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Effect of Foliar Application of Humic and Fulvic Acids on Yield and its Components of Some Carrot (*Daucus carota* L.) Cultivars

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Abstract: This investigation was conducted at the Experiment Station of the Faculty of Agriculture, Cairo University on 14 and 16 November in winter seasons of 2015-2016 and 2016-2017 to study the effect of growth stimulants (humic acid and fulvic acid) as foliar spray on some carrot cultivars. The experimental units were arranged in a split plot design with three replications. The growth stimulants were in main plot whereas the cultivars were assigned in sub-plots. The experiment includes 12 treatments which were the combination of control (without spray), humic acid (HA) (1g/l) and fulvic acid (FA) (0.5g/l) as foliar spray and four cultivars; viz Corall, Terracotta (Takii seeds), Siroco and Exelso (Semences seeds).all of tested cultivars follow chantenay type. The foliar application, were applied after month of sowing and then repeated at 45, 60 and 75 days from sowing. Results show that the HA at 1g/l treatment increased significantly average root weight, yield/plot, economic yield and harvest index. While, FA at 0.5g/l treatment improved significantly leaves chlorophyll content, roots dry matter, carbohydrates, carotenoids, nitrogen and phosphorus. Siroco cultivar gave the highest values of average root weight and yield/plot. Exelso cultivar had the greatest dry matter and harvest index. The maximum values of chlorophyll in leaves and carbohydrates in roots were observed in Terracotta cultivar.

Key words: Carrot (*Daucus carota* L.) · Humic acid (HA) · Fulvic acid (FA) · Cultivars · Yield · Root Quality

INTRODUCTION

Carrot (*Daucus carota* L.) is of the favorite vegetables in Egypt. Carrot is an important vegetable for health diet and therefore is should be obtained with high quality [1]. Carrot are rich source of beta-carotene, antioxidant that improve immunity and decrease incidence of cancer [2, 3]. The consumption of carrots increased because it is an important source of carbohydrates and minerals, carotenes and vitamin C which play basic role in many physiological processes [4, 5]. Humic substances (HS) are divided into three fractions humic acid, fulvic acid and humin. The humic acid (HA) are brown to black the humic acid is not soluble in water under acidic conditions (pH<2).The fulvic acid (FA) are orange to brown is soluble in water under all pH conditions [6]. Humic and fulvic acids are plant biostimulants largely derived from the decomposition of plant and animal remains and the activity of microorganisms [7]. HS isolated from peat, compost or vermicompost more effective than HS isolated from brown coal (e.g. lignite, leonardite) [8]. Biostimulants are environmentally friendly method that improve plant growth and facilitate soil elements absorption [9]. The positive effect of the use of plan biostimulants such as HA and FA is a way to improve crops production and maintain soil fertility [10]. HS are natural resource increase production quality [11]. HA and FA are cheap and non – polluting materials if used excessively [12]. FA is a non – toxic organic fertilizer easy to lose by leaching and most absorbed by leaves [13]. FA has beneficial effects on plant growth, but the mechanism is still unclear [14]. HA is one of natural sources that can be used instead of unnatural fertilizer to increase crop productivity, directly by influencing enzymatic activity, or indirectly by improving chemical and physical properties of the soil [15]. HA induced the same effect of IAA in improving carrot cell growth [16]. Foliar application of HA improved the growth and development by improving photosynthesis [17]. Plant responses to HA and FA varies by species, rate of addition, source of extraction and environmental conditions [18]. The carrot

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is a stressful crops of the soil so the one of the ways to improve the yield by using the growth stimulators HA and FA in addition to mineral fertilization. Therefore, the objective of this study was conducted to evaluate carrot cultivars by using HA and FA for improving yield and yield components.

