EFFECT OF DIFFERENT PLANTING DATES AND ORGANIC FERTILIZERS TREATMENTS ON GROWTH AND YIELD OF *HIBISCUS SABDARIFFA* L. PLANTS

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This research was conducted at the El-Qantara Sharq Research Station, Desert Research Center, during two successive summer seasons of 2013 and 2014 to study the effect of planting dates (15th April, 1st May and 15th May) and organic fertilization treatments (control, 15 m^3/ feddan cattle manure, 15 m^3/ feddan compost and a mixture of organic fertilizers [15 m^3/ feddan compost + 15 m^3/ feddan cattle manure]) on growth, yield and active ingredients of *Hibiscus sabdariffa* L. plants.

Early planting date (15th April) resulted in significant increase in all growth characters, while delaying the planting dates decreased it in both seasons. The application of organic fertilizers produced the highest value in all growth characters during the two experimental seasons, while the treatment of mixed organic fertilizer significantly increased vegetative growth parameters, chemical ingredients and the chemical constituents. The interaction between planting dates and organic fertilization show that, the treatment of cultivation date on 15th April and fertilization with mixed organic fertilizer significantly increased most of the studied characters, however this treatment gave the maximum sepals per plant and per feddan, yield of seeds per plant and per feddan, the anthocyanins content and fixed oil content in seeds compared with the other treatments.

Keywords: *Hibiscus sabdariffa*, planting dates, organic fertilization, compost, cattle manure

Roselle (*Hibiscus sabdariffa* L.), commonly known as "Karkade" in Egypt and most Arab countries, belongs to the family Malvaceae (Mohamed et al., 2007). Dried fleshly calices is the part of the flower used as having a large quantities of organic acids, vitamin C, and the therapeutic properties of diuretic acids and anthocyanins (Peng-Kong et al., 2002). Roselle plant is one of the most important medicinal plants cultivated in the tropical and

subtropical countries. The drink of "Karkade" made of calyx has many medicinal uses for killing various types of bacteria and microorganisms, remedy for cancer, has soporific action, and has a favorable effect on the functions of the stomach possession (Aziz et al., 2007). It decreases blood pressure and causes relaxation of the rest parts of the human body. The flowers of 'roselle' are suitable to be used as natural food coloring agents, and the red beverage is also used in jams, tea pies, deserts and sauces. Sanyo (1981) reported that the plant is a good source for lipid-soluble antioxidant and particularly ǵ-tocopherol.

Organic fertilizers are safe for human health and environment, and are made by recycling of organic waste materials from animal, plants, or food scraps in a controlled process. Compost increases soil organic matter, provides and facilitates the absorption of nutrients. Mathur et al. (1993) and Tara et al. (1996) mentioned that adding different composts to the soil caused remarkable improvement of different growth characters, of medicinal and aromatic plants; such as peppermint (Tara et al., 1996), and *Rosmarinus officinalis* and *Tagetes erecta* (Khalil, 2002). Compost is used to improve water retention capacity, draining, pH and better availability of soil microorganism (Khandar and Nigam, 1986 and Herrera et al., 1997). In this concern, Badran and Safwat (2004), on fennel plants, the organic manure has promoted flowering and increased sepals' productions by enhancing the nitrogen content and the rate of photosynthesis.

Sowing date is an important factor in crop production, performance and yield. Sowing date affects the quality of calyxes consumer acceptability's based on calyx quality in terms of color, taste, calyx size, aroma, and yield. Roselle a tropical annual shrub, which fruit like structures containing eligible pigment belongs to family Malvaceae (Ghazali, 1999). Roselle calices were being shipped to Germany, France, Switzerland and Italy at the rate of 10 to 25 tons annually (Morton, 1987), but now it is considered one of the competitive beverages in the world (Schippers, 2000). Roselle is tolerant to a wide range of environmental conditions, well-suited to cultivation in hot and dry regions on a wide range of soils, requiring a short day of 12 to 13 hours (Tindal, 1983). The explanation for the relative earliness of sown roselle date is due to temperature and photosensitivity, such plant would flower early in condition of short sunlight durations and may not flower when sunlight duration is above 11 hours (Twain et al., 2001). Depending on the variety, it matures from 12 to 16 weeks from sowing date, where diseases and pest are rarely serious. Rain, high humidity, and drying during the harvest time can downgrade the quality of the calices and reduce the yield.

