Evaluation of Agro-Morphological Characters And Oil Percentage of *Origanum syriacum* L. and *Origanum majorana* L. at Three Dates Of Initial Cutting

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ABSTRACT

This study was conducted during the 2006/2007 and 2007/2008 seasons, under open field and plastic houses conditions in the Jordan Valley, to evaluate yield and quality of *Origanum syriacum, and Origanum majorana* cultivated accessions and wild population at three dates of initial cutting. Several agro-morphological traits including oil content were studied. Spilt-plot arranged in a randomized complete block design with repeated measurement design replicated three times was used. The highest fresh and dry weight production was found to be produced when the first cut was performed at February 26. The highest essential oil percentage was obtained when the first cut was performed in March 26 for all population/accessions. The cultivation of *Origanum* under plastic house in Jordan valley positively affected plant height, fresh and dry weight, leaf/stem ratio, leaf area but it had no significant effect on essential oil content. Essential oil content varied during the growing seasons. In the second season the highest essential oil content was for the wild *O. syriacum* population when the first cut was performed on March 26 (2.12%), followed by the cultivated *O. syriacum* accessions 1 (1.91%) and 2 (1.90%) and then the two accessions of *O. majorana* with 1.66% each.

Keywords: wild Origanum, cultivated origanum, medicinal plants, Jordan.

INTRODUCTION

Origanum syriacum L. is cultivated under rainfed and irrigated conditions. It is harvested at the early blooming stage for high herb production and at full blooming for essential oil production (Lendaris, *et al*., 2000). While *Origanum majorana* L. is cultivated under high input conditions in fertile soil (Hammer and Junghanns, 1997). In Jordan, *O. syriacum* when planted under open field conditions is harvested twice; in April and September, but under plastic house conditions, 5 to 6 cuts per year is possible from the beginning of February to the end of October, with about 50 to 45 days between each cut. Cutting height is recommended (at 7 cm above ground) (Halasah, 1994). Similarly, Abu Al Rub, 1996 carried out an experiment at Jubeiha Agricultural Research Station in Jordan, to study the effect of cutting height (3, 7, 11 and 15 cm) from soil surface on the growth and yield of *O. syriacum* L. grown under irrigation and field conditions, she found that 7 cm cutting height gave the highest dry yield (29.9 g/m^2) as compared to the 15 cm cutting hight (17g /m^2)..

On the hills of Lebanon, Daouk, and Sattout (1995) found that *O. syriacum* L. (Za'atar) crop was harvested during April, July, August, and October. They found that the essential oil content of the edible part of the plant was about 3% (wt /vol) and the major components of

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this oil were carvacrol and thymol.

In Jordan Khairallah (1998) working on thyme (*Thymus vulgaris* L.) at Maru station in northern Jordan reported that harvesting was performed on 28 May, 5 July, and 12 August, and found that August harvest gave the highest fresh and dry yield, for both covered (under plastic tunnels) and uncovered (open field). Thyme yield under open field was less by 70% than that in the plastic tunnels.

It was found that the season of collection affected the qualitative and quantitative composition of the essential oil of *Origanum vulgare* L (Jerkovic, *et al*., 2001; Yaldiz, *et al*. 2005); essential oil content changed according to the seasons and the hours of the day. The highest essential oil content (1.92%) was found in the post-flowering- at the beginning of the seed formation period in the afternoon harvests during the second half of June (40^{th} week). The essential oil composition varied monthly and the highest value (73.65%) of carvacrol the main component of the essential oil, was obtained at the flowering period in May.

Vogel, *et al*. (1996), found out that the maximum yields of dried herb and essential oil of *Origanum vulgare* were obtained between weeks 5 and 8 after first bloom (January) in two locations of the central region of Chile, reaching values of about 3000 Kg/ha of dried herb and 120 liters/ha of essential oil.

The objectives of the study are to evaluate the effect of harvesting date on agro-morphological characters and oil content of wild and cultivated *O. syriacum* and *O. majorana*, cultivated in Jordan valley under both plastic house and open field conditions, also to find out the cultivation potential of wild O. *syriacum* collected from Jordan under the Jordan Valley conditions.

