{a}	136.5^{a}	25.0^{a}	26.2^{a}	37.7^{a}

FW= fresh weight (g plant^{-1}), DW=dray weight (g plant^{-1}), PH= plant high (cm), RL= root length (cm), NS= number of sepals/ plant, NB= number of branch/plant, C= control, T_1= urea, T_2= compost, T_3= 75% Urea+ 25 % compost, T_4 = 50% urea +50% compost.
The data were collected at the blooming stage.

Effect of organic and inorganic treatments on some photosynthetic pigments

Figure 1 present the effect of organic and inorganic fertilizers on the leaf pigments content. As can be seen, the results indicated significant increases in the content of most pigments with increasing N-fertilizer dose. However, the impact differs between the various pigments and depends on the combination of N levels in the fertilizer dose. Most of the treatments were significant whether they were added to mineral fertilizers alone or mixed with organic fertilizers. The best treatments for chlorophyll A were T_3, chlorophyll B was T_1, while total chlorophyll was T_1 and T_3 together. The proportion of chlorophyll A+ B increased by 66, 16 and 61.77% compared with control. This may be due nitrogen is a structural element of chlorophyll and protein molecules, and it thereby affects the formation of chloroplasts and accumulation of chlorophyll in them (Tucker, 2004; Daughtry *et al*., 2000). Also N-fertilizer enhanced chlorophyll and carotenoid contents of spinach (Okunlola and Adeona 2016). These results are in agreement with Shah *et al*. (2017). The humic substances in organic manure were responsible for the increased chlorophyll contents observed in plants receiving the treatment, which might increase in plant photosynthesis and therefore increase in yield attributes (Tejada *et al*., 2008).

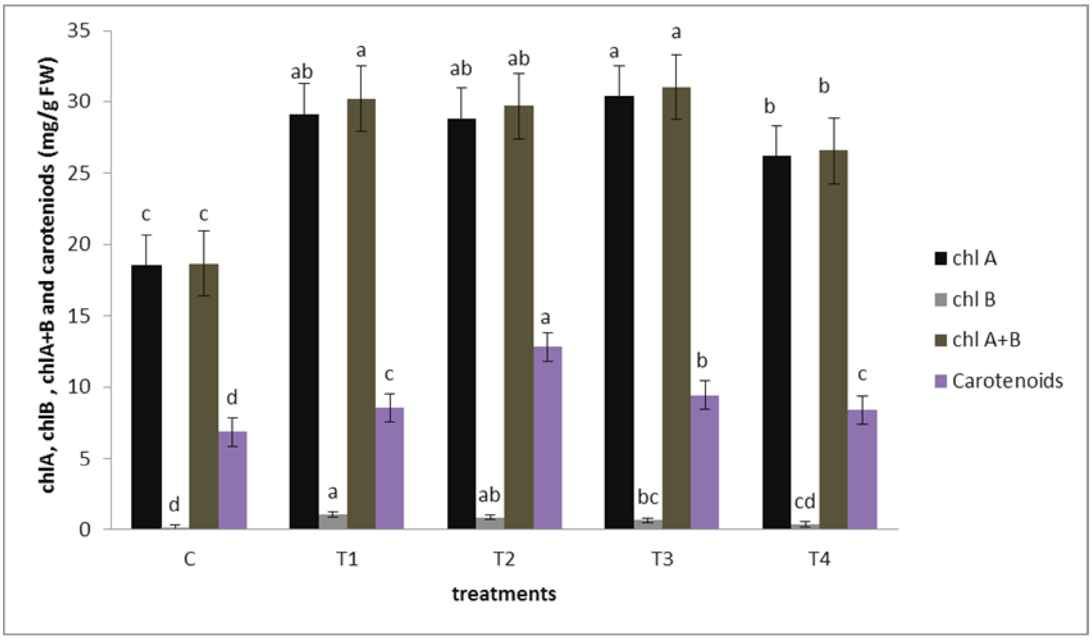

Figure 1. Effect of organic and inorganic fertilizer treatments on some photosynthetic pigments of roselle plants

Chl A= chlorophyll A, Chl B= chlorophyll B, Chl A+B= chlorophyll A and B.
The data were collected at the full blooming stage.