Some studies of planting dates in *Hibiscus sabdariffa* plant found that, the early planting dates gave the highest values of plant heights, number of branches, fresh and dry weight of plant, sepals, seeds also early planting dates increased N, P, K and total carbohydrates percentage, acidity and

anthocyanin in sepals and fixed oil in seeds (Futuless et al., 2010; Okosun, 2000; Babatinde et al., 2002; Oyewole and Mera, 2010; Seghatoleslami et al., 2013; Nnebue et al., 2014; Timothy and Futuless, 2014 and Ado et al., 2015).

This study was conducted to evaluate the effect of sowing date and organic fertilizers on vegetative growth, yield production and active ingredients of *Hibiscus sabdariffa* plants in new reclamation areas.

MATERIALS AND METHODS

This investigation was carried out at the Experimental Station of Desert Research Center at El-Qantara Sharq, North Sinai, Egypt, for two successive seasons of 2013 and 2014. Seeds of roselle (*Hibiscus sabdariffa*) were sown in the field plots (5×5 m), each plot contained 50 plants, since the distance between rows was 100 cm and between plants within row was 50 cm. Seedlings were thinned to one plant per hill. The irrigation system of the experiment was drip irrigation with the rate of 4 l/h/hill. The mechanical and chemical properties of the experimental soil are shown in table (1).

Table (1). Physical and chemical analysis of soils of the experimental site at El-Qantara Sharq- North Sinai Research Station.

		Chemical analysis					
Mechanical analysis	**Value**	**Soluble anions (meq/l)**	**Value**	**Soluble cations (meq/l)**	**Value**	**Available (mg/l)**	**Value**
Fine sand %	43.28	**CO_3^-**	-	**Ca^{++}**	8.92	**N**	0.16
Coarse sand %	42.26	**Cl^-**	9.00	**Mg^{++}**	7.95	**P**	13.21
Silt %	13.28	**SO_4^{--}**	25.35	**Na^+**	20.42	**K**	69.67
Clay %	1.18	**pH**	8.29	**K^+**	1.21	**$CaCO_3$**	6.20
Soil texture		Sandy		**E.C mmhos/ cm**		3.85	

The experiment consisted of 12 treatments including combinations among planting date treatments (15^{th}April, 1^{st} May and 15^{th} May) and different organic fertilization treatments (control, 15 m^3/fed compost (comp.), 15 m^3/fed cattle manure (C.M.) and a mixture of organic fertilizer [15 m^3/fed compost + 15 m^3/fed cattle manure (M.O.F.)]). The chemical properties of experimental fertilization are shown in table (2). These treatments were arranged in a split plot design with three replicates. Planting date treatments were randomly arranged in the main plots, while the organic fertilizer levels treatments were randomly arranged in the sub plots.

Table (2). Chemical analysis of compost and cattle manure at El-Qantara Sharq, North Sinai Research Station.

Parameters	Compost	Cattle manure	Parameters	Compost	Cattle manure
Organic matter (%)	63.35	39.13	**Potassium (%)**	1.30	0.88
Organic carbon (%)	36.83	22.75	**Iron (ppm)**	248.10	120.50
Total nitrogen (%)	1.97	0.85	**Zinc (ppm)**	149.20	104.60
C/N ratio	24.30 : 1	12.71 : 1	**Copper (ppm)**	23.30	10.60
Phosphorus (%)	0.93	0.75	**Manganese (ppm)**	114.90	30.10

Compost and cattle manure were added during soil preparation, as all plants received half the recommended dose of NPK fertilizers, as 100 kg/fed calcium superphosphate was added during soil preparation and 150 kg/fed ammonium sulfate and 50 kg/fed potassium sulfate were added as two equal doses. The first addition was 45 days after sowing and the second one was added after 90 days from planting. All plants received normal agricultural practices whenever they needed. The harvest was after 6 months from planting in all treatments.

The following data were recorded: vegetative growth parameters i.e. plant height, number of branches per plant and fresh and dry weights of whole plant, straw, sepals and seeds per plant (g) and per plot (kg). Chemical ingredients determined are; i.e. active ingredients of total acidity percentage, anthocyanin percentage (mg/100 g) and fixed oil percentage in seeds. The chemical constituents i.e. total carbohydrates, nitrogen, and phosphorus and potassium percentage per plant were determined in roselle sepals.

Percentage of anthocyanin content (mg/100 g) was determined calorimetrically according to the method described by Fuleki and Francis (1968) and developed by Francis (2000) for *Hibiscus sabdariffa*; total acidity percentage and fixed oil percentage in seeds according to the methods of A.O.A.C. (1984); total carbohydrate, nitrogen, phosphorus and potassium percentages per plant were determined in leaves according to Dubios et al. (1956), Naguib (1969), Hucker and Catroux (1980) and Brown and Lilleland (1964), respectively.

