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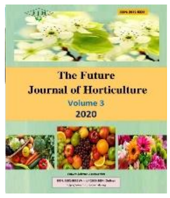

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STUDY THE RESPONSE OF GROWING SOME CULTIVARS OF CORIANDER (*Coriandrum sativum* L.) SOWING AT DIFFERENT DATES

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ABSTRACT: The present investigation on coriander (*Coriandrum sativum* L.) included three sowing dates viz. 15th October (D1), 30th October (D2) and 15thNovember (D3) and four selected cultivars; Baladi (C1), Syrian (C2), Indian (C3) and Sudan cultivars (C4). The experiment was conducted during two successive cultivation seasons of 2018/2019 and 2019/2020 in the experimental farm of Assuit. This experiment carried out to assess yield, quality and economics of coriander cultivars under agro-ecological conditions of this region. Phenological traits (time to flowering initiation, maturation and harvest), along with morphological characters, yield and two chemical traits related to seed composition were evaluated. As a result of this study, all investigated characters of coriander were varied significantly, as well as the maximum number of branches, number of umbels / plants, seed yield/ plot and seed yield/ fed. were recorded in the plants sown on 15th October followed by 30th October. The essential oil percentage from coriander fruits was ranged between 0.26% and 0.63%. Linalool was found to be the principal constituent. The other major compounds were Alpha pinene, Limonene, Citronellal and geranyl acetate. The maximum oil percentage was recorded in Syrian cultivar at all dates. Results revealed that parameters like minimum days to flowering initiation, minimum days to 50% fruit maturation and minimum days to harvest were recorded with Indian followed by Syrian cultivars at different dates. The result of experiment revealed that the D1 significantly improved growth parameters among all the dates of sowing. The best results were obtained from Baladi, Syrian cultivars, with respect to fruits yield and essential oil respectively.

Key words: *Coriandrum sativum*, dates, cultivars, GC, essential oil and chemical constituent

INTRODUCTION

Coriander (*Coriandrum sativum* L.), is an annual herb that belonging to the family Umbelliferae / Apiaceae, known popularly in Egypt and Sudan as Kazbra and In India is locally known as "Dhania. It is one of important herb that functions as both spice and herbal medicine **(Bhat *et al.*, 2014)**. Coriander is a very variable species, and the botanical literature contains several sub classifications into subspecies, varieties and forms. Many studies of variation in *C. sativum* L. have been conducted based on morphological characteristics supplemented with a few selected chemical characteristics. **Purseglove *et al.* (1981)** divided coriander into two types, based on fruit size: the large-fruited types (= var. *sativum)* are mainly produced in tropical and subtropical countries with seed essential-oil percentage of about 0.1 to 0.35% and have a short life-cycle, and the small-fruited types (var. *microcarpum* DC) are commonly produced in temperate regions and produce an essential-oil content of more than 0.4% **(Bandara *et al.*, 2000). Shahwar *et al.* (2012)** reported that content of essential oil of coriander fruits varies from 0.03–2.6 %, these essential oils variations can be attributed to some factors like climatic conditions, species and growing conditions. The previous studies reported that the chemical composition of *C. sativum* differs considerably with variety, region and age of the product. **Ivanova and Stoletova (1990)** reported that India, Northern Africa, Central Asia and Ethiopia are centers of formation and cradles for different types of coriander. On the other hand, coriander shows a broad adaptation as crop around the world; as it grows well in different types of soil, in different weather conditions at extreme latitudes, longitudes, and altitudes **(Guenther, 1952; Purseglove *et al.*, 1981 and Simon, 1990).** In addition, the short life cycle in most coriander cultivars makes them successful under many different environmental conditions, by allowing farmers to fit their cultivation into some part of the growing season in almost any region. There are dissimilarity in seed yield and EO content of *C. sativum* cultivars grown at different locations but there are many problems; such as many of these traits in coriander are environmentally influenced, and genotype-by - environment interactions are common **(Bhandari and Gupta, 1991; Angelini *et al.*, 1997; Ali *et al.*, 1999). Shriya *et al.* (2020)** reported that growth, development and yield of crop / variety is an outcome of genomic, environmental and agronomic interactions. Since, both the varieties were grown under similar agronomic practices and environmental conditions; the observed differences in overall growth of varieties may be due to their genetic. Coriander is generally sown in winter season for seed production.

Time of sowing is crucial for the vegetative growth and ultimate expressions of yield as well as quality, any early or delayed sowing may harmful the growth, yield and quality of the crop. Change in sowing date leads to significant change in weather microclimate and ultimately the performance of crop **(Sharangi and Roychowdhury, 2014 and Rashed and Darwesh, 2015).** The results of the study indicated that sowing date significantly influenced the yield and yield attributes of coriander and earliness and delay in sowing resulted in inferior yields **(Kassu *et al.*, 2018)**. The present investigation was done to evaluate four selected cultivars of coriander (*Coriandrum sativum* L.) sown at different dates to obtain the superior cultivar and optimum date for higher yield and quality.