Effect of organic and inorganic treatments on nitrogen (N), phosphorus (P) and potassium (K) uptake by roselle plants

The effect organic and inorganic fertilizer treatments on the uptake of N, P and K were investigated at the full blooming stage (Figure 2 and 3). Figure showed that both of mineral and organic fertilizer application were significantly (P<0.05) increased the N, P and K concentration at the full blooming stage. Concerning the effect of different fertilization treatments at a full blooming stage, N, P and K concentrations were increased by 357.92, 182.25 and 67.85% in T_4,T_2 and T_1 respectively, while the uptake was increased by 936.36, 420 and 352.83% in T_4, T_4 and T_3 respectively as compared with un-fertilizer plants. The obtained results indicate that the contents of those macro elements were significantly increased in plants. The highest N, P and K contents were obtained with organic amendments applied alone or in combination with N fertilizer. The highest N concentration was recorded with T_4, This could be attributed to a higher N and P content of the organic amendments and a slow and sustained availability of the nutrients as observed by several workers in mints plant (Chand *et al.,* 2001), in basil plant (Anwar *et al.,* 2004). Also the compost was very rich in NPK contents this could explain the increase of these elements in the plants treated by this compound, which agree with the results of (Aziz *et al*., 2007 and Ahmed *et al*., 2011). The highest P and K concentration was recorded with T_1 (100% urea), this may be due the application of phosphorus and potassium fertilizer would lead to increased phosphorus and potassium content in soil and would increase its concentration in plants. This result is in agreement with (Himawati *et al.,* 2018 and Akhtar *et al*., 2019).

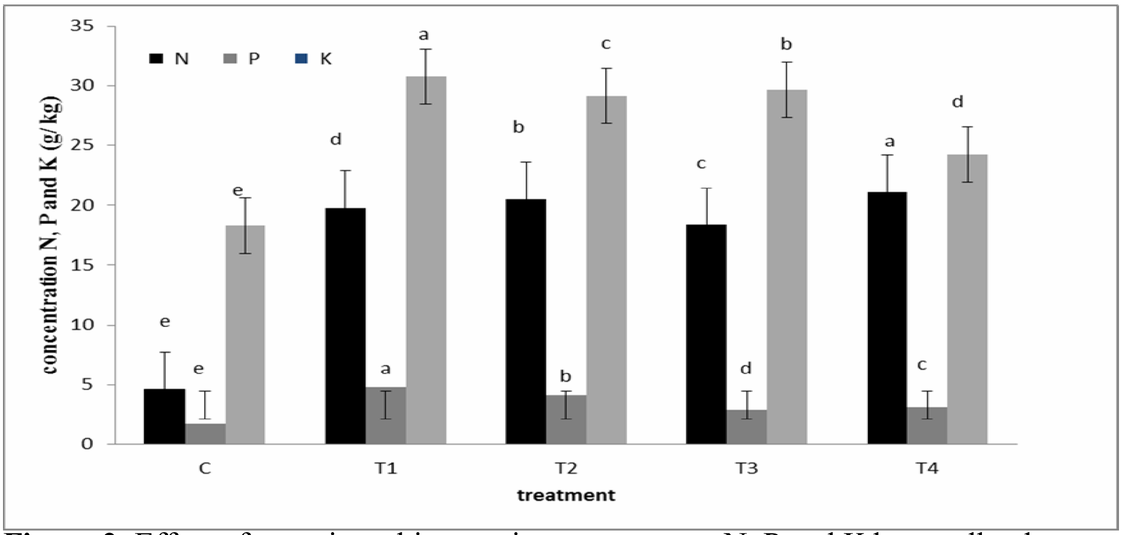

Figure 2. Effect of organic and inorganic treatments on N, P and K by roselle plants

The data were collected at the full blooming stage.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

