ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Influence of Foliar Spray with Yeast Extract on Vegetative Growth, Yield of Fresh Herb, Anatomical Structure, Composition of Volatile Oil and Seed Yield Components of Basil Plant (*Ocimum basilicum* L.)

Mohamed A. Nassar, Mohamed U. El-Segai and Samah N. Azoz
Department of Agricultural Botany, Faculty of Agriculture, Cairo University, Giza, Egypt

Manuscript Info

Manuscript History:

Received: 15 August 2015
Final Accepted: 22 September 2015
Published Online: October 2015

Key words:

Basil, Ocimum basilicum L., Yeast extract, Morphology, Anatomy, Productivity, Volatile oil.

Corresponding Author

Samah N. Azoz

Abstract

In the present study the effect of foliar spray with different concentrations of yeast extract (2,4,8 and 12 g yeast extract/L.) on morphological characters of vegetative growth, yield of fresh herb, anatomical structure of vegetative organs, percentage and composition of volatile oil and seed yield components of Basil plant was observed.

The obtained results revealed that foliar application with yeast extract (YE) at (2,4 and 8 g YE/L.) increased significantly all investigated morphological characters of vegetative growth and yield of fresh herb per Basil plant at full blooming stage without significant differences among the three mentioned concentrations.

Anatomical studies indicated that spraying Basil plant with the most effective concentration (4g YE/L.) induced favourable enhancements in most of included tissues of the main stem and leaves especially in conducting tissues (phloem and xylem).

Basil herb at full blooming stage yielded 0.6% volatile oil for control plants against 0.65% volatile oil for plants sprayed with 4 g YE/L. The volatile oil of control plants and that of treated plants shared 27 compounds. The main constituents are linalool, geranial and neral. Linalool comprised 32.69% of the volatile oil of control plants against 35.36% of the volatile oil of treated plants.

All assigned concentrations of yeast extract showed no significant effect on specific weight of Basil seeds. Whereas, the first three used concentrations (2,4 and 8 g YE/L.) showed significant promotive effect on other investigated yield characters of Basil seeds. The maximum significant promotion was detected at 4g YE/L. which induced significant increases of 26.7, 20.5, 20.5, 52.6 and 51.9% for number of inflorescences/plant, number of fruits/inflorescence, number of nutlets (seeds)/ inflorescence, number of seeds/plant and yield of seeds/plant over those of the control; respectively.

INTRODUCTION

Ocimum basilicum L. (Basil or Sweet Basil), belongs to the family Lamiaceae (Labiatae), is an annual herb native to Southern Asia and the Middle East but it has long been grown in Europe as an ornamental, culinary and medicinal herb. Nowadays, it grows in several regions all over the world. The plant is widely used in food and oral care products. The essential oil of the plant is also used as perfumery. The leaves and flowering tops of the plant are used

as carminative, galactogogue, stomachic and antispasmodic medicinal plant in folk medicine (Chiej, 1988; Bunney,1992 and Evans, 1996). Also, it was reported about its antiviral and antimicrobial activities (Baratta et al., 1998 and Chiang et al., 2005).

Basil is one of the most important aromatic plants grown in Egypt, the cultivated area is about 1091 feddans produced about 1951 tons fresh herb per year and yielded about 29.262 tons essential oil (Arafa, 2007). Increasing productivity of Basil plant from fresh herb and essential oil per unit area is highly recommended to meet the demand of human needs and exportation.

Plant growth and development is known to be under the control of extremely minute quantity of endogenous hormones produced within the plant. Recently, a great attention has been paid on the possibility of using natural and safety substances which are rich sources of phytohormones in order to improve plant growth, flowering and fruit setting. In this connection, yeasts have been reported to be rich source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals (Barnett et al., 1990; Fathy and Farid, 1996, Khedr and Farid, 2000 and Mahmoud, 2001). It was reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Kraig and Haber, 1980 and Castelfranco and Beal, 1983). It participates in a beneficial role during stress due to its cytokinins content (Barnett et al., 1990). In this respect, El-Gamal (2005) found that yeast extract have promotive effect on vegetative growth, productivity and essential oil percent of Sweet Basil (*Ocimum basilicum* L.) either grown under normal conditions or grown under stress of salinity or drought. The enhancement effect of yeast extract on vegetative growth, productivity and essential oil percent and composition was also recorded on other medicinal and aromatic plants, for instance, Eid (2001) on *Coriandrum sativum*; Nagiub and Khalil (2002) on *Nigella sativa*; Abd El-latif (2006) as well as Massoud (2006) on *Salvia officinalis* and Ahmed (2009) on *Melissa officinalis*.

Therefore, the present investigation was designed to disclose the influence of spraying different levels from yeast extract on vegetative growth characters, stem and leaf anatomy, productivity and essential oil (percentage and composition) of Basil plant.

MATERIALS AND METHODS

The present study was carried out at the Agricultural Experiments and Researches Station, Faculty of Agriculture Cairo University, Giza, Egypt during the two successive summer growing seasons of 2011 and 2012 in order to study the effect of foliar spray with different concentrations of yeast extract on morphological, anatomical and productive characteristics of Basil plant (*Ocimum basilicum* L.). Moreover, the effect of yeast extract on the percentage and composition of essential oil of Basil herb was also investigated.

Seeds of Basil were procured from the Experimental Station of Medicinal Plants, Faculty of Pharmacy, Cairo University, Giza, Egypt. Yeast extract was obtained commercially as a powder from Electro Sciente Company, Egypt which was imported from Lab M Limited Company, United Kingdom. Yeast extract prepared by autolysis of *Saccharomyces cerevisiae*, which provides amino acids, peptides, vitamins, carbohydrates, enzymes and phytohormones making it suitable for foliar application. Yeast extract (YE) was spayed at concentrations of 2,4,8 and 12 g YE/L. The control plants were sprayed with tap water. Tween-20 was added as a spreading agent for tested treatments.

Field work procedure

Seeds of Basil were sown on 19th March, 2011 in the first season and replicated on 17th March, 2012 in the second season to provide the experimental plant materials. The experiment was made in a randomized complete block design with four replicates. The four levels of yeast extract beside the control required that the experimental land of each replicate be divided into five plots, each contained one treatment. The plot was six ridges, four meters long, 60 cm. apart. Seeds were sown in hills, spaced 20 cm. The plants were later thinned to two plants per hill. All field practices were carried out as recommended for the studied crop in the vicinity.

The tested concentrations of yeast extract were applied twice application at seven weeks from sowing date and the second application was three weeks from the first one and the volume of spraying solution per plot was almost 1.25 and 2.0 liters.

Morphological characters of vegetative growth

A random sample of 12 plants for each tested treatment (3 plants from each replicate) was assigned for investigation. Vegetative characters were recorded after 14 weeks from sowing date; i.e., four weeks after second application of yeast extract. This age represents full blooming. The following characters were studied in both growing seasons.