The recorded data were statistically analyzed and means of treatments were compared using least significant difference L.S.D. test at 5% level according to Snedecor and Cochran (1980) by using computer program of Statistics version 9 (http://www.statistix.com/freetrial.html) Analytical Software (1985).

RESULTS AND DISCUSSION

1. Vegetative Growth Parameters

1.1. Effect of planting dates

The main effect of planting dates declares that, all vegetative growth parameters such as plant height (cm), number of branches per plant and fresh and dry weights of whole plant, straw, sepals and seeds per plant (g) and per plot (kg) have given significant differences by the variation in planting dates (Tables 3, 4 and 5). The highest vegetative growth parameters were recorded with the early planting date (15th April). These results followed the same direction during both seasons. This effect might be attributed to the environmental conditions, especially temperature and day length. The increment in the weight of fruits could be attributed to the suitable growing conditions especially temperature, which was more favorable for plant development and consequently produced more number of branches, which was reflected in producing more fruits per plant and plot. The previous result is in harmony with these obtained by Tindall (1983), Morton (1987), Ghazali (1999), Schippers (2000) and Barzgaran (2011) on *Hibiscus Sabdariffa* and Singh et al. (2009), Blazewicz-Wozniak (2010) and Selim et al. (2013) on *Foeniculum vulgare*.

Table (3). Effect of planting dates, organic fertilizer and their interaction on plant height (cm) and number of branches per plant of *Hibiscus sabdariffa* plant in 2013 and 2014 seasons.

Planting dates (A)	Organic fertilizer (B)									
	Control	C.M.	Comp.	M.O.F.	Mean (B)	Control	C.M.	Comp.	M.O.F.	Mean (B)
	Season 1 (2013)					Season 2 (2014)				
	Plant height (cm)									
15th April	110.00	148.33	180.67	205.00	161.00	112.33	149.67	183.33	213.33	164.67
1st May	104.00	136.67	171.33	191.00	150.75	109.67	140.00	193.33	173.33	154.08
15th May	105.00	115.00	155.33	180.00	138.83	108.67	116.67	158.00	183.00	141.58
Mean (A)	106.33	133.33	169.11	192.00		110.22	135.44	171.56	196.56	
L.S.D. at 5%	A: 4.10		B:6.51	AB: 10.54		A: 5.13		B: 6.18	AB: 10.54	
	Number of branches per plant									
15th April	5.53	7.00	9.60	12.33	8.62	5.77	7.43	10.37	13.17	9.18
1st May	5.77	7.10	8.37	10.90	8.03	5.93	7.43	9.00	12.00	8.59
15th May	5.03	6.17	7.67	9.67	7.13	5.08	6.22	7.98	9.97	7.31
Mean (A)	5.44	6.76	8.54	10.97		5.59	7.03	9.12	11.71	
L.S.D. at 5%	A: 0.54		B:0.74	AB: 1.22		A: 0.55		B: 0.77	AB: 1.28	

1.2. Effect of organic fertilizers

Concerning the main effect of organic fertilizers, data presented in tables (3, 4 and 5) showed that, treating plants with organic fertilizers resulted in significant increases in all vegetative growth parameters compared with untreated plants (control). In this regard, mixture of organic fertilizer was the most effective for increasing the values of all growth parameters. These results hold true during both seasons. The increments in plant growth parameters using organic fertilizers treatments may be attributed primarily to that organic fertilizers application led to improve microorganism activities in soilm which led to availability of mineral element absorption (Salem and Awad, 2005), caused more vegetative growth production. Also, organic fertilizers increase the growth rate because the water and mineral uptake such as; nitrogen and phosphorus (Kaplan et al., 2009), which leads to the biomass yield improvement. This finding is in accordance with the observations of Scheffer et al. (1993) and Khalid and Shafei (2005) on *Anethum graveolens*, Santos et al. (2009) on *Melissa officinalis* and Carrubba (2009) on *Coriandrum sativum.*

1.3. Effect of the interaction

Data presented in tables **(**3, 4 and 5**)** indicate that, the interaction between different planting dates and organic fertilizers had a significant effect on vegetative growth parameters. The highest values of plant height (205.00 and 213.33 cm), number of branches per plant (12.33 and 13.17), fresh weight of whole plant (2462.10 and 2716.70 g), dry weight of whole plant (714.00 and 786.67 g), fresh weight of the whole plant per plot (123.10 and 135.83 kg), dry weight of the whole plant per plot (35.70 and 39.33 kg), fresh weight of straw per plant (1618.90 and1695.70 g); dry weight of straw per plant (493.63 and 508.89 g), fresh weight of straw per plot (80.95 and 84.95 kg), dry weight of straw per plot (24.68 and 25.45 kg), fresh weight of sepals per plant (319.36 and 336.42 g), dry weight of sepals per plant (68.67 and 70.07 g), fresh weight of sepals per plot (15.99 and 16.82 kg), dry weight of sepals per plot (3.13 and 3.51 kg), weight of seed per plant (90.83 and 97.03 g) and weight of seed per plot (4.55 and 4.85 kg) were recorded when plants were sown on 15th April and treated with the mixed organic fertilizer in the first and second seasons; respectively.

