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COMPARATIVE STUDY ON SOME SPECIES OF THE GENUS CYMBOPOGON GROWN IN EGYPT

HARRIDY, I.M.A., S. GABR AND M.N. SHALAN

Medicinal & Aromatic Plants Research Section, Hort. Res. Inst. (HRI), Agric. Res. Centre (ARC) Ministry of Agric. Egypt.

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Abstract

This work was conducted in two successive seasons 1998 & 1999 in the Experimental Farm of the Medicinal and Aromatic Plants in El-Kanater El-Khayria Egypt. The aim of the present work is to study the growth pattern, herbage yield, oil production and composition as well as oil properties of three cultivars belong to two species of the genus *Cymbopogon Which were C. citrates* (El-Kanater type), *C. citrates* (El-Farafra type) *and C. nardus.*

Results were recorded for growth characters *i.e.* plant height, tillers no., fresh and dry weights (gm/plant). It was found that, there were some differences in growth characters between the three cultivars. *C. citratus* (El-Kanater type) recorded the highest values with respect to plant height, tillers no. fresh and dry weights (gm/plant). Also, it was observed that, absolute growth rate was found to be in harmony with growth behaviour of each cultivar.

With regard to essential oil, results pointed out that, *C. nardus* was highest in oil percentage, however the highest oil yield (ml/plant) was obtained from the *C. citratus* (El-Kanater type).

As for oil properties it was found that, values of physicochemical properties of the three oils met those of standards.

Regarding oil composition it could be concluded that, the oil of the El-Kanater lemongrass contained citral (the main component) and geraniol (the second main component) higher than those in the oil of El-Farafra lemongrass.

Citronella oil contained values of geraniol, citronellol and citronellal agreed with the values of standards.

INTRODUCTION

The genus *Cymbopogon* spreng, includes 50 - 60 species of tropical, perennial, course-growing tufted grasses, many having highly aromatic foliage (Weiss, 1997).

Among them, *Cymbopogon citratus* (DC.) Stapf. (West Indian lemongrass) syn. *Andropogon nardus* var. ceriferus Hack; *A. citratus* DC. Weiss (1997), is a tufted perennial grass with numerous stiff stems arising from a short rhizomatous rootstocks and it

seldom flowers in cultivation. The plant tillers strongly and leaf blade narrow, linear, glaucous and drooping Guenther (1961). The number of stems (tillers) significantly affects the amount of leaves produced and any increase in total herbage produced by *C. citratus* is related to extent of tillering Weiss (1997).

Quantitative comparisons between the growth of living systems can be made from two point of view. One can measure and compare their absolute growth rate *i.e.* the total growth of each per unit time or one can compare their relative growth rates (Street & Opik, 1984).

Misra and Srivastava (1991) working on lemongrass, mentioned that, increase in shoot biomass, photosynthesis and chlorophyll were significantly correlated with essential oil content.

West Indian lemongrass oil usually a rather viscous liquid, yellow to dark yellow or dark amber becoming more red with age (Weiss, 1997).

Standard characteristics of lemongrass oil are presented in Table (1)

Table 1. Standard characteristics of lemongrass oil.

References / Characters	Rutovskii and Vinogran-dova (1930)	Squibbs (1933)	Guenther (1961)	Ibrahim (1965)	El-Zahwey *et al.* (1992)	Gabr (1994)	S. Soad (1995)
Solubility	---	---	Clondy up to 10 vol of 80%	1.3 vol of 90% 0.2 vol of 80% insol. in 70%	1 vol of 90%	0.6-1.1 vol of 80%, 1.6 vol of 90%	---
Sp. gravity at 15 °C	0.9026	0.8676-0.9215	0.8820	0.8922	0.8912	0.8534	0.8865
Ref. Index at 20 °C	1.48	1.4812-1.4892	1.4895	1.4975	1.4834	1.4883	1.4815
Optical Rotation	-0.15	-2.20 to+12.75	-0.13	-0.74	-2.19	-0.11	-0.78
Acid No.	11.04–14.4	---	---	4.30	7.70	3.84	---
Ester No.	19.1-39.6	---	---	35.40	24.64	20.28	---
Ester No. after Acetyl	176.1-244.3	211.5	---	216.0	182.2	214.81	---

