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Inducing early flowering in roselle (*Hibiscus sabdariffa* L.) plants by organic acids

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ABSTRACT

The current study was conducted at the Agricultural Research Center farm at the Agricultural Research Station at Gemmayzeh, Gharbia Governorate, Egypt, during the two consecutive summer seasons 2017 and 2018, with the aim of evaluating the effect of Citric acid treatments (2 and3 g/L) and Potassium humate (2and 3g /L) on the early flowering of the hibiscus (*Hibiscus sabdariffa* L.) plant, the treatments were as follows (T1) control (spray with water) and (T2) Citric acid (2g/L) and (T3) Citric acid (3g/L), (T4)Potassium humate (2g /L), (T5) Potassium humate (3g /L), (T6) Citric acid (2g/L) +Potassium humate (2g/L) and (T7) Citric acid (2 g /L) + Potassium humate (3 g /L) and (T8) Citric acid (3g/L) +Potassium humate (2g /L) and (T9) Citric acid (3g /L) + Potassium humate (3g /L). It was found that the foliar spraying of the two acids, either alone or together, had a positive effect on all growth factors, sepals yield and oil. The interaction treatments were better than the solo treatments and the best of them was the ninth treatment which is Citric acid (3 g/L) + Potassium humate (3g /L), which gave the best results in early flowering and most of the growth and production characteristics of sepals, seeds, oil yield and Vitamin C. Therefore, it is recommended to use a mixture between Citric acid and Potassium humate for early flowering, harvesting and drying before Winter season.

Therefore, the main goal of this study to elucidate the effect of foliar spraying with organic acids such as Citric acid and Potassium humate on the early flowering, growth factors, sepals yield and oil of the hibiscus (*Hibiscus sabdariffa* L.) plant.

Keywords: *Hibiscus sabdariffa* L., Citric acid, Potassium humate, early flowering, Anthocyanins

INTRODUCTION

Medicinal plants are used for treating many disorders that are either non-curable or rarely cured by modern systems of medicine Abadi *et al*. (2015). Roselle plants (*Hibiscus sabdariffa* L.) belong to the family Malvaceae, known commonly as "karkade" in Egypt and most Arab countries Mohamed *et al.* (2007). The part of the flower used by customers is the dried and fleshly calyces which have large quantities of organic acids (that is, oxalic, malic, citric and tartaric acids). The calyces have, also, vitamin C and the properties of therapeutic and diuretic acids, in addition to two types of anthocyanins, namely: hibiscin (delphinidin) and gossyptin (cyanidin) Wong *et al.*, (2002). Shamkhi, (2012) Its leaf juice reduces high blood pressure, strengthens the heart's, reduces blood viscosity and calmness, and is rich in vitamins C, A and B, calcium, iron, phosphorous, anthocyanins, Thiocene, and repo flavin, It should be noted that roselle tea helps in the process of digestion and works where an anti-rotten stomach and anantiseptic for microbes. in addition to its other uses where it is a drink that reduces the high temperatures in the body and includes candy making Louis *et al*. (2013).

Mandour *et al*. (2019) on strawberry plants showed that, spraying strawberry plants with CaCl2 at 20 ml/l, amino acids at 10 ml/l, Citric Acid at 2g/l increased yield, yield components and decreased incidence and severity of gray mould disease compared to control. Haggag *et al.* (2016) on "Canino" Apricot Trees studied, the effect of foliar sprays with active dry yeast at the concentration of 0.1%, 0.2, 0.3% and "mega power-x" as liquid organic fertilizer (19% Humic acid, 5% Free amino acids, 2% Fulvic acid, 2% Citric Acid, 2% potassium citrate and some chelated micro-elements) at concentrations 0.5, 1.0 and 1.5cm/L on yield, fruit quality and all the studied characters were improved by different treatments used than the control. Citric acid (CA) is a six-carbon organic acid, having a cen- tral role in CA cycle in mitochondria that creates cellular energy by phosphorylative oxidation reactions. It is created by addition of acetyl-CoA to oxaloacetic acid that is converted to succinate and malate in next steps Wills *et al.* (1981). The positive effect of pre-harvest Citric Acid sprays on postharvest longevity of cut flowers is first reported recently on tuberose Eidyan (2010) on tuberose (*Polianthes tuberose* L.) plants. Later studies revealed that the CA effect is not just due to Ph change and there are a variety of physiological responses to applied CA. Use of CA alone or in combinations with SA and malic acid increased the essential oil production of sweet basil plants Jafari and Hadavi (2012) on basil (*Ocimum basilicum* L.) plants and Jafari and Hadavi (2012) on dill (*Anethum graveolens* L.) plants. Foliar pre-harvest application of the combinations of SA and CA in the soilless culture increased the vase life of cut rose flowers Hajreza *et al.* (2013). A recent study on sweet basil revealed that the combination of 1mM SA with 7 mM CA was superior to others in many physiological traits and yield Mirzajani (2013) on sweet basil plants**.**