Table (4). Effect of planting dates, organic fertilizer and their interaction on fresh and dry weights of whole plant; straw and sepals per plant (g) of *Hibiscus sabdariffa* L. plant in 2013 and 2014 seasons.

Planting dates (A)	Organic fertilizer (B)									
	Control	C.M.	Comp.	M.O.F.	Mean (B)	Control	C.M.	Comp.	M.O.F.	Mean (B)
	Season 1 (2013)					Season 2 (2014)				
	Fresh weight of whole plant (g)									
15th April	1156.90	1649.00	1944.90	2462.10	1803.20	1273.70	1800.00	2146.70	2716.70	1984.30
1st May	1238.70	1515.50	1873.70	2235.70	1715.90	1345.00	1666.70	2033.30	2499.70	1886.20
15th May	1016.40	1058.50	1508.80	2072.20	1414.00	1103.70	1150.00	1646.70	2256.70	1539.30
Mean (A)	1137.40	1407.70	1775.80	2256.60			1538.90	1942.20	2491.00	
L.S.D. at 5%	A: 50.44		B: 95.19	AB: 150.97		A: 55.20		B: 108.01	AB: 170.67	
	Dry weight of whole plant (g)									
15th April	335.51	478.20	564.03	714.00	522.94	366.67	526.67	620.00	786.67	575.00
1st May	359.23	439.49	543.37	648.35	497.61	384.67	479.00	600.00	713.33	544.25
15th May	294.75	306.96	437.56	600.92	410.05	308.00	332.67	483.00	663.33	446.75
Mean (A)	329.83	408.22	514.99	654.42		353.11	446.11	567.67	721.11	
L.S.D. at 5%	A: 14.63		B: 27.60	AB: 43.78		A: 14.36		B: 31.68	AB: 49.53	
	Fresh weight of straw per plant (g)									
15th April	748.00	1077.50	1270.30	1618.90	1178.70	774.20	1137.30	1383.80	1695.70	1247.80
1st May	791.50	966.60	1208.70	1444.20	1102.70	823.80	1043.50	1210.30	1455.40	1133.20
15th May	654.40	679.30	972.40	1324.80	907.70	673.10	699.20	981.80	1370.30	931.10
Mean (A)	731.30	907.80	1150.50	1462.60		757.00	960.00	1192.00	1507.1.	
L.S.D. at 5%	A: 39.05		B: 65.24	AB: 104.98		A: 66.25		B: 71.84	AB: 125.66	
	Dry weight of straw per plant (g)									
15th April	214.37	311.20	361.20	493.63	345.10	231.90	337.13	380.76	508.89	364.67
1st May	227.17	282.30	342.90	418.23	317.65	252.12	308.77	377.47	457.57	348.98
15th May	187.03	194.47	278.20	384.47	261.04	205.40	211.98	303.59	420.50	285.37
Mean (A)	209.52	262.66	327.43	432.11		229.81	285.96	353.94	462.32	
L.S.D. at 5%	A: 15.00		B: 19.11	AB: 32.18		A: 12.32		B: 21.88	AB: 34.94	
	Fresh weight of sepals per plant (g)									
15th April	185.33	230.33	254.43	319.63	247.43	198.26	234.87	264.40	336.42	258.49
1st May	142.97	183.13	221.44	276.67	206.05	153.32	197.23	243.83	279.90	218.57
15th May	98.42	150.28	194.72	252.07	173.87	103.65	158.73	203.85	259.13	181.34
Mean (A)	142.24	187.91	223.53	282.79		151.74	196.94	237.36	291.82	
L.S.D. at 5%	A: 8.02		B: 6.85	AB: 12.93		A: 10.00		B: 6.11	AB: 13.43	
	Dry weight of sepals per plant (g)									
15th April	36.33	45.83	50.67	68.67	50.38	41.50	49.27	55.27	70.07	54.03
1st May	28.23	34.97	44.03	57.67	41.23	30.70	41.00	48.90	61.23	45.46
15th May	20.13	31.83	38.07	51.70	35.43	20.47	32.57	39.23	54.80	36.77
Mean (A)	28.23	37.54	44.26	59.34		30.89	40.94	47.80	62.03	
L.S.D. at 5%	A: 2.23		B: 1.82	AB: 3.50		A: 1.79		B: 1.62	AB: 2.99	

Table (5). Effect of planting dates, organic fertilizer and their interaction on fresh and dry weights of whole plant; straw and sepals per plot (kg.) of *Hibiscus sabdariffa* L. plant in 2013 and 2014 seasons.

