Effect of Mineral, Organic and Bio-fertilization on Growth and Production of Moringa (*Moringa oleifera*, L.) Plants

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ABSTRACT: Two filed experiments were carried out at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University at Abees region, Alexandria, Egypt during the two growing seasons of 2014 and 2015 to study the effect of mineral, organic and bio-fertilization on growth and productivity of moringa plants (*Moringa oleifera*, Lam).The experimental design was split plot were three replicates. The main plot were conducted for the five combination of organic manure plus mineral fertilizer of (100% organic, 75% organic manure + 25% mineral, 50% organic manure + 50% mineral, 25% organic manure + 75% mineral and 100% mineral), while, the four bio-fertilization treatments were uninoculation, phosphorein, A- mycorrhizal and cerealine were arranged in the sub-plot. The main results could be summarized as follows: (1) The application of 75% organic manure + 25% mineral; gave the highest mean values of all studied characters, (2) the application of 75% organic manure + 25% mineral with A- mycorrhizal inoculation was the best combination to obtain the highest mean values of plant height, stem length, stem diameter, number of branches /plant, fresh and dry weights/plant, K (%), total carbohydrate (%) and vitamin (C). However, all traits under study increased significantly due to inoculation treatments over the application 100% mineral with uninoculation treatments.

Keywords: *Moringa oleifera*, vegetative growth, inorganic, organic and bio-fertilization.

INTRODUCTION

Moringa (*Moringa oleifera*) is well known for its multi-purpose attributes, wide actaplability and case of establishment. Every part of the plant is of food value, moringa leaves contain seven times more vitamin-C than oranges, four times more calcium than milk, four times more vitamin-A than carrot, three times more potassium than banana and two times more milk. Hence, it is considered as a powerhouse of nutritional value (Morton, 1991). The seeds are also used for oil productions; this oil is used in art, cosmetics and medicine; and can be consumed as food. Bio-fertilizers are microbial inoculants used for application to either seeds or soil for increasing soil fertility with objective of increasing the number of such micro- organisms and to accelerate ecertain microbial processes (Mazher, *et al*. 2014).

Fertilization is one of the most important factors limiting the productivity of plants. The intensive use of expensive mineral fertilizers in recent gears results in environmental pollution problems. However, chemical fertilizers at extremely high rates for a long period decreased the potential activity of microflora. (Adeoye *et al*., 2005).

Additionally, organic manures in the form of compost, animal manure, farmyard manure (FYM) and green manure organic materials are generally added to soils to improve their physical and chemical properties. They enhance the soil fertility by their composition of macro and micro-elements, amino acid, organic acids, sugars and organic matter (Abou El-Fadi, 1968). Furthermore, biofertilization is an important factor being used to produce products without some mineral fertilizer that cause environmental pollution problems and high rates of it leads in decrease the potential activity of microflora and the mobility of organic matters. Hence, the attention has been focused on the researches of biofertilization to safe alternative specific chemical fertilizers. Biofertilizers play vital role of increasing the number of microorganisms and accelerate certain of microbial process in the rhizosphere of inoculated soil of plants which can change the available form of some nutrients to be plants (Anjorin *et al*., 2010; Adebayo *et al*., 2011; Attia *et al*., 2014). This research, however, in an attempt to find out the best fertilization treatments, i.e. mineral fertilizer plus organic manure and biofertilizer on the vegetative growth and chemical composition of moringa (*Moringa oleifera*).

MATERIALS AND METHODS

The present investigation was carried out during both seasons of 2014 and 2015 at Abees Experimental Farm of the Faculty of Agricultural (Saba Basha), Alexandria University. A filed experimental was designed to study the effect of mineral, organic and bio-fertilization on growth and production of Moringa plants.

Some physical and chemical properties of the experimental field soil and organic matter during the two seasons were done and the data are shown in Tables (1 and 2).

Regarding the cultivated of *Moringa oleifera* plant look place the research and production station, Cairo (National Research Center). However, planted in 2.5 x 2.5 meter space. Mineral fertilizer was applied at 600 g/tree of ammonium nitrate (33.5%N), 250 g/tree of calcium super-phosphate (15.5% P_2O_5) and 300g/tree of potaium sulphate (50% K_2O). 1.5 kg sheep manure with 400 g biofertilizer (phosphorein and cerealine) and and cerealine) liter of A-mycorrhizal, and rate of calcium superphosphate were mixed with 0.15 m depth of top soil around the tree trunk at one dose at March, while nitrogen and potassium fertilizer were applied in three equal doses at April, May and June.