Potassium humate can be used as a non-expensive source for potassium and it could be used as soil dressing, drenching or foliar applications. In addition, humic acid (HA) is one of the major components of humus. Application of (HA) has several benefits and agriculturists all over the world are accepting HA as an integral part of their fertilizer program. Mahmoud and Youssif (2015) on garlic (*Allium sativum* L.) plants. Humic acid is an organic substance naturally occurring in soils, coal and peat which results from the decomposition of organic matter, particularly the dead plants El-Ghamry *et al.* (2009) on faba bean plants. Abd EL-Kader (2016) on wheat plants studied that, the effect of organic acids and N-mineral fertilizers as well as their combination, on some soil properties, yield and nutrient uptake of wheat (*Triticum aestivum* L.) plants. The results presented in this work showed that, the combined effect of urea and organic acid gave better results in increasing the yield of wheat especially. when nitrogen fertilizers coated with humic acid and applied to the soil as it increases the yield by 2.56% and 10.21% in the first and second season, respectively relative to urea alone. The combination of N-mineral and organic acids can be considered as an integrated nutrient management to improve the soil fertility and wheat yield. Also, Denre *et al*. (2014) on garlic bulbs found that humic acid promotes the conservation of mineral nutritions in the cloves of garlic bulb. High N and P content were also observed in the treatments having foliar applied humic acid. Mohammad *et al.* (2016) on potato plants. In addition, spraying sweet pepper plants with Potassium humate at a rate of 4 gm/L markedly improving plant growth parameters, yield and quality of sweet pepper plant and increased plant chemical composition El-Bassiony *et al*. (2010). Also, humic acid has positive effects on the promotion of root development. Potassium humate increases production and quality of a crop, plant tolerance to drought stress, salinity, heat, cold, disease and pests Ajalli *et al.* (2013) on potato plants. Also, humate highly beneficial for both plant and soil; it maintains proper plant growth as well as it increases nutrient uptake, tolerance to drought and availability of soil nutrients particularly in calcareous soil and low organic matter of soil Ismail *et al.* (2007). Therefore, applying biofertilizers such as Humic acids (HA) which considered the main fractions of humic substances (HS) and the most active components of soil and compost organic matter Ferrara and Brunetti (2010) on grape *(Vitis vinifera* L.) seedless, could be useful for increasing the productivity and quality of superior seedless grape. HA have been shown to stimulate plant growth and consequently yield by acting on mechanisms involved in: cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities Aseri *et al.* (2008) on pomegranate (*Punica granatum* L.). There is a study on mango trees mentioned that, humic acid (HA) and boric acid (BA) effects on plant morphological, physiological, biochemical, and genetic processes, which ultimately affect plant growth, yield, and fruit quality El-Hoseiny *et al.* (2020) on mango trees. Mohamed and Ghatas (2020) on chia plants, illustrated that, the combinations of humic acid at 5m/l with Zn at 200 ppm could be used to improve growth, seeds yield, chemical constituents, fixed oil productivity and fixed oil constituents of chia (*Salvia hispanica* L.) plant. Hamad and Tantawy (2018) on sorghum plants, used three humic acids isolated from different sources, i.e., clayey soil (HAS); podrite (HAP) and compost (HAC) were used. Each HA was applied at rates of 0, 25, 50, 75 and 100 mg kg-1 refined sand. Either of Ca or Fe was added as acetate form (CH3COO) at rates of 0, 25, 50 and 100 mg kg-1 refined sand. The experimental design was a split-split plot design with three replicates. Results showed that, applications of each three HA individually and in combination with Ca or Fe were associated by a significant increase of dry weights of shoots and roots of sorghum plants. The highest dry weights were found in the plants treated by HAC. Abdelgawad *et al.* (2018) on lettuce plants said, super biomin affected positively total yield, the head height, head diameter, fresh weight, TSS% parameters, total yield (ton/feddan) and yield kg /m2 of the lettuce plants were obtained from the plants treated with Super biomin compared with control. While, ascopin treatments were significantly increased by spraying lettuce plants as compared with control plants in both seasons in all vegetative growth parameters. Abdel-Salam (2016) on ruby seedless grapevine studied, the effect of humic acid, ascorbic acid and citric acid used either separately or in combination form on physical and chemical properties of Ruby seedless grapevine. This research proved that, the foliar application had ability to increase and improve physical and chemical properties of Ruby seedless grapevine cultivar. In addition, the important of use them is a promising natural resource that can be used as an alternative to synthetic fertilizers for increasing crop production and reducing of chemical fertilizers application and hence reducing both of the environmental pollution and the fertilizers cost. Discussion recommended that, the treatment which includes the combination of humic acid, ascorbic acid and citric acid reached to the best increment of quality and improvement when used as a foliar application where it is more advantage than soil application because of rapid response and effectiveness.

MATERIALS AND METHODS

This work was carried out at Farm of Agricultural Research Center in Gemmeiza Agricultural Research Station, El- Gharbia Governorate during the two consecutive summer seasons of 2017 and 2018.

Field preparation:

Field was ploughed two times as cross-ploughing to remove the remains of the previous crops. The field was divided to experimental plots, The area of the experimental unit was 2.16 m^2 (1.2m length and 0.60 m width.), each plot contained 3 rows, the distance between hills was 30 cm, every hill contained 2 plants and each plot contained from 25 to 30 plants. These treatments were distributed in a randomized complete blocks design system with three replications.

The treatments were:

- (T1). Control spraying with tap water (Con.)
- (T2). Citric acid at concentration (2g/L).
- (T3). Citric acid at concentration (3g/L).
- (T4). K humate at concentration (2g/L).
- (T5). K humate at concentration (3g/L).
- (T6). Citric acid at concentration (2g/L)+ K humate (2g/L).

- (T7). Citric acid at concentration (2g/L)+ K humate (3g/L).
- (T8). Citric acid at concentration (3g/L)+ K humate (2g/L).
- (T9. Citric acid at concentration (3g/L)+ K humate (3g/L).

