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RESPONSE OF *Monstera deliciosa* Liebm. TO PLANT SPACING AND NITROGEN SOURCES FERTILIZER

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ABSTRACT

A field experiment was carried out in the black saran green house during 2007/2008 and 2008/2009, at the Research and Production Station, National Research Centre, Nubaria, Egypt, to study the effect of plant spacing and nitrogen sources fertilizer *i.e.*, mineral nitrogen (MN) and organic nitrogen (ON); on the growth of ceriman (*Monstera deliciosa* Liebm.). Plant spacing treatments were 50, 60 and 75 cm between plants in rows, the distance between each row 70 cm. MN and ON fertilization treatments were (control, 100% MN, 100% ON, 75% MN+25% ON, 50% MN+50% ON, 25% MN+75% ON). The results of this study revealed that the maximum values of stem diameter, number of leaves/plant, petiole length, leaf length, leaf width, leaf area (cm^2) and fresh and dry weights of all plant organs were obtained when the spacing was 75 cm between the plants, while the maximum values of plant height was obtained when the spacing was 50 cm between the plants. Also, the results indicated that the maximum values for plant height, stem diameter, number of leaves/plant, petiole length, leaf length, leaf area (cm^2) and fresh and dry weights of all plant organs were obtained with 100% MN fertilization in both seasons. Whereas, the broadest leaves were obtained with applying 75% MN+25% ON fertilization in both seasons. Interaction between plant spacing and nitrogen sources resulted in the maximum values of the number of leaves/plant, petiole length, leaf length, leaf width, leaf area and fresh and dry weights of all plant organs with spacing of 75 cm between plants and applying 100% MN fertilization, except, the maximum value of plant height under spacing 50 cm treated with 100% MN fertilization.

***Key words**: ceriman, fertilization, Monstera deliciosa, nitrogen sources, plant spacing*

1.INTRODUCTION

Monstera deliciosa is a popular foliage houseplant easily recognized by its large glossy leaves that are dissected with deep splits and perforated with oblong holes. In nature, *Monstera* is an evergreen liana that climbs high into the rain forest canopy, attaching itself to trunks and branches and supporting itself above the ground with long tentacle-like aerial roots. The aerial roots grow downward out of the thick stem and take root where they touch the ground. The vines are only sparingly branched and a single vine can reach more than 70% (170 cm) in length. The leaves of a young monstera are heart shaped and without holes. They often overlap and cling closely to a tree trunk, and the plants in that stage are called 22% shingle plants.Twenty two % older plants develop the characteristic split and perforated adult leaves that stand away from the supporting tree trunk. Monstera occurs naturally in the tropical jungles of Central America from southern Mexico to Panama. Monstera is an easy house plant to maintain. It tolerates dry air and semi-shade better than most plants.

Monstera does best in half shade or a moderately bright position, but not in direct sun light. Moisture it during active growth, water Monstera plants thoroughly before the soil becomes dry. Water less in winter, Monstera tolerates the dry air typical of most homes fairly well, but it appreciates a little misting when humidity is very low.

Moreover, plant density is one of the most important factors affecting plant growth and chemical constituents due to its effect on the efficiency of light, the photosynthetic process, water and nutrients uptake. Several investigators revealed that spacing had a marked effect on growth, yield, chemical constituents as well as the active constituents of various medicinal and aromatic plants; El-Gengaihi *et al.,* (1995) on

D*racocephalum moldavica*, Damato *et al.* (1994 a, b) on *Foeniculum vulgare*, Omar *et al.*, (1998) on *Silybum marianum*, Tremblay *et al.*(1995) on *Angelica archanglica* and Mahmoud (1997) on *Hibiscus sabdariffa*.

Organic manures contain a high level of relatively easily available nutrient elements which are essentially required for plant growth. Moreover, they play an important role for improving soil physical properties (Bhandari *et al.*, 1989).

Compost fertilizer is made by recycling organic materials as wood chips, food scraps, and animal and plant wastes in a controlled process. Compost can be used to improve soil structure, making soil easier to cultivate and encouraging root development, provides plant nutrients and enables their increased plants uptake. Moreover, compost can aid water absorption and retention by soil, help to bind agricultural chemicals, keeping them out of waterways and later it can increase levels of beneficial soil micro-organisms. Several investigators stated that adding different organic composts to the soil resulted in marked stimulation on various growth and chemical constituents of different medicinal and aromatic plants.

In the recent past some studies have been conducted to elucidate the beneficial effects of adding crop residue compost into the soil. The practice improves soil physical, chemical and biological activities as well as improving crop yields and nutritional values (Manna *et al.*, 1999; Akanbi and Togun, 2002; Adediran *et al.*, 2003; Ghosh *et al.*, 2004; Maharishnan *et al.*, 2004; Ashutosh *et al.*, 2006).