MATERIALS AND METHODS

This investigation was conducted at the Experiment Station of the Faculty of Agriculture, Cairo University on 14 and 16 November in winter seasons of 2015-2016 and 2016-2017 to study the effect of growth stimulants (humic acid and fulvic acid) as foliar spray on some carrot cultivars. The experimental units were arranged in a split plot design with three replications. The growth stimulants were randomly arranged in main plot, whereas the cultivars were assigned in sub-plots. Each experimental unit was $10.5m^2$ and consisted of five ridges, each 3.5m long and 0.6m wide. The experiment includes 12 treatments which were the combination of control (without spray), humic acid (1g/l) and fulvic acid (0.5g/l) as foliar spray and four cultivars; viz Corall, Terracotta (Takii seeds), Siroco and Exelso (Semences seeds). All of tested cultivars follow chantenay type. Mineral fertilization was the same for all the treatments. Fertilization was applied at the following does: 60kg N in form ammonium sulfate (20.5%), 40kg P_2O_5 in form calcium superphosphate (15.5%) and 50 kg K_2O in form of potassium sulfate (48%). The calcium superphosphate was added as one does during seed bed preparation. Nitrogen and potassium fertilization was divided into three equal batches the first does applied at preparing the soil and the second after four weeks of sowing and the third after eight weeks of sowing. The foliar application, were applied after month of sowing and then repeated at 45, 60 and 75 days from sowing. Seeds were drilled on one side of ridges. Carrot roots were harvested after 120 days from sowing. The yield of roots as kg/plot, economic yield and harvest index was calculated: Economic yield (EY) =yield of economic part of the plant; harvest index (HI) =EY/total plant dry matter at harvest×100 [19]. In the same time, samples of 10 plants from each experimental plot were randomly taken to record yield components: root length, root diameter and root weight. Root chemical composition: TSS (measured by digital refractometer) dry matter percentage. Total carotenoids in roots and total chlorophyll in leaves at harvest were determined by using N.N. Dimethyl formamide according to Nornia [20]. Total carbohydrates percentage (%) was determined according to the method described by Dubois *et al*. [21], total nitrogen percentage, potassium percentage and phosphorus percentage were determined according to the method described in AOAC [22]. The L.S.D. method Snedecor and Cochran [23] was used for testing the significance of means in the experiment.

RESULTS AND DISCUSSION

Yield Components: Data presented in Table 1 show that spraying carrot plants with humic acid (HA) and fulvic acid (FA) had significant effect on root diameter in the 1st season and root weight in both seasons, but had no significant effect on root length in both seasons and root diameter in the 2nd season. Spraying with HA at 1g/l gave the highest values of average root weight in both seasons. Foliar application of HA increased significantly the average fruit weight and total yield in peppers and enhanced average pod fresh weight in beans [24, 25]. The response of plants to HA is better than FA [26].

As for cultivars, there were significant differences among four cultivars with respect to root length, root diameter and root weight in both seasons (Table 1). In the 1st season, Coral cultivar recorded maximum values of root diameter and root weight, whereas Siroco cultivar recorded maximum values of root diameter and root weight in the 2nd season. Concerning root length, Exelso cultivar gave the tallest root in the 1st season.

Respecting the interaction effect data in Table 1 illustrate that the interaction between spraying with humic substances (HA and FA) and cultivars reflect a significant effect on root length, root diameter and root weight in both seasons. In the 1st season, spraying Exelso cultivar with HA at 1g/l increased root length and root weight, whereas spraying Coral cultivar with HA increased root diameter. In the 2nd season spraying Siroco cultivar with HA increased root length, root diameter and root weight with no significant differences with HA and Coral cultivar with respect to root diameter and with HA and Terracotta cultivar with respect to root weight.

From the foregoing results, it could be concluded that, in general, spraying carrot plants with HA at 1g/l increased average root weight, Siroco and Coral cultivars gave the highest values of average root weight and spraying Siroco and Exelso cultivars with HA at 1g/l increased average root weight.