The applied treatments were a follow:
1.Fertilization
100 % organic
75% organic manure + 25% mineral
50% organic manure + 50% mineral
25% organic manure + 75% mineral
100% mineral

Table (1). Some physical and chemical properties of the experimental soil in 2014 and 2015 seasons

Soil properties	Season	
	2014	2015
A) Mechanical analyses :		
Clay %	42.50	43.00
Sand %	16.50	15.80
Silt %	41.00	41.20
Soil texture	**Clay loam soil**	
B) Chemical properties		
pH (1 : 1)	7.60	7.80
EC (dS/m)	2.20	2.30
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	0.90	0.92
Ca^{++}	4.20	4.25
Mg^{++}	3.10	3.20
Na^{++}	8.20	8.15
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.80	2.70
Cl^-	11.30	11.50
SO_4^{--}	0.48	0.50
Calcium carbonate (%)	7.80	7.90
Total nitrogen (%)	0.48	0.49
Available phosphate (mg/kg)	3.60	3.70
Organic matter (%)	0.95	0.90

Table (2). Analysis of the applied organic manure (sheep manure).

Properties of organic manure	Value
pH	7.2
O.M %	35.5
O.C %	22.6
Total N%	2.05
Total P%	1.20
Total K%	1.50
C/N ratio	13.0:1

1.Biofertilizers treatments were randomly distributed in the sub plot a follows:

- Without inoculation (control)
- Inoculation with cerealine: An inoculate for all crops containing of *Azospirillum pp.* (10 cell/g), *Azotobacter chrooococum.*
- Inoculation with phosphorein: An inoculate for all crops containing of (*Bacillus megatherium*) soluble calcium phosphate. These inoculations are produced by the General Organization for Agriculture Equalization Ministry of Agriculture and land Reclamination Egypt (Ismali *et al.*, 2009).

- Inoculation of A- mycorrhizal fungi: inoculants for Moringa with fungi (*Glomus mcrocarpium*) strain from plant production Dept. (Saba Basha) Alex. Univ., at a rate of 250ml of infected roots and was mixed with tress of Moringa plants.

The plants were harvested 3 times per seasons i.e. August 10th September 10th in the first and second seasons by cutting the vegetative parts.

The following data of vegetative growth were recorded:

Plant height (cm), stem length (cm), stem diameter (cm), number of branches /plant, shoot fresh weight (g) and shoot dry weight (g).

The chemical compositions were recorded as following:

For these analyses, the leaves were dried at 70℃ for 48hr., and ground. Leaves (0.5 g) were digested with sulphuric acid and hydrogen peroxide H_2SO_4+H_2O_2 according to the method of (Lowther, 1980) and the following determining were carried out in the digested solution to determine the following:

- Nitrogen content (N%)

Nitrogen was determined in digested plant material colorimetrically by Nessler`s method (Chapman and Pratt, 1978). Nessler solution (35 g KI/100 ml d.w. + 20g $HgCl_2$ / 500 ml d.w.) +120 g NaOH / 250 ml d.w. Reading was achieved using wave length of 420 nm and N was determined as percentage as follows:

% N = NH_4 % x 0.776485

- Phosphorus content (P %)

Phosphorus was determined by the Vanadomolyate yellow method as given by Jackson (1973) and the intensity of color developed was read in spectrophotometer at 405nm.

- Potassium content (K %)

Potassium was determined according to the method described by method Jackson (1973) using Beckman Flame photometer.

- Total soluble carbohydrates were determined, quantitatively, in the herb of sage by Anthron method according to Yemm and Willis (1954) as follows:

Extraction was carried out by grinding dry matter in Mahadavaine buffer (sodium citrate buffer, pH 6.8). Extracts were homogenized for 3 minutes and centrifuged at 4000 rpm for 15 min. the supernatant was then used to determine total soluble carbohydrates.

- Protein was determined by estimating the total nitrogen in the herbs and multiplied by 6.25 to obtain the percentage according to AOAC (1990).

- The ascorbic acid content of the juice was determined by titration with 4, 6 dichloro phenol-indo-phenol (AOAC, 1984) and calculated as milli-grams per 100 ml of juice.

The obtained data were statistically analyzed according to Gomez and Gomez (1984). The least significantly differences test (L.S.D.) at 0.05 was used in compare between means of the different treatments.

