Initial Growth Response and Chemical Composition of *Moringa oleifera* Seedlings to Different Levels of NPK and Biofertilizer at Two Different Soil Types

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ABSTRACT

The present work was carried out in the experimental greenhouse at Antoniadis Research Branch, Horticultural Research Institute, Minestry of Agriculture, Alexandria, Egypt, during two successive growing seasons, 2013, 2014 from first of March to end of November for each season to study initial growth response and chemical composition of *Moringa oleifera* seedlings to different levels of NPK, biofertilizer and two different types of soil. *M. oleifera* seeds were sawn cultivated in polyethylene bags (3 kg capacity) filled with two soil types; sandy loam and a mixture of peatmoss: sand (1:1 w/w). The resultant seedlings were treated with mineral fertilizer and biofertilizers inoculums. Plants were harvested after 9 months of cultivation. The height of seedlings (cm), total fresh and dry weight, (g) and mineral contents (N, P, Ca, Mg, K, and Fe) were recorded. Protein content, carbohydrates, total antioxidant activity and total phenols were also determined. Best results in all parameters were obtained with sandy loam soil at mix level of NPK and biofertilizers (1 g N + 1⁄2 g P +1⁄2 g K +1⁄2 g HALEX)⁄kg soil. Seedlings height recorded 154.50 and 174.75 cm in the first and second seasons, respectively, however, total fresh weight was 77.68 and 90.03 g; total dry weight was 41.35 and 43.55 g, at the same order was found for the mineral content of the leaves, (5.42, 1.63, 1.93, 5.61, 1.42 % and 310 ppm for N, P, K, Ca, Mg and Fe, respectively) in the first season. Also, leaves of *M. oleifera* seedlings gave high content of protein, carbohydrates, total antioxidant activity % and total phenols (mg GAE/g extract) with sandy loam soil and mix of mineral and biofertilizers at the same rate. Since it was 23.28, 18.28, 56.24, % and 125.1 mg GAE/g extract, for protein, carbohydrates, total antioxidants activity and total phenols, respectively.

Keywords: *Moringa oleifera*; chemical composition; NPK and biofertilizer.

INTRODUCTION

Moringa oleifera Lamarck is a species of the mono generic family Moringaceae (order: Brassicales), widely known as the drumstick tree or the horse radish tree, that includes 13 species of trees and shrubs (Fahey, 2005). *M. oleifera* is indigenous to Northwest India (Ramachandran *et al*., 1980) but, at present it is widely distributed in the tropics throughout the Pacific region (Aregheore, 2002), West Africa (Lockett *et al.,* 2000), as well as Central America and the Caribbean (Foidl *et al*., 1999). Leaves of *M. oleifera* represent an important source of nutrients for rural populations (Lockett *et al*., 2000). Most reports indicate that *M. oleifera* leaves are rich in protein and contained a lot of amino acids, which is suitable for human and animal nutrition (Gupta *et al*., 1989; Makkar and Becker 1996). Fahey (2005) mentioned that *M. oleifera* considered as a nutrient dense food source because of its high nutritional value of is, pods and seeds. About 100 g of *M. oleifera* leaves contain four times more vitamin A than the same quantity of carrots, four times of calcium in a cup of milk, iron more than 100 g of spinach leaves seven times of vitamin C in 100 g of oranges and three times of potassium in 100 g of bananas. The protein quality of *M. oleifera* leaves also rivals that of milk and eggs. Therefore, *M. oleifera* is a relatively good source of vitamins, minerals and essential amino acids and could be considered as a good alternative to be used to help alleviate the micronutrient malnutrition at household as well as national levels. The micronutrients of major concern include vitamin A deficiency (VAD), iron deficiency and iodine deficiency, with zinc being recently added (Kuhnlein, 2003). According to Fuglie, (2001), *M. oleifera* has gained popularity as a source of nutrition that can feed the needy, and save lives as well. Moringa leaves or leaf powder can be used successfully as a complex food to nourish small children, pregnant women and nursing mothers as a treatment for malnutrition, because it has significant quantities of vitamins A, B, C, calcium, iron and protein (Ramachandran *et al.,* 1980).

The aim of this study was to investigate the effect of mineral and biofertilizers on the growth, mineral content, total phenol, total antioxidant, protein and carbohydrates content of *Moringa oleifera* seedling planted under two different soil types.

MATERIALS AND METHODS

The present study was carried out in the greenhouse at Antoniadis Research Branch, Horticultural Research

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Institute, Minestry of Agriculture, Alexandria, Egypt during two successive growing seasons (2013 and2014) from first March to end of November for each season.