Chemical composition of *C. citratus* (DC.) Stapf was studied by many scientists. The quality of the oil is determined by its content of aldehyde (chifly citral). The largest constituent next to citral in the west Indian type of lemongrass is mercene (12-20%) (Guenther, 1961). El-Zahwey *et al.* (1992) found that, citral (49.04%) was the

main component of lemongrass oil and geraniol was amounted by (34.98%). GLC analysis proved also D-limonene, linaloyl acetate, citronellal and geranyl acetate. In the same way, Gabr (1994) emphasized that, lemongrass oil contains the following components, α-pinene (1.3%), 1-8 cineol (1.235 %), limonene (4.764%), citral (33.759 % the main component), linalool (2.089 %), linaloyl acetate (3.829 %), geranyl acetate (1.62%), geraniol (24.082 %), anicic (2.898 %), menthone (0.979%) and thymol (4.852%). Salem, Soad (1995) pointed out that, 10 peaks were indentified from 16 constituents (peaks) in lemongrass oil, the identified components were citral (47.4%), geraniol (34.5%), linalool (1.43 %), α-pinene (2.71%) and limonene (0.83%) as well as menthone, linaloyl acetate, geranyl acetyate, anicic and thymol.

Torres and Ragadio (1996), mentioned that, citral 69.39% was the main component of philippine lemongrass oil and the following components were also found, geraniol, myrcene, α and β-pinene, ethyl laurate, 1-8 cineole, limonene, phellandrene, methyl heptanone, citronellal, linalool, caryophllene, menthol, terpineol and citronellol.

Whole oils are mainly used as a source of citral. Citral has numerous uses and can be further processed to isolate the ionone group which possess a violet-like fragrance important in perfumery, and vitamins especially vitamin A (Weiss, 1997).

Another important species of the genus *Cymbopogon* is *C. nardus*, L. Rendle Syn. *Andropogon nardus* ceylon, de Jong. It is a tufted, perennial grass with long narrow leaves and numerous stems arising from short rhizomatous roots (Weiss, 1997).

Many authors pointed out that, plants of the *Cymbopogon* species were differed in growth and oil production, Behura *et al.* (1991) in a comparative study included some species of *Cymbopogon*, found that plants of *C. nardus* were the shortest ones (76.69 cm). There was a marked difference between species in the production of tillers. Also, citronella plants gave the lowest yield, however it had the highest oil content (3.36%).

The oil content of *C. nardus*, L. Rendle in Sri lanka average 0.5%. Leaf oil content varies with age time of cutting and soil fertility (Weiss, 1997).

Standard characteristics of ceylon type of citronella according to the British Standard Specification (BSS) and Essential Oil Association of USA (EOA), were shown in Table (2).

Table 2. Standard characteristics of citronella oil (Ceylon type)*.

Characters	BSS	EOA
Solubility in alcohol	1.2 vol.	1.1 – 2.0 vol.
Sp. gravity at 20 °C	0.890 – 0.898	0.890 – 0.910
Ref. Index at 20 °C	1.4790 – 1.4850	1.4790 – 1.4850
Optical rotation	-0.18 ° - 9 °	-0.18 ° - 9 °

* After Weiss (1997).

The oil content of the leaves of citronella differs significantly and young leaves synthesize and accumulate most essential oil. During leaf expansion, citronellal, geraniol and citronellol content increase, but decrease with maturity (Luthra *et al.*, 1991).

Chemical composition of *C. nardus* (ceylon type) essential oil was studied by Weijesekera *et al.* (1973) and found the following components, triyclene (1.6%), α-pinene (2.6%), camphene (8.0%) α-phellandrene (0.8%), limonene (9.7%), cis-ocimene (1.4%), trans ocimene (1.8%), citronellal (5.2%), comphor (0.5%), bourbanene (1.0%), linalool (1.2%), linaloyl acetate (0.8%), β-caryophellene (3.2%), terpineol (0.7%), citronellyl acetate (1.9%), borneol (6.6%), geranyl formate (4.2%), citronellol (8.4%), nerol (0.9%), geraniol (18.6%), geranyl butyrate (1.5%), methyl iso eugenol (7.2%) and farnesol (trace).

Major components of citronella oil "Ceylon" in percent are geraniol to 60, citronellal to 15 and citronellol to 10, not necessarily in the same sample (Weiss. 1997).

The oil is frequently used as a domestic insect repellent. Also, the oil is a raw material for geraniol, citronellol, citronellal and menthol production. The oil is considered an industerial oil and used extensively in detergents, waxes, houshold soap and cleansers for masking unpleasant odours of insecticides and similar preparations and to a minor extract in cheaper perfumes and toiletries (Weiss, 1997).

