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Response of Tuscany Basil (*Ocimum basilicum* '*Tuscany*') to Foliar Application and Different Growing Media under Aquaponic Unit

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ABSTRACT

Two field trials were carried out during 2021 / 2022 seasons for evaluating the growth of Tuscany basil as affected by some natural foliar application (yeast and seaweed) under different aquaponic growing media. Scarcity of global resources as a result of population growth, climatic changes, and water deficit. Aquaponics (including crops and fish) have the potential to achieve high yields per unit area with limited land, water and no soil. Soilless cultivation research was carried out at the Fish Research Unit Faculty of Agriculture, Mansoura University, Mansoura city, Egypt. The growth of *Ocimum basilicum* '*Tuscany*' grown in three different media (cocopeat + perlite mix, peatmoss + vermiculite mix and sponge) as well as the effect of spraying each of the yeast at 1, 2 and 3 g/ L and seaweed extract at1, 2 and 3 cm/L as natural materials that are environmentally friendly and improve growth, yield quality and do not affect the hydroponics system. It could be recommend to use the mixture of peat moss : vermiculite in equal proportions, as well as spraying yeast at 3 g/L every two weeks as a foliar spray for obtaining the best vegetative growth (plant height, leaf area, number of leaves/plant, fresh and dry weight), as well as the mineral contents (nitrogen, phosphorus, potassium, carbohydrates, nitrates, nitrites, content of the pigments total chlorophyll and carotenoids) of Tuscany basil under the Egyptian conditions.

Keywords: Aquaponic, Tuscany basil, growth media, yeast and seaweed extracts.

INTRODUCTION

Fast-growing global population, Water scarcity and development in urban areas needs to be addressed through the development of new and improved agricultural systems (Lal, 2013). The aquaponic system treats the scarcity of water and agricultural land and is considered a modern system to produce fish and food production (Medina *et al.*, 2016). Aquaponics is an integration of hydroponics and aquaculture, crops and aquatic can grow together on system (Love *et al.*, 2015). At the fish farming, the water is polluted, which may cause environmental pollution (Dauda *et al.*, 2019). Through the work of the aquaponic system by culturing plants with fish farming, it helped to reduce pollution (Saha *et al.*, 2015). The system reduces the use of fertilizers and the plants purify the water (Kloas *et al.*, 2015). In the aquaponics system, plants use fish wastes as fertilizers (Roosta and Hamidpour, 2011). Plants play a role in disposing of fish waste, in addition to selling it to generate an economic return (Saha *et al.*, 2016). It was found that this system provides water through fish farming and the use of the same water for plant growth, which helps solve the problem of water scarcity (Mullis and Reyes, 2019).

Also, Tuscany basil **(***Ocimum basilicum 'Tuscany'***)** known as Lettuce leaf basil. It is native to family Lamiaceae with herbaceous growth habit. This variety produces stunning 7.00 to 13.00 cm. long, bright green full leaves, that are puckered and ruffled throughout. A truly gorgeous variety that may be chopped fresh into salads, blitzed into pesto or used in warps. Aroma is like traditional basil, but with a mild hint of anise. Stunning in the garden, harvest leaves often and pinch off any developing flower spikes and this variety will produce new leaves throughout the summer.

Yeast extract is a safe nutrient for plants and contains a group of amino acids that help plants resist various stresses, like nutrients (Na, K, Ca, Fe, Mg, S, P, Si, Zn) and cytokinins, can activate cell division processes and fruit size and improve the growth of certain plants (Massoud *et al.*, 2022). Seaweed extracts like laminaria, Ascophyllum and Nodsum are used in growing crops. The chemical composition of seaweed consists of amino acids, complex sugars, minerals Zn, Co, Mo, Mn, Ni, vitamins and hormones (Begum *et al.*, 2018). It improve the plant resistance to many diseases and fungi. It can increase resilience by accelerating root growth and nutrient uptake, and plants can withstand stress, such as temperature and starvation. It has a significant effect on the content of basil, with a regularly increasing percentage of mineral content (El-Naggar *et al.*, 2020). There are many growing media that could utilize for hydroponics, which are environmentally friendly, produced organically, maintains an even air to water ratio, protects plants from pH changes over time, and is light enough to be easily transported.

Therefore, in this study, it is considered to be a good idea to use different types of media to fix plants by aquaponics system, spray yeast and seaweed extracts as natural materials to improve the growth of basil *'Tuscany'* vegetative parameters and internal chemical components.

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MATERIALS AND METHODS

The experiment was done at the Fish Research Unit and measurements were taken at Laboratory of the Vegetable and Ornamental Plants Dept., Faculty of Agriculture, Mansoura Univ., Egypt. In two successive planting seasons of 2021 / 2022.

