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Growth and Productivity of Rue (*Ruta graveolens*) under Different Foliar Fertilizers Application

S.E. El-Sherbeny, M.Y. Khalil and M.S. Hussein

Department of Cultivation and Production of Medicinal and Aromatic Plants,
National Research Centre, Giza, Egypt.

Abstract: An experiment was carried out during the two successive seasons (2004/2005 and 2005/2006), to investigate the effect of dry yeast and Ascobin foliar fertilizers on growth characters and chemical constituents of *Ruta graveolens* plants. The results revealed that the two foliar applications increased plant height, number of branches, fresh and dry weight of leaves, stem, root and flowers. Chemical constituents included essential oils, coumarin and rutin content percentage. The identified terpenic constituents of essential oil fractioned were 28 and 30 known components for leaves and flowers respectively. 2-undecanone represented the major constituent for essential oil. The maximum percentage of 2-undecanone was obtained as a result of applying dry yeast at level of 2500ppm.

Key words: Rue, *Ruta graveolens*, Yeast, Ascobin, foliar fertilizer, essential oil, 2-undecanone, rutin, cumarin.

INTRODUCTION

Rue (*Ruta* spp.) is a small strongly aromatic shrub native to the Mediterranean, has been used in Europe, North Africa and the Middle East, as medicinally and magically, since ancient times. The medicinal and aromatic properties of rue come from its essential oil, rutin and methylnonilctone[1,2]. In this respect, rutin increases visual sharpness and treats other visual problems. It is also used against edema, thrombogenesis, inflammation, spasms and hypertension. Moreover, it is employed as antihistamine, vermifuge and rubefacient. Its bitter-eupeptic properties make it useful for stomach troubles. On moist skin in direct sunlight, it leads to photosensitivity. The essential oil is a central nervous system depressant and at high doses has becomes a narcotic[3,4].

Recently, a great attention was focused on biofertilizer of medicinal and aromatic plants for its safety effect on human and animal. In addition, biofertilizer lowers pollution greatly in our environment. Active dry yeast is a natural safey biofertilizer causes various promotive effects attributed to its character of richness in protein, B-vitamin and natural plant growth regulators such as cytokinins. It also releases CO_2 which reflected on improving net photosynthesis[5,6]. Moreover, several researchers on marjoram plant[7], roselle plant[8], black cumin[9] and on thyme[10] report that active dry yeast as foliar fertilizer enhanced growth, plant nutritional and essential oil yield.

On the other hand, the foliar application of micro and macro nutrients leads to considerable improvement of healthy vegetative growth and chemical constituents. The foliar nutrient is applied at times when demand is particularly high and rapid response may be desired. Several researchers reported the beneficial role of foliar fertilization on some medicinal and aromatic plants, on *Cymbopogon flexuosus*[11] and on *Mentha* species[12]. Similarly, the new Ascobin foliar fertilizer, contain some activator hormones and organic acid as ascorbic and citric acid, had a promotion effect on growth and active constituents compounds on various plant such as fenugreek plant[13], Plantago species[14] and on faba bean, maize and pea plants [15].

The aim of this investigation was to explore the response of Rue (*Ruta graveolens*) plants to different concentration of active dry yeast and foliar spray with Ascobin on growth, yield, oil production and oil constituents as well as some metabolic constituents.

MATERIALS AND METHODS

An experiment was carried out at the experimental area of the National Research Centre, Giza, Egypt during the two successive growing seasons of 2004/2005 and 2005/2006 to study the foliar

Corresponding Author: M.Y. Khalil, Department of Cultivation and Production of Medicinal and Aromatic Plants, National Research Centre, Giza, Egypt.
Khalilmona2003@yahoo.com

application effect of active dry yeast and Ascobin treatments on *Ruta graveolens* plants.

Plant Materials: Seeds of rue plant were obtained from experimental farm of the Pharmaceutical Sciences Dept., Cairo Univ. at Giza, were planted in pots on 1st of October during both seasons. The pots (30 cm diameter) where filled with loam clay soil. Some of the physical and chemical soil properties obtained using standard method described by Klute[16] recorded as follows: clay 37 %, silt 35 % sand 25% with pH 7.7, E.C. 0.59, organic matter 1.30, soluble anions (maq/100 g soil) HCO^{-3} 0.69, Cl^- 2.1, SO_4^- 1.12 and soluble cations (meq/100g soil) Ca^{++} 1.11, Mg^{++} 0.88, Na^+ 2.23, K^+ 0.19.