This work aimed to study the growth, absolute growth rate *i.e.* the total growth of each organ per time unit biomass yield, essential oil production and its physicochemical properties as well as chemical composition of three plants belong to two species of the genus *Cymbopogon* fam. *Gramineae* , namely:

1. *C. citratus* (El-Kanater) and commercially cultivated in Egypt.
2. *C. citratus* cultivated in El-Farafra (New Valley Governorate).
3. *C. nardus*.

The former and later ones were grown in the Experimental Farm of Medicinal and Aromatic Plants in El-Kanater El-Khayria, Egypt.

MATERIALS AND METHODS

This study was carried out in the Experimental Farm of Medicinal and Aromatic Plants in El-Kanater El-Khayria, Egypt during two successive seasons 1998 and 1999. Plants of *Cymbopogon citratus* (DC.) Stapf. and *C. nardus*, L. Rendle were obtained from El-Kanater El-Khayria Farm and the third plant *C. citratus* (D.C) Stapf was introduced from El-Farafra in the New Vally region and put under normal cultivation in the new environment in El-Kanater El-Khayria Farm till the plants became well adapted. All tested plants were cultivated using tillers in a suitable size separated from mother plants. Cultivation was done on October, 19 for the two seasons in a well prepared soil in plots (2.5 x 3.0 m). Each contain 4 ridges at a distance of 40 cm between plants and 60 cm apart. Fertilization and irrigation as well as all agronomical practices were done as usual.

The plants were harvested three times during the growing season, at July, 3; August, 28 and November, 3 for the two seasons.

Data were recorded for growth characters and absolute growth rate for plant height, tillers number, plant fresh weight and dry matter (gm/plant). Also, essential oil content, oil yield (ml/plant) and physicochemical properties of the oil of the 2nd cut only (according to Guenther, 1961) as well as oil composition using Hewlett Packard 5890 GLC with a column HP 20 N carbowax 25 M x 0.32 mm x 0.3 micrometer (film thickness).

Flow rates N2 : 2 ml/min
H2 : 30 ml/min
Air : 330 ml/min

Program temp. : 50 – 140 °C (50°C/2 min increased by 5 °C/min till 100 °C for $^1/_2$ min and increased by 3 °C/min. till 140°C for $^1/_2$ min)
Injector temp. 180°C
Detector temp. 200°C

The experimental design was complete randomized blocks and the statistical analysis was done according to Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

I. Growth characters:

Data in Table (3) indicated that growth pattern of *Cymbopogon* plants showed differences in some characters i.e. length, tillering, biomass and dry matter production.

The El-Kanater of *Cymbopogon citratus* (DC.) Stapf produced the maximum growth during the two growing seasons 1998 and 1999 in comparison with the others (El-Farafra) *C. citratus* and *C. nardus* plants.

It was found that, the highest values of plant height, tillers no. per plant, fresh and dry weight (gm/plant) were recorded in case of *C. citratus* plants (the El-Kanater), while the lowest values in this respect were found in the plants of *C. nardus* (L.).

Data clearly emphasized that, grand period of growth in the *Cymbopogon* plants was existed in an extended period started from the early summer till the beginning of autumn with some differences. The rapid phase of grand growth was established from July to November. It was observed that, growth of leaves (elongation) showed maximum values at the time of 3rd cut (Nov.) in all species. This behaviour was also shown with regard to tillers formation. Maximum values of tillers no. was recorded after the 2nd cut (August, 28) till the time of the 3rd cut (Nov. 3) for all plants especially the plants of *C. citratus* (DC.) Stapf (El-Kanater).

Vegetative growth as well as dry matter production was shown to follow a course similar to that of plant height and tillers growth. Greatest growth was attained mostly during summer period to the beginning of autumn and reached its maximum during the period from Aug. 28 to Nov. 3.

II. Absolute growth rate:

Absolute growth rate (according to Street & Opik, 1984) as shown in Table (4) was found to be in harmony with the previous results *i.e.* elongation growth in term of plant height attained maximum rate (cm/day) during the period from July to Nov. in the two seasons for all species.

Tillers formation "horizontal growth" showed maximum growth rate (tiller/day) mostly at a time starting later than that of plant height mainly in August for *C. citratus* (El-Farafra) and at Nov. for the rest of the plants in the two seasons.

