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EFFECT OF NUTRIENT SOLUTIONS AND HUMIC ACID ON GROWTH, PRODUCTIVITY AND SOME CHEMICAL CONSTITUENTS OF SWEET BASIL UNDER NUTRIENT FILM TECHNIQUE CONDITIONS

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ABSTRACT

The present work was conducted at the Laboratory of Horticulture Department, Faculty of Agriculture, Zagazig University during the two successive seasons of 2012and 2013. It aims to study the effect of some nutrient solutions (150 and 300 ml/l) and humic acid (HA) concentrations (0, 100 and 200 ppm) as well as their combinations on growth characters, productivity and some chemical constituents of *Ocimum basilicum* L. *cv.* Genovese under nutrient film technique (NFT) system. The data recorded were growth characters (plant height, number of leaves/ plant, branch number/ plant, leaf area and leaf fresh and dry weight/plant), productivity (yield fresh and dry weight/ plant and (%) of oil content) and some chemical constituents (total chlorophyll, NPK and total carbohydrates content). The obtained results came to conclusion that, using the treatment of nutrient solution at 300 ml/ l recorded significant increase in growth characters, productivity and some chemical constituents of *Ocimum basilicum* L. cv. Genovese as compared to the other treatments (150 ml/l) under study in most cases. HA also, enhanced the efficiency of the nutrient solution and increased leaf area, number of leaves/plant and branch number/ plant.

Key words: nutrient solution, humic acid, sweet basil, nutrient film technique, oil content.

INTRODUCTION

The *Ocimum* genus, collectively called basil, is an important member of Lamiaceae family. Sweet basil (*Ocimum basilicum* L.) is largely employed as a flavoring agent for food and is cultivated worldwide (Makri and Kintzios, 2007). Sweet basil is also used for cosmetical and pharmaceutical preparations, as it contains large amounts of essential oils (Makri and Kintzios, 2007) and rosmarinic acid (Juliani *et al.,* 2008). Medicinal plants, including sweet basil, are generally cultivated in open field and these results in year-to-year variability in both biomass production and the content of active principles (Bourgaud *et al.,* 2001). Hence, there is an increment interest for greenhouse hydroponic (or soilless) culture, where growing conditions can be strictly controlled and the production of the metabolites of interest can be maximized (Pardossi *et al.,* 2006; Prasad *et al.,* 2012).

The nutrient film technique (NFT) is a novel system of water or solution flowing down the troughs or gullies, the plant roots form a more or less thin mat over the base of the gully. The primary purposes for this shallow layer of solution are twofold. Firstly, the usual problem of solution culture, namely mounting the plants above the solution with only their roots immersed, is avoided. The solution is kept so shallow that the young plants, in their propagation blocks or pots, can simply stand in the gullies; roots the rapidly emerge into the flowing liquid. Secondly, the high ration of surface area to solution volume helps to ensure good aeration (Cooper, 1979; Molyneux, 1988; Resh, 1989; Winsor and Shwartz, 1990; Adams,

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1992; Burrage, 1992).Nutrient Film Technique (NFT) can be used to overcome soil problems where, plants grow in the nutrient solution directly, so it did not need any disinfection as will as it had an enormous latent potential for agriculture production in areas where soil has a pest and disease problems (Burrage, 1992), especially in near future when the methyl bromide will be band. Abou-Hadid *et al.* (1989) demonstrated that under Egyptian conditions, NFT produced higher yield in shorter time when compared with conventional cultivation. As well as, the cost of production by the NFT is similarly to the soil grown crops.

Nutrient solutions can influence plant growth, appearance, nutritional value, and shelf life of basil (De Pascale *et al.*, 2006). The EC is monitored and adjusted frequently for hydroponic culture in water-based systems such as NFT. Many researchers have conducted experiments on basil to help determine proper ratios of essential elements for adequate plant growth (Bugbee, 2004). Research on basil production outdoors in fields or greenhouse production in containers has reported that increasing nitrogen (N) fertilization increases shoot mass (Biesiada and Kuś, 2010; Golcz *et al.*, 2006; Nurzynska-Wierdak *et al.*, 2012; Sifola and Barbieri, 2006). However, nutrient management for closed-loop hydroponic culture is distinctly different.