1-Soil types

Two soil types were used:

a- Soil 1: sandy loam (SL) soil. It was taken from Antoniadis Research Branch, Horticultural Research, Alexandria, Egypt.

b- Soil 2: mixture of peatmoss and sand (1w:1w) (PS)

2- Fertilizer treatments

Two kinds of fertilizers were used:

a- Mineral fertilizers

Three commercial fertilizers namely; urea (46 % N),super phosphate (15 % P_2O_5) and potassium sulphate (48 % K_2O) as a source of nitrogen, phosphorus and potassium, respectively, were used.

b- Biofertilizer inoculums

HALEX inoculate was used as a biofertilizer which include strains of N2-fixing rhizobacteria, namely, Azospirillum brasielense SBR, Azotobacter chroococcum ZCR and Klebsiella pneumoniae KPR, (Hassouna et. al 1998)**.** HALEX biofertilizer was obtained from Plant Pathology Department, Faculty of Agriculture, Alexandria University, Egypt.

3- Experimental techniques

Seeds of M. oliefera were soaked in water for three days, water was changed every twelve hours. Then they were sown in seedbeds contained 1:1 sand: peatmoss in March (2013 and 2014) for both seasons successive. The seedlings were transplanted after 30 days into polyethylene bags, (35 cm height 25 cm in diameter). Each bag was filled to about 2cm from the rim with three Kg of soil based on dry weight. Seedlings were watered with tap water until they attained nine months old.

Fertilization treatments are:

1- FT1=Control (untreated plants)

2- FT2=(1⁄2 gN+1⁄4 g P +1⁄4 g K)/kg soil

3- FT3=(1 g N+1⁄2 g P +1⁄2 g K)/ kg soil

4- FT4 =(1⁄2 g N + 1⁄4 g P +1⁄4 g K +1⁄4 g HALEX)/ kg soil

5- FT5=(1 g N + 1⁄2 g P +1⁄2 g K +1⁄2 g HALEX)/ kg soil

6- FT6=1 g HALEX /kg soil

Fertilizers were added (as the seedling aged 75 and 135 days) in two dressings, first in mid-May and the second in mid-July in two successive growing seasons.

Growth parameters

1- The height of seedlings (cm) was measured by the end of every month in the two growing seasons.

2- Total fresh weight (g) (TFW).

3- Total dry weight (g) (TDW).

Chemical analysis

Mineral content were determined as follows:

Total Nitrogen was determined in the leaves plants according to Nessler's method (Chapman and Pratt, 1978). Phosphorus was determined by the Vanadomolybdate yellow method Jackson, (1958) using Millton Ray spectronic 21 D. Total potassium content in the plants was determined according to the method described by Jackson (1958) using Beckman flame photometer. Calcium and Magnesium content in the plants were determined according to the method described by Jones and Steyn (1973).Total iron content in the plants was determined according to the method described by Anonymous (1989).

Protein content and others:

Protein content in the plants was determined using were Kjeldahl method (Page et al, 1982). Carbohydrates leaves determined according to the method described by Weinmann and Reinhold (1946). The total antioxidant activity (TAA %) was measured by the 2.2-diphenyl-1-picrylhydrazyl method (DPPH, Sigma-Aldrich) (Ali et al., 2013). Finally, total phenolic content was determined with the Folin-Ciocalteau assay (Salem et al., 2013).

The layout of the experiment was split-plot design with six replicates. Each replicate contained three plants. The main plot was soil types, while subplots were fertilizer treatments. The means of the individual factors and their interactions were compared by L.S.D Test at 5% level of probability according to Steel and Tarrie (1980).

RESULTS AND DISCUSSION

Effect of soil types and fertilizer treatments on growth parameters:

1-Seedings height (cm) - First season:

The analysis of variance revealed that the differences among soil types and among fertilizer treatments were highly significant. In addition, the interaction between soil type and fertilizer treatments was highly significant in terms of seedlings height.

Table (1) shows the height (cm) of the *M. oleifera* seedlings as affected by the soil types and fertilizer treatments at the end of the first and second seasons.

In the first season, data presented in Table (1) showed that the height of seedlings growing on sandy

loam soil was significantly higher than those grown in mixture of peatmoss and sand (PS). However, the seedling height was 95.79 cm for sandy loam soil (SL), 76.55 cm was for PS one. Table (1) showed that all fertilizer treatments enhanced the height of the seedling significantly. The highest seedlings height was with FT5 (135.91 cm), while the second in the rank was with FT4 (104.58 cm).

The seedlings fertilized with biofertilizer (FT6) were the fourth in the rank, since it showed height of 75.58 cm. On the other hand, the seedling treated with, FT3 and FT2 displayed 87.80 and 65.20 cm in the height, respectively. However, control treatment (FT1) induced the lowest, value (48.66 cm). The mean values of the interaction between fertilizer treatments and soil types indicated that the highest seedlings height was with treatment FT5 for both soil types, since it was 154.50 and 117.33 cm for soil type 1 and soil type2, respectively (Table 1).

However, treatment FT1 (control) produced the lowest shoot height (56.50 and 40.83cm) for soil 1 and 2, respectively. While treatment FT4 for soil type1 and soil type2 recorded 112.50 cm and 96.66 cm, respectively. The differences between FT5 and FT4 were not significant. The lowest height was obtained with control plants.