Biomass and dry matter of the three plants have a highest growth rate (gm/

Table 3. Growth characters of *Cymbopogon* plants.

Growth characters / Species \ Cuts	Plant height (cm)			Tiller no. /plant			Fresh weight (gm /plant)				Dry weight (gm /plant)			
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	Total	1st	2nd	3rd	Total
First season														
Cymbopogon citratus (1)	139.66	150.00	155.00	55.00	56.66	140.00	984.66	1756.7	1443.3	4184.6	209.86	359.16	356.15	934.17
	a	a	a	a	b	a	a	a	a	a	a	a	a	a
Cymbopogon citratus (2)	104.66	120.00	120.30	28.66	68.33	92.6	348.33	798.3	935.0	2083.7	76.65	225.21	249.85	551.71
	a	b	b	b	a	b	b	b	b	b	b	b	b	b
Cymbopogon nardus	86.66	91.66	103.33	27.33	35.33	70.00	288.33	498.3	573.3	1360.0	68.47	162.67	158.59	389.73
	c	c	c	b	c	c	c	c	c	c	b	c	c	c
Second season														
Cymbopogon citratus (1)	135.33	144.66	152.00	53.33	56.66	174.00	846.66	1511.7	1550.0	3908.3	171.60	414.31	378.09	964.0
	a	a	a	a	ab	a	a	a	a	a	a	a	a	a
Cymbopogon citratus (2)	109.33	130.33	125.60	29.00	61.66	85.00	401.66	900.0	1021.6	2323.3	87.48	199.30	261.76	548.54
	a	b	b	b	a	b	b	b	b	b	b	b	b	b
Cymbopogon nardus	85.33	96.66	111.66	32.66	48.60	77.00	311.66	620.0	731.7	663.3	71.92	126.02	182.18	380.12
	c	c	c	b	b	c	c	c	c	c	b	c	c	c

(1) El-Kanater

(2) El-Farafra

day)at different periods in each case. For *C. citratus* (El-Kanater), it was on August followed by Nov., while *C. citratus* of El-Farafra and *C. nardus* , the highest growth rate (gm /day) was recorded in Aug. and Nov.

Table 4. Absolute growth rate of *Cymbopogon* plants.

	Absolute growth rates							
	Plant height (cm/day)		Tillers no. (Tillers/day)		Vegetative growth (gm/day)		Dry matter (gm/day)	
	1st seas.	2nd seas.	1st seas.	2nd seas.	1st seas.	2nd seas.	1st seas.	2nd seas.
C. citratus (El-Kanater) :								
1	0.471	0.608	0.212	0.204	3.824	3.282	0.824	0.675
2	2.364	2.273	0.018	0.073	31.760	27.300	6.527	7.520
3	2.077	2.031	1.292	1.800	22.040	23.690	5.615	5.810
C. citratus (El-Farafra) :								
1	0.333	0.349	0.110	0.110	1.320	1.576	0.302	0.341
2	1.818	2.000	0.709	0.600	14.320	16.180	4.091	3.618
3	1.538	1.630	0.385	0.354	14.230	15.560	3.846	4.031
C. nardtus :								
1	0.263	0.255	0.102	0.125	1.090	1.184	0.267	0.282
2	1.309	1.400	0.145	0.273	8.870	11.090	2.964	2.291
3	1.277	1.415	0.538	0.446	8.660	11.100	2.462	2.800

1 : 1st cut (255 days from planting)
2 : 2nd cut (55 days from 1st cut)
3 : 3rd cut (65 days from 2nd cut)

This highest growth rate of biomass and dry matter (gm/day) was positivelly correlated with the highest elongation rate (cm/day) existed in Aug. rather than tillering rate (tiller/day) in case of *C. citratus* (El-Kanater). However, it was observed that, the highest growth rate of these two charcters was correlated with highest growth rates of both elongation and tillering in *C. citratus* (El-Farafra) and *C. nardus* .

It could be concluded that, plants of the Genus *Cymbopogon* showed differences in growth characters in term of plant height, tillering, biomass and dry matter production. These results hold true in case of absolute growth rate of each organ (per day) of the three plants. These findings were found to be in accordance with those of Behura *et al.* (1991). Also, it was found that herbage yield fresh or dry of *Cymbopogon* plants was affected by elongation and tillering, these results agreed with those stated by

Weiss (1997).

