Effect of plant spacings, cattle manure levels and their interaction on vegetative growth, flowering and some active ingredients of *Verbascum thapsus* L. under sandy soil conditions

Salem, S. M. M.*; E. M. Koriesh; A. M. M. Khalil* and H. K. Atta-Alla**.**
* Medicinal and Aromatic Plants Res. Dept., Hort. Res. Inst., A. R. C., Giza, Egypt.
** Hort. Dept., Faculty of Agriculture, Suez Canal University. 41522 Ismailia, Egypt.

***Received:** 20/10/2010*

Abstract: Three culture spacings at 20, 30 and 40 cm between the plants in row and three rates of cattle manure at 0.0, 30 and 45 m³/fed. were used to study the effect of culture spacings, cattle manure levels and their interaction on *Verbascum thapsus* L. (mullein) growth and active ingredients. Data were recorded on growth, dry leaves and flowers yields as well as some active ingredients. Generally, the highest yield of dry leaves and flowers as well as the highest contents of total iridoid glycosides, total saponins and total mucilages/plant in leaves and flowers were obtained from using the widest plant spacing (40cm) and the highest level of cattle manure (45m³/fed.) each alone or in combination. However, the highest yield of dry leaves and flowers as well as the active components/fed. were produced with the narrow spacing (20 cm) alone or in combination with the highest level of cattle manure (45 m³/fed.) in both seasons.

Keywords: *Verbascum thapsus*, Cattle manure, Plant spacing.

INTRODUCTION

Common mullein *(Verbascum thapsus* L.), Family: Scrophulariaceae, is a herb with a long history of use in folk medicine. Historically, mullein has been used a remedy for the respiratory tract, particularly in cases of irritating coughs with bronchial congestion (Hoffman, 1988). The flowers are mildly diuretic and have a soothing and anti-inflammatory effect on the urinary tract (Mabey, 1988). The leaves are also diuretic, helping to reduce inflammation of the urinary system and to counter the irritating effect of acid urine (Tyler, 1994). The leaves, roots and flowers are also anodyne, antiseptic, antispasmodic, astringent, emollient, nervine, vulnerary, analgesic, antihistaminic, anticancer, antioxidant, antiviral, bacteristat, cardiodepressant, oestrogenic, fungicide, hypnotic and sedative (Null and Null, 1972 and Grieve, 1981). Mullein oil is recommended for earache and discharge from the ear, and for any eczema of the external ear and its canal (Yarnell, 1997).

The constituents of *Verbascum thapsus* include polysaccharides, iridoid glycosides including harpagoside; harpagide and aucubin (especially in the leaves); flavonoids including 3-methylguercitin, hesperedin and verbascoside; saponins and volatile oil (Khuroo *et al.*, 1988; Mehrotra *et al.*, 1989 and Warashina *et al.*, 1992).

Concerning the effect of plant spacing on *Verbascum thapsus* plants, very few researches were found in the literature, where Mahmoud (1980) reported that vegetative growth was significantly improved by increasing the spacing between plants in a sandy soil supplemented with loamy-clay and organic materials. The fresh and dry weights of plant at the beginning of flowering stage and leaf number as well as fresh and dry weights of flowers were increased as plant spacing increased. In contrast, flower yield per feddan was increased as culture spacing decreased; the highest yield of flowers per feddan was produced with 25 cm spacing. The wide spacings (50 and 75 cm) recorded the highest content of mucilages in the leaves and flowers. However, the narrowest and widest spacings recorded significant increase in saponins percentage in flowers compared with the middle spacing (50 cm) the highest percentage of saponins in flowers was obtained with the widest spacing (75 cm). Also, Kleitz *et al.* (2003) showed that mullein (*Verbascum thapsus* L.) plants had the highest plot yield of dried leaves and flowers at the narrowest spacing (12 inch).

Regarding the effect of organic fertilizers on *Verbascum thapsus*, Salama *et al.* (2003) indicated that the organic nitrogen source stimulated the growth and favored the production of biomass. The two levels of organic nitrogen at 33.5 and 67.0 kg/fed. gave the best growth parameters, i.e. plant height, leaf number and plant weight, and in the most cases 67.0 kg N/fed. level was the best treatment in this respect. The highest level of organic nitrogen (100.5 kg/fed.) led to the maximum values of total saponins percentage and total iridoid glycosides content, whereas the maximum value of total mucilages in leaves was obtained with 33.5 kg N/fed. In flowers total saponins percentage reached the maximum values with 100.5 kg N/fed. However, total iridoid glycosides content and total mucilages percentage were reached the highest values at 67 kg organic nitrogen/feddan. Abou El-Fetouh (2002) showed that cattle and horse manure at 20, 40 and 60 m³/fed. increased plant height, number of leaves, fresh and dry weights of leaves/plant and significantly increased glycosides content in both leaves and flowers of pot marigold (*Calendula officinalis* L.) Also, Hamad and Khalil (2008) stated that plant height and dry weight of leaves and sepals of roselle (*Hibiscus sabdariffa* L.) were significantly increased with increasing cattle manure rate from 15 to 30m³/fed., also, cattle manure significantly enhanced the anthocyanins content in sepals.