Planting dates (A)	Organic fertilizer (B)									
	Control	C.M.	Comp.	M.O.F.	Mean (B)	Control	C.M.	Comp.	M.O.F.	Mean (B)
	Season 1 (2013)					Season 2 (2014)				
	Fresh weight of whole plant per plot (kg)									
15th April	57.85	82.45	97.25	123.10	90.16	63.68	90.00	107.33	135.83	99.21
1st May	61.94	75.77	93.68	111.78	85.79	67.25	83.33	101.67	124.98	94.31
15th May	50.82	52.92	75.44	103.61	70.70	55.18	57.50	82.33	112.83	76.96
Mean (A)	56.87	70.38	88.79	112.83	56.87	62.04	76.94	97.11	124.55	
L.S.D. at 5%	A: 2.52		B: 4.75		AB: 7.54	A: 2.76		B: 5.40		AB: 8.53
	Dry weight of whole plant per plot (kg)									
15th April	16.78	23.91	28.20	35.70	26.15	18.33	26.33	31.00	39.33	28.75
1st May	17.96	21.97	27.17	32.42	24.88	19.23	23.95	30.00	35.67	27.21
15th May	14.74	15.35	21.88	30.05	20.50	15.40	16.63	24.15	33.17	22.34
Mean (A)	16.49	20.41	25.75	32.72		17.66	22.31	28.38	36.06	
L.S.D. at 5%	A: 0.73		B: 1.37		AB: 2.18	A: 0.72		B: 1.58		AB: 2.47
	Fresh weight of straw per plot (kg)									
15th April	37.41	53.88	63.52	80.95	58.94	38.71	56.87	69.19	84.79	62.39
1st May	39.58	48.33	60.43	72.21	55.14	41.19	52.17	60.51	72.77	56.66
15th May	32.73	33.96	48.62	66.24	45.39	33.66	34.96	49.10	68.52	46.56
Mean (A)	36.57	45.39	57.524	73.132		37.854	48.002	59.6	75.359	
L.S.D. at 5%	A: 1.95		B:3.26		AB: 5.24	A: 3.31		B: 3.59		AB: 6.28
	Dry weight of straw per plot (kg)									
15th April	10.72	15.56	18.06	24.68	17.26	11.60	16.86	19.04	25.45	18.23
1st May	11.36	14.12	17.15	20.91	15.88	12.61	15.44	18.87	22.88	17.45
15th May	9.35	9.73	13.91	19.23	13.06	10.27	10.60	15.18	21.03	14.27
Mean (A)	10.478	13.13	16.374	21.608		11.491	14.299	17.697	23.119	
L.S.D. at 5%	A: 0.74		B: 0.95		AB: 1.61	A: 0.61		B: 1.09		AB: 1.74
	Fresh weight of sepals per plot (kg)									
15th April	9.27	11.52	12.72	15.99	12.37	9.91	11.75	13.22	16.82	12.93
1st May	7.15	9.16	11.07	13.83	10.30	7.67	9.86	12.19	14.00	10.93
15th May	4.92	7.52	9.74	12.61	8.70	5.18	7.94	10.20	12.96	9.07
Mean (A)	7.11	9.40	11.18	14.14		7.59	9.85	11.87	14.59	
L.S.D. at 5%	A: 0.40		B: 0.34		AB: 0.64	A: 0.49		B: 0.36		AB: 0.67
	Dry weight of sepals per plot (kg)									
15th April	1.82	2.29	2.53	3.43	2.52	2.08	2.47	2.77	3.51	2.70
1st May	1.41	1.75	2.20	2.88	2.06	1.54	2.05	2.45	3.07	2.28
15th May	1.01	1.59	1.90	2.59	1.77	1.03	1.63	1.96	2.74	1.84
Mean (A)	1.41	1.88	2.21	2.97		1.55	2.05	2.39	3.10	
L.S.D. at 5%	A: 0.11		B: 0.09		AB: 0.17	A: 0.08		B: 0.08		AB: 0.14

