

Essential oils and Heavy Metals accumulation in *Salvia officinalis* cultivated at different Inter-row Spaces in Ash-Shoubak South Region of Jordan



Mohammad S. Abu-Darwish¹, Ziad H. Abu-Dieyeh², Ahmad H. Al-Fraihat² and Sati Y.A. Al-dalain²

¹Department of Basic and Applied Sciences, ² Department of Agricultural Science, Ash-Shoubak University College, Al-Balqa' Applied University, Al-Salt 19117, Jordan



Introduction

Salvia is a well-known medicinal and culinary herb that has been used for many centuries in the Mediterranean region. In Jordan, twenty species of *salvia* are grown widely throughout the territories of country (Al-Eisawi, 1982). Essential oil extracted from *S. officinalis* exhibited antioxidant and antimicrobial properties (Dragan et al., 2003). Heavy metals are presented as contents of many medicinal plants (El- Rjoob et al., 2008; Abu-Darwish et al., 2009). Therefore, this study was designed to Pb, Cd, Cr, Co, Ni, Zn, Fe, Cu, Mn, and essential oil contents in *Salvia officinalis* cultivated at 15, 30, and 45cm intra-row spaces in Ash-shoubak south region of Jordan.

Materials and Method

This study was performed in an experimental area of Ash-shoubak University Collage in Ash-Shoubak region (30° 32N, 35° 33 E), 1365 m above the sea level. *S. officinalis* seedlings that have a well-developed root system were transplanted and cultivated in the experimental area in May of 2007 in 50 cm-rows with intra-row spacing of 15, 30 and 45 cm apart. Five plants from each intra-row spacing were harvested at the following phenological stages, vegetation (VEG), beginning of blooming (BB), full-blooming (FB) and fruit Maturation (FM) stages on middle of June, July, August, September, 2007, respectively. All the plant samples were dried in draughtly place at about 20°C for heavy metals and essential oil treatments.

Essential Oil Extraction

20gr of the dried mild and sieved collected specimens including leaves, stems, flowers, and fruits (depending on the phenological stage) of *S. officinalis* were steam distilled for 2 h at a rate of 2-3ml/min using a Clevenger-type system. The values reported are the mean of at least 3 distillations.

Determination of Heavy Metal

Heavy metals content were analyzed in selected samples with highest and lowest essential oil contents at 15, 30, and 45cm intra-row spacing by using Atomic Absorption Flame Emission Spectrophotometer Model (Shimadzu Japan) AA-6200.

Results and Discussion

Essential Oils

The results of essential oil yield are shown in table (1). The results showed a clear effect of both intra-row planting spacing and phenological stage on the oil yields. The maximum yields of oil extracts were 2.00, 1.80, and 1.73% during the VEG stage of *S. officinalis* planted in 15, 30, and 45cm intra-row spaces, respectively, then decreased to 0.80, 0.90, and 0.87% during the FM and BB stage, respectively; the minimum range of oil extracted from *S. officinalis* in the south Shoubak region was ranged from 0.80 to 0.90% during the FB and FM stages, respectively. The results of essential oils extracted during the life cycle stages of all studied intra-row planting spaces of *S. officinalis* were decreased in the order: VEG>BB>FB>FM. The same trend was observed by Mirjalili et al., (2006). These differences could be explained by the effect of geographical and climate variations among regions (Perry et al., 1999), seasonal variations and harvesting time (Qiu et al., 2005).

Table (1): The % of oil content in *salvia officinalis* cultivated at 15, 30, and 45 cm planting spaces in Ash-shoubak region.

Inter- Row Planting Space	Phenological Stage			
	VEG	BB	FB	FM
15 cm	2.00±0.1155	1.8±0.2517	0.84±0.0058	0.80±0.00
30 cm	1.80±0.0058	1.70±0.1155	0.93±0.0058	0.90±0.001
45 cm	1.73±0.1155	1.50±0.1155	0.93±0.002	0.87±0.001

Heavy metals in Plant samples

The results of trace element contents are shown in Table (2). Lead (Pb) was not detectable during VEG and FM phenological stages of *S. officinalis* planted at 15, 30 and 45cm intra-row spaces. The absence of Pb in our studied samples *S. officinalis* is mainly due to the location of cultivation area that is away from the road and motor vehicles; the leading factors of plant contamination with Pb (El- Rjoob et al., 2008). Cadmium (Cd) values were not detectable in all specimens of *S. officinalis* collected from Ash-shoubak region. Chromium (Cr) and Cobalt (Co) were not detectable. The same results were found in the middle region of Jordan (Amr and and.Dordević, 2000).