1- Plant height (cm): measured from the cotyledonary node up to the upper most point of the plant.

2- Number of primary branches developed per plant.

3- Number of leaves per plant.

4- Total leaf area (cm^2) per plant: measured by means of leaf area meter.

5- Fresh weight of shoot (g) per plant (represents yield of fresh herb per plant in grams).

Anatomical studies

A comparative microscopical examination was performed on plant material for treatment which showed remarkable response. In addition to the control, tested materials included the main stem at its median portion and lamina of the corresponding leaf. Specimens were taken throughout the second growing season of 2012 at the age of 12 weeks. Specimens were killed and fixed for at least 48 hrs. in F.A.A. (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax of melting point 56^{o}C, sectioned to a thickness of 20 microns, double stained with crystal violet-erythrosin, cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Sections were read to detect histological manifestations of the noticeable responses from application of yeast extract and photomicrographed.

Volatile oil (percentage and composition)

A chemical analysis was carried out to gain information about the effect of foliar spray with yeast extract on the percentage and composition of volatile oil of Basil herb at full blooming stage of the first growing season (the age of 14 weeks). Hydrodistillation of the volatile oil was conducted using the technique described by (Densy and Simon 1990). For each studied treatment, plant material was placed in a 2-liter roundbottomed flask with distilled deionized water (400 ml for 200 g fresh herb) and the volatile oil was extracted by water distillation using a modified Clevenger trap (ASTA, 1968). For smaller fresh plant samples, the distillation period was one hour and the volatile oil content was determined on an oil volume to tissue weight.

GC-MS technique was used to separate and detect the volatile oil constituents. Analysis was performed at Research Parks, Faculty of Agriculture, Cairo University, Giza, Egypt. GC-MS analysis was carried out on a Hewlett-Packard 6890 gas chromatograph fitted with a fused silica HP-5MS capillary column (30 m × 0.25 mm; film thickness 0.25 µm). The oven temperature was programmed from 50°-180°C at 5°C/min. Helium was used as carrier gas at a flow rate of 1 ml/min. The gas chromatograph was coupled to a Hewlett-Packard 6890 mass selective detector. The MS operating parameters were ionization voltage, 70 eV; and ion source temperature, 250°C.

Reproductive and seed yield characters

A random sample of 20 plants for each tested treatment (5 plants from each replicate) was taken at harvest time (16 and 18 weeks from sowing date for the first and second season; respectively) to investigate the following yield characters in each of the two growing seasons:

1- Number of inflorescences per plant.

2- Number of fruits per inflorescence.

3- Number of nutlets (seeds) per inflorescence.

4- Number of nutlets per plant.

5- Specific weight of seeds in grams (weight of 1000 nutlets).

6- Yield of seeds (g) per plant.

Statistical analysis

Data on morphological and yield characters were subjected to appropriate statistical analysis according to Snedecor and Cochran (1982). The data were statistically analyzed for each season and the homogeneity of experimental error, in both seasons, was tested. Then the combined analysis of the two seasons was done. The least significant difference (L.S.D.) at 0.05 level of probability was calculated for each determined character under different assigned treatments.

RESULTS AND DISCUSSION

Morphological characters of vegetative growth

Data on morphological characters of vegetative growth of Basil plant as affected by foliar spray with different concentrations of yeast extract are presented in Table (1). The studied morphological characters included plant height, number of primary branches/plant, number of leaves/plant and total leaf area/plant at full blooming stage, the age of 14 weeks.

Table (1): Morphological characters of vegetative growth and yield of fresh herb per Basil plant at full blooming stage, the age of 14 weeks from sowing date, as affect by foliar application with different concentrations of yeast extract (Average of the two seasons, 2011 and 2012 combined)

Treatments	Morphological characters of vegetative growth				Yield of fresh herb (g)/plant
	Plant height (cm)	No. of primary branches/plant	No. of leaves/plant	Total leaf area (cm^2)/plant	
Control (tap water)	73.9 B	14.1 B	311.7 B	4706 B	511.5 B
Yeast extract					
2g/L.	82.6 A	15.3 A	347.9 A	5212 A	581.3 A
4g/L.	**88.4 A**	**15.9 A**	**365.6 A**	**5624 A**	**619.8 A**
8g/L.	81.9 A	15.1 A	344.8 A	5196 A	577.1 A
12g/L.	68.4 B	13.3 B	292.1 B	4372 B	464.9 B
L.S.D. (0.05)	7.35	0.94	30.8	457.2	49.6

Means having the same letter are not significantly different at 0.05 level.

It is clear from Table (1) that all sprayed concentrations of yeast extract increased significantly all investigated morphological characters of vegetative growth of Basil plant except those of plants which were sprayed with the high used concentration of 12 g yeast extract /L. where the differences with the control plants proved insignificant in this respect. The maximum significant increase in any of the studied morphological characters was achieved when Basil plants were sprayed with 4 g yeast extract /L. (Fig. 1), being 19.6, 12.8, 17.3 and 19.5% more than the control for plant height, number of primary branches/plant, number of leaves/plant and total leaf area/plant; respectively. Worthy to note that the differences among the three effective concentrations of yeast extract (2,4 and 8 g/L.) were not significant.

In this respect, El-Gamal (2005) found that yeast extract at 5 g/L. have promotive effect on vegetative growth characters (plant height, number of lateral branches/plant and number of leaves/plant) of Sweet Basil (*Ocimum basilicum* L.) either grown under normal conditions or grown under stress of salinity or drought. The enhancement effect of yeast extract on vegetative growth was also recorded on other medicinal and aromatic plants, for instance, Eid (2001) on *Coriandrum sativum*; Nagiub and Khalil (2002) on *Nigella sativa*; Abd El-Latif (2006) as well as Massoud (2006) on *Salvia officinalis* and Ahmed (2009) on *Melissa officinalis*. Likewise, such enhancement effect of yeast extract on vegetative growth of some vegetable crops was also reported by Fathy and Farid (1996), Amer (2004), El-Tohamy and El-Greadly (2007), Nassar et al. (2011) and Abd El-Hakim et al. (2012) on Beans; Hewedy et al. (1996) and El-Tohamy et al. (2008) on Eggplant; El-Ghamriny et al. (1999), Fathy et al. (2000) and Abou El-Yazid and Mady (2011) on Tomatoes and Tartoura (2001) as well as El-Desouky and El-Greadly (2006) on Pea. All, being in agreement with the present findings.

Figure 1. Habit of mature plants, at flowering stage, of Basil as affected by foliar application with yeast extra
A- Control plant. B- Plant treated with 4g YE/L.

Yield of fresh herb/plant

The mean values of yield of fresh herb per Basil plant as affected by foliar application with different concentrations of yeast extract are presented in Table (1).