Materials and methods

Plant materials

The study evaluated the performance of five accessions/populations of *Origanum* species. Seeds of two cultivated *Origanum* species, namely; *O. syriacum* accessions 1 and 2 and *O. majorana* accessions 1 and 2 were obtained from farmers and market in Jordan and one wild population was collected from southern Jordan, which was under threat of grazing and collection. . More details on these are in Table 1.

Table 1. Accessions of cultivated *O. majorana* and *O. syriacum* and wild population of *O. syriacum* with information on their sources.

Origanum species	Source/ Collection site	Description of the source/ collection site	Coordinates		
			Altitude (m)	Latitude	Longitude
O. majorana accession1	Amman	Taha and Qashou CO. the origin from (Royalfleur CO.– France)	-	-	-
O. majorana accession2	Amman	Taha and Qashou CO. the origin from (Vilmorin CO. – France)	-	-	-
O. syriacum accession 1	Jordan valley/ Wadi AL-Rayan	AL-Sari nursery	-	-	-
O. syriacum accession 2	Amman	Taha and Qashou CO.	-	-	-

Origanum species	Source/ Collection site	Description of the source/ collection site	Coordinates		
			Altitude (m)	Latitude	Longitude
O. syriacum wild population	* Tafelah/ AL-O'mia village	AL- Hala Road (road sides)	1260	35.61	30.78

*Courtesy of Dr. Sabah Saifan, National Center for Agricultural and Extension (NCARE).

In this research, accession is defined as a sample (seeds) of crop species collected at a specific location and time, and was used to refer to the cultivated species, while population represent the seeds that were collected from several plants at a specific area, and refer to the collected wild species.

Treatments and experimental design

The treatments that were evaluated consisted of the four accessions and the wild population mentioned above. They were evaluated on three harvesting dates during 2006/2007 and 2007/2008 growing seasons, and grown under open field and plastic house conditions. Harvesting dates (harvesting date is the date of the first cut) were in February 26, March 12 and March 26 during the two seasons. The first harvesting date was at the flowering stage, the second and third harvesting dates were conducted 2 and 4 weeks from the first harvesting date. Three cuts were carried out for each harvesting date with one month between each cut. The plants were cut at seven centimeters above soil surface.

The experiment was planted under the Jordan Valley conditions at the Institute of Agricultural Research Training, Extension and Education (The University of Jordan). Drip irrigation system under black mulch was used, weeds were controlled manually as needed, plants were fertilized monthly with 7.1 kg nitrogen/ha, and irrigated according to the prevailing temperature and plant needs.

The treatments were arranged in a split–plot, in a randomized complete block design with repeated measurements and replicated three times. The five *Origanum* accessions/populations were the treatment applied to the main plots and the harvesting dates were applied to the sub-plots. The *Origanum* species were planted in rows with 50 cm distance and 40 cm between plants within the row. The main plot dimension was 0.6 m x 4.80 m and included 24 plants and the sub-plot was 0.6 m x 1.60 m and consisted of eight plants.

Measurements

a. Agro- morphological characters

At cutting, observations were recorded on the following characters:

- Fresh and dry weight (g/plant): the value is the average of three replicates of the three cuts total for each harvesting date.

- Plant height (cm): the value is the average of three replicates of the three cuts average for each harvesting date.

- Leaf area (cm^2) using the leaf area meter: the value is the average of two replicates of the three cuts average for each harvesting date.

- Leaf/stem ratio (%): the value is the average of two replicates of the three cuts average for each harvesting date, converted to percentage.

Representative samples from each treatment were taken and kept in the refrigerator for essential oil content determination.

b. Estimation of essential oil content

Fresh plant samples were dried at room temperature for three days in an area with good aeration. Ten grams of each sample were weighed and steam distilled until the collection of 100 ml distillate using the British

Pharmacopoeia Distillation apparatus (BSI, 1985) with slight modifications that is by using 100 ml of distillate, 50 ml of diethyl ether twice to collect the essential oil from the distillate. The distillate was separated using liquid/liquid separation in a separating funnel. The diethyl ether solvent of 20 samples was evaporated in rotary evaporator (Buchi, Switzerland model) at 35 ^{o}C temperature, under vacuum until a complete removal of the solvent, the dry residue was weighed. Oil percentage for each sample was calculated using the following equation:

Essential oil content % = (weight of dry residue/weight of dry sample) x 100%

Where:

Weight of dry residue = (weight of the round bottom flask + residues)-weight of the round bottom flask alone.

