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EFFECT OF SOWING DATES AND NITROGEN SOURCES ON *SIDERITIS MONTANA* PLANT.

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ABSTRACT

Two experiments were carried out at experiments farm station, National Research Center, at Shalakan, El-Kanater El-Khairya, Kalubia Governorate, Egypt, for two successive seasons of 2004/2005 and 2005/2006 to study the response of Sideritis montana L. plant to different sources of nitrogen, (i.e. Urea, compost and Azotobacter at the levels 50,75 and 100N unit), with three different sowing dates (30th September, 30th October and 30th November).

Data indicated that all nitrogen sources increased vegetative growth (plant height, number of branches/plant, herb fresh and dry weight) and chemical composition (essential oil % and yield/plant, flavonoides %, total chlorophyll content, carotenoids content and carbohydrate %) significantly, compared to untreated plants. Moreover, raising the N level resulted in steady significant increases in vegetative growth parameters and chemical composition. In general, the second sowing date (30th October) was the most effective date on promoting the vegetative growth. It can be recommended that for the best vegetative growth and flavonoides content of Sideritis montana L. plants, the seeds should be sown on 30th October, while for the highest essential oil % and yield, plants should be sown on 30th September, and the plants should be supplied with the highest level of compost plus Azotobacter in both sowing dates.

Key words: Sowing date, fertilizer, essential oil, *Sideritis montana.*

INTRODUCTION

Sideritis montana L. "mountain ironwort" is an annual herb, belonging to the family Labiatae (Lamiaceae) that includes about 100 species of *Sideritis* distributed mainly throughout the Mediterranean region. The plants are simple or branched from base, sparsely lanate and greenish. *Sideritis spp*. were supposed to have a healing power for wounds caused by iron (Bailey, 1976).

It is widely used as herbal tea in Turkey as a folk remedy for several respiratory diseases It is used as diuretic, digestive, carminative , treats gastro-intestinal disorders anti-microbal , anti-rheuatic activities due to its flavonoid contents. Taha *et al.*, (1993).

Aziz and El-Sherbeny (2003), and El-Sherbeny *et al*., (2005) reported that the main constituents of sideritis oil were in a descending order: germacreane-D, B-caryophyllene and bicyclogermacrene compounds.

Nutrient supply to plants greatly affects their growth, production and plant constituents. Plants require nitrogen in relatively larger quantities than other macronutrients, because of its effective role in plant metabolism. Nitrogen is a main component of main compounds as protein, amino-acids, chlorophylls, enzymes, phytohormones and other materials (Devlin, 1975).

Several investigators gained effective improvements in different growth parameters as well as various plant constituents. Naguib (2003) on german chamomile, Mokhtar (2002) on lupin and Agamy (2004) on sweet fennel .

Compost supplementations supply the soil with different plant nutrients, mainly nitrogen, in addition to break down to its mineral matter. Compost, also improves soil properties as water retention capacity, structure, drainage and aeration (Herrera *et al*., 1997). Applying compost to soil markedly stimulated plant growth, yield, chemical components and oil production in various plants as mentioned by Khalil and El-Sherbeny (2003) on mint and El-Sherbeny *et al*., (2005) on mountain ironwort.

Nitrogen fixers as Azotobacter and Azospirillum bacteria gave an appreciable improvement of growth, herb and oil yield as well as plant and oil constituents. Gomaa and Abo-Aly (2001) on anis and El-Desuki *et al*., (2006) on onion, stated that bio-nitrogen fertilizers improved vegetative growth, herb and oil yield and quality and their main constituents of these plants.

Date of sowing or planting could affect the different characters of various plants. Abd El-Bary *et al.,* (1997). This might be a result of variability in atmospheric conditions as temperature, relative humidity, solarity,…etc.

The present experimentation aimed to detect the response of *Sideritis montana* L. to the application of mineral, organic (compost) and N-bio-fertilizers, throughout growth, herb and oil yield, chemical composition and oil quality parameters under Egyptian conditions.

MATERIALS AND METHODS

This study was carried out at Experimental Farm Station, National Research Centre, at Shalakan, El-Kanater El-Khairya, Kalubia Governorate, Egypt, for two successive winter seasons of 2004/2005 and 2005/2006.

Sideritis montana L. seeds were obtained from conservative El-Jardins Botanious De Nacy in France. The layout of the experiment was a split-plot design, with the main plots arranged in a randomized complete block design, with three replicates. The main plots were assigned to the sowing date, while the sub-plots were assigned to the nitrogen fertilizers. The soil was prepared and divided into plots 3x3.5m with four rows in the open field, the distance between rows was 70cm apart and 25cm between plants. Plot area was 10.5 m^2.

The experimental soil was sandy loam in texture and the physical and chemical properties of the experimental soil was presented in Table (A).

Soil physical properties were analyzed using the procedures described by Black *et al.,* (1981) for particle size distribution and soil texture, while soil chemical analysis was measured according to the procedures described by Jackson (1973).

Table A: The physical and chemical properties of the experimental soil during the seasons of 2004/2005 and 2005/2006.

	A. Physical properties %				B. Chemical properties				
Characters	Clay	Silt	Sand	Organic matter	pH	E.C (m.mhos/cm)	%		
							N	P	K
2004/2005	23.4	25	49.2	1.45	8.71	0.45	0.12	4.30	5.10
2005/2006	23.4	27	51.3	1.52	8.62	0.75	0.14	26.85	26.91

Soil physical properties were analyzed using the procedures described by Black *et al.* (1981) for particle size distribution and soil texture, while soil chemical analysis was measured according to the procedures described by Jackson (1973).

The investigation included eleven nitrogen fertilization treatments: Control (untreated), 50, 75 and 100N unit/feddan from urea; 50, 75 and 100 N unit from compost; *Azotobacter* (1 kg /fed.); 50, 75 and 100 N unit from compost + *Azotobacter* (1 kg /fed.), with three sowing dates: 30th of September, October and November. The characteristics of the compost are presented in Table (A). followed the procedure of Black *et al*. (1981). Soil and organic fertilizer samples were analyzed in the National Research Center Laboratories.

