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EFFECT OF DIFFERENT PLANTING DISTANCES AND HARVESTING DATES ON GROWTH AND PRODUCTIVITY OF MOGHAT (GLOSSOSTEMON BRUGUIERI, DESF.) PLANTS UNDER ASSIUT VALLEY CONDITIONS.

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ABSTRACT

This study was carried out at Assiut Valley desert, Egypt during the three successive seasons of 2006/2007, 2007/2008 and 2008/2009, to study the effect of different planting distances and harvesting dates on growth and productivity of moghat plants (*Glossostemon bruguieri,* Desf). Moghat was planted by seeds in sandy soil at three planting distances; 20, 30 and 40 cm between hills and was harvested at three dates; 12, 18 and 24 months from planting dates. Results showed that, the widest plant spacing (40 cm) and the longest growing period (24 month) gave the maximum vegetative growth highest seeds and roots yield/plant. On the other hand, roots yield/fed. decreased with the widest spacing (40 cm), meanwhile, shortest spacing distances gave the highest yield of roots/fed.

The interaction effect showed strong relationship between planting distances and harvesting dates; the highest starch, mucilage contents in the roots were obtained with plants planted at wide distance and long growing period.

INTRODUCTION

Moghat (*Glossostemon bruguieri* Desf.) plant belongs to family *Buttneriaceae* (*Sterculaceae*). As a medicinal plant, Moghat is used for astringent, anti hemorrhagic, intestinal anti-euplastic, cardio-inhibitory and sedative effects. Also, it is used as folk remedy against amoebiasis, headache, jaundice and leprosy. Moghat grows wild in some countries (Iraq and Iran) but it was introduced to Egypt in 1932 and was cultivated in very small areas. Recently, the plant attracted the attention of investigators to be cultivated in newly reclaimed lands. The important part is the roots, which can be harvested after1 to 3 years from planting. In folk medicine, it is used as a tonic, nutritive, demulcent and for the treatment of gout and spasm. Chemical composition showed that dry roots of moghat contain 24% starch, 5% pectin, 3% sugars, 5% fats, 27% mucilage, 5.5% crude protein, as well as, different mineral elements. Methionine, tyrosine, proline, threonine, glutamic acid, glycine, serine, argenine and aspartic acid were identified in the roots. Glutamic and aspartic acids were the major ones. The powdered roots with some additives, spices, flavoring agents, sugars and butter, are used by the majority of Arab nations for preparing a hot drink especially in winter, and after childbirth. Women especially use hot drinks of powdered moghat as a general tonic and lactagogue. The advantages of cultivation moghat in newly reclaimed lands, is its cultivation as first crop in poor soils where it is difficult to cultivate any traditional crop. The plant prefers sandy and light soils than heavy soils. It has very minimal nutritional requirements. Also, has low water requirements, and grows well under drip or sprinkler irrigation systems available in these areas. Very limited labor work is required during the growth period. Insects or diseases rarely attack it, so no need for any pesticides. No special skills are required for its production. It may stay in the same land for two years, so no costs for successive cultivation. During winter season, the same area could be intercropped with any winter crop like beans or peas. The harvested crop could be stored for several

months without any harm under good storage condition. There is increased demand of moghat roots in local market. The present work deals with the effect of different planting distances and harvesting dates on growth and productivity of moghat (*Glossostemon bruguieri,* Desf) plants under Assiut valley conditions.

Ibrahim (2004) studied the effect of time of harvest on plant growth and yield of Achillea herb. The results revealed that first cut gave better results (plant height, fresh and dry weights, flowers and oil yield) than the second cut. El-Weshahy (2007) studied the effect of plant distances 40, 50 and 60 cm, on vegetative growth, herb and oil yield of *Rosmarinus officinalis,*L. The results showed that growing rosemary plants at 40cm resulted in the highest production of dry leaves yield/fed., fresh and dry weight of herb and leaves/plant. Massoud *et al.*, (2007) on *Rosmarinus officinalis,* L. tested different plant spacing; 40, 50 and 60 cm. They found that the tallest plants were produced from the closer spacing (40 cm.) and the shortest plants resulted from the wider spacing (60 cm). Meanwhile, the highest values of number of branch and the heaviest fresh and dry weights per plant resulted from cultivation at wider spacing (60 cm).