Cultivating plants on 15th April and treatment with mixed organic fertilizer increased vegetative growth parameters, followed by 15th April with compost and then 15thApril with cattle manure, and this increase was significant. The planting date on 15thApril with cattle manure and then 15th April without fertilizer and 1st May with mixed organic fertilizer increased the vegetative growth parameters, but this increase was insignificant in the first and second seasons; respectively. This effect might be due to that mixture (compost and cattle manure) had some macro and micronutrients, which enhanced plant growth (Amine-Khodja et al., 2006). Also organic fertilizers may contain many species of living organisms, which release phytohormones; such as GA_3, IAA and CYT, which stimulate plant growth, nutrient absorption and photosynthesis and this is reflected on plant dry matter accumulation.

2. Chemical Ingredients

2.1. Effect of planting dates

Data presented in table (6), reveal that, the chemical ingredients; such as total acidity percentage, anthocyanin percentage (mg/100 g) and fixed oil seed content were significantly different with the different planting dates. The highest values of these parameters were pertinent to the early planting date (15th April). Similar trend was recorded by Nnebue et al. (2014), Ado et al. (2015), Futuless et al. (2010) and Seghatoleslami et al. (2013) on roselle plants.

The increment in the anthocyanin could be attributed to not only high sepals yield per plant, but also the response of relatively high percentage in the sepals as a result of early planting date. This results are in line with those reported by Sudeep et al. (2005); Ayub et al. (2008) on *Foeniculum vulgare*; Sree and Reddy (2004); Gahannavard et al. (2009) on *Ricinus communis* and Seghatoleslami and Mousavi (2009) on *Calendula officinalis.*

Table (6). Effect of planting dates, organic fertilizer and their interaction on seed weight per plant (g) and per plot, anthocyanin content (mg/100 g) and total acidity percentage of *Hibiscus sabdariffa* plant in 2013 and 2014 seasons.

Planting dates (A)	Organic fertilizer (B)									
	Control	C.M.	Comp.	M.O.F.	Mean (B)	Control	C.M.	Comp.	M.O.F.	Mean (B)
	Season 1 (2013)					Season 2 (2014)				
	Seeds weight per plant (g)									
15th April	50.57	70.03	73.63	90.83	71.27	52.63	70.80	74.97	97.03	73.86
1st May	39.73	57.83	64.57	81.50	60.91	42.20	59.63	65.20	85.50	63.13
15th May	22.70	52.67	57.83	76.27	52.37	24.17	55.03	60.17	77.43	54.20
Mean (A)	37.67	60.18	65.34	82.87		39.67	61.82	66.78	86.66	
L.S.D. at 5%	A: 1.34		B: 2.26		AB: 3.64	A: 2.38		B: 2.67		AB: 4.63
	Seeds weight per plot (kg)									
15th April	2.53	3.51	3.68	4.55	3.57	2.63	3.54	3.75	4.85	3.69
1st May	1.99	2.89	3.23	4.08	3.05	2.11	2.98	3.26	4.28	3.16
15th May	1.14	2.64	2.90	3.81	2.62	1.21	2.76	3.01	3.87	2.71
Mean (A)	1.89	3.01	3.27	4.15		1.99	3.09	3.34	4.33	
L.S.D. at 5%	A: 0.06		B: 0.11		AB: 0.18	A: 0.11		B: 0.13		AB: 0.23
	Fixed oil percentage									
15th April	19.19	20.19	21.30	25.25	21.48	19.27	20.33	21.35	25.67	21.65
1st May	17.86	18.73	20.14	24.18	20.23	16.57	18.77	20.25	24.20	19.95
15th May	15.01	16.04	17.71	23.03	17.95	15.13	16.13	17.77	23.05	18.02
Mean (A)	17.353	18.32	19.72	24.15		16.99	18.41	19.79	24.30	
L.S.D. at 5%	A: 0.73		B: 0.43		AB: 0.97	A: 0.86		B: 0.67		AB: 1.31
	Anthocyanin content (mg/100 g)									
15th April	345.00	448.33	489.33	569.00	462.92	347.13	450.13	492.80	574.53	466.15
1st May	325.67	398.00	425.67	543.00	423.08	327.90	402.00	427.40	543.57	425.22
15th May	287.70	301.00	384.33	500.00	368.26	289.00	302.93	385.70	503.47	370.28
Mean (A)	319.46	382.44	433.11	537.33		321.34	385.02	435.30	540.52	
L.S.D. at 5%	A: 3.00		B: 3.25		AB: 5.69	A: 2.86		B: 3.26		AB: 5.62
	Total acidity percentage									
15th April	11.43	12.12	12.70	14.26	12.63	11.44	12.14	12.73	14.28	12.65
1st May	11.07	12.06	13.32	13.62	12.52	11.09	12.06	13.33	13.63	12.53
15th May	10.68	11.08	12.46	13.42	11.91	10.69	11.09	12.48	13.10	11.84
Mean (A)	11.06	11.75	12.83	13.77		11.08	11.76	12.85	13.67	
L.S.D. at 5%	A: 0.06		B: 0.07		AB: 0.12	A: 0.22		B: 0.19		AB: 0.35