The measurements were carried out in duplicates.

c. Statistical analysis

Data was statistically analyzed using ANOVA following SAS (Version 9- 2002).

Results:

a. Agro-morphological characters

Fresh and dry weight

The highest fresh weight was for *O. majorana* accession 2 cultivated under plastic house conditions at the first harvesting date (227.5 g/plant) which gave 5.3% more fresh weight compared with its production under the open field condition, and 14.6% more than *O. syriacum* accession 2 which is the highest in these species (198.5 g/plant). The lowest fresh weight was obtained with the wild population under the different treatments as shown in table 2.

Table 2. Mean effect of harvesting date (HD), growing conditions and Origanum species on fresh and dry weight production, during 2006/2007 and 2007/2008 seasons.

Origanum species	Fresh weight (g/plant)					
	Plastic house			Open field		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
O. majorana accession1	223.6 b*	216.9 d	202.5 f	214.4 d	206.0 e	187.9 i
O. majorana accession2	227.5 a	219.4 c	207.4 e	216.0 d	206.1 e	190.9 h
O. syriacum accession 1	182.6 j	174.1 k	165.9 m	175.1 k	164.8 m	156.6 o
O. syriacum accession 2	198.5 g	183.8 j	173.9 k	183.4 j	174.4 k	165.4 m
O. syriacum wild population	170.1 l	164.7 m	156.3 o	159.7 n	156.7 o	147.1 p
LSD (0.05%)	2.7					
	Dry Weight (g/plant)					
O. syriacum accession1	57.8 ab*	56.1 bcd	52.4 g	55.4 cde	52.6 fg	48.0 hijk
O. syriacum accession2	59.5 a	57.2 bc	53.7 efg	56.9 bc	53.2 fg	49.6 hi
O. syriacum accession 1	49.4 hi	47.1 k	44.4 l	47.4 jk	44.6 l	42.4 mn
O. syriacum accession 2	54.4 def	49.7 h	47.7 ijk	49.4 hij	46.9 k	44.4 lm
O. syriacum wild population	46.8 k	44.2 lm	40.1 op	42.9 lmn	41.9 no	39.3 p
LSD(0.05%)	2.0					

*For each character, means followed by the same letters are not significantly different.

+ HD (Harvesting Date) which is the date of the first cut: HD1=February 26; HD2= March 12, and HD3= March 26.

Similar to fresh weight, the highest dry weight was for *O. majorana* accession 2 cultivated under plastic house conditions at the first harvesting date (59.5 g/plant) (Table 2). *O. majorana* accession 2 gave 9.2% more dry weight than the highest producer of the *O. syriacum* (accession 2) at the first harvesting date under plastic house conditions (54.4 g/plant). Also it gave 4.5% more dry weight under plastic house conditions over that produced under open field. On the other hand the wild population recorded the lowest dry weight across all treatments combinations.

The dry weight production for *Origanum* species was the highest at the second growing season (Table 3). *O. majorana* accession 2 at the second season, gave 23% more dry weight compared to its productivity at the first season, and gave 18.2% more dry weight than *O. syriacum* accession 2 which gave the highest dry weight for these species (51.2 g/plant). The wild population continued to be the lowest producer among the five tested accessions with 40.0 g/plant dry weight production in the first season and 45.0 g/plant dry weight production in the second season.

There is a general trend that fresh and dry weights tends to decrease with delayed harvesting under both growing seasons (Table2). This trend is less pronounced under the first season

Table 3. Mean effect of growing season and Origanum species on dry weight production, cultivated under Jordan Valley conditions.

Origanum species	Dry weight (g/plant)	
	2006/2007 Season	2007/2008 Season
O. majorana accession1	48.5 d*	59.1 b
O. majorana accession2	49.2 d	60.6 a
O. syriacum accession 1	43.1 g	48.7 d
O. syriacum accession 2	46.3 e	51.2 c
O. syriacum wild population	40.0 h	45.0 f
LSD(0.05%)	1.2	

*Means followed by the same letters are not significantly different.

Plant height

The tallest plants were recorded for *O. majorana* accession 2 cultivated under plastic house conditions at the second and third harvesting dates (42.7 cm), which exceeded the tallest accession (accession 2) in *O. syriacum* by 13.5%. Wild population was the shortest in most cases under both open field at the 3rd harvesting date (32.8 cm) and plastic house condition at the 3rd harvesting date (34.2 cm) (Table 4).