The aim of the present work was to find out the best plant spacing and N-sources fertilizer application treatments for the vegetative growth of Monstera plant.

2. MATERIALS AND METHODS

A field experiment was carried out on a sandy soil (Table,1) in the saran greenhouse during 2007/2008 and 2008/2009 at the Research and Production Station, National Research Centre, Nubaria , Egypt, to study the effect of plant spacing and nitrogen source fertilization on vegetative growth of Ceriman (*Monstera deliciosa* Liebm.). The experimental design used was a split-plot with three replications. Plant spacing treatments were 50, 60 and 75 cm, assigned to the main plot. Fertilization treatments [mineral nitrogen (MN) and organic nitrogen (ON)] were [control, 100% MN, 100% ON, 75% MN +25% ON, 50% MN+50% ON, 25% MN +75% ON], assigned to the sub-plot. Mineral nitrogen was ammonium sulphate (20.5% N) and organic nitrogen was compost (1.3% N). The field was prepared for cultivation, the plants of *Monstera deliciosa* transported to the green house and repotting processes were carried out to 10 cm pots in the second week of March 2007 and 2008. In the first week of May in both seasons, homogenous plants (number of leaves/plant: three leaves, plant length: 20 cm, petiole: 10 cm) were transplanted to the permanent experimental plots (a black green house 63%). Each experimental unit (plot) was (2.1×3.0 m) containing three rows 70 cm distance between rows. Drip irrigation system was applied in the experiment using drippers (4 Liters /hour) for two hours every two days. Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) were applied at 200 and 100 kg/fed., respectively in two equal doses, first at the preparation of the soil for cultivation and the second after 6 months from transplanting. Organic fertilizer (compost 1.3% N) (Table, 2) was applied at the preparation of the soil.

In both seasons, data were recorded for the following growth characters:-

- Plant height (cm), stem diameter (10 cm from soil surface), number of leaves/plant, petiole length (cm), leaf width (cm), leaf length (cm), leaf area (cm²), fresh and dry weights of leaves/plant (gm), fresh and dry weights of stem/plant (gm), fresh and dry weights of roots/plant (gm).

Data recorded on vegetative growth, were statistically analyzed, and separation of means was performed using the least significant difference (L.S.D.) test at the 5% level, as described by (Snedecor and Cochran, 1980).

3. RESULTS AND DISCUSSION

3.1. Effect of plant spacing and fertilization on vegetative growth of *Monstera deliciosa*

3.1.1. Plant height

The data shown in Table (3) reveal that plant spacing at 50 cm significantly increased plant height than 60 and 75 cm in the first and second seasons. These results may be due to that narrow spacing decreased light intensity for *Monstera deliciosa* plants which encouraged IAA synthesis and increased IAA concentration in stem tissues caused cell enlargement and hence plant height. The differences between the three spacing distances reached significant level. Similar results were reported by Zayed *et al.* (2003) who found that the narrow spacing of 40 cm gave taller *Borago officinalis* plants than the medium and the

Table (1): Chemical analysis of the experimental greenhouse sandy soil

$CaCO_3$	O.M. %	pH [1:2½]	S Ec (ds/m) [1:2½]	Ions concentration (meg/l)						
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$(CO_3^{--}+HCO_3^{-})$	Cl^{-}	SO_4^{--}
1.7	1.9	7.54	0.53	0.5	1.3	3.2	0.3	1.5	0.6	3.2

Table (2): Chemical composition of the plant compost material

Total content (%)						Total content of heavy metals (ppm)				Ec (ds/m) S	pH
N	P	K	C	O.M	C/N	Fe	Mn	Cu	Zn	(1:10)	
1.3	0.55	0.92	24.2	41.62	18.6	2300	96.5	25	98	1.37	6.74

Table (3): Effect of plant spacing and nitrogen sources on plant height (cm) and stem diameter (cm) of *Monstera deliciosa* Liebm. during 2007/2008 - 2008/2009.

Plant spacing (cm) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Plant height (cm)							
Control	60.62	64.00	67.50	64.04	72.33	72.25	75.37	73.32
100% MN*	80.50	83.30	87.25	83.68	95.83	97.80	99.10	97.58
100% ON*	71.22	72.90	73.00	72.37	83.02	86.45	86.83	85.43
75% MN+25% ON	76.80	80.25	81.10	79.38	90.86	96.03	96.16	94.35
50% MN+50% ON	74.22	79.67	79.70	77.86	88.32	92.96	93.41	91.56
25% MN+75% ON	73.17	75.32	77.17	75.22	87.50	89.90	91.75	89.72
Mean	72.75	75.91	77.62		86.31	89.23	90.44	
L.S.D. at 0.05%								
Plant spacing	1.08				2.50			
Fertilization	2.14				1.70			
Interaction	2.76				4.17			
	Stem diameter (cm)							
Control	4.08	4.01	4.02	4.04	4.06	4.05	4.03	4.05
100% MN	5.13	5.10	4.95	5.06	5.16	4.82	4.71	4.90
100% ON	4.14	4.12	4.11	4.12	4.16	4.15	4.10	4.14
75% MN+25% ON	5.83	5.41	5.25	5.50	5.70	5.54	5.25	5.50
50% MN+50% ON	4.64	4.61	4.47	4.57	4.60	4.48	4.45	4.51
25% MN+75% ON	4.60	4.43	4.29	4.44	4.48	4.32	4.24	4.35
Mean	4.74	4.61	4.51		4.70	4.56	4.46	
L.S.D. at 0.05%								
Plant spacing	0.09				0.07			
Fertilization	0.12				0.13			
Interaction	0.17				0.21			