Table A. Chemical analysis of compost during the seasons of 2004/2005 and 2005/2006.

Characters	pH	E.C (mmhos)	%						
			N	P	K	Organic mater	C/N	Organic carbon	Dry matter
2004/2005	7.1	1.2	1.2	0.5	1.25	34	1: 14.2	33.26	57.35
2005/2006	7.3	1.05	1.4	0.75	1.75	38	1: 14.3	23.28	40.31

Compost was mixed with the soil seven days before sowing. Rhizobacterin (*Azotobacter chroococcum*) produced by General Organization for Agriculture Equalization Fund (GOAEF) provided from Agriculture Microbiology Department, Agriculture Research Center (ARC), Egypt, was inoculated to the seed using aqueous solution of Arabic gum as an adhesive. The seeds were air dried in shade, as described by Barakat *et al.,* (2004).

The soil was mixed during its preparation with 25 P_2O_5 unit/fed provided from calcium superphosphate (15.5% P_2O_5) fertilizer; also 40 K_2O unit/fed., from potassium sulphate (48% K_2O) was added to plants at two equal doses at 30 and 60 days from sowing. Other routine agriculture practices, as watering, hoeing, weeding…etc, were made whenever necessary.

After sowing by 195, 180 and 170 days from the first, second and third sowing dates respectively, a random sample of five plants were chosen from each replicate estimating of the following parameters: Plant height (cm), number of branches/plant, herb fresh and dry weights (g/plant) .

- Chemical analysis:
- Plant pigments, total chlorophylls and carotenoids as (mg /g fresh weight) as described by A.O.A.C. (1995).
- Flavonoides (%) as mentioned by (Mabry *et al.,* 1970) and (Zhuang *et al.,* 1992).
- Total carbohydrates (%) in dried herb, was determined according to A.O.A.C. (1995).
- N, P and K (%) determination, in dried herb, using the methods of Hach *et al.,* (1985), Chapman and Pratt (1978) and Cottenie *et al*., (1982), consecutively.
- Essential oil production:
- Essential oil (%) in fresh herb was estimated according to the Egyptian Pharmacopoeia (1984).
- Oil yield: in plant (ml/plant) was assessed.
- Oil constituents: samples of control and 100 N unit compost from the three sowing date were subjected Mass spectrometry (GC/MS) analysis. Compounds of essential oil were identified by matching their retention times with those of the authentic samples injected under the same conditions. The relative percentage of each compound was calculated from the peak area of the peak corresponding to each compound.

Data obtained were averaged and the means were subjected to standard analysis of variance procedure, and L.S.D. was determined whenever the calculated F values were significant (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Vegetative growth

The results recorded in the two seasons (Tables,1-4) show that the different nitrogen sources had a considerable effect on the plant height, number of branches, as well as herb fresh and dry weights.

Among the different treatments, plants supplied with 100units N/fed urea gave the best results in terms of increasing plant height with mean values 74.33 and 76.99cm in the first and second seasons, respectively. Followed by the treatment of 100units N/fed compost plus *Azotobacter* with mean values 71.53 and 75.98cm in the first and second seasons, respectively.

Table 1. Effect of sowing dates and nitrogen sources on plant height (cm) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatments / Nitrogen sources (B)		Sowing dates (A) (2004/2005) Sep.	Oct.	Nov.	Means	(2005/2006) Sep.	Oct.	Nov.	Means
Control		47.87	64.11	67.89	**59.96**	51.90	64.09	66.55	**60.85**
Urea	**50**	52.93	74.53	71.89	**66.45**	56.27	76.20	73.22	**68.56**
	75	57.47	79.22	74.89	**70.53**	63.13	83.23	75.46	**73.94**
	100	61.43	85.45	76.11	**74.33**	68.20	86.77	76.00	**76.99**
Compost	**50**	52.20	69.10	70.53	**63.94**	53.40	68.99	70.79	**64.39**
	75	56.37	75.66	73.45	**68.49**	58.60	79.90	74.80	**71.10**
	100	57.20	79.12	73.88	**70.07**	61.60	81.57	75.33	**72.83**
Azotobacter	**———**	52.80	70.67	71.09	**64.85**	53.97	73.43	72.53	**66.64**
	+ 50 Compost	53.20	75.63	72.09	**66.97**	56.80	78.43	74.80	**70.01**
	+75 Compost	57.13	78.56	73.57	**69.75**	59.53	80.77	74.87	**71.72**
	+100 Compost	57.60	81.66	75.32	**71.53**	65.93	86.10	75.90	**75.98**
Means		**55.11**	**75.79**	**72.79**		**59.03**	**78.13**	**73.66**	
LSD at 5%		**A**		**1.56**			**1.50**		
		B		**2.65**			**3.37**		
		AXB		**N.S.**			**4.10**		

Plants received 100 units N/fed compost plus *Azotobacter* had a significantly stronger vegetative growth in both seasons (in terms of increasing number of branches per plant, herb fresh and dry weight) than control plants, or plants receiving any other treatment in most cases. The increment values over the control reached 42.05% and 61.49% for herb fresh weight in the first and second seasons, respectively, 37.30% and 51.06% for number of branches per plant in the first and second seasons, respectively and 19.72% and 38.15% for herb dry weight in the first and second seasons, respectively.

This could be explained by the effect of nitrogen fixed by the *Azotobacter* strain combined with the availability of other elements caused by using compost, this may lead to promotion of cell division, photosynthetic processes resulting in promotion of vegetative growth. Similar promotion of vegetative growth as a result of compost and *Azotobacter* treatments has been reported by El- Khyat and Zaghloul, (1999).

