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EFFECT OF GROWING MEDIA AND CHEMICAL AND BIO FERTILIZATION ON VEGETATIVE GROWTH OF *MORINGA OLEIFERA* PLANTS

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ABSTRACT: This trial was outlined at the nursery of the Ornamental Horticulture Department, Faculty of Agric., Cairo Univ., Egypt during two successive seasons of 2014 and 2015.

The investigation was conducted to investigate the effect of soil type (sandy, clayey and sandy + clayey) and bio fertilizers (green power) and chemical fertilization (NPK at 6, 8 and 10 g/pot) and the interaction between them of vegetative growth parameters of *Moringa oleifera* plants.

The obtained results revealed that clayey or sandy + clayey as a medium in combination with green power fertilization and NPK at 8 g/pot gave the highest values of plant height and stem diameter. Also, the obtained highest values of fresh and dry weights of vegetative growth parts resulted due to using clayey or sandy + clayey medium in combination with green power and NPK 8 g/pot.

The best results of root fresh and dry weights, were obtained due to the use of sandy + clayey medium in combination with green power bio fertilizer and NPK at 10 g/pot.

Key words: *Moringa oleifera*, soil type, fertilization, bio-fertilizer, NPK, vegetative growth.

INTRODUCTION

Moringa oleifera, Lam. (horseradish or drumstick tree) is a fast growing tree which belongs to the Moringaceae Family. Moringa is one of the important traditional multipurpose food plants. It has a great potential to become one of the most economically important crops for the tropics and subtropics considering its use in many fields as a medicine, food and fodder plant (Ramachandran *et al*., 1980; Morton, 1991; Amaglo, 2007; Peixoto *et al*., 2011 and Pontual *et al*., 2012).

Seeds of *Moringa oleifera* are used as a natural coagulant of raw water clarification, the powder of crushed seed kernels can leave water clear with 90:99% of the bacteria removed (Sutherland *et al.*,1989). Also the seeds are used for oil production, which is used cosmetics and medicine.

Many authors studied the effects of bio fertilizer and mineral NPK fertilization on *Moringa oleifera*. Dash and Gupta (2009) and Asdolu *et al*. (2012) on *Moringa oleifera* concluded that bio fertilizers treatments significantly increased plant heights, stem diameter and fresh and dry biomass as well as pigments compared to control.

Fagbenro *et al*. (2013); Abd Ullahi *et al*. (2013) and Umar (2014) on *Moringa oleifera*, reported that supplying plant with NPK (15:15:15) increased plant height, stem diameter, leaf production and fresh and dry biomass as compared with non-fertilized plants (control).

This work aimed to investigate the response of *Moringa oleifera* to bio and mineral fertilization in order to enhance and improve their characteristics.

MATERIALS AND METHODS

This study was carried out during the two successive seasons of 2014 and 2015 at the nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt. The investigation aimed to evaluate the effect of the type of medium, biofertilizer and chemical fertilizer on vegetative growth traits of *Moringa oleifera.*

The seeds of *Moringa oleifera* were obtained from the National Research Center, Dokki, Giza. The seeds were sown in unheated greenhouse, on February, 15th for the two experimental seasons in 15 cm diameter pots filled with clayey/sandy soil (1:1 v/v). The seedling were transplanted on March, 15th in both seasons in plastic pots (25 cm) filled with soil [clayey, sandy and sandy + clayey (1:1 v/v)].

The fertilization with NPK (Kristalon 20:20:20) began after one month after transplanting and continued at intervals of 45 days until end of the experiments.

The NPK fertilization was used with 6, 8 and 10 g/pot and the first inoculation of biofertilization began after one month from transplanting and the second after 6 months using liquid fertilizer (Green power) at 200 ml/pot.

The layout of the experiment was a factorial in a randomized complete block design with three replicates.

The recorded data on vegetative growth parameters were: plant height (cm), stem diameter (cm), fresh and dry weights of vegetative growth (g) and the fresh and dry weights of roots (g).

RESULTS AND DISCUSSION

Effect of soil type and fertilization on vegetative growth of Moringa:

1- Plant height (cm):

Data presented in Table (1) showed that the soil type had a significant effect on plant height in both seasons.

In the first season, the growing medium of sandy + clayey was the most effective, which gave the tallest plants (89.54 cm) followed by clayey (71.21 cm) compared with 41.67 cm for plants growing in sandy soil. The similar trend of the results was obtained in the second one.

