

## Comparative Studies of Mineral and Organic Fertilization on *V. thapsus* Plant

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**V**ERBASCUM, an old latin name of the mullein, (Scrophulariaceae) hardly biennial herbs, rarely perennial or subshrubs. *Verbascum* genus includes many species most wildly grown, however two species only were grown regularly; *V. thapsus* and *V. densiflorum*.

Mullein flowers contain a large amount of mucilage in addition to an acid saponin, iridoid glycosides and a small quantity of volatile oils. It is no longer a pure demulcent and it is often a constituent of chest and cough teas.

Organic farming took on a new lease of life during the 1980s around the world. Many countries and farmers convert to organic agriculture for both health and environmental reasons (Lampkin, 1994).

In a thesis dealing with sustainable agriculture of different *Verbascum* species, this part of work includes a comparable study between mineral and organic fertilization on one of the *Verbascum* species, *V. thapsus*.

### Material and Methods

The aim of this study is to compare the effect of mineral and organic fertilization on the growth, yield, and chemical components of *Verbascum thapsus*. The experiments were carried out during two successive seasons of 1999-2000 and 2000-2001 in the experimental farm of Medicinal and Aromatic Plants Department, National Research Centre, Giza. Seeds of the plant were obtained from Sekem Company (Egypt), and sown in nursery on September 2<sup>nd</sup> (1999) and (2000) and the seedlings were transplanted on 28<sup>th</sup> of November of the aforementioned years in clay loam soil at 50 cm apart in rows 60 cm in-between. The treatments included 4 levels of mineral nitrogen and 4 levels of organic compost as follow:

- 1- Zero mineral nitrogen+(75 kg potassium sulphate (48% K<sub>2</sub>O) + 150 kg calcium super phosphate (15.5% P<sub>2</sub>O<sub>5</sub>)/ fed.).
- 2- 100 kg ammonium nitrate (33.5% N)/ fed.
- 3- 200 kg ammonium nitrate (33.5% N)/ fed.
- 4- 300 kg ammonium nitrate (33.5% N)/ fed.

In all the previous treatments a dose of 75 kg potassium sulphate (48% K<sub>2</sub>O) and 150 kg calcium super phosphate (15.5% P<sub>2</sub>O<sub>5</sub>)/ fed. were added.

- 5- Zero organic nitrogen.
- 6- 33.5 kg organic nitrogen per feddan (as compost).
- 7- 67 kg organic nitrogen per feddan (as compost).
- 8- 100.5 kg organic nitrogen per feddan (as compost).

Potassium sulphate and calcium super phosphate were added to the soil during its preparation for cultivation and mixed well with the soil, while compost was added to the ridges before transplanting and incorporated with the soil particles. Ammonium nitrate was added as top dressing in three doses; the first one a month after transplanting, the second one month later, and the third dose was added month after the second dose. Each treatment was replicated three times in plots 2X2 m<sup>2</sup> with 3 ridges in a complete randomized blocks design.

The following growth parameters were recorded:

- 1- Plant height in cm at maturity.
- 2- Plant weight (kg) at the starting of the flowering stage.
- 3- Leaf number/ plant at the starting of the flowering stage.
- 4- Peduncle number/ plant at maturity.
- 5- Peduncle length (cm) at maturity.
- 6- Flowering yield/ plant (kg).
- 7- Flowering period (days/ plant).
- 8- Seed yield (g/ plant) at maturity.

On the other hand, chemical analysis of leaves and flowers of *V. thapsus* included the following aspects:

1. Total Hydrolysable carbohydrates and soluble sugars both were determined spectrophotometrically according to Dubois *et al.* (1956).
2. Reducing sugars were determined with dinitrosalicylic acid reagent method described by Miller (1959).
3. Non-reducing sugars were calculated from the difference between soluble and reducing sugars.

4. Total saponin glycosides were evaluated adopting the method of Ebrahimzadeh & Niknam (1998).
5. Total iridoid glycosides were assessed with the described method of Kotenko *et al.* (1994).

Statistical analysis of the obtained data were done with ANOVA (Snedecor & Cochran, 1980).

### Results and Discussion

Different growth parameters were recorded as a result of adding the two kinds of fertilization. The data obtained were presented in Table 1 & 2 and Fig. 1-8.