The results shown in Tables (1-4) indicated that the second sowing date (30th October) gave the best vegetative parameters in both seasons, in most cases. Plants sown on 30th October were the tallest with mean values 75.79 and 78.13cm in the first and second seasons, respectively. Those plants had also the biggest mean

Table 2.Effect of sowing dates and nitrogen sources on number of branches of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatments Nitrogen sources (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		6.93	9.66	9.87	**8.82**	7.40	9.99	10.87	**9.42**
Urea	**50**	8.00	12.53	10.66	**10.40**	11.20	12.22	12.20	**11.87**
	75	8.87	12.76	11.22	**10.95**	12.87	13.87	12.44	**13.06**
	100	9.53	13.09	11.56	**11.39**	13.47	14.12	12.55	**13.38**
Compost	**50**	6.97	9.76	10.10	**8.94**	8.40	11.23	11.33	**10.32**
	75	7.33	10.34	10.20	**9.29**	10.33	11.80	11.76	**11.30**
	100	8.27	12.66	10.78	**10.57**	11.87	13.23	12.33	**12.48**
Azotobacter	**——**	7.20	10.11	10.21	**9.18**	8.97	11.57	11.56	**10.70**
	+ 50 Compost	7.73	11.97	10.67	**10.12**	10.53	12.13	11.99	**11.55**
	+75 Compost	8.40	12.76	11.11	**10.76**	12.47	13.70	12.43	**12.87**
	+100 Compost	11.10	13.32	11.90	**12.11**	15.23	14.80	12.67	**14.23**
Means		**8.21**	**11.72**	**10.75**		**11.16**	**12.61**	**12.01**	
LSD at 5%		**A**			**0.37**			**0.67**	
		B			**1.06**			**1.04**	
		AXB			**N.S.**			**N.S.**	

number of branches/plant which was 11.72 in the first season and 12.61 in the second one.

The second sowing date produced heavy herb fresh weight (185.22 gm/plant) but was not the best in the first season and the greatest herb fresh weight in the second season (220.93 gm/plant) where as the results of herb dry weight proved that second sowing date was the best sowing date to have the greatest herb dry weight which was the form of marketing the *Sideritis montana* plants.

In this concern, Abd El-Bary *et al.*, (1997) on some spinach hybrids, stated that sowing on December 10th increased growth and fresh weight of the plants as compared to October and November sowing.

Regarding the interaction between the effect of nitrogen fertilizer and sowing date, the data presented in Tables (1-4) show that the control plants of the different sowing dates were short, had small number of branches/plant which in turn produced small amount of herb growth but the control plants sown on30th September had the lower values.

Data shown in Tables (1-2) revealed that the interaction didn't significantly affect on the plant height in the first season and number of branches/ plant in both seasons.

Table 3. Effect of sowing dates and nitrogen sources on herb fresh weight (g /plant) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		First season (2004/2005)				Second season (2005/2006)			
		Sowing dates (A)				Sowing dates(A)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		136.77	169.91	147.16	**151.28**	156.77	188.30	159.68	**168.25**
Urea	**50**	156.50	173.35	190.31	**173.39**	189.90	214.09	225.27	**209.75**
	75	161.40	199.32	203.29	**188.00**	212.03	238.37	234.97	**228.46**
	100	191.67	202.69	204.79	**199.72**	234.73	244.53	244.75	**241.34**
Compost	**50**	150.63	171.12	161.68	**161.15**	166.40	199.16	170.89	**178.81**
	75	157.10	176.37	190.42	**174.63**	193.17	214.17	226.60	**211.31**
	100	159.47	191.70	195.66	**182.27**	194.83	226.53	229.30	**216.89**
Azotobacter	**——**	154.33	172.50	185.96	**170.93**	172.10	203.89	215.60	**197.20**
	+ 50 Compost	155.40	172.68	191.10	**173.06**	173.40	204.72	219.40	**199.17**
	+75 Compost	159.97	197.01	201.42	**186.13**	211.30	236.50	230.13	**225.98**
	+100 Compost	210.90	210.80	223.00	**214.90**	307.73	259.97	247.43	**271.71**
Means		**163.10**	**185.22**	**190.44**		**201.12**	**220.93**	**218.55**	
LSD at 5%		**A**			**1.65**				**3.47**
		B			**2.67**				**3.14**
		AXB			**4.63**				**5.44**

Those two parameters followed the same trend in response to increasing the level of nitrogen on the different sowing dates. So the best results of number of branches per plant were obtained on the second sowing date with plants received 100units N/fed compost plus *Azotobacter* (13.32 branches per plant) followed by the treatment of 100units N/fed urea (13.09) in the first season on the same sowing date. Similar trend was obtained in the second season. The greatest number of branches was produced with plants received the highest level of compost plus *Azotobacter* with value 15.23 branches/plant in the first sowing date.

Regarding the effect of interaction between fertilizers and sowing date on herb fresh and dry weights, the results obtained indicate that applying 100units N/fed compost plus *Azotobacter* to the plants sown on the last sowing date in the first season and on the first sowing date in the second , significantly yielded the heaviest fresh herb (223.00 and 307.73 g/plant respectively) compared to all other treatments.

The same trend was found with the combined treatments on the herb dry weight. The highest herb dry weight was obtained with the plants received 100units N/fed compost plus *Azotobacter* and sown on the second sowing date (with value