2-Plant height (cm) (PH) - Second season:

The trend of statistical analysis results of the second season in similar to that obtained in the first one.

The data presented in Table (1) showed that the seedlings growing in soil type1 displayed PH higher than that of those growing in soil type2. However (129.44 and 99.27 cm), respectively (Table 1).

With fertilization treatments, seedlings of M. oleifera showed different responses. The ranking was: FT5, FT4, FT3, FT6, FT2 and FT1, that they recorded 155, 147.58, 112.66, 102.70, 92.08 and 76.13 cm, respectively.

Table (1) indicated that the seedlings of treatment FT5 the two soil types displayed the highest PH (174.75 and 135.25 cm) for soil type1 and soil type2, respectively. However, seedlings of FT1 (control) displayed the lowest PH (96.50 and 55.75 cm for soil type1 and soil type2, respectively). However,.

As for the fertilization effect, it has been found that the treatment FT5 induced the highest PH (155.00cm), followed by FT4 (147.58cm), whereas the lowest value was for the treatment FT1 (76.13 cm).

Based on the significant interaction between the impact of fertilization and soil used, it was obvious that the treatment FT5 has produced the highest PH for both soil mixture used (174.75and 135.25 cm)for soil 1 and soil 2, respectively (Table 1).

3-Total fresh weight (g) (TFW) - First season:

The statistical analysis of variance revealed that there were highly significant differences for the total fresh weight (g) owing to soil type and fertilizer treatments, however, the interaction between soil type and fertilizer treatments was highly significant. Table (2) showed that TFW for seedlings growing on the soil type1 was significantly higher than that of those growing on soil type2, and (44.69 and 35.35g, respectively).

As for the fertilization effect, it has been found that the treatment FT5 induced the highest TFW (64.86g), followed by FT4 (51.01 g), whereas the lowest value was for the treatment FT1 (14.93 g).

Based on the significant interaction between the impact of fertilization and soil used, it was obvious that the treatment FT5 has produced the highest TFW for both soil mixture used (77.68 and 51,68 g) for soil 1 and soil 2, respectively (Table 2).

4- Total fresh weight (g) (TFW) - Second season:

The trend of statistical analysis results of the second season in similar to that obtained in the first one.

As for the fertilization effect, it has been found that the treatment FT5 induced the highest TFW (80.45 g), followed by FT4 (70.19 g), whereas the lowest value was for the treatment FT1 (26.85 g).

Based on the significant interaction between the impact of fertilization and soil used, it was obvious that the treatment FT5 has produced the highest TFW for both soil mixture used (90.03and 70.86 g) for soil 1 and soil 2, respectively (Table 2).

5- Total dry weight (g) (TDW) - First season:

The results of analysis of variances revealed that the differences among soil types and fertilizer treatments were highly significant. In addition, the interaction between soil types and fertilizer treatments were highly significant of TDW for first season.

As for the fertilization effect, it has been found that the treatment FT5 induced the highest TDW (38.22 g), followed by FT4 (29.65 g), whereas the lowest value was for the treatment FT1 (7.78 g).

Based on the significant interaction between the impact of fertilization and soil used, it was obvious that the treatment FT5 has produced the highest TDW for both soil mixture used (41.35 and 35.08g)for soil 1 and soil 2, respectively (Table 3).

Table 1. Mean values of height (cm) of *Moringa oleifera* seedlings grown on two different soils and applied with 6 fertilizers at the end of the first and second seasons

Soil types(a)	Soil types × Fertilizer treatments												
	First season							Second season					
	FT1	FT2	FT3	FT4	FT5	FT6	Soil types	FT1	FT2	FT3	FT4	FT5	FT6
S(1) 95.79	56.50	73.58	99.33	112.50	154.50	78.33	S(1) 129.44	96.50	104.58	124.75	165.75	174.75	110.33
S(2) 76.55	40.83	56.83	74.83	96.66	117.33	72.33	S(2) 99.27	55.75	79.58	100.58	129.41	135.25	95.08
Fertilizer treatments(b)	48.66	65.20	87.08	104.58	135.91	75.58	Fertilizer treatments(b)	76.13	92.08	112.66	147.58	155.00	102.70
$LSD_{0.5}$(A)	1.502							10.916					
$LSD_{0.5}$ (b)	3.5032							13.81					
$LSD_{0.5}$ a×b	38.76							37.16					

S (1) =Soil type1: Sandy loam soil S (2) =Soil type2: Mixture of peatmoss and sand (1w:1w)
1-FT1=Control (untreated plants) 2-FT2= (1/2 g N+1/4 g P +1/4 g K) / kg soil
3- FT3= (1 g N+1/2 g P +1/2 g K)/kg soil 4-FT4= (1/2 g N + 1/4 g P +1/4 g K +1/4 g HALEX)/kg soil
5-FT5= (1g N + 1/2 g P +1/2 g K +1/2 g HALEX)/kg soil 6-FT6= 1 g HALEX/kg soil