Massoud (2008) studied the effect of plant distance (12 x 25, 25 x 30, 30 x 60 and 40x90 cm) on Tagetes erecta L. plant density, growth and flower characteristics. He demonstrated that increasing planting spaces between plants over 12 x 25 cm resulted in a significant increase in plant height, weight and flower production and quality.

Emad El-Deen (1997), Mattar (1997) and Ahmed *et al.*, (1998) reported that plant height and number of branches/plant. herb weight and stem diameter of *Nigella sativa,* L. plants, were increased with increasing spacing between plants compared with the closer ones. The same trend was observed on *Ammi visnaga,* L. plants by Shalaby *et al.*, (1983), Nofal *et al.*, (2001), Yuonis *et al.*, (2004). Also, El-

Shaer (1989) and Kandeel *et al.*, (2001) on *Foeniculum vulgare*, L. found that decreasing plant spacing to 30 cm. using one plant/hill increased plant height. However, at 50 cm. using one plant/hill increased number of umbels. Also, On *Tagetes erecta*, L., Belorkar *et al.*, (1992), Mohanty *et al.*, (1997) and Ramu and Farooqi (1998) found that the greatest diameter, stem thickness were produced from planting spacing of 60 x 30 cm. Meanwhile, they demonstrated that closer spacing (45 x 45 cm.) resulted in maximum increase in plant height and primary branch number.

El-Tantawy and Hanafy (1994), Malav and Yadav (1997) reported that the widest distance between hills led to increase plant height, number and setting umbels of (*Coriandrum sativum*, L.,). Also, number of green leaves, number of branches and fresh and dry weights/plant were the highest.

Meawad *et al.*, (2000) evaluated the effect of three planting density levels (30, 50 and 70 cm) on *Hyoscyamus muticus*, L. plants. Results indicated that dense cultivation enhanced plant height only, whereas low planting density improved leaf and branch number, leaf area, root length as well as fresh and dry weights of leaves per plant.

Sukhadia *et al.*, (1986) investigated the response of coriander plant to planting patterns. Five sowing methods (broadcast, line sowing at 22.5, 30.0 and 37.5 and cross sowing at 30 cm.). They found that line sowing at 30 cm gave the highest seed yield. Bhati (1988) grew *Coriandrum sativum*, L. plants in row spacing at 20, 30 or 40 cm apart, and found that, seed yield was highest at medium spacing (30 cm) compared with 20 and 40 cm. El-Tantawy and Hanafy (1994) reported that the widest distance between hills (40 cm) increased dry fruit yield per plant or per fed of coriander plants. They recommended cultivation of coriander fruits in hills as 40 cm. apart within the row and 60 cm distance between the rows. Malav and Yadav (1997) studied the effect of row spacing of 20, 30 or 40 cm. on *Coriandrum sativum*, L.

plants and stated that seed yield increased significantly at 40 cm. row spacing than at 20 or 30 cm. Nehra *et al.*, (1998) found, *Coriandrum sativum,* L. plants had the highest seed yields at 30 x 20 cm compared with 20 x 20 and 40 x 20 cm).

El-Shaer (1989) reported that *Foeniculum vulgare*, L. plants grown on 35 cm. spacing had the highest seed yield per plant, whereas, 15 cm. spacing produced the highest seed yield per area unit. Kandeel *et al.*, (2001) on fennel plants, demonstrated that decreasing plant spacing to 30 cm. using one plant per hill increased seed yield per fed. However, at 50 cm. using one plant per hill increased number of umbels per hill and seed yield per plant.

Omar *et al.*, (1996) studied the effect of three row spacings (20, 40 or 60 cm. between hills) on *Silybium marianum,* L. plants. They found that the narrowest spacing of 20 cm resulted in greater seed yield/fed than wider row spacing.