III. Volatile oil:

1. Oil content:

Results in Table (5) pointed out that, *C. nardus* plants recorded the highest oil percentage (fresh and dry weight basis) in all cuts in comparison with the plants of *C. citratus* of both two locations in the two seasons.

Plants showed a gradual increase in oil production in term of oil content (fresh and dry weight basis) as the plants advanced in age during the growing season.

C. citratus plants (El-Kanater) showed a slight increase in oil percent (fresh weight) while this trend was not clear in case of oil percent (dry weight basis).

El-Farafra *C. citratus* showed a fluctuation in oil percent (fresh weight basis) during the growing seasons, while it tended to decrease when dry weight basis was considered.

2. Oil yield:

Lemongrass (El-Kanater) produced the highest oil yield (ml/plant) though its oil content is significantly lower in comparison with the rest plants. This is due to the significant highest production of biomass as well as the dry matter production in the plant.

Essential oil production in the plants of these three species tended to increase during the growing season and the plants produced maximum yield (ml/plant) at the time of the 3rd cut in Nov. 3 in most cases.

Total yield of essential oil (ml/plant/year) showed the highest values in case of *C. citratus* (El-Kanater) followed by El-Farafra *C. citratus*, while the lowest one was obtained from *C. nardus* plants (Table 5).

This behaviour was found to be in harmony with the biomass and dry matter production of these plants.

In general, these results clearly emphasized that, *Cymbopogon* plants showed differences in essential oil content i.e. citronella plants recorded the highest oil content followed by El-Farafra plants and the lowest one was detected in lemongrass (El-Kanater).

Table 5. Volatile oil content of *Cymbopogon* plants.

Growth characters / Species / Cuts	Oil percentage based on fresh weight			Oil percentage based on dry weight			Oil yield (ml /plant)			
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	Total
First season										
Cymbopogon citratus (1)	0.22 b	0.25 c	0.28 c	1.06 b	1.27 c	1.10 c	2.23 a	4.44 a	4.03 b	10.7 a
Cymbopogon citratus (2)	0.47 a	0.41 b	0.44 b	2.16 a	1.64 b	1.64 b	1.64 b	3.29 b	4.10 ab	9.03 b
Cymbopogon nardus	0.51 a	0.56 a	0.73 a	2.18 a	2.14 a	2.64 a	1.47 b	2.78 b	4.20 a	8.45 b
Second season										
Cymbopogon citratus (1)	0.26 b	0.26 c	0.28 c	1.32 b	1.08 c	1.14 c	2.25 a	3.92 a	4.33 b	10.5 a
Cymbopogon citratus (2)	0.46 a	0.39 b	0.43 b	2.10 a	1.56 b	1.66 b	1.84 b	3.53 a	4.35 b	9.72 b
Cymbopogon nardus	0.50 a	0.61 a	0.66 a	2.16 a	2.33 a	2.66 a	1.52 c	3.80 a	4.84 a	10.16 ab

(1) El-Kanater

(2) El-Farafra

Also, essential oil biosynthesis and accumulation (in term of oil yield ml/plant) showed variation according to many factors, such as growth stage and growth behaviour of both elongation and tillering in which the biomass and dry matter production were influenced.

These findings met those of Misra and Srivastava (1991), Behura *et al.* (1991) and Weiss (1997).

3. Physicochemical properties of *Cymbopogon* plants essential oil:

Data in Table (6) pointed out that, physicochemical properties of the essential oil of the three plants of *Cymbopogon* recorded values met those of the standard specification, Rutovskii and Vinogranova (1930), Squibbs (1933), Guenther (1961), Ibrahim (1965), El-Zahwey *et al.* (1992), Gabr (1994) and S.Soad (1995). However, found that, lemongrass oil (El-Kanater) showed the lowest values in this respect.

Table 6. Physicochemical properties of *Cymbopogon* plants essential oil.