#### *Mineral fertilization*

Mineral fertilization produced taller plants with its two first doses, however the third dose did not produce proportional increase. The same trend was repeated in the second seasons (Fig. 1).

With peduncle height, mineral fertilization had no effect with any of the doses added in the two growth seasons. On the other hand, peduncle number per plant increased proportionally with mineral nitrogen in the two seasons. The third nitrogen dose produced 11.01 peduncle in the first season versus 10.81 in the second one, which was the highest number (Fig. 3 & 4).

Leaf number per plant increased by the addition of mineral nitrogen over that of control, with significant and higher increase due to the first or the second nitrogen dose in the two successive seasons. The flowering period as revealed from Tables 1&2 lasted 88.15 days on both seasons with the second nitrogen dose (Fig. 5&6).

Biomass production presented by plant weight, flower and seed weight was greatly influenced by mineral nitrogen fertilization. The second nitrogen dose produced the higher weight either in the whole plant or flowers and seeds weight per plant. The same trend was obtained with the second season (Fig.2, 7&8).

Based on the previous finding, one can conclude that the second dose of nitrogen was sufficient to obtain the highest yield in both growth parameters or biomass represented by leaf, flower or seed yield per plant (Fig.5, 7&8).

#### *Organic fertilization*

Compost was applied with the same nitrogen ratio of the mineral one to *V. thapsus* plants. Growth parameters as plant height or peduncle height increased

TABLE 1. Effect of mineral and organic fertilization on *Verbascum thapsus* parameters (first season 2000).

parameter Treatment	Plant height (cm)	Plant weight (kg)	Peduncle height (cm)	Peduncle number /plant	Leaf number /plant	Flowering period (days /plant)	Flowering yield (kg/plant)	Seed weight (g /plant)
<b>Mineral fertilization</b>								
I	90.95	0.77	102.60	8.31	46.47	73.19	0.35	26.79
II	102.94	1.37	102.79	10.91	54.83	83.00	0.53	37.62
III	106.19	1.50	100.90	11.01	54.17	88.59	0.57	37.63
IV	94.10	1.24	99.29	10.22	48.35	83.45	0.45	28.53
<b>Organic fertilization</b>								
I	91.60	0.79	93.82	8.27	45.06	73.18	0.36	26.88
II	104.74	1.42	102.40	11.39	55.56	78.98	0.41	30.92
III	101.46	1.46	96.38	11.66	56.30	86.15	0.42	38.83
IV	97.60	1.50	96.94	12.20	56.31	85.53	0.43	40.96
L.S.D. 5%	1.58	1.06	2.08	1.06	2.69	3.52	0.06	1.21
L.S.D. 1%	2.35	0.09	3.10	1.58	4.01	5.24	0.09	1.80

I= 0 g N/m<sup>2</sup> (control)

II= 8.38 g N/m<sup>2</sup>

III= 16.75 g N/m<sup>2</sup>

IV= 25.13 g N/m<sup>2</sup>

TABLE 2. Effect of mineral and organic fertilization on *Verbascum thapsus* parameters (second season 2001).

parameter Treatment	Plant height (cm)	Plant weight (kg)	Peduncle height (cm)	Peduncle number /plant	Leaf number /plant	Flowering period (days /plant)	Flowering yield (kg/plant)	Seed weight (g /plant)
<b>Mineral fertilization</b>								
I	88.86	0.75	102.29	7.61	45.22	68.21	0.35	24.07
II	102.78	1.29	102.02	10.73	53.75	83.13	0.54	37.22
III	107.69	1.40	101.28	10.81	54.72	88.15	0.57	37.83
IV	97.53	1.14	99.48	10.69	48.54	83.44	0.45	26.22
<b>Organic fertilization</b>								
I	91.56	0.80	95.36	8.15	45.77	73.52	0.36	27.44
II	105.17	1.45	110.38	15.03	56.89	91.35	0.65	39.28
III	101.03	1.52	116.52	14.97	57.80	96.82	0.68	43.48
IV	97.93	1.51	115.43	15.14	57.11	95.93	0.68	44.02
L.S.D. 5%	3.16	0.08	2.66	0.84	2.42	3.72	0.06	1.97
L.S.D. 1%	4.71	0.12	3.96	1.26	3.61	5.54	0.08	2.94