MATERIALS AND METHODS

A field experiment was carried out at Assiut Valley desert, Assiut governorate, during three successive years; 2006/2007, 2007/2008 and 2008/2009 to investigate the effect of different planting distances and harvesting dates on growth and productivity of moghat plant (*Glossostemon bruguieri*, Desf). The experiment area was sandy soil and arranged in a split-plot design with three replicates divided into 27 beds (5 X 5 m) (9 treatments X three replicates). Planting distances treatments were distributed randomly in the main plots, while the harvesting dates in the sub plots. On 15th March/2006 and on 15th march 2007 seeds were sown directly in rows for the first and second years, respectively. The distance between rows was 60 cm but it was 20 or 30 or 40 cm between hills. All treatments received organic manure compost at the rates of 30 m^3/fed. Flood irrigation system was used. All agricultural practices (watering, weed control, etc.) were done

as usual. The plants were harvested after 12, 18 or 24 month from planting date.

Treatments:

Main plots (Planting distances):

1- P1 (20 cm)
2- P2 (30 cm)
3- P2 (40 cm)

Sub plots (Harvesting dates):

1- H1 (after 12 month).
2- H2 (after 18 month).
3- H3 (after 24 month).

The mechanical and chemical analysis of compost manure and soil of the experimental area were determined according to Jackson (1958) are presented in Tables a and b.

Table a: Chemical properties of compost manure.

pH	E.Cm mhos	Soluble cations (meq/L.)				Solublec anions (meq/L.)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.10	4.10	15.00	45.00	90.00	30.00	-	45.00	10.00	140.50
Humidity		Ash	O.M	N%		P%		K%	
25%		9%	65%	2%		1.5%		1%	

Table b: Mechanical and chemical analysis of the experimental soil

Physical analysis	Fine Sand (%)	Silt (%)	Clay (%)	Type of soil
	76.5	16.6	6.9	Sandy soil
Chemical analysis	pH	E.C. Mmhos/cm	O.M. %	Ca $(CO_3)_2$
	7.8	5.2	1.1	16.3

The following data were recorded:

Vegetative growth characteristics:

The plants were harvested on15th March/2007 (after 12months), 15th Sept. 2007(after 18 months) and 15th March 2008 (after 24 months) for the first planting year, as well as, 15th March 2008, 15th Sept. 2008 and 15th March 2009 for the second planting year.

After harvesting, ten plants were selected at random from each sub-unit to measure the following parameters:

Plant height (cm): length of main stem from soil surface to the plant apex.

Fresh and dry weights of herb (g/plant): fresh mass of aerial parts above soil surface. Then, the fresh plants were reserved under shaded place for ten days till a constant air-dried weight.

Yield components:

Root length (cm): from stem base to the longest root.

Root diameter (cm): at the base (5 cm. under soil surface)

Root weight (fresh & dry) in gm: fresh mass of roots under soil surface. Then, the fresh roots were reserved under a shaded place for fifteen days till a constant air-dried weight.

Roots dry weight in ton/fed: it was calculated by multiplying root dry weight /plant by number of plants/fed. (32000, 21760 and 16640 plant for 20, 30 and 40 cm distance treatments, respectively).

Seed yield/plant (gm)

Chemical analysis:

Starch (%) in the roots, on dry matter bases according to Herbert and Philips (1971)

2- Mucilage (%) in the roots, on dry matter bases according to Amer (1978)

3- Crude fiber (%) in the roots, on dry matter bases according to A.O.A.C. (2000)

Statistical analysis:

Data were subjected to statistical analysis using "F" test and L.S.D. value for comparisons according to Gomez and Gomez (1984).

RESULTS

Vegetative growth characteristics

Plant height:

Data presented in Table 1 show significant increases in plant height as affected by planting distances in the two seasons. The narrow planting distances (20 cm) resulted in the tallest plants compared with the other treatments. Planting on 30 cm gave a significant increase plant height compared to 40 cm during the second season. However, harvesting dates had insignificant effect on plant height.

The interaction effect, data showed significant effect on plant height as a result of different planting distances and harvesting times. The treatments of 20 cm with 12 months followed by 18 months in the first season and 20 cm with 18 months in the second one resulted in the tallest plant compared with the other treatments.