MATERIALS AND METHODS

Field experiment

The present experiments were laid out for two years (2018/2019 and 2019/2020) as a winter plant at the sandy calcareous soil of the Experimental field of Arab El-Awammer Research Station, Agric. Res. Center (A.R.C.), Assiut Governorate, (A.R.E.).The experiment included three sowing dates viz., 15th October (D1), 30th October (D2) and 15th November (D3) and four selected cultivars; Baladi (C1), Syrian (C2), Indian (C3) and Sudan (C4) cultivars, (All cultivars of *C. sativum* were obtained from Indian Institute of Horticultural Research, Bengaluru, India). There were 12 treatment combinations were arranged in a split plot design with three replications. Cultivars were assigned to main plots whereas sowing time to sub plots. Plots were 2 x1.5 meters each plot consists of 3 row, Sowing row intervals were 60 cm and distance between plants in the same ridge was 30 cm in the two sides of the ridge. About 5-7 fruits were sown per hill, and then thinned after three weeks to two plants/ hill. All agricultural practices were management as recommended. The Physical and chemical characteristics of the experimental field soil of the surface layer (0-25 cm) are shown in Table 1. Seeds were sown at the same dates for both seasons. The necessary observations from the germination to harvest were recorded (flowering initiation days, 50% fruits maturation days and time of harvesting). At harvest time, ten plants were randomly chosen for each plot to evaluate the plant height (cm), no. branches per plant, no. of umbels per plant, fruit yield (gm)/plot as well as fruit yield (kg)/ fed., essential oil content and essential oil composition.

Table 1. Physical and chemical properties of representative soil samples from the field experimental site

Physical properties									
Particle size distribution				Moisture content % (w/w)			Total $CaCO_3$ %	Organic Matter %	Bulk Density
Sand %	Silt %	Clay %	Texture Grade	S.P.	F.C.	W.P.			
88.91	5.90	5.19	Sandy	23.70	10.97	4.45	33.4	0.22	1.63

Chemical properties									
pH (1:1)	EC (1:1)	Soluble Cations (meq / L)				Soluble Anions (meq / L)		Total N (%)	Available P (mg/kg)
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{-}+HCO_3^{-}$	Cl^{-}		
8.63	0.97	4.69	2.77	1.55	0.57	4.81	3.61	0.009	7.63

Isolation of essential oil

One hundred grams of coriander seed samples in 0.5 L water from each treatment were extracted by hydro-distillation for 3 hours using Clevenger apparatus according to the method described in European Pharmacopoeia **(Stainier, 1975)** for determining the oil content (v/w, %). The obtained oil was dried over anhydrous sodium sulphate then filtered and stored in a sealed vial at 4 °C. The yield of the oil (v/w %) was calculated.

Gas chromatography analysis of the essential oil

The gas chromatography (GC) analysis of the essential oil samples was carried out in the Laboratory of Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, ARC using Ds Chrom 6200 Gas Chromatograph apparatus, fitted with a capillary column BPX-5, 5 phenyl (equiv.) polysillphenylene-siloxane 30 x 0.25 mm ID x 0.25µ film. The temperature program varied in the range 70˚-200˚C, at a rate of 10˚ C/min. Flow rates of gases were nitrogen at 1 ml/min, hydrogen at 30 ml/min and 330 ml/min for air. Detector and injector temperatures were 300˚ C and 250˚ C respectively. The identification of the compounds was done by matching their retention times with those of authentic samples injected under the same conditions.

Statistical Analysis

Results of experiments were analyzed using split-plot design; main plots were cultivars whereas sub-plots were the dates. All the data were subjected to variance analysis (ANOVA) by using Statistix 8.1 software and showing significant difference at $P \leq 0.05$, the mean comparison was done following by the Tukey's comparison test.