The experimental design was completely randomized, consisting of eight groups, each of 20 pots with three replicates. Every pot contain three plants, the plants were sprayed two times, the first 60 days after plantation and the second month later. Two foliar sprays were used, the first was active dry yeast added at four levels of 1250, 2500, 5000 and 10.000ppm and the second was Ascobin contains (62% growth promotive organic substance, 38% ascorbic acid and citric acid) applied at three concentrations (1000, 2000 and 3000 ppm) beside the control treatment. Thus, the foliar spray treatments included eight treatments as following:

- Control treatment (sprayed with distilled water).
- 1250 ppm dry yeast treatment
- 2500 ppm dry yeast treatment
- 5000 ppm dry yeast treatment.
- 10000 ppm dry yeast treatment.
- 1000 ppm Ascobin treatment.
- 2000 ppm Ascobin treatment.
- 3000 ppm Ascobin treatment.

All agriculture practices were done according to plant needs. Two plant samples were taken, the first at the beginning of flowering stage (at end of March) and the second during flowering stage (at 10th of June). The following vegetative and flowering data were recorded:

- Plant height (cm)
- Number of branches per plant
- Fresh weight of leaves, stems and roots per plant (g).
- Dry weight of leaves, stems and roots per plant (g).
- Fresh weight of flowers/plant (g).

II- Chemical analysis: The chemical analysis for different organs of *Ruta graveolens* was carried to determine:

- Essential oil percentage: in fresh leaves and flowers by hydrodistillation using Clevenger-type apparatus according to Egyptian Pharmacopeia[17].
- The essential oil composition for the samples dehydrated over anhydrous sodium sulphate then subjected to GC/MS. Separation of the resulting crude, fractions and volatile oil was accomplished on a Varian Gas Chromatograph (Walnut Creek, California, USA) equipped with Finnigan mat SSQ 700 (Thermo Inst., USA) mass spectrometer and a 30cm x 0.25mm. DB-5 capillary column film thickness (J & W Scientific, USA). The column temperature was programmed from 50°C (constant for 3 min.), at a rat of 7°C/min to 250°C with 10 min isothermal hold. The injector temperature was 220^0C and the transition time temperature was 250°C. The carrier gas was helium and the column head pressure was 10-15 psi. The identification of the constituents was determined by comparing the spectrum with the other stored in Wiley Mass Spectral Library containing over 147.000 volatile compounds.
- Rutin percentage determined in dried herb at two growth period cuts according to Zhuang *et al* [18].
- Cumarin percentage determined in dried herb at two growth period as described by Harbone[19].

III- Statistical Analysis: The obtained results were subjected to statistical analysis according to the methods of Snedecor and Cochran[20].

RESULTS AND DISCUSSIONS

1- Vegetative Growth Characters: The data shown in Table (1), illustrates the effect of dry yeast and Ascobin on vegetative characters of rue plants. The data reveal that spraying rue plants with dry yeast or Ascobin significantly increase most of the growth characters, as plant height, number of branches, fresh and dry weight of leaves. The maximum increase for plant height was shown by plants treated with 2500ppm of dry yeast and 3000ppm of Ascobin during 1st and 2nd stage, respectively. The promotion effect of dry yeast at (2500ppm), on plant height and number of branches, reached 25.2% and 28.6% over the control at the first stage, while at second stage this increment recorded 24.2% and 21.2%. Similarly, the increase caused by Ascobin at level of 3000ppm for both characters (plant height and number of branches) were 19.6, 33.7% for the first stage and 17.6, 424% for second stage, respectively. As the mention, the highest significant promotion for the fresh and dry weight of leaves, stems and roots were recorded with yeast at 2500ppm and Ascobin at 3000ppm applied at the first and second stage.

Table 1: Effect of dry yeast and Ascobin foliar fertilizers on some growth characters of *Ruta graveolens* (Mean values of two successive seasons)

