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Effect of carboxylic acids fertilization on growth and chemical composition of *Althaea rosea* Cav. grown in different soil types

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ABSTRACT

In a trial to improve one of the most important economic plants quality of *Althaea rosea* Cav. under local conditions in Egypt, this investigation was consummated throughout successive seasons (2015/2016 and 2016/2017) at the nursery of Horticulture Research Institute, Agriculture Research Center, Giza, Egypt. The individual as well as the combined effect of different media types (clayey, sandy and calcareous media), different levels of carboxylic acid (PRO- MIX) (1, 2, 3 ml/l) and their interaction on growth, flowering and chemical constituents of the plant were investigated. The results emphasized that using clayey medium in plantation proved its mastery in improving all plant traits, with occupying the first rank (plant height, number of leaves/plant, leaf area, leaves fresh and dry weights, root fresh and dry weights, stem diameter, fresh and dry weights of stem and No. of flowers/plant). Meanwhile, sandy medium occupied the second rank in this concern, whereas, calcareous medium belonged to the third rank. Carboxylic acid (PRO MIX) at the highest level (3 ml/l) was the best treatment used for improving the above mentioned traits as it gave the highest records of vegetative growth traits and No. of flowers/plant in the two seasons. Meantime, the medium level (2 ml/l) occupied the second position for improving the same trait, then came the effect of the lowest level (1ml/l), which was the least for improving such traits in the two seasons. However, the medium level (2 ml/l) in some instances gave close results to those recorded from the highest level (3 ml/l) as in case of fresh and dry weights of roots. Chemical constituents of the plant as affected by the different treatments revealed that clayey medium was the best medium used in recording the utmost high values of chlorophyll a, b and carotenoids as well as total carbohydrates % in leaves, stem, roots and flowers. A progressive increment in pigments % (chlorophyll a, b and carotenoids) in the leaves, as well as total carbohydrates content in leaves, stem, roots and flowers was noticed due to increasing carboxylic acid (PRO MIX) levels in the two seasons. The interaction revealed that growing plants in clayey medium with applying the highest level of carboxylic acid (PRO MIX) (3 ml/l), was the best treatment for raising pigments contents (chlorophyll a, b and carotenoids) besides total carbohydrates % in the leaves, stem, roots and flowers.

From the aforementioned results, it could be recommended to grow *Althaea rosea* plant in clayey medium with applying carboxylic acid (PRO MIX) 10 times at 15 days interval at the highest level (3 ml/l) for obtaining the best growth and quality of *Althaea rosea* plant under local conditions in Egypt.

Key words: *Althaea rosea*, growing media, carboxylic acid

Introduction

Althaea rosea Cav. (Malvaceae) (Boulos, 2000), hollyhock is widely grown in botanical gardens in Egypt as an ornamental plant, gardens and parks in the Southern Europe, Asia. In Egypt, this genus is represented by 6 species growing mainly in Sinai (Tackholm, 1974). *Althaea rosea* flower is used in folk medicine for prophylaxis and treatment of respiratory, gastrointestinal and urinary disorders. The herb, root and seed are used to treat cough and lung diseases (Physicians' Desk Reference (PDR) for Herbal Medicine, 2004). It is biennial or short-lived perennial in U.S. zones 3-8 herbs, with erect stems up to ~8 ft tall in full sun. The blade of the alternate leaves is oval in outline, it has a distinguished flowers, each flower has 5 petals, 5 sepals, 6-9 sepal like bracts and columnar structure in the center with the reproductive organs. The flower is 5-8 cm in diameter, it has colors

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ranging from white to yellow, pale orange, various pinks, and a deep reddish purple almost black, different colors prefer different soils, the darker red variety seems to favor sandy soil while the lighter colors seems to favor clayey soil. Blooms mid-summer to early fall (Bailey, 1953 and Tackholm, 1974). Leaves are large and rounded, somewhat 3-5 lobed, hairy on both surfaces, it has a great history of folkloric medicinal uses. Several pharmacological studies have reported that this plant possesses anti-inflammatory, antibacterial and analgesic effects. (Wang and Shang. 1989; Mert *et al*. 2010; Marzieh *et al*. 2012 and Abd El Hakeem, 2015), it has an important role of phytoremediation (Nasim *et al*., 2017 and Ahmet *et al*., 2015), it is cultivated in soil that is moderately acidic to moderately alkaline and well-drained, although it will tolerate moist soil, it reproduces from seeds. The black flowers produce lavender to purple, changing the pH of the dye bath water provides even greater color variations, including blue, green and brown. (Rendle, 1959; Bayer and Kubitzki, 2003; Judd and Manchester, 1997). They are found throughout the world, growing in many different environments and climates (Baum *et al.,* 1988). Over the centuries, hollyhocks have been used for various medicinal purposes, and the flowers and herbage are edible.