Table 1. Effect of growing media and biofertilizer and NPK on plant height (cm) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Plant height (cm) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	19.00	23.00	27.00	23.00	13.00	15.33	19.00	15.78
Green power	38.00	65.67	97.00	66.89	108.33	94.67	64.67	89.22
Green power & NPK 6	55.67	74.00	110.67	80.11	47.33	98.33	102.00	82.56
Green power & NPK 8	37.33	120.67	121.67	93.22	62.00	95.67	113.67	90.44
Green power & NPK 10	32.00	69.67	102.00	67.89	55.33	85.67	106.67	82.56
NPK 6	30.67	62.67	107.00	66.78	34.33	66.67	120.33	73.78
NPK 8	89.33	101.00	93.33	94.56	78.67	109.00	125.33	104.33
NPK 10	31.33	53.00	57.67	47.33	30.00	60.00	105.27	65.09
Mean	41.67	71.21	89.54		53.63	78.16	94.62	
L.S.D at 0.05 of A	8.10				8.94			
L.S.D at 0.05 of B	3.78				4.17			
L.S.D at 0.05 of A × B	10.70				11.81			

It is clear in the second season that the growing medium of sandy + clayey was the most effective treatment, which gave the tallest plants (94.62 cm) compared to 53.63 cm for plants in sandy soil.

These results are in agreement with those obtained by Mahmood (2005) on *Caesalpinia pulcherrima* and *Thevetia peruviana*, El-Mahrok *et al.* (2009) on *Cestrum aurantiacum*; Azza *et al.* (2010) on *Jatropha curcas* L.; Youssef (2011) on *Populous euramericana*; El-Assaly (2011) on *Khaya senegalensis* and El-Sayed (2013) on *Moringa oleifera*.

Regarding the effect of fertilization the plant height was increased significantly in both seasons compared with (control) untreated plants. The highest values were obtained in the first and second seasons (94.56 and 104.33 cm, respectively) with NPK (20:20:20) at 8 g/pot, compared with 23.0 and 15.78 cm for control in the first and second seasons respectively.

These results are in harmony with the findings obtained by Gad (2003) on *Ficus benjamina*, pointed out that NPK at 8 g/pot resulted in the highest values of growth than control.

The interaction between soil type and fertilization had a significant effect on plant height in both seasons. Plants treated with green power and NPK at 8 g/pot and growing in sandy + clayey soil gave the tallest plants (121.67 cm) compared with control plants (27.0 cm).

In the second season, the plants treated with NPK at 8 g/pot and growing in sandy + clayey soil gave the tallest plants (125.33cm) compared with (19.00 cm) for control plants growing in the same medium and without any fertilization.

2- Stem diameter (cm):

Data presented in Table (2) showed the effect of fertilization and soil type treatments on the stem diameter.

It is clear that the soil type had a significant effect on stem diameter in both seasons.

The biggest stem diameter (0.75 cm) in the first season, and (0.82 cm) in the second season, were obtained from plants cultivated in sandy + clayey soil compared with control and other treatments.

Table 2. Effect of growing media and biofertilizers and NPK on stem diameter (cm) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Stem diameter (cm) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	0.20	0.27	0.27	0.25	0.17	0.27	0.30	0.24
Green power	0.53	0.70	0.70	0.64	1.03	0.87	0.73	0.88
Green power & NPK 6	0.60	0.63	0.80	0.68	0.50	0.90	0.87	0.76
Green power & NPK 8	0.47	1.03	0.97	0.82	0.63	0.90	1.03	0.86
Green power & NPK 10	0.50	0.73	0.87	0.70	0.60	0.67	0.80	0.69
NPK 6	0.40	0.67	0.87	0.64	0.50	0.63	1.03	0.72
NPK 8	0.97	0.93	0.87	0.92	0.77	1.03	1.07	0.96
NPK 10	0.50	0.63	0.70	0.61	0.40	0.67	0.83	0.63
Mean	0.53	0.69	0.75		0.59	0.73	0.82	
L.S.D at 0.05 of A			0.13				0.14	
L.S.D at 0.05 of B			0.06				0.07	
L.S.D at 0.05 of A × B			0.17				0.19	

These results are in agreement with those obtained by Azza *et al.* (2010) on *Jatropha curcas* L.; El-Mahrouk *et al*. (2009) on *Cestrum aurantiacum* and Youssef (2011) on *Populous euramericana*. They showed that cultivation in sandy + clayey soil increased stem diameter (cm).