Treatments (ppm)		Plant height (cm)	Branches Number	Fresh weight (g/plant) Leaves	Fresh weight Stem	Fresh weight Root	Dry weight (g/plant) Leaves	Dry weight Stem	Dry weight Root
1st stage									
Control	O	30.6	7.7	15.7	19.1	3.7	3.8	4.7	2.2
Yeast	1250	37.6	9.1	17.1	18.7	3.8	4.2	5.1	2.4
	2500	38.3	9.9	20.8	18.9	5.9	5.2	5.5	3.6
	5000	31.6	9.1	16.4	18.2	5.8	4.4	5.4	3.2
	10	36	9.5	20.2	18.3	4.3	5.1	5.2	2.7
Ascobin	1000	35.9	9.8	20.3	18.8	4.2	4.9	4.6	1.8
	2000	35.6	9.4	21.9	19.4	5.7	5.1	5	2.6
	3000	36.6	10.3	22.1	20.8	5.8	5.7	5.1	2.7
L.S.D. at 5%		2.77	0.86	1.09	0.92	0.7	0.85	N.S.	0.75
2nd stage									
Control	O	31.8	9.8	16.8	20.9	4.5	6.4	7.3	4.3
Yeast	1250	37.9	9.9	17.7	20.1	4.9	7.8	7.9	4.8
	2500	39.5	11.9	21.1	28.6	7.5	8.6	9.9	4.7
	5000	33.7	10	17.7	26.6	6.4	6.8	9.2	5.1
	10	36.9	11.1	20	21.2	5.4	7.4	9.3	4.8
Ascobin	1000	36.8	12	21.5	24.5	8.9	10.9	11	8
	2000	36.2	10.3	28.8	26.6	9.1	10.3	11.9	8.6
	3000	37.4	14.1	31.5	27	8.7	13.5	12.6	5.1
L.S.D. at 5%		1.6	N.S.	3.24	3.36	2.87	2.84	2.05	N.S.

Table 2: Effect of dry yeast and Ascobin on flowers yield, essential oil percent and yield of *Ruta graveolens* (Mean values of two successive seasons)

Treatments (ppm)		Flowers (F.W.) yield (g/plant)	Essential oil % Leaves	Essential oil % Flowers	Essential oil (ml/plant) Leaves	Essential oil (ml/plant) Flowers
1st stage						
Control	O	3.1	0.053	0.026	0.008	0.001
Yeast	1250	3.5	0.073	0.063	0.012	0.002
	2500	6.1	0.076	0.082	0.016	0.005
	5000	6.3	0.069	0.053	0.011	0.003
	10.000	7.0	0.071	0.060	0.014	0.004
Ascobin	1000	7.5	0.052	0.042	0.011	0.003
	2000	7.4	0.081	0.062	0.018	0.005
	3000	8.9	0.086	0.076	0.019	0.007
L.S.D. at 5%		0.64	0.005	0.005	N.S.	0.003

Table 2: Continue

Treatments (ppm)		Flowers (F.W.) yield (g/plant)	Essential oil %		Essential oil (ml/plant)	
			Leaves	Flowers	Leaves	Flowers
2nd stage						
Control	O	5.6	0.121	0.082	0.020	0.005
Yeast	1250	6.2	0.101	0.090	0.018	0.006
	2500	6.3	0.153	0.137	0.032	0.009
	5000	7.9	0.079	0.128	0.014	0.010
	10.000	8.8	0.065	0.113	0.013	0.010
Ascobin	1000	5.3	0.098	0.140	0.021	0.007
	2000	7.0	0.089	0.092	0.026	0.006
	3000	9.7	0.067	0.097	0.021	0.009
L.S.D. at 5%		N.S.	0.017	0.016	0.010	0.005

Table 3: Percentage composition of the leaves essential oil of *Ruta graveolens* L. as influenced by yeast and Ascobin foliar fertilizers

Compounds	Con.	1	2	3	4	5	6	7	Mean
Hydrocarbon compound									
Limonene	0.08	0.11	0.12	0.30	0.31	0.05	0.10	0.27	0.17
Geyrene	3.04	5.22	4.54	2.28	4.19	3.90	1.65	5.30	3.77
1-Nonene	1.20	0.45	0.13	0.55	0.49	0.84	1.57	0.27	0.69
2-Nonene	2.47	2.00	1.17	2.80	0.92	2.55	3.54	0.99	2.06
1-Undecene	1.41	0.87	0.18	0.96	0.54	1.21	0.96	1.88	1.00
Anthracene	1.21	1.00	0.85	1.15	0.96	1.26	1.31	1.02	1.10
Neophytadiene	0.07	0.11	0.13	0.06	0.12	0.14	0.12	0.08	0.10
3,4-Dihydrobenzo[b]fluoranthene	1.42	0.69	0.23	0.68	0.91	1.06	0.85	0.62	0.81
Total hydrocarbon	10.9	10.45	7.35	8.78	8.44	11.01	10.1	10.43	
Oxygenated compound									
2-Octanone	0.13	0.20	0.14	0.21	0.06	0.09	0.11	0.11	0.13
2-Nonanone	17.47	10.19	13.74	19.49	17.87	15.17	13.14	15.00	15.26
Teteradecanal	0.17	0.30	0.17	0.16	0.07	0.26	0.13	0.19	0.18
Dodecanal	0.88	0.15	0.63	0.67	0.81	0.63	0.59	0.24	0.58
2-Docanone	2.04	1.03	1.33	1.72	1.91	1.75	2.00	0.42	1.53
2-Undecanone	50.50	55.50	56.86	48.73	53.86	52.27	57.12	54.70	53.69
2-dodecanone	4.69	5.88	3.10	6.28	4.29	4.98	6.31	0.77	4.54
9-Methyl-10-Methylene-Tricyclo (4.2.1.1.2.5) Decan-9-ol	0.34	1.12	0.47	0.77	0.29	0.13	0.81	0.25	0.52
1-Dodecanol, 3.7.11-trimethyl	0.23	0.62	0.76	0.31	0.29	0.27	0.50	1.54	0.57
2-Tridecanone	0.16	0.81	0.64	0.44	0.35	0.15	0.10	1.70	0.54
12-Methyl-oxa-cyclododec-6-EN-2-one	1.43	1.00	0.81	0.68	1.11	0.99	0.39	0.25	0.83
Elemol	0.13	0.43	0.13	0.25	0.38	0.27	0.20	0.27	0.26
9-Methyl 4-(1,3-benzodioxol-5-yl) butanoate	0.78	1.44	2.05	1.39	1.15	1.85	1.11	1.56	1.42