The soils of Egypt comprise the alluvial soils of the Delta and Valley, the calcareous soils along the coastal littoral of Egypt, the soils of the Eastern and Western Deserts as well as the soils of Sinai Peninsula. The major alluvial soils were formed from the suspended solid matter of the Nile, which were deposited every year during the flood season (Hamdi and Abdelhafez, 2001). In Egypt, degradation of soils through salinity and alkalinity has been a major agricultural problem. The high evapotranspiration rate in combination with high ground water level causes salinity development especially in the northern part of Nile Delta (Abdel-Hamid and Shrestha, 1992). Growing media play a major role in plant growth and development. They act as plant support, serve as a source of water and essential plant nutrients and permit the diffusion of oxygen to the roots. Clayey soil is easily compacted with minimal force, which can cause further blockage for roots and seedlings. They also tend to be alkaline, and are modified with sulfur to increase acidity (Askar, 1988). On the other side, many authors agreed that sandy soil is usually considered the cheapest and most readily available material (Floyed, 1965 and Hall and Richmound, 1968). In this connection, with a higher proportion of sand, water flows quickly washing out nutrients so sandy soils tend to be poorer. Ibrahim (2002) found that clayey medium 100% gave the best vegetative growth of *Gasteria verriscosa* and *Haworthia fasciata* plants. However, Saeed *et al.* (2014) on Gladiolus cv. Novalux reported that using sandy medium in plantation occupied the second rank for improving corms yield, corm fresh and dry weights, corm circumference, corms yield and cormel fresh and dry weight.

A calcareous soil is the soil contains more than 10% $CaCO_3$. It is defected with the loss of the water irrigation quickly. $CaCO_3$ is assembled in a layer, and it hinder the airing and the water motion in the soil and the high value of pH affect the suitability of some elements such as P, Fe, Mn and Zn. This kind of soil spread in the northern western coast from Alexandria to the West limits of Egypt and in lots of the Arab countries, especially those located in Mediterranean Basin (Hassan *et al.* 2015).

A carboxylic acid is an organic compound that contains a carboxyl group (C(=O)OH), (Gold Book, 2014). The general formula of a carboxylic acid is R–COOH, with R referring to the rest of the (possibly quite large) molecule. Carboxylic acids occur widely and include the amino acids (which make up proteins) and acetic acid (which is part of vinegar and occurs in metabolism). Carboxylic acids as a type of organic acids contain carboxyl group which has a high chemical activity which influences the soil properties and soil solution by decreasing the pH number in soil which increases the availability of most minerals in soil with high pH number as calcareous and sandy soils (William and Jerry 2017). The relative proportion of aliphatic carboxylic acids varies for different soils (Dormaar, 1982).

The aim of this experiment is to study the effect of different soil types, carboxylic acid concentrations and their interaction on plant growth and chemical composition of *Althaea rosea* Cav. for achieving the hope of producing plant of high quality under local conditions in Egypt.

Materials and Methods

The present experiment was conducted during two successive seasons of 2015/2016 and 2016/2017 at the Nursery of Horticulture Research Institute, Agriculture Research Center, Giza, Egypt, to study the effect of carboxylic acids fertilization (three concentrations 1, 2 and 3ml/l were

applied as a soil drench) on growth and chemical composition of *Althaea rosea* Cav. grown in different soil types (clayey, sandy and calcareous soils). The physical and chemical properties of the 3 used soils were determined and illustrated in Table (1).

Table 1: The physical and chemical properties of the sandy, clayey and calcareous soils used in 2015 and 2016 seasons.

Soil type	Particle size distribution (%)				*S. P.	EC (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sandy	83.76	7.30	1.49	7.45	21.87	3.70	7.81	13.46	4.98	20.40	0.63	2.40	14.91	22.16
Clayey	7.54	22.28	38.63	30.55	40.00	1.97	7.80	4.96	3.10	10.64	1.09	1.02	11.32	7.45
Calcareous	10.36	25.54	32.50	31.60	28.99	2.37	7.89	12.10	6.77	0.36	5.83	5.81	8.66	10.59

**S. P. Saturation Percentage*

Materials:

14 cm plastic pots were used for studying the effect of different growing media (sandy, clayey and calcareous media) on growth and flowering of the plant.
Seeds of *Althaea rosea* Cav. were used in both seasons (2015/2016 and 2016/2017).

Carboxylic acid solution is a commercial name (PRO MIX) which contains Carboxylic acids 45%; Mg 2.4%; Mn 2.7%; Zn 4%; Fe 2,7%; S 7.9% - pH 3.5.

Procedure:

The seeds were planted, in both seasons, on the October 1st. After 15 days from planting (October 15th), the small plants reached 10-12cm length bearing 2-4 leaves, soil drench of the different concentrations of carboxylic acid (PRO MIX)were applied (10 times) at 15 days interval commencing from November 1st till April 1st.

The layout of the experiment was factorial in a randomized complete block design (RCBD) with three replicates. The first factor was soil types, whereas, the second one was carboxylic acids concentrations. Every experimental unit was represented by 9 plants.

Regular agricultural practices such as weeding, watering and fertilization with kristalon (2g/l) were carried out whenever needed.

The following data were recorded:

Plant morphological traits: plant height (cm.), number of leaves/plant, number of flowers/plant, leaf area (cm^2), stem diameter (mm), fresh weight and dry weight for leaves, roots, stems and flowers (g).

Chemical constituents of the leaves and flowering stem

Pigments content in the leaves

Pigments content of chlorophyll a, b and carotenoids % in fresh leaves were carried out according to Wettstein (1957).

Determination of total carbohydrates in the ethanol extract:

The total carbohydrates % was determined using the method of phenol sulphuric acid reagent at the end of the experiment (last May), according to Dubois *et al*. (1956).