Sowing:

Seeds of roselle (*Hibiscus sabdariffa* L.) were obtained from the Medicinal and Aromatic Plants Section of Agricultural Research Center, El-Dokki, Cairo, Egypt. The hibiscus cultivar used in the experiment was the Sabahiya cultivar 1. Seeds were planted on 14th of May and during the two seasons studied respectively.

Table 1. Physical and chemical properties of experimental farm soil (average of two seasons)

Mechanical analysis												**Soil texture**
Clay (%)		**Silt (%)**	**SP (saturation %)**			**ρb (Mg m^{-3})**						**Clayey**
51.14		37.17	68.00			1.12						
Chemical analysis												
pH	E C m.mohs/cm	OM (%)	Soluble cations (meq. / l)				Soluble anions (meq. / l)			Available (ppm)		
			Mg^{++}	Ca^{++}	K^{+}	Na^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}			K
7.95	0.55	0.74	0.90	1.70	0.80	2.48	3.29	0.23	1.89			0.80

This experiment included 9 treatments, which were the roselle plants were sprayed with Citric Acid (2 g and 3 g/L) and (K humate) Potassium humate (2 g and 3 g/L)solo and mixed, except for control treatment twice times by at 60 and 90 days from planting. In addition, control treatment was sprayed with tap water and wetting agent. Potassium humate granule contains of (potassium humate 85% + K2O 8% + fulvic acid 3%) and the source of potassium humate were from Al-Gomhoria Chemicals Company Egyptian Company for Chemicals, Egypt.

Fertilization:

The recommended amounts of mineral N, P and K fertilizers for Roselle (*Hibiscus sabdariffa* L.) plants were applied to all experimental units as soil application 163kg/ fedd. of ammonium nitrate (% 20,5), 150kg/ fedd. calcium superphosphate (15.5 % P_2O_5) and 75 kg/ fedd. Potassium sulphate (48% K2O) were used as sources of N, P and K, respectively.

Data recorded:

The first flowers in the experiment were in the treatment of citric acid (3 g /L) + Potassium humate (3 g/L) and the age of the plants were approximately 120 days, followed by the treatments of Citric acid (3 g/L) + Potassium humate (2 g/L) and treatment of Citric acid (3 g/L) alone, plant harvesting in two stages and between them a difference 8 days. At harvesting stage of roselle (*Hibiscus sabdariffa* L.) plants were plant height (cm), number of branchs /plant, number of fruits /plant, fresh weight of fruits (gm) /plant, fresh weight of sepals (gm) /plant, dry weight of sepals (gm) /plant, fresh weight of sepals (Kg/fedd.), dry weight of sepals (Kg/fedd.), weight of 100 seeds (gm), weight of seeds (gm)/plant, weight of seeds (Kg/fedd.), fixed oil_%, oil /plant ml/Plant, weight of oil L/fedd., total carbohydrate % in sepals, anthocyanin content (µM) and Vitamin C mg/100g. A sample of sepals of roselle were randomly taken from each treatment for chemical analysis. The fixed oil contents of seeds were estimated as described by Munshi *et al.* (1987). Powder of each sample was extract using a solvent hexan. Fixed oil is made volatile by converting them in to methyl ester. Also, total carbohydrate percentage of roselle was determined according to the methods described by A.O.A.C. (2000).

Statistical analysis:

Data of the present study were statically analyzed and the differences between were considered significant when they were more than or equal to the least significant differences (L.S.D) at the 5% level by using computer program of Statistix Version 9 (Analytical Software, 2008).

RESULTS AND DISCUSSION

1.1 EFFECT OF CITRIC ACID AND POTASSIUM HUMATE ON ROSELLE (*HIBISCUS SABDRIFFA* L.) PLANTS ON VEGETATIVE GROWTH PARAMETERS:

It is quite clear from the data in Table (2) and Fig. (1) that all treatments had significantly higher compared to control on all tested vegetative growth measurements i.e. plant height (cm), number of branches/plant, number of fruits/plant and fresh weight of fruits (gm)/plant during the two seasons were the highest values from(T3) Citric acid (3g/L) on plant height (cm), number of branches/plant were (244.00 and 244.99 cm) for plant height and (12.33 and 13.32) for number of branches/plant respectively and followed (T9) Citric acid (3g/L)+ K humate (3g/L). These results agreed with those obtained by Eidyan (2010) who found on tuberose (*Polianthes tuberosa* L.) plants and Jafari and Hadavi (2012) on dill plants. Treatment of (T9) Citric acid (3g/L)+ K humate (3g/L) recorded the best results with both number of branches and Fresh weight of fruits (gm)/plant were (92.00 and 94.17) for number of fruits/plant and (1300 and 1307) for Fresh weight of fruits (gm)/plant respectively and followed

(T8) Citric acid (3g/L)+ K humate (2g/L). These results agreed with those obtained by Haggag *et al.* (2016) who found on Canino" Apricot Trees and Mandour *et al*. (2019) on strawberry plants.

Table (2) Effect of Citric acid and Potassium humate on vegetative growth parameters for roselle (*hibiscus sabdriffa* L.*)* plants in the two seasons of 2017 and 2018.