Table 1: Plant height (cm) of *Glossostemon bruguieri*, Desf as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	70.00	66.67	68.33	68.33	69.33	73.33	69.33	70.66
30 cm	62.33	62.67	64.00	63.00	65.00	65.67	65.67	65.44
40 cm	58.67	60.33	61.67	60.22	60.67	66.33	63.67	63.56
Mean B	63.67	63.22	64.67		65.00	68.44	66.22	
L.S.D	0.05				0.05			
A	1.82				1.38			
B	NS				1.52			
AB	2.25				2.63			

A: Planting distances B: Harvesting dates

Herb weight/plant (fresh & dry):

Data in Tables 2 and 3 clearly show increase in fresh and dry weights of herb due to planting distances and harvesting times. Significant increases were recorded in herb weight as a result of planting at 40 cm compared with 20 cm and 30 cm, in the meantime, 30 cm showed significant increases in fresh and dry weight of herb compared to 20 cm. Plants harvested after 24 month gave the heavier plant than those harvested after 12 and 18 months with significant differences between them. Also, harvesting after 18 month significantly increased herb fresh and dry weight compared with harvesting after 12 month in the two seasons.

Table 2: Herb fresh weight (g/plant) of *Glossostemon bruguieri* Desf. as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	308.33	316.67	318.33	314.44	320.00	321.67	320.00	320.56
30 cm	321.67	345.00	358.33	341.67	331.67	363.33	348.33	347.78
40 cm	328.33	371.67	310.00	336.67	331.67	381.67	316.67	343.34
Mean B	319.44	344.44	328.89		327.78	355.56	328.33	
L.S.D. 0.05	0.05				0.05			
A	6.296				11.44			
B	7.06				6.21			
AB	12. 26				10.63			

A: Planting distances B: Harvesting dates

The interaction effects between planting distances and harvesting dates on herb weight were significant in both seasons. In general, the heaviest fresh weight of herb per plant were obtained from plants grown at 40 cm and harvested after 18 month in the first season and the plants grown at 30 cm and harvested after 18 month in the second one. Meanwhile;

the heaviest herb dry weight resulted from plants grown under the treatments of 40 cm and 24 month in the second season and 30 cm and 24 month in the two seasons, respectively.

Table 3: Herb dry weight (g/plant) of *Glossostemon bruguieri* Desf. as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	72.67	83.98	87.18	81.27	75.69	80.80	85.32	80.60
30 cm	76.26	90.46	97.67	88.13	77.27	91.60	96.33	88.40
40 cm	77.23	96.49	90.99	88.24	77.10	98.33	109.20	94.88
Mean B	75.39	90.31	91.95		76.68	90.24	96.95	
L.S.D. 0.05	0.05				0.05			
A	1.18				2.16			
B	1.32				1.52			
AB	2.63				2.63			

A: Planting distances B: Harvesting dates

Root length:

Data in Table 4 reveal no significant differences in root length as a result of different planting distances in the first season, while, in the second one, planting on 40 cm significantly increased root length compared to 20 cm. It was noticed that harvesting at 18 month and 24 month significantly increased root length compared with 12 month in the two seasons.

Regarding the interaction between planting distances and harvesting dates, results showed significant effect on root length during the two growing seasons. The longest roots resulted from the combination between treatments of 40 cm with 24 month in the two seasons.

Table 4: Root length (cm) of *Glossostemon bruguieri,* Desf. plant as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	44.19	54.45	57.85	52.16	44.79	56.90	57.02	52.90
30 cm	44.57	54.67	59.77	53.00	47.00	56.93	60.67	54.87
40 cm	44.40	53.95	60.63	53.00	47.28	56.07	61.11	54.82
Mean B	44.39	54.36	59.42		46.36	56.63	59.60	
L.S.D. 0.05	0.05				0.05			
A	1.72				1.09			
B	1.07				1.18			
AB	1.85				2.03			

A: Planting distances B: Harvesting dates

Root diameter:

Data presented in Table 5 reveal that treatment of 40 cm significantly increased root diameter during the two season compared with 20 or 30 cm. Obviously, the long harvesting period followed by the medium one, resulted in a significant increase in root diameter compared with the short one (12 month) during both seasons.