Species / Properties	*Cymbopogon citratus* (1)	*Cymbopogon citratus* (2)	*Cymbopogon nardus*
Solubility in alcohol	Soluble in 1.7 vol. of 90% alco.	Soluble in all vol. of 90% alco. 50% in 0.8–1.9 vol. of 80% alc.	Soluble in 3.5 vol of 90% alco. Sol. in 0.8-1.9 vol. of 80% alco.
Specific gravity at 15 °C	0.8886	0.9154	0.9090
Refractive index at 20°C	1.4871	1.4901	1.4896
Specific optical rotation	-2.81	-3.7	-3.2
Colour	Light yellow	Light yellow	Light yellow
Acid number	4.74	16.00	13.14
Ester number	14.62	36.72	26.82
Ester no. after acetylation	208.48	219.88	219.84

(1) El-Kanater

(2) El-Farafra

IV. Essential oil chemical composition:

Data in Table (7) and Figs (1 and 2) represent the chemical composition of lemongrass oil of the two sources (the El-Kanater and El-Farafra one). It was found that, citral (aldehyde) was the main component in the two plants of lemongrass and geraniol (alcohol) was the 2nd main component. Citral content showed an increase during the growing season and attained maximum values at the time of the 3rd cut (70.24 and 59.13%) in the oil of the El-Kanater lemongrass and El-Farafra, respectively.

Geraniol content showed its maximum in the oil of the 2nd cut (36.94 and 27.78% for the El-Kanater and El-Farafra lemongrass oil, respectively).

Table 7. Essential oil chemical composition in percent of *Cymbopogon* plants.

Species	El-Kanater lemongrass			ElFarafra lemongrass			Citronella		
Components	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Myrcene	26.76	11.67	3.85	28.32	16.62	8.79	---	---	---
Citronellal	---	---	---	---	---	---	28.98	38.16	33.91
Linalool	0.75	0.65	0.71	---	0.28	0.37	0.29	0.38	---
Linaloyl acetate	1.69	1.56	2.35	0.94	1.62	2.30	1.00	1.39	0.37
Citronellol	---	---	---	---	---	---	20.69	16.78	17.48
Geraniol	26.64	36.94	21.43	20.87	27.78	27.57	48.13	42.80	45.59
Citral	42.72	45.46	70.24	49.14	50.46	59.13	---	---	---
Geranyl acetate	0.50	0.95	1.03	---	0.71	0.49	0.12	---	---
Nerol	0.95	2.08	0.05	0.72	2.03	1.34	0.58	0.48	0.38

It was observed that, the oil of the two plants showed differences in the contents of these two main components (citral and geraniol) and others i.e. citral content recorded the highest values in the oil of El-Kanater lemongrass in the 3rd cut (70.24%) in comparison with El-Farafra oil (59.13%). However, the opposite trend was found in the oil of 1st and 2nd cut for the two plants.

Also, it was found that, geraniol showed a higher content in the oil of the El-Kanater lemongrass than that of El-Farafra oil especially in the 1st and 2nd cut.

Myrcene content decreased gradually as the plants advanced in age during the growing season. So, it increased from (26.76 and 28.32%) in the 1st cut to (3.85 and 8.79%) in oil of the 3rd cut for the El-Kanater lemongrass and El-Farafra, respectively. These relations may be explained by the interconversion of geraniol to myrcene and citral and vice versa.

Also, the following components linalool, linaloyl actetate geranyl acetate and nerol were detected in the two oils.

In general, it could be concluded that, the oil of lemongrass (El-Kanater) *C. citratus* (DC.) Stapf have the best quality as its citral and geraniol contents were highest than those of El-Farafra lemongrass oil.

These findings were in accordance with many authors, El-Zahwey *et al.* (1992), Gabr (1994), Salem, Soad (1995) and Torres & Ragadio (1996) worked on lemongrass and came to the conclusion that, citral was the 1st main component of the oil followed by geraniol as the 2nd one.

As for citronella (Ceylon) oil, data in Table (7) and Fig (3) emphasized that, geraniol oil (alcohol) was found to be the main component. The highest content of geraniol was detected at the time of the 1st cut (48.13%), however the oil of the 2nd and 3rd cuts contain geraniol (42.8 and 45.59%, respectively) slightly less than the oil of the 1st cut.

Citronellol, another alcohol was found in the oil by about (20.69%) in the 1st cut (16.78%) in the 2nd and (17.48%) in the 3rd one. It showed a slight decrease during the growing season, the same behaviour previously observed in case of geraniol.

The second main component in Ceylon citonella oil was citronellal (aldehyde) it was estimated by (28.98, 38.16 and 33.91%) in the oil of 1st , 2nd and 3rd cuts, respectively.

It was observed that, the highest geraniol and citronellol contents were accompanied with the lowest content of citronellal and vice versa. This observation was expected due to enzymatic reactions that interconvert a great variety of the monoterpene derivatives to each other.

The oil contained linaloyl acetate and traces of linalool, geranyl actete and nerol. These results agreed with those of Weijeskera *et al.* (1973) and Weiss (1997).