* Mineral nitrogen (MN), * Organic nitrogen (ON)

wide spacing of 60 and 80 cm, respectively. Also, Makinde *et al*. (2009) found that *Corchorus olitorius* plants showed a gradual increase in plant height as population density/m² increased.

The results showed that using fertilization gave a significant effect on increasing plant height compared to the untreated plants in both seasons .The increment was correlated with the level of mineral fertilization ; *i.e.*, the higher the level, the tallest the plants . Maximum height was recorded when 100% MN was used, while minimum height was obtained by untreated plants in the first season. The observed response towards fertilization occurred also in the second season. These results are in agreement with Rathod *et al*. (2002) on gaillardia and Badran and Safwat (2004) on fennel plants. They found that plant height was greatly increased due to the use of 100% mineral fertilizer.

The interaction between plant spacing and fertilization showed that the tallest plants were produced from fertilization treatment at 100%

MN under the spacing at 50 cm apart in both seasons. While, the shortest plants were observed in untreated plants combined with the spacing at 75 cm apart in the two seasons.

3.1.2. Stem diameter

Data on stem diameter in response to plant spacing and N source fertilizer treatments are presented in Table (3). The distance of 75 cm followed by 60 cm between plants gave significantly higher stem diameter compared with 50 cm distance between plants. The reduction in stem diameter as a result to distance could be attributed to low light prevailing during the vegetative growth. This finding is in agreement with the findings of Sanchez Lianes *et al*. (2000) and Olowe (2005) on sunflower *Helianthus annuus* L. They found that the stem diameter increased in wide spacing as compared with the narrowest one.

The data in Table (3) revealed that all organic and chemical nitrogen fertilizer treatments significantly produced thicker stems in the two seasons compared to untreated plants, except 100 % ON in both seasons. Fertilizing the plants at 100 % MN increased stem diameter by 22.8 % and 18.4 % in the first and second seasons, respectively compared to 100 % ON. In both seasons, the thickest stems resulted from 75% MN+ 25 % ON. These findings are in agreement with those of Abdou and El Sayed (2002) on *Carum carvi* L. and Karavadia and Dhaduk (2002) on *Chrysanthemum coronarium* 'Local White'.

The results indicated that stem diameter was decreased with decreasing the distance between plants at any fertilizer treatment. The treatment of 75 % MN+ 25 % ON combined with 75 cm apart spacing resulted in the thickest stems during the two seasons. While, the thinnest stems in the two seasons were recorded on the plants treated with 100 % organic nitrogen combined with 50 cm apart spacing.

3.1.3. Number of leaves/plant

The average number of leaves / plant as affected by plant spacing and organic and chemical fertilizer are presented in Table (4).

The average number of leaves / plant in the first and second seasons ranged between 6.87 to 6.61 and 7.30 to 6.93, respectively. In both seasons, the wider spacing (75 cm) gave the highest number of leaves / plant. The differences in the number of leaves / plant were statistically not significant during the two seasons. These findings are in agreement with the results of Muchow (1979) on *Hibiscus cannabinus* and Makinde *et al*. (2009) on *Corchorus olitorius*.

All fertilization treatments significantly increased the number of leaves / plant compared to the control in both seasons, except 100 % ON in the second season. The largest number of leaves / plant was formed on plants treated with 100 % chemical fertilizer in both seasons. Whereas, using 100 % ON led to the formation of the least number of leaves / plant in the two seasons, but more than the control. These results are in agreement with the findings of Pal (1990) on *Coreopsis picta*; Barman and Pal (1994) on *Calendula officinalis* L. and Sunita *et al*. (2003) on *Dianthus caryophyllus* L. They found that the number of leaves increased as N rate increased.

Concerning the effect of the combinations between plant spacing and fertilizers, the data revealed that the highest number of leaves / plant was found on the plants received 100 % MN at 60 cm apart spacing and 100 % MN at 75 cm apart spacing in the two seasons, respectively. However, the least number of leaves / plant was observed on the plants received 100 % ON combined with 50 cm apart spacing in the two seasons.