It is realized from Table (1) that foliar application with yeast extract at any of the first three tested concentrations (2,4 and 8 g yeast extract/L.) increased significantly yield of fresh herb per Basil plant at full blooming stage without significant differences among them. Whereas, foliar spray with the relatively high used concentration of 12 g yeast extract/L. showed no significant effect in this respect although insignificant decrease of 9.1% in yield of fresh herb below the control of Basil plant was observed. Worthy to mention that the maximum significant increase in yield of fresh herb was detected when Basil plants were sprayed with 4 g yeast extract/L., being 21.2% more than yield of fresh herb per control plant.

In this connection, Abd El-Latif (2006) and Massoud (2006) found that foliar application with yeast extract, especially at the rate of 5 g/L., induced significant increase in yield of fresh herb of *Salvia officinalis*. Likewise, Ahmed (2009) recorded insignificant increase in herb fresh weight of *Melissa officinalis* as a result of foliar application with yeast extract at 2,4 and 6 g/L., being in harmony with the present findings.

Anatomical studies

Anatomy of the main stem

Microscopical measurements of certain histological characters in transverse sections through the median portion of the main stem of Basil plant sprayed with 4g yeast extract/L. and those of control are presented in Table (2). Also, microphotographs depict these treatments are shown in Figure (2).

Table (2): Measurements in micro-meter (μm) of certain histological features in transverse sections through the median portion of the main stem of Basil plant, aged 12 weeks, as affected by foliar application with 4g yeast extract /L. (Means of three sections from three specimens)

Histological characters	Treatments		
	Control	Yeast extract (4 g/L.)	± % to control
Stem diameter	3994	4731	+ 18.5
Cortex thickness	201.2	173.8	- 13.6
Fiber strands thickness	74.8	94.7	+ 26.6
Phloem tissue thickness	156.2	195.7	+ 25.3
Xylem tissue thickness	525.8	936.1	+ 78.0
Vessel diameter	31.4	39.7	+ 26.4
Pith diameter	2049	1883	- 8.1

It is obvious from Table (2) and Figure (2). That foliar application with yeast extract at concentration of 4g/L. increased the diameter of the main stem by 18.5% more than that of the control. It is clear that the increase in stem diameter, due to foliar application of yeast extract, could be attributed mainly to the prominent increases in most of the included tissues although a decrement of 13.6% in thickness of the cortex and a decrement of 8.1% in diameter of the pith were observed less than those of the control. The obtained results indicated that the increase in stem diameter due to application of yeast extract was accompanied with 26.6, 25.3 and 78.0% increments in thickness of fiber strands, phloem tissue and xylem tissue compared with the control; respectively. Likewise, vessel diameter was increased over that of the control by 26.4% due to foliar application of 4 g yeast extract/L.

As far as the authors are aware, previous information about the effect of spraying yeast extract on anatomical structure of the main stem of Basil plant or other related species are not available in the literature. However, Nassar et al. (2011) stated that foliar application with active yeast extract at concentration of 100 ml/L. increased the diameter of the main stem of Kidney bean plant cv. Giza 6 due mainly to the increase in the thickness of epidermis, cortex, phloem tissue, xylem tissue and parenchymatous area of the pith more than those of the control although a slight reduction in diameter of hollow pith less than the control was observed, being almost (in general) in harmony with the present findings.

Anatomy of the leaf

Microscopical counts and measurements of certain histological features in transverse sections through the blade of the foliage leaf developed at the median portion of the main stem of control plants of Basil and of those sprayed with 4 g yeast extract/L. are given in Table (3). Likewise, microphotographs illustrating these treatments are shown in Figure (3).

It is clear from Table (3) and Figure (3) that spraying yeast extract at concentration of 4g/L. increased thickness of both midvein and lamina of leaf blades of Basil plant by 24.8 and 22.7% more than the control; respectively. It is noted that the increase in lamina thickness was accompanied with 11.1 and 29.5% increments in thickness of palisade and spongy tissues compared with the control; respectively. Likewise, the vascular bundle of the midvein was increased in size as a result of spraying yeast extract. The increment was mainly due to the slight increase in length by 2.4% over the control and due to a prominent increase in width by 54.6% over the control. Also, number of xylem rows per midvein bundle was increased by 63.7% more than the control. Moreover, xylem vessels increased in diameter, being 9.3% more than the control, which amounted to more total active conducting area to cope with vigorous growth resulting from treatment with 4 g yeast extract /L.