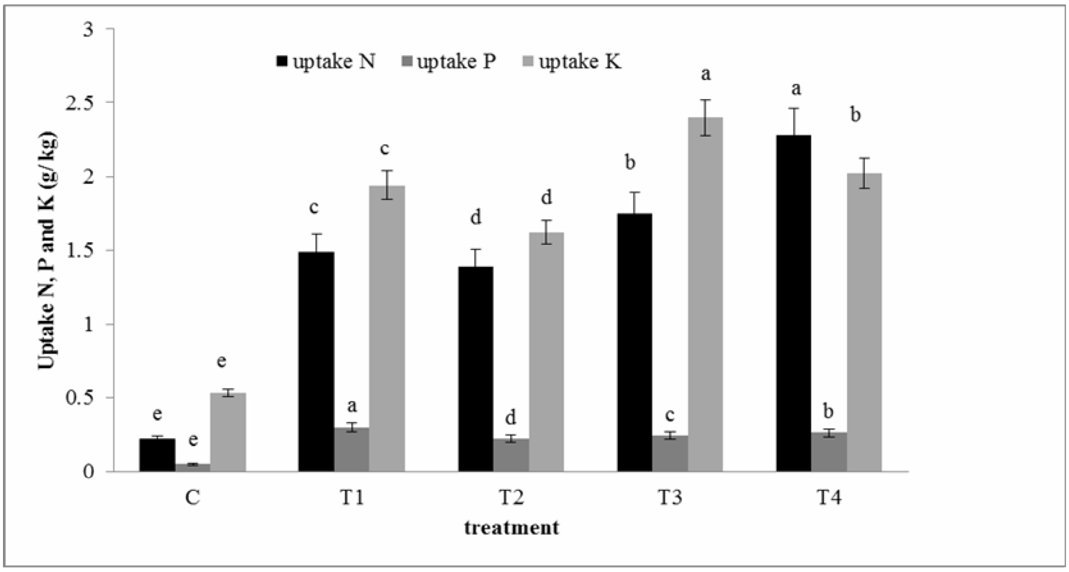

Figure 3. Effect of organic and inorganic treatments on N, P and K uptake by roselle plants

The data were collected at the full blooming stage.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

Effect of organic and inorganic treatments on some soil chemical characteristics

Some soil properties i.e., pH, EC, OM as well as N, P, and K availability were studied after the harvesting of roselle plants and the data are presented in Table 4. The results indicated that a slight significant decrease in the soil pH values as result of organic amendments. The low pH was recorded with T_2 (100% compost) by 5.18 % compared with the un-fertilizer treatments. pH decreasing can be arranged according to their effect as follow C > T_4 > T_3 >T_1 > T_2. Benefits of compost amendments added to soil include pH depressing and faster infiltration rate due to enhancing soil aggregation (Liang *et al.,* 2011). The decrease in soil pH in the organic amendment treatments might result from the release of organic acids and carbon dioxide (CO_2) into the soil during the decomposition of the manure (Meena *et al.,* 2018). The production of aliphatic and aromatic hydroxyl acids as a result of decomposition of organic manure (FYM) could also result in complexing and exchangeable aluminum ions and thus decrease the pH of soil (Grewal *et al*., 1981).

The results indicated that the soil EC values were reduced as result of organic amendments. The highest EC was recorded with T_4 by 59.09 % compared with the un-fertilizer. Treatments can be arranged according to their effect on EC increasing as follow T_4 > T_3 > T_1 > T_2 > C. This may be due composts application, such as high levels of soil-borne diseases suppression and removal of soil salinity (Sinha *et al*., 2009). It was noticed that most of all soil samples were found in normal category EC < 2 dS/m (Sing and Mishra 2012). The normal electrical conductivity may be ascribed to leaching of salts to lower horizons (Pathak, 2010 and Mahmoud *et al.,* 2019).

The results indicated significant increase in soil organic matter (SOM) which was recorded in the soil of organic manure. The results of the study showed that application of organic manure, especially the composted is a better proposition than application of manure alone for higher (SOM), nutrient uptake, and quality of roselle, it can helped in building soil fertility in terms of soil nutrient availability and supply of microbial mediated C and N in soil. The high O.M was recorded with T_2 and T_1 by 153.7 and 83.33% compared with un-fertilizer treatments may be due to organic N sources comparatively mineralized slowly than mineral N which resulted in improvement in soil organic matter (Shafi *et al.,* 2012). Also, addition of organic matter result in higher crop growth and biomass addition due to leaf shedding and root biomass might have contributed to higher soil organic carbon content (Acharya *et al.,* 1988 and Menna *et al.,* 2018). Agreement with Aoyama *et al*. (1999) who observed that organic carbon addition through manure led to higher concentration of total carbon in dry sieved macro-aggregates than in micro aggregate. Researchers observed that application of organic matter has an impact on the chemical, physical and biological properties of the soil. Organic matter of manure is considered a source of major plant nutrients such as N, P and K (Liang *et al*., 2011).