RESULTS AND DISCUSSION

Effect of sowing dates, cultivars and their interaction on growth and yield characters

From the analysis of data, significant or highly significant differences between planting dates were observed for morphological, phenological, and chemical characteristics. Our results revealed that maximum plant height (106.96), number of branches (23.05), number of umbel plant-1 (47.81) were recorded at 15th October date of sowing (Table 2) in the second season. The maximum seed yield (Kg)/fed. (602.77 and 417.11 Kg) were recorded in the crop sown on 15th October followed by 30th October of second season respectively (Table 3). Higher yield in D1 sowing was probably due to the crops enjoyed with suitable temperature during the vegetative and reproductive stage and also subjected to low temperature resulted in long maturity duration which was optimum for early growth. The crops of D2 sowing matured at less days after sowing, it had seed yield less than D1 sowing may due to the plants in delayed sowing face adverse climatic condition during vegetative and flowering stages, this happened may be due to very low temperature during early vegetative growth and high temperature over optimum during flowering and fruit stage and shorter growing seasons. In delayed sowing plants do not get optimum temperature during vegetative and reproductive growth in coriander and eventually seed yield decreases **(Moniruzzaman *et al.*, 2015)**. With respect to cultivars, Syrian followed by baladi cultivars were superior in growth parameters, respectively. Plant height is mainly controlled by genotype × environment interactions and this may be influenced by ecological conditions and agronomic practices **(Inan *et al.*, 2014)**. Concerning the interaction, it is clear that the highest fruit yields of coriander were attained from coriander sowed on D1 from baladi and Sudan respectively (Table 3). Differences between morphological, and chemical features due to cultivars and planting dates demonstrate the effect of the environment on the expression of many of these features **(Lombard *et al.*, 2001; Nuel *et al.*, 2001)**, and also confirm the capacity of the plants to modify trait expression, as a consequence of changes in the environment; this phenomenon is called phenotypic plasticity **(Dewitt and Scheiner, 2004)**. It might be concluded from the study that the cultivars differed significantly in most of the parameters and offer a good scope for selecting of for desired characters. **Balai and Keshwa (2010)** concluded that growth, development and yield of crop/ cultivar is an outcome of genomic, environmental and agronomic interactions. Since, both the cultivars were grown under analogous agronomic practices and environmental conditions; the observed variation in overall growth of cultivars seems to be related to their genetic ambiances. Sowing dates and their interaction with cultivars significantly ($P<0.005$) affected the fruit yields of coriander, the findings are similar with the result of to the report of **Pal and Murty (2010)** in wheat. Differences of these values might be due to genotype × environment interactions **(Kaya *et al.*, 2000 and Inan *et al.*, 2014)**.

Effect of sowing dates, cultivars and their interaction on phonological characters

The cultivars differed significantly for days to flowering initiation, 50% fruit maturation and days for harvesting (Table 4). The baladi cultivar took the maximum days (116 days) to reach 50% fruit maturation stage followed by Sudan. In the present study baladi cultivar had long maturity duration and gave better seed yield. It was observed that earliest flowering was recorded in the Indian (40 days), followed by Syrian cultivar, thus Syrian and Indian cultivars performed as early. The cultivars varied significantly in this trait. Similarly, **Islam *et al*. (2004)** harvested seeds of 14 genotypes within 97.25-111 days and reported that the variation in GDDs in different genotypes might be due to variation in maturity days of the genotypes **(Moniruzzaman *et al.*, 2015).**

Table 2. Effect of sowing dates, type of cultivar and their Interaction on plant height, number of branches and number of umbels /plants of *Coriandrum sativum* L. during 2018/2019 and 2019/2020 seasons