Statistical analysis

Data collected were subjected to analysis of variance using the MSTAT-C program (Anonymous, 1986). Mean separation was performed using the Multiple Range Test at the 5% level of significance as described by Duncan (1955) and Steel *et al*. (1997).

Results and Discussion

Effect on vegetative growth traits

It is evident from data registered in Tables (2, 3, 4, 5, 6) using clayey medium in plantation prevails in raising plant height, number of leaves/plant, leaf area, leaves fresh and dry weights, compared with that gained from other media used in both seasons, whereas, the same parameters recorded the lowest means by growing plants in calcareous medium in the two seasons. Meanwhile, the significantly highest values of the above mentioned traits were obtained due to applying the highest level of "PRO MIX" (3ml/l) in the two seasons. In the matter of the interaction, it is clear from the same Tables that plants grown in clay medium and receiving "PRO MIX" at either 2 or 3 ml/l recorded the highest values compared with the scored from other treatments used in both on seasons, but on the upper hand, it was that obtained from using the highest level (3 ml/l) combined with using clayey medium in plantation. In contrast, the lowest scores of the different treatments were attained due to plants grown in calcareous medium and untreated with "PRO MIX" in the two seasons.

Table 2: Effect of soil type, PRO MIX treatments and their interaction on plant height (cm) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	121.59 d	122.62 c	115.81 h	120.33 C
1	116.56 g	123.95 b	116.33 g	118.95 D
2	120.79 e	123.90 b	117.23 f	120.64 B
3	123.82 b	124.79 a	120.32 e	122.97 A
Mean	120.69 B\	123.82 A\	117.42 C\	
Second season				
0	123.29 d	123.92 c	117.51 j	121.57 C
1	118.26 h	125.39 b	118.03 i	120.56 D
2	122.49 e	125.61 a	118.93 g	122.34 B
3	125.39 b	123.49 d	122.01 f	123.63 A
Mean	122.36 B\	124.60 A\	119.12 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 3: Effect of soil type, PRO MIX treatments and their interaction on number of leaves/plant of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	34.43 e	35.53 cd	33.98 e	34.65 C
1	34.95 de	36.50 bc	34.12 e	35.19 BC
2	35.65 b-d	36.40 bc	34.09 e	35.38 B
3	36.67 b	38.10 a	34.43 e	36.40 A
Mean	35.43 B\	36.63 A\	34.15 C\	
Second season				
0	35.83 gh	36.93 fg	35.28 h	36.01 D
1	38.57 de	40.35 c	35.45 h	38.12 C
2	37.64 ef	43.38 b	35.69 gh	38.90 B
3	39.17d	45.07 a	36.03 gh	40.09 A
Mean	37.80 B\	41.43 A\	35.61 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 4: Effect of soil type, PRO MIX treatments and their interaction on leaf area (cm^2) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	44.54 i	48.16 e	39.97 l	44.22 D
1	46.44 g	48.61 c	41.75 k	45.60 C
2	46.92 f	51.68 b	43.57 j	47.39 B
3	48.32 d	53.09 a	45.03 h	48.81 A
Mean	46.55 B\	50.38 A\	42.58 C\	
Second season				
0	45.15 i	48.77 e	40.58 l	44.83 D
1	47.05 g	49.22 c	42.36 k	46.21 C
2	47.53 f	52.29 b	44.18 j	48.00 B
3	48.93 d	53.70 a	45.64 h	49.42 A
Mean	47.16 B\	50.99 A\	43.19 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 5: Effect of soil type, PRO MIX treatments and their interaction on leaves fresh weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	7.84 de	8.55 cd	5.51 g	7.30 C
1	7.91 de	9.16 bc	6.64 f	7.90 C
2	9.37 bc	9.97 b	7.12 ef	8.82 B
3	12.03 a	11.40 a	7.45 ef	10.29 A
Mean	9.29 A\	9.77 A\	6.68 B\	
Second season				
0	8.56 de	9.27 cd	6.23 g	8.02 C
1	8.63 de	9.88 bc	7.36 f	8.62 C
2	10.09 bc	10.69 b	7.84 ef	9.54 B
3	12.75 a	12.12 a	8.17 ef	11.01 A
Mean	10.01 A\	10.49 A\	7.40 B\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 6: Effect of soil type, PRO MIX treatments and their interaction on leaves dry weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	2.27 g	3.17 e	0.68 j	2.04 D
1	2.83 f	3.42 d	1.31 i	2.52 C
2	4.04 c	4.14 c	1.64 h	3.27 B
3	5.72 a	0.68 b	2.03 g	4.21 A
Mean	3.72 B\	3.90 A\	1.41 C\	
Second season				
0	3.01 h	3.91 f	1.20 l	2.71 D
1	3.57 g	4.16 e	2.05 k	3.26 C
2	4.78 d	4.88 c	2.38 j	4.01 B
3	6.46 a	5.63 b	2.77 i	4.95 A
Mean	4.46 B\	4.64 A\	2.10 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Stem parameters

Clayey medium succeeded to produce the thickest stem in the two seasons. However, sandy medium occupied the second rank in raising such trait in both seasons. In contrast calcareous medium recorded the lowest means in the two seasons. Referring to the effect of "PRO MIX", it is clear from data outlined in Table (7), the superiority of treating plants with the highest level of "PRO MIX" (3 ml/l) for increasing stem diameter, followed by those treated with the medium level (2 ml/L). The lowest means were obtained as a result of untreated plants (control) in the two experimental trials. With regard to the interaction, it is evident from data that growing plants in either clayey or sandy medium and receiving either the medium or the highest levels of "PRO MIX" (2 and 3 ml/l) the best treatments, for raising stem diameter in the two seasons. In contrast, the lowest means were registered as a result of growing plants in calcareous medium and untreated with "PRO MIX" in the two seasons.