The present work aimed to study the effects of plant spacings, cattle manure levels and their interaction on vegetative growth, flowering and some active ingredients of *Verbascum thapsus* L. plants under the sandy soil conditions.

MATERIALS AND METHODS

This work was carried out at the Experimental Farm of Horticulture Research Station in El-Quassasin, Ismailia Governorate, Egypt, during the two successive seasons of 2005-2006 and 2006-2007, to investigate the effects of plant spacings at 20, 30 and 40 cm between the plants, cattle manure levels at 0.0, 30 and 45 m^3/fed., and their interaction on vegetative growth, flowering and some active ingredients of *Verbascum thapsus* L. plants under the sandy soil conditions.

The experimental soil in the two seasons was sandy soil and its physical and chemical properties are shown in Table (1).

Seeds of *Verbascum thapsus* L. were obtained from Sekam Company, Cairo, Egypt and sown in the nursery on 30th and 25th September in the two seasons of 2005 and 2006, respectively in foam trays (209 eyes) containing sand: peat: vermiculite at 1:1:1 ratio (v: v: v). On 15th and 11th November in the two seasons, uniform seedlings at 45 days age (about 15 cm. length) were transplanted in the sandy soil in rows 60 cm apart. The experimental unit area was 2.4 m^2 (0.6 X 4 m.), and the whole experiment has 27 plots.

Cattle manure was added and well mixed with the soil during the preparation process, three weeks before planting. The chemical composition of the air dried cattle manure for the two seasons is recorded in Table (2).

The combination treatments between plant spacings and cattle manure levels consisted of 9 treatments. All plants received normal agricultural practices whenever they needed.

At the beginning of flowering stage during March of each season, the data were recorded as follows: number of leaves per plant, fresh and dry weights of leaves per plant (g). The yield of dry leaves per feddan (ton) was calculated by multiplying dry weight of leaves/plant by number of plants/feddan, while, plant height (cm) was recorded in the end of the flowering stage (harvest time in June). Also, from the beginning of flowering stage and along of the flowering season, the fresh flowers was daily collected from certain plants till the end of flowering. The daily yields of flowers were weighed and dried, then at the end of season the total yield was collected to obtain the fresh and dry weight of flowers per plant (g.). The yield of dry flowers per feddan (ton) was calculated at the end of harvest or flowering stage by multiplying dry weight of flowers/plant by plant number/feddan.

For chemical analysis, total iridoid glycosides (T.I.G) content (mg/100 g dry matter) and total saponins (T.S) percentage [Triterpenoid saponins] in the leaf and flower samples were colorimetrically assessed according to the methods of Kotenko *et al.* (1994) and Ebrahimzadah and Niknam (1998), respectively. However, total mucilages (T.M) percentage in the leaf and flower samples was determined according to the method described by Karawya *et al.* (1980).

Factorial experiment was arranged in a randomized complete block design in three replicates and the collected data were computed and statistically analyzed with the analysis of variance using Mstat program. The differences between the means of treatments were tested using Duncan Multiple Range Test at 0.05 level according to Jayaraman (1999).

Table (1): The physical and chemical properties of the used soil in the two seasons.

Properties	1st season	2nd season
1- Physical properties:		
Sand (%)	91.5	92
Silt (%)	1.5	1.0
Clay (%)	7.0	7.0
Texture	Sandy	Sandy
2- Chemical properties :		
Salt analysis :		
EC dS_m^{-1}	0.62	1.12
pH	7.12	7.51
Cations (meq/l):		
Ca^{2+}	1.8	1.0
Mg^{2+}	0.8	0.4
Na^{+}	2.7	5.2
K^{+}	0.8	4.6
Anions (meq/l):		
Cl^{-}	0.6	5.6
$HCO_3^{-}+CO_3^{2-}$	1.8	1.0
SO_4^{2-}	3.7	4.6
Available elements:		
Nitrogen (mg/kg)	14.0	28.0
Phosphorus (mg/kg)	16.4	25.8
Potassium (mg/kg)	252	379
Total nitrogen (g/kg):	0.28	0.28
2-4- Organic matter (OM) (%)	0.32	0.50

Table (2): Chemical properties of cattle manure in both seasons.

Chemical properties	First season	Second season
C/N ratio	19.05:1 or 5.25 %	12.91:1or 7.70 %
Salt analysis :		
EC dS_m^{-1}	2.04	3.36
pH	7.56	7.60
Cations (meq/l) :		
Ca^{2+}	0.20	0.40
Mg^{2+}	0.80	0.60
Na^{+}	12.20	28.10
K^{+}	7.80	7.90
Anions (meq/l) :		
Cl^{-}	10.00	19.00
$HCO_3^{-}+CO_3^{2-}$	3.00	2.80
SO_4^{2-}	8.00	15.20
Available elements :		
Nitrogen (mg/kg)	84.00	70.00
Phosphorus (mg/kg)	182.00	151.00
Potassium (mg/kg)	902.00	911.00
Total nitrogen (g/kg)	0.84=0.084%	1.96=0.196%
Organic matter (OM) (%)	2.75	4.36
Organic carbon (OC) (%)	1.60	2.53

RESULTS AND DISCUSSION

Effect of plant spacings on some vegetative growth parameters:

The results presented in Table (3) show that the plant height of *Verbascum thapsus* was decreased by increasing the plant spacing. The tallest plants (222.83 and 221.58 cm) were obtained from 20 cm spacing during the first and second seasons, respectively.