Table 3: Continue

Compounds	Con.	1	2	3	4	5	6	7	Mean
Nepetalactol	0.24	0.32	0.60	0.10	0.46	0.39	0.53	0.55	0.40
Ascaridole	0.15	0.18	0.35	0.12	0.30	0.24	0.28	0.52	0.27
Guaiol	0.11	0.18	0.09	0.14	0.11	0.20	0.20	0.28	0.16
Eudesmol	0.22	0.19	0.25	0.25	0.20	0.12	0.33	0.23	0.22
Methyl 4-(1,3-benzodioxol-5-yl)butanoate	0.13	0.20	0.15	0.14	0.07	0.14	0.10	0.11	0.13
6-Hydroxymethyl-1,4,4-trimethyl-bicyclo(3.1.0)hexan-2-ol	0.06	0.10	0.03	0.08	0.05	0.05	0.10	0.06	0.07
Hexadecanal	0.13	0.09	0.20	0.07	0.44	0.15	0.18	0.06	0.17
(Z)-8-(3,5-dimethyl-4-hydroxyphenyl)-2-octene	3.84	3.82	2.98	3.3	1.18	2.59	1.35	2.47	2.69
9,12,15-Octadecatrienal	0.51	1.12	0.37	0.14	0.70	0.55	0.24	0.28	0.49
Hexadecanoic acid	0.24	0.66	0.33	0.09	0.45	0.80	0.15	0.29	0.38
3-Ethoxy-4-hydroxy-4-(4-methoxyphenyl)cyclopent-2-enone	2.46	2.57	3.90	4.08	3.39	3.88	1.90	6.32	3.56
9,12,15-Octadecatrienoic acid methyl ester	0.10	0.33	0.09	0.25	0.08	0.19	0.85	0.17	0.26
Total oxygenated	87.14	88.43	90.17	89.86	89.87	88.11	88.72	88.34	88.83
Total identified	98.04	98.88	97.52	98.64	98.31	99.12	98.82	98.77	

Con. = Control1 = Yeast 1250ppm2 = Yeast 2500ppm3 = Yeast 5000ppm 4 = Yeast 10.000ppm5 = Ascobin 1000ppm6 = Ascobin 2000ppm 7= Ascobin 3000ppm

Stimulating vegetative growth by foliar application of dry yeast may be due to its influence on the availability of the essential nutrient, producing plant growth regulators and suppressing pathogen. The beneficial effect of dry yeast was supported with finding of other workers, i.e. on coriander plant[21], black cumin[9], caster bean[22] and on thyme[10].

As shown in above results, Ascobin improved vegetative growth characters. These beneficial effects may be due to its vitamins content like ascorbic acid and citric acid. Ascorbic acid play an important role in the stimulation of respiration, cell division and promotion of various enzymes such as lipase, catalase peroxidase. In addition Ascorbic acid has an effect on metabolism of gibberallic acid[23-25]. Similarly, citric acid was reported to be involved in krebs cycle[26]. In this connection other authors concluded a promotional effect for foliar spray with Ascobin on various vegetative growth and yield characters e.g. on fenugreek[13], *Plantago* species[14] and on faba bean, maize and pea[7].

2- Flowers Yield: The results obtained for flowers yield as affected by the two foliar fertilizers were recorded in Table (2). It was found that foliar spray with dry yeast resulted in gradual increase for this parameter by increasing concentration from zero to 10000ppm with the maximum mean value of flowers yield 7.0 and 8.8 g/plant for the 1st and 2nd stages, respectively.