3.1.4. Petiole length

The results obtained on petiole length, as affected by plant spacing and fertilizers are presented in Table (4). These results may be discussed as follows:

The longest petioles were formed on plants at 75 cm in the two seasons, while the shortest petioles were noticed on plants spaced 50 cm apart. The medium spacing (60 cm) produced plants with mean petioles length. The differences between all treatments were statistically insignificant. Similar results were obtained by Kizil *et al.* (2007) on *Isatis tinctoria* who found that wide row spacing was effective in obtaining maximum petiole length.

Regarding the effect of fertilization on the petiole length, the results showed that 100% chemical fertilization led to the longest petioles (34.24 and 31.30 cm, respectively) followed by 75% MN+ 25% ON in the two seasons. All fertilization treatments significantly increased petiole length compared to the control except 100% ON in the second season. The differences between 50% MN +50% ON and 25% MN +75% ON treatments were insignificant in both seasons.

The effect of the combination between plant spacing and fertilization as shown in Table (4) indicate that the longest petioles resulted from treating the plants with 100% MN combined with 75 cm apart in the two seasons. Generally, petiole length was increased with increasing the spacing of plants at using 100% MN fertilizer.

3.1.5. Leaf length

Leaf length was influenced by plant spacing and fertilizer as shown in Table (5). Plant spacing at 75 cm apart led to the longest leaves in the two seasons. Whereas, the shortest leaves resulted from the distance of 50cm. Decreasing the distance between plants caused a gradual decrease in leaf length in both seasons and reached the level of significance in the first season. These results are in agreement with the findings of Adham (1997) on carnation plants, who reported that the wider plant spacing was the most favourable treatment concerning leaf length.

Using 100% mineral fertilizer caused the formation of the longest leaves in the two seasons. While, the shortest ones were found on the plants treated with 100% ON fertilizer in the two seasons, but more than the control. Increasing organic fertilizer rate from 50% MN+50% ON to 25% MN+75% ON decreased the leaf length in both seasons, but such decrease did not attain the level of significance.

All the combinations between plant spacing and fertilizer led to a significant increase in leaf length over the untreated plants with any plant spacing in the two seasons. The tallest leaves were formed on the plants treated with 100% MN under the distance 75cm apart in the two seasons. Whereas, the shortest ones were obtained when the plants were treated with 100% organic nitrogen combined with plant spacing at 50 cm.

3.1.6. Leaf width

The data on leaf width in response to plant spacing and fertilizer treatments are presented in Table (5). Increasing the distance between plants resulted in a significant increase in leaf width in both seasons. The broadest leaves resulted from plant spacing at 75 cm in both seasons. However, the narrowest leaves were formed on the plants spaced 50 cm apart in the two seasons. These results are in good match with those of Adham (1997) on carnation who reported that the wider plant spacing was the most favourable treatment concerning leaf width.

The data in Table (5) indicate that all the sources of fertilizer resulted in a significant increase in leaf width compared to the control in both seasons. The broadest leaves were formed on the plants that received fertilizer at 75% MN +25% ON in the two seasons. Whereas, the narrowest leaves were found on the plants supplied with 100% organic nitrogen, but more than the control. There was insignificant effect of fertilizer on leaf width between 50% MN +50 % ON and 25% MN+ 75% ON in the two seasons.

Concerning the effect of plant spacing and fertilizer treatments on leaf width it can be observed that the broadest leaves resulted from plant spacing at 75 cm combined with 75% MN +25% ON in both seasons followed by fertilizing the plants at 100% MN with the wider space in the first season and 75% MN+25% ON with the distance 60 cm apart in the second one. Mixing 100% ON with the closer space (50 cm) resulted in the narrowest leaves in both seasons, but more than the control.

3.1.7. Leaf area

Monstera deliciosa plants are used as indoor plants, thus they are more attractive and saleable when they have large leaves. So, any treatment leading to an increase in leaf area is appreciated. From the data in Table (6) it can be shown that the largest leaf area was recorded on plants at 75 cm apart in the two seasons. However, the smallest leaf area was formed on plants at 50 cm apart in the two seasons. Increasing the distance between plants significantly increased leaf area. From the above mentioned results, it may be concluded that the wider plant spacing (75 cm) apart, was the most favorable treatment concerning leaf area. These results are mostly in alignment with those of Muchow (1979) on *Hibiscus cannabinus* L. and Makinde *et al*. (2009) on *Corchorus olitorius* L. The results indicated that all fertilizer treatments had a significant effect on increasing leaf area compared with the control. In the first season, the average leaf area of the treated plants ranged from 484.7 to 745.0 cm², whereas in the second one, it ranged from 497.8 to 649.2 cm². Adding 100% MN caused the greatest value in leaf area in the first season, while it was observed on the plants treated with 75% MN+25% ON in the second season. The smallest leaves were recorded on the plants treated with 100% ON in both seasons. This reduction in leaf area may be attributed to decreasing in both leaf length and width. These findings are in agreement with those of Kasem and El Mesilhy (1992), Mahboob *et al.* (1992) on *Helianthus annuus* L.; Singh and Singh (1998) on *Cymbopogon flexuosus*; Abd El-Azim (2003) on *Salvia officinalis* and Sunita *et al*. (2003) on *Dianthus caryophyllus* L. They reported that increasing nitrogen rates caused an increase in leaf area.