Table 4. Mean effect harvesting date, growing conditions and Origanum species and season on plant height, during 2006/2007 and 2007/2008 seasons.

Origanum species	Plant height (cm)					
	Plastic house			Open field		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
O. majorana accession1	39.4 de*	41.1 b	40.7 c	37.1 ij	38.8 f	38.3 g
O. majorana accession2	40.7 c	42.6 a	42.7 a	38.3 g	39.7 d	39.3 e
O. syriacum accession 1	36.8 j	36.9 j	35.8 kl	35.0 n	33.8 p	33.6 pq
O. syriacum accession 2	37.3 hi	37.6 h	35.9 kl	35.6 lm	34.7 n	34.7 n
O. syriacum wild population	35.3 m	36.0 k	34.2 o	33.4 q	33.0 r	32.8 r
LSD(0.05%)	0.3					

*For each growing conditions and season, means followed by the same letters are not significantly different.

+ HD (Harvesting Date) which is the date of the first cut: HD1=February 26; HD2= March 12, and HD3= March 26.

Plant height was significantly affected by the growing season and harvesting date (Table 5).

By comparing the values of HD1 under plastic house conditions with HD1 under open field conditions, which are the highest values under the second season (41.4 and 39.4 cm for cultivation under plastic house and open field respectively), it showed that cultivation under plastic house gave 6.4% taller plants than the open field. Also, there is a general trend that dry weight tend to decrease with delayed harvesting under both growing conditions (Table 2). This trend is less pronounced under the first season (Table 5).

Table 5. Mean effect of growing season and harvesting date (HD) on dry weight and plant height of Origanum grown under plastic house and open field conditions.

Seasons	Dry weight (g/plant)					
	Plastic house			Open field		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
2006/2007	46.4 g *	47.7 ef	46.5 g	44.4 h	44.7 h	43.1 i
2007/2008	60.6 a	54.1 c	48.5 e	56.4 b	51.5 d	46.4 fg
LSD(0.05%)	1.2					
	Plant height (cm)					
	HD 1	HD 2	HD 3	HD 1	HD 2	HD 3
2006/2007	34.4 j *	38.9 c	38.1 d	32.4 k	35.2 i	35.9 g
2007/2008	41.4 a	38.8 c	37.7 e	39.4 b	36.8 f	35.6 h
LSD(0.05%)	0.2					

*for each character, means followed by the same letters are not significantly different.

+ HD (Harvesting Date) which is the date of the first cut: HD1=February 26; HD2= March 12, and HD3= March 26.

Leaf/stem ratio

Leaf/stem ratio for the studied *Origanum* species differ significantly as a result of the interaction between harvesting date and growing season (Table 6). Unlike the previously presented characters, *O. syriacum* accession 2 gave the highest leaf/stem ratio for different harvesting dates in both seasons. The wild population gave lowest values in the first season at the first harvesting date (51.3 %) and in the second season at the 2nd harvesting date (52.5 %) .

Table 6. Mean effect of growing season, harvesting date and Origanum species on leaf/stem ration, cultivated under Jordan Valley conditions.

Origanum species	Leaf/stem ratio (%)					
	2006/2007 Season			2007/2008 Season		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
O. majorana accession1	55.8 fghi*	58.5 def	58.0 efg	56.8 efgh	59.0 de	59.5 de
O. majorana accession2	55.3 ghij	57.8 efg	57.8 efg	59.5 de	59.8 de	61.3 d
O. syriacum accession 1	67.5 c	64.5 c	64.8 c	65.5 c	66.3 c	64.5 c
O. syriacum accession 2	77.75 a	78.3 a	74.3 b	77.8 a	78.0 a	77.0 ab
O. syriacum wild population	51.3 k	57.0 efgh	57.8 efg	54.0 hijk	52.5 jk	52.8 ijk
LSD(0.05%)	3.0					

*Means followed by the same letters are not significantly different.

+ HD (Harvesting Date) which is the date of the first cut> HD1=February 26; HD2= March 12, and HD3= March 26

Leaf/stem ratio production was higher under plastic house conditions compared with open field (Table 7), except for *O. syriacum* accession 2 which gave the highest leaf/stem ratio under both plastic house (77.3%) and open field conditions (77.0 %). The wild population gave higher ratio under plastic house conditions (56.8 %) but continue to record the lowest values among the tested accessions.