General conclusion:

It could be concluded that, lemongrass *Cymbopogon citratus* (DC.) Stapf (El-Kanater cultivated commercially) was superior in growth, herbage yield, essential oil production and higher contents of citral and geraniol in comparison with the other plant of lemongrass (El-Farafra).

Citronella plant, gave good parameters in growth, herbage yield and essential oil production as well as its geraniol, citronellol and citronellal contents, under the environmental conditions of Egypt.

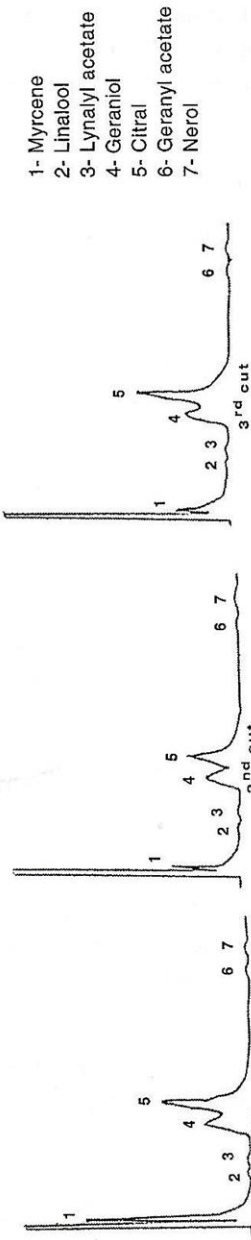

Fig. 1. Gas chromatogame of local lemongrass oil.

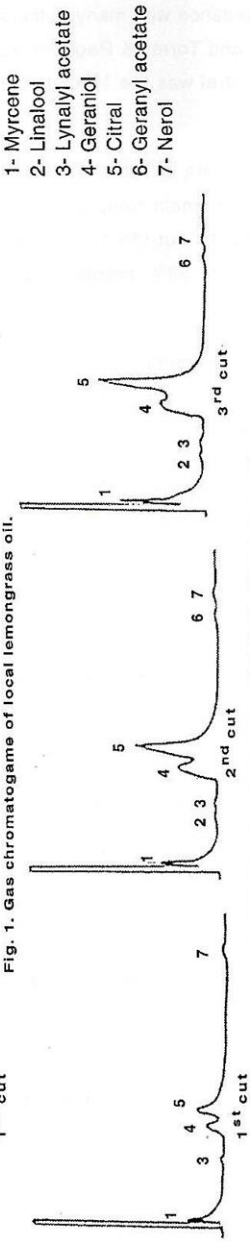

Fig. 2. Gas chromatogame of El-Frafra lemongrass oil.

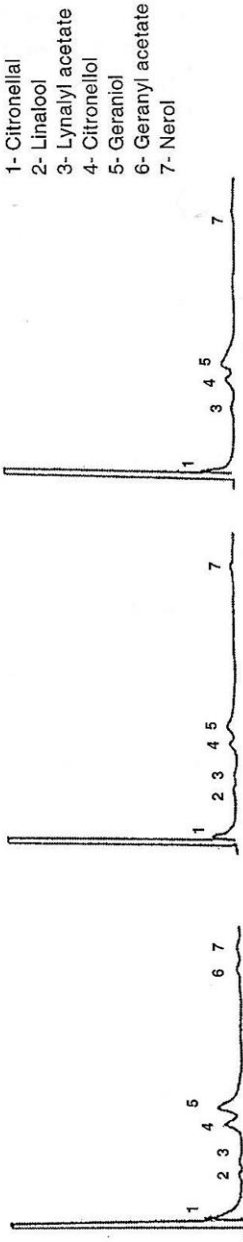

Fig. 3. Gas chromatogame of citronella oil.

REFERENCES

1. Behura, B., S. Sahoo, N.K. Pradhan and P.K. Dutta. 1991. *Cymbopogon* natural hybrid Jamrose the aromatic grass suitable for chromite overburden plantation. Indian Perfumer, 35 (2): 90 - 92. (C.F. Hort. Abst., 62 (6): 5071).

2. El-Zahwey, A.E., I.M. Harridy and El-Deeb A. Sohir. 1992. Effect of drying on the physicochemical properties and chemical composition of lemongrass oil. Menofiya J. Agric. Res., 17 (3): 1211 - 1230.