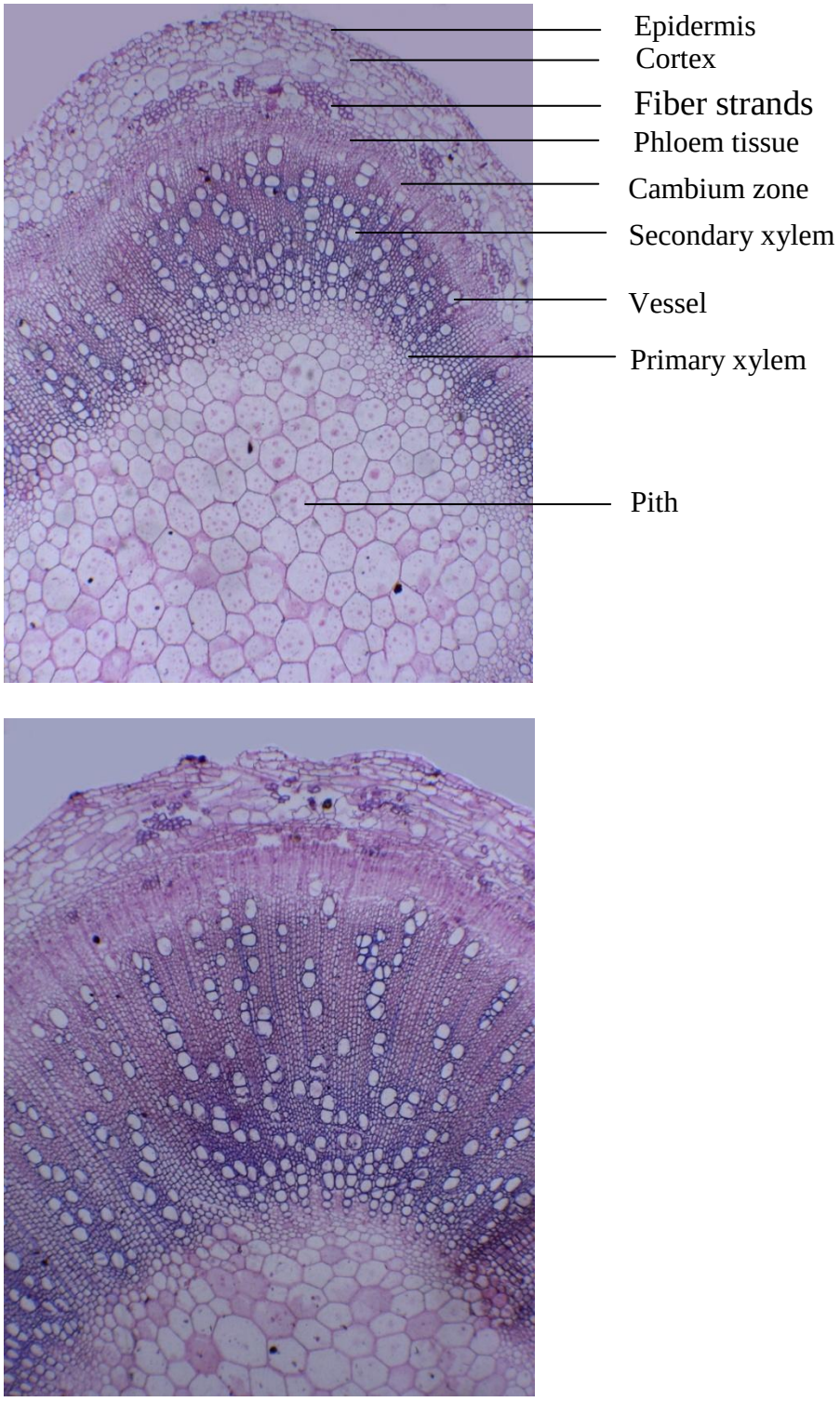


Figure 2. Transverse sections through median portion of the main stem of Basil plant, at the age of 12 weeks, as affected by foliar spray with yeast extract. (x 68)

A- From untreated plant (control).

B- From plant treated with 4g YE/L.

Table (3): Counts and measurements in micro-meter (μm) of certain histological features in transverse sections through the blade of the foliage leaf developed at the median portion of the main stem of Basil plant, at the age of 12 weeks, as affected by foliar application with yeast extract (Means of three sections from three specimens)

Histological characters	Treatments		
	Control	Yeast extract (4 g/L.)	± % to control
Midvein thickness	473.6	590.8	+ 24.8
Lamina thickness	229.1	281.2	+ 22.7
Palisade tissue thickness	68.5	76.1	+ 11.1
Spongy tissue thickness	125.8	162.9	+ 29.5
Dimensions of midvein bundle:			
Length	199.5	204.2	+ 2.4
Width	325.6	503.2	+ 54.6
No. of xylem rows/midvein bundle	19.3	31.6	+ 63.7
Vessel diameter	22.5	24.6	+ 9.3

As far as the authors are aware, previous information about the effect of spraying yeast extract on anatomical structure of Basil leaves are not available in the literature. However, Nassar et al. (2011) reported that foliar application with active yeast extract at concentration of 100 ml/L. increased thickness of both midvein and lamina of leaflet blades of Kidney bean, 'Giza 6'. The increase in lamina thickness was accompanied with increments in thickness of palisade and spongy tissues. Also, the main vascular bundle of the midvein was increased in size and components as a result of spraying active yeast extract, being in accordance with the present findings.

Volatile oil

The composition and percentage of volatile oil of Basil herb at full blooming stage, age of 14 weeks, as affected by foliar application with yeast extract at concentration of 4 g/L. are presented in Table (4). Likewise, components of volatile oil analyzed by GC-MS are shown in Figures (4 and 5).

The volatile oil of Basil herb at full blooming stage was obtained by means of water-steam distillation. Basil herb at this stage yielded 0.6% volatile oil for control plants against 0.65% volatile oil for plants treated with 4g yeast extract/L.

Using GC-MS technique in analyzing volatile oil of Basil herb (Figs. 4 and 5) proved the presence of 39 compounds in control plants against 37 compounds in plants sprayed with 4 g yeast extract/L. (Table 4).

Data presented in Table (4) clearly show that the volatile oil obtained from control plants and that obtained from treated plants shared 27 compounds which comprised 92.58% of the volatile oil for control and comprised 92.82% of the volatile oil for treated plants with 4 g yeast extract/L. The main constituents are linalool, geranial and neral. Linalool (the first major component) comprised 32.69% of the volatile oil of control plants against 35.36% of the volatile oil of treated plants. Geranial (the second major component) comprised 17.41% of the volatile oil of control plants against 14.73% of the volatile oil of treated plants. Whereas, neral (the third main component) constitute 14.77% of the volatile oil of control plants against 12.98% of the volatile oil of treated plants. Such three main components comprised 64.87 and 63.07% of the volatile oil for control and treated plants; respectively. This means that spraying Basil plants with 4g yeast extract/L. showed no effect on the major constituents of volatile oil of Basil herb. However, such treatment affected other constituents where 22 different components are present in volatile oil of which 12 components belongs to control and comprised 6.94% of its volatile oil and 10 other different components belongs to the treated plants and comprised 6.82% of its volatile oil. Thus, it could be stated that spraying Basil plant with 4 g yeast extract/L. reduced 12 minor compounds in the composition of volatile oil which were found in control. Moreover, such treatment present 10 minor compounds in the composition of volatile oil which were not found in control.