Table 1: Effect of humic acid and fulvic acid as foliar application, cultivars and their interaction on yield components of carrots in seasons of 2015/2016 and 2016/2017

Treatments		2015/2016 season			2016/2017 season		
		Root length (cm)	Root diameter (mm)	Root weight (g)	Root length (cm)	Root diameter (mm)	Root weight (g)
Growth stimulants							
control		11.83a	25.05b	39.50c	11.83a	26.85a	42.25b
HA		13.17a	27.84a	53.25a	12.92a	28.29a	54.75a
FA		12.50a	25.10b	44.25b	11.42a	27.14a	43.50b
Cultivars							
Coral		12.00b	29.48a	50.33a	12.22ab	26.39bc	47.00c
Terracotta		12.22b	26.49b	47.00b	11.78ab	29.65a	49.00b
Siroco		12.11b	23.29c	38.00c	12.78a	28.93ab	53.67a
Exelso		13.67a	24.73bc	47.33b	11.44b	24.75c	37.67d
Interaction							
Control	Coral	10.00d	28.31abc	43.00g	11.00cd	24.28cd	38.00f
	Terracotta	11.33cd	25.16cdef	34.00ij	13.00abc	29.09abc	54.00c
	Siroco	12.33bc	23.09ef	33.00j	11.33cd	28.65abc	36.00g
	Exelso	13.67ab	23.63def	48.00e	12.00bcd	25.40cd	41.00e
HA	Coral	13.33abc	30.51a	53.00c	14.67a	27.01bcd	60.00b
	Terracotta	12.00bcd	26.51abcde	56.00b	12.00bcd	32.28a	55.00c
	Siroco	12.67abc	25.99bcde	46.00f	14.00ab	31.79ab	70.00a
	Exelso	14.67a	28.33abc	58.00a	11.00cd	22.07d	34.00h
FA	Coral	12.67abc	29.61ab	55.00b	11.00cd	27.87abc	43.00d
	Terracotta	13.33abc	27.79abcd	51.00d	10.33d	27.57abc	38.00f
	Siroco	11.33cd	20.79f	35.00hi	13.00abc	26.34cd	55.00c
	Exelso	12.67abc	22.22ef	36.00h	11.33cd	26.78bcd	38.00f

In each column, values followed by the same letter do not differ significantly at P=0.05 by LSD.
HA: humic acid, FA: fulvic acid

Yield: Data presented in Table 2 show that there were significant differences in the yield, economic yield and harvest index between the treatments in the both seasons. The HA treatment showed the maximum yield, economic yield and harvest index in both seasons. These results are in harmony with Karakurt *et al.* [24] who indicated that foliar application by HA increased significantly the total yield in peppers. Zaky *et al.* [25] reported that HA at 1g/l does as foliar application enhanced yield of beans. FA did not effect on growth and yield on cotton [27].In contrast FA improved the yield in tomato [28]. Moradi *et al.* [29] reported that control treatment had the maximum HI compared by FA treatment.

Data in Table 2 show that there were significant differences among four cultivars with respect to yield /plot, economic yield (EY) and harvest index (HI) in both seasons. In the 1st season Terracotta cultivar gave the highest values of yield/plot and EY and Exelso cultivar gave the highest values of HI, whereas in the 2nd season, Siroco cultivar gave the highest values of yield/plot and EY with no significant differences with Exelso cultivar with respect to EY and Exelso cultivar gave the highest values of HI. From the foregoing results, it could be concluded that Siroco and Terracotta cultivars gave the highest values of yield/plot. The results are in line with those of Moradi *et al.* [29] who reported that HI was affected by cultivars in Safflower (*Carthamus tinctorius*) plants.