Plant material

The plant of Ocimum basilicum 'Tuscany' Photo .1 seeds were obtained from Harraz farm and garden (6 Palestine Square, New Maadi, Cairo, Egypt). Seeds were sown in mix peatmoss and vermiculite 1:1 in seedling trays (11*19) 209 eyes for planting seeds and were covered with mixed soil, in August 15th of both seasons after two weeks complete germination, until after a month and a half (first October) 6 leaves (12-15cm) were appeared on each plant and then cultivation in foam under the aquaponics system.

Photo 1. The plant material under study *Ocimum basilicum'Tuscany'*after 45 days from seeds culturing.

Aquaponic unit:

The unit is made up of the following components Photo. 2:

1. Fish tanks: The facility consists of two plastic tanks (1 m^3 of water) in which Nile tilapia fingerlings were reared. At a stocking density of 100 fish/m^3, the average starting weight of seedlings was 30.5 g. The fish were fed a floating feed containing 30% crude protein, two meals a day at 9:00 am and 2:00 pm. The fish on which the fish were fed accounted for an average of 4% of the total fish biomass.

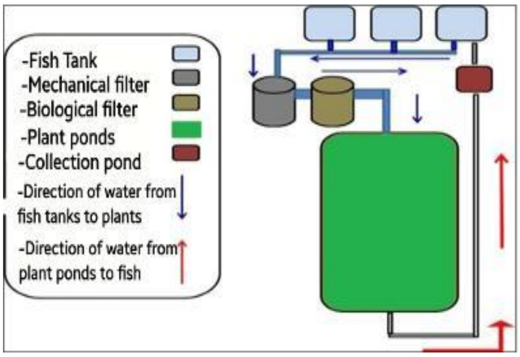

Photo2. Aquaponic unit components

2. A series of filters for water treatment including a 250 liter mechanical filter designed to separate solid waste (fish excrement and uneaten food) from the aquarium through a series of nets. The biofilter (capacity 250 liters) converts the gaseous waste (toxic ammonia) produced by the fish into less toxic nitrates. This is due to the presence of certain plastic materials that are considered vectors for the growth of bacteria such as Nitromonas and Nitrobacter.
3. Plant ponds: A 6m^3 plant growth tank (6mL x 2mW x 0.5mH) with water supply. It is covered with perforated foam panels, with each hole spaced 20 cm from the other for planting.
4. Collection pond: A basin to collect the water returning from the plant basin, which is then lifted to the fish tanks through a water lifting pump. Work with a timer so that it works for half an hour and stops for half an hour.

Experimental design:

Treatments were arranged in a split plots with three replicates. Planting media was assigned in the main plot (coco peat + perlite, peat moss + vermiculite and sponge), foliar applications with yeast extract spraying every two weeks was in the sub plot. In addition yeast extract analyses was achieved in Table (A) at three concentrations 1, 2 and 3 g / l and seaweed extract at three concentrations 1,2 and 3 cm / l were allocated in the sub plots a commercial seaweed extract product was used.

Replicate included nine plants and experiment design included the interaction treatments were twenty-one treatments. Foliar spraying was done every two weeks. Prior to any practices, aquaponics water analysis table before the experiment in Table (B).

Table A. Yeast extract composition according to Mohamed *et al.*, (2022).

yeast extract			
Macro (g/100 g dry weight)		Micro (mg/100 g dry weight)	
P_2O_5	7.22	Al	650.1
K_2O	49.66	B	177.3
N	33.24	Co	67.7
Amino acids		Mn	82.2
(mg/100 g dry weight)		Sn	223.8
Arginine	1.98	Zn	334.9
Histidine	2.66	MgO	5.75
Isoleucine	2.30	Cao	3.02
Leucine	3.08	SiO_2	1.54
Methionine	0.70	SO_2	0.50
Phenylalanine	2.03	Cl	0.05
Thereonine	2.08	FeO	0.93
Tryptophan	0.46	NaCl	0.28
Valine	2.17	Vitamins (mg/100 g dry weight)	
Glutamic acid	2.02	B1	2.21
Serine	1.58	B2	1.34
Aspartic acid	1.33	B6	1.26
Cystine	0.24	B12	0.14
Proline	1.52	Riboflavin	4.95
Tyrosine	1.47	Insitrol	0.24
		Biotin	0.08
Carbohydrates		Nicotinic	39.88
(mg/100gdryweight)		Piminobenzocic acid	19.56
carbohydrates	23.22	Folic acid	4.36
Glucose	13.31	Pyridoxine	2.90

Table B. Analysis of the fish water before the experiment.

Temperature (°C)	pH	Dissolved Oxygen (mg-L)	Total ammonia nitrogen (mg-L)	NH_3-N (mg-L)	NH_4-N (mg-L)
25.88 ±2.18	7.88 ±0.55	4.06 ±0.37	0.547 ±0.13	0.045 ±0.008	0.502 ±0.103

The harvest was done at January 15th in both seasons.