Seasons	2018/2019					2019/2020				
Main	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
Sub main	Plant height (cm)									
D1	113.8^{B} ±1.5	125.4^{A} ±3.5	76.3^{F} ±2.1	92.8^{CD} ±1.5	102.08^{A}	118.2^{C} ±2.9	138.6^{A} ±1.7	76.9^{J} ±1.4	94.1^{EF} ±1.2	106.96^{A}
D2	112.7^{B} ±2.0	120.9^{A} ±0.5	79.5^{F} ±1.5	82.6^{E} ±0.6	98.95^{B}	114.5^{C} ±1.4	127.4^{B} ±1.2	80.3^{GH} ±2.1	85.3^{F} ±2.6	101.88^{B}
D3	89.7^{DE} ±1.4	95.83^{C} ±0.7	60.9^{G} ±1.3	80.4^{EF} ±0.2	81.7^{C}	92.8^{E} ±1.4	100.0^{D} ±1.0	65.3^{I} ±0.6	84.3^{FG} ±1.5	85.61^{C}
Mean	105.41^{B}	114.06^{A}	72.24^{D}	85.27^{C}	-	108.52^{B}	122.02^{A}	74.16^{D}	87.91^{C}	-
	Branches No./ plant									
D1	24.5^{B} ±0.63	28.2^{A} ±0.64	15.5^{E} ±0.31	17.4^{D} ±0.53	21.4^{A}	24.8^{B} ±1.25	32.5^{A} ±0.23	16.3^{DE} ±0.3	18.5^{CD} ±0.3	23.05^{A}
D2	14.3^{EF} ±0.41	20.5^{C} ±0.25	15.4^{E} ±0.46	14.8^{EF} ±0.46	16.24^{B}	14.6^{EF} ±0.08	20.8^{C} ±0.58	15.0^{EF} ±0.00	14.3^{EF} ±0.43	16.2^{B}
D3	11.9 ^{G}±0.56	13.8^{F} ±0.49	7.6^{I} ± 0.20	10.1^{H} ±0.46	10.82^{C}	12.1^{F} ±0.6	15.0^{EF} ±0.4	6.8^{G} ±0.20	14.5^{EF} ±0.5	12.11^{C}
Mean	16.9^{B}	20.8^{A}	12.9^{D}	14.1^{C}	-	17.2 ^{B}	22.9^{A} ±8.9	12.7^{C} ±5.2	15.8^{B} ±2.4	-
	Number of umbels/ plant									
D1	60.6^{A} ±0.81	50.9^{B} ±0.63	33.6^{EF} ±1.10	39.3^{C} ±0.47	46.1^{A}	62.5^{A} ±0.3	52.9^{B} ±0.70	35.9^{E} ±1.10	39.9^{D} ±1.07	47.8^{A}
D2	35.0 ^{E} ±0.65	38.4^{CD} ±1.0	29.9^{G} ±1.10	35.9^{DE} ±0.4	34.79^{B}	37.3^{DE} ±0.5	43.5^{C} ±1.28	30.8^{F} ±0.48	35.9^{E} ±1.29	36.88^{B}
D3	30.8^{FG} ±0.70	21.8 ^{H}±1.73	13.4^{I} ±0.20	24.4^{H} ±0.32	22.610^{C}	31.3^{F} ±1.04	22.5^{G} ±1.03	14.2^{H} ±0.20	25.3^{G} ±0.31	23.33^{C}
Mean	42.13^{A}	37.02^{B}	25.62^{D}	33.22^{C}	-	43.72^{A}	39.63^{B}	26.97^{D}	33.71^{C}	-

D1 = 15 October D2 = 30 October D3 = 15 November
C1 = Baladi cultivar C2 = Syrian cultivar C3 = Indian cultivar C4 = Sudan cultivar

Table 3. Effect of sowing dates, type of cultivar and their interactions on fruit yield (g)/plot, fruit yield (kg)/fed. and essential oil (%) of *Coriandrum sativum* L. during 2018/2019 and 2019/2020 seasons

Treat.	2018/2019					2019/2020				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
	Fruit yield (g)/plot									
D1	439.97^{A} ± 0.7	372.27^{D} ±1.3	408.73^{C} ±1.6	427.87^{B} ±1.1	412.2^{A}	453.03^{A} ±0.6	395.51^{D} ±1.17	429.80^{C} ±1.3	443.87^{B} ±1.5	430.6^{A}
D2	301.4^{E} ±0.8	250.67^{G} ±1.2	261.70^{F} ±0.9	296.23^{E} ±0.6	277.5^{B}	312.72^{E} ±0.6	280.37^{F} ±0.32	287.15^{F} ±1.5	311.51^{E} ±2.1	297.9^{B}
D3	203.53^{H} ±1.2	172.80^{I} ±0.3	199.97^{H} ±1.2	205.93^{H} ±0.5	195.6^{C}	221.86^{G} ±0.9	199.92^{I} ±1.68	208.68^{H} ±1.7	217.28^{G} ±1.1	211.9
Mean	314.9^{A}	265.3^{D}	290.13^{C}	310.01^{B}		329.20^{A}	291.93^{D}	308.54^{C}	324.22^{B}.	
	Fruit yield (kg)/fed.									
D1	615.95^{A} ±1.3	521.18^{D} ±0.2	572.23^{C} ±1.1	599.01^{B} ±2.2	577.1^{A}	634.25^{A} ±0.8	553.70^{D} ±1.62	601.72^{C} ±1.9	621.41^{B} ±1.1	602.7^{A}
D2	421.97^{E} ±1.2	352.93^{G} ±1.6	366.38^{F} ±1.2	414.73^{E} ±0.8	389.0^{B}	437.81^{E} ±0.9	392.51^{F} ±1.60	402.00^{F} ±2.0	436.12^{E} ±0.5	417.1^{B}
D3	289.14^{H} ± 2.1	241.92^{I} ±1.2	280.15^{H} ±1.3	288.30^{H} ±0.7	274.9^{C}	310.60^{G} ±2.9	279.88^{I} ±2.4	292.15^{H} ±2.3	304.19^{G} ±2.1	296.7^{C}
Mean	442.35^{A}	372.01^{D}	406.25^{C}	434.01^{B}		460.89^{A}	408.70^{D}	431.96^{C}	453.91^{B}	
	Essential oil (%)									
D1	0.44^{E} ± 0.00	0.51^{C} ±0.00	0.35^{G} ±0.01	0.41^{F} ±0.01	0.43^{C}	0.45^{F} ± 0.0	0.51^{D} ±0.0	0.36^{H} ± 0.0	0.42^{G} ± 0.0	0.44^{C}
D2	0.48^{D} ± 0.01	0.57^{B} ±0.01	0.45^{E} ±0.01	0.35^{G} ±0.00	0.46^{A}	0.48^{E} ± 0.0	0.58^{B} ±0.00	0.46^{F} ± 0.0	0.36^{H} ± 0.0	0.47^{A}
D3	0.40^{F} ± 0.00	0.62^{A} ±0.00	0.52^{C} ±0.01	0.26^{H} ±0.00	0.45^{B}	0.42^{G} ± 0.0	0.63^{A} ±0.00	0.52^{C} ± 0.0	0.26^{I} ± 0.0	0.46^{B}
Mean	0.44^{B}	0.57^{A}	0.44^{B}	0.34^{C}		0.45^{B}	0.57^{A}	0.45^{B}	0.35^{C}	