RESULTS AND DISCUSSIONS

A) Vegetative growth

The obtained results, given in Tables (3, 4 and 5) clearly show that combination of mineral plus organic manure fertilizer exhibited a significant effect on all estimated traits at the achieved three cuts during both seasons. Application of 75% organic manure + 25% mineral, significantly, increased plant height, stem length, stem diameter, number of branches /plant, shoot fresh and shoot dry weight/plant at the three cuts during both seasons. These results may be due to the nutritional benefits of organic manure which include improvement of soil fertility, water holding capacity and organic matter and response to organic manure attributed to increasing nitrogen nutrition as indicated by increased concentration in plant tissues (Dania *et al.*, 2014).

Inoculation of A- mycorrhizal fungi, significantly, increased plant height, stem length, stem diameter, number of branches /plant, shoot fresh and shoot dry weight/plant at three cuts during both seasons in comparison to uninoculation treatments (control). It could be concluded that A- mycorrhizal fungi inoculation treatment promoted the production of moringa growth. However, these events could be attributed to more adsorption of nutrients which reflected more on growth, more cell division and enlargement more of tissue and organs and plant elongation. Also, the phosphate solubilizing bacteria and nitrogen fixing may increases. The synthesis of endogenous phytohormones, i.e. IAA, GAs and CKs which play an important role in formation of mass active root system which allow more nutrients uptake. The previous results agree, more or less, with the findings of Rajendrn *et al*. (2000) on *Cassuasin equisetifolia*, Manorama *et al*. (2007) on *Acaci mellifera* and Attia *et al*. (2014) on *Moringa oleifera*.

The interaction between organic manure + mineral and bio-fertilization was significant and affected all traits at the three cuts during both seasons (Tables 3, 4 and 5). Tables (6 and 7) decleard, the application of 75% organic manure+ 25% mineral, resulted in the highest shoot fresh and shoot dry weight mean values with inoculation with A- mycorrhizal.

Table (3). Plant height (cm) and stem length (cm) as affected by mineral-organic and biofertilization at the three cuts in 2014 and 2015 seasons.

Treatments	Plant height (cm)						Stem length (cm)					
	2014 Season			2015 Season			2014			2015		
	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut
A) Mineral + Organic												
100% Organic	100.24e	111.65d	124.10cd	111.65d	121.05d	134.83d	71.70b	89.30b	111.47b	79.14b	98.37b	123.69b
75% org. + 25% mineral	106.25a	118.06a	131.18a	118.04a	131.18a	115.75a	79.16a	98.95a	123.70a	87.95a	109.94a	137.42a
50 % org. + 50% mineral	102.30b	114.75b	127.12b	114.42b	127.13b	141.25b	64.09c	80.15c	100.19c	71.21c	89.05c	111.32c
25% org. +75% mineral	101.46c	112.75c	125.27c	112.88c	125.38c	139.16c	57.67d	72.09d	90.17d	64.13d	80.08d	100.09d
100% mineral	100.72d	111.92cd	123.54d	111.91d	125.18c	137.25c	52.23e	64.92e	81.15e	58.03e	73.13e	90.16e
LSD 0.05	**0.44**	**1.05**	**1.25**	**0.40**	**1.70**	**2.05**	**3.10**	**4.50**	**6.30**	**3.70**	**4.70**	**6.90**
B) Bio-fertilization												
Uninoculation	92.44d	102.73d	114.12d	102.71d	114.12d	126.73d	60.66d	75.85d	94.96d	67.43d	84.88c	105.10d
Phosphorein	101.43b	116.26b	125.89b	116.23b	129.85b	143.33b	66.27b	82.45b	103.08b	73.56b	93.61b	114.53b
Mycorrhizal	112.52a	125.03a	138.92a	124.96a	138.92a	154.33a	69.51a	86.71a	108.04a	76.89a	96.13a	120.14a
Cerealine	99.92e	111.29c	122.70c	111.15c	123.36c	136.33c	63.43c	79.29c	99.11c	70.49c	84.99c	110.06c
LSD 0.05	**1.02**	**2.10**	**2.30**	**1.50**	**2.20**	**2.50**	**2.40**	**3.10**	**3.90**	**2.20**	**3.30**	**4.10**
Interaction												
AxB	*	*	*	*	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference at 5% level using (L.S.D.) test

*: Significant at 0.05 level of probability.