Table 7. Mean effect of cultivation under plastic house and open field on leaf/stem ratio of Origanum accessions/population during 2006/2007 and 2007/2008 seasons.

Origanum species	Leaf/stem ratio (%)	
	Plastic house	Open field
O. majorana accession1	60.7 d*	55.2 e
O. majorana accession2	61.2 d	55.9 e
O. syriacum accession 1	67.6 b	63.4 c
O. syriacum accession 2	77.3 a	77.0 a
O. syriacum wild population	56.8 e	51.6 f
LSD(0.05%)	2.0	

*Means followed by the same letters are not significantly different.

Leaf area/plant

The highest leaf area/plant was at the first harvesting date at the second season in *O. syriacum* accession 2 (1582.0 cm^2) and accession 1 (1565.4 cm^2) (Table 8). While *O. majorana* accessions showed the lowest leaf area/plant in the first season 639.3 and 649.3 cm^2, for O. majorana accessions 1 and 2, respectively compared to the others. The leaf area/plant for *O. syriacum* accession 2 exceeded that for the wild population by 27.8 %, 39 % and 38.1 % in the first, second and third harvesting dates in the second season, respectively. Unlike other characters, the wild population exceeded the *O. majorana* under the different treatments.

Table 8. Mean effect of growing season, harvesting date and Origanum species on leaf area/plant, cultivated under Jordan Valley conditions.

Origanum species	Leaf area/ plant (cm^2)					
	2006/2007 Season			2007/2008 Season		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
O. majorana accession1	639.3 q*	647.5 pq	681.7 op	909.2 ghi	914.0 ghi	868.5 jk
O. majorana accession2	649.3 pq	656.0 pq	695.8 no	939.0 g	933.9 gh	880.6 ij
O. syriacum accession 1	814.8 l	837.0 kl	838.8 kl	1565.4 a	1498.8 bc	1452.0 d
O. syriacum accession 2	879.5 ij	899.0 hij	900.0 hij	1582.0 a	1515.5 b	1470.5 cd
O. syriacum wild population	718.8 mn	749.0 m	738.1 m	1237.8 e	1090.6 f	1064.6 f
LSD (0.05%)	36.7					

*Means followed by the same letters are not significantly different.

+ HD (Harvesting Date) which is the date of the first cut:HD1=February 26; HD2= March 12, and HD3= March 26.

b. Essential oil percentage (%)

Wild population had the highest oil content compared with the other accessions (Table 9). Essential oil content differs significantly as affected by harvesting date and growing conditions (plastic house or open field). The highest oil content over the two seasons, was for the wild population under plastic house conditions and when the first cut carried out at March 26 (Third date) (2.03%), which tended to decrease with early harvesting (1.91% in the second harvesting date and 1.81% in the first harvesting date) . The wild population gave 4.5% more oil content than *O. syriacum* accession 2 both at the third harvesting date under plastic house conditions, and 3.9% under open field conditions. The lowest oil content was found in *O. majorana* accessions under the open field conditions at the first harvesting date (1.57 and 1.59 % for the *O. majorana* accessions 1 and 2, respectively) compared with the others.

As shown in table 9, the Origanum species oil content was significantly affected by the season and the harvesting date. The wild population at the second season gave 2.12% oil which exceeded oil content of *O. majorana* accession 2 by 27.7% both at the third harvesting date. It is clear that for all the studied accessions, that oil content percentage increased at the third harvesting date and it is higher in the second season.

Table 9. Mean effect harvesting date, growing conditions and Origanum species on essential oil content, during 2006/2007 and 2007/2008 seasons.