D1 = 15 October D2 = 30 October D3 = 15 November
C1 = Baladi cultivar C2 = Syrian cultivar C3 = Indian cultivar C4 = Sudan cultivar

Table 4. Effect of sowing dates, type of cultivar and their interactions on flowering initiation, 50% fruit maturity (days) and days for harvesting of *Coriandrum sativum* L. during 2018/2019 and 2019/2020 seasons

Treat.	2018/2019					2019/2020				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
Days of flowering initiation										
D1	54.0^{A} ±1.0	45.0^{BC} ±1.0	41.0^{D} ±2.0	52.0^{A} ±1.0	48.00^{A}	56.0^{A} ±0.0	47.0^{CD} ±1.0	47.0^{CD} ±1.0	53.0^{AB} ±1.0	49.75^{A}
D2	48.0^{B} ±2.0	41.3^{CD} ±0.6	40.0^{D} ±1.0	45.0^{BC} ±1.0	43.58^{B}	50.0^{BC} ±1.0	44.0^{DE} ±1.0	40.0^{EF} ±1.0	47.0^{CD} ±2.0	45.25^{B}
D3	45.0^{B} ±1.0	40.0^{D} ±1.0	36.0^{E} ±1.0	41.0^{D} ±1.0	40.50^{C}	47.0^{CD} ±1.0	42.0^{EF} ±1.5	39.00^{F} ±1.0	42.67^{EF} ±1.0	42.67^{C}
Mean	49.00^{A}	42.11^{C}	40.00^{D}	46.00^{B}		51.00^{A}	44.33^{C}	40.67^{D}	47.56^{B}	
50% fruit maturation (days)										
D1	111.7^{A} ±1.5	99.7^{C} ±1.2	90.3^{E} ±0.6	101.3^{C} ±1.5	100.7^{A}	116.0^{A} ±1.0	99.0^{D} ±1.0	91.67^{E} ±1.5	103.3^{C} ±1.5	102.50^{A}
D2	106.67^{B} ±1.2	91.67^{E} ±0.6	82.00^{G} ±1.0	96.0^{D} ±1.0	94.08^{B}	110.3^{B} ±0.6	93.33^{E} ±1.0	81.67^{G} ±0.6	97.00^{D} ±1.0	95.58^{B}
D3	104.67^{B} ±1.2	86.00^{F} ±1.0	77.33^{H} ±1.5	91.3^{E} ±0.6	89.83^{C}	105.7^{C} ±0.6	87.3^{F} ±1.5	79.3^{G} ±0.6	93.0^{E} ±1.0	91.33^{C}
Mean	107.67^{A}	92.44^{C}	83.22^{D}	96.22^{B}		110.67^{A}	93.22^{C}	84.22^{D}	97.78^{B}	
Days for harvesting										
D1	160.33^{A} ±0.6	142.0^{C} ±2.0	135.3^{D} ±0.6	147.7^{B} ±1.5	147.33^{A}	160.0^{A} ±1.0	146.0^{DE} ±2.0	137.0^{F} ±1.0	150.7^{C} ±1.2	149.92^{A}
D2	151.0^{B} ±1.0	132.6^{DEF} ±1.5	131.3^{EF} ±1.5	141.7^{C} ±1.5	139.17^{B}	152.7^{B} ±1.5	135.67^{F} ±1.5	131.7^{G} ±0.6	145.0^{E} ±1.0	141.75^{B}
D3	148.67^{B} ±0.6	129.67^{F} ±1.5	133.7^{DE} ±1.5	133.7^{DE} ±1.5	134.25^{C}	149.7^{CD} ±0.6	131.0^{G} ±1.7	126.0^{H} ±1.0	136.0^{F} ±1.0	135.67^{C}
Mean	154.67^{A}	134.78^{C}	130.56^{D}	141.00^{B}		156.78^{A}	137.56^{C}	131.56^{D}	143.89^{B}	