Spraying carrot cultivars with humic substances (HA and FA) had significant effect on yield/plot, EY and HI in both seasons (Table2). In the 1st season, spraying Terracotta cultivar with HA at 1g/l increased yield/plot and EY. whereas, in the 2nd season, spraying Siroco cultivar with HA at 1g/l increased yield/plot and EY. Respecting HI, unsprayed Exelso cultivar gave the highest values of HI in both seasons. From the foregoing results, it could be concluded that spraying Terracotta and Siroco cultivars with HA increased yield/plot and EY.

Root Quality: Data presented in Table 3 show that there were significant differences between the treatments in dry matter content and total carbohydrate in the both seasons. The dry matter content and total carbohydrates were greatest in the FA treatment followed by the control. HA treatment showed the lowest dry matter and total carbohydrates in both seasons. TSS was not influenced by humic substances (HS) treatments in the first season. Aminifard *et al.* [30] indicated that FA application

Table 2: Effect of humic acid and fulvic acid as foliar application, cultivars and their interaction on yield, economic yield (EY) and harvest index (HI) of carrots in seasons of 2015/2016 and 2016/2017

		2015/2016 season			2016/2017 season		
Treatments		Yield/plot (kg)	EY(g)	HI (%)	Yield/plot (kg)	EY(g)	HI (%)
Growth stimulants							
control		14.80 b	257.09b	57.21b	14.40 c	255.50c	57.38c
HA		16.20 a	274.78a	63.22a	19.50 a	340.40a	62.21a
FA		13.20 c	234.51c	58.05b	14.50 b	267.60b	60.55b
Cultivars							
Coral		13.10 d	212.57d	55.67d	16.30 b	273.29b	61.10b
Terracotta		16.70 a	282.01a	57.26c	16.00 c	258.67c	54.62d
Siroco		14.50 c	248.43c	62.12b	17.60 a	310.65a	60.04c
Exelso		14.70 b	278.83b	62.90a	14.60 d	308.72a	64.43a
Interaction							
Control	Coral	14.40 e	215.25g	50.46h	14.60 g	224.21f	58.93c
	Terracotta	14.70 d	228.44f	54.37f	15.40 f	262.18d	52.01e
	Siroco	11.6 0 j	205.24i	52.03g	11.80 k	200.81g	52.82e
	Exelso	18.70 b	379.42b	71.97a	15.80 e	334.80c	65.75a
HA	Coral	12.60 h	193.79j	57.69e	20.90 b	366.79b	65.71a
	Terracotta	24.30 a	422.92a	63.98d	18.70 c	262.73d	55.65d
	Siroco	13.60 g	235.90e	68.29b	22.40 a	401.85a	63.03b
	Exelso	14.20 f	246.51d	62.90d	15.90 e	330.24c	64.46ab
FA	Coral	12.20 i	228.66f	58.87e	13.40 i	228.87f	58.66c
	Terracotta	11.20 k	194.66j	53.43f	14.00 h	251.10e	56.19d
	Siroco	18.30 c	304.15c	66.04c	18.50 d	329.30c	64.26ab
	Exelso	11.10 k	210.57h	53.84f	12.10 j	261.12d	63.09b

In each column, values followed by the same letter do not differ significantly at P=0.05 by LSD.
HA: humic acid, FA: fulvic acid, EY: Economic yield, HI: Harvest index, plot area (10.5m^2)

Table 3: Effect of humic acid and fulvic acid as foliar application, cultivars and their interaction on dry matter, TSS and total carbohydrate of carrots in seasons of 2015/2016 and 2016/2017