Available soil N was significantly, the increase in available soil N was recorded in the soil of T_4 (50% Urea+ 50% compost) by 270.43 % compared with un-fertilizer treatment. This might be attributed to mineralization of organic matter and the residual effect of N sources which enhanced the N levels in soil (Shafi *et al*., 2012). Also nutrient contents of organic sources served as soil amendment for crops and provided appreciable quantities of N, organic sources (poultry manure) effectively increased soil fertility, yield and nutrient content of crops (Shafi *et al*., 2012).

These results agree with those obtained by Sharif *et al.* (2013) who reported that available nitrogen of soil was improved when composts added to soil. Suhane (2007) applied 100 kg nitrogen fertilizers to soil, only 20-25 kg is available in soil to plants, while when applied with compost gave higher available N in soil to plants and showed that exchangeable potassium (K) was over 95% higher in organic manure. The increase in total N might be due to the direct addition of N through organic manure to soil. Available phosphorus and potassium was significantly increased in most treatments in the soil. The increase in available soil P, K was recorded in the soil of T_2 (100% compost) by 152.63 and 44.36% respectively compared with un-fertilizer treatment. This may be due soils receiving organic matter improved the soil organic carbon (C), total N, P, and K status (Sim and Wolf, 1994 and Kaur *et al*., 2005). Organic N sources released nutrients slowly and contribute to the residual pool of organic N and P in the soil and reduce N leaching in soils (Shafi *et al.,* 2012). Also, Atiyeh (2000) showed that applied compost to soil increased soil available potassium compared to the traditional organic fertilizers. The increase in available potassium in soil receiving organic manure applied alone than control status may be ascribed to the direct potassium addition in the potassium pool of the soil. The result is corroborated (Choudhary *et al.,* 1997 and Shukla and Ruhal, 1978). The increase in Olsen-P in treatment receiving applied organic manure alone may be due to the release of organically bound P during decomposition of organic matter, solubilization of soil P by organic acids produced during decomposition of organic matter. Continuous application of organic manure also reduced the activity of polyvalent cations such as Ca, Fe, and Al due to chelation which in turn considered responsible for reduction in P-fixation (Gupta *et al*., 1988). The application of organic manure increased Olsen-P because of its P content, and possibly by increasing retention of P in soil. A positive effect of organic manure on P availability was also observed (Roy *et al*., 2001).

Table 4. Effect of organic and inorganic treatments on some soil chemical characteristics after the harvesting of roselle plants

Treatments	p H (1:2.5)	Ec (ds/m)	OM %	N ppm	P ppm	K ppm
C	8.11^{a}	0.22^{d}	0.54^{c}	33.58^{d}	5.89^{c}	286.3^{c}
T1	7.88^{c}	0.28^{c}	0.99^{b}	80.32^{b}	9.71^{b}	350.1^{b}
T2	7.69^{d}	0.24^{bc}	1.37^{a}	70.28^{c}	14.88^{a}	413.3^{a}
T3	7.92^{bc}	0.29^{b}	0.94^{b}	115.99^{a}	8.99^{b}	344.1^{b}
T4	7.95^{b}	0.35^{a}	0.90^{b}	124.39^{a}	8.93^{b}	337.5^{b}

The data were collected at plant harvest.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

Effect of organic and inorganic treatments on total yield and quality of roselle sepals