D1 = 15 October D2 = 30 October D3 = 15 November
C1 = Baladi cultivar C2 = Syrian cultivar C3 = Indian cultivar C4 = Sudan cultivar

Content and composition of essential oil

The result in Table 3 showed that the content of coriander fruits essential oils from different cultivars were varied from 0.21- 0.69 % in both years. According to the two-cultivated years, there was a significant effect of cultivar on essential oil content where Syrian cultivar have the highest essential oil content (0.63 %) than other studied cultivars. The coriander seed essential oil content was high for Syrian cultivar although the seed yield/fed. was low. Overall, *C. sativum* essential oil from Syria is rich in beneficial chemical compounds and the fruits have a health-supporting reputation **(Ruba *et al.*, 2018)**. Significant interaction was observed between dates and cultivars for the content and composition of essential oil in two cultivated seasons. The slight variation of this oil percentage and the composition of the essential oil depend on many factors such as genotype, stage of maturity, cultivation practices, soil composition and climatic differences in various locations. This result is in close conformity with **Anwar *et al.*, 2011 and Siddharth *et al.*, 2014**. Results revealed that different climatic and geographic characters had significant effects in coriander genotypes for yield, yield components and essential oil content **(Duran *et al.*, 2016)**.

The essential oils from fruits of coriander cultivars analyzed by GC (Table 5 figure 1), linalool content as main component was ranged between 76.91 and 86.00 %. During two years, the highest mean values of linalool content (86.009 %) were obtained from Syrian cultivar the lowest ones were obtained from Sudan cv. (76.91 %) at the first sowing date. **Shahwar *et al.* (2012)** studied the chemical composition of coriander, and they found that the major volatile compounds in coriander seed were linalool (55.59 %), γ-terpinene (7.47 %), α-pinene (7.14 %), camphor (5.59 %). **Omnia and Itmad (2017)** reported that the dominant constituent in essential oil of *C. sativum* (coriander) cultivated in Northern Sudan was linalool (64.61%), This confirms that the reported variation in oil is due to geographic divergence and ecological conditions. Linalool is the main volatile compound in seeds, typically constituting more than 50% of the total essential oil **(Ehssan *et al.*, 2018)**. **Leung and Foster (2003)** reported that the major component of the coriander fruits oil is d-linalool, which is present in 55-74 %, depending on the ripeness of the fruits, there is a great variation in the chemical composition of these five regions essential oil of Coriander seed.

Table 5. Chemical compounds identified in the essential oil of *C. sativum* cultivars by the gas chromatography

Cultivars / Compounds	Baladi cultivar	Syrian cultivar	Indian cultivar	Sudan cultivar
α-pinene	0.93411	1.81721	3.13298	3.32462
p-cymene	1.14262	0.93933	3.10825	3.05123
Limonene	2.03204	1.90735	5.58207	5.51495
Gamma Terpine	0.10355	0.14849	0.23951	0.23225
Linalool	84.74245	86.00938	77.11239	76.91107
Citronellal	3..86502	3.79775	3.67723	3.63941
Camphor	0.37261	0.38151	0.32637	0.32102
Genaryl acetate	1.65997	1.38159	1.40974	1.41231