Humic acid is a commercial product contains many elements which improve the soil fertility and increasing the availability of nutrient elements and consequently affected plant growth and yield. Humic acid particularly is used to remove or decrease the negative effects of chemical fertilizers and some chemicals from the soil major effect of humic acid on plant growth has long been reported (David *et al.*, 1994; Hartwigsen and Evans, 2000; Lee and Bartlett, 1976; Linchan, 1978). There is basic agreement on the benefits of humus, but there is quite a controversy on the benefit of application of applied humate (the deposits containing the humic acids) (Nguyen and Niemeyer, 2008). Khalil *et al.* (2002) indicated that foliar application of micro elements such as iron, zinc, manganese in both shooting and a little before the flowering stages increased the yield and yield components of corn cilage.

Humic substances consists of humic acid (HA) and fulvic acid (FA) (Tan, 1998). Humic substances positively affected the germination of *Chenopodium album* (Šerá and Novák, 2011). Nitrogen content of tomato (*Solanum lycopersicum*) increased when 250 ml/L HA was used as the source of minerals (Valdrighi *et al.*, 1996). Root length increased more than stem length in tomato when HA was added to the nutrient solution in the range of 0, 640, 1280, or 2560 ml/l (David *et al.*, 1994), and similar root growth that exceeded shoot growth was observed in tobacco (*Nicotiana tabacum*) (Mylonas and McCants, 1980), olive (*Olea europea*) with range of 30-240 ml/pot (Tattini *et al.*, 1991) and other crops (Chen and Aviad 1990). Hartwigsen and Evans (2000) revealed that HA at 5000, 10,000, or 15,000 ml/l increased growth of *Pelargonium* × *hortorum* L.H. Bailey Freckles' (geranium) and *Tagetes patula* L. 'Bonanza' (marigold). The effectiveness of HA on growth is due to the ready availability of HA to the plasma lemma of plant cells, as well as to the positive effect of HA on respiration and photosynthesis and enhancement of nutrient uptake like nitrogen, phosphorus and sulfur and micronutrients, *i.e.* (Fe, Zn, Cu and Mn) (Chen and Aviad, 1990)

Natural fertilizer is a proming technology to reduce the environmental pollution and increase the yield quality on basil. De kreij and Basar., (1995) tested how humic substances affected nutrient uptake of plants. The tested plants, oregano were thyme, and basil, were grown in nutrient film technique at two pH levels (4.5 and 6.5), in two substrates (peat and perlite), and at three levels of humic substance that was a peat extract (control, low, and high concentration). Nutrient uptake of potassium (K), calcium (Ca), magnesium (Ml), iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) were determined by elemental contents in aerial parts of the plant and its weight. Humic substance had no effect on K, Ca, and Ml uptake but lowered the uptake of Fe, Mn, Zn, and Cu for the three test plants, more pronounced with perlite than peat and more at low pH than at high pH.

The use of NFT with organic nutrient solution will be very important in the near future for environment and human health, while using chemical nutrient solution produced plants that contains high levels of nitrate which, is hazard for human health (Hill, 1990). The aim of this study is to test the ability of using humic acid as a nutrient solution for *Ocimum basilicum*L.cv. *Genovese* production under nutrient film technique (NFT).

MATERIALS AND METHODS

This study was carried out in the Hort. Dept. Lab., Fac. Agric., Zagazig Univ. during the two successive seasons of 2012 and 2013. The present work aimed to study the effects of two factors *viz*, nutrient solutions and humic acid on growth characters, of sweet basil cv. Genovese productivity and some chemical constituents under NFT conditions.

The source of transplants of *Ocimum basilicum* L.cv. genovese from Sekem, Salam City, Cairo, Egypt. Seedlings were planted in the Nutrient Film Technique (NFT) on April each year.