In the two experimental seasons, data showed that plants grown under the treatment of 40 cm with 24 months resulted in the thickest diameter in both season compared to the other treatments.

Table 5: Root diameter (cm) of *Glossostemon bruguieri*, Desf. plant as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	3.03	5.03	7.57	5.21	3.17	4.97	7.57	5.23
30 cm	3.17	5.33	8.03	5.51	3.27	5.37	8.30	5.64
40 cm	3.23	5.77	8.73	5.91	3.47	5.83	8.93	6.08
Mean B	3.14	5.38	8.11		3.30	5.39	8.27	
L.S.D. 0.05	0.05				0.05			
A	0.11				0.11			
B	1.16				0.14			
AB	2.18				0.24			

A: Planting distances B: Harvesting dates

Roots weight/plant (fresh and dry):

Results in Tables 6 and 7 clearly show that planting distance of 40cm and 30 cm significantly increased root weight (fresh and dry) compared to 20 cm treatment, on the other hand, plants that harvested after 24 month gave the heaviest roots compared to the other treatments with significant increases among this treatment and the other ones. Likewise, the treatment of 18 month significantly increased root weight (fresh and dry) compared with 12 month in the two seasons.

The interaction among planting distances and harvesting dates showed significant increases in root weight (fresh and dry) during both seasons. The treatment of 40 cm with 24 month followed by 40 cm with 18 month gave the heaviest roots compared with the other treatments in the two growing seasons.

Table 6: Roots fresh weight (g/plant) of *Glossostemon bruguieri*, Desf. as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	260.00	331.67	411.67	334.45	283.33	320.00	413.33	338.89
30 cm	301.67	433.33	498.33	411.11	306.67	453.33	481.67	413.89
40 cm	396.67	603.33	640.00	546.67	383.33	646.67	693.33	574.44
Mean B	319.45	456.11	516.67		324.44	473.33	529.44	
L.S.D. 0.05	0.05				0.05			
A	24.69				23.68			
B	10.52				12.37			
AB	25.66				28.74			

A: Planting distances B: Harvesting dates

Table 7: Roots dry weight (g/plant) of *Glossostemon bruguieri*, Desf. as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	37.20	46.07	63.85	49.04	40.43	48.57	60.52	49.84
30 cm	42.20	61.78	74.47	59.48	43.57	60.94	68.13	57.55
40 cm	55.10	85.97	91.69	77.58	52.27	88.67	96.03	78.99
Mean B	44.83	63.60	76.67		45.42	66.06	74.90	
L.S.D. 0.05	0.05				0.05			
A	1.90				1.72			
B	1.52				1.13			
AB	5.06				4.16			

A: Planting distances B: Harvesting dates

Roots dry weight (ton/fed.).

Table 8 shows that planting at 20 cm significantly increased roots dry weight compared with the other treatments. The results also show that, 24 month significantly increased root dry weight compared to 18 month or 12 month. Likewise, 18 month treatment increased dry weight of root compared to 12 month treatments.

Interaction among planting distances and harvesting dates resulted in a significant increase in dry weight of root compared to individual treatments in the two seasons. The best results were obtained from plants grown at 20 cm and harvested after 24 month.

Table 8: Roots dry weight (ton/fed.) of *Glossostemon bruguieri*, Desf. plant as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	1.19	1.47	2.94	1.57	1.29	1.55	1.94	1.59
30 cm	0.92	1.34	1.62	1.29	0.95	1.33	1.48	1.25
40 cm	0.92	1.43	1.53	1.29	0.97	1.48	1.60	1.32
Mean B	1.01	1.41	1.73		1.04	1.45	1.67	
L.S.D. 0.05	0.05				0.05			
A	0.22				0.34			
B	0.15				0.21			
AB	0.56				0.66			

A: Planting distances B: Harvesting dates

Yield components:

Seed yield/plant (gm):

Data in Table 9 show that wide distance between hills (40 cm) gave higher seed yield per plant than the other distances (38.83 gm in the first season and 43.38 gm in the second one). Also, medium distance (30 cm) significantly increased seed yield per plant compared to the least distance in the two

seasons. On the other hand, long harvesting period produced higher seed yield/plant in the two seasons (39.39 and 41.73 gm for the first and second seasons, respectively) compared with the other treatments.