Table 2. Mean values of total fresh weight (g) of *Moringa oleifera* seedlings grown on two different soils and applied with 6 fertilizers at the end of the first and second seasons

Soil types(a)	Soil types ×Fertilizer treatments												
	First season							Second season					
	FT1	FT2	FT3	FT4	FT5	FT6	Soil types	FT1	FT2	FT3	FT4	FT5	FT6
S(1) **44.69**	18.15	30.20	46.65	52.83	77.68	42.60	S(1) **55.43**	33.08	42.68	55.61	72.95	90.03	38.23
S(2) **35.35**	11.70	16.28	42.00	49.18	51.68	41.18	S(2) **44.71**	20.62	28.07	47.16	67.43	70.86	34.13
Fertilizer treatments(b)	14.93	23.24	44.37	51.01	64.68	41.89	Fertilizer treatments(b)	26.85	35.37	51.38	70.19	80.45	36.18
$LSD_{0.5}$(A)	2.086							6.2648					
$LSD_{0.5}$ (b)	2.5213							7.5899					
$LSD_{0.5}$ a×b	33.51							20.92					

S (1) =Soil type1: Sandy loam soil S (2) =Soil type2: Mixture of peatmoss and sand (1w:1w)
1-FT1=Control (untreated plants) 2-FT2= (1/2 g N+1/4 g P +1/4 g K) / kg soil
3- FT3= (1 g N+1/2 g P +1/2 g K)/kg soil 4-FT4= (1/2g N + 1/4 g P +1/2 g K +1/4 g HALEX)/kg soil
5-FT5= (1 g N + 1/2 g P +1/2 g K +1/2 g HALEX)/kg soil 6-FT6= 1 g HALEX/kg soil

Table 3. Mean values of total dry weight (g) of *Moringa oleifera* seedlings grown on different soils and applied with 6 fertilizers at the end of the first and second seasons

Soil types(a)		Soil types × Fertilizer treatments												
		First season						Second season						
		FT1	FT2	FT3	FT4	FT5	FT6	Soil types	FT1	FT2	FT3	FT4	FT5	FT6
S(1)	23.30	9.28	15.87	24.23	28.28	41.35	20.80	S(1) 28.18	11.43	25.67	32.62	36.54	43.55	19.45
S(2)	21.34	6.28	10.42	21.62	31.02	35.08	23.60	S(2) 22.52	9.67	14.12	23.32	33.77	37.35	16.91
Fertilizer treatments(b)		7.78	13.14	22.93	29.65	38.22	22.20	Fertilizer treatments(b)	10.55	19.84	27.97	35.11	40.45	18.18
$LSD_{0.5}$(A)		1.6752							3.2278					
$LSD_{0.5}$ (b)		1.9097							4.1546					
$LSD_{0.5}$ a×b		14.27							14.62					

S (1) =Soil type1: sandy loam soil S (2) =Soil type2: Mixture of Peatmoss and sand (1w:1w)
1-FT1=Control (untreated plants) 2-FT2= (1/2 g N +1/4g P +1/4 g K)/kg soil
3-FT3= (1 g N+1/2 g P +1/2 g K)/kg soil 4-FT4= (1/2 g N + 1/4 g P +1/4 g K +1/4 g HALEX)/kg soil
5-FT5= (1 g N + 1/2 g P +1/2 g K +1/2 g HALEX)/kg soil 6-FT6= 1 g HALEX/kg soil

6-Total dry weight (g) (TDW) - Second season:

The trend of statistical analysis results of the second season in similar to that obtained in the first one.

As for the fertilization effect, it has been found that the treatment FT5 induced the highest TDW (40,45g), followed by FT4 (35.11 g), whereas the lowest value was for the treatment FT1 (10.55 g).

Based on the significant interaction between the impact of fertilization and soil used, it was obvious that the treatment FT5 has produced the highest TDW for both soils mixture used (43.55 and 37.35 g)for soil 1 and soil 2, respectively (Table 3).

On the other hand, the results obtained from the study were in harmony with those obtained by Xu (2011) found that N, P, K, had different significant effect on the biomass Moringa oleifera seedlings. In addition, NPK fertilizer at level 15g had the best results in the number of leaves of M. oleifera (Aduradola, 2012). However, biofertilization increased growth of the M. oleifera seedlings. (Mona, 2012) The highest records of shoot and root lengths, and shoot and root dry weights were obtained with soil inoculation with mixed cultures of (Azotobacter chroococcumand Saccharomyces cerevisiae) and (Azot. chroococcumand Bacillus circulans).