NFT Units Preparation

NFT units were designed by using plastic pipes (4 inches with 5 cm diameter) with 15 holes in every (4 m. length) in the upper surface of each. Pipes were fixed with a gental slope 1:100, so that solution could be flowed under the influence of gravity. The solution was pumped in PVC hose (0.5inch diameter), continuously from the tank to higher end of pipe by using electrical pump (120 1 hr^{-1}). Solution was flowed to the lower end of pipe and accumulated in the tank with continuous recirculation. Lower end of pipe were closed with plastic nets to prevent the exiting of culture media (in the case of using perlite or gravel as culture medium).The nutrient solution pH was hold at 5.8:6 by adding phosphoric acid. The nutrient solutions were changed when its EC decreased to 1.8:2.dsm/cm. Plants are grown in channels through which the nutrient solution is pumped. The plant roots are kept a moist by thin film of nutrient solution as it passed by.

The present work treatments could be under the following topics:

Nutrient solutions

Chemical composition of nutrient solutions which prepared with tap water as shown in Table A , concentrations of nutrient solution were 150 and 300 ml/l. The nutrient solutions were prepared according to El-Bahairy *et al.* (2008), all used nutrient solutions were changed weekly to avoid the changes in pH and the electrical conductivity (EC) since every used solution was adjusted at pH 6:6.5 and EC.1.8:2.

Humic acid (HA)

Humic acid treatments were at 0,100 and 200 ppm. Humic acid consists of potassium hyomate percentage 86% in humic acid. Humic acid commercial product (Hammer) was obtained from Union for Agriculture and Development company (UAD) it contains 86% humic acid, 6% K_2O and 7% fulvic acid.

Interaction treatments between nutrient solutions and humic acid treatments

Each treatment of humic acid was combined with each treatments of nutrient solutions to consist 6 interaction treatments.

NFT systems were presented by different pipes which divided to three groups. Since each group will be supplied with a different concentration of nutrient solution (150, 300 ml/ l). All previous solutions were compared with humic acid with 3 concentrations (0,100 and 200 ppm).

Data recorded

Growth characters

1-Plant height (cm)

2-Number of leaves/ plant

3- Number of branches/ plant

4-Fresh weight of leaves /plant (g.)

5- Dry weight of leaves /plant (g.)

Productivity of herb:

1- Yield fresh weight/plant(g.)

2- Yield dry weight/plant(g.)

Chemical constituents determination

Sample of vegetative leaves was taken at the beginning of flowering and the following data were recorded:

Table A. The chemical composition of nutrient solution

Macro element(ppm)	NFT solution (A)	The fertilizer Source
N	250	Ammonium nitrate (commercial fertilizer 33%N)
P	30	Phosphoric acid (9.5% P_2O_5)
K	300-350	Potassium salphate (commercial fertilizer 48% K_2O)
Ca	180-200	Calcium sulphate
Ml	50	Magnesium sulphate
Micro element (ppm)	**NFT solution (B)**	
Fe	3	Iron chelated (10. 5% Fe)
Mn	0.719	Manganese sulphate
Bo	0.250	Boric acid
Cu	0.125	Cupper sulphate
Mo	0.05	Ammonium molybodate
Zn	0.133	Zinc sulphate
Heavy metals (ppm)		
Cd	0.014	
Pb	0.157	
Co	0.013	
Ni	0.015	

Total chlorophyll was determined in fresh leaves according to the method described by cherry (1973). Total carbohydrate percentage in dry leaves determined according to the method described by Dubois *et al.* (1956). Total nitrogen, phosphorus and potassium percentage were determined in dry leaves according to Naguib (1969), Troug and Mayer (1939) and Jackson (1970), respectively. Quantitative analysis study of basil (herb) essential oil of dry leaves was achieved by hydrodistillation according to Guenther (1961).

Statistical Analysis

The treatments was arranged in a factorial experiment. In split plot design with three replicates. Each replicate consisted of 4 plants.

Nutrient solutions were arranged in the main plot and humic acid concentrations were distributed in the sub plot.

The collected data were subjected to statistical analysis according to Tomas and Hill (1978). The treatments means were compared using the least significant difference (LSD) at 5% level by using statistical analysis program (statistix 9).