Regarding the effect of Ascobin, it is obvious that all applied concentrations significantly increased flowers yield/plant during the 1st stage compared with control while the increase in the second stage didn’t reach any significant value at the levels 1000 and 2000ppm. However, the application of Ascobin at level of 3000ppm increased flowers yield (g/plant) by 187.1% and 73.2% during the 1st and 2nd stages, respectively over the control treatment.

Generally, it could be concluded that Ascobin, especially at the highest level was more effective than dry yeast during the two growth periods studied.

3- Chemical Constituents:

3-1- Essential Oil Content: Data presented in Table (2) showed a pronounced increase in essential oil percentage in leaves and flowers, for both two growth stages, due to application of various levels of dry yeast or Ascobin.

Dry yeast caused maximum percentage for essential oils as a result of 2500ppm level for leaves and flowers, at the two growth periods. The oil percentage increase for flowers was more than that of leaves. Moreover, Ascobin at the first stage caused gradual increase of essential oil percentage for leaves and flowers by increasing concentration, while an opposite trend was noticed in the second stage.

For the effect of dry yeast and Ascobin on essential oil yield (ml/plant), it was evident from Table (2) that both substances had a beneficial effect in increasing these criteria, with some exception during the 2nd stage.

Table 4: Percentage composition of the flowers essential oil of *Ruta graveolens* L. as influence by yeast and Ascobin foliar fertilizers

Compounds	Con.	1	2	3	4	5	6	7	Mean
Hydrocarbon compound									
Limonene	0.10	0.06	0.08	0.02	0.09	0.14	0.11	0.05	0.08
Geyrene	2.06	1.88	2.50	2.33	3.15	3.54	2.06	3.00	2.57
1-Nonene	1.02	1.69	2.61	1.25	1.81	1.19	1.92	2.10	1.70
2-Nonene	0.85	0.38	0.55	0.34	0.25	0.13	0.48	0.71	0.46
1-Undecene	2.02	3.90	2.11	3.11	1.17	1.88	2.31	1.93	2.30
Anthracene	0.79	1.04	1.14	1.00	0.69	0.95	1.14	0.85	0.95
Neophytadiene	0.06	0.02	0.08	0.02	0.07	0.03	0.06	0.04	0.05
3,4-Dihydrobenzo[b]fluoranthene	1.57	1.10	2.83	2.12	2.22	1.16	1.94	1.65	1.82
Pentacosane	0.08	0.03	0.08	0.05	0.09	0.10	0.11	0.06	0.08
Total hydrocarbon	8.55	10.1	11.98	10.24	9.54	9.12	10.13	10.39	10.01
Oxygenated compound									
2-Nonanone	6.31	6.22	4.56	5.11	2.50	7.25	7.60	5.12	5.58
Cyclotridecanone	0.09	0.04	0.01	0.07	0.03	0.08	0.07	0.11	0.06
2-Docanone	2.64	2.60	1.17	1.58	3.17	2.81	2.04	2.31	2.29
2-Undecanone	68.94	63.83	75.27	74.67	73.54	69.90	70.21	70.0	70.80
Ethyl 3-phenyl propionate	0.12	0.10	0.05	0.18	0.22	0.10	0.07	0.10	0.12
2-Dodecanone	3.18	4.00	2.13	2.01	2.19	1.36	0.99	2.00	2.23
9-Methyl-10-Methylene-Tricyclo (4.2.1.1.2.5) Decan-9-ol	0.15	0.21	0.11	0.05	0.10	0.08	0.06	0.18	0.12
2-Tridecanone	0.21	0.60	0.09	0.10	0.42	0.53	0.33	0.14	0.30
1-Dodecanol, 3,7,11-trimethyl	0.13	0.18	0.04	0.12	0.61	0.21	0.07	0.05	0.18
2-Tridecanone	1.95	2.35	1.00	1.18	1.28	1.92	2.81	2.17	1.83
Epiglobulol	0.06	1.30	0.02	0.14	0.20	0.07	0.63	0.54	0.37
Elemol	0.66	0.85	0.03	0.51	0.16	0.24	0.41	0.49	0.42
2-Tetradecanone	0.05	0.07	0.01	0.08	0.05	0.05	0.10	0.09	0.06
Cycloundecanone	0.14	0.21	0.01	0.11	0.09	0.12	0.14	0.22	0.13
Guaiol	0.22	0.32	0.15	0.21	0.30	1.17	0.61	1.00	0.50
Eudesmol	0.79	0.34	0.17	0.57	0.56	0.37	0.47	0.55	0.48
Cis-2-(3,4-dimethoxy) phenl cyclopetanonol	1.03	0.95	0.36	0.56	0.82	0.73	0.22	0.85	0.69
1-(3,4-dimethoxyphenyl)-1-Acetoxy-z-propene	0.06	0.12	0.09	0.04	0.10	0.25	0.15	0.13	0.12
(Z)-8-(3,5-dimethyl-4-hydroxyphenyl)-2-octene	1.29	1.60	0.08	0.14	0.16	0.15	0.58	0.22	0.53
9,12,15-Octadecatrienal	0.17	0.26	0.04	0.15	0.11	0.09	0.17	0.15	0.14
Hexadecanoic acid	0.12	0.47	0.11	0.23	0.93	0.73	0.30	0.10	0.37
9,12,15-Octadecatrienoic acid methyl ester	1.46	1.89	1.00	0.99	1.13	1.97	1.48	1.90	1.48
Total oxygenated	89.77	88.51	86.50	88.80	88.67	90.18	89.51	88.42	88.80
Total identified	98.32	98.61	98.48	99.04	98.21	99.3	99.64	98.81	