Table 7: Effect of soil type, PRO MIX treatments and their interaction on stem diameter (mm) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	10.61 f	11.72 c	9.46 h	10.60 D
1	11.12 e	11.47 d	9.58 h	10.72 C
2	11.95 b	12.04 ab	10.37 g	11.45 B
3	12.19 a	11.99 b	10.63 f	11.60 A
Mean	11.47 B\	11.80 A\	10.01 C\	
Second season				
0	11.04 f	12.15 c	9.89 h	11.03 D
1	11.55 e	11.90 d	10.01 h	11.15 C
2	12.38 b	12.47 ab	10.80 g	11.88 B
3	12.62 a	12.42 b	11.06 f	12.03 A
Mean	11.90 B\	12.23 A\	10.44 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Stem fresh and dry weights

The significantly highest values of either fresh or dry weights of stem in both seasons were a result of plants grown in clayey medium, in both seasons, as shown in Tables (8, 9). Moreover, the heaviest fresh and dry weights of stem belonged to plants which receiving the highest level of "PRO MIX" (3 ml/l) followed with significant difference by plants treated with the medium level (2 ml/l) in the two seasons. However, the lowest values were registered in untreated plants (control), in the same seasons. In the matter of the interaction, it is obvious that growing plants in clayey medium with receiving either the medium or the highest levels of "PRO MIX" (2 and 3 ml/l) succeeded to produce the heaviest fresh and dry weights of stem in the two seasons. In contrast, the lowest values were gained as a result of plants grown in calcareous medium and untreated with "PRO MIX" in both seasons.

A- Effect on root fresh and dry weights

Data exhibited in Tables (10, 11) exhibited the beneficial effect of growing plants in clayey medium for raising either fresh or dry weight of roots over that gained from other growing medium used in plantation in the two seasons. Meanwhile, clayey medium with the lowest means and the highest levels of "PRO MIX" (2 and 3 ml/l), proved their mastery in elevating both fresh and dry weights of roots comparing with that obtained from untreated plants (control) and other treatments used in the two seasons. Concerning the interaction it is clear from data presented in Tables (10, 11)

the superiority of growing plants in clayey medium with receiving plants the highest level of "PRO MIX" (3 ml/l) for elevating either fresh or dry weights of roots in the two seasons.

Table 8: Effect of soil type, PRO MIX treatments and their Interaction on stem fresh weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	27.74 e	34.96 b	23.56 h	28.76 D
1	30.18 d	35.11 b	24.86 g	30.05 C
2	30.45 d	36.74 a	26.67 f	31.29 B
3	32.81 c	37.50 a	28.12 e	32.81 A
Mean	30.30 B\	36.08 A\	25.80 C\	
Second season				
0	28.19 e	35.41 b	24.01 h	29.21 D
1	30.63 d	35.56 b	25.31 g	30.50 C
2	30.90 d	37.19 a	27.12 f	31.74 B
3	33.26 c	37.95 a	28.57 e	33.26 A
Mean	30.75 B\	36.53 A\	26.25 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 9: Effect of soil type, PRO MIX treatments and their interaction on stem dry weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	10.73 f	12.01 d	3.12 k	10.60 D
1	9.57 g	12.75 c	4.32 j	10.72 C
2	9.60 g	14.21 b	5.69 i	11.45 B
3	11.42 e	16.19 a	7.23 h	11.60 A
Mean	10.33 B\	13.79 A\	5.09 C\	
Second season				
0	11.19 f	12.47 d	3.58 k	9.08 D
1	10.03 g	13.21 c	4.78 j	9.34 C
2	10.06 g	14.67 b	6.15 i	10.29 B
3	11.88 e	16.65 A	7.69 h	12.07 A
Mean	10.79 B\	14.25 A\	5.55 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 10: Effect of soil type, PRO MIX treatments and their interaction on root fresh weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	42.68 d	46.19 c	38.30 g	42.39 D
1	42.96 d	46.58 bc	39.57 f	43.04 C
2	43.59 d	47.24 ab	40.66 e	43.83 B
3	45.60 c	47.83 a	40.93 e	44.79 A
Mean	43.71 B\	46.96 A\	39.86 C\	
Second season				
0	43.37 d	46.88 c	38.99 g	43.08 D
1	43.66 d	47.27 bc	40.26 f	43.73 C
2	44.28 d	47.93 ab	41.35 e	44.52 B
3	46.29 c	48.52 a	41.62 e	45.48 A
Mean	44.40 B\	47.65 A\	40.55 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 11: Effect of soil type, PRO MIX treatments and their interaction on roots dry weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	5.89 h	7.67 g	3.61 l	5,73 D
1	7.82 f	10.51 c	4.56 k	7,64 C
2	8.66 e	11.47 b	4.84 j	8.33 B
3	9.60 d	13.02 a	5.17 i	9.27 A
Mean	7.99 B\	10.67 A\	4.54 C\	
Second season				
0	6.59 h	8.37 g	4.31 l	6.42 D
1	8.52 f	11.21 c	5.26 k	8.33 C
2	9.36 e	12.17 b	5.54 j	9.02 B
3	10.30 d	13.72 a	5.87 i	9.96 A
Mean	8.69 B\	11.37 A\	5.24 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