The obtained results showed significant differences for planting distances and harvesting dates during the two seasons. Maximum seed yield/plant obtained with the widest distance and the longest harvesting period, 43.92 gm in the first season and the treatment of 40 cm and 18 month, gave 46.87 gm in the second one.

Table 9: Seeds yield (g/plant) of *Glossostemon bruguieri*, Desf. as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	10.32	25.47	36.23	24.01	17.98	27.07	39.67	28.52
30 cm	27.19	36.97	38.03	34.06	34.53	39.80	41.23	38.52
40 cm	30.65	42.03	43.92	38.87	38.98	46.87	44.30	43.38
Mean B	22.72	34.82	39.39		30.50	37.91	41.73	
L.S.D 0.05	0.05				0.05			
A	2.78				3.78			
B	1.04				1.98			
AB	3.27				3.90			

A: Planting distances B: Harvesting dates

Chemical constituents:

Starch (%) in the roots:

Averages starch percentage of moghat roots as affected by different planting distances and harvesting dates are shown in Table 10. Plant spacing resulted in an increase in starch percentage in roots, as plant spacing increased from 20 cm to 40 cm during both seasons.

Treatment of 24 month significantly increased starch content in roots compared with 12 or 18 month in the two

seasons. A significant increases were also observed as a result of harvesting plants after 18 month compared to that harvested after 12 month.

The interaction among plant spacing and harvesting dates showed significant effect on starch content in roots during both growing seasons. Clearly, 40 cm and 24 month treatment were more effective than the other treatments as it produced the highest starch content in roots than the other treatments.

Table 10: Starch (%) of *Glossostemon bruguieri*, Desf roots as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	37.03	40.20	42.07	39.77	36.03	41.07	43.11	40.07
30 cm	37.72	39.95	42.07	39.91	37.03	40.80	42.94	40.26
40 cm	38.23	40.03	42.73	40.33	38.09	41.03	42.82	40.65
Mean B	37.66	40.06	42.29		37.05	40.97	42.96	
L.S.D. 0.05	0.05				0.05			
A	NS				NS			
B	0.70				0.75			
AB	1.21				1.30			

A: Planting distances B: Harvesting dates

Crude fiber content (%) in roots:

Table 11 demonstrates that plant spacing exerted a significant influence on crude fiber content, where it was increased as plant spacing increased from 20 to 30 to 40 cm during both seasons. A significant effect on crude fiber content between 30 and 20 cm during both seasons. Treatment of 24 month significantly increased crude fiber content compared with 12 or 18 months in the two seasons. Likewise, there were significant increases as a result of harvesting after 18 month compared to harvesting after 12 month.

The interaction between plant spacing and harvesting dates showed significant effect on crude fiber content during both growing seasons. Clearly, 40 cm and 24 month treatment were more effective than the other treatments as it produced the highest crude fiber content than the other treatments.

Table 11: Crude fiber (%) of *Glossostemon bruguieri,* Desf roots as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods.

Treatments	First period				Second period			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	1.05	1.13	1.37	1.18	1.07	1.13	1.36	1.19
30 cm	1.08	1.16	1.43	1.22	1.07	1.17	1.42	1.22
40 cm	1.08	1.17	1.53	1.26	1.09	1.19	1.52	1.26
Mean B	1.07	1.15	1.44		1.07	1.16	1.44	
L.S.D. 0.05	0.05				0.05			
A	0.02				0.01			
B	0.01				0.02			
AB	0.02				0.03			

A: Planting distances B: Harvesting dates

Mucilage (%) in the roots

Results in Table 12 show insignificant effect of planting distance on mucilage content in moghat roots. Prolonging harvest time increased mucilage content, the highest content of mucilage was obtained from prolong harvesting time to 24 month. Also, significant effect between 18 and 12 month treatments.