Table 4. Effect of sowing dates and nitrogen sources on herb dry weight (g /plant) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		First season (2004/2005)				Second season (2005/2006)			
		Sowing dates(A)			Means	Sowing dates(A)			Means
		30th Sep.	30th Oct.	30th Nov.		30th Sep.	30th Oct.	30th Nov.	
Control		43.93	63.67	38.71	**48.77**	43.76	78.56	42.33	**54.88**
Urea	**50**	39.75	73.38	47.52	**53.55**	49.29	71.71	56.93	**59.31**
	75	40.75	73.25	55.26	**56.42**	62.32	81.73	59.16	**67.74**
	100	46.54	71.79	54.67	**57.66**	64.88	81.97	61.37	**69.41**
Compost	**50**	41.06	65.80	40.44	**49.10**	41.06	73.17	44.16	**52.80**
	75	40.37	72.14	52.03	**54.85**	49.60	77.04	59.25	**61.96**
	100	40.43	64.66	53.10	**52.73**	50.32	80.90	58.71	**63.31**
Azotobacter	**—**	39.43	64.83	46.22	**50.16**	37.97	72.17	55.83	**55.32**
	+ 50 Compost	39.07	66.32	45.01	**50.13**	41.71	75.61	57.37	**58.23**
	+ 75 Compost	40.99	66.70	51.50	**53.06**	54.46	80.09	59.42	**64.66**
	+ 100 Compost	43.44	76.57	55.18	**58.39**	73.88	90.51	63.06	**75.82**
Means		**41.43**	**69.01**	**49.06**		**51.75**	**78.50**	**56.14**	
LSD at 5%		**A**			**1.88**				**1.26**
		B			**2.78**				**2.59**
		AXB			**4.82**				**4.84**

76.57 and 90.51 gm/plant in the first and second seasons ,respectively) with significant difference compared to the other interaction.

Such findings are in coincidence with the results of many researches. Agamy (2004) on sweet fennel, and Boulus (2007) on *Caryota mitis*, *Keulreutaria* and *Weddelia trilobata* who stated that mineral nitrogen fertilization significantly increased plant height. Salah *et al*., (1998), Wessam (2001) on datura and sweet fennel consecutively, recorded appreciable improvement on branches number as well as fresh and dry weight of vegetative growth due to using N fixer biofertilizer + compost application.

Essential oil

Essential oil percentage and yield per plant:

The data presented in Table 5 show that in both seasons, raising the fertilizers level resulted in increasing the essential oil percentage and oil yield per plant than untreated plants.

Among the different fertilizers, applying 100 unit N/fed compost plus *Azotobacter* was clearly the most effective one for promoting essential oil percentage and oil yield per plant giving the highest mean values (0.019% and 0.041ml/plant in

Table 5. Effect of sowing dates and nitrogen sources on essential oil (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		0.013	0.010	0.010	**0.011**	0.015	0.010	0.010	**0.012**
Urea	50	0.018	0.013	0.013	**0.015**	0.019	0.017	0.013	**0.016**
	75	0.022	0.014	0.013	**0.016**	0.020	0.017	0.015	**0.017**
	100	0.022	0.015	0.015	**0.017**	0.022	0.020	0.017	**0.019**
Compost	50	0.014	0.012	0.010	**0.012**	0.012	0.012	0.010	**0.011**
	75	0.017	0.013	0.013	**0.014**	0.017	0.015	0.013	**0.015**
	100	0.018	0.013	0.013	**0.015**	0.018	0.017	0.013	**0.016**
Azotobacter	—	0.015	0.012	0.012	**0.013**	0.017	0.013	0.012	**0.014**
	+ 50 Compost	0.022	0.015	0.013	**0.017**	0.021	0.017	0.015	**0.018**
	+ 75 Compost	0.022	0.015	0.015	**0.017**	0.022	0.018	0.015	**0.018**
	+100 Compost	0.023	0.017	0.017	**0.019**	0.024	0.020	0.017	**0.020**
Means		**0.019**	**0.014**	**0.013**		**0.019**	**0.016**	**0.014**	
LSD at 5%		A		0.002				0.002	
		B		N.S.				0.003	
		AXB		N.S.				N.S.	

the first season and 0.020% and 0.056 ml/plant in the second season). These results are in agreement with the findings of El-Khyat and Zaghloul (1999) on caraway plants and Amin 1997 on coriander who found that the combination between *Azotobacter* and half dose of nitrogen fertilizer recorded the highest oil percentage.

The results presented in Tables (5-6) indicate that the effect of sowing the *Sideritis montana* seeds on any of the three sowing dates under study had insignificant differences on the oil percentage and yield per plant in the first season and some cases in the second one. The highest oil percentage and yield per plant were obtained from plant sown in 30th September (the first date) with values 0.019% and 0.031 ml/plant in the first season and 0.091% and 0.039 ml/plant in the second season. Bagchi *et al.,* (2003) on *Artemisia vulgaris*, stated that the different sowing dates had moderate effect on the oil yield.

Regarding the interaction between sowing dates and fertilizers it could be noticed that the obtained results reveal that the interaction had insignificant effect on essential oil percentage and oil yield per plant in both seasons Tables (5-6).

Table 6. Effect of sowing dates and nitrogen sources on essential oil yield (ml/plant) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		0.018	0.017	0.015	**0.017**	0.023	0.019	0.016	**0.019**
Urea	50	0.029	0.023	0.025	**0.026**	0.037	0.036	0.030	**0.034**
	75	0.035	0.029	0.027	**0.030**	0.042	0.040	0.035	**0.039**
	100	0.042	0.030	0.031	**0.034**	0.051	0.049	0.041	**0.047**
Compost	50	0.021	0.020	0.016	**0.019**	0.019	0.023	0.017	**0.020**
	75	0.026	0.024	0.025	**0.025**	0.032	0.032	0.029	**0.031**
	100	0.029	0.026	0.026	**0.027**	0.036	0.038	0.031	**0.035**
Azotobacter	—	0.023	0.020	0.022	**0.022**	0.029	0.027	0.025	**0.027**
	+50 Compost	0.034	0.026	0.026	**0.028**	0.036	0.034	0.033	**0.035**
	+75 Compost	0.035	0.029	0.030	**0.031**	0.046	0.043	0.035	**0.041**
	+100 Compost	0.049	0.035	0.037	**0.041**	0.074	0.052	0.041	**0.056**
Means		**0.031**	**0.025**	**0.025**		**0.039**	**0.036**	**0.030**	
LSD at 5%		**A**		**0.003**			**0.004**		
		B		**0.008**			**0.007**		
		AXB		**N.S.**			**N.S.**		

Essential oil constituents

Data in Table 7 revealed that total identified compounds in Sideritis herb oil amounted 94.74%, more that its half (55.17%) was hydrocarbonic compounds, while the rest (39.57%) was oxygenated compounds.