B- Effect on flowering

Data presented in Table (12) indicate that growing plants in clayey medium proved its mastery in elevating No. of flowers/plant in both seasons followed with significant difference by plants grown in sandy medium and then came those obtained from plants grown in calcareous medium in the two experimental trials. Meantime, No. of flowers/plant, was progressively increased by raising "PRO MIX" levels, recording the highest means by applying the highest "PRO MIX" level (3 ml/L) in both seasons. Meanwhile, the interactions indicated the superiority of growing plants in clayey medium with applying either the medium or the highest level of "PRO MIX" (2 and 3 ml/l) for elevating No. of flowers/plant in the two seasons, while, the lowest record, were obtained due to growing plants in sand medium, untreated with "PRO MIX" in the two seasons.

Table 12: Effect of soil type, PRO MIX treatments and their interaction number of flowers/plant of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	16.48 ef	18.83 b-d	18.77 b-d	18.03 B
1	17.45 d-f	19.30 bc	16.08 f	17.61 B
2	17.80 c-e	20.04 ab	17.42 d-f	18.42 B
3	19.63 ab	20.97 a	17.65 d-f	19.42 A
Mean	17.84 B\	19.79 A\	17.48 B\	
Second season				
0	19.20 d	20.13 c	20.10 c	19.81 B
1	19.33 d	20.61 b	17.38 f	19.10 C
2	20.35 bc	21.34 a	18.65 e	20.11 A
3	20.60 b	21.27 a	18.85 e	20.24 A
Mean	19.87 B\	20.84 A\	18.74 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

In the matter of the interaction, treating the plants grown in clayey medium with the highest "PRO MIX" level (3 ml/l) was the best treatment used for raising fresh and dry weights of flowers, followed in the second category by plants grown in the same medium and receiving the medium level of "PRO

MIX" (2 ml/l) in the two seasons as, Tables (13, 14). In contrast, the lowest means were recorded on the same parameters due to planting in calcareous medium and untreated with "PRO MIX" in the two seasons.

The aforementioned results revealed the mastery of growing plants in clayey medium for improving all plant traits in both seasons. However, such results are in agreement with many scientists on various plant species. In this connection, Ibrahim (2002) found that clayey medium 100% gave the best vegetative growth of *Gasteria verrucosa* and *Haworthia fasciata* plants. In contrast, calcareous soil revealed the worst results in this regard. This medium is the soil which contains more than 10% $CaCO_3$. It is detected with the loss of the water irrigation quickly. CaCO3 is assembled in layer, and it hinders the airing and the water motion in the soil and the high value of pH affected the suitability of some elements such as P, Fe, Mn and Zn.

Table 13: Effect of soil type, PRO MIX treatments and their interaction on flowers fresh weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	64.87 e	72.25 d	59.95 h	65.69 D
1	64.98 e	73.19 cd	61.27 g	66.48 C
2	65.53 e	74.06 bc	61.74 g	67.11 B
3	76.50 a	74.87 b	63.14 f	71.50 A
Mean	67.97 B\	73.59 A\	61.52 C\	
Second season				
0	65.90 e	73.28 d	60.98 h	66.72 D
1	66.01 e	74.22 cd	62.30 g	67.51 C
2	66.56 e	75.09 c	62.77 g	68.14 B
3	77.53 a	76.90 b	64.17 f	72.53 A
Mean	69.00 B\	74.87 A\	62.55 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

Table 14: Effect of soil type, PRO MIX treatments and their interaction on flowers dry weight (gm.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	9.82 h	12.27 g	4.97 l	9.02 D
1	14.89 c	13.09 f	5.30 k	11.09 C
2	15.48 b	13.96 e	5.72 j	11.72 B
3	16.49 a	14.76 d	7.09 i	12.78 A
Mean	14.17 A\	13.52 B\	5.77 C\	
Second season				
0	10.90 h	13.35 g	6.05 l	10.10 D
1	15.97 c	14.17 f	6.38 k	12.17 C
2	16.56 b	15.04 e	6.80 j	12.80 B
3	17.57 a	15.84 d	8.17 i	13.86 A
Mean	15.25 A\	14.60 B\	6.85 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test (DMRT)

The results revealed also the role of carboxylic acid (PRO MIX) in improving plant traits (plant height, number of leaves/plant, leaf area, leaves and roots fresh and dry weights, stem diameter, and number of flowers/plant). In this connection, Chen and Avaid 1990 claimed that humic substances

have reported to influence plant growth both directly and indirectly. The indirect effects of humic compounds on soil fertility include: (i) Increase the soil microbial population including beneficial microorganisms, (ii) Improved soil structure and (iii) Increase the cation exchange capacity and pH buffering capacity of the soil. Directly, humic acid compounds may have various bio chemical effects at cell wall, membrane level or in the cytoplasm, including increased photosynthesis and respiration rates in plants, enhanced protein synthesis and plant hormone-like activity. They added that the stimulatory effects of humic substances have been directly correlated with the enhanced uptake of macronutrient, such as nitrogen, phosphorus, sulfur and micronutrients, such as Fe, Zn, Cu and Mn. Pettit, (2004) stated that humic substances have a very strong influence on the growth of plant roots. When humic and fulvic acids were applied on the soil, enhancement of root initiation and increased root growth may be observed. Recently, Asal *et al.* (2015) concluded that the effects of humic substances as a source of carboxyl groups on plant growth depended on the source and concentration, as well as on the molecular fraction weight of humus. Lower molecular size fraction easily reaches the plasma lemma of plant cells, determining the positive effect on plant growth that is the nutrient uptake especially nitrate.