2.2. Effect of organic fertilizers

Regarding the chemical ingredients determination such as total acidity percentage, anthocyanin percentage (mg/100 g) and fixed oil seed content as affected by organic fertilizers treatments from data reported in table (6), it was found that, treated plants with organic fertilizers resulted in significant increase in these characters compared with untreated plants (control). The treatment of mixed organic fertilizer recorded the significant increase in both seasons, respectively. These results are in line with those reported by Biasi et al. (2009) on *Ocimum basilicum* and Amer (2008) on *Dracocephalum moldavica*.

2.3. Effect of the interaction

Among the different interaction treatments between the different planting dates and organic fertilizers, the treatment of sowing in 15th April and treatment with mixed organic fertilizer gave the highest total anthocyanin (569.00 and 574.53 mg/100 g), total acidity (14.25 and 14.28%) and fixed oil seed content (25.25 and 25.67%) during in the first and second seasons, respectively, as shown in table (6).

Planting date on 15thApril with mixed organic fertilizer, followed by 15th April with compost and 15th April without fertilization showed an increase in the total acidity and fixed oil seed content and the increase was significant. However the plant cultivation in 15th April with mixed organic fertilizer increased total anthocyanin, followed by 15th April with compost, then15th April with cattle manure, and this increase was significant in both seasons (2013 and 2014). The treatment of 15th April without fertilization followed by 1st May with mixed organic fertilizer increased the total acidity and fixed oil seed content, but this increase was insignificant.

3. Chemical Constituents

3.1. Effect of planting dates

Data presented in table (7) show that, nitrogen, phosphorus, potassium and total carbohydrates percentages were significantly different at planting date of 15th April, which gave the highest values of these characters compared with other planting dates. The increment in the NPK and total carbohydrates content as a result of early planting was probably due to the fact that the earliest planted plants had comparatively more time for their vegetative growth and consequently, the absorbency of these elements was increased so, the percentages of these elements can be increased.

This result is in harmony with those obtained by Nagabhushanam and Raghavaiah (2005), Rezvani et al. (2008) on *Ricinus communis*, Futuless et al. (2010), Ado et al. (2015) on *Hibiscus sabdariffa*, Sanjeet et al. (2010), El-Khayat and Gouda (2005) and Abd El-Wahab and Mehasen (2009) on *Foeniculum vulgare*.

Table (7). Effect of planting dates, organic fertilizer and their interaction on nitrogen, phosphorus, potassium and total carbohydrate percentage of *Hibiscus sabdariffa* plant in 2013 and 2014 seasons.

Planting date (A)	Organic fertilizer (B)									
	Control	C.M.	Comp.	M.O.F.	Mean (B)	Control	C.M.	Comp.	M.O.F.	Mean (B)
	Season 1 (2013)					Season 2 (2014)				
	Nitrogen percentage									
15th April	3.43	3.67	4.04	4.84	4.00	3.45	3.69	4.06	4.90	4.03
1st May	3.17	2.96	3.74	4.38	3.56	3.18	2.97	3.75	4.40	3.58
15th May	1.96	2.43	3.07	4.08	2.89	1.98	2.45	3.10	4.10	2.91
Mean (A)	2.86	3.02	3.62	4.44		2.87	3.04	3.64	4.47	
L.S.D. at 5%	A: 0.04		B: 0.04	AB: 0.08		A: 0.06		B: 0.03	AB: 0.08	
	Phosphorus percentage									
15th April	0.066	0.496	0.879	1.180	0.655	0.073	0.513	0.903	1.254	0.686
1st May	0.037	0.361	0.769	0.996	0.541	0.042	0.396	0.786	1.020	0.561
15th May	0.048	0.117	0.580	0.868	0.403	0.065	0.124	0.610	0.899	0.424
Mean (A)	0.050	0.325	0.743	1.015		0.060	0.344	0.766	1.057	
L.S.D. at 5%	A: 0.069		B: 0.067	AB: 0.121		A: 0.062		B: 0.071	AB: 0.123	
	Potassium percentage									
15th April	1.94	2.45	3.36	4.32	3.02	2.02	2.60	3.63	4.61	3.21
1st May	2.02	2.49	2.93	3.82	2.81	2.08	2.60	3.15	4.20	3.01
15th May	1.76	2.16	2.68	3.38	2.50	1.78	2.18	2.79	3.49	2.56
Mean (A)	1.91	2.36	2.99	3.84		1.96	2.46	3.19	4.10	
L.S.D. at 5%	A: 0.18		B: 0.25	AB: 0.42		A: 0.19		B: 0.27	AB: 0.44	
	Total carbohydrates percentage									
15th April	17.85	18.43	19.25	22.23	19.44	17.87	18.43	19.25	22.64	19.55
1st May	17.15	17.62	18.98	20.83	18.65	17.17	17.64	19.02	20.86	18.67
15th May	16.12	17.12	18.21	19.43	17.72	16.13	17.10	18.22	19.44	17.72
Mean(A)	17.04	17.73	18.81	20.83		17.06	17.72	18.83	20.98	
L.S.D. at 5%	A: 0.05		B: 0.06	AB: 0.010		A: 0.10		B: 0.14	AB: 0.24	