Treatments	Plant Height (cm)		Number of branches /plant		Number of fruits /plant		Fresh weight of fruits (gm) /plant	
	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018
(Con.) with tap water	197.83	198.82	7.835	8.83	60.99	63.15	742	749
Citric acid (2g/L)	222.84	223.82	10.830	11.82	76.17	78.34	917	924
Citric acid (3g/L)	244.00	244.99	12.33	13.32	83.00	85.17	975	982
K humate (2g/L)	216.17	217.16	9.835	10.83	67.50	69.67	817	824
K humate (3g/L)	219.83	220.82	10.000	10.99	72.00	74.17	850	857
Citric acid (2g/L)+ K humate (2g/L)	215.00	214.32	8.667	9.66	63.84	64.00	792	795
Citric acid (2g/L)+ K humate (3g/L)	215.84	211.49	9.500	10.10	65.67	65.51	817	820
Citric acid (3g/L)+ K humate (2g/L)	225.84	226.82	11.000	11.99	87.50	89.67	1175	1182
Citric acid (3g/L)+ K humate (3g/L)	242.00	242.99	11.50	12.49	92.00	94.17	1300	1307
LSD at 5%	6.707	8.615	0.573	0.691	8.113	8.607	92.4	92.5

(T1) Control (Con.),(T2) Citric acid (2g/L), (T3)Citric acid(3g/L), (T4) K humate (2g/L),(T5) K humate (3g/L), (T6)Citric acid(2g/L)+K humate(2g/L), (T7)Citric acid(2g/L)+ K humate(3g/L),(T8Citric acid(3g/L)+ K humate(2g/L),(T9)Citric acid(3g/L)+ K humate(3g/L)

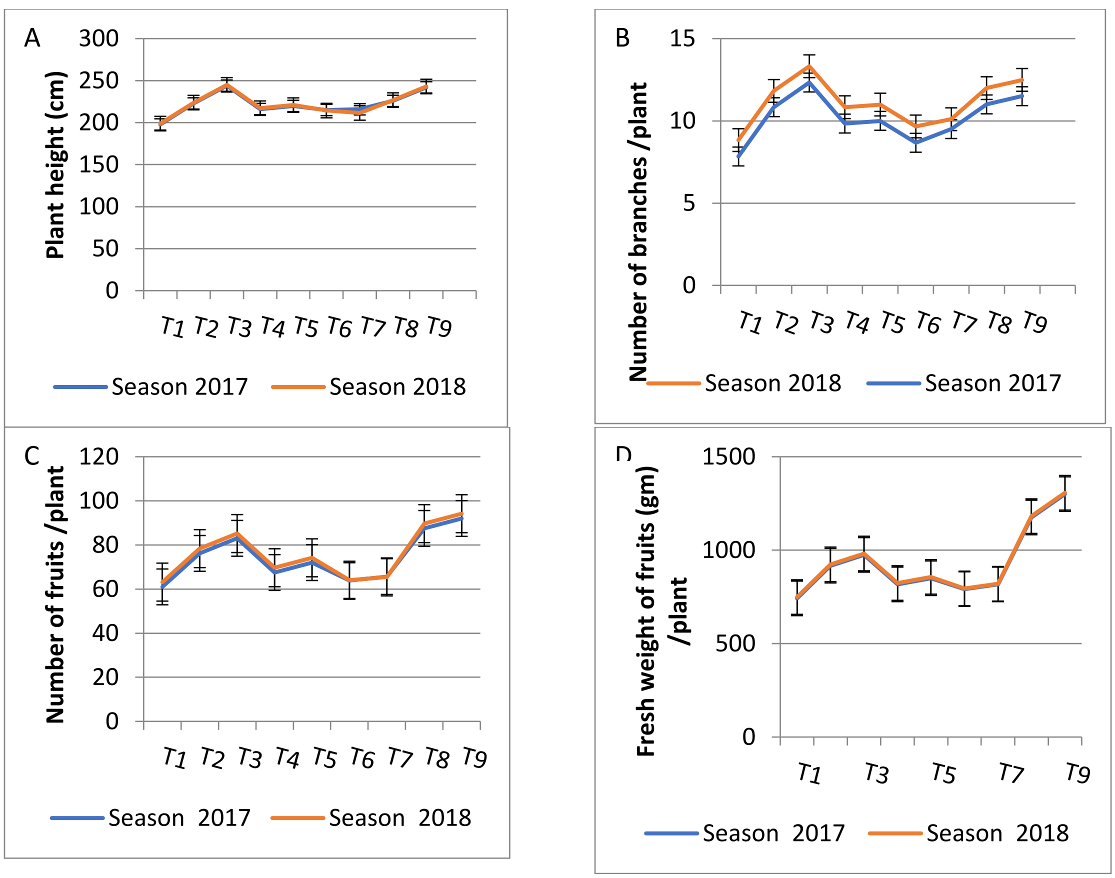

Fig.1: Effect of Citric acid and Potassium humate on vegetative growth parameters for roselle (*Hibiscus sabdriffa* L.*)* plants in the two seasons of 2017 and 2018. (A) plant height (cm), (B) Number of branchs /plantm (C) Number of fruits /plant. (D) fresh weight of fruits (gm) /plant

1.2 EFFECT OF CITRIC ACID AND POTASSIUM HUMATE FOLAIR SPRAY ON ROSELLE (*HIBISCUS SABDRIFFA* L.*)* PLANTS ONFRESH AND DRY WEIGHT OF SEPALS (GM)/PLANT /KG/FEDD.