C- Effect on chemical constituents

Pigments content

Data presented in Tables (15, 16, 17) indicate that clayey medium was the best medium used for recording the utmost highest values of chlorophyll a, b and carotenoids in leaves in the two seasons, followed in the second category by plants grown in sandy medium, then came the effect of calcareous medium, which occupied the third rank in both seasons.

On the other hand, a progressive increment in the same constituents was gained due to increasing the level of "PRO MIX", reaching its maximum by applying "PRO MIX" at 3 ml/l in the two seasons. With respect to the interaction, it is evident from scored values that growing plants in clayey medium with plants receiving the highest level of "PRO MIX" (3 ml/l) was the best treatment used in elevating all pigments content in the leaves in both season. In contrast, the lowest record was obtained as a result of plants growing in calcareous medium with no "PRO MIX" in the two seasons.

Table 15: Effect of soil type, PRO MIX treatments and their interaction on chlorophyll a (mg/g. f.w.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	4.02	5.55	3.21	4.26
1	4.57	5.84	4.22	4.88
2	4.74	6.32	4.78	5.28
3	6.22	7.56	5.53	6.44
Mean	4.89	6.32	4.44	
Second season				
0	4.81	6.25	4.01	5.02
1	5.73	6.84	4.75	5.77
2	5.79	6.91	5.07	5.92
3	6.42	7.73	5.71	6.62
Mean	5.69	6.93	4.89	

Table 16: Effect of soil type, PRO MIX treatments and their interaction on chlorophyll b (mg/g. F.W.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	1.57	2.35	1.21	1.71
1	1.65	2.33	1.2	1.73
2	1.64	2.57	1.31	1.84
3	2.02	2.84	1.87	2.24
Mean	1.72	2.52	1.40	
Second season				
0	1.69	2.51	1.28	1.83
1	1.85	2.6	1.34	1.93
2	2.04	2.67	1.68	2.13
3	2.32	2.87	1.91	2.37
Mean	1.98	2.66	1.55	

Table 17: Effect of soil type, PRO MIX treatments and their interaction on carotenoids (mg/g. F.W.) of *Althaea rosea* in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	1.8	2.20	1.21	1.74
1	1.84	2.51	1.25	1.87
2	2.22	3.12	1.73	2.36
3	2.61	3.55	2.14	3.10
Mean	2.37	4.85	1.58	
Second season				
0	1.91	2.31	1.22	1.81
1	1.94	2.55	1.37	1.95
2	2.25	3.17	1.77	2.40
3	3.30	3.35	2.31	2.99
Mean	2.35	2.85	1.67	

Total carbohydrates %

Results of the effect of growing media and "PRO MIX" treatments on total carbohydrates % in the leaves, stems, roots and flowers revealed the above mentioned trend in the two seasons as indicated in Tables (18, 19, 20). However, it could be concluded that clay medium proved its mastery in inducing the highest % total carbohydrates in the above mentioned organs, whereas, the opposite was right concerning the effect of calcareous medium. Meanwhile, sandy medium gave an intermediate effect in this regard. Total carbohydrates % of the different organs was progressively increased by raising "PRO MIX" levels, recording the highest value by applying the highest level (3 ml/L) in the two seasons.

The interactions, on the other side, clarified that treating plants grown in clayey medium with the highest level of "PRO MIX" (3 ml/l) was the best medium used for producing the highest total carbohydrates % in the different organs, mentioned above. On the contrary, the lowest scores were gained due to plants grown in calcareous soil with no "PRO MIX" in the two seasons.

Table 18: Effect of soil type, PRO MIX treatments and their interaction on carbohydrates in leaves (% D.W.) of *Althaea rosea*in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	2.87	3.15	2.34	2.79
1	3.08	3.42	2.47	2.99
2	3.36	366	2.68	3.23
3	3.71	3.87	3.31	3.63
Mean	3.26	3.53	2.70	
Second season				
0	2.83	3.21	2.37	2.80
1	3.15	3.37	2.39	2.97
2	3.29	3.61	2.70	3.20
3	3.45	3.81	3.28	3.51
Mean	3.18	3.50	2.69	

Table 19: Effect of soil type, PRO MIX treatments and their interaction on carbohydrates in stem (% D.W.) of *Althaea rosea*in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	2.03	2.56	1.74	2.11
1	2.79	2.61	1.78	2.39
2	3.08	3.09	1.94	2.7
3	3.34	3.31	2.11	2.92
Mean	2.81	2.89	1.89	
Second season				
0	2.14	2.45	1.58	2.06
1	2.65	2.64	1.75	2.35
2	2.97	3.15	2.02	2.71
3	3.09	3.37	2.27	2.91
Mean	2.71	2.9	1.91	

Table 20: Effect of soil type, PRO MIX treatments and their interaction on carbohydrates in roots (% D.W.) of *Althaea rosea*in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	2.98	3.5	2.56	3.01
1	3.21	3.64	2.64	3.16
2	3.54	3.91	2.88	3.44
3	3.87	4.2	3.12	3.73
Mean	3.4	3.81	2.8	
Second season				
0	2.79	3.34	2.49	2.87
1	3.35	3.71	2.65	3.24
2	3.61	3.88	2.93	3.47
3	3.85	3.96	3.2	3.67
Mean	3.4	3.72	2.82	

Table 21: Effect of soil type, PRO MIX treatments and their interaction on carbohydrates in flower (% D.W.) of *Althaea rosea*in two seasons.