Data recorded:

1. Morphological characters:

1. Plant length (cm).

2. Plant leaf area (cm^2).
3. Number of leaves/plant.
4. Plant fresh weight (g).
5. Plant dry weight (g).

2. Chemical determination analysis:

1. Nutrient elements determination from the dry plant samples:

-N%, P % and K% determined according to Mertens (2005 a and b).

-Total carbohydrates: determined according to Hedge and Hofreiter (1962).

-Nitrate and nitrite contents determined by spectrophotometric method after zinc reduction (Merino 2009).

-Total chlorophylls and carotenoids (mg/g FW) in fresh leaf: were determined according to Mackinney (1941).

Statistical analysis:

Data were statistically analyzed using the analysis of variance according to Steel and Torrie (1980). The statistical software GenStat Ver 11 computer program was used. The treatment means were compared using the Duncan multiple range method at 0.05 level of probability, as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Morphological characters:

In Table .1 when studying the effect of agricultural media on vegetative growth in both seasons, the highest value in plant length, leaf area, fresh and dry weight. was found when using a mixture of peat moss: vermiculite without significant differences with coco peat + perlite in most cases. In the first season, only when used a mixture coco peat + perlite the characteristic of the number of leaves / plant of the highest number concerned, while in the second season it was similar to the result of the previous characteristics.

The increasing in vegetative measurements is may be due to the presence of strong root growth in the agriculture mixture of peat moss: vermiculite, which helped in the absorption of nutrients, which led to its superiority over other agriculture mixture.

When studying the effect of foliar spraying alone, it was found that the use of yeast extract of higher concentration 3g/L as a foliar spraying gave significantly higher values in all treats without significant differences with seaweed extract 3 cm / l in addition it was also found that the foliar spray using seaweed extract 3 cm / l took the second position nearly and gave similar results to the higher concentration of yeast extract of higher concentration 3 g/l in the two seasons.

Table.2 and photo.3 recorded the interaction effect between media and foliar application. The plants treated with 3g/ l yeast extract and planted in peatmoss + vermiculite resulted in the greatest significant increase in plant length without significant difference with seaweed extract 3 cm / l and coco peat: perlite, leaf area, number of leaves / plant and plant dry weight.

Cleared that used foliar spray using yeast extract the highest concentration 3 g / l or seaweed extract 3 cm / l foliar spray and planted in cocopeat + perlite gave the highest values significantly in an increase in plant length in both seasons than 1g/l and control with significant difference.

These results are in agreement with reported by Nassar *et al*., (2015) on basil. El-Naggar *et al*., (2020) on basil since mentioned that leaf area increased as a result of yeast extract foliar application.

This may be due to that yeast enhances most metabolism processes needed for vegetative growth. The superiority of yeast extract may be due to it contains major and minor elements, amino acids and vitamin's role for the growth carbohydrate metabolism, cell wall, protein synthesis and sugars translocation of higher plants. The results agree in the basil plant with those obtained by Mohamed *et al*., (2017). It is important to note that there is a strong relationship between leaf area and photosynthetic content, which is predictably reflected in all plant growth parameters.

Photo 3. Showing the size leaf basil Tuscany as affected by foliar application with yeast extract at 3g/l.

In the 1st season, it was found that spraying with active dry yeast at 3 g / L and it was cultivated in the mix of cocopeat: perlite or sponge, gave heaviest fresh weight (g) (36.02 and 38.76 respectively) while spraying with sea weed extract at a concentration of 3 g / l in a mixture of either peatmoss: vermiculite or sponge gave (36.02 and 38.76 respectively) and there was no significant difference between any of them.

In the second season, it was found that the heaviest significant weight was obtained either by spraying with active dry yeast 3 g / l and cultured in a mixture of cocopeat + perlite or algae extract at a concentration of 3 g / l and cultured in peatmoss: vermiculite (36.51 and 35.12 respectively) and it was not there is a significant difference between them.

Table 1. Effects of cultivation in different media and foliar applications on *'Tuscany'* plant length (cm), Plant leaf area (cm^2), number of leaves/plants, plant fresh and dry weight (g) during the two seasons of 2021and 2022.