		2015/2016 season			2016/2017 season		
Treatments		Dry matter (%)	T.S.S	Total Carbohydrate (%)	Dry matter (%)	T.S.S	Total Carbohydrate (%)
Growth stimulants							
control		17.15b	16.40a	11.78 b	17.69b	15.98a	11.72 b
HA		16.90c	14.03a	10.85 c	17.59c	13.58c	10.79 c
FA		17.95a	15.15a	12.18 a	18.62a	14.05b	12.12 a
Cultivars							
Coral		16.40d	16.93a	12.20 b	16.68c	14.73a	12.15 b
Terracotta		16.79c	14.74a	12.27 a	16.38d	14.58b	12.22 a
Siroco		17.27b	14.56a	11.17 c	17.62b	14.42c	11.11 c
Exelso		18.87a	14.53a	10.77 d	21.18a	14.40c	10.71 d
Interaction							
Control	Coral	15.00l	18.63ab	12.20 d	15.41i	18.20a	12.15 d
	Terracotta	15.54j	16.17abc	13.80 a	17.08h	15.70b	13.75 a
	Siroco	17.77d	14.83bc	11.20 f	17.09h	14.40e	11.15 f
	Exelso	20.29a	15.97abc	9.90 j	21.19b	15.60b	9.84 j
HA	Coral	15.38k	12.43c	11.00 h	17.55g	11.90i	10.94 h
	Terracotta	17.44e	14.27bc	11.10 g	14.05j	13.83g	11.05 g
	Siroco	17.41f	14.17bc	11.20 f	17.98e	13.77g	11.14 f
	Exelso	17.36h	15.23abc	10.10 i	20.77c	14.80d	10.05 i
FA	Coral	18.82c	19.73a	13.40 b	17.08h	14.10f	13.35 b
	Terracotta	17.38g	13.80bc	11.90 e	18.00d	14.20f	11.85 e
	Siroco	16.62i	14.67bc	11.10g	17.80f	15.10c	11.05 g
	Exelso	18.97b	12.40c	12.30 c	21.58a	12.80h	12.25 c

In each column, values followed by the same letter do not differ significantly at P=0.05 by LSD.
HA: humic acid, FA: fulvic acid

Table 4: Effect of humic acid and fulvic acid as foliar application, cultivars and their interaction on total chlorophyll in leaves and total carotenoids in roots of carrots in seasons of 2015/2016 and 2016/2017

		2015/2016 season		2016/2017 season	
Treatments		Total chlorophyll (mg/100g f.w)	Total carotenoids (mg/100g f.w)	Total chlorophyll (mg/100g f.w)	Total carotenoids (mg/100g f.w)
Growth stimulants					
control		45.38 c	154.22 a	44.19 c	152.00 b
HA		46.40 b	119.78 b	45.82 b	117.25 c
FA		49.14 a	160.66 a	48.61 a	157.03 a
Cultivars					
Coral		43.01 c	150.83 a	44.41 c	147.40 b
Terracotta		51.74 a	136.61 b	50.38 a	133.10 c
Siroco		43.35 c	154.93 a	42.40 d	154.24 a
Exelso		49.77 b	137.16 b	47.63 b	133.63 c
Interaction					
Control	Coral	38.33 h	182.93 a	42.64 i	180.00 a
	Terracotta	44.82 e	103.93 f	43.70 g	101.00 h
	Siroco	35.10 i	179.10 a	34.00 l	177.00 a
	Exelso	63.25 a	150.90 bc	56.43 b	150.00 d
HA	Coral	42.09 g	114.33 ef	42.98 h	112.00 g
	Terracotta	58.40 b	140.00 cd	57.30 a	138.00 e
	Siroco	43.35 f	129.10 de	42.30 j	129.00 f
	Exelso	41.74 g	95.67 f	40.70 k	90.00 i
FA	Coral	48.62 d	155.23 bc	47.60 e	150.20 d
	Terracotta	52.01 c	165.90 ab	50.15 d	160.30 bc
	Siroco	51.61 c	156.60 bc	50.90 c	156.73 c
	Exelso	44.33 ef	164.90 ab	45.77 f	160.90 b

In each column, values followed by the same letter do not differ significantly at P=0.05 by LSD.
HA: humic acid, FA: fulvic acid

improved quality parameter in pepper plants such as carbohydrates. Young Suh *et al*. [31] reported that FA at 0.8g/l enhanced dry weight of shoot and root in tomato plants.in contrast, Yildirma [32] indicated that TSS increased by application of HA and FA.