Origanum species	Essential oil content (%)					
	Plastic house			Open field		
	HD 1+	HD 2	HD 3	HD 1	HD 2	HD 3
O. majorana accession1	1.59 op*	1.62 lmn	1.63 l	1.57 p	1.60 no	1.63 lm
O. majorana accession2	1.60 mnop	1.64 l	1.65 l	1.59 op	1.63 lm	1.65 l
O. syriacum accession 1	1.78 k	1.86 efg	1.88 cd	1.79 jk	1.85 efgh	1.86 def
O. syriacum accession 2	1.79 jk	1.84 fghi	1.87 de	1.79 jk	1.83 ghi	1.86 def
O. syriacum wild population	1.81 ijk	1.91 c	2.03 a	1.82 hij	1.85 efg	1.95 b
LSD(0.05%)	0.03					
Origanum species	2006/2007 Season			2007/2008 Season		
O. majorana accession1	1.53 p*	1.58 o	1.60 n	1.63 m	1.64 lm	1.66 l
O. majorana accession2	1.55 op	1.63 m	1.64 lm	1.63 m	1.64 lm	1.66 l
O. syriacum accession 1	1.71 k	1.81 hi	1.84 fg	1.87 e	1.90 cd	1.91 bc
O. syriacum accession 2	1.72 k	1.79 ij	1.83 gh	1.87 e	1.90 cd	1.90 cd
O. syriacum wild population	1.77 j	1.83 gh	1.86 ef	1.86 ef	1.93 b	2.12 a
LSD(0.05%)	0.03					

*For each growing condition and season, means followed by the same letters are not significantly different

+ HD (Harvesting Date) which is the date of the first cut: HD1=February 26; HD2= March 12, and HD3= March 26

Discussion

a. Agro-morphological characters

Origanum economical yield is the vegetative parts, mainly the leaves, which are used in this region as a food or for its medical properties. The oil content is a second economical yield that is usually extracted and used in different products and recently it got more attention by the producers, collectors, and consumers.

The results showed that all the studied traits were performed better under the plastic house conditions and under the second growing season. Plastic house conditions provide a warmer environment in winter, which enhances plant growth as compared to its growth under the open field. Similar trend was also found by Khairallah (1998) who worked in the highland of Jordan, and found that thyme (*Thymus vulgaris*) yielded 70% less under open field conditions than that under plastic tunnels conditions. Planting *Origanum* under plastic house conditions increases yield and eventually will increase farmers' income.

The second growing season resulted, in general, in a higher plant performance as compared to its performance under the first season and for all the studied traits. With a perennial species such as *Origanum*, the plants in the first season take time to adapt to the environment and the root system starts to penetrate and extend in the soil. As a result, plants in the second season are well established and thus produced higher

vegetative growth. In the present study, fresh weight production in the second season and in the first harvesting date was 33.14 ton/ha for *O. syriacum* accession 2, 28.47 ton/ha for the wild population and 39.56 ton/ha for *O. majorana* accession 2. The production in the first season was much lower (24.17, 21.00 and 26.96 for *Origanum syriacum* accession 2, wild population and *O. majorana* accession 2, respectively) (Table 3).

Similarly, the dry weight has also increased from 6.95 to 7.68 ton/ha for *O. syriacum* accession 2 in the second season and from 6 to 6.75 ton/ha for wild population and from 7.32 to 9.09 ton/ha for *O. majorana* accession 2 (Table 6). It is important to mention that growers need to keep their plants for more than one season, since the production will be increased in the second season. Our results are in agreement with Azizi and Honermeier, (2009) whom they found that the dry matter of oregano in the second growing season was higher.

In general, the first harvesting date resulted in a higher plant performance as compared to their performance under the second and third harvesting date, and for all the studied traits. It is expected that plants harvested early will have the chance to regenerate well before the growing season ends, on the other hand, harvesting of plants should not be very early, because the plants are in developing and adaptation stages, and that will affect their growth and will result in weak plants. These results are in agreement with Vogel, *et al*. (1996) in Chile found that the maximum yields of dried herb of *Origanum* were obtained between weeks 5 and 8 after first bloom (January), also Badi, *et al.* (2004), found that harvesting time affected fresh herbage, yield and plant height significantly of *Thymus vulgaris*. The tallest plants were obtained from plants harvested at the fruit setting stage. The maximum yield of dry and fresh herbage yield was obtained at the beginning of blooming stage.

b. Essential oil percentage (%)

Essential oil contents were the highest at the second growing season compared with the first season, where the wild population produced 143.1 liter /ha in the second season at the third harvesting date compared with 111.6 liter/ha in the first season (Table 9). This is in agreement with Jerkovic, *et al*., 2001, who found that the season of collection affected the qualitative and quantitative composition of the essential oil of *Origanum vulgare* L. Similarly, Yaldiz, *et al*. (2005) in Turkey studied the seasonal and diurnal variability of the essential oil content in *Origanum onites* L. who found that the essential oil content changed according to the seasons and the hour of the day. Also Vogel, *et al.* (1996) in Chile found that the maximum yields of essential oil of *Origanum* were obtained between weeks 5 and 8 after first bloom (January).