Abdullahi *et al*. (2013) suggested that application of urea fertilizer at the rate of 200 kg/ha will be the best for *M. oleifera*, in terms of biomass production. However, Isaiah (2013) investigated the effects of inorganic fertilizer on the growth and nutrient composition of *M. oleifera* leaves. N: P: K: fertilizer was applied at five levels which include 0, 30, 60, 90 and 120kgN: P: K/ha. He found also that 120kgN: P: K/ha significantly produced more leaves and gave best height and stem girth. Attia *et al.* (2014) investigated the effect of mineral fertilizers, biofertlilzers and organic fertilizers on yield of leaves of *M. oleifera* on sandy soil at two rates 0.3 and 0.6 kg/tree of NH4NO3, 0.13 and 0.26 kg/tree of calcium super phosphate and 0.15 and 0.3kg/tree of K2SO4, 1.5 kg compost/tree with 1liter biofertilizers/tree (*Azotobacter* and *Bactria solvedphosphor*). They found that the yield components of *M. oleifera* trees were increased with increase of NPK fertilizers rates and integration between fertilization types.

7- Mineral content (N, P, K, Ca, Mg, Fe):

7-1-Nitrogen content (N %):

Based on analysis of N content of the *M. oliefera* leaves, it was detected that the treatment FT5 with soil type1 contained the highest content N (5.42 %) compared with the same treatment with soil type2 5.21 % (Table 4), followed by the FT4 for soil type1 and soil type2, (4.49 % and 4.74 %,respectively). It was found that N content was 3.58 %, 3.52 % and 3.06 % for treatment FT6, FT3 and FT2, respectively which grown on soil type1 (Table 4). However, N content was 3.38 % 3.19 % and 2.62 % for FT3 FT6 and FT2 with soil type2, respectively. The lowest N content was found in FT1 (control) for soil type2 (2 2.21 %) and soil type1 (2.54 %) (Table 4).

7-2-Phosphorus content (P %):

Analyzing P content of the M. oliefera leaves, it was detected that the treatment FT5 with soil type1 contained the highest content 1.63 % compared with FT5 with soil type2 1.56 % (Table 4), followed by the treatment FT4 for soil type1 and type2, (1.08 % and 1.06 %, respectively). It was found that P content was 0.97 % 0.93 % and 0.86 % for FT3 FT6 and FT2, respectively with soil type 1, while P content was 0.95 % 0.89 % and 0.75 % for FT3 FT6 and FT2 with soil type2, respectively. The lowest P content was found at FT1 with soil type2 (0.56 %) and type 1 (0.71 %) (Table 4).

7-3- Potassium content (K %):

Table (4) showed that M. oliefera leaves showed higher K content in FT5 (1.93 % for soil type1, 1.82 % for soil type2), followed by FT4 for soil type1 and recorded 1.59 %, and 1.42 % for soil type2, while the lowest K content was for FT1, since was 0.57 % and 0.51 % for soil type1 and soil type2, respectively. The leaves of M. oleifera grown on soil type1 recorded high K content as compared with soil type2 for treatment FT6)(1.32% and 1.29%, respectively), followed by FT3(1.22% and 1.12% for soil type1 and soil type2 respectively). However, K content in FT2 recorded 1.15 % and 1.06 % for soil type1 and 2, respectively. The lowest K content was with FT1 both in soil type1 and 2, 0.57 % and 0.51%, respectively.

7-4- Calcium (Ca %) content:

The treatment FT5 with soil type1 has brought about the highest Ca content in leaves of M. oleifera (5.61 %) compared with the same treatment with soil type2 5.12% (Table 4), followed by the treatment FT4 for soil type 1 and soil type 2, it was 4.99 % and 4.51 % respectively. It was found that the Ca content was 3.33% 4.00% and 3.15 % with the treatments FT6 FT3 and FT2 with soil type2, respectively. However, Ca content of M. oliefera leaves was 3.92 % 3.12 % and 3.00 % for FT3, FT6 and FT2 with soil type 2, respectively. The lowest Ca content was found at control treatment FT1 with soil type2 1.99 %, and with soil type1 2.21%.

7-5- Magnesium (Mg %) content:

For Mg content, the M. oliefera seedlings grown on soil type1 recorded the highest content compared with soil type2 under different fertilizer treatments.

Table (4) indicated that the treatment FT5 for the seedlings grown soil type1 induced the highest content of Mg (1.42%) compared with FT5 (1.22%) for soil type2, followed by FT4 of soil type1 and soil type2, (1.32 %and 1.11%, respectively).

It was found that the Mg content was (1.30 %, 1.29% and 1.22 % for FT3 FT6 and FT2, respectively) with soil type1, while it was 1.21% 1.22% and 1.11 % for FT3 FT6 and FT2 with soil type2, respectively. The lowest Mg content was found at FT1 with soil type2 0.90 % and soil type1 1.01%.