Combining plant spacing at 75 cm with 100% MN led to the largest leaf area in the first season. While in the second one, it was recorded on the plants fertilized with 75% MN + 25% ON with the wider space. The smallest leaves were found on the plants treated with 100% organic nitrogen combined with the closer distance (50 cm) apart in both seasons. The reduction in leaf area was gradually increased with increasing the rate of organic fertilizer under any plant spacing.

3.1.8. Fresh and dry weights of different plant parts

Table (4): Effect of plant spacing and nitrogen sources on the number of leaves/plant and petiole length (cm) of *Monstera deliciosa* **Liebm. during 2007/2008 - 2008/2009.**

Plant spacing (cm) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Number of leaves/plants							
Control	6.15	5.83	5.75	5.91	6.50	6.44	6.33	6.42
100% MN*	7.42	7.47	7.11	7.33	7.78	7.75	7.60	7.71
100% ON*	6.68	6.47	6.40	6.52	7.15	6.70	6.33	6.73
75% MN+25% ON	7.11	7.11	7.00	7.07	7.60	7.45	7.28	7.44
50% MN+50% ON	7.00	6.92	6.89	6.94	7.42	7.40	7.22	7.35
25% MN+75% ON	6.89	6.73	6.50	6.71	7.33	7.25	6.80	7.13
Mean	6.87	6.75	6.61		7.30	7.16	6.93	
L.S.D. at 0.05%								
Plant spacing	N.S				N.S			
Fertilization	0.42				0.36			
Interaction	0.58				0.55			
	Petiole length (cm)							
Control	25.67	27.33	29.92	26.97	27.33	27.56	27.73	27.54
100% MN	37.44	33.67	31.60	34.24	32.20	31.33	30.37	31.30
100% ON	28.22	28.00	28.75	28.32	28.08	28.39	28.41	28.30
75% MN+25% ON	31.78	30.55	31.53	31.29	31.00	30.25	30.33	30.53
50% MN+50% ON	29.12	29.62	30.07	29.60	29.16	30.02	29.80	29.66
25% MN+75% ON	28.78	29.02	30.01	29.27	29.08	29.08	29.45	29.20
Mean	30.17	29.70	29.98		29.47	29.44	29.35	
L.S.D. at 0.05%								
Plant spacing	N.S				N.S			
Fertilization	1.14				0.95			
Interaction	2.07				1.88			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

Table (5): Effect of plant spacing and nitrogen sources on leaf length and leaf width of *Monstera deliciosa* **Liebm. during 2007/2008 - 2008/2009.**

Plant spacing (mc) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Leaf length(cm)							
Control	21.83	22.22	20.00	21.35	22.08	23.03	21.83	22.31
100% MN*	30.40	27.80	27.45	28.55	28.40	26.90	26.47	27.26
100% ON*	22.92	23.11	22.67	22.90	23.83	23.67	23.11	23.54
75% MN+25% ON	27.32	26.87	25.80	26.66	26.27	25.85	25.11	25.74
50% MN+50% ON	26.18	24.33	24.33	24.95	25.78	24.93	24.33	25.01
25% MN+75% ON	25.32	23.75	23.37	24.15	25.17	24.46	23.92	24.52
Mean	25.66	24.68	23.94		25.25	24.81	24.13	
LSD at 0.05%								
Plant spacing	0.43				N.S			
Fertilization	1.04				1.10			
Interaction	1.88				1.76			
	Leaf width(cm)							
Control	20.73	20.67	19.22	20.21	20.70	19.92	19.90	20.17
100% MN	27.17	26.00	25.00	26.06	24.15	23.78	23.17	23.70
100% ON	21.50	21.11	20.89	22.29	21.42	21.17	20.85	21.15
75% MN+25% ON	28.87	26.58	25.50	26.98	26.13	24.93	24.56	25.21
50% MN+50% ON	24.23	23.47	22.56	23.42	23.16	22.51	22.27	22.65
25% MN+75% ON	22.58	22.50	22.07	22.38	22.78	22.17	21.95	22.30
Mean	24.18	23.39	22.54		23.06	22.41	22.12	
LSD at 0.05%								
Plant spacing	0.38				0.34			
Fertilization	0.87				0.67			
Interaction	1.04				1.01			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

Table (6): Effect of Plant spacing and nitrogen sources on leaf area (cm²) of *Monstera deliciosa* Liebm. during 2007/2008 – 2008/2009.