The identified components amounted to thirty six ones; fifteen compounds were hydrocarbonic, while 21 compounds were oxygenated. The main constituents of Sidritis herb oil were in a descending order: the hydrocarbonic compounds: germacrene-D (22.55%), trans- caryophyllene (12.0) and bicyclogermacrene (5.227) followed by the oxygenated: Veridifloral (4.68%), E-citral (4.47%) and spathulenol (4.05%). Whereas, the lowest components were in an ascending order: the oxygenated: ç-ionone (0.145%); the hydrocarbonic: Trans-farnesene (0.363), à-Guaiene (0.388%) and α –Myrcene (0.48%).

Table 7. Effect of 100 N unit compost treatment at three sowing dates on essential oil constituents (%) of *Sideritis montana* L. herb at flowering stage, during the second season(2005/2006).

Constituents	Sep.		Oct.		Nov.	
Hydrocarbonic Compounds	Control	Compost	Control	Compost	Control	Compost
α-Pinene,	0.52	1.20	0.72	0.36	0.66	0.79
β-Pinene	0.87	1.20	0.79	0.51	0.85	0.65
α -Myrcene	0.64	0.48	0.50	0.33	0.61	0.32
dl-Limonene	0.88	0.96	1.11	1.03	1.05	0.90
ç-Gurjunene	0.20	0.35	1.50	1.31	0.88	0.92
ç-Elemene	1.24	0.92	1.53	1.80	1.26	1.22
à -Copaene	1.11	1.53	0.91	0.57	0.77	1.01
Germacrene-D	21.08	22.45	23.17	24.56	20.45	23.60
Trans-Farnesene	0.41	0.37	0.22	0.09	0.51	0.58
Trans-Caryophyllene	12.33	10.04	12.58	12.00	13.44	11.66
à-Cubebene	3.12	3.27	3.81	3.98	3.91	4.82
Bicyclogermacrene	6.90	5.56	4.65	4.42	5.93	3.90
à-Cadinene	4.34	4.62	4.00	3.95	1.02	3.21
à-Guaiene	0.25	0.38	0.33	0.43	0.69	0.25
Neophyt adiene	1.98	1.22	1.01	1.00	0.71	0.84
Total	**55.87**	**54.55**	**56.83**	**56.34**	**52.74**	**54.67**
			Oxygenated compounds			
1-0cten-3-0L	1.61	1.82	1.03	1.20	1.11	1.15
Linalool	0.58	0.45	0.47	0.64	0.71	1.36
Nerol	0.74	0.92	0.65	1.33	0.89	1.65
Z-Citral	2.52	3.70	2.00	3.17	1.83	2.99
Geraniol	3.36	5.76	2.88	3.85	3.56	3.89
E-Citral	3.69	4.10	5.15	4.98	3.94	5.00
Neryl acetate	0.42	0.73	0.62	0.91	0.95	1.87
Geranyl acetate	0.33	0.77	0.53	0.77	0.85	1.39
Ledenoxide-(I)	1.17	2.00	1.90	2.00	2.02	0.91
Spathulenol	3.22	5.55	4.00	3.83	3.66	4.06
Veridiflorol	5.04	3.70	3.87	5.44	5.11	4.29
ç-Ionone	0.04	0.05	0.08	0.11	0.13	0.46
Isospathulenol	0.32	0.63	0.71	0.65	0.79	0.94
ë-Cadinol	0.75	1.62	1.13	1.08	1.30	1.78
Caryophyllene oxide	0.50	2.87	1.13	1.60	1.25	1.02
Ledenalkohol	0.91	0.59	1.11	0.94	0.90	0.88
Eudesmol	0.99	1.02	1.00	1.31	1.12	1.20
Platambin	3.21	2.71	2.63	3.89	3.00	4.04
Geranyl linalool	1.08	1.00	1.42	1.25	1.40	1.13
Phytol isomer	2.84	1.90	3.00	2.55	3.08	3.90
Pentacosane	1.11	1.28	1.24	1.47	1.35	1.54
Total oxygenated	**34.43**	**43.17**	**36.55**	**39.08**	**38.95**	**45.27**
Total identified	**90.30**	**97.72**	**93.38**	**95.42**	**91.96**	**99.94**

However, El-Sherbeny *et al.*, (2005) could identify only twenty four compounds which composed about 91.48% of the total components of sidritis herb oil. Aziz and El-Sherbeny (2003), Kirimer *et al* (2000) and Todorova *et al.,* (2000) agreed with our results that the main constituents of sidritis herb oil were germacrene D, B-caryophyllene and bicyclogermacrene.

Concerning sowing dates, it is clear from Table 7 that the third date slightly raised the percentage of the identified compounds in *sidritis* herb oil, in comparison to the first and second dates (95.82 against 94.01% and 94.40%, consecutively). Hydrocarbonic compounds were lowest under third date sowing conditions (53.71%), but the second date resulted 56.58% of hydrocarbonics. Nevertheless, oxygenated compounds were higher (42.51%) in herb of plants cultivated in 30th November (third date) against 38.80 and 37.81% at the first and second date of sowing, successively. Sowing dates did not alter the main constituents of the oil; but trans-caryophyllene, à-Copaene, Veridiflorol and platambin favoured the third sowing date. Germacrene and E-Citral compounds were increased under the second date; compared with the other two dates.

Compost treatments raised the percentage of identified compounds to 97.68% of siderites herb oil, compared to the control (91.79%). Such increment was mainly due to an increase in the oxygenated compounds which recorded 42.50% against 36.64% for the control, while the carbonic compounds were nearly the same (55.19 and 55.15% for compost and control, respectively).

Compost did not alter, the main components, but slightly affected their percentage. Compost treatments raised most oxygenated compounds, as well as germacrene-D and à-Cubebene (23.53 and 4.2%) against 21.56 and 3.61% for control).