Treatments		Plant length (cm)		Plant leaf area (cm^2)		number of leaves/plant		Plant fresh weight (g)		Plant dry weight (g)	
		S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
media type											
coco peat + perlite		28.47a	27.71a	85.61b	77.66b	20.47a	21.14b	24.97a	24.44a	4.73a	4.87a
peatmoss +vermiculite		30.47a	29.14a	120.42a	117.19a	22.71b	22.66a	24.26a	23.84a	4.69a	4.61ab
sponge		22.76b	21.80b	95.38b	84.42b	19.28b	18.19c	25.42a	24.13a	4.60a	4.34b
Foliar application											
Control		17.77d	16.11d	60.66d	50.44f	15.44e	10.88e	13.26d	12.14d	3.60d	3.43e
yeast extract	1g/l	20.88c	20.22c	79.55cd	75.77e	18.22de	18.22cd	19.12c	18.20c	3.66d	3.98d
	2g/l	25.88b	27.44b	97.00bc	93.88cd	22.55bc	26.22ab	22.81b	25.89b	4.96bc	5.02c
	3g/l	33.22a	35.00a	135.77a	129.00a	25.88a	27.88a	35.26a	33.68a	6.61a	6.34a
seaweed extracts	1cm/l	27.00b	23.22c	87.33c	81.11de	19.88cd	16.33d	25.12b	23.38b	4.06d	3.88d
	2cm/l	31.55a	27.44b	118.44ab	105.44bc	20.44bcd	19.33c	25.65b	24.57b	4.30cd	4.16d
	3cm/l	34.33a	34.11a	124.55a	116.00ab	23.33ab	25.77b	32.97a	31.10a	5.54b	5.45b

The same letter (s) in a column are not significant at 5% level

Table 2. Effects of interaction cultivation in different media and foliar applications on *'Tuscany'* plant length (cm), plant leaf area (cm^2), number of leaves/plants, plant fresh and dry weight (g) during the two seasons of 2021 and 2022.

Treatments			Plant length (cm)		Plant leaf area (cm^2)		number of leaves/plant		Plant fresh weight (g)		Plant dry weight (g)	
media type	Foliar application		S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
cocopeat + perlit	Control		14.33i	13.00j	56.00g	50.00i	12.00h	10.00i	14.49 gh	12.80 j	3.41i	3.70 gh
	yeast extract	1g/l	18.66hi	20.00hi	75.66c~g	72.66fghi	15.33gh	16.66ef	20.22ef	19.19hi	3.86ghi	4.40defg
		2 g/l	25.66efg	28.66ef	94.33b~g	91.66defg	23.66bcd	28.00ab	24.54de	28.82cd	4.84def	4.86cdef
		3 g/l	37.00ab	38.66ab	108.66bcd	98.00defg	26.66ab	29.00ab	36.02ab	36.51a	6.64a	6.96a
	seaweed extracts	1cm/l	30.66bcde	26.33fg	72.33defg	65.33ghi	21.66b~f	15.00fgh	24.78de	22.74efgh	4.26fghi	4.03 fgh
		2cm/l	35.33abc	31.33de	87.00c~g	72.66fghi	20.66cdef	23.33cd	26.21cd	25.02defg	4.64efg	4.84cdef
		3cm/l	37.66a	36.00abc	105.33bcde	93.33defg	23.33bcd	26.00bc	28.54cd	26.03def	5.46cde	5.30bcd
peatmoss +vermiculite	Control		19.33ghi	17.66i	59.33fg	54.66hi	17.00fg	10.66hi	12.87h	11.42j	3.66i	3.23h
	yeast extract	1g/l	24.00fgh	22.66 gh	85.00c~g	86.66d~h	20.66cdef	23.33cd	18.39fg	16.49i	3.69hi	3.79gh
		2g/l	32.66abcd	35.66abcd	110.00bcd	116.66cde	25.00abc	30.66a	25.31cde	27.91d	6.28abc	6.12 ab
		3g/l	38.00a	39.00a	168.66a	177.33a	29.66a	31.33a	31.00bc	32.41 bc	6.47ab	6.90 a
	seaweed extracts	1cm/l	30.66bcde	27.33efg	116.00bc	106.66cdef	20.66cdef	18.66ef	22.64def	21.34 gh	3.59i	3.55 gh
		2cm/l	32.66abcd	27.33efg	169.00a	158.33ab	22.00b~f	18.00ef	23.50def	22.23 fgh	3.66i	3.31h
		3cm/l	36.00ab	34.33bcd	135.00ab	120.00cd	24.00bcd	26.00bc	36.16ab	35.12ab	5.50cde	5.41 bc
sponge	Control		19.66ghi	17.66i	66.66efg	46.66i	17.33efg	12.00ghi	12.42h	12.20j	3.73ghi	3.37h
	yeast extract	1g/l	20.00ghi	18.00i	78.00c~g	68.00ghi	18.66defg	14.66fgh	18.76fg	18.91hi	3.44i	3.75 gh
		2g/l	19.33ghi	18.00i	86.66c~g	73.33fghi	19.00defg	20.00de	18.59fg	20.94h	3.75ghi	4.07fgh
		3g/l	24.66efgh	27.33efg	130.00ab	111.66cde	21.33cdef	23.33cd	38.76a	32.13bc	6.71a	5.15cde
	seaweed extracts	1cm/l	19.66ghi	16.00ij	73.66defg	71.33ghi	17.33efg	15.33fg	27.96cd	26.08def	4.31fghi	4.07fgh
		2cm/l	26.66def	23.66gh	99.33b~f	85.33efgh	18.66defg	16.66ef	27.26cd	26.47de	4.61efgh	4.34 efg
		3cm/l	29.33cdef	32.00cde	133.33ab	134.66bc	22.66bcde	25.33bc	34.23ab	32.17 bc	5.65bcd	5.65bc