7-6- Iron content(Fe ppm):

Table (4)showed that the M. oliefera leaves under fertilizer different treatments and two soil types had the highest Fe content at FT5 310 ppm with soil type1, and 301 ppm with soil type2, follwed by FT4 for soil type1 289 ppm and for soil type2 272 ppm, while the lowest Fe content was with FT1 (167 and 153 ppm for soil type1 and soil type2, respectively). The leaves of M. oleifera grown on soil type1 recorded high iron content compared with soil type2 in treament FT6 (233 ppm and 229 ppm), respectivelv, followed by FT3 231 ppm and 220 ppm for soil type1 and soil type2, respectively. However, Iron content in FT2 recorded (177 and 164 ppm) for soil type1 and soil type2, respectivly.

8- Protein content:

Table (5) showed the protein content % of leaves of M. oleifera seedling under two different soil types and fertilizer treatments. The higher protein content was with FT5(23.28% for soil type1, and 18.84% for soil type2), followed by FT4 for soil type1, 19.23%, and 16.34 % for soil type2, while the lowest protein content was with FT1, it was 15.39% and 13.82% for soil type1 and soil type 2, respectively.

Soil type1 recorded the high protein content as compared with soil type2 for treatment FT6 and they recorded (17.15% and 15.73%, respectively), followed by FT3 17.75% 15.28% for soil type1 and soil type2, respectively. Protein content in FT2 recorded (16.89 % and 14.43 % for soil type1 and soil type2, respectively).

9- Carbohydrates content:

Analyzing carbohydrates content of M. oliefera leaves, it was detected that soil type1 recorded the high carbohydrates content compared with soil type2 of M. oliefera leaves under fertilizer treatments (Table 5). The treatment FT5 with soil type1 contained the highest content (18.28%) compared with the same treatment (17.50%) with soil type2, followed by the treatment FT4 for soil type1 and soil type2, it was (16.11% and 15.11 % respectively). It was found that the carbohydrates content were 15.20% 15.62%and 14.22% with treatments FT6 FT3 and FT2 with soil type1, respectively; however, they were 14.80% 14.90% and 14.00% with soil type2, respectively. The lowest carbohydrates content was found at FT1 with soil type2 13.40%, while it was with soil type113.92 %.

10- Total antioxidants activity (TAA %):

Table (5), indicated that soil type1 recorded the highest total antioxidants activity (TAA %) compared with soil type2 of M. oliefera seedling leaves under fertilization treatments. Based on analysis TAA% of the M. oliefera, it was detected that the treatment FT5 for soil type1 contained the highest content (56.24% compared with 43.11% soil type2, followed by the treatment FT4 for soil type1 and soil type2), (41.38% and 35.02 %, respectively).

It was found that the TAA% were (34.19 % 47.48% and 30.61% for FT3 FT6 and FT2, respectively) with soil type1, however it was (35.01% 34.36% and 34.36% for FT3 FT6 and FT2 with soil type2, respectively). The lowest TAA% was found at FT1 with soil type2 31.73% while it was31.29% with soil type1 Table (5).

11- Total phenols:

Analyzing total phenols content of the M. oliefera leaves, it was detected that the treatment FT5 with soil type 1 contained the highest content (125.1 mg GAE/g extract) compared with the same treatment 120.1 mg GAE/g extract with soil type2 (Table 5), followed by the FT4 for soil type1 and for soil type2, (120.1 and 100.01 mg GAE/g extract, respectively). It was found that the total phenols content were 95.01, 100.01 and 95.1mg GAE/g extract for treatments FT6 FT3 and FT2, respectively with soil type 1, however, it was 70.01, 75.01 and 60.01mg GAE/extract for FT6, FT3 and FT2 with soil type2, respectively. The lowest content was found at FT1 (control) with soil type2 45.1mg GAE/g extract, while it was 49.01mg GAE/g extract with soil type1.

These results were in line with the findings of many investigators. Ndukwe *et al*., (2011) demonstrated that fertilizer treatment using 30kgN: P: K/ha gave the highest value of calcium and iron content in Moringa leaves, while phosphorus concentration was best be supported by 60kgN: P: K10:10:10/ha. Alternatively, higher application of P may expose the plant nutrient to larger surface area that can enhance fixation of the nutrient.

Table 4. Mineral content (N, P, K, Ca, Mg, Fe) of leaves of *Moringa oleifera* seedlings grown on two different soils and applied with 6 fertilizers

mineral content	Soil type(1)						Soil type (2)					
	FT1	FT2	FT3	FT4	FT5	FT6	FT1	FT2	FT3	FT4	FT5	FT6
Nitrogen (N %)	2.54	3.06	3.52	4.49	5.42	3.58	2.21	2.62	3.38	4.74	5.21	3.19
Phosphorus (P %)	0.71	0.86	0.97	1.08	1.63	0.93	0.56	0.75	0.95	1.06	1.56	0.89
Potassium (K %)	0.57	1.15	1.22	1.59	1.93	1.32	0.51	1.06	1.12	1.42	1.82	1.29
Calcium (Ca %)	2.21	3.15	4.00	4.99	5.61	3.33	1.99	3.00	3.92	4.51	5.12	3.12
Magnesium (Mg %)	1.01	1.22	1.30	1.32	1.42	1.29	0.90	1.11	1.21	1.11	1.22	1.22
Iron (Fe ppm)	167	177	231	289	310	233	153	164	220	272	301	229