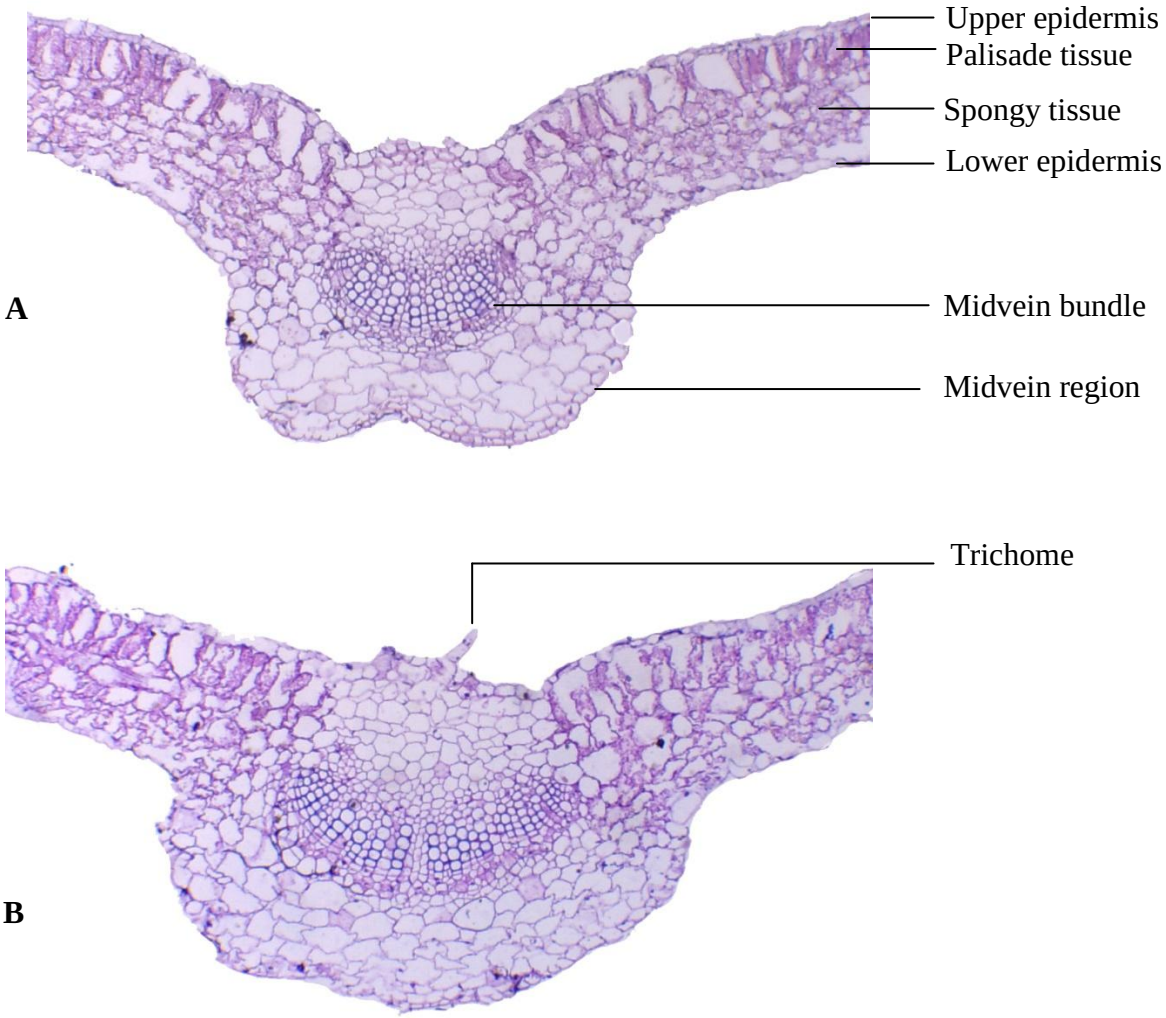


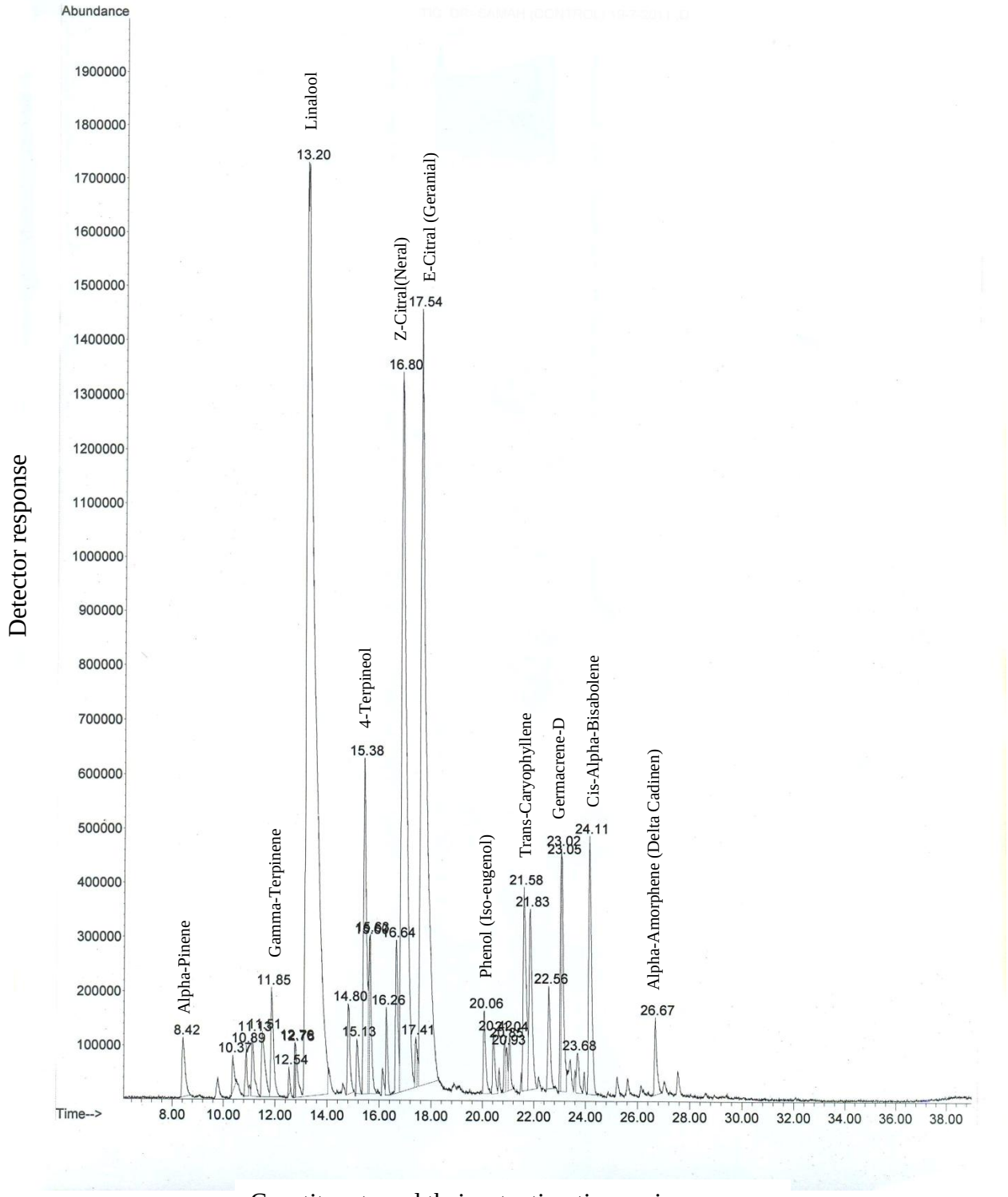
Figure 3. Transverse sections through lamina of the leaf developed at the median portion of the main stem of Basil plant, aged 12 weeks, as affected by foliar application with yeast extract. (x 68)

A- From untreated plant (control).

B- From plant sprayed with 4g YE/L.