The same letter (s) in a column are not significant at 5% level

2. Chemical determination analysis:

- N%, P % and K%:

In Table .3 to study the individual effects of each of the cultivation media and the type of foliar spraying, it was found that. The best media was the mixture of peat moss: vermiculite which gave the highest value of N, P and K% content, with a significant difference compared to other treatments and the second treatment was taken by the cocopeat + perlit and the last when growing the Tuscan basil in the sponge.

When studying the effect of foliar spraying, it was found that the use of an extract concentration of 2 or 3 g / l gave the highest of N, P and K% in both seasons, and the difference was significant compared to the lower concentration and the control.

It was also found in the same table that spraying with seaweed extract at a concentration of 3 cm / l gave the highest value for both N and P%, and that was in the second season only.

Table 3. Effects of cultivation in different media and foliar applications on'Tuscany' N%, P% and K % during the two seasons of 2021 and 2022.

Treatments		N%		P %		K%	
		S1	S2	S1	S2	S1	S2
media type							
cocopeat + perlit		2.73b	2.66b	0.40b	0.39b	3.24b	3.27b
peatmoss +vermiculite		2.79a	2.76a	0.41a	0.41a	3.30a	3.32a
sponge		2.35c	2.35c	0.36c	0.36c	2.94c	3.01c
Foliar application							
Control		2.13d	2.06d	0.34f	0.34d	2.75f	2.77f
yeast extract	1g/l	2.58c	2.45c	0.38d	0.38c	3.12d	3.16d
	2g/l	2.85a	2.80a	0.41a	0.41a	3.35a	3.40a
	3g/l	2.89a	2.88a	0.38a	0.42a	3.38a	3.42a
seaweed extracts	1cm/l	2.50c	2.44c	0.38e	0.38c	3.06e	3.10e
	2cm/l	2.67b	2.66b	0.39c	0.39bc	3.19c	3.23c
	3cm/l	2.76b	2.83a	0.40b	0.40ab	3.27b	3.31b

The same letter (s) in a column are not significant at 5% level

Data in Table .4 showed that interaction plants cocopeat + perlit or peat moss: vermiculite treated with the yeast extract 2 or 3 g / l gave the highest N % in both seasons than the 1g/ l and control. Without significant differences with cocopeat + perlit or peat moss: vermiculite and using 2 or 3cm/l of seaweed extract in the second seasons.

It was quite obvious that nitrogen % was in an ascending order in relation with the increase of yeast level. This increase appeared to be related to yeast that have an effect in promoting minerals uptake.

In the same table, it was found that P%, there was no significant difference between the use of any treatment under study.

Data in Table .4 showed that planted in peat moss: vermiculite treated with the 2 or 3 g / l yeast extract gave the highest potassium % in both seasons.

The effect of yeast extract on mineral elements content was studied by Abou El Salehein *et al.,* (2021) on sweet basil were recorded the highest values on chemical contents.

Table 4. Effects of interaction cultivation in different media and foliar applications on 'Tuscany' N%, P% and K % during the two seasons of 2021 and 2022.

Treatments			N%		P %		K%	
Media type	Foliar application		S1	S2	S1	S2	S1	S2
cocopeat + perlit	Control		2.13o	2.04h	0.34a	0.33a	2.76op	2.75k
	yeast extract	1g/l	2.69ghi	2.46ef	0.40a	0.37a	3.21gh	3.24fg
		2g/l	2.99abc	2.94ab	0.42a	0.438a	3.46c	3.49ab
		3g/l	3.03ab	2.97ab	0.43a	0.43a	3.49bc	3.55a
	seaweed extracts	1cm/l	2.58ij	2.46ef	0.39a	0.39a	3.13hi	3.17gh
		2cm/l	2.79efg	2.79bcd	0.40a	0.40a	3.30ef	3.33de
		3cm/l	2.89cde	2.96ab	0.41a	0.41a	3.37de	3.39cd
peatmoss +vermiculite	Control		2.18no	2.11gh	0.35a	0.35a	2.80no	2.84j
	yeast extract	1g/l	2.73fgh	2.63de	0.40a	0.41a	3.25fg	3.29ef
		2g/l	3.08a	3.00ab	0.43a	0.42a	3.55ab	3.49ab
		3g/l	3.11a	3.11a	0.44a	0.44a	3.57a	3.56a
	seaweed extracts	1cm/l	2.65hi	2.69cde	0.39a	0.39a	3.18gh	3.22fg
		2cm/l	2.84def	2.88abc	0.41a	0.41a	3.34e	3.37de
		3cm/l	2.95bcd	2.92ab	0.42a	0.42a	3.42cd	3.46bc
sponge	Control		2.08o	2.04h	0.34a	0.34a	2.69p	2.73k
	yeast extract	1g/l	2.30m	2.27fgh	0.36a	0.36a	2.90lm	2.96i
		2g/l	2.48jkl	2.47ef	0.38a	0.38a	3.06ij	3.22fg
		3g/l	2.53jk	2.57de	0.38a	0.38a	3.09ij	3.16gh
	seaweed extracts	1cm/l	2.26mn	2.16gh	0.36 a	0.36a	2.86mn	2.93i
		2cm/l	2.37lm	2.32fg	0.36a	0.36a	2.95kl	2.99i
		3cm/l	2.44kl	2.60de	0.37a	0.37a	3.02 jk	3.09h