Data presented in Table (3) showed that, all treatments had significantly higher compared to control on all tested vegetative growth measurements during the two seasons were the highest values from (T9) Citric acid (3g/L)+ K humate(3g/L) recorded the best results were (223.7 and 224.9) for fresh weight of sepals/plant (gm), (74.57 and 75.73 gm) for dry weight of sepals/plant (gm),(4971 and 4972) for fresh weight of sepals (Kg/fedd.) and (1657 and 1677 Kg/fedd.) for dry weight of sepals (Kg/fedd.) respectively and followed (T8) Citric acid (3g/L)+ K humate(2g/L). These results are supported by Abdelgawad *et al*. (2018) on lettuce plant, Abdel-Salam (2016) on ruby seedless Grapevine and Hamad and Tantawy (2018) on sorghum , Maha (2016) on Ruby Seedless Grapevine Studied, the effect of humic acid, ascorbic acid and Citric acid used either separately or in combination form on physical and chemical properties of Ruby seedless grapevine.This research proved that, the foliar application had ability to increase and improve physical and chemical properties of Ruby seedless grapevine cultivar, Malik and Tantawy (2018) on sorghum plants ,Yousry and Ghatas (2020) on chia plants and Karima *et al.* (2018) on lettuce plants.

Table (3) Effect of Citric acid and Potassium humate on fresh and dry weight of sepals (gm)/plant / kg/fedd. for roselle (*Hibiscus sabdriffa* L.*)* Plants in the two seasons of 2017 and 2018.

Treatments		Fresh Weight of sepals/plant (gm)		Dry Weight of sepals/plant (gm)		Fresh Weight of sepals (Kg/fedd.)		Dry Weight of sepals (Kg/fedd.)	
		1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018
(Con.) with tap water	T1	71.1	72.3	23.71	24.88	1580	1582	527	522
Citric acid (2g/L)	T2	142.6	143.8	47.53	48.70	3169	3170	1056	1054
Citric acid (3g/L)	T3	158.0	159.2	52.68	53.84	3511	3513	1170	1150
K humate (2g/L)	T4	129.1	130.3	43.04	44.20	2869	2870	956	944
K humate (3g/L)	T5	135.4	136.6	45.13	46.30	3009	3010	1003	1014
Citric acid (2g/L)+ K humate (2g/L)	T6	95.8	94.9	31.92	31.42	2128	2119	709	757
Citric acid (2g/L)+ K humate (3g/L)	T7	114.0	113.5	38.01	37.17	2534	2530	845	839
Citric acid (3g/L)+ K humate (2g/L)	T8	172.6	173.8	57.20	58.36	3835	3836	1271	1274
Citric acid (3g/L)+ K humate (3g/L)	T9	223.7	224.9	74.57	75.73	4971	4972	1657	1677
LSD at 5%		15.14	15.34	5.021	5.581	336.6	336.7	111.6	107.6

(T1) Control (Con.),(T2) Citric acid (2g/L), (T3)Citric acid(3g/L), (T4) K humate (2g/L),(T5) K humate (3g/L), (T6)Citric acid(2g/L)+K humate(2g/L), (T7)Citric acid(2g/L)+ K humate(3g/L),(T8Citric acid(3g/L)+ K humate(2g/L),(T9)Citric acid(3g/L)+ K humate(3g/L)

1.3 EFFECT OF CITRIC ACID AND POTASSIUM HUMATE FOLAIR SPRAY ON ROSELLE (*HIBISCUS SABDRIFFA* L.*)* PLANTS ON WEIGHT OF 100 SEEDS (GM), WEIGHT OF SEEDS /PLANT(GM) AND WEIGHT OF SEEDS (KG/FEDD.)

Regarding the effect of Citric acid and Potassium humate on data in Table (4) indicated that, the highest results were recorded in the weight of 100 seeds (gm) from the highest results were recorded on the treatment of (T3) Citric acid (3g/L). There is the highest significantly between treatments in the frist season compared to control, while there is no significant between treatments in the second season. the best results were (4.19 and 4.46gm) in both seasons respectively and followed by (T9) Citric acid (3g/L)+ K humate (3g/L) then the treatment of (T8) Citric acid (3g/L)+ K humate (2g/L). The results of the current study are in agreement with those of Nosser (2011) on (*Vicia faba* L.) plants mentioned that, this increase may be due to the content of those materials of ascorbic acid, Citric acid and Thomson *et al.* (2017) on garden pea plants strated that, the effect of Citric acid and ascorbic acid. Vitamin C (ascorbic acid) pits as coenzyme reaction by which polysccharaide, fats and protein. Ascorbic acid is an abundant material of plants. It participates in a variety of processes including photosynthesis, cell wall development and cell expansion. Eidyan (2010) on tuberose (*Polianthes tuberosa* L.).There is the highest significantly compared to control between treatments in both of weight of seeds/plant (gm) and weight of seeds (kg/fedd.) in both seasons, were the highest values from (T9) Citric acid (3g/L)+ K humate (3g/L) recorded the best results were (104.2 and 105.3 gm) for weight of seeds/plant and (2315 and 2322 kg) for weight of seeds (kg/fedd.) respectively and followed by (T8) Citric acid (3g/L)+ K humate (2g/L), then the treatment of (T3) Citric acid (3g/L). The former results were proved by Hamad and Tantawy (2018) on sorghum plants, Mohamed and Ghatas (2020) on chia plants, El-Hoseiny *et al.* (2020) on mango trees and Abd EL-Kader (2016) on wheat plants., Maha (2016) on Ruby Seedless Grapevine Studied, the effect of humic acid, ascorbic acid and Citric acid used either separately or in combination form on physical and chemical properties of Ruby seedless grapevine. This research proved that, the foliar application had ability to increase and improve physical and chemical properties of Ruby seedless grapevine cultivar. Malik and Tantawy (2018) on sorghum plants. Yousry and Ghatas (2020) on chia plants and Karima *et al.* (2018) on lettuce plants.