First season				
PRO MIX conc. (ml/L)	Sandy	Clayey	Calcareous	Mean
0	1.74	2.21	1.41	1.79
1	2.21	2.54	1.61	2.12
2	2.49	2.73	1.83	2.35
3	3.2	3.18	2.06	2.81
Mean	2.41	2.67	1.73	
Second season				
0	1.87	2.33	1.55	1.92
1	2.32	2.55	1.68	2.18
2	2.51	2.82	1.8	2.38
3	3.16	3.21	2.57	2.98
Mean	2.47	2.73	1.9	

The previous results showed the superiority of clayey medium for increasing chemical constituents of the plant. However, this finding is in accordance with the results recorded by many authors on many plants. In this connection, Manoly (1989) on tuberose recorded that clayey loam soil caused significant increase in reducing and total sugars content in the leaves and bulbs compared with the sandy soil. Also, Manoly (1996) on Iris mentioned that, clay loamy soil caused a significant increase in reducing, non-reducing and total sugars content in the new leaves. Meanwhile, Nasr (2000) on *Polianthes tuberosa* demonstrated that total sugars content was increased by planting the bulbs in clayey medium. Also, the promotive effect of carboxylic acid in improving chemical constituents of the plant in the current study is in conformity with many authors. Mukhtar (2008) on *Hibiscus sabderiffa* (Red Sorrel) reported that the treatment comprised of 50 and 100 ppm of indole acetic acid (IAA) and 10 and 15 % coconut milk, where all the treatments significantly increased chlorophyll content of vegetable with higher values recorded in treatments with 100 ppm IAA and 15% coconut milk. Moreover, Abd Allah *et al.* (2015) on quinoa plant claimed that exogenous application of benzoic acid and salicylic acid led to marked increase in photosynthesis pigments (chlorophyll a, b, carotenoids) and total carbohydrates. They added that benzoic acid was more pronounced than salicylic acid in this concern.

References

Abd Allah, M. M.S., H. M. S. El-Bassiouny, T.A. Elewa and T. El sebaiy, 2015. Effect of salicylic acid and benzoic acid on growth, yield and some biochemical aspects of quinoa plant grown in sandy soil. International Journal of Chem. Tech. Research., 8 (12): 216-225.

Abd El Hakeem, Rasha, E., 2015. A phytochemical and biological study of *Althaea rosea* Cav. Family Malvaceae cultivated in Egypt. M.Sc. Thesis., Fac. Pharma., Cairo Univ., Egypt.

Abdel-Hamid, M.A. and D.P.Shrestha.1992. Soil salinity mapping in the Nile delta, Egypt using remote sensing techniques. International Society for Photogrammetry and Remote Sensing (ISPRS), Vol. 29 : Part 7B, commission VII, pp. 783-787.

Ahmet U., C. Seydahmet, S. E. Mehmet and G. K. Hamdi, 2015. Effect of EDTA and Tannic Acid on the Removal of Cd, Ni, Pb and Cu from Artificially Contaminated Soil by *Althaea rosea* Cavan. International Journal of Phytoremediation., 17(6): 568-574.

Anonymous, 1986. MSTATC. Microcomputer Statistical programme. Michigan State University. Michigan, Lansing, USA.

Asal, M. W., A. Badr, Elham, O. M. Ibrahim and E. G. Ghalab, 2015. Can humic acid replace part of the applied mineral fertilizers? A study on two wheat cultivars grown under calcareous soil conditions. International Journal of ChemTech Research., 8 (9):20-26.

Askar, F. A., 1988. Suitability of soil conditioners for desert and cultivated soil in Egypt. Inter. Synp. Soil conditioners, Egypt: 133-142.

Bailey, L. H., 1953. The Standard Cyclopedia of Horticulture, Volume II. The Macmillan Company, New York, p. 92-95 .

Baum, D. A., W. S. Alverson and R. Nyffeler, 1988. Taxonomy and Nomenclature of the Core Malvalea, Volume 3. Harvard Papers in Botany, p. 315-330

Bayer, C. and K. Kubitzki, 2003. The Families and Genera of Vascular Plants, Volume 5. Springer-Verlag, Berlin Heidelberg, p. 255-311

Boulos, L., 2000. Flora of Egypt, Volume 2. Al Hadara Publishing Egypt, p. 97-98

Chen, Y. and T. Aviad, 1990 . Effect of humic substances on plant growth. In MacCarthy , CE Clapp RL. Malcolm, PR Bloom (eds). Humic Substances in Soil and Crop Sciences. Selected Readings. Soil Sci. Society of America. Madison. Wisconsin p. 161-186.