Such results are in a parallel line with the findings reported by El-Sherbeny *et al*., (2005) on *Sideritis*, Naguib (2003) on German chamomile found that compost treatments raised the percentage of the main constituents in the essential oils.

Chemical constituents

Flavonoides percentage

The results recorded in the two seasons in Table 8 show that all applied nitrogen sources, significantly increased the falvonoides percentage compared to the untreated plants. The highest falvonoides percentage occurred when 100 unit N /fed from Urea resulted the values 2.227 and 2.193% in the first and second seasons, respectively.

The combination between compost and Azotobacter had promotion effect on flavonoides percentage compared to using each of them lonely. Also, the promotion effect of the combination significantly increased with increasing of the nitrogen level. These results are in accordance with the findings of Borella *et al.,* (2001) on *Baccharis trimera* and Barbara (2002) on goldenrod, they found that increasing the nitrogen level, significantly enhanced the biosynthesis of flavonoids.

Table 8. Effect of sowing dates and nitrogen sources on flavonoids (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates(A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		1.330	1.285	1.355	**1.323**	1.360	1.349	1.330	**1.346**
Urea	50	1.496	1.526	1.698	**1.573**	1.609	1.449	1.582	**1.547**
	75	2.105	1.975	1.989	**2.023**	1.848	2.053	2.028	**1.976**
	100	2.208	2.244	2.230	**2.227**	2.188	2.230	2.161	**2.193**
Compost	50	1.451	1.429	1.366	**1.415**	1.418	1.438	1.360	**1.405**
	75	1.490	1.496	1.640	**1.542**	1.562	1.582	1.582	**1.575**
	100	1.778	1.640	1.914	**1.777**	1.773	1.778	1.712	**1.754**
Azotobacter	—	1.474	1.443	1.590	**1.502**	1.518	1.438	1.424	**1.460**
	+ 50 Compost	1.764	1.601	1.867	**1.744**	1.640	1.709	1.587	**1.645**
	+ 75 Compost	1.911	1.825	1.981	**1.906**	1.817	2.125	1.897	**1.946**
	+ 100 Compost	2.150	2.022	2.053	**2.075**	2.161	2.255	2.050	**2.155**
Means		**1.742**	**1.681**	**1.789**		**1.718**	**1.764**	**1.701**	
LSD at 5%		A			**0.010**				**0.006**
		B			**0.024**				**0.025**
		AXB			**0.042**				**0.043**

It is clear from the results shown in Table 8 that plants sown at the three sowing dates had closed results of flavonoides percentage in both seasons with one exception in the first season at the second date (30th October) which produced the lowest flavonoides percentage (1.681 %).

Different combination of nitrogen source and sowing date resulted in a considerable variation in flavonoides percentage. The highest level of nitrogen applied to the plants sown at the second date resulted in the highest flavonoides percentage (2.244%) in the first season. Also in the second season, the second sowing date showed good interaction with the highest level of compost plus *Azotobacter* giving the highest flavonoides percentage (2.255%).

Carbohydrate percentage

Addition of different nitrogen sources caused significant increase in the carbohydrate content accumulation in plant tissues compared to the untreated plants in the both seasons. There was pronounced increment in total carbohydrates percentage with the increasing of nitrogen level in both seasons with one exception when urea level increased from 50 to 75 units in the first season which resulted insignificantly decrease in total carbohydrate % from 23.62 to 21.29%. The obtained results are in harmony with those obtained by l- Gomaa and Abo-Aly (2001) on Anis.

Table 9. Effect of sowing dates and nitrogen sources on total carbohydrates (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates(A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		19.74	15.82	8.09	**14.55**	26.21	20.78	21.83	**22.94**
Urea	50	26.84	25.08	18.95	**23.62**	30.60	24.84	24.96	**26.80**
	75	14.78	28.09	20.99	**21.29**	32.06	27.26	27.57	**28.96**
	100	30.81	31.33	24.23	**28.79**	32.48	30.49	29.35	**30.77**
Compost	50	20.57	22.14	12.43	**18.38**	26.63	21.72	24.12	**24.16**
	75	24.54	23.60	18.33	**22.16**	30.38	22.87	24.23	**25.82**
	100	27.67	26.84	19.63	**24.72**	30.70	25.79	26.32	**27.61**
Azotobacter	—	23.60	21.67	13.89	**19.72**	27.78	21.51	23.08	**24.12**
	+50 Compost	23.81	21.41	17.81	**21.01**	28.82	22.14	24.13	**25.03**
	+75 Compost	29.24	28.93	19.74	**25.97**	31.85	26.32	26.84	**28.34**
	+100Compost	35.30	29.03	27.51	**30.62**	32.79	31.12	29.24	**31.05**
Means		**25.17**	**24.90**	**18.33**		**30.03**	**24.99**	**25.61**	
LSD at 5%		A			1.14				0.56
		B			0.80				0.30
		AXB			1.38				0.52

The percentage of total carbohydrate was affected by the sowing date. The highest total carbohydrate accumulation was found in the plant sown at the first sowing date (30th September) 25.17 and 30.03 % in the first and second seasons, respectively.

Concerning the effect of the interaction between levels of nitrogen source and sowing date, it was noticed that in most cases the high level of different N source with the first sowing date resulted in the highest total carbohydrates percentage in both seasons compared to the other interaction treatments of each nitrogen sources. Among all the interactions, applying the high level of compost plus *Azotobacter* to the plants sown at 30th September produced the highest carbohydrate content with value 35.30 and 32.79 % in the first and second seasons, respectively.