Similar results were obtaine by Sellami, *et al.* (2009), where they studied the variation in the oil content of *O. majorana* L. who found that the highest oil yield was during the full-flowering stage. They also found that *O. majorana* produced lower yield of essential oil compared with *O. syriacum* which is in full agreement with our findings.

Wild population produced more essential oil percentages compared with cultivated accessions of *O. syriacum* and *O. majorana* which is in agreement with the findings of Hudaib and Aburjai, (2007), who studied the essential oil content of wild-growing and cultivated plants of *Thymus vulgaris* L. grown in Jordan.

One of the main objectives of this study is to evaluate and compare the performance of the Origanum species for yield and quality. *O. syriacum* native species in our region and in Jordan, whereas, *O. majorana* is an introduced species. Studying fresh, dry weight and plant height, which consist of the vegetative growth of the plants (leaves and stem), showed that *O. majorana*

accession 2 was superior to the cultivated and the wild of *O. syriacum* under both plastic house and open field conditions. This showed the high adaptation of this species to the Jordan Valley environment. However when leaf/stem ratio and leaf area/plant are considered, the situation started to change and the *O. syriacum* was superior. Leaves are the main products that are used by consumers either fresh or dry which showed that *O. syriacum* is expected to be preferred by growers and consumers. This analysis indicated the importance of *O. syriacum* for cultivation by growers in Jordan and by countries which have similar environmental conditions. This has also been reflected in the essential oil contents.

The wild population is adapted to dry and stress environment prevailed in its natural habitats in the mountains of Jordan. However, when leave yield is considered, wild populations gave reasonable yield and exceeded that of *O. majorana.* This showed a good potential for its domestication by cultivation. It also showed high leaves productivity compared to stems, a character which is very desirable by consumers. A breeding program for improving these traits in the wild will be worth to start to increase their leave size and maintain their low stem /leaf ratio. Again the superiority of the wild is evident in their oil productivity which significantly exceeded the other accessions. It is also worth mentioning that with the water scarcity for irrigation that prevailed in Jordan and many countries in the region, it is expected that wild plants could be successfully grown under lower water amounts or even under rain-fed condition, but this needs further investigations.

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تقييم الصفات الظاهرية والمحصولية ومحتوى الزيت تحت ثلاث مواعيد حصاد ل Origanum majorana و Origanum. Syriacum

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ملخـص

نفذت التجربه خلال الموسمين 2007/2006 و2008/2007 تحت ظروف الحقل المفتوح وتحت البيوت البلاستيكيه في وادي الأردن من أجل تقييم الصفات الظاهريه والمحصولية ومحتوى الزيت ل *Origanum syriacum*, *Origanum majorana* تحت ثلاث مواعيد حصاد. أستعمل تصميم القطاعات العشوائية الكاملة متداخلاً معه تصميم القياسات المتكررة، بثلاث مكررات. كان أعلى إنتاج من الوزن الرطب والجاف في موعد الحصاد الأول (أي عند اجراء اول قطعه في 26 شباط) بينما كانت أعلى نسبة لمحتوى الزيت هي في موعد الحصاد الثالث (أي عند اجراء اول قطعه في 26 اذار) لجميع المجتمعات/المدخلات. زراعة (Origanum) تحت ظروف البيت البلاستيكي في غور الأردن كان لها تأثير إيجابي في كل من طول النبات والإنتاج من الوزن الرطب والجاف ومساحة الأوراق للنبتة ولم يكن لها تأثير في نسبة محتوى الزيت. خلال موسمي النمو كان هناك اختلاف معنوي في نسبة محتوى الزيت. في الموسم الثاني كانت اعلى نسبة للزيت (2.12%) في الصنف البري وفي موعد الحصاد الثالث (أي عند اجراء اول قطعة في 26 آذار) ، وتبع ذلك الصنف المزروع (*Origanum syriacum*) للمدخل 1 (1.91) و2 (1.90) وكانت النسبة الأقل للزيت في المدخلين من صنف (*Origanum majorana*) حيث بلغت النسبه 1.66 لكل منهما.

الكلمات الدالة: الزعتر البري، الزعتر المزروع، النباتات الطبية، الأردن.

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