A significant effect resulted the interaction among planting distances and harvesting dates. Highest values were obtained from 40 cm apart and harvested after 24 month treatment during both season.

Table 12: Mucilage (%) in *Glossostemon bruguieri,* Desf roots as affected by different planting distances and harvesting dates during 2006-2008 and 2007-2009 periods

Treatments	First year				Second year			
	12 months	18 months	24 months	Mean A	12 months	18 months	24 months	Mean A
20 cm	12.97	17.57	27.17	19.23	13.53	18.06	26.90	19.50
30 cm	13.47	18.09	26.83	19.46	13.52	18.35	27.27	19.71
40 cm	13.20	17.11	27.42	19.24	13.48	17.61	27.95	19.68
Mean B	13.21	17.59	27.14		13.51	18.01	27.37	
L.S.D. 0.05	0.05				0.05			
A	NS				NS			
B	1.02				0.84			
AB	1.76				1.46			

A: Planting distances B: Harvesting dates

DISCUSSION

The present work was devoted to study the behavior and performance of *Glossostemon bruguieri,* Desf, plants under different plant spacing (20, 30 and 40 cm) and harvesting time; 12, 18 and 24 months) and their combinations, to improve vegetative growth, yield components and chemical constituents of moghat plant. The performance of studied parameters is reported in the results.

Regarding the effect of plant spacing on vegetative growth (plant height (cm), herb fresh and dry weights (g/plant), root length (cm), root diameter (cm), roots weights (fresh and dry) per plant (gm), roots dry weight (ton/fed.). Obtained results showed that increasing plant spacing up to 40 cm. significantly increased previous characters except plant height. The favorable effect of planting spacing treatments on vegetative growth characteristics can be attributed to the important role in the different physiological processes within the plant growth. The increase in most vegetative growth parameters was discussed by Kandeel *et al.,* (2001) who

attributed this increments in vegetative characters to less competition between plants for the environmental conditions necessary for building up more metabolites and producing more lateral branches and increasing fresh and dry weights. Meanwhile, El-Gendy *et al.,* (2001) reported that the competition between plants for solar energy trapping in the narrow spacing pushed plants to grow higher so that plant height will increased. These results are in agreement with Mattar (1997) on *Nigella sativa,* L., Hyunsuk *et al.,* (1999) on *Capsicum annum,* L. and , Massoud *et al.,* (2007) on rosemary and others.

Concerning mucilage content, the results were harmony with those obtained by El-Leithy, *et. al.,* (2002) and Ibrahim *et. al.,* (1997) on moghat. They mentioned that mucilage content reached 15.75%-29.60% in the roots with the longest period. Also, Kumar and Vijaykumar (1997) on *Artemisia pallens*, L., El-Gendy *et al.,* (2001) on sweet basil, Khater *et al.,* (2002) on *Ambrosia moritima,* Singh (2004) and Shaalan *et al.,* (2006) on *Salvia officinalis,* L. demonstrated that wider spacing was the best for increasing active constituents in the previous plants.

Likewise, the prolonged harvest time gave advantage for good growth and establishment of plant which reflected on root growth and yield. In this regard it was mentioned that growing Moghat for two years (24 month) resulted in a significant increases in root length, diameter, fresh and dry weights/plant, dry roots/fed., and mucilage content, in most cases. Similar findings were reported by many investigators; and Ibrahim *et. al.,*(1997) El-Leithy, *et. al.,* (2002) on *Glossostemon bruguieri,* Desf., and Öztürk, *et. al.* (2008) on sugar beet.

The interaction among plant spacing and different harvesting dates treatments were mostly significant for vegetative growth and yield components parameters. Treatment of 40 cm with 24 month significantly increased

previous characters, meanwhile, Roots dry weight (ton/fed.). pronouncedly increased with 20 cm and 24 month treatment compared to other treatments. Those effects are normal as found by Ibrahim *et. al.*, (1997) on *Glossostemon bruguieri,* Desf. and Öztürk, *et. al.* (2008) on sugar beet.