The decrease in plant height by increasing the spacing between plants may be due to the competition between plants for solar energy trapping in the narrow spacing which pushed the plants to grow taller for obtaining its solar requirements. This clearly explains the opposite relation between plant spacing and plant height.

Leaf number of *Verbascum thapsus* L. recorded significant increase by increasing plant spacing. The widest spacing (40 cm) gave the highest leaf number per plant with significant differences in the two seasons in comparison with the other two spacings. This treatment produced an increment over the narrow one (20 cm) by 12.14 and 12.37% in the two seasons, respectively.

From the data recoded in Table (3), it can be concluded that the fresh and dry weight of leaves/plant was significantly increased by widening the spacing between plants. The widest spacing (40 cm) gave the heaviest fresh and dry weight of leaves/plant in both seasons. These results are in harmony with those reported by Mahmoud (1980) on common mullein.

Such increase in number and weights of leaves/plant at the wide spacing may be due to lower competition between plants which led to more utilization of light, water and nutrients. The highly photosynthesis rate is also expected to be the main reason for higher accumulation rate of nutrients and increase the growth of plants.

Data presented in Table (3) clear that by increasing the spacing between plants, the yield of dry leaves/feddan was decreased. The narrow spacing (20 cm) exhibited the highest dry leaf yield/feddan as 2.26 and 2.47 tons in the first and second seasons, respectively. These results agreed with those found by Kleitz *et al.* (2003) on *Verbascum thapsus* L.

The positive effect of closer spacing on the yield of dry leaves per feddan may be due to the increase in cultivated plants per unit area which reflected on producing the heaviest dry weight of leaves per feddan.

Effect of cattle manure levels on some vegetative growth parameters:

Results in Table (3) show that increasing cattle manure levels from 0.0 to 30 and 45 m^3/fed. significantly increased the plant height in the two seasons. These results coincided with those obtained by Salama *et al.* (2003), who found that organic nitrogen fertilizer increased plant height of mullein, Abou El-Fetouh (2002) on pot marigold and Hamad and Khalil (2008) on roselle. Data given in Table (3) show that number of leaves/plant was increased with increasing the rates of cattle manure in the two seasons. Moreover, the high rate (45 m^3/fed.) caused significant increase in this respect, compared to the low one (30 m^3/fed.) or control during the two seasons. These results agreed with those found by Abou El-Fetouh (2002) on *Calendula officinalis*.

The fresh and dry weights of leaves/plant were increased by increasing cattle manure rates. In addition, the high rate (45m^3/fed.) caused significant increases over the control by 37.28, 45.68% and 29.93, 33.23% of leaf fresh and dry weight/plant in the first and second seasons, respectively. Similar results were recorded by Salama *et al.* (2003) on mullein, Abou El-Fetouh (2002) on marigold and Hamad and Khalil (2008) on roselle.

Data illustrated in Table (3) reveal that the dry yield of *Verbascum thapsus* leaves/feddan was increased by using cattle manure with significant differences in the two seasons. Moreover, the high rate (45m^3/fed.) exhibited 1.89 and 2.15 ton. of dry leaves/fed. with an increase over control by 31.25 and 34.38% for the first and second seasons, respectively.

Improving the vegetative growth by using organic (cattle) manure may be due to that the organic manure amendment of the soil, increased the availability and uptake of the nutrients (macro and micro), beside increasing the water holding capacity of the soil, which reflected on the metabolic processes activation, and hence, increasing the vegetative growth of plants.

Effect of the interaction between plant spacings and cattle manure levels on some vegetative growth parameters:

As shown in Table (3), data indicate that the interaction between plant spacing at 20 cm and cattle manure at 45 m^3/feddan significantly produced the highest values of plant height during the two seasons (229.79 and 228.83 cm in the first and second seasons, respectively). Plant height was significantly increased by increasing cattle manure rate and decreasing spacings between plants.

From the recorded data in Table (3) it can be concluded that the high rate of cattle manure (45 m^3/fed.) combined with the wide spacing (40 cm) significantly produced the highest number of leaves as 20.88 and 26.33 in the first and second season, respectively.

The fresh and dry weights of leaves/plant were significantly increased by all interaction treatments between plant spacing and cattle manure rates during the two seasons. The treatment of the widest spacing (40 cm) and the highest rate of cattle manure (45 m^3/fed.) recorded the heaviest fresh and dry weight of leaves with significant differences in both seasons as compared to the other treatments.

Data recorded in Table (3) clearly indicate that the yield of dry leaves/fed. has a similar trend of plant height in regard to the effect of interaction between plant spacing and cattle manure treatments in the two seasons. Since, the yield of dry leaves/fed. was increased with raising the cattle manure rates combined with decreasing plant spacing. The highest yield of dry leaves (2.56 and 2.83 ton/fed. in the first and second seasons, respectively) was significantly recorded by the treatment of the highest rate of cattle manure plus the narrowest plant spacing.