S (1) =Soil type1: sandy loam soil S (2) =Soil type2: Mixture of peatmoss and sand (1w:1w)
1-FT1=Control (untreated plants) 2-FT2= (1/2 g N+1/4 g P +1/4 g K)/kg soil
3- FT3= (1 g N+1/2 g P +1/2 g K)/kg soil 4-FT4= (1/2 g N + 1/4 g P +1/4 g K +1/4 g HALEX)/kg soil
5-FT5= (1 g N + 1/2 g P +1/2 g K +1/2g HALEX)/ kg soil 6-FT6= 1 g HALEX/ kg soil

Table 5. Protein, Carbohydrates, Total antioxidant activity and Total phenols of leaves of *M. oleifera* seedlings grown on two different soils and applied with 6 fertilizers

Component	Soil types (1)						Soil types (2)					
	FT1	FT2	FT3	FT4	FT5	FT6	FT1	FT2	FT3	FT4	FT5	FT6
Protein (%)	15.39	16.89	17.75	19.23	23.28	17.15	13.82	14.43	15.28	16.34	18.84	15.73
Carbohydrates (%)	13.92	14.22	15.62	16.11	18.28	15.20	13.40	14.00	14.80	15.11	17.50	14.90
Total antioxidant (%)	31.29	30.61	34.19	41.38	56.24	47.48	31.73	34.36	35.01	35.01	43.11	34.36
Total phenol (mg GAE/g extract)	49.1	95.01	100.01	120.1	125.1	95.1	45.01	60.014	75.01	100.01	120.1	70.01

S (1) =Soil type1: Sandy loam soil S (2) =Soil type2: Mixture of Peatmoss and sand (1w:1w)
1-FT1=Control (untreated plants) 2-FT2= (1/2g N+1/4 g P +1/4 g K)/kg soil
3- FT3= (1g N+1/2 g P +1/2 g K)/kg soil 4-FT4= (1/g N + 1/4 g P +1/4 g K +1/4 g HALEX)/kg soil
5-FT5= (1 g N + 1/2 g P +1/2 g K +1/2 g HALEX)/ kg soil 6-FT6= 1 g HALEX/ kg soil

In addition, Isaiah (2013) investigated that the effects of inorganic fertilizer on the growth and nutrient composition of *M. oleifera* leaves. N: P: K: fertilizer was applied at five levels which include 0, 30, 60, 90 and 120kgN: P: K15:15:15/ha. The highest fertilizer rate of 120kgN: P: K/ha produced the highest protein content (19.01%), there is therefore, such trend may be observed with higher fertilizer rate. In diet that requires more calcium and iron minerals, fertilizer could be applied at 30kgN: P: K/ha while 60kgN: P: K/ha favors phosphorus accumulation in the leaves. The highest protein contents (g/g dry weight leaves) were obtained with soil inoculation with (*Azot. chroococcum*and *B. circulans*), *(Bacillus megatherium)* and *(Azot. Chroococcum* and *S. cerevisiae*), which gave 0.73, 0.59 and 0.58 g protein/g leaves based on dry weight, respectively .Generally, soil inoculation with B. *megatherium*, *B. circulans, (Azot. chroococcum*and *Pseudomonas fluorescens*), *(Azot. chroococcum*and *B. circulans),Azot. chroococcum*, and (*Azospirillum brazilense*and *B. megatherium*) gave the highest records of Mg, P, K, Zn, Mn, Fe and Cu respectively (Mona, 2012). In the other study by Makinde (2013), the highest fertilizer rate (120 kg N: P: K 15:15:15/ha) produced the highest protein content (19.01%) and the other yield parameters of *M. oleifera* plants However, Mendieta *et al.* (2013) showed that the highest protein content was found in the Moringa vas at N fertilizer levels 521 and 782 kg N/ha/year (87.9 and 93.7 g kg^{-1} DM) compared with lower levels. Azza *et al.* (2014) stated that the Phosphorine and Nitrobine gave the highest carbohydrates content; all biofertilizers treatments increased nutrients contents compared with the control. However, Attia *et al.* (2014) concluded that the effect of fertilization types application on yield components, nutrients concentration, total phenols and total antioxidants activity in leaves and seeds of *M. oleifera* trees can be follows; NPK fertilization > organic matter (OM) fertilization > bio fertilization.