RESULTS AND DISCUSSION

Growth Characters

Data in the Table 1 show that there are a significant differences between different treatments. 300 ml/l nutrient solution enhanced significantly plant height, number of leaves and number of branches compared to the 150 ml/ l nutrient solution in the two seasons. Expect number of branches in the first season.

Humic acid at 100ppm increased number of leaves/plant in both seasons, but humic acid concentration had no signifect effect on plant height and number of branches/plant.

Table 1. Effect of nutrient solutions and humic acid concentrations on plant height (cm), number of leaves /plant and number of branches/plant of *Ocimum basilicum* L. *cv.* Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient Solution	Humic acid (ppm)											
	plant height (cm)				Number of leaves/plant				branches /Plant Number of			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
					First season (2012)							
150 ml/l	26.00d	29.58cd	32.00bcd	29.19B	96.00c	269.50b	197.17b	187.56B	7.17d	17.67bc	15.33cd	14.83A
300 ml/l	43.33ab	45.33a	42.00abc	43.56A	455.33a	454.50a	220.17b	376.67A	27.83a	26.17ab	18.33a-c	24.11A
Mean (HA)	34.67A	37.46A	37.00A		275.67B	362.00A	208.67C		17.50B	24.08A	16.83B	
					Second season(2013)							
150 ml/l	32.52c	34.57c	31.45c	32.84B	152.50c	332.50b	177.75c	220.92B	11.50c	20.67b	18.75b	16.97B
300 ml/l	51.50a	40.03bc	45.25ab	45.59A	488.62a	331.00b	308.33b	375.99A	34.50a	20.00b	21.17b	25.22A
Mean (HA)	42.01A	37.30A	38.35A		320.56A	331.75A	243.04B		18.83A	20.33A	18.25A	

Data in Table 1 indicate that the interaction treatment between 300 ml /l nutrient solution and 100 ppm humic acid significantly increased the plant height, the number of leaves, and number of branches compared to 150 ml/l of the nutrient solution.

Represented treated by nutrient solution + 0 HA and NFT + 100 HA has significant effect in increasing the number of leaves and number of branches / plant compared to the control and the other treatments under study in the two seasons. These results were in agreement with those revealed by Padem *et al.* (1999).They recorded that adding of humic acid increased the plant height and number of leaves/ plant in eggplant and pepper seedlings. Adani and Spagnol. (1998) on tomato plants, used commercial humic acid at 20 and 50 ml/l and showed that, plant growth was stimulated with all humic acid concentrations.

Data in Table 2 indicate that NFT with 300 ml/l nutrient solution showed a significant differences in leaf area (cm²), fresh weight of leaves / plant (g) and dry weight of leaves / plant (g) in the two seasons. Different concentrations of HA had no significant effect during both seasons on the studied parameters. The interaction between nutrient solution and HA concentrations had a significant effect on dry and fresh used of leaves/plant. The result of the combination treatment between nutrient solution at 300 ml/l + HA at 100 ppm showed significantly the highest ability to increase leaf area in the first season only. Whereas, the increase in leaf area was insignificant in the second season. As for leaf fresh and dry weight the treatment of 300 ml/l as nutrient solution showed the highest effect in the two seasons. In this respect, Walters and Currey (2015) found the fresh weight of basil grown in deep flow technique systems was 2.6 g/plant greater compared with plants grown in NFT systems.

Productivity of herb /plant

The obtained results in Table 3 shows that nutrient solution at 300 ml /l had a superior effect on yield fresh and dry weight (g/plant) compared with 150 ml/ l during both seasons. Regarding the effect of HA on yield of fresh and dry weight of herb (g/plant), it can be observed that HA had a significant effect on these characters. In this respect, HA at 100 and 200 ppm resulted in the maximum mean value of fresh and dry weights of herb (g/plant) compared to control in both seasons.