Con. = Control 1 = Yeast 1250ppm 2 = Yeast 2500ppm3 = Yeast 5000ppm 4 = Yeast 10.000ppm 5 = Ascobin 1000ppm 6 = Ascobin 2000ppm 7= Ascobin 3000ppm

During the 1st stage Ascobin at the highest level gave the maximum oil yield which reached to 0.019 and 0.007 ml/plant for leaves and flower, respectively. Also, yeast at 2500ppm produced highest oil yield for leaves and flowers that recorded 0.032 and 0.01 ml /plant, respectively.

The promotive effect of yeast foliar fertilizers on oil percentage and oil yield of rue plants may be due to its contains of some organic substances that improve the growth and flower which is reflected on oil yield[13].

In addition, the effect of yeast on oil percentage and yield may be due to improving the formats of flower initiation due to its effect on carbohydrate accumulation[27]. Moreover, Robinson[28] revealed the fact that yeast contains vitamins recognized as coenzymes involved in specific biochemical reaction in the plant such as oxidative and non oxidative carboxylation process. He added that the biochemical active pyrophosphates are the units which condense the form of many varied forms that constitute the terpene. These results are in accordance with those obtained on black cumin[9] and on marjoram plants[15].

The positive effect of Ascobin on the accumulation of essential oil yield and its percentage for rue plant, may be it contains normal activator, free hormone and some organic acid that include ascorbic acid which induce many stimulating effects on physiological activities[22] and citric acid which is involved in Kerbs cycle[26].

3-2- Chemical Composition of Essential Oil: The components of essential oil of leaves or flowers collected from plants of the second season under different treatments were separated and identified GC/MS 33 compounds in the oil leaves, while the oil produced from flowers contained 31 compounds (Tables 3 and 4). The identified compounds compromised about 98.51% and 98.80% in the leaves and flowers oil, respectively. The number of hydrocarbonic compounds was 8 and 9 in the leaves and flowers oil, compromised about 9.68 and 10.01% respectively. The missed compound in leaves oil was pentacosane. On the other hand, the oxygenated components were 25 and 22 in oil leaves and flowers representing about 88.83 and 88.80% respectively. Eleven identified oxygenated compounds were the same in both leaves and flowers essential oil.

The obtained data appeared that the percent of identified compounds in the leaves and flowers oil increased largely by Ascobin fertilization at 1000ppm and at 2000ppm respectively compared with control. Moreover, the highest total hydrocarbons compounds percentage recorded in leaves oil with foliar Ascobin 1000ppm but in flower oil with yeast at level of

Table 5: Effect of dry yeast and Ascobin foliar fertilizers on rutin and cumarin content of *Ruta graveolens* (Mean values of two successive seasons)

Treatments (ppm)		Rutin Leaves %	ml/plant	Cumarin Leaves %	ml/plant
1st stage					
Control	O	1.76	0.276	0.022	0.0035
Yeast	1250	1.88	0.321	0.022	0.0037
	2500	1.97	0.409	0.026	0.0054
	5000	2.05	0.336	0.025	0.0041
	10.000	2.06	0.416	0.030	0.0061
Ascobin	1000	1.85	0.376	0.030	0.0061
	2000	1.90	0.416	0.028	0.0061
	3000	1.92	0.424	0.028	0.0062
2st stage					
Control	O	2.21	0.371	0.016	0.0027
Yeast	1250	2.24	0.396	0.020	0.0035
	2500	2.25	0.475	0.020	0.0042
	5000	2.28	0.404	0.018	0.0032
	10.000	2.30	0.460	0.020	0.0040
Ascobin	1000	2.28	0.490	0.022	0.0575
	2000	2.32	0.668	0.022	0.0653
	3000	2.32	0.731	0.021	0.0893