Regarding, cultivars, there were significant differences among cultivars in the dry matter content, TSS and total carbohydrate in the both seasons, except TSS in the 1st season. The maximum dry matter content was observed in Exelso cultivar followed by Siroco cultivar in the both seasons. The results showed that the maximum total carbohydrate was observed in Terracotta cultivar followed by Coral cultivar, whereas the minimum values were observed in Exelso cultivar in the both seasons. There were no significant differences between cultivars in TSS content in the first season. Meanwhile, the maximum TSS content was observed in Coral cultivar followed by Terracotta cultivar. The minimum TSS content was observed in Siroco and Exelso cultivars in the second season.

Spraying carrot cultivars with humic substances (HA and FA) reflect a significant effect on root quality in both seasons (Table 3). Unsprayed Exelso and Terracotta cultivars with humic substances (control) recorded maximum values of dry matter (%) in the 1st season and total carbohydrates (%) in both seasons, respectively. Spraying Coral with FA recorded maximum values of TSS in the 1st season and spraying Exelso cultivar with FA recorded maximum values of dry matter (%) in the 2nd season.

From the foregoing results, it could be concluded that, spraying carrot plants with FA increased dry matter (%) and total carbohydrates, Exelso cultivar recorded maximum values of dry matter (%). Whereas, Terracotta cultivar recorded maximum values of total carbohydrate in roots and unsprayed Coral cultivar with humic substances recorded maximum values of TSS in roots.

Total Chlorophyll in Leaves and Total Carotenoids in Roots: Data presented in Table 4 show that there were significant differences between the treatments in total chlorophyll in leaves and total carotenoids in roots in the both seasons. The maximum leaves chlorophyll content and roots carotenoids were obtained in FA treatment in both seasons. Which, was statistically identical with the control in roots carotenoids content in the first season.

Table 5: Effect of humic acid and fulvic acid as foliar application, cultivars and their interaction on nitrogen, phosphorus and potassium in carrots root in seasons of 2015/2016 and 2016/2017

		2015/2016 season			2016/2017 season		
Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Growth stimulants							
control		0.94 b	0.29 a	2.10 a	0.96 b	0.32 a	2.16 a
HA		0.83 c	0.28 b	2.01 c	0.85 c	0.30 b	2.07 c
FA		0.97 a	0.29 a	2.06 b	0.99 a	0.32 a	2.12 b
Cultivars							
Coral		0.88 c	0.26 c	2.05 c	0.90 c	0.29 c	2.11 c
Terracotta		0.80d	0.29 b	1.59 d	0.82 d	0.32 b	1.65 d
Siroco		1.02 a	0.31 a	2.50 a	1.04 a	0.34 a	2.56 a
Exelso		0.96 b	0.28 b	2.09 b	0.98 b	0.31 b	2.15 b
Interaction							
Control	Coral	0.83f	0.35 a	2.10 e	0.85 f	0.38 a	2.16 e
	Terracotta	0.76 i	0.27 d	1.92 i	0.78 i	0.30 d	1.98 i
	Siroco	1.16 a	0.30 c	2.37 c	1.18 a	0.33 c	2.43 c
	Exelso	1.01 c	0.25 e	2.00 h	1.03 c	0.28 e	2.06 h
HA	Coral	0.78 h	0.22 f	2.01 h	0.80 h	0.25 f	2.07 h
	Terracotta	0.81 g	0.28 d	1.20 k	0.83 g	0.31 d	1.26 k
	Siroco	0.88 d	0.27 d	2.65 a	0.90 d	0.30 d	2.71 a
	Exelso	0.86 e	0.33 b	2.18 d	0.88 e	0.36 b	2.24 d
FA	Coral	1.03 b	0.22 f	2.04 g	1.05 b	0.25 f	2.10 g
	Terracotta	0.83 f	0.31 c	1.65 j	0.85 f	0.34 c	1.71 j
	Siroco	1.01 c	0.35 a	2.48 b	1.03 c	0.38 a	2.54 b
	Exelso	1.01 c	0.27 d	2.08 f	1.03 c	0.30 d	2.14 f