Plant spacing (cm) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Leaf area (cm²)							
Control	452.5	459.3	384.4	432.1	457.0	458.7	434.4	450.0
100% MN*	825.9	722.8	686.3	745.0	685.9	639.7	613.3	646.3
100% ON*	492.8	487.8	473.6	484.7	510.4	501.1	481.8	497.8
75% MN+25% ON	788.7	714.2	657.9	720.3	686.4	644.4	616.7	649.2
50% MN+50% ON	634.3	571.0	548.9	584.7	597.1	561.2	541.8	566.7
25% MN+75% ON	571.7	534.4	515.8	540.6	573.4	542.3	525.0	546.9
Mean	627.7	590.9	544.4		585.0	557.9	535.5	
L.S.D. at 0.05%								
Plant spacing	8.2				11.8			
Fertilization	19.3				21.6			
Interaction	34.7				47.8			

*Mineral nitrogen (MN) - *Organic nitrogen (ON).

Table (7): Effect of plant spacing and nitrogen sources on fresh and dry weights of leaves(gm) of *Monstera deliciosa* Liebm. during 2007/2008 - 2008/2009.

Plant spacing (mc) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Fresh weight of leaves(gm)							
Control	543.1	358.2	351.3	417.5	561.8	424.4	368.8	451.7
100% MN*	1755.3	1685.3	917.2	1452.6	1730.3	1653.4	1280.7	1554.8
100% ON*	738.2	722.5	703.5	721.5	736.3	724.9	572.4	677.9
75% MN+25% ON	1327.3	916.5	882.5	1042.1	1254.4	979.3	937.5	1057.1
50% MN+50% ON	980.3	880.1	853.2	904.5	971.5	882.5	825.9	893.3
25% MN+75% ON	880.1	763.2	760.1	801.1	841.8	832.2	747.1	807.0
Mean	1037.4	887.6	744.6		1016.0	916.1	788.7	
L.S.D. at 0.05%								
Plant spacing	33.0				26.9			
Fertilization	57.3				35.7			
Interaction	80.8				65.8			
	Dry weight of leaves(gm)							
Control	258.4	238.2	229.7	242.1	269.1	232.7	229.7	243.8
100% MN	499.5	483.3	475.4	486.1	482.5	451.9	448.4	460.9
100% ON	303.1	302.5	285.2	296.9	333.7	324.3	302.5	320.2
75% MN+25% ON	471.4	450.5	348.5	423.5	441.7	441.5	362.9	415.4
50% MN+50% ON	439.2	345.1	318.4	370.9	353.7	342.5	337.5	344.6
25% MN+75% ON	331.3	325.2	310.5	322.3	340.7	335.7	325.4	333.9
Mean	383.8	359.1	327.9		370.2	354.8	334.4	243.8
L.S.D. at 0.05%								
Plant spacing	13.4				10.2			
Fertilization	17.6				16.0			
Interaction	32.9				24.9			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

Table (8): Effect of plant spacing and nitrogen sources on fresh and dry weights of stems (gm) of *Monstera deliciosa* Liebm. during 2007/2008 - 2008/2009.

Fertilization / Plant spacing (mc)	First season 75	60	50	Mean	Second season 75	60	50	Mean
	Fresh weight of stems(gm)							
Control	227.5	207.5	171.5	202.2	214.1	197.9	194.1	202.0
100% MN*	992.5	691.1	635.5	773.0	963.3	651.5	607.3	740.7
100% ON*	278.1	277.5	273.5	276.4	308.7	247.7	245.3	267.2
75% MN+25% ON	549.2	537.4	369.5	485.4	566.3	536.5	469.1	523.7
50% MN+50% ON	478.5	383.2	337.5	399.7	448.3	412.3	353.5	404.7
25% MN+75% ON	348.5	347.3	328.1	341.3	398.3	327.5	318.2	348.0
Mean	479.1	407.3	352.6		483.2	395.6	364.6	
L.S.D. at 0.05%								
Plant spacing	22.1				16.3			
Fertilization	22.0				26.8			
Interaction	54.0				39.9			
Dry weight of stems(gm)								
Control	41.3	40.3	32.1	37.9	46.6	46.4	42.1	45.0
100% MN	140.1	134.5	123.7	132.8	144.2	128.4	118.1	130.2
100% ON	65.5	48.8	47.6	54.0	52.7	47.8	47.0	49.2
75% MN+25% ON	113.6	107.6	82.4	101.2	100.0	94.3	90.8	95.0
50% MN+50% ON	80.7	75.1	71.8	75.9	94.3	85.9	72.7	84.3
25% MN+75% ON	72.6	70.5	65.7	69.6	75.7	66.1	64.2	68.7
Mean	85.6	79.5	70.6		85.6	78.2	72.5	
L.S.D. at 0.05%								
Plant spacing	5.9				4.2			
Fertilization	9.9				6.3			
Interaction	14.4				9.8			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

Table (9): Effect of plant spacing and nitrogen sources on fresh and dry weights of air roots (gm) of *Monstera deliciosa* Liebm. during 2007/2008 - 2008/2009.