2500ppm. Also, the highest total oxygenated compound percentage in leaves and flowers were obtained with yeast at 2500ppm and Ascobin at 1000ppm respectively. In this connection Pino[29], identified 32 compounds in leaves of *Ruta graveolens* grown in Cuba and found that 2-undecanone (48.67%) was the major volatile compound, followed by curcuphenol (8.18) and 2-hexadecanoic acid (5.68%).

The major constituents of essential oil of both leaves and flowers were the oxygenated compound, 2-undecanone, compromising about 53.69 and 70.80% in the oil of the leaves and flowers, respectively. In the second order, 2-Nonanone, 2- dodecanone and geyrene represent (15.26, 4.54 and 3.77% respectively) in leave oil, 2-Nonanone, geyrene and 1-undecene (5.58, 2.57 and 2.30% respectively) in flowers oil. The maximum percentages of 2-undecanone (75.27 and 56.86%) was as a result of yeast fertilization at 2500ppm in leaves and flowers oil respectively.

In this respect, Stashenko *et al*[30] extracted essential oil from different parts of Colombian rue by subcritical-fluid extraction and analyzed by capillary chromatography and found that 2-Nonanone (8.9%), 2-Undecanone (13.4%), chalepensin (13.0%) and Geijerene (19.3%) were the main constituents in the extracts from rue leaves, flowers, stem and roots, respectively.

In this connection, the essential oil biosynthesis in plant is the integration of several metabolic pathways which require linking of several steps such as continuous production of precursors, their transport and translocation to the active site of synthesis. It depends finally upon normal functioning of associated metabolic pathways such as carbon fixation, respiration, isoprenoid pathway. Thus the foliar applications may play an important role on these steps.

3-3- Rutin and Coumarin Content: Table (5), showd that all foliar fertilization stimulated the accumulation of both rutin and coumarin in rue leaves. The highest increment of rutin percentage and content were observed at 10.000ppm yeast and 3000ppm Ascobin at the two growth stages. Moreover, the rue leaves at the second stage resulted in more rutin percentage and yield than the first.

For, cumarin percentage and yield/plant (Table 5) showed that at the first stage the application of the highest level of yeast and Ascobin, gave the highest mean value while in second stage, the highest cumarin yield were recorded with 2500ppm yeast and 3000ppm Ascobin. In general, it can be noticed that, the mean value of cumarin percentage and yield was higher in the second stage and also with application of various Ascobin levels.

From the obtained results it is worthy to note that spraying rue plants with dry yeast or Ascobin foliar fertilizer caused a promotion of vegetative and flowering growth as well as increased the accumulation of active constituents including essential oil, cumarin and rutin. Therefore, it is recommended to apply these foliar nutrients especially at the level 2500ppm for yeast and 3000ppm for Ascobin to obtain the highest production of herb and flowers and the maximum content of active chemical constituents.