The lowest content of Ni recorded 0.42 ppm at 15 cm intra-row planting space and harvested during the VEG stage, while the highest was 4.94 ppm, detected in samples harvested during the FM stage in the same intra-row planting space. On the other hand, Ni content during the VEG stage at 30 and 45cm intra-row planting spaces were 2.78 and 4.17 ppm, respectively, these results showed that the content of Ni was increased by increasing intra-row planting space, indicating to the activity of the root, Ni absorbing system and/or the metabolic activity of the tissue-metal accumulating (Sengar et al., 2008). The lowest concentration of Zn (95.81ppm) was found in *S. officinalis* during the VEG stage within 30cm intra-row planting space, the highest was 125.71ppm and detected in plants collected during FM stage in 15 cm intra-row planting space. On the other hand, Zn content was increased during the life cycle of *S. officinalis* cultivated at 15 cm intra-row space from 116.91ppm in VEG to reach a maximum of 125.71 ppm during FM stage indicating to the Zn accumulation in the leaf tissue of *S. officinalis* (Angelova et al., 2005).

Table (2) Concentration of heavy metals (ppm) in *Salvia Officinalis* cultivated in Ash-shoubak region depending on phenological stages and intra-row spacing.

Stage /cm	Pb	Cd	Cr	Co	Ni	Zn	Fe	Cu	Mn
VEG (15cm)	nd	nd	nd	nd*	0.421 ±0.25	16.91 ±0.036	736.17 ±6.94	7.32 ±0.81	45.0 ±0.46
VEG (30cm)	nd	nd	nd	nd	2.78 ±1.08	95.87 ±1.191	68.97 ±5.41	7.02 ±0.50	51.35 ±0.42
VEG (45cm)	nd	nd	nd	nd	4.17 ±1.38	108.85 ±0.52	524.67 ±3.35	3.07 ±0.70	44.63 ±0.72
FM (15cm)	nd	nd	nd	nd	4.94 ±1.09	125.71 ±0.29	935.40 ±8.84	12.14 ±0.93	45.00 ±0.64

*nd: not detected
In our studied samples the concentration of Fe reached its maximum of 935.40ppm in 15cm intra-row planting space and harvested during FM stage, while the minimum was 524.67ppm in the samples cultivated within 45 cm intra-row planting space and harvested during VEG stage. The content of Fe was found to be increased proportionally with a progressive growth stage of plant life cycle planted in 15 cm intra-row space. However, *S. officinalis* cultivated in Ash-shoubak environment is more rich in Fe, than that cultivated in the middle region. (Amr and.Dordević, 2000). These results seem to indicate that both soils and plants in Ash-shoubak south region are well supplied with this essential microelement (Fe) compared to the middle region of Jordan (Amr and.Dordević 2000) and other various geographical locations in the world (Malenic et al., 2003). However the concentrations of Cu in all samples of *S. officinalis* grown in Ash-shoubak south environment were within the normal range and lower than those recorded in the middle region of Jordan, (Amr and.Dordević, 2000). The contents of Mn in all samples of *S. officinalis* were found to be very closely to each other, the highest content was 51.35ppm in samples cultivated in 30cm intra-row spacing and harvested during the VEG stage, while the lowest was 44.63 ppm in 45cm intra-row spacing. In the yields of essential oil and heavy metals content in *S. officinalis* are affected by phenological stages and intra-row planting spaces. *Salvia officinalis* L., cultivated in Ash-shoubak south region of Jordan is rich in essential oil content and free from hazard heavy metals.

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Pb

Cd

Cr

Co

Ni

Zn

Fe

Cu

Mn