Table (3): Effect of plant spacings, cattle manure levels and their interaction on some vegetative growth parameters of *Verbascum thapsus* L. during seasons 2005-2006 and 2006-2007.

Treatments		First season					Second season				
Plant spacing	Cattle manure	Plant height (cm)	Number of leaves/plant	Fresh weight of leaves/ plant (g)	Dry weight of leaves/ plant (g)	Yield of dry leaves/ fed. (ton)	Plant height (cm)	Number of leaves/plant	Fresh weight of leaves/ plant (g)	Dry weight of leaves/ plant (g)	Yield of dry leaves/ fed. (ton)
20 cm	0.0 m^3/fed	213.4 ^{d}	15.00 ^{g}	221.83 ^{g}	54.21 ^{g}	1.90 ^{c}	212.7 ^{f}	18.21 ^{h}	256.59 ^{g}	57.66 ^{f}	2.02 ^{c}
	30 m^3/fed	225.3 ^{ab}	17.42 ^{e}	288.72 ^{e}	66.07 ^{d}	2.31 ^{b}	223.2 ^{c}	21.67 ^{e}	346.70 ^{e}	72.84 ^{d}	2.55 ^{b}
	45 m^3/fed	229.8 ^{a}	18.96 ^{c}	332.49 ^{c}	73.15 ^{b}	2.56 ^{a}	228.8 ^{a}	22.96 ^{d}	402.33 ^{c}	80.91 ^{bc}	2.83 ^{a}
30 cm	0.0 m^3/fed	210.7 ^{d}	16.09 ^{f}	257.15 ^{f}	56.63 ^{f}	1.32 ^{f}	210.0 ^{g}	19.17 ^{g}	300.12 ^{f}	64.08 ^{e}	1.50 ^{g}
	30 m^3/fed	222.9 ^{bc}	18.00 ^{d}	312.16 ^{d}	68.15 ^{cd}	1.59 ^{e}	221.7 ^{d}	23.00 ^{d}	377.22 ^{d}	77.67 ^{cd}	1.81 ^{e}
	45 m^3/fed	227.5 ^{ab}	19.84 ^{b}	353.26 ^{b}	74.62 ^{b}	1.74 ^{d}	227.6 ^{ab}	25.05 ^{b}	435.06 ^{b}	85.50 ^{b}	2.00 ^{d}
40 cm	0.0 m^3/fed	203.5 ^{e}	17.13 ^{e}	292.45 ^{e}	62.85 ^{e}	1.10 ^{h}	208.6 ^{h}	19.96 ^{f}	346.30 ^{e}	66.18 ^{e}	1.27 ^{i}
	30 m^3/fed	220.0 ^{c}	19.63 ^{b}	326.63 ^{c}	69.75 ^{c}	1.22 ^{g}	219.7 ^{e}	24.29 ^{c}	403.45 ^{c}	81.80 ^{bc}	1.43 ^{h}
	45 m^3/fed	225.5 ^{ab}	20.88 ^{a}	373.25 ^{a}	77.93 ^{a}	1.37 ^{f}	226.7 ^{b}	26.33 ^{a}	478.11 ^{a}	92.70 ^{a}	1.62 ^{f}
Main effect of plant spacing	20 cm	222.8 ^{a}	17.13 ^{c}	281.01 ^{c}	64.48 ^{c}	2.26 ^{a}	221.6 ^{a}	20.95 ^{c}	335.21 ^{c}	70.47 ^{c}	2.47 ^{a}
	30 cm	220.4 ^{a}	17.98 ^{b}	307.52 ^{b}	66.47 ^{b}	1.55 ^{b}	219.8 ^{b}	22.41 ^{b}	370.80 ^{b}	75.75 ^{b}	1.77 ^{b}
	40 cm	216.3 ^{b}	19.21 ^{a}	330.78 ^{a}	70.18 ^{a}	1.23 ^{c}	218.4 ^{c}	23.53 ^{a}	409.29 ^{a}	80.23 ^{a}	1.44 ^{c}
Main effect of cattle manure	0.0 m^3/fed	209.2 ^{c}	16.07 ^{c}	257.14 ^{c}	57.90 ^{c}	1.44 ^{c}	210.5 ^{c}	19.11 ^{c}	301.00 ^{c}	62.64 ^{c}	1.60 ^{c}
	30 m^3/fed	222.7 ^{b}	18.35 ^{b}	309.17 ^{b}	67.99 ^{b}	1.71 ^{b}	221.5 ^{b}	22.99 ^{b}	375.79 ^{b}	77.44 ^{b}	1.93 ^{b}
	45 m^3/fed	227.6 ^{a}	19.89 ^{a}	353.00 ^{a}	75.23 ^{a}	1.89 ^{a}	227.7 ^{a}	24.78 ^{a}	438.50 ^{a}	86.37 ^{a}	2.15 ^{a}

* Means in the same column with the same letters are not significantly different at $p < 0.05$ according to Duncan's multiple range test.