Figure 4 shows the effect of fertilization treatment's on the fresh and dry weight of sepals. This figure showed that both of organic and inorganic fertilizers significantly (P<0.05) increased the recoded growth parameters of roselle plants at the harvest stages. The treatment of 100% compost increase fresh weight and dry weight of sepals by 228.54 and 138.96% above the un-treated plants. This may be attributed to the release of nutrients to soil slowly for longer duration after decomposition resulting in better plant growth and yield. Also the role of nitrogen in enhancement meristematic activity and cell division, consequently enhance yield (Lawlor, 2002). These results are in agreement with those reported by (Cupina *et al*., 2011, Anfinruda *et al.,* 2013 and Abo-Zeid *et al.,* 2017). Similar observation had been reported by Akanbi, (2002) on okra and maize, Stefano *et al.* (2004) on tomato and Akanbi *et al.* (2009) on roselle. The yield advantage on application of organic sources of nutrients was due to addition of micronutrients (Manna *et al.,* 2005; Banik *et al*., 2006) along with the major nutrients, increased nutrient absorption capacity due to the higher root density. It also improved soil physical properties (Boparai *et al*., 1992).

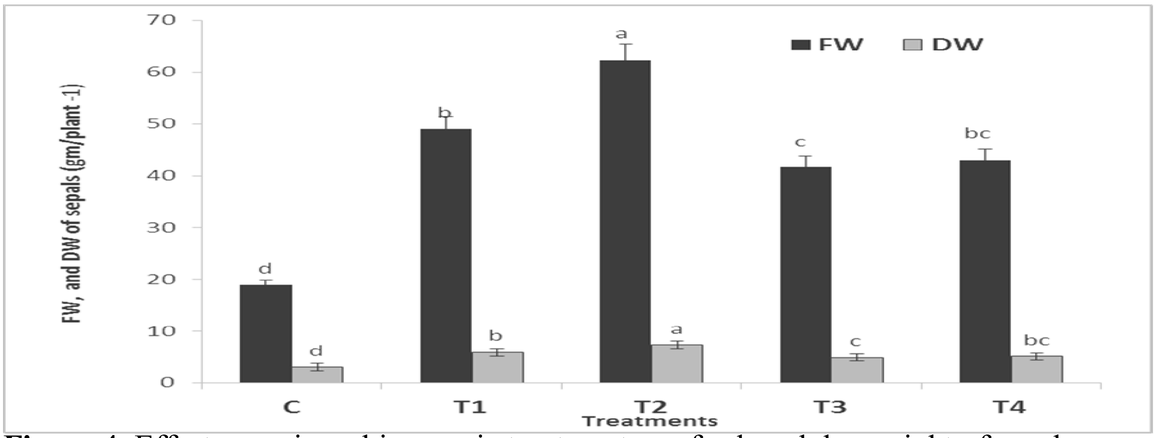

Figure 4. Effect organic and inorganic treatments on fresh and dry weight of sepals

FW= fresh weight of sepals (g plant^{-1}), DW=dry weight sepals (g plant^{-1}).
The data were collected at plant harvest.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

Anthocyanin pigments play many roles in plants, including providing protection against biotic and abiotic stresses (Middleton, 1986). Anthocyanins are pigments in the flavonoid family of phenylpropanoid compounds that are responsible for the blue, purple, and red colors of leaves, flowers and fruits (Middleton, 1986). As dietary components they also have beneficial effects on human health as they provide a source of antioxidants, reduce the incidence of coronary heart disease and exhibit anticancer activity (Koes, 2005). Figure, 5 shows the effect of fertilization on the anthocyanin and total flavonol. The fertilizer with significantly (P<0.05) increased the anthocyanin and flavonol in T2 by 71.46 and 75.01% above the untreated plants. Similar results on roselle obtained (Abbas and Ali, 2011 and Soha and Rabia, 2014).