Regarding the effect of fertilizer, data presented in Table (2) during both seasons, revealed that the use of NPK at 8 g/pot significantly increased the stem diameter to 0.92 cm and 0.96 cm, followed by green power + NPK at 8 g/pot which gave 0.82 cm and 0.86 cm, compared with untreated ones which gave 0.25 cm and 0.24 cm in the first and second seasons respectively.

Concerning the effect of the interaction between soil type and fertilization on stem diameter, data in Table (2) showed a significant effect in all treatments in the two seasons compared with the untreated plants.

The highest stem diameter (1.03 cm) was obtained due to the treatment of biofertilization + NPK at 8 g/pot in clayey soil compared with 0.27 cm in the control treatment in the first season.

Also in the second season, the biofertilization + NPK at 8 g/pot gave the highest values (1.03 cm) and (0.90 cm) of stem diameter in sandy + clayey medium and clayey compared with 0.30 cm and 0.27 cm in the control respectively.

These findings go parallel with those of Rabie (2002) on *Taxodium distichum* and El-Assaly (2011) on *Khaya senegalensis*.

3- Vegetative parts fresh weight (g):

Data presented in Table (3) showed that the growing medium significantly increased vegetative parts fresh weight in both seasons.

The highly significant fresh weight values (50.73 and 61.05 g/plant) were obtained from plants cultivated in sandy + clayey growing medium in the first and second seasons respectively. However, the lowest values (26.01 and 30.42 g/plant) were obtained from plants growing in sandy + clayey mixture medium in both seasons respectively.

Regarding the effect of fertilization on fresh weight of vegetative growth parts data presented in Table (3) showed that the fertilization with NPK at 8 g/pot gave the

Table 3. Effect of growing media and biofertilizers and NPK on vegetative parts fresh weight (g) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Vegetative parts fresh weight (g) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	9.64	11.67	12.40	11.24	7.87	8.34	9.23	8.48
Green power	19.88	32.42	41.66	31.32	84.33	45.20	28.82	52.78
Green power & NPK 6	27.56	31.86	51.87	37.10	22.01	40.88	77.72	46.87
Green power & NPK 8	19.70	95.60	81.33	65.54	34.11	68.44	80.01	60.86
Green power & NPK 10	18.54	36.29	50.05	34.96	24.01	33.47	52.79	36.75
NPK 6	15.16	24.93	82.31	40.80	17.93	21.67	97.94	45.85
NPK 8	79.35	68.67	59.34	69.12	35.57	78.24	97.47	70.43
NPK 10	18.23	23.53	26.90	22.89	17.04	21.56	44.41	27.67
Mean	26.01	40.62	50.73		30.42	39.67	61.05	
L.S.D at 0.05 of A	5.90				9.70			
L.S.D at 0.05 of B	2.76				4.53			
L.S.D at 0.05 of A × B	7.79				12.82			

significantly highest values (69.12 and 70.43 g/plant) in the first and second seasons respectively compared with untreated plants (11.24 and 9.23 g/plant).

The interaction between bio and/ or mineral NPK fertilization treatments in any used growing medium was significant in the two seasons compared with control plants.

The highest value of fresh weight of vegetative growth parts (95.60 g/plant) were obtained by green power + NPK at 8 g/pot treatment for plants growing in clayey medium compared with untreated plants (11.67 g/plant) in the first season, while in the second season. NPK at 8 g/plants treatment gave the highest value of 97.47 g/plant in the mixture medium compared with untreated plants (9.23 g/plant).

These results are in accordance with those obtained by Knapik and Angelo (2007) on *Prunus sellowii koehne*; Gad (2003) on *Ficus benjamina*; El-Sallami (2002) on *Chorisia speciesa*, *Leucaena leucocephala* and *Prosoppis juliflora*, and Rabie (2002) on *Taxodium distichum*.

4- Vegetative parts dry weight (g):

The results recorded in both two seasons in Table (4) show that the growing medium sandy + clayey significantly increased the dry weight of *Moringa oleifera* vegetative parts compared with the other used medium.

The heaviest dry weight of vegetative growth parts (15.71 and 16.79 g/plant) were obtained from plants growing in sandy + clayey medium in the first and second seasons, respectively.