I= 0 g N/m<sup>2</sup> (control)II= 8.38 g N/m<sup>2</sup>III= 16.75 g N/m<sup>2</sup>IV= 25.13 g N/m<sup>2</sup>

only by applying the first dose of compost, meanwhile the other doses produced taller plants than the control, yet were shorter than the plants treated with the first amount of compost. (Fig. 1&3). A similar trend was obtained in the second season. Other growth parameters calculated as number, (leaves and peduncles, were increased significantly over the control, but when the doses applied were considered, no remarkable effect was attained between them. These results were confirmed by the results obtained from the second season (Fig. 4&5).

The biomass produced as a result of compost application was presented in Tables 1 & 2 for the two successive seasons. High and significant plant weight was observed by the first dose over the control, in which the percentage increase was 42% in the whole plant weight. Proportional increases caused by the other doses were obtained, but when compared with each other, no great differences occurred (Fig. 2).

In the view point of economic value, the first amount was sufficient enough, to produce the highest gain.

Flowering yield as kg / plant goes the same feature like the whole plant weight as affected by compost application, with the two growth seasons (Fig. 7).

Seed yield per plant was pronouncedly increased due to the application of different compost doses, with higher significancy difference over the control and between doses. The increases obtained were parallel to the increases in the doses (Fig. 8). The comparison of the net results between the two kinds of fertilizers came in favour of organic one. Taller plants, more number of peduncles and leaves, also heavy plants with more flower and seed yield were obtained (Table. 1&2) This is useful in an approach maintaining organic fertilization to medicinal and / or aromatic plants in order to reduce pollution and any other hazards.

In this concern, Allison (1973) listed the importance of organic matter or organic fertilization to soil; it serves as an ion exchange material and a chelating agent to hold water and nutrients in available form, it promotes soil aggregation and root development, and it improves water infiltration and water use efficiency. Nothing was traced in literature concerning the effect of nitrogen fertilization either in mineral form or in organic one on *Verbascum*, however many investigations were dealing with the effect of different kinds of manuring on other plants. Pareek *et al.* (1989) concluded that Farm Yard Manure (FYM) improved the total leaf and pod yield of senna plant by 38.7 and 45.5%, respectively versus 24.3% (leaf & pods) by using mineral nitrogen. Dethier *et al.* (1993) stated that high N application either as mineral or organic increased biomass and leaf hyoscyamine concentration in *Datura* species.

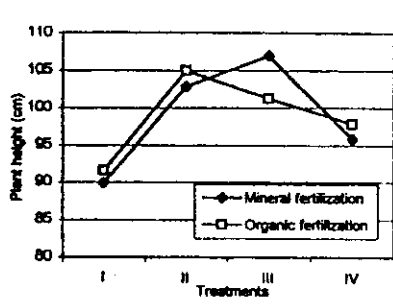


Fig. 1. Effect of mineral and organic fertilization on plant height of *Verbascum thapsus* (Mean of two successive seasons; 2000 and 2001).

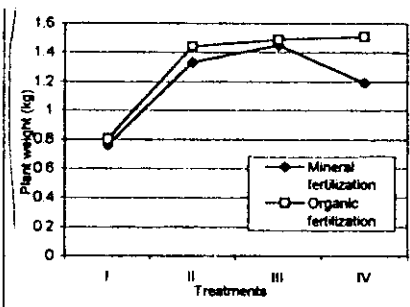
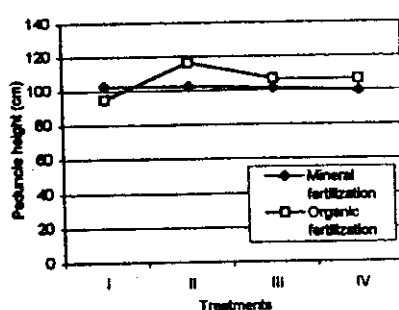


Fig. 2. Effect of mineral and organic fertilization on plant weight of *V. thapsus* (Mean of two successive seasons; 2000 and 2001).



I= 0 kg N/ fed. II= 33.5 kg N/ fed. III= 67 kg N/ fed. IV= 100.5 kg N/ fed.