The same letter (s) in a column are not significant at 5% level

- Carbohydrates%, NO_3-N mg.kg^{-1} and NO_2-N mg.kg^{-1}:

Data recorded in Table .5 showed that the best media was the mixture of peat moss: vermiculite which gave the highest value of carbohydrates%, NO_3-N mg.kg^{-1} and NO_2-N mg.kg^{-1} content in both seasons, with a significant difference compared to other treatments.

When growing the Tuscan basil in a mixture of cocopeat + perlite it gave 30.41% of carbohydrates in the second season, and this result was no significant difference between it or peat moss: vermiculite, it was also found that the proportion of NO_3-N mg.kg^{-1} is superior for the same media with no significant difference between cultivation in the two mixture of media.

When studying the effect of foliar spraying, it was found that the use of active dry yeast extract at concentration of 2 or 3 g / l gave the highest of carbohydrates%, NO_3-N mg.kg^{-1} and NO_2-N mg.kg^{-1} in both seasons, and the difference was significant compared to the lower concentration and the control.

Carbohydrates% as affected by yeast a spraying may be attribute to the many enzymes, vitamins etc. Which the yeast a possess that have a response on photosynthesis process.

Table 5. Effects of cultivation in different media and foliar applications on 'Tuscany' Carbohydrates%, NO_3-N mg.kg^{-1} and NO_2-N mg.kg^{-1} during the two seasons of 2021 and 2022.

Treatments		Carbohydrates %		NO_3-N mg.kg^{-1}		NO_2-N mg.kg^{-1}	
		S1	S2	S1	S2	S1	S2
media type							
cocopeat + perlit		30.30b	30.41a	313.86a	315.76a	4.15b	4.16b
peatmoss +vermiculite		30.60a	30.60a	316.18a	318.56a	4.27a	4.29a
sponge		28.61c	28.60b	297.82b	300.71b	3.42c	3.41c
Foliar application							
Control		27.56e	27.66e	301.00d	305.00c	3.55e	3.58f
yeast extract	1g/l	29.63c	29.64c	305.98c	308.76bc	3.8c	3.83d
	2g/l	30.88a	31.04a	316.44a	319.66a	4.27a	4.26a
	3g/l	31.11a	31.13a	315.62a	319.28a	4.25a	4.26a
seaweed extracts	1cm/l	29.24d	29.19d	304.55c	305.66c	3.72d	3.71e
	2cm/l	30.03b	29.85c	310.5b	309.05bc	4.00b	4.00c
	3cm/l	30.41b	30.59b	310.92b	314.34ab	4.03b	4.05b

The same letter (s) in a column are not significant at 5% level

In the Table .6, the highest value of carbohydrates%, NO_3-N mg.kg-1 and NO_2-N mg.kg^{-1} in both seasons observed resulted from the Tuscan basil in peat moss: vermiculite and spray by using 2or 3 g/l of yeast extract, and found that using the same concentration of active dry yeast and mixture of cocopeat + perlite gave the highest value of carbohydrates%, NO_3-N mg.kg^{-1} in this was evident through the results obtained during the two seasons.

The effect of yeast extract on carbohydrates content was studied by some workers. El-Leithy *et al*., (2007) on *Origanum syriacum;* plant found that the content of total carbohydrates was increased when plant treated by yeast. Abou El Salehein *et al*., (2021) on sweet basil showed that, the total carbohydrates were increased with increasing the concentrations of yeast.

Table 6. Effects of interaction cultivation in different media and foliar applications on 'Tuscany' carbohydrates%, NO_3-N mg.kg^{-1} and NO_2-N mg.kg^{-1} during the two seasons of 2021 and 2022.