3.2. Effect of organic fertilizers

Results presented in table (7) declare that, total carbohydrates, nitrogen, phosphorus and potassium percentages were significantly increased when plants were treated with organic fertilizers compared to untreated plants. The highest values of all these characters were obtained when mixed organic fertilizer was applied during both seasons. Similar results were reported by Khalil and El-Sherbeny (2003) on *Mentha* species, El-Sherbeny et al. (2007) on *Ruta graveolens* and Shaalan (2005) on *Borage officinalis*.

Organic fertilizer is the source of N and other nutrients for plants (such as phosphorus, potassium, calcium,, iron, zinc and copper) that can make valuable contributions to soil organic matter, can improve physical

fertility, and is a center for biological activities as reported by Khalid and Shafei (2005) on *Anethum graveolens*.

3.3. Effect of the interaction

The combined effect between different planting dates and organic fertilizers (Table, 7) show that, the highest values of total carbohydrate percentage (22.23 and 22.64%), nitrogen percentages (4.84 and 4.90%), phosphorus percentages (0.400 and 0.402%) and potassium percentages (4.69 and 5.16%) were recorded when plants were sown on 15th April and supplied with mixed organic fertilizer during both seasons; respectively.

The beneficial effect of different organic fertilizers on the chemical constituents may be due to the role of macro and micro nutrients provided by these fertilizers, which stimulate the metabolic processes and photosynthetic apparatus that leads to more photosynthesis and carbohydrate synthesis. The beneficial effect of organic fertilizer on chemical composition were observed by Hussein et al. (2006) on *Dracocephalum moldavica* and El-Sherbeny et al. (2005) on *Sideritis montana*.

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تأثير مواعيد الزراعة المختلفة والمعاملة بالأسمدة العضوية على نمو وإنتاجية نباتات الكركديه

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أجريت هذه الدراسة في محطة بحوث القنطرة شرق التابعة لمركز بحوث الصحراء خلال عامين متتاليين ٢٠١٤ و٢٠١٥ لدراسة تأثير مواعيد الزراعة المختلفة (١٥/ابريل، أول مايو، ١٥/مايو) والتسميد العضوي (كنترول، ١٥ م٣ / فدان سماد الماشية، ١٥ م٣ / فدان كمبوست، خليط من السماد العضوي {سماد الماشية والكمبوست}) والتفاعل بينهما على النمو والمحصول والمكونات الفعالة لنبات الكركديه.

أدت الزراعة المبكرة في ١٥ أبريل إلى زيادة كبيرة في جميع صفات النمو، في حين تأخير مواعيد الزراعة انخفضت في كلا الموسمين. إن إستخدام الأسمدة العضوية أنتج أعلى قيم في جميع صفات النمو خلال الموسمين، في حين أعطت المعاملة بالأسمدة العضوية مختلطة زيادة كبيرة في صفات النمو الخضري والمكونات الفعالة والكيميائية. أشار التفاعل بين مواعيد الزراعة والتسميد العضوي، إن زرعة النباتات في ١٥/ ابريل مع إضافة خليط من السماد العضوي أدى إلى زيادة معنوية كبيرة في معظم الصفات المدروسة، كذلك أعطت هذه المعاملة إلى زيادة في محصول السبلات للنبات والفدان، العائد من البذور في النبات والفدان، ومحتوى الأنثوسيانين ومحتوى الزيت الثابت في البذور مقارنة بالمعاملات الأخرى.