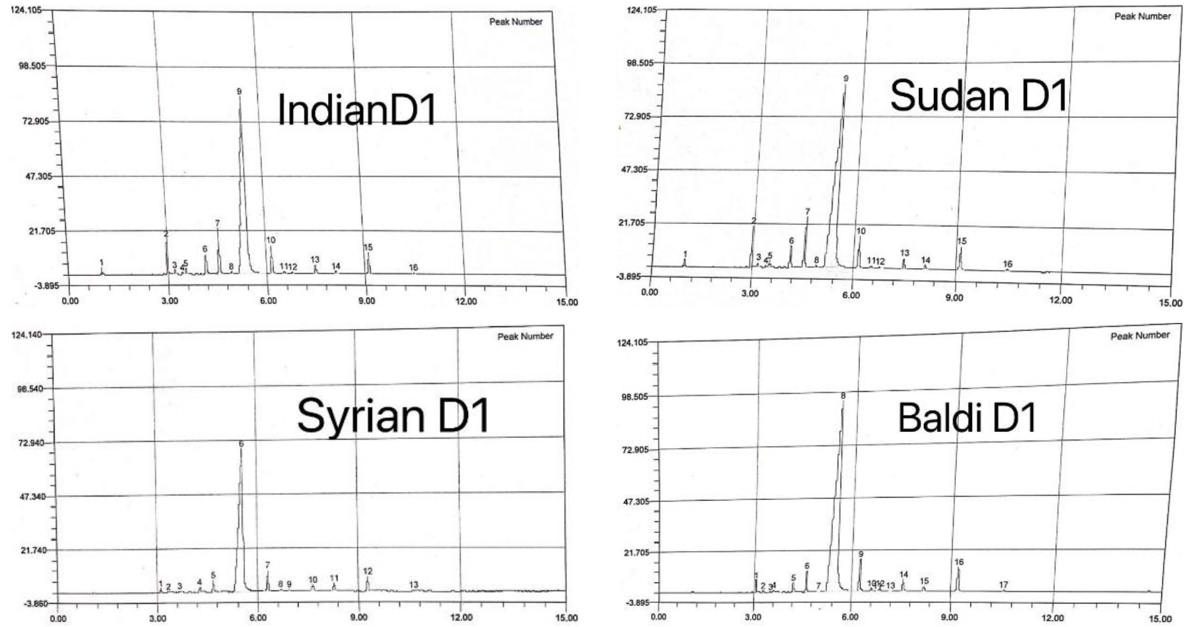

Figure 1. The gas chromatography analysis of essential oil of Baladi, Syrian, Indian and Sudan cultivars.

Conclusion

In our study, coriander cultivars were evaluated in climatic conditions of Assuit governorate, Egypt. Results revealed that coriander cultivars and different climatic conditions had significant effects in coriander yield, and essential oil content as well as composition. As a result of studies, the maximum fruit yield was observed from baladi cultivar followed by Sudan cultivar while the maximum oil content in Syrian followed by baladi cultivar. All cultivars in the study have high linalool contents and the component had similar variation according to cultivars and date. On the basis of results, all studied cultivars were suitable and prevailing agro-climatic conditions in Assuit governorate Egypt. Besides baladi followed by Syrian cultivars were found most suitable and lucrative in respect of seed yield, oil content respectively.

REFERENCES

Ali, S.A.; Chaurasia, S.C.; Yadav, L.N.; Jaiswal, R.K. and Upadhyay, P.C. (1999). Phenotypic stability of seed yield and its attributes in coriander (Coriandrum sativum L.). Intern. J. Trop. Agric., 17: 125-130.

Angelini, L.G.; Moscheni, E.; Colonna, G.; Belloni, P. and Bonari, E. (1997). Variation in agronomic characteristics and seed oil composition of new oil seed crops in Central Italy. Industrial Crops & Products, 6: 313-323.

Anwar, F.; Sulman, M.; Hussain, A.I.; Saari, N.; Iqbal, S.; and Rashid, U. (2011). Physicochemical composition of hydro-distilled essential oil from coriander (*Coriandrum sativum* L.) seeds cultivated in Pakistan. Journal of Medicinal Plants Research., 5(15): 3537-3544.

Balai, L.R. and Keshwa, G.L. (2010). Effect of thiourea on yield and economics of coriander (*Coriandrum sativum* L.) varieties under normal and late sowing conditions. Journal of Progressive Agriculture, 1(1): 52-55.

Bandara, M.; Wildschut, C.; Russel, E.; Ost, L.; Simo, T. and Weber, J. (2000). Special crops program (Brooks). Alberta, Agriculture, Food, and Rural Development. Crop Diversification Centers. Annual Report. Alberta, Canada. Accessed online at http://www.agric.gov.ab.ca/ministrv/pid/cdc/00/sc brooks.html

Bhandari, M.M. and Gupta, A. (1991). Variation and association analysis in coriander. Euphytica 58:1-4.

Bhat, S.; Kaushal, P.; Kaur, M. and Sharma, K. (2014). Coriander (*Coriandrum sativum* L.): Processing, nutritional and functional aspects. Afr J Plant Sci.; 8:5-33.

DeWitt, T.J. and Scheiner, S.M. (2004). Phenotypic variation from single genotypes. In:DeWitt T.J. and Scheiner S.M. (eds.) Phenotypic plasticity: Functional and conceptualapproaches. Oxford University Press, New York. pp. 1-9.

Duran, K.; Nimet, K. and Nimet, K.I. (2016). Yields and Quality Performances of Coriander (*Coriandrum Sativum* L.) Genotypes Under Different Ecological Conditions Turk. J. Field Crops, 21(1): 79-87.

Ehssan, H.J. Ahmed; Ragaa, S.M. Abadi and Abdelhafeez, M.A. Mohammed (2018). Phytochemical screening, chemical composition and antioxidant activity of seeds essential oil of *Coriandrum sativum* L. from the Sudan. International Journal of Herbal Medicine, 6(1): 01-04

Guenther, E. (1952). The essential oils. D. van Nostrand Co., New York. pp. 602-615.