Treatments			**Carbohydrates%**		**NO_3-N mg.kg^{-1}**		**NO_2-N mg.kg^{-1}**	
Media type	**Foliar application**		**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
cocopeat + perlit	Control		27.55qr	27.65hi	304.80ghij	306.80fg	3.73kl	3.76i
	yeast extract	1g/l	30.11ghij	30.23e	310.86d~h	314.20defg	4.04h	4.08f
		2g/l	31.48abcd	31.79ab	322.53ab	326.20abc	4.55bc	4.57b
		3g/l	31.72abc	31.71abc	319.93abc	323.26abcd	4.46cd	4.52bc
	seaweed extracts	1cm/l	29.68ijkl	29.65f	308.30efghi	304.30ghi	3.88ij	3.83h
		2cm/l	30.57efgh	30.72de	316.43a~e	318.76abcde	4.23f	4.25e
		3cm/l	31.01cdef	31.18cd	314.16b~f	316.83bcdef	4.16fg	4.12f
peatmoss +vermiculite	Control		27.88pqr	28.00gh	306.16f~j	312.83efg	3.79jk	3.84h
	yeast extract	1g/l	30.33fghi	30.42e	313.16c~g	316.50cdef	4.11gh	4.14f
		2g/l	31.91ab	31.98a	324.93a	328.26a	4.68a	4.65a
		3g/l	32.14a	32.26a	323.33a	326.66ab	4.63ab	4.64a
	seaweed extracts	1cm/l	29.87hijk	29.67f	309.33e~i	316.00def	3.94i	3.98g
		2cm/l	30.81defg	30.49e	317.20a~e	313.86defg	4.33e	4.34d
		3cm/l	31.26bcde	31.41bc	319.16abcd	315.83def	4.41de	4.47c
sponge	Control		27.26r	27.34i	292.03m	295.36hi	3.12r	3.16n
	yeast extract	1g/l	28.45nop	28.28g	293.93lm	295.60hi	3.25q	3.27m
		2g/l	29.24klmn	29.36f	301.86ijkl	304.53gh	3.59mn	3.55k
		3g/l	29.48jklm	29.43f	303.60hijk	307.93fg	3.66lm	3.63j
	seaweed extracts	1cm/l	28.16opq	28.27g	296.03klm	296.70hi	3.35p	3.33m
		2cm/l	28.71mno	28.35g	297.86jklm	294.53i	3.45op	3.42l
		3cm/l	28.97lmno	29.18f	299.43jklm	310.36efg	3.52no	3.55k

The same letter (s) in a column are not significant at 5% level

-Total chlorophyll and carotene (mg \ g FW):

In Table .7 when sown Tuscan basil in the mixture of peat moss: vermiculite which gave the highest value of total chlorophyll and carotene (mg \ g FW) in both seasons.

Used sponge in the same table nearly as the same as the mixture of peat moss: vermiculite except carotene in second seasons with significant difference.

When studying the effect of foliar spraying, it was found that the use of yeast extract at concentration of 3 g / l or seaweed extract at 3 cm/ l gave the highest of total chlorophyll and carotene (mg \ g FW) in both seasons.

In Table .8 when studying the interaction between the two factors, the cultivation mixture and the effect of foliar spraying, it was found that the best result was in the two seasons, planting in cocopeat + perlite and spraying with a concentration of 3 g / l of yeast extract.

Moreover, it may be noted that the lowest chlorophyll and carotene (mg \ g FW) level in general was observed with interaction of the lowest levels of yeast extract in all mixture media and control.

These results were in harmony with those reported by some workers. Nassar *et al*., (2015) and Abou El Salehein *et al*., (2021) on basil increased total chlorophyll content in leaves.

This result assures the availability of not using the chemical fertilizers and using yeast extract as a foliar spray every two weeks during the growth stage to harvest.

Table 7. Effects of cultivation in different media and foliar applications on 'Tuscany' total chlorophyll and carotene (mg \ g FW) during the two seasons of 2021 and 2022.

Treatments		**Total chlorophyll (mg \ g f.w.)**		**Carotene (mg \ g f.w.)**	
		S1	**S2**	**S1**	**S2**
media type					
cocopeat + perlit		34.18b	33.37b	9.01b	8.87a
peatmoss +vermiculite		36.85ab	36.85a	9.77a	9.77a
sponge		38.29a	38.33a	10.05a	10.19b
Foliar application					
Control		29.13c	26.64d	8.00c	7.12d
yeast extract	1g/l	30.28c	31.30c	7.63c	8.21c
	2g/l	35.09b	36.12b	9.65b	9.80b
	3g/l	42.18a	42.74a	10.86a	11.34a
seaweed extracts	1cm/l	38.24ab	36.29b	10.11ab	9.57b
	2cm/l	39.28ab	37.59b	10.69ab	10.12b
	3cm/l	40.87a	42.63a	10.35ab	11.13a

The same letter (s) in a column are not significant at 5% level

Table 8. Effects of interaction cultivation in different media and foliar applications on 'Tuscany' total chlorophyll and carotene (mg \ g FW) during the two seasons of 2021 and 2022.