The results reported here indicate high quality basil can be produced in greenhouse using HA as organic nutrient sources in a certified soilless mixture. Aboutalebi *et al.* (2013) grow the basil in organic and non organic

Table 2. Effect of nutrient solution and humic acid concentrations on leaf area (cm²), fresh weight of leaves/plant (g) and dry weight of leaves/plant (g) of *Ocimum basilicum* L. *cv.* Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient Solution	Humic acid (ppm)											
	Leaf area (cm²)				Leaf fresh weight/ plant (g)				Leaf dry weight/ plant (g)			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
					First season(2012)							
150 ml/l	3.81b	5.39b	5.81b	4.997B	18.79b	87.66ab	57.65ab	54.70B	1.43a	7.93a	4.71a	4.69B
300 ml/l	11.41b	17.38a	11.19b	13.32A	505.92a	347.81ab	345.43ab	399.72A	52.06a	41.98a	16.55a	36.86A
Mean (HA)	7.61A	11.38A	8.50A		262.35A	217.73A	201.54A		26.74A	24.95A	10.63A	
					Second season(2013)							
150 ml/l	7.55a	9.00a	7.47a	8.01A	63.46a	337.91a	85.80a	162.39B	3.88a	22.12a	6.88a	10.96A
300 ml/l	7.68a	11.40a	11.74a	10.27A	551.82a	442.87a	411.20a	468.63A	48.31a	36.90a	29.83a	38.35A
Mean (HA)	7.62A	10.20A	9.60A		307.64A	390.39A	248.50A		26.095A	29.51A	18.35A	

Table 3. Effect of nutrient solution and humic acid concentrations on yield of fresh weight(g)/ plant and yield of dry weight(g)/ plant of *Ocimum basilicum* L. cv. Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient solution	Humic acid (ppm)							
	Yield fresh weight (g)/ plant				Yield dry weight (g)/ plant			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
				First season(2012)				
150 ml/l	133.13d	250.21c	243.78c	209.04B	21.48d	33.21bc	29.64cd	28.11B
300 ml/l	382.29b	400.00ab	417.76a	400.02A	43.24ab	50.58a	49.34a	47.72A
Mean (HA)	257.71B	325.11A	330.77A		32.36B	41.91A	39.49AB	
				Second season(2013)				
150 ml/l	133.13e	250.21d	241.15d	208.16B	17.26d	28.63d	29.26cd	25.05B
300 ml/l	379.03c	395.85b	417.76a	397.54A	41.39bc	48.99b	66.67a	52.35A
Mean (HA)	256.08B	323.03A	329.46A		29.32B	38.81A	47.96A	

nutrient solution. The results showed that the highest yield was obtained in inorganic nutrient solution while the lowest one was attained in solid organic manure. Comparison between inorganic nutrient sources and organic nutrient solution indicated that there was no remarkable difference among them. Rakocy *et al.* (2003), compared different cropping systems to grow basil; his results showed that the mean yield of basil was 2.0, 1.8 and 0.6 kg/m^2 using batch, staggered and field cropping systems, respectively.

Chemical Constituents' Determination

Total nitrogen, phosphorus and potassium percentage

Table 4 show that nutrient solutions had no significant effect on N, P and K percentage except p and K% in the 2nd season wherein nutrient solutions at 150 and 300ml/l increased p and K content in leaves , respectively .

Concerning the effect of HA on N, P and K (%), data tabulated in Table 4, indicate that, N

Table 4. Effect of nutrient solutions and humic acid concentrations on nitrogen (%), phosphorus (%) and potassium (%) in leaves of *Ocimum basilicum* L. *cv.* Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient Solution	Humic acid (ppm)											
	N (%)				P (%)				K (%)			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
	First season (2012)											
150 ml/l	1.83bc	2.32a	1.96abc	2.04A	0.23a	0.21a	0.18ab	0.207A	5.23a	3.52c	3.26c	4.00A
300 ml/l	2.23ab	1.45c	2.18ab	1.96A	0.12b	0.19a	0.25a	0.184A	4.39b	5.31a	3.75bc	4.48A
Mean (HA)	2.03A	1.88A	2.07A		0.177A	0.197A	0.213A		4.81A	4.41A	3.50B	
	Second season(2013)											
150 ml/l	1.85c	2.32a	2.02bc	2.06A	0.23ab	0.21bc	0.19cd	0.21A	5.23a	3.49cd	3.24d	3.99B
300 ml/l	2.35a	1.47d	2.20ab	2.01A	0.11e	0.16d	0.25a	0.17B	4.35b	5.42a	3.72c	4.49A
Mean (HA)	2.10A	1.89B	2.11A		0.17B	0.18B	0.22A		4.79A	4.45B	3.48C	