Fig. 3. Effect of mineral and organic fertilization on peduncle height of *Verbascum thapsus* (Mean of two successive seasons; 2000 and 2001).

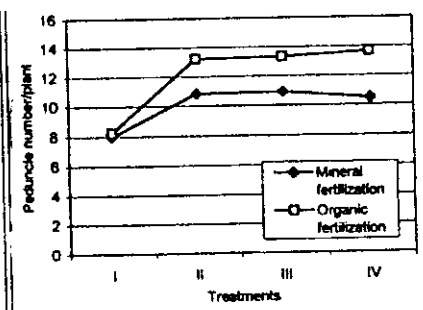


Fig. 4. Effect of mineral and organic fertilization on peduncle number per plant of *V. thapsus* (Mean of two successive seasons; 2000 and 2001).

Scheffer *et al.* (1993) used different sources of nitrogen fertilization; as cattle manure and straw which contain 1.17% nitrogen and found that all the fertilizers used increased the biomass and essential oil yield of yarrow compared with control.

Lieres *et al.* (1994) in Jena Germany, pointed out that N application increased the stem and leaf yield of *Urtica dioica*. However with plants bearing essential oils like hyssopus, achillia and calendula, there was no effect on plant yield and or essential oil content, in response to N application.

In India, Mallanagonda *et al.* (1995) reported that when FYM and the recommended rate of NPK were added, a highest yield of coriander seeds was obtained.

#### Chemical analysis

Total carbohydrates and different sugar fractions were measured in *V. thapsus* leaves and flowers during flowering stages, in the treatments with mineral and organic fertilization with its different levels beside the control.

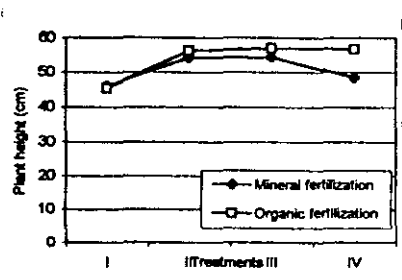


Fig. 5. Effect of mineral and organic fertilization on leaf number per plant of *Verbascum thapsus* (main of two successive seasons; 2000 and 2001).

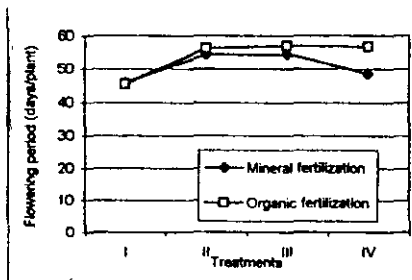
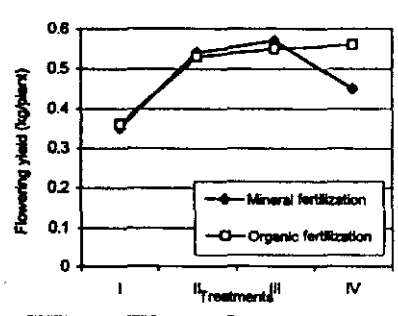


Fig. 6. Effect of mineral and organic fertilization on flowering period of *V. thapsus* (main of two successive seasons; 2000 and 2001).



I= 0 kg N/fed. II= 33.5 kg N/ fed. III= 67 kg N/ fed. IV= 100.5 kg N/ fed.

Fig. 7. Effect of mineral and organic fertilization on flowering yield of *Verbascum thapsus* (main of two successive seasons; 2000 and 2001).

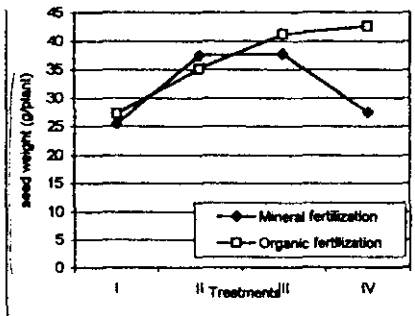


Fig. 8. Effect of mineral and organic fertilization on seed weight of *V. thapsus* (main of two successive seasons; 2000 and 2001).

## Total carbohydrates content

### a- Leaves

As shown in Table 3, it is obvious that both types of manuring did not affect total carbohydrates in leaves. With mineral fertilization, highly and significant decrease was attained with increasing nitrogen level, with maximum decrease by the second level to 6.69% against 10% in control. On the other hand, organic fertilization slightly enhanced total carbohydrates by increasing N levels, however, that increasing was insignificant.