Effect of plant spacings on some flowering parameters:

Data presented in Table (4) show that the widest spacing (40 cm) significantly increased the fresh and dry weight of flowers comparing to the other treatments during the two seasons. Since, it gave 513.85 and 516.95; 57.32 and 71.06 g of fresh and dry weight of flowers for the two seasons, respectively. These results are in harmony with those reported by Mahmoud (1980) and Kleitz *et al.* (2003) on *Verbascum thapsus* L.

In contrast, the narrowest spacing (20 cm) exhibited a significant increase in dry flower yield per feddan, since, it gave increases by 24.11 and 39.0%; 19.55 and 28.23% over 30 and 40 cm spacings in the both seasons, respectively.

Effect of cattle manure levels on some flowering parameters:

As shown in Table (4) the results indicate that using cattle manure significantly increased the fresh and dry weight of flowers of mullein. The highest rate (45m³/fed.) significantly gave increases in this regard comparing to the other rate or control in both seasons. Similar results, regarding the weight of flowers/plant, were reported by Salama *et al.* (2003) on *Verbascum thapsus* and Hamad and Khalil (2008) on roselle.

Moreover, increasing cattle manure rate resulted in an increase of the dry flowers yield. In addition, the highest rate (45m³/fed.) exhibited significant increase in dry flower yield/fed. in comparison with the 30 m³/fed. or control. This treatment produced 1.39 and 1.58 ton/fed. of dry flowers with an increase of 49.46 and 31.67% in comparison with the control in the first and second seasons, respectively.

Effect of the interaction between plant spacings and cattle manure levels on some flowering parameters:

The results in Table (4) indicate that the interaction treatment between the highest rate of cattle manure (45m³/fed.) and the widest spacing (40 cm) significantly gave the heaviest fresh and dry weight of flowers per plant in comparison with the other treatments. Also, the data given in Table (4) reveal that the yield of dry flowers of *Verbascum thapsus* per feddan was increased by increasing cattle manure rates and decreasing plant spacing. The interaction treatment between the highest rate of cattle manure (45m³/fed.) and the narrowest spacing (20 cm) significantly produced the heaviest yield of dry flowers per feddan in the two seasons comparing to the other interaction treatments.

Effect of plant spacings on some active ingredients in the dry leaves and flowers:

From the data in Table (5) it is clear that total iridoid glycosides content, total saponins and total mucilages percentages were increased in the dry leaves and flowers with increasing the spacing between plants. Generally, the values of T.I.G content, T.S and T.M percentages were slightly higher in the second season than that in the first one. In addition, significant increases in T.I.G content, T.S and T.M percentages were obtained with the wide spacing (40cm) comparing to the other two spacings in both seasons. This spacing recorded 171.64 and 179.82 mg/100g.d.w of T.I.G, 28.98 and 31.96% of T.S and 3.41 and 3.44% of T.M in the flowers for the two seasons, respectively. Similar increases in mucilages in mullein leaves were reported by Mahmoud (1980).

The wider spacing may permit more vegetative and root growth, consequently more nutrients absorption and/or accumulation than closer one. Moreover, sufficient utilization of light due to the increase in the spacing between plants might induce more chlorophyll and carbohydrates synthesis and/or accumulation as well as N, P, K content in the leaves. Also, this positive effects might increase the content of the active components like total iridoid glycosides, total saponins and total mucilages in the leaves and flowers.

Effect of cattle manure levels on some active ingredients in the dry leaves and flowers:

Table (5) demonstrated that the highest rate of cattle manure (45 m³/fed.) gave significant increases in each of total iridoid glycosides (T.I.G) content, total saponins (T.S) and total mucilages (T.M) percentages in both of dry leaves and flowers comparing to the other rate (30 m³/fed.) or control in the two seasons. Similar results were found by Salama *et al.* (2003) on *Verbascum thapsus* and Hamad and Khalil (2008) regarding anthocyanins content in roselle sepals.

Such improvement in the content of active components in leaves and flowers might be due to the effect of organic manure on soil fertility, water holding capacity of soil, availability and uptake of minerals and activation of the active processes including synthesis of proteins and carbohydrates and hence, synthesis and accumulation of these components.

Effect of the interaction between plant spacings and cattle manure levels on some active ingredients in the dry leaves and flowers:

From the recorded data in Table (5) it can be concluded that the highest content of total iridoid glycosides as well as the highest percentages of total saponins and total mucilages in dry leaves of *Verbascum thapsus* (78.45 and 78.14 mg/100g.d.w. of T.I.G, 7.21 and 7.63 % of T.S. and 4.41 and 4.52% of T.M. in the two seasons, respectively) were obtained with the interaction between the widest spacing (40 cm) and the highest rate of cattle manure (45 m³/fed.) with significant differences in this respect. Also, this treatment produced the highest content of total iridoid glycosides and the highest percentages of total saponins and total mucilages in the flowers (179.50 and 185.50 mg/100g.d.w of T.I.G, 31.13 and 34.25% of T.S and 3.60 and 3.62% of T.M in the two seasons, respectively).