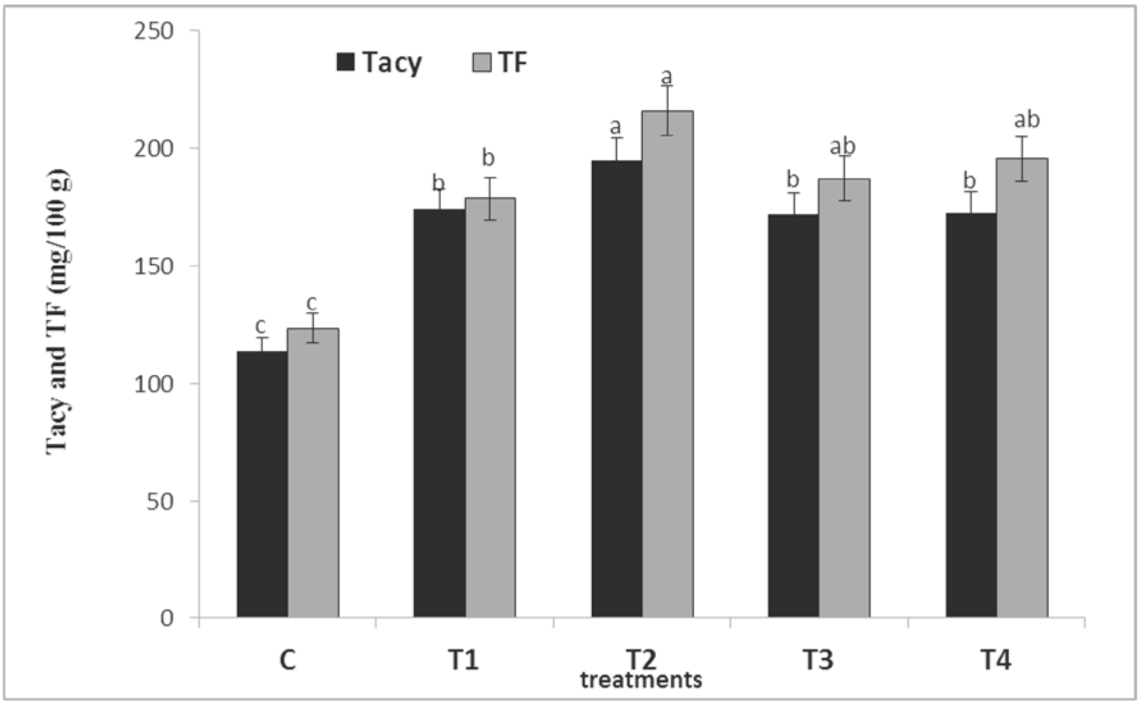

Figure 5. Effect of organic and inorganic treatments on quality of roselle sepals

TAC = total anthocyanin and TF = total flavonol.
The data were collected at plant harvest.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

Effect organic and inorganic treatments on nitrogen use efficiency

Synchronization of crop N requirement with N supplies improving N use efficiency. A crop's demand for N is firmly related to yield potential, which in turn is associated with N supply and crop management practices. In this study, different N application rates significantly increased NUE and in particular. The nitrogen use efficiency (NUE) by sepals significantly improved due to the application 100% compost compared to the control treatment (Figure 6). It increased from 28.04 mg sepals /mg N compared to the control treatment. The agronomic efficiency of the applied nitrogen (AEN) was significantly improved with applying the 100% compost. It rose from 44.46 mg sepals /mg N compared to the control treatment. Borlaug and Doswell (1994) stated that soil fertility is the single most important factor that limits crop yields and as much as 50 % of the increase in crop yields worldwide during the twentieth century is due to the use of chemical fertilizers. High or low crop yield in different parts of the world could be correlated to level of fertilizer use per unit of land. Or may be due have improve applied urea efficiency by preventing or suppressing the transformation of amide-N in urea to ammonium hydroxide and ammonium through the hydrolytic action of the enzyme urease (Trenkel 2010).