### b- Flowers

Total carbohydrates in flowers have another picture than leaves. This item increases slightly by increasing mineral nitrogen level though insignificant.

Organic nitrogen increases total carbohydrates beginning with the second organic nitrogen level, however, significant increase was produced with the high level only.

TABLE 3. Effect of mineral and organic fertilization on chemical constituents of leaves and flowers of *Verbascum thapsus*.

Treatments	Leaves						Flowers					
	Total carbohydrates %	T.S. sugars %	Red. sugars %	Non-reducing sugars %	Saponins %	Iridoids mg/100g dry sample	Total carbohydrates %	T.S. sugars %	Red. sugars %	Non-reducing sugars %	Saponins %	Iridoids mg/100g dry sample
Zero mineral nitrogen	10.00	3.61	2.32	1.29	3.54	36.36	12.21	22.54	4.61	17.92	21.52	80.43
33.5 kg mineral N/fed.	9.15	3.99	1.65	2.31	1.96	32.08	15.80	17.56	3.84	13.72	18.95	117.48
67 kg min. N/fed.	6.69	2.98	1.82	1.16	2.15	43.19	13.74	19.84	2.30	17.54	19.84	56.79
100.5 kg min. N/fed.	7.75	3.70	1.03	2.67	3.40	45.63	13.75	26.89	3.51	23.38	19.83	81.58
Zero organic nitrogen	9.26	4.64	1.38	3.25	3.11	27.70	12.51	19.33	3.87	15.46	20.77	94.65
33.5 g organic N/fed.	9.53	3.47	1.06	2.42	2.83	85.16	11.99	17.49	4.93	12.56	22.11	108.56
67 kg organic N/fed.	9.37	4.81	1.05	3.76	3.23	41.83	13.80	17.22	3.90	13.33	22.20	117.37
100.5 kg organic N/fed.	9.58	5.37	1.58	3.79	4.92	85.65	14.53	26.07	6.52	19.55	24.08	95.81
L.S.D. 5%	0.71	0.64	0.21	0.73	0.66	2.10	1.72	2.13	0.61	2.14	1.15	5.12
L.S.D. 1%	0.97	0.88	0.29	1.01	0.91	2.91	2.36	2.94	0.84	2.94	1.59	7.11

### *Total soluble sugars content*

#### *a- Leaves*

Mineral nitrogen had a slight effect on total soluble sugars level with maximum decrease by the second nitrogen level. When organic nitrogen was used, higher and significant increases in total soluble sugars were obtained, parallel to rates used.

#### *b- Flowers*

Total soluble sugars content was high in zero nitrogen level. When nitrogen was added with its different doses using the two nitrogen sources, T.S.S. decreased by the addition of the lower doses than control, then an increase was observed only by the higher nitrogen dose.

### *Reducing sugars content*

#### *a- Leaves*

Reducing sugars content decreased in both the two kinds of manuring by increasing nitrogen level against the control.

#### *b- Flowers*

Similar trend of reducing sugars content in, *i.e.* leaves was recorded with flowers; the content decreased by increasing mineral nitrogen levels, and maximum decrease was also observed with the second nitrogen level.

Opposite trend obviously occurred with organic manure, the reducing sugars content increased parallel to nitrogen doses, to reach the maximum with the higher organic nitrogen dose, which equal double fold that of the control.

### *Iridoid glycosides content*

Iridoid glycosides are a group of monoterpene derivatives present in a large number of plant families. These compounds have an important pharmacological effect such as antibiotic, hypotensive, anti-inflammatory, fungistatic and antibacterial properties (Bazylak *et al.*, 1996).

#### *a- Leaves*

Looking in Table 3, the first sight revealed that iridoides in flowers were from 2-4 fold that in leaves of control and treated plants when using both kinds of manuring, which means that the flowers are the main site of formation of this secondary metabolites.

Concerning the effect of mineral nitrogen on iridoides (mg/100g), the second and third doses enhanced the accumulation of iridoids, Whereas a

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reverse effect was observed with organic manuring. The first and third nitrogen levels increased the iridoid content while the second level produced less but significant effect.