Regarding the effect of fertilization, data in Table (4) show that all fertilization treatments significantly increased the dry weight of vegetative growth as compared with the control values (6.69 and 7.42 g/plant in the first and second seasons respectively).

5- Roots fresh weight (g):

Data presented in Table (5) during both seasons revealed that all used fertilization treatments increased roots fresh weight in all used growing medium.

The highest values of roots fresh weight were obtained for fertilization by green power + NPK at 10 g/pot, which were 38.71 and 51.26 g/plant in the first and second seasons, compared to the control, which gave 9.83 and 9.17 g/plant in the first and second seasons respectively.

Table 4. Effect of growing media and biofertilizers and NPK on vegetative parts dry weight (g) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Vegetative parts dry weight (g) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	6.37	7.05	7.47	6.96	6.63	7.51	8.12	7.42
Green power	9.12	12.40	14.64	12.05	23.34	14.46	12.05	16.61
Green power & NPK 6	11.37	12.04	16.75	13.39	9.28	16.34	17.57	14.40
Green power & NPK 8	9.01	23.06	21.30	17.79	13.59	18.85	19.67	17.37
Green power & NPK 10	9.15	13.86	16.09	13.03	10.34	13.14	16.35	13.28
NPK 6	8.28	11.13	17.84	12.42	8.66	10.39	22.88	13.98
NPK 8	16.24	18.38	21.93	18.85	12.68	20.57	22.42	18.56
NPK 10	8.71	10.16	9.69	9.52	8.77	11.17	15.26	11.73
Mean	9.78	13.51	15.71		11.66	14.05	16.79	
L.S.D at 0.05 of A	2.14				3.18			
L.S.D at 0.05 of B	1.00				1.48			
L.S.D at 0.05 of A × B	3.23				4.20			

Table 5. Effect of growing media and biofertilizers and NPK on roots fresh weight (g) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Roots fresh weight (g) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	9.17	10.00	10.33	9.83	8.22	9.05	10.29	9.17
Green power	13.91	28.72	33.11	25.25	40.32	34.76	29.76	34.95
Green power & NPK 6	27.84	21.01	26.64	25.16	23.78	56.64	33.34	37.92
Green power & NPK 8	16.67	39.00	33.60	29.76	20.38	30.36	36.52	29.09
Green power & NPK 10	19.38	36.42	60.34	38.71	28.79	63.42	61.58	51.26
NPK 6	13.95	31.41	28.55	24.64	15.97	48.20	47.41	37.19
NPK 8	29.26	22.73	32.59	28.19	24.64	62.52	37.37	41.51
NPK 10	15.10	18.19	39.76	24.35	30.83	14.97	27.06	24.29
Mean	18.16	25.93	33.11		24.12	39.99	35.42	
L.S.D at 0.05 of A	4.64				9.34			
L.S.D at 0.05 of B	2.17				4.36			
L.S.D at 0.05 of A × B	6.13				12.35			

Regarding the effect of growing medium, the medium of sandy + clayey gave the highest values of roots fresh weight, which were 33.11 and 35.42 g/plant in the first and second seasons compared with those cultivated in sandy soil which gave 18.16 g/plant in the first season and 24.12 g/plant in the second one.

The interaction between growing medium and fertilization had a significant effect on roots fresh weight.

The medium of sandy + clayey with using of green power + NPK at 10 g/pot gave the highest value of roots fresh weight as 60.34 g/plant compared with 10.33 g/plant from the plants growing in the same medium without any fertilization. In the second season the highest value of 63.42 g/plant was obtained from plants cultivated in clayey soil and fertilized with green power + NPK at 10 g/pot compared to 9.05 g /plant from plants cultivated in the same medium without any fertilization treatments.

These results are in agreement with findings by Mahmood (2005) on *Caesalpinia pulcherrima* and *Thevetia peruviana*; El-Khateed *et al.* (2006) on *Ficus alii*; El-Mahrouk *et al.* (2009) on *Cestrum aurantiacum*; Singh and Niar (2003) on some foliage plants; Gavat *et al.* (2008) on some coniferous and deciduous species and Karihikeyan *et al.* (2007) on *Azadirachta indica*.

They showed that the growing medium of sandy + clayey and also the bio fertilization and NPK treatments increased the roots fresh weight.

6- Roots dry weight (g):

Data in Table (6) showed that the type of growing medium had a significant effect on roots dry weight in both seasons.