From the obtained results it is recommended to cultivate the plants in rows 60 apart at 20 cm spacing between plants with application of cattle manure at 45m³/fed. in order to maximize the yield of leaves and flowers of *Verbascum thapsus*. Because the difficulty of harvest and collection of flowers at the narrow spacing, it is suggested to cultivate Verbascum plants in rows at 40 cm spacing between the plants and fertilized with cattle manure at 45m³/fed. to make the flower harvesting more easier and maintains healthy flowers.

Table (4): Effect of plant spacings, cattle manure levels and their interaction on some flowering parameters of *Verbascum thapsus* L. during seasons 2005-2006 and 2006-2007.

Treatments		First season			Second season		
Plant spacing	**Cattle manure**	**Fresh weight of flowers/plant (g)**	**Dry weight of flowers/plant (g)**	**Yield of dry flowers/fed (ton)**	**Fresh weight of flowers/plant (g)**	**Dry weight of flowers/plant (g)**	**Yield of dry flowers/fed (ton)**
20 cm	**0.0 m^3/fed**	228.69 ^{i}	29.08 ^{h}	1.02 ^{e}	252.93 ^{h}	35.05 ^{h}	1.23 ^{ef}
	30 m^3/fed	330.69 ^{h}	41.14 ^{f}	1.44 ^{b}	349.78 ^{f}	45.18 ^{g}	1.58 ^{b}
	45 m^3/fed	395.75 ^{e}	49.03 ^{de}	1.72 ^{a}	428.11 ^{e}	56.24 ^{e}	1.97 ^{a}
30 cm	**0.0 m^3/fed**	348.75 ^{g}	38.36 ^{g}	0.89 ^{f}	341.57 ^{g}	51.84 ^{f}	1.21 ^{f}
	30 m^3/fed	381.64 ^{f}	48.33 ^{e}	1.13 ^{d}	426.60 ^{e}	57.10 ^{e}	1.33 ^{d}
	45 m^3/fed	434.69 ^{d}	56.74 ^{c}	1.34 ^{c}	505.29 ^{c}	62.26 ^{d}	1.45 ^{c}
40 cm	**0.0 m^3/fed**	473.24 ^{c}	49.96 ^{d}	0.87 ^{f}	455.42 ^{d}	66.16 ^{c}	1.16 ^{g}
	30 m^3/fed	516.96 ^{b}	58.09 ^{b}	1.02 ^{e}	514.88 ^{b}	71.13 ^{b}	1.24 ^{e}
	45 m^3/fed	551.36 ^{a}	63.90 ^{a}	1.12 ^{d}	580.55 ^{a}	75.90 ^{a}	1.33 ^{d}
Main effect of plant spacing	**20 cm**	318.38 ^{c}	39.75 ^{c}	1.39 ^{a}	343.61 ^{c}	45.49 ^{c}	1.59 ^{a}
	30 cm	388.23 ^{b}	47.81 ^{b}	1.12 ^{b}	424.49 ^{b}	57.07 ^{b}	1.33 ^{b}
	40 cm	513.85 ^{a}	57.32 ^{a}	1.00 ^{c}	516.95 ^{a}	71.06 ^{a}	1.24 ^{c}
Main effect of cattle manure	**0.0 m^3/fed**	350.09 ^{c}	39.13 ^{c}	0.93 ^{c}	349.97 ^{c}	51.02 ^{c}	1.20 ^{c}
	30 m^3/fed	409.77 ^{b}	49.19 ^{b}	1.19 ^{b}	430.42 ^{b}	57.80 ^{b}	1.39 ^{b}
	45 m^3/fed	460.60 ^{a}	56.56 ^{a}	1.39 ^{a}	504.65 ^{a}	64.80 ^{a}	1.58 ^{a}

* Means in the same column with the same letters are not significantly different at $p < 0.05$ according to Duncan's multiple range test.

Table (5): Effect of plant spacings, cattle manure levels and their interaction on some active ingredients in the dry leaves and flowers of *Verbascum thapsus* L. during seasons 2005-2006 and 2006-2007.