Table (4) Effect of Citric acid and Potassium humate on weight of 100 seeds (gm), weight of seeds/plant (gm) and weight of seeds (kg/fedd.) for roselle (*Hibiscus sabdriffa* L.*)* Plants in the two seasons of 2017 and 2018.

Treatments		**Weight of 100 seeds (gm)**		**Weight of seeds /plant (gm)**		**Weight of Seeds (Kg/fedd.)**	
		1st Season 2017	**2nd Season 2018**	**1st Season 2017**	**2nd Season 2018**	**1st Season 2017**	**2nd Season 2018**
(Con.) with tap water	T1	3.75	3.80	33.8	34.9	750	758
Citric acid (2g/L)	T2	3.94	3.82	66.0	67.1	1466	1473
Citric acid (3g/L)	T3	4.19	4.46	73.4	74.6	1632	1639
K humate (2g/L)	T4	3.94	4.21	60.2	61.4	1338	1345
K humate (3g/L)	T5	3.94	4.22	62.4	63.6	1387	1394
Citric acid (2g/L)+ K humate (2g/L)	T6	3.86	4.02	41.4	41.6	921	925
Citric acid (2g/L)+ K humate (3g/L)	T7	3.91	4.21	47.9	46.0	1064	1064
Citric acid (3g/L)+ K humate (2g/L)	T8	3.99	4.26	78.9	80.1	1753	1760
Citric acid (3g/L)+ K humate (3g/L)	T9	4.15	4.42	104.2	105.3	2315	2322
LSD at 5%		0.004	0.456	9.35	9.83	207.6	207.7

(T1) Control (Con.),(T2) Citric acid (2g/L), (T3)Citric acid(3g/L), (T4) K humate (2g/L),(T5) K humate (3g/L), (T6)Citric acid(2g/L)+ K humate(2g/L), (T7)Citric acid(2g/L)+ K humate(3g/L),(T8Citric acid(3g/L)+ K humate(2g/L),(T9)Citric acid(3g/L)+ K humate(3g/L).

2. EFFECT OF CITRIC ACID AND POTASSIUM HUMATE FOLAIR SPRAYON ROSELLE (*HIBISCUS SABDRIFFA* L.*)* PLANTS ON FIXED OIL%, FIXED OIL ML/ PLANT AND WEIGHT OF FIXED OIL L/FEDD. PARAMETERS IN THE TWO SEASONS OF 2017 AND 2018.

It is completely clear from the data presented in Table No. (5) and Fig. (2) that there is no significant compared to control between treatments in both seasons for fixed oil% of treatments. The highest results were recorded in the fixed oil% were 19.32% and 20.27% in both seasons resulted from (T3) Citric acid (3g/L), followed by (T9) Citric acid (3g/L)+ K humate (3g/L) then the treatment of (T8) Citric acid(3g/L)+ K humate (2g/L). The former results were proved by Eidyan (2010) on tuberose (*Polianthes tuberosa* L.) plants. , Jafari and Hadavi (2012) on basil (*Ocimum basilicum* L.) plants., Jafari and Hadavi (2012) on dill (*Anethum graveolens* L.) plants and Mirzajani (2013) on sweet basil plants. On the other hand, there is high significant between treatments in weight fixed oil ml/ plant and weight fixed oil L/fedd., were the highest values from (T9) Citric acid (3g/L)+ K humate (3g/L) recorded the best results were (20.10 and 21.32 ml/ plant) for weight fixed oil ml/ plant and (446.67 and 473.88 L/fedd.) for weight fixed oil L/fedd, followed by (T8) Citric acid (3g/L)+ K humate (2g/L).The former results were proved by Mohamed and Ghatas (2020) on chia plants., El-Hoseiny *et al.* (2020) on mango trees., Mandour *et al*. (2019) on strawberry plants and Hamad and Tantawy (2018) on sorghum plants.

Table (5) Effect of Citric acid and Potassium humate on fixed_oil% ,weight fixed oil ml/ plant and weight of fixed oil L/fedd. for roselle (*Hibiscus sabdriffa* L.*)* plants in the two seasons of 2017 and 2018.

Treatments		Fixed oil%		Fixed oil ml/ Plant		Weight of fixed oil L/fedd.	
		1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018	1st Season 2017	2nd Season 2018
(Con.) with tap water	**T1**	18.98	19.93	6.43	6.98	142.89	155.15
Citric acid (2g/L)	**T2**	17.60	18.55	11.63	12.48	258.52	277.24
Citric acid (3g/L)	**T3**	19.32	20.27	13.18	14.10	292.89	313.28
K humate (2g/L)	T4	19.16	20.11	11.52	12.33	256.07	273.97
K humate (3g/L)	T5	19.59	20.54	12.21	13.04	271.33	289.83
Citric acid (2g/L)+ K humate (2g/L)	T6	20.79	20.73	8.60	8.89	191.04	202.12
Citric acid (2g/L)+ K humate (3g/L)	T7	17.70	17.98	8.47	8.84	188.22	199.23
Citric acid (3g/L)+ K humate (2g/L)	T8	17.89	18.84	14.69	15.67	326.45	348.19
Citric acid (3g/L)+ K humate (3g/L)	T9	18.64	19.59	20.10	21.32	446.67	473.88
LSD at 5%		2.455	2.702	2.367	2.488	52.59	54.646