#### *b- Flowers*

Maximum content of iridoids was obtained by using mineral nitrogen or organic nitrogen manures which reach two times that of control. The highest content was obtained by the second nitrogen level in either mineral or organic.

#### *Saponin content*

Saponins form a pharmacodynamic group of natural products with a wide spectrum of biological activities. The distribution in nature, chemistry and biological activities of triterpenoidal saponins have been previously reviewed (Ibrahim, 1996).

#### *a- Leaves*

Saponin was determined in leaves and flowers of *V. thapsus* during the flowering stage and was estimated as percentage.

In leaves, saponin was found to be between 3.11 to 3.54% in untreated plants. As fertilization was conducted, the first level of mineral nitrogen caused significant decrease, then the two successive levels increased the saponin content but the values were lower than that in the control. With organic manure, all the levels used decreased the saponin content except the higher level which produced high and significant value.

#### *b- Flowers*

The same manner of saponin in leaves was obtained with flowers but with higher values in fertilized and unfertilized plants with mineral nitrogen. When organic nitrogen was used, the higher the level applied, the higher saponin content was obtained.

In conclusion; the decrease in the estimated chemical parameters was correlated with the higher production of growth parameters like plant weight or flower yield. The two sources of nitrogen stimulate growth and favour production of biomass.

Generally, the secondary metabolite accumulate and increase in plants when exposed to any physiological stress. In these experiments, the plant had not suffered this effect, so, its accumulation was in the expense of the higher yield produced.

Tracing the literature, nothing was found concerning the effect of nitrogen fertilization on mullien, however other plants with different secondary plant metabolites were reviewed.

Yadav *et al.* (1983) working on *Opium* found that, morphine content increased by increasing soil moisture. Morphine content was lower in plants supplied with higher N rate except in the least watered plots.

On *Dioscorea floribunda*, diosgenin yield increased with increasing nitrogen, (Saha *et al.*, 1991). Mineral and organic nitrogen manure were compared on Senna plant. FYM at 10 t/ha improved the total yield per hectare of leaves and pods by 38.7 and 45.5% over the control. Sennosides concentration in both leaves and pods remained unchanged as reported by Pareek *et al.* (1989).

In this respect, application of 16.75 g nitrogen/ m<sup>2</sup> was the best rate with respect to the crop yield, but increased rates beyond this did not have deleterious effect on other items studied. It could be concluded that the best economic return either in biomass or active ingredients was when using the second nitrogen level in mineral form or the higher level as with organic nitrogen when dealing with iridoids or saponins.

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## دراسات مقارنة للتسميد المعدنى والعضوى على نبات شمعدان الملك (الفريسكرم)

عادل بيومى سلامة، سهير محمد حسن، سعاد عيسوى الجنجيهى ونجلاء سيد أبوطالب

قسم زراعة وانتاج النباتات الطبية والعطرية-المركز القومى للبحوث و\*كلية الزراعة-جامعة عين شمس-القاهرة-مصر.

أجريت هذه الدراسة فى موسمى ١٩٩٩/٢٠٠٠، ٢٠٠٠/٢٠٠١ بمزرعة المركز القومى للبحوث بالجيزة وذلك لدراسة تأثير التسميد المعدنى والعضوى على النمو، المحصول والمكونات الكيميائية لنبات شمعدان الملك (أذن الدب). استخدمت أربع معدلات من السماد المعدنى وما يعادلها من السماد العضوى (الكمبوست) وهى صفر، ١٠٠، ٢٠٠، ٣٠٠ كجم من نترات النشادر للفدان.

أظهرت النتائج أن معدل ١٠٠ كجم للفدان كان كافيا للحصول على أفضل نمو وأكبر محصول وذلك فى كل من التسميد المعدنى والعضوى رغم تفوق معدل ٢٠٠ كجم فى بعض الصفات تحت الدراسة لكن دون فروق معنوية. أيضا أوضحت النتائج أن استخدام التسميد العضوى كبديل للتسميد المعدنى يمكن أن يعطى نتائج جيدة قد تقترب من نفس تأثير التسميد المعدنى على نمو ومحصول النباتات مما يودى إلى إمكانية الحد من الأثر الضار للأسمدة المعدنية على البيئة.