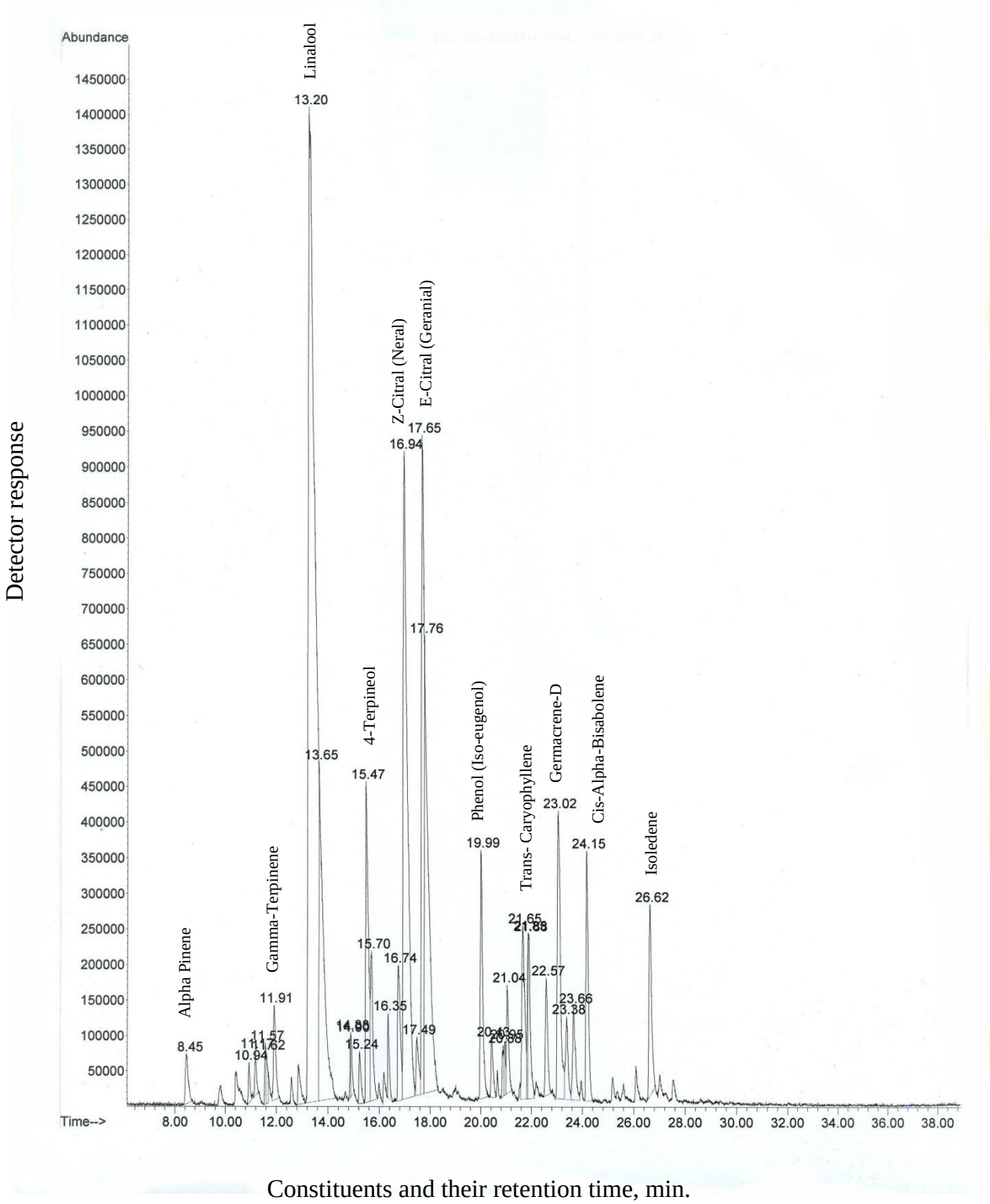
Table (4): Volatile oil of *Ocimum basilicum* L. herb at flowering stage as affected by foliar application with 4g yeast extract /L., retention time, components and their percentages

No of peaks	Retention time (min)	Components	%	
			Control	4g YE/L.
1	8.42	Alpha-Pinene	0.83	0.73
2	9.79	Sabinene	0.24	0.27
3	10.37	Beta-Pinene	0.70	-
4	10.43	Beta- Myrcene	-	0.55
5	10.94	Alpha-Terpinen	0.38	0.23
6	11.12	Limonene	0.71	0.47
7	11.50	Eucalyptol (1,8-Cineol)	0.98	0.88
8	11.86	Gamma-Terpinene	1.24	1.15
9	12.54	Alpha-Terpinolene	0.20	0.21
10	12.76	Cis-Sabinene Hydrate	0.74	0.50
11	**13.17**	**Linalool**	**32.69**	**35.36**
12	14.81	2,2 Dimethylocta-3,4-Dienal	0.97	-
13	14.89	Trans-Chrysanthemal	-	0.82
14	15.14	Cyclohexane	0.53	-
15	15.23	Bicyclo(3.1.1)hept-3-en-2-ol (Verbenol)	-	0.49
16	15.39	4-Terpineol	4.02	3.75
17	15.62	Cyclofenchene	1.78	-
18	15.69	4-Carvomenthenol (3-cyclohexen-1-ol)	-	1.69
19	16.12	Linalyl Propionate	0.21	-
20	16.19	Camphene	-	0.28
21	16.26	Acetic Acid	0.64	0.64
22	16.64	Nerol	1.55	1.64
23	**16.81**	**Z-Citral(Neral)**	**14.77**	**12.98**
24	17.41	Geraniol	0.57	0.71
25	**17.55**	**E-Citral (Geranial)**	**17.41**	**14.73**
26	20.05	Phenol (Iso-eugenol)	0.83	2.66
27	20.42	Neryl Acetate	0.59	0.60
28	20.65	Alpha-Copaene (Alpha-cubebene)	0.15	0.15
29	20.85	1,2,6-Octadienol	0.37	0.33
30	20.93	Germacrene-D	0.31	-
31	21.04	Beta-Elemene	0.52	1.11
32	21.59	Trans-Caryophyllene	2.60	2.37
33	21.83	Bicyclo[3.1.1]Heptene	2.28	2.09
34	22.56	Alpha-Caryophyllene	1.17	1.32
35	23.02	Germacrene-D	3.27	3.92
36	23.38	Ledene	-	0.97
37	23.41	Junipene	0.48	-
38	23.60	Beta-Bisabolene	0.13	-
39	23.68	Naphthalene	0.49	1.19
40	23.94	Gamma-Cadinene	0.15	-
41	24.12	Cis-Alpha-Bisabolene	3.06	2.58
42	25.18	Cyclopropane	-	0.17
43	25.21	1,6,10-Dodecatrienol-3	0.21	-
44	25.62	Farnsyl Acetate,2	0.71	-
45	26.10	Alpha-Copaene	-	0.30
46	26.61	Isoledene	-	2.33
47	26.67	Alpha-Amorphene (Delta Cadinen)	0.76	-
48	27.02	Patchoulene	-	0.19
49	27.54	Trans-Beta-Farnesene (beta bisabolene)	0.28	0.25
% of volatile oil in Basil herb			**0.60**	**0.65**



Constituents and their retention time, min.

Figure 4. GC / MS of volatile oil of Basil herb (*Ocimum basilicum* L.) at full blooming stage of untreated plants (control).



Constituents and their retention time, min.

Figure 5. GC / MS of volatile oil of Basil herb (*Ocimum basilicum* L.) at full blooming stage of plants treated with 4g YE/L.

As far as the authors are aware, information about the effect of spraying yeast extract on composition of volatile oil of Basil herb are not available.

Yield of seeds/plant and its components

The mean values of seed yield characters of Basil plant as affected by foliar application with different concentrations of yeast extract are given in Table (5).