Total chlorophyll and carotenoids content

Data presented in Tables (10 and 11) indicated that in both seasons, the mean values recorded increased steadily with raising the nitrogen level. The highest total chlorophyll and carotenoids content (2.628, 1.682 mg/gm in the first season and 2.360, 1.496 mg/gm F.W. in the second season) were obtained from plants fertilized with 100 urea, followed by plants fertilized with 75 urea with mean values 2.184, 1.453 in the first season and 2.191, 1.454 mg/gm F.W. in the second seasons, respectively. These results could be explained by the fact of that nitrogen is essential

Table 10. Effect of sowing dates and nitrogen sources on Total chlorophyll-(a+b) (mg/gm fresh weight) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		1.080	1.060	1.541	**1.227**	0.968	1.484	1.517	**1.323**
Urea	50	1.869	1.425	1.852	**1.715**	1.329	2.055	2.143	**1.842**
	75	2.231	1.765	2.555	**2.184**	1.634	2.312	2.628	**2.191**
	100	2.568	2.215	3.100	**2.628**	1.751	2.506	2.821	**2.360**
Compost	50	1.270	1.158	1.664	**1.364**	1.178	1.834	1.804	**1.605**
	75	1.678	1.268	1.774	**1.573**	1.322	1.977	2.087	**1.795**
	100	1.929	1.565	2.094	**1.863**	1.399	2.145	2.201	**1.915**
Azotobacter.	—	1.405	1.208	1.652	**1.421**	1.132	1.851	1.560	**1.514**
	+ 50 Compost	1.757	1.370	1.784	**1.637**	1.317	1.930	2.096	**1.781**
	+ 75 Compost	1.968	1.634	1.972	**1.858**	1.432	2.193	2.296	**1.974**
	+ 100 Compost	2.076	1.713	2.429	**2.073**	1.586	2.497	2.264	**2.116**
Means		**1.803**	**1.489**	**2.038**		**1.368**	**2.071**	**2.129**	
LSD at 5%		A			0.016				0.011
		B			0.022				0.031
		AXB			N.S.				N. S.

in the structure of porphyrines, which are found in many metabolically active compounds, including chlorophylls (Devlin, 1975).

The results showed that in both seasons, untreated plants had lower chlorophyll and carotenoids content in their leaves (1.227, 0.917 in the first season and 1.323, 0.920 mg/gm F.W. in the second season), compared to the fertilized plants. The results considered in agreement with the findings of Gomaa and Abo-Aly (2001) and Rashed (2002).

The obtained results show that the highest total chlorophyll and carotenoids contents (2.038 and 1.416 mg/gm F.W. in the first season and 2.129 and 1.496 mg/gm F.W. in the second season) were obtained as a result of sowing the plants on the third date (30th November) in both seasons compared to other sowing dates.

On the third sowing date (30th November) in both seasons the application of urea at the rate of 100 unit N/fed was the most effective interaction on increasing the total chlorophyll (a+b) and carotenoids content giving 3.100, 2.187 mg/gm F.W. in the first season and 2.821, 1.933 mg/gm F.W. in the second season.

Table 11. Effect of sowing dates and nitrogen sources on Carotenoids (mg/gm fresh weight) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		0.961	0.663	1.126	**0.917**	0.698	0.940	1.121	**0.920**
Urea	**50**	1.227	0.923	1.301	**1.150**	0.907	1.286	1.494	**1.229**
	75	1.401	1.132	1.825	**1.453**	1.135	1.364	1.862	**1.454**
	100	1.621	1.239	2.187	**1.682**	1.135	1.421	1.933	**1.496**
Compost	**50**	1.019	0.673	1.162	**0.951**	0.824	1.179	1.192	**1.065**
	75	1.165	0.806	1.181	**1.051**	0.906	1.220	1.429	**1.185**
	100	1.318	0.925	1.325	**1.189**	1.003	1.298	1.560	**1.287**
Azotobacter	**——**	1.046	0.770	1.154	**0.990**	0.895	1.216	1.148	**1.086**
	+50 Compost	1.170	0.827	1.264	**1.087**	0.921	1.249	1.524	**1.231**
	+75 Compost	1.327	0.925	1.366	**1.206**	1.012	1.349	1.585	**1.315**
	+100 Compost	1.355	1.016	1.687	**1.353**	1.131	1.653	1.602	**1.462**
Means		**1.238**	**0.900**	**1.417**		**0.961**	**1.289**	**1.494**	
LSD at 5%		**A**			**0.008**				**0.007**
		B			**0.016**				**0.022**
		AXB			**N.S.**				**N.S.**

Minerals content

Data in Tables (12-14) indicated that the highest rate of urea (100 N unit) resulted in the highest nitrogen and potassium content in both seasons while the highest phosphours content was obtained from plants treated with compost (75 N unit) plus *Azotobacter* in the first season and compost (100 N unit) plus *Azotobacter* in the second season .

In the first season, sowing the seeds on 30th November produced plants with the highest Nitrogen, phosphorus and potassium content, in comparison to the other two sowing dates.

In the second season, the obtained results from second and third sowing dates were the same.

Regarding the interaction between sowing dates and N fertilization, plants received 100 N unit of urea at the third sowing date had the highest N and K content compared to the other treatments.

The results are in agreement with the finding of Gomaa and Abo-Aly (2001) and Rashed (2002).

Table 12. Effect of sowing dates and nitrogen sources on Nitrogen (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates (A)							
		(2004/2005)				(2005/2006)			
		Sep.	**Oct.**	**Nov**	**Means**	**Sep.**	**Oct.**	**Nov**	**Means**
Control		2.15	1.80	2.97	**2.30**	1.06	2.50	2.51	**2.03**
Urea	**50**	2.46	2.08	3.13	**2.56**	2.00	2.84	2.74	**2.53**
	75	2.65	2.75	3.29	**2.90**	2.39	3.08	2.97	**2.81**
	100	2.60	2.42	3.24	**2.76**	2.15	3.08	2.79	**2.67**
Compost	**50**	2.96	3.42	3.73	**3.37**	2.73	3.53	3.78	**3.35**
	75	2.50	2.41	3.18	**2.70**	2.09	3.06	2.76	**2.64**
	100	2.92	3.32	3.68	**3.31**	2.57	3.21	3.29	**3.02**
Azotobacter	**—**	2.78	2.98	3.29	**3.02**	2.54	3.16	3.14	**2.95**
	+50 Compost	3.39	3.68	3.84	**3.64**	2.97	4.00	4.33	**3.77**
	+75 Compost	2.19	1.99	3.06	**2.41**	1.94	2.72	2.63	**2.43**
	+100 Compost	2.10	1.79	2.84	**2.24**	0.94	2.04	2.27	**1.75**
Means		**2.61**	**2.60**	**3.30**		**2.13**	**3.02**	**3.02**	
LSD at 5%		**A**			**0.7**				**0.09**
		B			**0.04**				**0.05**
		AXB			**0.07**				**0.08**