Treatments			Total chlorophyll (mg \ g f.w.)		Carotene (mg \ g f.w.)	
Media type	Foliar application		S1	S2	S1	S2
cocopeat + perlit	Control		23.84f	23.84k	6.82g	6.32 k
	yeast extract	1g/l	29.74def	28.69ijk	6.62g	7.12 jk
		2g/l	33.34bcde	34.39efgh	9.08cdef	9.08 efgh
		3g/l	44.24a	44.24ab	11.15ab	11.15abc
	seaweed extracts	1cm/l	37.35abcd	31.69 ghij	9.44abcde	8.44ghi
		2cm/l	33.34bcde	31.41 ghij	10.13abcd	9.43defg
		3cm/l	37.43abcd	39.36bcde	9.85abcd	10.55 abcd
peatmoss +vermiculite	Control		33.28bcde	26.75 jk	9.21bcdef	7.25ijk
	yeast extract	1g/l	28.31ef	31.72 ghij	7.58fg	9.01fgh
		2g/l	36.29abcde	38.06cdef	9.89abcd	9.97cdef
		3g/l	38.32abcd	39.67 bcde	10.56abcd	11.00abc
	seaweed extracts	1cm/l	38.57abc	38.38cdef	10.20abcd	9.58defg
		2cm/l	40.28ab	40.70abcd	10.58abcd	10.44 bcd
		3cm/l	42.93a	42.70abc	10.40abcd	11.16abc
sponge	Control		30.29cdef	29.34 hij	7.97efg	7.79hij
	yeast extract	1g/l	32.80bcde	33.50fghi	8.70def	8.50ghi
		2g/l	35.66abcde	35.91 defg	9.98abcd	10.36 bcde
		3g/l	43.99a	44.32ab	10.86abc	11.86a
	seaweed extracts	1cm/l	38.79abc	38.79cde	10.68abc	10.68 abcd
		2cm/l	44.24a	40.65abcd	11.38a	10.51bcd
		3cm/l	42.25 a	45.84 a	10.81 abc	11.67ab

The same letter (s) in a column are not significant at 5% level

CONCLUSION

From the aforementioned study, it could be recommended that using of a mixture of peat moss: vermiculite in under aquaponic systems with limited water and spraying with yeast at 3 g /L every two weeks as foliar spray to achieve the best results during the growth period and gave the best results for vegetative growth, as well as content mineral of Tuscany basil under soilless systems in Egyptian conditions.

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استجابة الريحان التوسكان للرش الورقى والبيئات المختلفة تحت نظام الاكوابونكس

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الملخص

تم إجراء التجربة في موسميين زراعيين (٢٠٢١ / ٢٠٢٢) وذلك لدراسة تأثير نظم زراعية غير تقليدية التي يمكن ان تزيد من الموارد الناتجة وتحل مشكلة تغير المناخ وتزايد عدد السكان. الممارسات الزراعية البديلة مثل الاستزراع النباتي والسمكي (بما في ذلك نباتات المحاصيل والأنواع المائية) والتي لديها القدرة على إنتاج محاصيل عالية الجودة في حدة المساحة باستخدام مساحة محدودة من الأرض والمياه. أجريت التجربة بوحدة بحوث الأسماك بكلية الزراعة جامعة المنصورة لدراسة نمو نبات الريحان "التوسكان" الذي ينمو في ثلاث أوساط مختلفة (خليط الكوكوبيت مع البيرليت او خليط البيتموس مع الفيرميكيوليت او الاسفنج) وكذلك تأثير الرش الورقي بكل من الخميرة بمعدل ١ او ٢ او ٣ جم / لتر ومستخلص الطحالب في ١ او ٢ او ٣ سم / لتر كمواد طبيعية صديقة للبيئة وتحسن النمو وجودة المحصول ولا تؤثر على نظام الزراعة المائية. يمكن التوصية باستخدام خليط من البيت موس: الفيرميكيولايت بنسب متساوية، وكذلك رش الخميرة بمعدل ٣ جم / لتر كل أسبوعين كرذاذ ورقي لتحقيق أفضل النتائج خلال فترة النمو وإعطاء أفضل النتائج للنمو الخضري (طول النبات، مساحة الورقة ، عدد الأوراق / النبات ، الوزن الطازج والجاف) ، وكذلك المحتوى المعدني (النيتروجين ، الفوسفور ، البوتاسيوم ، الكربوهيدرات ، النترات ، النيتريت ، محتوى الأصباغ الكلوروفيل الكلي والكاروتين) للريحان التوسكان تحت الظروف المصرية.