Seed yield/plant increased significantly as plant spacing increased. While, seed yield (kg/fed.) increased as plant spacing decreased because number of plants in area unit was increased; the highest value was produced from narrow spacing (20 cm.). These results are in line with those obtained on *Nigella sativa,* L. plants by Das *et al.*, (1992), Emad El-Deen (1997) and Mattar (1997). They found that narrow spacing increased seed yield/fed., while wider spacing increased seed yield/plant. El-Shaer (1989) on *Foeniculum vulgare*, L. Malav and Yadav (1997) on *Coriandrum sativum*, L. and Omar *et al.*, (1996) on *Silybium marianum,* L. plants. They found that the narrowest spacing resulted in greater seed yield/fed than wider row spacing. The increases of seed yield/fed at narrow spacing was due to the increase of the number of plants per unit area.

The interaction among plant spacing and harvesting dates treatments showed that highest seed yield in gm per plant were resulted from the wider plant spacing at 40 cm and 24 month. Meanwhile, highest seed yield (in kg/fed.) was produced from narrow spacing (20 cm.) with 24 month treatment. Some investigators found that wider plant spacing with the longest harvesting date increased seed yield/plant, while, narrow plant spacing increased seed yield/fed; Emad El-Deen (1997) on *Nigella sativa,* L., Omar *et al.*, (1996) on *Silybium marianum,* L,. Kandeel *et al.*, (2001) on *Foeniculum vulgare,* L. and Nofal *et al.*, (2001) on *Ammi visnaga,* L. plants.

The positive observations on plant growth, seed yield and the main active constituents of moghat plant may be due to the increase in the important compounds in plant tissue

especially, chlorophyll and carbohydrates content as a result of applied planting density especially the wider one and harvesting dates especially the longest period from planting till harvesting, Other investigators attributed those findings; El-Tantawy and Hanafy (1994) on coriander plant, Abd El-Salam (1994) on *Pimpinella anisum,* L. plant and Meawad *et al.,* (2000) on *Hyoscyamus muticus,* L. plant demonstrated that chlorophylls a, b and carotenoids in leaves were increased in wider space (low planting density) in comparison to closer one (high planting density).

On black cumin, Mattar (1997) and Emad El-Deen (1997), on *Pimpinella anisum*, L., Abed El-Salam (1994), on *Hyoscyamus muticus,* L. plants, Meawad *et al.,* (2000) and Kandeel *et al.,* (2001) on *Foeniculum vulgare*,L. plant revealed that total carbohydrates were increased in wider space (low planting density) in comparison with closer one (high planting density).

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تأثير مسافات الزراعة وموعد الحصاد على نمو وإنتاجية نباتات المغات تحت ظروف صحراء الوادى الأسيوطى

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تم إجراء هذه التجربة بصحراء الوادى الأسيوطى ، مصر، خلال فترتين متتاليتين (٢٠٠٦ – ٢٠٠٨ ، ٢٠٠٧ – ٢٠٠٩) وذلك بهدف دراسة تأثير ثلاثة مسافات للزراعة وثلاثة مواعيد للحصاد على نمو وإنتاجية نباتات المغات. تمت الزراعة بالبذور على أعلى مسافات ٢٠، ٣٠ ، ٤٠ سم بين الجور وتم الحصاد فى ثلاثة مواعيد هى ١٢ ، ١٨ ، ٢٤ شهر بداية من موعد الزراعة.

أظهرت النتائج أن كل من أطول مسافة للزراعة (٤٠سم) وأطول مدة للحصاد (٢٤ شهر) قد أعطى أفضل نموات خضرية وأعلى محصول من البذور والجذور للنبات، بينما ذاد محصول الجذور للفدان بتقليل مسافات الزراعة، كما أظهرت النتائج وجود علاقة إيجابية بين كل من مسافات الزراعة ومواعيد الحصاد ، حيث تم الحصول على اعلى محتوى من النشا والميوسيلاج فى الجذور نتيجة الزراعة على أطول مسافة بين الجور وأطول موعد للحصاد.