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الملخص العربي

استجابة النمو الأولي والمحتوي الكيميائي لبادرات المورينجا أوليفيرا لمستويات مختلفة من NPK والتسميد الحيوي في نوعين مختلفين من التربة

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أجريت هذه الدراسة في صوبه تابعة لحدائق أنطونيادس التابعه الي معهد بحوث البساتين-مركزالبحوث الزراعية وذلك خلال موسمي ٢٠١٣-٢٠١٤، وذلك لدراسة إ ستجابة النمو الأولى والمحتوي الكيميائى لبادرات المورينجا أوليفيرا لخمس مستويات من التسميد المعدني NPK والتسميد الحيوي بالهالكس HALEX بالاضافة الي الكنترول مع نوعين مختلفين من التربة هما التربة الطميية الرملية، خليط من البيت موس والرمل بنسبه وزنية متساويه. تم زراعة البذور في بداية شهر مارس ثم نقلت البادرات بعد شهر الي أكياس البولي اثيلين سعة ٣ كجم من نوعي التربة المستخدمة. أستخدمت اليوريا والسوبر فوسفات وكبريتات البوتاسيوم كمصادر ل NPK بينما استخدم الهالكس كسماد حيوي وذلك في خمس معاملات بلاضافة الي الكنترول وهم:

(١)-الكنترول(بدون تسميد)

(٢)-٢ /١ جرام نيتروجين +١/٤ جرام فوسفور+١/٤ جرام بوتاسيوم لكل كيلو جرام تربة

(٣)-١جرام نيتروجين +١/٢جرام فوسفور+١/٢جرام بوتاسيوم لكل كيلو جرام تربة

(٤)-٢ /١ جرام نيتروجين +١/٤ جرام فوسفور+١/٤ جرام بوتاسيوم لكل كيلو جرام تربة+١/٤ جرام هالكس

(٥)-١ جرام نيتروجين +١/٢ جرام فوسفور+١/٢ جرام بوتاسيوم لكل كيلو جرام تربة+١/٢ جرام هالكس

(٦)-١ جرام هالكس لكل كيلو جرام تربة

أضيف السماد علي جرعتين: في منتصف مايو ويوليو خلال موسمي التجربة. في نهاية شهر نوفمبر –بعد تسعة أشهر –تم حصد النباتات. أخذ قياس الطول شهريا وبعد الحصاد قدر الوزن الأخضر الكلي والوزن الجاف الكلي للنباتات. قدرت النسبة المئوية من عناصر النتروجين، الفوسفور، البوتاسيوم، الكالسيوم، الماغتسيوم بالاضافة الي تركيز الحديد في أوراق البادرات. قدر أيضا المحتوي البروتيني كنسبة مئوية، الكربوهيدرات، المحتوي الكلي لمضادات الاكسدة بالأضافة الي المحتوي الكلي من الفينولات.

استخدام في التجربة تصميم القطع المنشقة مع ست مكررات وبكل مكررة ثلاثة نباتات مع اعتبار التربة هو العامل الرئيسي المعاملة السمادية هى العامل الفرعي. اختبرت النتائج باستخدام إختبار L. S. D عند مستوي معنوية 5%.

سجلات أفضل النتائج بالنسبة لجميع العوامل تحت الأختبار مع النباتات النامية في التربة الطميية الرملية وعند خليط من التسميد المعدني والتسميد الحيوي(١ جرام نيتروجين +٢/١ جرام فوسفور+٢/١ جرام بوتاسيوم لكل كيلو جرام تربة+٢/١ جرام هالكس)/ كيلو جرام تربة. سجل ارتفاع النباتات في الحالة السابقة ١٥٤,٥٠سم، ١٧٤,٧٥ سم خلال الموسمين الاول والثاني علي التولي. سجل الوزن الأخضر الكلي ٧٧,٦٨ جرام ، ٩٠,٠٣ جرام، الوزن الجاف الكلي ٤١,٣٥ جرام، ٤٣,٥٥ جرام خلال الموسمين الأول والثاني علي التوالي.

المحتوي المعدني في الاوراق أعطي ٥,٤٢، ١,٦٣، ١,٩٣، ٥,٦١، ١,٤٢ % لكل من نتروجين، الفوسفور، البوتاسيوم، الكالسيوم، الماغتسيوم بالأضافة الي ٣١٠ جزء في المليون لعنصر الحديد علي الترتيب. سجلات أعلي نسبة من البرتين، الكربوهيدرات، مضادات الأ كسدة الكلية، المحتوي الفينولي مع نفس المعاملة السابقة وهي التربة الطميية الرملية وعند مستوي خليط من التسميد المعدني والتسميد الحيوي ١ جرام نيتروجين +٢/١ جرام فوسفور+٢/١ جرام بوتاسيوم لكل كيلو جرام تربة+٢/١ جرام هالكس)/ كيلو جرام تربة- حيث سجلات النتائج ٢٣,٢٨، ١٨,٢٨، ٥٦,٢٤% و١٢٥,١ ملليجرام GAE/جرام مستخاص.

كانت أقل النتائج لكل المقاييس تحت الاختبار مع النباتات التي لم تسمد بأي نوع من الأسمدة(الكنترول)وذلك في كل من نوعي التربة تحت الأختبار.