Fertilization / Plant spacing (cm)	First season 75	60	50	Mean	Second season 75	60	50	Mean
	Fresh weight of air roots(gm)							
Control	128.5	85.2	52.5	88.7	146.6	100.8	65.1	104.2
100% MN*	625.4	437.5	356.5	473.1	588.3	439.6	390.9	472.9
100% ON*	197.5	192.5	132.5	174.2	219.3	206.3	166.9	197.5
75% MN+25% ON	355.5	342.2	325.3	341.0	369.2	359.1	326.3	351.5
50% MN+50% ON	340.5	318.1	244.2	300.9	331.9	292.8	253.3	292.7
25% MN+75% ON	283.5	230.5	214.3	242.8	268.5	234.3	229.4	244.1
Mean	321.8	267.7	220.9		320.6	272.1	238.6	
L.S.D. at 0.05%								
Plant spacing	20.3				12.5			
Fertilization	21.4				18.0			
Interaction	49.6				30.6			
Dry weight of air roots(gm)								
Control	47.4	37.2	30.3	38.3	50.5	40.5	35.5	42.2
100% MN	99.6	97.8	96.4	97.9	104.6	99.9	98.9	101.1
100% ON	60.9	59.4	54.9	58.4	61.3	60.8	60.7	60.9
75% MN+25% ON	93.6	89.9	85.9	89.8	96.8	92.4	77.6	88.9
50% MN+50% ON	87.5	82.5	71.1	80.4	78.6	76.2	74.8	76.5
25% MN+75% ON	78.4	74.1	68.1	73.5	75.3	70.3	68.6	71.4
Mean	77.9	73.5	67.8		77.8	73.3	69.4	42.2
L.S.D. at 0.05%								
Plant spacing	5.3				3.7			
Fertilization	5.3				3.9			
Interaction	12.9				8.9			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

Table (10): Effect of Plant spacing and nitrogen sources on fresh and dry weights of under ground roots (gm) of *Monstera deliciosa* Liebm. during 2007/2008 - 2008/2009.

Plant spacing (cm) / Fertilization	First season				Second season			
	75	60	50	Mean	75	60	50	Mean
	Fresh weight of underground roots(gm)							
Control	100.3	99.5	99.5	99.8	98.2	96.3	90.3	94.9
100% MN*	321.4	235.1	157.5	238.0	313.7	221.6	164.6	233.3
100% ON*	115.2	107.5	101.5	108.1	103.7	103.7	100.3	102.6
75% MN+25% ON	148.5	143.5	138.5	143.5	150.9	150.7	139.4	147.0
50% MN+50% ON	142.5	141.5	130.3	138.1	143.7	135.7	114.3	131.2
25% MN+75% ON	137.2	116.5	115.1	122.9	135.4	113.7	107.7	118.9
Mean	160.8	140.6	123.7		157.6	136.9	119.4	
L.S.D. at 0.05%								
Plant spacing	7.1				10.5			
Fertilization	10.8				11.3			
Interaction	17.3				21.0			
	Dry weight of underground roots (gm)							
Control	26.8	26.3	23.7	25.6	26.9	25.2	24.3	25.5
100% MN	48.9	48.5	47.2	48.2	57.9	49.4	44.6	50.6
100% ON	31.7	29.8	27.8	29.8	32.7	30.8	30.3	31.3
75% MN+25% ON	46.8	39.7	36.5	41.0	42.8	42.2	39.7	41.6
50% MN+50% ON	36.3	36.2	32.6	35.0	41.2	36.9	34.7	37.6
25% MN+75% ON	31.6	31.6	31.3	31.5	36.2	35.3	33.6	35.0
Mean	37.0	35.3	33.2		39.6	36.6	34.5	
L.S.D. at 0.05%								
Plant spacing	2.5				2.1			
Fertilization	6.1				4.2			
Interaction	7.2				4.9			

*Mineral nitrogen (MN), *Organic nitrogen (ON)

The data presented in Tables (7 to 10) show that the fresh and dry weights of leaves, stems, air and under ground roots were affected by plant spacing and nitrogen fertilizer.