REFERENCES

1. De Feo, V., F. De Simone and F. Senatore, 2002. Potential allelochemicals from the essential oil of *Ruta gravolens*. Phytochemistry, 61: 573-578.
2. Kuzovkina, I., I. Al'terman and B. Schneider, 2004. Specific accumulation and revised structures of acridone alkaloid glucosides in the tips of transformed roots of *Ruta gravolens* phytochemistry, 65: 1095-1100.
3. Miguel, S., 2003. Rue (*Ruta* L. Rutaceae) in traditional spain frequency and distribution of its medicinal and symbolic application. Economic Botany, 57: 231-244.
4. Claus, E.P., 1961. Pharmacognosy. Lea and Febger, Philadelphia, U.S.A.
5. Larson, P., A. Herbo, S. Klangson and T. Ashain, 1962. On the biogenesis of some compounds in *Acetobacter xyliam*. Physiol. Plant, 15: 552-565.
6. Idso, S.B., K.E. Idso, R.L. Garcia, B.A. Kimball and J.K. Hoober, 1995. Effect of atmospheric CO_2 enrichment and foliar methanol application on net photosynthesis of sour orange trees (*Citrus aurantium*, Rutaceae) leaves. Amer. J. Botany., 82: 26-30.
7. Ahmed, A.K., 2004. Effect of using new fertilizers on some Egyptian crops. Ms.c. Thesis, Fac. of Agric. Cairo Univ.,
8. Ahmed, S.K., E.O. El-Ghawas and A.F. Aly, 1998. Effect of active dry yeast and organic manure on Roselle plant. Egypt. J. Agric. Res., 76: 1115-1143.
9. Naguib, N.Y. and M.Y. Khalil, 2002. Studies on the effect of dry yeast, thiamine and biotin on the growth and chemical constituents of black cumin (*Nigella sativa* L.). Arab Univ. J. Agric. Sci. Ain shams Univ. Cairo., 10: 919-937.
10. Heikal, A.E., 2005. Effect of organic and biofertilization on growth production and composition of thyme (*Thumus vulgaris* L.) plants. M.Sc. Thesis, Cairo, Univ., Agric. Fac.,
11. Refaat, A.M. and L.K. Balbaa, 2001. Yield and quality of lemongrass plants (*Cymbopogon flexuosus* stapf) in relation to foliar application of some vitamins and microelements. Egypt. J. Hort., 28: 41-57.
12. Khalil, M.Y. and S.E. El-Sherbeny, 2005. Behaviour of three *Mentha* species, recently cultivated under Egyptian conditions in relation to some foliar fertilizers. Egypt J. Appl. Sci., 20: 163-183.
13. Mohamed, S.A. and N.Y. Naguib, 2002. Influence of foliar sprays with potassin P, N, Ascobin and their combination on yield parameters and chemical constituents of seeds of fenugreek plants. Arab Univ. J. Agric., Ain Shams Univ. Cairo., 10: 879-891.
14. Ezz El-Din, A. and M.Y. Khalil, 2003. Effect of foliar fertilization on growth and yield of two Plantago species cultivated in Egypt. Egypt. J. Hort., 30: 227-237.
15. Ahmed, E.T., 1998. Influence of concentration and time spraying active yeast on growth and volatile oil content of marjoram plants. J. Agric. Sci. Mansoura Univ., 23: 5067-5081.
16. Klute, A., 1986. Methods of soil Analysis. Part 1-Physiological and Mineralogical methods Agronomy. Chapter 9, (ed, Klute A.) ASA and SSSA, Madison, W.I., pp: 636-650.
17. Egyptian Pharmacopeia, 1984. General Organization for Governmental. Printing Office, Ministry of Health, Cairo, Egypt.
18. Zhuang, X.P., X.Y. Yu and G.S. Yang, 1992. Determination of total flavonoid in the leaves of Ginkgo. Chinese Traditional and Herbal Drugs, 23: 122-124.
19. Harbone, J.B., 1998. Phytochemical methods. A guide to modern techniques of plant analysis, 3rd Edition Chapman and Hill, London, pp: 279.
20. Snedecor, G.W. and W.G. Cochran, 1989. Statistical Methods. 8 ed. IOWA State University Press, Ames., Iowa, U.S.A.

21. Eid, M.I., 2001. Response of coriander plant to foliar spray with active dry yeast and phosphorus fertilization. J. Agric. Sci. Mansoura Univ., 26: 7869-7878.
22. El-Ghadban, E.A.E., S.A. Kulb and M.I. Eid, 2003. Effect of foliar spraying with active dry yeast and complete fertilizer (Sengral) on growth, yield and fixed oil of (*Ricinus communis*). Egypt. Pharm. Jour., 1: 55-66.
23. Oertil, J.J., 1987. Exogenous application of vitamins as regulators for growth and development of plants. Z. Pflanzenernahr, Bodenk, 150: 375-391.
24. Forti, G. and G. Elli, 1995. The function of ascorbic acid in photosynthetic phosphorylation. Plant physiol, 109: 1207-1211.
25. Smirnoff, N., 1996. The function and metabolism of ascorbic acid in plants. Annals Bot., 78: 661-669.
26. Bidwell, R.G.S., 1974. Plant physiology Publisher, London, New York.
27. Winkler, A.J., J.A., Cook, W.M. Kliewer and L.A. Lider, 1962. General Viticulture. Univ. of Calif. Press. U.S.A.
28. Robinson, F.A., 1973. Vitamins Phytochemistry vol 111: pp: 195-198. Lawrence p. Miller (Ed), Van-Nostrand Reinhold comp., New York.
29. Pino, J.A., 1997. Leaf oil of *Ruta graveolens* L. grown in Cuba. J. Essential oil, 9: 365-366.
30. Stashenko, E.E., R. Acosta and J.R. Martinez, 2000. High-resolution gas-chromatographic analysis of the secondary metabolites obtained by subcritical-fluid extraction from Colombian rue (*Ruta graveolens* L.). J. Biochem. Biophys. Methods, 43: 379-390.