It is realized from Table (5) that all assigned concentrations of yeast extract showed no significant effect on specific weight of Basil seeds; i.e., weight of 1000 seeds in grams did not affected by foliar application with any of the four tested concentrations of yeast extract. At the same time, the first three used concentrations (2,4 and 8 g yeast extract/L.) showed promotive effect on all other seed yield characters of Basil plant. The maximum significant

Table (5): Seed yield characters of Basil plant, at harvest time, as affected by foliar application with different concentrations of yeast extract (Average of the two seasons, 2011 and 2012 combined)

Treatments	Seed yield components					
	No. of inflorescences / plant	No. of fruits / inflorescence	No. of nutlets (seeds) / inflorescence	No. of seeds/plant	Weight of 1000 seeds (g)	Yield of seeds (g) / plant
Control (tap water)	62.6 C	87.0 BC	348.0 BC	21785 C	1.355	29.332 C
Yeast extract 2g/L.	70.1 B	93.5 B	374.0 B	26217 B	1.363	35.496 B
4g/L.	**79.3 A**	**104.8 A**	**419.2 A**	**33243 A**	1.349	**44.638 A**
8g/L.	69.8 B	92.3 B	369.2 B	25770 B	1.353	34.651 B
12g/L.	58.3 C	79.6 C	318.4 C	18563 D	1.371	25.331 D
L.S.D. (0.05)	6.42	9.18	33.5	2379	N.S.	3.186

Means having the same letter are not significantly different at 0.05 level.

promotion was detected when Basil plants were sprayed with 4 g yeast extract/L. Such treatment induced significant increases of 26.7, 20.5, 20.5, 52.6 and 52.2% for number of inflorescences/plant, number of fruits/inflorescence, number of nutlets (seeds)/inflorescence, number of seeds/plant and yield of seeds/plant over those of the control; respectively. By contrast, the relatively high used concentration of 12 g yeast extract/L. showed negative effect on the previous yield characters. Such treatment induced decrements of 6.9, 8.5, 8.5, 14.8 and 13.8% below the control for number of inflorescences/ plant, number of fruits/inflorescence, number of nutlets (seeds)/ inflorescence, number of seeds/plant and yield of seeds/plant; respectively. Worthy to note that the decrements below the control proved significant only for number of seeds/plant and for seed yield/plant.

The previous report of El-Gamal (2005) indicated that yeast extract at 5 g/L. induced significant increase in number of inflorescences per Sweet Basil plant either grown under normal conditions or under stress of salinity or drought. Such effect might be due to its content from phytohormones especially cytokinins, gibberellins and indol acetic acid which overcome the deleterious effects of both water and salt stresses on growth and productivity of Sweet Basil plants. Some reviewers conformid the present findings using other medicinal and aromatic plants; for instance, Ahmed et al. (1998) indicated that yeast extract at concentration of 2 g/L. gave highest increase in yield of calyxes and seeds of Rosselle (*Hibiscus sabdariffa*). Likewise, Eid (2001) found that active dry yeast at 1g/L. induced significant increase in fruit yield/plot of Coriander (*Coriandrum sativum*). Also, Nagiub and Khalil (2002) reported that spraying *Nigella sativa* with 1 or 2 g dry yeast/L. gave an increment in number of capsules per plant and in number of seeds/capsule. All, being generally in harmony with the present findings.

REFERENCES

Abd El-Ghany, A. A.; El-Said, A. S.; Said, B. A. and Marwad, I. A.(2001). The Effect of Two Yeast Extract Strains or Their Extraction on Vines Growth and Cluster Quality of Thompson Seedless. Assiut J. Agric. Sci., 32 (1): 215-224.

Abdel-Hakim, W.M.; Moustafa, Y.M.M. and Gheeth, R.H.M. (2012). Foliar Application of Some Chemical Treatments and Planting Date Affecting Snap Bean (*Phaseolus vulgaris* L.) Plants Grown in Egypt. Journal of Horticultural Science & Ornamental Plants 4 (3): 307-317.

Abd El-Latif, E. S. M. (2006). Effect of Chemical, Organic Fertilizers and Spraying with Active Dry Yeast on Growth, Oil Production and Plant Constituents of Sage (*Salvia officinalis* L.) Plant. M. Sc. Thesis. Cairo Univ., Egypt, 155p.

Abou EL-Yazied, A. and Mady, M. A. (2012). Effect of Boron and Yeast Extract Foliar Application on Growth, Pod Setting and both Green Pod and Seed Yield Of Broad Bean (*Vicia Faba* L). Journal of American Science,8 (4).

Ahmed, F. F.; Ragab, M.A.; Ahmed ,A.A. and Mansour, A.E.M. (1997). Improving The Efficiency of Spraying Different Nutrients For Red Roomy Grape vines (*Vitis vinifera* L.) By Using Glycerol and Active Dry Yeast, Egypt. J. Hort., 24: 91-108.

Ahmed, M. M. (2009). Effect of Amino Acids and Yeast Extract on Growth and, Yield, Essential Oil Production and Chemical Constituents of Commom Balm (*Melissa officinalis* L.) Plant. M.Sc. Thesis, Fac. Agric., Cairo Univ., 99 pp.

Ahmed, Sh.K.; El-Ghawas, E.O. and Ali, A.F. (1998). Effect of Active Dry Yeast and Organic Manure on Roselle Plant. Egypt. J. Agric. Res. 76 (3): 1115-1142.

Amer, S. S. A.(2004). Growth, Green Pods Yield and Seeds Yield of Common Bean (*Phaseolus vulgaris* L.) as Affected By Active Dry Yeast, Salicylic Acid and Their Interaction. J. Agric. Sci., Mansoura Univ., 29 (3): 1407-1422.

Arafa, G. K. (2007). Optimum Drying Conditions for Thin-Layer Drying of Sweet Basil. Misr J. Ag. Eng., 24(3): 540- 556.

ASTA. (1968). Official Analytical Method of American Spice Trade Association ASTA, Englewood cliffs, N. J. p. 8-11.

Atawia, A. A. R. and. El-Desouky, S. A. (1997). Trials For Improving Fruit Set, Yield and Fruit Quality of Washington navel Orange By Application of Some Growth Regulators and Yeast Extract as a Nature Source of Phytohormones. Annals of Agric. Sci., Moshtohor, 35 (3): 1613-1632.

Baratta, M. T.; Dorman, H. J. D.; Deans, S. G.; Figneiredo, A. C.; Barroso, J. G. and Ruberto, G. (1998). Antimicrobial and Antioxidant Properties of Some Commercial Essential Oils. Flav. Fragr. J.; 13: 234-235.

Barnett, J. A.; Payne, R. W. and Yarrow, D. (1990). Yeasts, Characteristics and Identification. Cambridge University Press, London, 999 pp.

Bunney, Sarah. (1992). The Illustrated Encyclopedia of Herbs (Their Medicinal and Culinary Uses). Chancellor Press, London, p. 200.