Treatments		Dry leaves						Dry flowers					
		First season			Second season			First season			Second season		
Plant spacing	Cattle manure	T.I.G. (mg/100g .d.w.)	T.S. (%)	T.M. (%)	T.I.G. (mg/100g .d.w.)	T.S. (%)	T.M. (%)	T.I.G. (mg/100g .d.w.)	T.S. (%)	T.M. (%)	T.I.G. (mg/100g .d.w.)	T.S. (%)	T.M. (%)
20 cm	0.0 m^3/fed	51.91 ^{i}	4.78 ^{h}	3.22 ^{f}	56.45 ^{h}	5.09 ^{h}	3.29 ^{h}	142.15 ^{i}	21.00 ^{h}	2.88 ^{h}	149.40 ^{h}	24.83 ^{i}	2.91 ^{f}
	30 m^3/fed	60.27 ^{e}	6.26 ^{f}	3.50 ^{e}	60.20 ^{g}	6.59 ^{f}	3.72 ^{f}	155.91 ^{h}	22.99 ^{f}	3.12 ^{g}	169.18 ^{f}	26.87 ^{h}	3.13 ^{e}
	45 m^3/fed	61.49 ^{d}	6.49 ^{e}	3.54 ^{e}	68.56 ^{d}	6.92 ^{d}	3.77 ^{e}	170.65 ^{d}	25.33 ^{e}	3.41 ^{d}	176.30 ^{c}	28.07 ^{f}	3.44 ^{c}
30 cm	0.0 m^3/fed	54.49 ^{h}	6.08 ^{g}	3.51 ^{e}	60.94 ^{g}	6.47 ^{g}	3.60 ^{g}	158.49 ^{g}	22.21 ^{g}	3.11 ^{g}	168.07 ^{g}	27.10 ^{g}	3.13 ^{e}
	30 m^3/fed	59.62 ^{f}	6.93 ^{c}	3.65 ^{d}	67.45 ^{e}	7.14 ^{c}	4.11 ^{d}	167.58 ^{e}	25.25 ^{e}	3.35 ^{e}	174.83 ^{d}	28.98 ^{e}	3.40 ^{c}
	45 m^3/fed	78.45 ^{a}	7.00 ^{b}	4.23 ^{b}	75.50 ^{b}	7.29 ^{b}	4.31 ^{c}	174.46 ^{b}	26.80 ^{c}	3.51 ^{b}	181.09 ^{b}	30.15 ^{c}	3.53 ^{b}
40 cm	0.0 m^3/fed	55.54 ^{g}	6.70 ^{d}	3.64 ^{d}	62.59 ^{f}	6.85 ^{e}	3.78 ^{e}	162.30 ^{f}	26.33 ^{d}	3.17 ^{f}	173.48 ^{e}	29.57 ^{d}	3.20 ^{d}
	30 m^3/fed	70.89 ^{c}	7.01 ^{b}	4.02 ^{c}	72.79 ^{c}	7.33 ^{b}	4.40 ^{b}	173.11 ^{c}	29.48 ^{b}	3.47 ^{c}	180.48 ^{b}	32.07 ^{b}	3.51 ^{b}
	45 m^3/fed	76.73 ^{b}	7.22 ^{a}	4.41 ^{a}	78.14 ^{a}	7.63 ^{a}	4.52 ^{a}	179.50 ^{a}	31.13 ^{a}	3.60 ^{a}	185.50 ^{a}	34.25 ^{a}	3.63 ^{a}
Main effect of plant spacing	20 cm	57.89 ^{c}	5.84 ^{c}	3.42 ^{c}	61.74 ^{c}	6.20 ^{c}	3.59 ^{c}	156.24 ^{c}	23.11 ^{c}	3.14 ^{c}	164.96 ^{c}	26.59 ^{c}	3.16 ^{c}
	30 cm	64.19 ^{b}	6.67 ^{b}	3.79 ^{b}	67.96 ^{b}	6.97 ^{b}	4.00 ^{b}	166.85 ^{b}	24.76 ^{b}	3.33 ^{b}	174.66 ^{b}	28.74 ^{b}	3.35 ^{b}
	40 cm	67.72 ^{a}	6.97 ^{a}	4.02 ^{a}	71.17 ^{a}	7.27 ^{a}	4.24 ^{a}	171.64 ^{a}	28.98 ^{a}	3.41 ^{a}	179.82 ^{a}	31.96 ^{a}	3.45 ^{a}
Main effect of cattle manure	0.0 m^3/fed	53.98 ^{c}	5.85 ^{c}	3.45 ^{c}	59.99 ^{c}	6.14 ^{c}	3.56 ^{c}	154.31 ^{c}	23.18 ^{c}	3.06 ^{c}	163.65 ^{c}	27.17 ^{c}	3.08 ^{c}
	30 m^3/fed	63.59 ^{b}	6.73 ^{b}	3.72 ^{b}	66.81 ^{b}	7.02 ^{b}	4.07 ^{b}	165.54 ^{b}	25.90 ^{b}	3.31 ^{b}	174.83 ^{b}	29.30 ^{b}	3.35 ^{b}
	45 m^3/fed	72.22 ^{a}	6.90 ^{a}	4.06 ^{a}	74.07 ^{a}	7.28 ^{a}	4.20 ^{a}	174.87 ^{a}	27.75 ^{a}	3.51 ^{a}	180.97 ^{a}	30.83 ^{a}	3.53 ^{a}

*Means in the same column with the same letters are not significantly different at $p < 0.05$ according to Duncan's multiple range test.
*T.I.G = total iridoid glycosides, T.S = total saponins and T.M = total mucilages.

REFERENCES

Abo El-Fetouh, M. M. (2002). Growth and composition of marigold as affected by chemical and organic fertilization in the presence of copper and zinc. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Ebrahimzadah, H. and V. Niknam (1998). A revised spectrophotometric method for determination of triterpenoid saponins. Indian Drugs 35(6): 379-381.

Grieve, M. (1981). A Modern Herbal (Vol. 11). Dover Publications: New York, p: 562-566.

Hamad, E. H. and A. M. Khalil (2008). Effect of cattle manure and some biofertilizers on the growth and chemical constituents of roselle (*Hibiscus sabdariffa* L.). Egypt. J. of Appl. Sci. 23 (11B) 635-654.