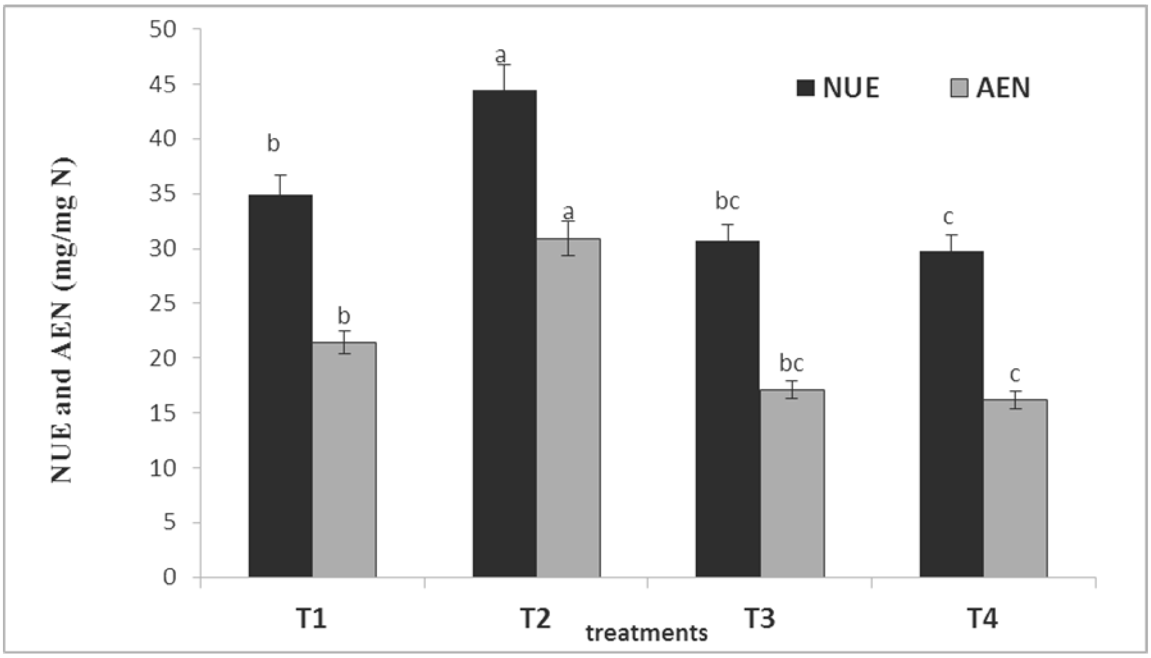

Figure 6. Effect organic and inorganic treatments on nitrogen use efficiency

NUE=nitrogen use efficiency (mg sepals/mg N), AEN= agronomic efficiency of the applied nitrogen (mg sepals /mg N).
The data were collected at plant harvest.
Means denoted by different letters are significantly difference according to Duncan's test at P<0.05.

Conclusion

Generally it is concluded that roselle sepals yield and quality can be improved through the treatment of 100% composted and application of 50 % urea + 50 % compost improved the growth and yield of roselle also increased the available N nutrients in the soil as well as the macronutrients concentrations. The maximum yield and yield quality of sepals ware obtained from the treatment of 100% compost. Therefore, this treatment could be recommended to obtain economical yield with satisfactory quality and to improve the soil fertility under the conditions of the studied area.

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التأثير المتكامل لمصادر النيتروجين غير العضوية والعضوية على نمو وإنتاجية الكركديه (*Hibiscus sabdariffa L.*)

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الملخص

تم إجراء تجربة أصص في موسم صيف عام ٢٠١٧ بمحافظة أسيوط ، مصر ، لدراسة تأثير السماد العضوي ومعدلات مختلفة من النيتروجين غير العضوي على نمو نبات الكركدية والتركيب الكيميائي وكذلك المحصول. تشمل المعاملات التي تمت دراستها إضافة الجرعة الموصى بها من النيتروجين T_1 = اليوريا ، T_2 = كمبوست ، T_3 = 75 % يوريا + ٢٥٪ كمبوست و T_4=50٪ يوريا + ٥٠٪ كمبوست. أعطت النباتات التي تمت معاملتها بخليط من النيتروجين المعدني والتسميد العضوي زياده معنوية فى صفات النمو ، ارتفاع النبات ، وكذلك الوزن الطازج والجاف للأوراق ، والكلوروفيل، والكاروتينات ، ومحتوى N، P و K في أنسجة الأوراق. بينما أدت إضافة الجرعة الكاملة في صورة سماد معدنى قيم متوسطة مقارنة بالكنترول. تم الحصول على أقصى إنتاجية للسبلات من المعاملة ١٠٠٪ كمبوست مما زاد من الوزن الطازج والوزن الجاف للسبلات بنسبة ٢٢٨,٧٥ و ١٣٨,٩٦٪ عن الكنترول. لذلك يمكن التوصية باستخدام الكمبوست بمعدل ١٠٠ % و ٥٠% يوريا +٥٠ % كمبوست من الجرعة الموصى بها لزيادة محصول السبلات وجودتها.

الكلمات المفتاحية: *يوريا، كمبوست، سبلات، كلوروفيل، كاروتينات.*