Increasing the distances between the plants from 50 to 60 or 75 cm caused a significant increase in fresh and dry weights of different plant parts, in both seasons. Fresh and dry weights of air roots were heavier than the underground roots. In the first season, the heaviest fresh weights of leaves, stems, air and underground roots resulted from the longest distance between plants (75 cm). In the second season, the same effect was observed *.i.e.,* plant spacing at 75 cm apart caused the formation of the heaviest weights of leaves, stems, air and underground roots. Spacing 75 cm between plants increased fresh and dry weights of different plant organs significantly than 60 and 50 cm, except the dry weight of underground roots with 60 cm apart in the first season. In both seasons, the lightest fresh and dry weights of different plant organs were produced from the closer spacing (50 cm). From the previous results, it may be concluded that the wider plant spacing (75 cm apart) was the most favorable treatment concerning fresh and dry weights of leaves, stems, air and underground roots of *Monstera deliciosa*. These results are in conformity with those obtained by Abd El Salam (1994) on *Pimpinella anisum*; Hafez (1998) on *Nigella sativa* and Poonia (2000) on Sunflower. They reported that the wider and medium spacing produced the highest plant fresh and dry weights.

According to the data in Tables(7 to 10), it is clearly noticed that the highest fresh and dry weights of leaves, stems, air and underground roots were recorded with 100% MN fertilization in both seasons followed by 75% MN fertilizer +25% ON fertilizer. While, the lowest fresh and dry weights of different plant organs were obtained with 100% ON fertilizer, but more than the untreated plants. Increasing the amount of organic fertilizer led to a gradual reduction in fresh and dry weights of different plant organs. In the two seasons, no significant difference was obtained on increasing fresh and dry weights of underground roots by using 100% ON fertilizer compared to the control except dry weight in the second season. The obtained results are in harmony with those of Badran and Safwat (2004) on fennel plants; Gujar *et al.*(2005) on coriander and Abdel-Mawgoud *et al.*(2007) on tomato plants; they found that with increasing levels of nitrogen, fresh and dry weights of different plant parts showed favourable response.

The combined effect of plant spacing and fertilizer on fresh and dry weights of leaves, stems, air and underground roots was statistically significant in the two seasons. The highest fresh and dry weights of different plant organs resulted from fertilizing the plants with 100% MN fertilizer under spacing 75 cm apart. While, supplying 100% ON with plant spacing at 50 cm apart caused the lowest fresh and dry weights of different plant organs, but more than the control with any plant spacing.

Non – significant differences in fresh and dry weights of leaves and underground roots were recorded in combined 100% ON fertilizer with the three plant spacing. There were a significant differences on fresh weight of leaves and stems when the distance between plants was 75 cm apart combined with 75% MN +25% ON , 50% MN +50% ON and 25% MN + 75% ON.

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إستجابة نبات مونستيرا ديليسوزا "*Monstera deliciosa* Liebm"
لمسافات الزراعة ومصادر التسميد النيتروجينى

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***قسم نباتات الزينة و الأشجار الخشبية – المركز القومى للبحوث – الدقى – الجيزة – مصر**

ملخص

أجريت تجربة حقلية فى محطة البحوث و الإنتاج – المركز القومى للبحوث بمنطقة النوبارية خلال موسمى الزراعة 2007-2008 و 2008-2009 لدراسة اثر مسافات الزراعة و المصادر النيتروجينية على نمو نبات القشطة. كانت مسافات الزراعة 50 و60 و75 سم بين النباتات. أما معاملات التسميد (النيتروجينى المعدنى – النيتروجينى العضوى) فكانت (الكنترول و 100% تسميد معدنى و 100% تسميد عضوى و (75% تسميد معدنى+ 25% تسميد عضوى) و (50% تسميد معدنى+50% تسميد عضوى) و (25% تسميد معدنى+75% تسميد عضوى).

أظهرت النتائج أن أعلى قيم لقطر الساق، عدد الأوراق لكل نبات و طول العنق و طول الورقة و عرض الورقة و مساحة الورقة و الوزن الغض و الجاف لأجزاء النبات المختلفة تم الحصول عليها عند استخدام المسافة 75 سم بين النباتات بينما حققت صفة طول النبات أعلى قيمة عند استخدام المسافة 50 سم بين النباتات. تتضمن النتائج كذلك أن صفات طول النبات و قطر الساق و عدد الأوراق لكل نبات و طول العنق و طول الورقة و مساحة الورقة و الوزن الغض و الجاف لأجزاء النبات المختلفة كانت أعلى عند اضافة 100% تسميد معدنى خلال الموسمين و أظهرت النتائج أيضا ان اضافة 75% تسميد معدنى+25% تسميد عضوى أعطت اوراقا عريضة خلال الموسمين. أوضحت النتائج كذلك أن صفات عدد الأوراق و طول العنق و طول الورقة و عرض الورقة و مساحة الورقة و الوزن الغض و الجاف لجميع أجزاء النبات كانت أعلى القيم عند استخدام 75 سم بين النباتات و اضافة 100% تسميد معدنى. وأظهرت النتائج كذلك أن أعلى قيمة لطول النبات كانت عند استخدام 50 سم بين النباتات مع اضافة 100% تسميد معدنى.

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