(T1) Control (Con.),(T2) Citric acid (2g/L), (T3)Citric acid(3g/L), (T4) K humate (2g/L),(T5) K humate (3g/L), (T6)Citric acid(2g/L)+ K humate(2g/L), (T7)Citric acid(2g/L)+ K humate(3g/L),(T8Citric acid(3g/L)+ K humate(2g/L),(T9)Citric acid(3g/L)+ K humate(3g/L)

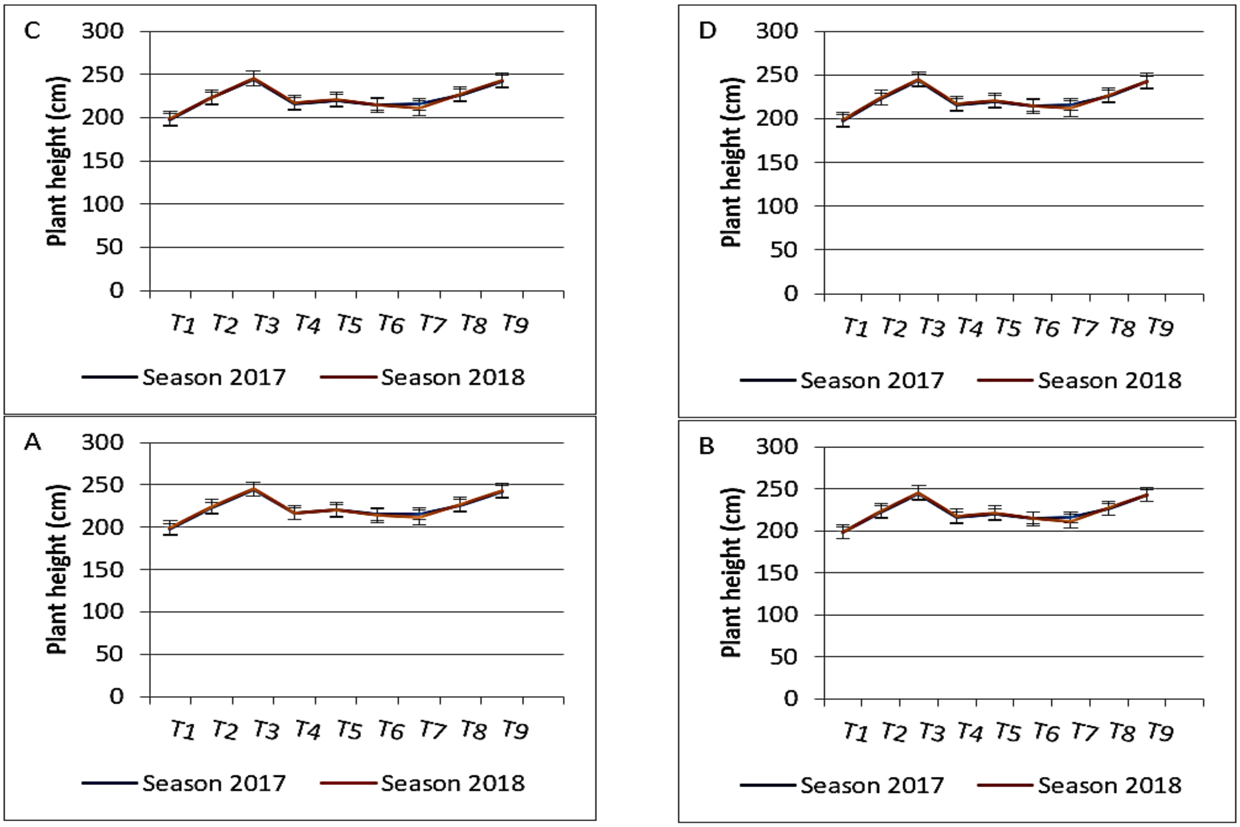

Fig. 2: Effect of Citric acid and Potassium humate on fixed oil%, weight fixed oil ml/ plant, weight of fixed oil L/fedd. and anthocyanin content (µM) for roselle (*Hibiscus sabdriffa* L.*)* plants in the two seasons of 2017 and 2018. (A) Fixed oil%, (B) weight fixed oil ml/ plant, (D) weight of fixed oil L/fedd, (D) anthocyanin content (µM)

3. EFFECT OF CITRIC ACID AND POTASSIUM HUMATE FOLAIR SPRAY ON ROSELLE (*HIBISCUS SABDRIFFA* L.*)* PLANTS ON TOTAL CARBOHDRATE%, ANTHOCYANIN CONTENT (µm) AND V.C MG/100GIN SEPALS PARAMETERS IN THE TWO SEASONS OF 2017 AND 2018.

Data presented in table (6) showed that, the effect Citric acid and Potassium humate on roselle plants. There is no significant compared to control between treatments in both seasons for total carbohydrate % in sepals were (10.06 and 10.22%) were result from (T7) Citric acid (2g/L)+ K humate (3g/L) respectively and followed by (T6) Citric acid (2g/L)+ K humate(2g/L), then the treatment of the treatment of (T3) Citric acid (3g/L). These results are in accordance to El-Bassiony *et al*. (2010) on sweet pepper plants. As for the of anthocyanin content character in sepals As shown in Table No. (6) and Fig. (2), There is the highest significantly in the frist season and significantly in the the second season compared to control between the treatments, the results were as follows (0.81 and 0.86) were result from (T9) Citric acid (3g/L)+ K humate (3g/L) respectively and followed by(T3) Citric acid (3g/L). These results are in accordance to Abdel-Salam (2016) on Ruby seedless mentioned that, The result showed that, the total anthocyanin was significantly increased with all treatments compared with control in two investigated seasons. The highest value was achieved by Denre *et al*. (2014) on garlic bulb and Abdelgawad *et al.* (2018) on lettuce plant. As for the of Vitamin C mg/100 gm. In sepals character, There is the highest significantly in the frist season and significantly in the the second season compared to control between the treatments, the results were as follows (1.51 and 1.56 mg/100g) were result from(T3) Citric acid (3g/L) respectively and followed by (T5) K humate (3g/L). These results agreed with those obtained by Mandour *et al*. (2019) on strawberry plants, Haggag *et al.* (2016) on "Canino" Apricot and Eidyan (2010) on tuberose (*Polianthes tuberosa* L.).