and P (%) increased gradually with increment of HA in the 2nd season. So, the maximum mean values of N and P (%) were obtained as a result of HA at 200 ppm in the 2nd season. On the otherhand, the same data clear that, there is a negative relation between HA concentrations and K (%), where untreated plants gave the highest percentage from K.

Regarding, the combination treatments effect, it can be reported that,these treatments had a significant effect on N, P and K (%) (Table 4). The interaction between nutrient solution at 150 ml/l and HA at 100 ppm increased N content in leaves, while the interaction between nutrient solution at 300 ml/l and 200 ppm HA increased P content in leaves. The combination treatment between nutrient solution at 300 ml/l + HA at 0 ppm gave the maximum mean value of K (%) during both seasons. These results are in harmony with those revealed by Tattini *et al.* (1991) on olive plants, Adani and Spagnol.(1998) on tomato and Padem *et al.* (1999) on eggplant and pepper seedlings.

On the contrary a study was carried out by Abd El-Monem *et al.* (2008) on grapevine planted they revealed that HA reduced N content in leaves, while P and K content were not affected, on the other hand Nikbakht *et al.* (2008) reported that HA might benefit plant growth by improving nutrient uptake and horomonal effects. They found that N, P and K were significantly enhanced by HA.

Total chlorophyl (mg/g) and total carbohydrate (%)

Data in Table 5 indicate that, nutrient solution at 300 ml/l gave the highest mean value of total chlorophyll compared with nutrient solution at 150 ml/ l during both seasons.

Concerning, the effect of HA on total chlorophyll (mg/g), the data presented in the same Table show that these treatments had a significant effect where total chlorophyll decreased gradually as HA concentration increased.

Data in Table 5 show that, the combination tratments between HA and NFT nutrient solution resulted in a significant effect on total chlorophyll. The mean value of total chlorophyll reached to its maximum value as a result of NFT at 300 ml/l without HA.

Regarding the effect of nutrient solution and HA, data presented in Table 5 show that nutrient solutions and HA had no significant effect on total carbohydrate in leaves in both seasons.

Table 5. Effect of nutrient solutions and humic acid concentrations on total chlorophyll (mg/ g fresh weight) and total carbohydrates (%) in leaves of *Ocimum basilicum* L.cv. Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient Solution	Humic acid (ppm)							
	Total chlorophyll (mg/ g fresh weight)				Total Carbohydrates (%)			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
				First season (2012)				
150 ml/l	6.61b	6.92b	5.57b	6.37B	15.92ab	14.34b	15.23b	15.17A
300 ml/l	10.54a	10.10a	7.20b	9.28A	15.65b	17.58a	14.81b	16.01A
Mean (HA)	8.58A	8.51A	6.39B		15.79A	15.96A	15.02A	
				Second season (2013)				
150 ml/l	6.47bc	5.53c	6.43bc	6.14B	15.51a	15.48a	15.24a	15.41A
300 ml/l	9.08a	6.75b	7.15b	7.66A	16.55a	15.63a	15.98a	16.06A
Mean (HA)	7.77A	6.14B	6.79B		16.03A	15.55A	15.61A	

Table 6. Effect of nutrient solutions and humic acid concentrations on essential oil content (%) and oil yield (ml/plant) of *Ocimum basilicum* L. *cv.* Genovese grown in NFT system during the two seasons of 2012 and 2013