3. Gabr, S.I.S. 1994. The effect of some essential oils on growth of food spoilage microorganisms. Ph.D. Thesis Moshtohour Fac. Agric. Zagazig Univ.

4. Guenther, F. 1961. Essential oil. Vol. 1, 4 D. Vau Nostrand comp. Inc. Princeton. New Jersy New York.

5. Ibrahim, S.S. 1965. Chemical studies on lemongrass oil. M.Sc. Thesis Fac. Agric. Ain Shams Univ. Cairo.

6. Luthra, R., N. Singh and S. Sharma. 1991. Changes in monoterpene content accompanuing development of *C. winterianus* leaves. J. Ess. Oil. Res., 3 (5): 349 - 354.

7. Misra, A. and N.K. Srivastava. 1991. Effect of the triacontanol formulation "Miraculan" on photosynthesis, growth, nutrient uptake and essential oil yield of lemongrass "*Cymbopogon flexuosus*" Steud Walts. Plant Growth Regulation, 10 (1): 57 - 63.

8. Rutovskii, B.N. and I.V. Vinograndova. 1930. Riechstoff Ind, 5, 15 (C.F. Guenther 4, 64, 1961).

9. Salem, Soad M. 1995. Studies on lemongrass oil. M. Sc. Thesis Moshtohour Fac. Agric. Zagazig Univ.

10. Snedecor, G.W. and W.G. Cochran. 1972. Statistical Methods 6th Ed. The Iowa State Univ. Press Ames, Iowa USA, pp 953.

11. Squibbs, F.L. 1933. Annual Report. Dept. Agric., 9 - 14 (C.F. Chem. Abst., 29: 3776).

12. Street, H.E. and H. Opik. 1984. The physiology of flowering plants. 3rd Ed. 14 Edward Arnold Ltd. London.

13. Torres, R.C. and A.G. Ragadio. 1996. Chemical composition of the essential oil of Philippin *Cymbopogon citratus* (DC.) Stapf . Philippin J. Sci., 125 (2): 147 - 156. FSTA, 27 (7): T 33.

14. Weiss, E.A. 1997. Essential Oil Crops. CAB International Ovon Ox 108 DE UK; New York NY 10016 - 4341, USA.

15. Wijesekera, R.O.B., A.L. Jayewardene and B.O. Fonseka. 1973. Varietal differences in the constituents of citronella oil phytochem., 12: 2697 - 2704. (Sited from Weiss. 1997).

دراسة مقارنة على بعض أنواع جنس *Cymbopogon* المنزرعة في مصر

إبراهيم محمد أحمد هريدى ، سعيد جبر ، محمد ناجى شعلان

قسم بحوث النباتات الطبية والعطرية - معهد بحوث البساتين - مركز البحوث الزراعية - مصر

أجرى هذا البحث في موسمين متتاليين ١٩٩٨ و ١٩٩٩ لدراسة النمو والمحصول وإنتاج الزيت ومواصفاته ومكوناته في ثلاثة نباتات لنوعين من جنس *Cymbopogon* وقد تم تسجيل بيانات النمو للنباتات الثلاثة فيما يخص ارتفاع النبات وعدد الخلفات للنبات والوزن الطازج والجاف (جم/نبات) وقد أوضحت النتائج وجود اختلافات في النمو ، حيث سجلت نباتات النوع *C. citratus* المنزرع في القناطر الخيرية (وهذا نفس النوع الذى يزرع على نطاق تجارى) أعلى القيم من حيث ارتفاع النبات وعدد الخلف والوزن الطازج والجاف.

أما من حيث الزيت الطيار ومكوناته ومواصفاته والمحصول الناتج من كل نوع من الأنواع الثلاثة فقد أظهرت النتائج أعلى نسبة زيت في نبات *C. nardus* ولكن تفوقت *C. citratus* المنزرعة في القناطر من حيث محصول الزيت (ملليتر/نبات) على باقى الأنواع وقد تم تسجيل النتائج فيما يخص مواصفات الزيت واتضح أن كل قيم الصفات الطبيعية للزيت متفقة مع الأرقام القياسية.

ومن ناحية مكونات الزيت فقد تفوقت حشيشة الليمون (القناطر) عن (الفرافرة) من حيث زيادة نسبة السترال (المكون الرئيسى) والجيرانيول (ثانى مكون رئيسى) ، أما حشيشة السترونيلا فقد كانت نسبة الجيرانيول والسيترونيللول والسترونيللال متفقة مع القيم القياسية.