Hoffman, D. (1988). The Herbal Handbook: A User's Guide to Medicinal Herbalist. Healing Arts Press: Rochester, p. 67.

Jayaraman, K. (1999). "A Statistical Manual for Forestry Research". FAO. UN. Bangkok, p: 78-88.

Karawya, M. S., G. M. Wassel, H. H. Baghdadi and N. M. Ammar (1980). Mucilages and pectins of *Opuntia, Tamarindus* and *Cydonia.* Planta Medica 40, Supplement: p: 68-75.

Khuroo, M. A., M. A. Qureshi, T. K. Razdan and P. Nichols (1988). Sterones, iridoids and a sesquiterpene from *Verbascum thapsus*. Phytochemistry 27(11): 3541-3544.

Kleitz, K. M., M. M. Wall, C. L. Falk, C. A. Martin, M. D. Remmenga and S. J. Guldan (2003). Yield potential of selected medicinal herbs grown at three plant spacings in New Mexico. Hort. Technology 13(4): 631- 636.

Kotenko, L. D., M. Ya. Yakubova, N. A. Tselishcheva, M. T. Turakhozhaev and T. A. Badalbaeva (1994). Quantitative determination of the total iridoids in plants of the genus *Lagochillus*. Chemistry of Natural Compound 30(6): 669- 672.

Mabey, R. (1988). The New Age Herbalist. Macmillan Publishing Company: New York, p: 113.

Mahmoud, S. M. (1980). Effect of some agricultural treatments on mullein plant (*Verbascum*). M. Sc. Thesis, Fac. Agric., Al-Azhar Univ., Egypt.

Mehrotra, R., B. Ahmed, R. A. Vishwakarma and R. S. Thakur (1989). Verbacoside: a new luteolin glycoside from *Verbascum thapsus.* Journal of Natural Products 52(3): 640-643.

Null, G. and S. Null (1972). Herbs For The Seventies. Robert Speller and Sons: New York, p: 129.

Salama, A. B., S. M. Hassan, S. E. El-Gengaihi and N. S. Abu-Taleb (2003). Comparative studies of mineral and organic fertilization on *Verbascum thapsus* plant. Egypt. J. Hort. 30(½): 111-124.

Tyler, V. E. (1994). Herbs of Choice: The Therapeutic Use of Phytcomedicinals Pharmaceutical Products Press: New York, p. 92.

Warashina, T., T. Miyase and A. Veno (1992). Phenylethanoid and lignan glycosides from *Verbascum thapsus* L. Photochemistry 31: 961-965.

Yarnell, E. (1997). Medicinal Herbs for Otitis Media. Alternative and Complementary Therapies Vol. 3, No. 5, Mary Ann Liebert, Inc. Publishers, p: 350-354.

تأثير مسافات الزراعة و مستويات سماد الماشية و التفاعل بينهما علي النمو الخضري والزهري و بعض المواد الفعالة لنبات الفرباسكم (آذان الدُب) تحت ظروف الأراضى الرملية

صلاح محمد محمد سالم*- عيد محمد قريش- أشرف محمد محمد خليل*- حمدي كمال عطاالله****

*قسم بحوث النباتات الطبية والعطرية - معهد بحوث البساتين- مركز البحوث الزراعية - الجيزة- مصر

** قسم البساتين - كلية الزراعة - جامعة قناة السويس. ٤١٥٢٢ الإسماعيلية - مصر

تم إجراء هذا البحث فى المزرعة البحثية لمحطة بحوث البساتين بالقصاصين محافظة الاسماعيلية، مصر خلال موسمي ٢٠٠٥- ٢٠٠٦ و ٢٠٠٦- ٢٠٠٧. و يهدف هذا البحث لدراسة التأثيرات المختلفة لمسافات الزراعة و مستويات سماد الماشية وكذلك معاملات التفاعل بينهما على النمو الخضرى والإزهار و بعض المكونات الفعالة لنباتات الفرباسكم النامية تحت ظروف الأراضى الرملية. ولقد تم استخدام ثلاث مسافات زراعة بين النباتات داخل الخط هى ٢٠ و٣٠ و ٤٠ سم وثلاث معدلات من سماد الماشية هى صفر و ٣٠ و ٤٥ م^3/فدان. و تم تسجيل بيانات عن النمو والإنتاجية من الأوراق والأزهار الجافة وكذلك بعض المواد الفعالة فى أوراق و أزهار الفرباسكم. عموماً فإن أعلى إنتاجيه من الأوراق والأزهار الجافة وكذلك أعلى محتوى من المواد الفعالة فى الأوراق والأزهار(الجليكوسيدات الأيريدويدية و السابونينات والمواد المخاطية) للنبات تم الحصول عليها باستخدام أكبر مسافة زراعة و أعلى مستوى من سماد الماشية منفردين و التفاعل بينهما فى حين أن أعلى محصول من الأوراق والأزهار الجافة وكذلك المواد الفعالة للفدان نتجت من المسافة الضيقة (٢٠ سم) أو المستوى الأعلى من سماد الماشية كل بمفردة أو تفاعلهما معاً فى كلا الموسمين.