The growing medium of sandy + clayey soil had a significant effect on roots dry weight, which gave the highest values 11.83 and 13.10 g/plant in the first and second seasons respectively compared with plants cultivated in sandy soil which gave 6.99 and 7.46 g/plant in the first and second seasons, respectively.

These results are in agreement with the findings obtained by Mahmood (2005) on *Caesalpinia pulcherrima* and *Thevetia peruviana*; El-Khateed *et al.* (2006) on *Ficus alii*; El-Mahrouk *et al.* (2009) on *Cestrum aurantiacum*. They showed that agriculture in sandy + clayey soil increased roots dry weight.

Fertilizers (green power + NPK 10g/pot) significantly increased roots dry weight in both seasons. In the first season, gave the

Table 6. Effect of growing media and biofertilizers and NPK on roots dry weight (g) of moringa (*Moringa oleifera* Lam.) plants during 2014 and 2015 seasons.

Fertilizer (A)	Growing media (B) Roots dry weight (g) 2014				2015			
	Sandy	Clayey	Sandy & Clayey	Mean	Sandy	Clayey	Sandy & Clayey	Mean
Control	4.00	4.22	4.29	4.17	3.94	4.20	4.71	4.29
Green power	5.34	10.74	11.24	9.11	7.71	12.54	9.79	10.02
Green power & NPK 6	7.71	5.64	6.52	6.63	9.34	14.69	8.92	10.98
Green power & NPK 8	8.93	10.34	8.33	9.20	7.19	9.33	22.05	12.85
Green power & NPK 10	8.61	15.22	32.32	18.72	7.68	32.20	20.96	20.28
NPK 6	7.10	7.93	8.05	7.69	5.67	23.42	21.29	16.79
NPK 8	8.70	7.98	10.84	9.17	8.20	32.59	8.75	16.51
NPK 10	5.53	8.70	13.05	9.09	9.92	7.21	8.29	8.47
Mean	6.99	8.85	11.83		7.46	17.02	13.10	
L.S.D at 0.05 of A			2.05				5.38	
L.S.D at 0.05 of B			0.96				2.51	
L.S.D at 0.05 of A × B			2.71				7.10	

highest value of 18.72 g/plant, while in the second season, gave the highest value of roots dry weight (20.28 g/plant) compared with 4.17 and 4.29 g/plant, in the first and second seasons respectively for control plants.

In relation to the influence of interaction between growing medium and fertilization on roots dry weight, the highest value of roots dry weight was obtained from clayey soil and green power with NPK at 10 g/pot which gave 15.22 g/plant in the first season, while in the second season the highest value (32.59 g/plant) was obtained from plants cultivated in clayey soil and fertilized with NPK 8 g/pot, compared to the lowest values of 4.22 and 4.20 g/plant in the first and second season respectively from unfertilized plants cultivated in clayey soil.

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تأثير أوسط النمو والتسميد الكيميائي والحيوي على النمو الخضري لنبات المورينجا اوليڤيرا

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أجريت هذه التجربة لدراسة تأثير نوع التربة (التربة الرملية والطينية والخليط [رمل + طين ١:١]) والاسمدة الحيوية والكيماوية بمعدلات (٦ ، ٨ و ١٠ جم/ الاصيص) على صفات النمو الخضري (ارتفاع النبات، قطر الساق، وزن المجموع الخضري الطازج والجاف، وزن المجموع الجذري الطازج والجاف).

تم الحصول على أعلى القيم لارتفاع النبات وقطر الساق عند الزراعة في التربة الخليط (الرمل + الطين ١: ١) مع المعاملة بالتسميد الكيمائي بمعدل ٨ جم / الاصيص. وأيضا تم الحصول على أعلى القيم من وزن المجموع الخضري الطازج والجاف عند الزراعة في التربة الخليط (الرمل + الطين ١: ١) مع معاملة بالتسميد الكيمائي ٦ جم / الاصيص. وتم الحصول على أفضل القيم من الوزن الطازج للمجموع الجذري في التربة الطينية مع المعاملة بالسماد الحيوي والسماد الكيمائي بمعدل ١٠جم / وعاء اما الوزن الجاف للمجموع الجذري فقد أعطى أعلى القيم في التربة الطينية عند معاملتها بالسماد الكيمائي ٨ جم/ الاصيص.