Dormaar, J. F., 1982. Aliphatic carboxylic acids in chernozemic soils. Can. J. Soil Sci., 62: 487-494.

Dubois, M., K. A. Gilles, J. K. Hamilton, P. A. Rebers and F. Smith, 1956. Colorimetric method for determination of sugars and related substances. Anal. Chem., 28:350–356.

Duncan. D. B., 1955. Multiple Range and Multiple F Test. J. Biometrics, 11: 1-42.

Floyed, C. A., 1965. Raising and planting out of blackout in Jiffy pots. For Corm. Tech. 9p.

Gold Book, 2014. International Union of Pure and Applied Chemistry, Compendium of Chemical Terminology. Version 2.3.3

Hall, N. and K. P. Richmound, 1968. Raising Eucalypto in pots. Aust. For., 23: 46-48.

Hamdi H. and S. Abdelhafez, 2001. Agriculture and soil survey in Egypt. Zdruli P. (ed.), Steduto P. (ed.), Lacirignola C. (ed.), Montanarella L. (ed.). Soil resources of Southern and Eastern Mediterranean. Bari, CIHEAM., 34: 111-125.

Hassan, Badreya, A., K. H. Mahmoud, M. E. Tarek and M.Weheda, Bothaina, 2015. Effect of some growing media on rowth and flowering of Gazania plant. Alex, Sci. Exchange Journal., 1:(36), 15-24 .

Ibrahim, A. A. E. L., 2002. Effect of growing media and chemical fertilization on growth and chemical composition of Gasteria and Haworthia plant. M. Sc. Thesis. Fac. Of Agric. Cairo Univ.

Judd, W. S. and S. R. Manchester, 1997. Circumscription of Malvaceae (Malvales) as determined by a preliminary cladistic analysis of morphological, anatomical, palynological, and chemical characters. Springer on behalf of the New York Botanical Garden Press. Brittonia., 49(3): 384-405. http://www.jstor.org/stable/2807839

Manoly, N. D., 1989. Some agricultural treatments affecting growth, and flowering of *Polianthes tuberosa*. M. Sc. Thesis, Fac. Agric. Minia Univ.

Manoly, N. D., 1996. Effect of soil type, fertilization, bulb size and growth regulators on growth, flowering and chemical composition of Iris plants Ph.D. Thesis. Fac. Agric. Minia Univ.

Marzieh, A.;, K. R. Abolfazl;, R. Ziba, A. H. Mousa, M. Nema, and S. T. Nafiseh, 2012. *Alcea rosea* root extract as a preventive and curative agent in ethylene glycol-induced urolithiasis in rats. Indian J Pharmacol.; 44(3): 304–307.

Mert, T. F. T., H. Kivcak and H. O. Tansel, 2010. Antimicrobial and cytotoxic activity of the extracts obtained from the flowers of *Alcea rosea* L., Hacet Univ. J, Pharm., 30:17-24.

Mukhtar, F. B., 2008. Effect of some growth regulators on the growth and nutritional value of *Hibiscus sabdariffa* L. (Red Sorrel). Int. Jor. P. App. Scs., 2 (3): 70-75.

Nasim, A. Y., U. K. Waheed, R. A. Sajid, A. Aamir, A. Shakil and A. Aqeel, 2017. Role of Ni-tolerant *Bacllus* spp. And *Althaea rosea* L. in the phytoremediation of Ni-contaminated soils. International Journal of Phytoremediation., 19(5): 470-477.

Nasr, A. M., 2000. Effect of some factors on growth, flowering and chemical composition of *Polianthes tuberosa* L. plant Ph.D. Thesis, Fac. Agric. Cairo Univ.

Pettit, R. E., 2004. Organic matter, humus, humate, humic acid, fulvic and humin: Their importance in soil fertility and plant health [online]. Available at www.humate. Info/mainpage.htm.

Physicians, Desk Reference for Herbal Medicine (PDR), by German Regulatory Authority Herbal Wakchdog Agency, 2004. “Commission E.” 3rd ed., New Jersy Medical Economics Company Publishing, p.438-439

Rendle, A. B., 1959. The Classification of Flowering Plants, 2, Dicotyledons Camb. Univ. Press,.

Saeed, Reem, M., W. M. Bazaraa and A. Nabih, 2014. Effect of growing media, organic fertilization and bio-stimulants on the production of Gladiolus (cv. Novalux) corms from cormlets. Scientific J. Flowers & Ornamental Plants., 1(1): 73-87.

Steel, R. O. D., J. H. Torrie, and D. Dickey, 1997. Principles and procedure of statistics. A. Biometrical Approach. 3rd Ed. Mc. Grow Hill Book Co. Inc. New York, p. 352- 358.

Tackholm, V., 1974. Student' Flora of Egypt. 2nd Edition. Cairo University Press, Cairo, Egypt, p. 351-353.

Wang, D., J. Yu and Q. Shang, 1989. Analgesic and anti-inflammatory effects of the flower of *Althaea rosea* (L.) Cav. Zhongguo Zhong Yao Za Zhi., 14: 46-48.

Wettstein, D., 1957. Chlorophyll-letale und der Submikroskopische Formwechsel der Plastiden. Experimental Cell Research, 12: 427–506.

William H. B. and M. Jerry, 2017. Carboxylic acid, Chemical compound. Encyclopedia Britannica. https://www.britannica.com/science/carboxylic-acid.