Table 13. Effect of sowing dates and nitrogen sources on Phosphorus (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates(A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		0.23	0.18	0.28	**0.23**	0.10	0.20	0.21	**0.17**
Urea	**50**	0.29	0.23	0.32	**0.28**	0.21	0.30	0.27	**0.26**
	75	0.21	0.32	0.36	**0.29**	0.26	0.31	0.31	**0.29**
	100	0.21	0.34	0.30	**0.30**	0.30	0.37	0.39	**0.35**
Compost	**50**	0.25	0.20	0.30	**0.25**	0.17	0.26	0.26	**0.23**
	75	0.26	0.26	0.31	**0.28**	0.20	0.28	0.26	**0.25**
	100	0.23	0.28	0.36	**0.29**	0.22	0.31	0.28	**0.27**
Azotobacter	**—**	0.27	0.26	0.31	**0.28**	0.10	0.25	0.25	**0.20**
	+50 Compost	0.21	0.20	0.27	**0.28**	0.21	0.30	0.27	**0.26**
	+75 Compost	0.28	0.31	0.31	**0.29**	0.24	0.31	0.30	**0.28**
	+100 Compost	0.31	0.23	0.34	**0.30**	0.27	0.34	0.36	**0.32**
Means		**0.25**	**0.26**	**0.31**		**0.21**	**0.29**	**0.29**	
LSD at 5%		**A**			**N.S.**				**0.10**
		B			**0.14**				**0.13**
		AXB			**0.24**				**N.S**

Table 14. Effect of sowing dates and nitrogen sources on Potassium (%) of *Sideritis montana* L. during 2004/2005 and 2005/2006 seasons.

Treatment (B)		Sowing dates(A)							
		(2004/2005)				(2005/2006)			
		Sep.	Oct.	Nov.	Means	Sep.	Oct.	Nov.	Means
Control		1.88	1.62	1.84	**1.78**	0.83	1.67	1.67	**1.39**
Urea	**50**	2.03	1.77	1.98	**1.92**	1.72	1.88	1.86	**1.82**
	75	2.08	1.79	2.04	**1.97**	1.81	1.93	1.88	**1.88**
	100	1.93	1.65	1.91	**1.83**	1.65	1.81	1.77	**1.74**
Compost	**50**	2.17	1.84	2.24	**2.08**	1.98	2.00	2.03	**2.00**
	75	1.98	1.66	1.97	**1.87**	1.69	1.86	1.79	**1.78**
	100	2.10	1.81	2.22	**2.04**	1.93	1.98	2.00	**1.97**
Azotobacter	**—**	2.10	1.80	2.05	**1.98**	1.88	1.96	1.89	**1.91**
	+50 Compost	2.22	2.05	2.29	**2.19**	2.05	2.03	2.08	**2.05**
	+75 Compost	1.91	1.63	1.91	**1.82**	1.55	1.77	1.74	**1.69**
	+100 Compost	1.80	1.57	1.79	**1.72**	0.62	1.53	1.72	**1.29**
Means		**2.02**	**1.74**	**2.02**		**1.61**	**1.86**	**1.86**	
LSD at 5%		**A**			**0.18**				**N.S.**
		B			**0.10**				**0.03**
		AXB			**N.S.**				**0.05**

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تأثير ميعاد الزراعة ومصادر نيتروجينية على نبات السيدراتس.

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**قسم زراعة وانتاج النباتات الطبية والعطرية- المركز القومى للبحوث – الدقى – الجيزة – مصر.

أجريت هذه الدراسة في محطة التجارب التابعة للمركز القومي للبحوث شلقان – القناطر الخيرية – محافظة القليوبية – مصر خلال موسمي ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦ لدراسة استجابة نبات شاي الجبل لمصادر مختلفة للنيتروجين وهى اليوريا والكمبوست والمخصب الحيوي المحتوى على البكتريا المثبتة للنيتروجين أزوتوباكتر وذلك بمستويات ٥٠-٧٥-١٠٠ وحدة نيتروجين مع الزراعة في ثلاث مواعيد مختلفة وهى ٣٠سبتمبر –٣٠أكتوبر –٣٠ نوفمبر وأشارت النتائج إلى أن كل مصادر النيتروجين المستخدمة أدت إلي زيادة النمو الخضري (ارتفاع النبات – عدد الأفرع / النبات – الوزن الطازج والجاف للعشب) وكذلك النسبة المئوية للزيت الطيار ومحصول الزيت الطيار للنبات والنسبة المئوية للفلافونيدات والكلوروفيلات والكاروتينات والكربوهيدرات .
بالإضافة لذلك فانه بزيادة مستوى النيتروجين تزيد الصفات المورفولوجية والكيميائية زيادة معنوية وبصفة عامه قد وجد أن موعد الزراعة الثاني وهو ٣٠ أكتوبر كان افضل كفاءة في تنشيط النمو الخضري للنبات.
ويمكن التوصية للحصول على افضل نمو خضري وأعلى محتوى من الفلافونيدات أن تزرع البذور في ٣٠ أكتوبر في حين للحصول على أعلى نسبة مئوية ومحصول للزيت الطيار أن تزرع البذور في ٣٠ سبتمبر مع التسميد بأعلى مستوى من الكمبوست مع استخدام المخصب الحيوي أزوتوباكتر في كلا الموعدين للزراعة.