Inan, M.; Kirici, S.; Giray, E.S.; Turk, M. and Taghikhani, H. (2014). Determination of suitable coriander (*Coriandrum sativum* L.) cultivars for Eastern Mediterranean region. Turk. J. Field Crops, 19(1): 1-6.

Islam, M.S.; Rahman, M.A.; Mazumder, M.M.; Hossain, R.K.; Bhuyan. M.A.J. (2004). Performance of some coriander genotypes for grain yield and its attributes. Bangladesh J. Agric. Res. 29(1): 59-66.

Ivanova, K.V. and Stoletova, E.A. (1990). The history of culture and intra specific taxonomy of *Coriandrum sativum* L. - Russian Bot., 133: 26-40.

Kassu, K.T.; Dawit, H.H.; Wubengeda, A.Y.; Almaz, A.T. and Asrat, M.T. (2018). Yield and yield components of coriander under different sowing dates and seed rates in tropical environment. Adv. Hort. Sci., 32(2): 193-203.

Kaya, N.; Yilmaz ve, G. and Telci, I. (2000). Agronomic and Technological Properties of Coriander (*Coriandrum sativum* L.) Populations Planted on Different Dates. Turk. J. Agric., 24: 355–364.

Leung, A.Y and Foster, S. (2003). Encyclopedia of common natural ingredients (used in food, drugs, and cosmetics), Second edition. A john wiley & Sons Inc, Hoboken. New Jersey.

Lombard, V.; Dubreuil, P; Dillman, C. and Baril, C.P. (2001). Genetic distance estimators based on molecular data for plant registration and protection: A review. Acta Horticulturae 546: 55-63.

Moniruzzaman, M.; Rahman, M.M.; Hossain, M.M.; Sirajul Karim, A.J.M. and Khaliq, Q.A. (2015). Effect of Sowing Dates and Genotypes on The Yield of Coriander (*Coriandrum sativum* L.) J. Agric. Res., 40(1): 109-119.

Nuel, G.; Baril, C. and Robin, S. (2001). Varietal distinctness assisted by molecular markers: A methodological approach. Acta Horticulturae, 546: 65-71.

Omnia, M.H. and Itmad, A.E. (2017). Characterization of essential oils from fruits of umbelliferous crop cultivated in Sudan II. *Coriandrum sativum* L. (Coriander) and *Foeniculum vulgare* Mill (Fennel). Journal of Pharmacognosy and Phytochemistry; 6(1): 113-116.

Pal, R.K. and Murty, N.S (2010). Thermal requirements of wheat under different growing environments of Tarai region (Uttarkhand) [On line]. pp. 78-79. *In*: http:// www. isprs.org/ proceedings/ XXXVIII/8W3.

Purseglove, J.W.; Brown, E.G.; Green, C.L. and Robbins, S.R.J. (1981). Spices. Vol. 2. Longman, New York. pp. 736-788.

Rashed, N.M. and Darwesh, R.K. (2015). A comparative study on the effect of microclimate on planting date and water requirements under different nitrogen sources on coriander (*Coriandrum sativum* L.). Ann. Agric. Sci., 60(2): 227-243.

Ruba J.; Ahmed, K.; Mohamed, N.O. and Dima, J. (2018). Essential oil composition of coriander (*Coriandrum sativum* L.) fruits. International Journal of Chemical Science, 2 (1): 10-15.

Shahwar, M.K.; El-Ghorab, A.H.; Anjum, F.M.; Butt, M.S.; Hussain, S. and Nadeem, M. (2012). Characterization of Coriander (*Coriandrum sativum* L.) Seeds and Leaves: Volatile and Nonvolatile Extracts. International Journal of Food Properties, **15**, 736-747.

Sharangi, A.B. and Roychowdhury, A. (2014). Phenology and yield of coriander (*Coriandrum sativum* L.) at different sowing dates. J. Plant Sci., 9(4): 32-42.

Shriya, R.; Karan, V.S.; Arjun, K. and Priyanka, G. (2020). Influence of PGRs, sowing time and varieties on growth of coriander *(Coriandrum sativum* L.), Journal of Pharmacognosy and Phytochemistry, 9(5): 1400-1403.

Siddharth, P. and Babasaheb, B.B. (2014). Effect of the Environment on Content and Composition of Essential oil in Coriander. International Journal of Scientific & Engineering Research, 5(2), P. 57.

Simon J.E. (1990). Essential oils and culinary herbs. In: Janick J. and Simon J.E. (eds). Advances in new crops. Proceedings of the First National Symposium. New Crops: Research, Development, Economics. Timber Press, Portland, Oregon, pp. 472-483.

Stainier, C. (1975). Role and functions of the European Pharmacopoeia. Ann Ist Super Sanita, 11(3-4): 211-219.