Castelfranco, P. A. and Beale, S.I. (1983). Chlorophyll Biosynthesis : Recent Advances and Area of Current Interest. Ann. Rev. Plant Physiol., 34: 241-278.

Charles, J. D. and Simon, J. E. (1990). Comparison of Extraction Method for The Rapid Determination of Essential Oil Content and Composition of Basil. Soc Hort. Sci., 115 (3): 458 – 462.

Chiang, L. C.; Cheng ,P.W.; Chiang, W. and Lin ,C. C. (2005). Antiviral Activity of Extracts and Selected Pure Constituents of *Ocimum basilicum*. Cli Exp. Pharmacol. Physiol.; 32:811-816.

Chiej, R. (1988). The Macdonald Encyclopedia of Medicinal Plants. London: Macdonald and Co. (Publishers) Ltd., p. 207.

Denys, J.C. and Simon ,J.E. (1990). Comparison of Extraction Method for The Rapid Determination of Essential Oil Content and Composition of Basil. *Soc Hort. Sci.*, 115 (3): 458 – 462.

Eid, M. I.(2001). Response of Coriander Plant to Foliar Spray with Active Dry Yeast and Phosphorus Fertilization. J. Agri. Sci. Mansoura Univ., 26 (12): 7869-7878.

El-Desouky, M. and El-Greadly ,N. H. M. (2006). Response of Pea Plants to Foliar Application of Yeast Extract. J. Agric. Sci., Mansoura Univ., 31 (10): 6667-6674.

El-Gamal, Sabah M. A. (2005). Physiological Response of Sweet Basil Plants Grown Under Stress Conditions as Affected By Yeast Extract, Ascorbic Acid and Potassium. Minufiy J. Agric. Res., 30 (1): 25-50.

El-Ghamriny, E. A.; Arisha ,H. M. E. and Nour ,K. A. (1999). Studies on Tomato Flowering, Fruit Set, Yield and Quality in Summer Season. Spraying With Thiamine, Ascorbic Acid and Yeast. Zagazig J. Agric. Res., 26 (5): 1345-1364.

El-Mogy, M. M.; Omar ,A. H. and Gasser, A. S. (1998). Effect of Yeast Application on Bed Fertility, Physical, Chemical Properties, Vegetative Growth and Yield of Thompson Seedless Grapevine. J. Agric. Sci., Mansoura Univ., 23(8): 3879-3886.

El-Tohamy, W. A. and El-Greadly, N. H. M. (2007). Physiological Responses, Growth, Yield and Quality of Snap Beans in Response to Foliar Application of Yeast, Vitamin E and Zinc Under Sandy Soil Conditions. Australian Journal of Basic and Applied Sciences, 1(3): 294-299.

El-Tohamy, W. A.; El-Abagy ,H. M. and El-Greadly ,N. H. M. (2008). Studies on The Effect of Putrescine, Yeast and Vitamine C on Growth, Yield and Physiological Responses of Egg Plant (*Solanum melongena* L.) Under Sandy soil conditions. Australian Journal of Basic and Applied Sciences, 2(2): 296-300.

Evans, W. C (1996). Trease and Evans Pharmacognosy.. WB Saunders Company LTD., London, p. 48.

Fathy, El-S. L. and Farid, S. (1996). The Possibility of Using Vitamin B and Yeast to Delay Senescence and Improve Growth and Yield of Common Beans (*Phaseolus vulgaris* L.). J. Agric. Sci., Mansoura Univ., 21(4): 1415-1423.

Fathy, El- S. L.; Farid, S. and El-Desouky,S. A. (2000). Induce Cold Tolerance of Outdoor Tomatoes During Early Summer Season By Using Adenosine Triphosphate (ATP), Yeast, Other Material and Chemical Treatments to Improve their Fruiting and Yield J. Agric. Sci., Mansoura Univ., 25(1): 377-401.

Hegab, M.Y.; Ahmed, F. F. and Ali , A. H. (1997). Influence of Spraying Active Dry Yeast on Growth and Productivity of Valencia Orange (*Citrus sinensis*). Producing of The 1st Scientific Conference of Agricultural Sciences, Fac. of Agric.AssuitUniv.,13-14:1.

Hewedy, A. M.; Morsy ,M. A. and Hafez, M. (1996). Effect of Frequency of Fruit Pickings and Foliar Spray with Some Stimulations on The Subsequent Seed Yield of Egg Plant. First Egyptian – Hungarian Hort. Conf., Kafr El-Sheikh, Egypt. 15- 17 Sept., 1: 50-61.

Ismaeil, Faten H. M.; Wahdan ,M. T. and El-Sheikh, A. F. (2003). Response of Thompson Seedless and Roumi 3 Red Grape Cultivars to Foliar Sprays With Yeast Extract and GA . J. Agric. Sci., Mansoura Univ., 28(8): 6321-6334.

Khedr, Z. M. A. and Farid ,S. (2000). Response of Naturally Virus Infected Tomato Plants to Yeast Extract and Phosphoric Acid Application. Annals of Agric. Sci., Moshtohor, 38(2): 927-939.

Kraig, E. and Haber ,J. E. (1980). Messenger ribonucleic acid and protein metabolism during sporulation of *Saccharomyces cerevisiae*. J. Bacteriol., 144: 1098-1112.

Mahmoud, T. R. (2001). Botanical studies on Growth and Germination of Magnolia (*Magnolia grandiflora* L.) Plants. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., 103pp.

Massoud, Hekmat Y. A. (2006). Effect of Phosphorus Fertilization Levels and Foliar Application with Active Dry Yeast Biofertilizer on Growth, Herb Yield, Essential Oil Productivity and Chemical Components of Sage (*Salvia officinalis* L.). J.Agric. Sci. Mansoura Univ., 31 (10): 6649-6665.

Naguib, N. Y. and Khalil, M. Y. (2002). Studies on The Effect of Dry Yeast, Thiamin and Biotin on The Growth and Chemical Constituents of Black Cumin (*Nigella stavia*). Arab Univ. J. Agric. Sci., 10 (3): 919-937.

Nassar, M. A. and El-Sahhar, K. F. (1998). Botanical Preparations and Microscopy (Microtechnique). Academic Bookshop, Dokki, Giza, Egypt. 219pp. (In Arabic).

Nassar, Rania. M. A., Ahmed ,Y. M., and Nassar ,Dalia. M. A. (2011). Effect of Foliar Spray with Active Yeast Extract on Morphological, Anatomical and Yield Characteristics of Kidney Bean (*Phaseolus Vulgaris* L.) Australian Jour. of Basic and Applied Sciences 5 (5): 1071-1079.

Snedecor, G. W. and Cochran, W. G. (1982). Statistical Methods (7th Edit., 2nd Printing). The Iowa State University Press, Ames, Iowa, U.S.A., 507pp.

Tartoura, E. A. A. (2001). Response of Pea Plants to Yeast Extract and Two Sources of N-Fertilizers. J. Agric. Sci., Mansoura Univ., 26(12): 7887-7901.