Nutrient Solution	Humic acid (ppm)							
	Oil (%)				Oil content (g)			
	0	100	200	Mean (NFT)	0	100	200	Mean (NFT)
				First season (2012)				
150 ml/l	0.050ab	0.033ab	0.017b	0.033A	0.44ab	0.36ab	0.171b	0.32A
300 ml/l	0.077a	0.067a	0.065a	0.069A	0.79a	0.71a	0.67ab	0.72A
Mean (HA)	0.063A	0.050A	0.041A		0.61A	0.53A	0.42A	
				Second season (2013)				
150 ml/l	0.040bc	0.030cd	0.013e	0.028B	0.35c	0.32c	0.14d	0.27B
300 ml/l	0.053b	0.070a	0.020de	0.048A	0.59b	0.74a	0.21cd	0.51A
Mean (HA)	0.047A	0.050A	0.017B		0.47A	0.53A	0.17B	

Concerning the interaction treatments effect, it can be observed from Table 5 that, these treatments had a significant effect on total carbohydrate (%) in the 1st season where the combination between nutrient solutions at 300 ml/l + HA at 100 ppm gave the highest mean value of total carbohydrate (%).

Essential oil content (%) and yield (g / plant)

The results in Table 6 show that the percentage of essential oil content (%) and oil yield (ml/plant) of basil increased significantly when the plants treated with 300 ml/l nutrient solution compared to 150 ml/ l nutrient solution in the 2nd season. HA at 200 ppm increased oil (%) and oil content in the 2nd season with no significant effect with control. The interaction between nutrient solutions and humic concentrations gave the highest oil content(%) and yield when treated by 300 ml/ l nutrient solutions only and 300 ml/l nutrient solutions +100 ppm (HA) compared to the control during both seasons.

A lot of studies revealed the importance of HA in agriculture where it is used as a bio stimulants and soil conditioners. As far as we now there is no previous work on HA in hydroponic systems, which will open a new window for a new agricultural nutrient solution. More studies and more physiological analysis are required to get the definitive formulations for growing *Ocimum basillicum* in hydroponic systems.

Generally, HA enhanced the efficacy of the nutrient solution and enhanced the *Ocimum basilicum* L.cv. Genovese growth and the optimum rate are 100 ppm HA. The Basil yield was increased 1.5 fold with 300 ml/l nutrient solution compared to 150 ml/l nutrient solution.

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تأثير المحاليل المغذية و حمض الهيوميك على نمو وإنتاجية وبعض المحتويات الكيميائية للريحان الحلو تحت ظروف تقنية الغشاء المغذي

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أجريت هذه الدراسة في معمل قسم البساتين كليه الزراعة جامعه الزقازيق خلال الموسمين المتتالين ٢٠١٢ و٢٠١٣، لدراسة تأثير بعض معاملات المحاليل المغذية (١٥٠، ٣٠٠ مل /لتر) وحمض الهيوميك (صفر، ١٠٠،٢٠٠ جزء في المليون) ومعاملات التفاعل بينهما تحت ظروف تقنيه الغشاء المغذي ، وكانت البيانات المسجلة هي صفات النمو (ارتفاع النبات، عدد الأوراق، عدد الأفرع، مساحه الورقة، الوزن الطازج والجاف للأوراق/للنبات) والإنتاجية (محصول العشب الطازج والجاف /للنبات، محصول الزيت) وبعض المحتويات الكيميائية (النسبة المئوية للنيتروجين، النسبة المئوية للفوسفور، النسبة المئوية للبوتاسيوم) لنبات الريحان صنف (جنوفيز)، يمكن التوصية من خلال النتائج بأستخدام المحلول المغذي بتركيز ٣٠٠ مل /لتر حيث أدى لزيادة بعض صفات النمو والإنتاجية والمحتوي الكيماوي لنبات الريحان وكانت الزيادة معنوية في معظم الحالات مقارنه بالكنترول، أن استخدام حمض الهيوميك بتركيز ١٠٠ جزء في المليون أدى لزيادة كفاءة المحلول المغذي وزيادة عدد الأوراق /نبات، عدد الأفرع /نبات، مساحه الورقة مقارنة بالكنترول.

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