Table (6) Effect of Citric acid and Potassium humate on total carbohdrate% , anthocyanin content (µM) and Vitamin C mg/100gin sepals for roselle (*Hibiscus sabdriffa* L.*)* plants in the two seasons of 2017 and 2018.

Treatments	Total Carbohydrate % In sepals		Anthocyanin content (µM)		Vitamin C mg/100g	
	1st Season 2017	2nd Season 2018	1st Season	2nd Season 2018	1st Season 2017	2nd Season

				2017			2018
(Con.) with tap water	T1	7.78	8.33	0.71	0.71	1.30	1.35
Citric acid (2g/L)	T2	8.62	9.17	0.69	0.75	1.44	1.49
Citric acid (3g/L)	T3	8.91	9.46	0.80	0.86	1.51	1.56
K humate (2g/L)	T4	8.37	8.92	0.80	0.85	1.49	1.54
K humate (3g/L)	T5	8.21	8.77	0.74	0.80	1.50	1.56
Citric acid (2g/L)+ K humate (2g/L)	T6	9.26	9.67	0.74	0.77	1.39	1.34
Citric acid (2g/L)+ K humate (3g/L)	T7	10.06	10.22	0.77	0.82	1.32	1.30
Citric acid (3g/L)+ K humate (2g/L)	T8	9.07	9.62	0.73	0.79	1.37	1.42
Citric acid (3g/L)+ K humate (3g/L)	T9	8.41	8.96	0.81	0.86	1.39	1.44
LSD at 5%		1.725	1.772	0.039	0.069	0.073	0.140

(T1) Control (Con.), (T2) Citric acid (2g/L), (T3) Citric acid(3g/L), (T4) K humate (2g/L), (T5) K humate (3g/L), (T6), Citric acid(2g/L) + K humate(2g/L), (T7), Citric acid(2g/L) + K humate(3g/L),(T8Citric acid(3g/L)+ K humate(2g/L),(T9)Citric acid(3g/L)+ K humate(3g/L)

CONCLUSION

Conclusively, from the results obtained, it can be recommended that combinations of Citric acid and Potassium humate gave the best results. The best treatment between was Citric acid at 3 g /L with Potassium humate at 3 g /L treatment can be used for early plant flowering and most of the growth and production characteristics of the sepals and seeds, oil yield and Vitamin C, chemical components of the hibiscus (*Hibiscus sabdariffa* L.) plants, followed by the use of Citric acid 3g /L treatment solo. Therefore, recommendation that, using the that best treatment in the experience for early flowering, harvesting and drying of sepals before rain and cold weather.

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حث الكركدية على الازهار المبكر باستخدام الاحماض العضوية

منال محمد مليجى

قسم بحوث النباتات الطبية والعطرية – معهد بحوث البساتين – مركز البحوث الزراعية

أجريت الدراسة الحالية في مزرعة مركز البحوث الزراعية بمحطة البحوث الزراعية بالجميزة بمحافظة الغربية بمصر خلال موسمي الصيف المتتاليين 2017 و 2018 ،بهدف تقييم تأثير معاملات حمض الستريك (2 جرام و 3 جم / لتر) و هيومات البوتاسيوم (2 جم و 3 جم / لتر) على التزهير المبكر لنبات الكركديه و كانت المعاملات على النحو التالي (T1) (الرش بالماء) , (T2) حمض الستريك (2 جم / لتر)) , (T3) حمض الستريك (3 جم / لتر) ، (T4) هيومات البوتاسيوم (2 جم / لتر) ، (T5) هيومات البوتاسيوم (3 جم / لتر) ، (T6) حمض الستريك (2 جم / لتر) + هيومات البوتاسيوم (2 جم / لتر) , (T7) حمض الستريك (2 جم / لتر) + هيومات البوتاسيوم (3 جم / لتر) , (T8) حمض الستريك (3 جم / لتر) + هيومات البوتاسيوم (2 جم / لتر)) , (T9) حمض الستريك (3 جم / لتر) + هيومات البوتاسيوم (3 جم / لتر) وجدأن الرش الورقي بالحمضين إما منفردًا أو معًا كان له تأثير إيجابي على جميع عوامل النمو , المحصول و الزيت كانت معاملات التفاعل الأفضل من معاملات المنفردة و أفضلهما المعاملة التاسعة وهي حمض الستريك (3 جم / لتر) + هيومات البوتاسيوم (3 جم / لتر) و التي أعطت أفضل النتائج في الإزهار المبكر ومعظم خصائص النمو و الإنتاج لمحصول لسبلات و البذور و الزيت وفيتامين سي . لذلك يوصى استخدام خليط بين حامض الستريك وهيومات البوتاسيوم للازهار المبكر و الحصاد و التجفيف قبل فصل الشتاء.

الكلمات المفتاحية: الكركديه. الازهار المبكر. حمض الستريك. هيومات البوتاسيوم