In each column, values followed by the same letter do not differ significantly at P=0.05 by LSD.
HA: humic acid, FA: fulvic acid

Gulser *et al.* [7] reported that FA application improve plant growth by enhancing photosynthesis. Most FA absorption done by leaves [13].These results are in agreement with those obtained by Aminifard *et al.* [30] who indicated that application by FA improved quality parameter in pepper plants such as antioxidant and carotenoids. Young Suh *et al.* [31] concluded that FA foliar application at 0.8g/l enhanced chlorophyll content in tomato leaves. In the same line Anjum *et al*. [33] indicated that FA improved the chlorophyll content in the maize leaves. Chlorophyll content in lettuce decreased significantly by using HA as foliar application [34].

Regarding, cultivars there were significant differences among cultivars in total chlorophyll in leaves and total carotenoids in roots in the both seasons. The maximum value of chlorophyll content was observed in Terracotta cultivar followed by Exelso cultivar. The maximum values of carotenoids in roots were observed in Siroco cultivar in the both seasons. Which, was statistically identical with the Coral cultivar in the first season.

The interaction effect, the maximum chlorophyll content in leaves was observed in control with Exelso cultivar in the first season. While, the HA with Terracotta cultivar had the maximum chlorophyll content in the second season. The minimum chlorophyll content was observed in control with Siroco cultivar.

The maximum values of root carotenoids content was observed in control with Coral cultivar and control with Siroco cultivar. The minimum carotenoids content was observed in HA with Exelso cultivar in both seasons.

N, P and K Content in Roots: Data presented in Table 5 show that there were significant differences between the treatments in nitrogen, phosphorus and potassium content in roots in the both seasons. The FA application consistently resulted in increased root nitrogen and phosphorus content. Which was statistically identical with the control in phosphorus content in the both seasons. The maximum value of potassium content was observed in the control (unsprayed with substances) treatment followed by the FA treatment. HA gave the lowest values nitrogen, phosphorus and potassium content in both seasons. Gulser *et al.* [7] reported that FA enhancing plant nutrients uptake. Nitrogen content was significantly lower by HA applied vs. conventional cultivation, while, phosphorus and potassium content did not effected in carrot roots [35].Tan [36] indicated that FA more effective than HA in enhancing nutrient uptake.

Regarding, cultivars there were significant differences among cultivars in nitrogen, phosphorus and potassium content in roots in the both seasons. The maximum values of nitrogen, phosphorus and potassium content were observed in Siroco cultivar followed by Exelso cultivar. Which, was statistically identical with the Terracotta cultivar in phosphorus content in the both seasons. Cultivars differed significantly in root chemical composition [37].

The interaction effect, the maximum value of nitrogen content was observed in treatment control with Siroco cultivar followed FA with Coral cultivar. The minimum value of nitrogen content was observed in control with Terracotta cultivar. The maximum phosphorus content in roots was observed of treatment control with Coral cultivar and FA with Siroco cultivar followed by HA with Exelso cultivar. The minimum phosphorus content was observed of HA with cv. Coral and FA with Coral cultivar. The maximum potassium content was observed of HA with Siroco cultivar followed by FA with Siroco cultivar. The minimum potassium content was observed of HA with Terracotta cultivar.

CONCLUSION

The using of humic substances (HA, FA) improves carrots plant growth characters compared to control. Spraying with HA at 1g/l enhanced the yield, economic yield and harvest index. While, FA improved the roots chemical composition. The differences between cultivars were a slightly significant, may be the cultivars are close in genotype because it is cultivars follow the same type chantenay.

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