Table (4). Stem diameter (cm) and number of branches/plant as affected by mineral-organic and biofertilization at the three cuts in 2014 and 2015 seasons.

Treatments	Stem diameter (cm)						Number of branches/plant					
	2014 Season			2015 son			2014			2015		
	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut
A)Mineral + Organic												
100% Organic	1.97b	2.20b	3.15b	2.20b	2.44b	3.52b	8.59c	9.70b	10.77b	9.68b	10.76b	11.96b
75% org. + 25% mineral	2.20a	2.45a	3.50a	2.44a	2.72a	3.88a	8.93a	9.93a	11.03a	9.93a	11.03a	12.26a
50 % org. + 50% mineral	1.99ab	2.02c	2.86c	2.21b	2.20c	3.16c	8.78b	9.75b	10.84b	9.75b	10.83b	12.04b
25% org. +75% mineral	1.61d	1.79d	2.57d	1.79d	1.99d	2.85d	7.89d	8.78d	9.75c	8.86c	9.75c	10.83c
100% mineral	1.66c	1.84d	2.31e	1.86c	1.88d	2.57e	7.24e	7.89c	8.69d	8.04d	8.77d	9.74d
LSD 0.05	**0.03**	**0.07**	**0.12**	**0.05**	**0.13**	**0.25**	**0.06**	**0.10**	**0.16**	**0.11**	**0.17**	**0.19**
B) Bio-fertilization												
Uninoculation	1.30d	1.44d	2.07d	1.44d	1.30d	2.29d	7.11d	7.90d	8.79d	7.91d	8.78d	9.76d
Phosphorein	2.01b	2.26b	3.21b	2.24b	2.49b	3.56b	8.60b	9.55b	10.61b	9.55b	10.61b	11.79b
Mycorrhizal	2.36a	2.63a	3.76a	2.62a	2.91a	4.17a	9.45a	10.46a	11.55a	10.51a	11.62a	12.91a
Cerealine	1.88c	1.90c	2.47c	2.08c	1.97c	2.74c	8.08e	8.90c	9.89c	9.05c	9.89c	10.99c
LSD 0.05	**0.04**	**0.11**	**0.20**	**0.14**	**0.23**	**0.30**	**0.11**	**0.13**	**0.18**	**0.20**	**0.25**	**0.40**
Interaction												
AxB	*	*	*	*	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference at 5% level using (L.S.D.) test
*: Significant at 0.05 level of probability.

Table (5). Fresh of shoot weight (g) and shoot dry weight (g) as affected by mineral-organic and biofertilization at the three cuts in 2014 and 2015 seasons.

Treatments	Shoot fresh weight (g)						Shoot dry weight (g)					
	2014 Season			2015 son			2014			2015		
	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut
A) Mineral + Organic												
100% Organic	81.27b	101.85b	127.35b	90.57b	113.35b	141.53b	16.30b	20.38b	25.48b	18.19b	22.64b	28.31b
75% org. + 25% mineral	90.58a	113.22a	136.41a	100.64a	125.63a	154.45a	18.11a	22.64a	29.06a	20.14a	25.16a	31.448a
50 % org. + 50% mineral	73.36c	91.70c	114.64c	86.51c	101.94c	127.31c	14.67c	18.34c	22.93c	16.30c	19.54c	25.48c
25% org. +75% mineral	66.72d	82.62d	103.18d	73.47d	91.54d	114.63d	13.20d	16.51d	20.72d	14.67d	18.34d	22.93d
100% mineral	59.43e	74.28e	93.61e	66.02	82.70e	103.17e	11.83e	14.85e	18.59e	13.19e	16.50e	21.48e
LSD 0.05	**3.10**	**5.10**	**6.20**	**3.60**	**5.50**	**7.20**	**0.85**	**1.10**	**1.18**	**1.03**	**1.15**	**1.30**
B) Bio-fertilization												
Uninoculation	66.04d	83.62d	103.20d	73.38d	91.70d	114.66d	13.29d	16.51d	20.64d	14.67d	17.67d	22.93d
Phosphorein	75.79b	94.74b	118.40b	84.21b	105.23b	131.59b	15.16b	18.94b	23.75b	16.76b	21.05b	26.35b
Mycorrhizal	83.81a	104.77a	130.94a	93.12a	116.40a	145.45a	16.76a	20.91a	26.20a	18.62a	23.18a	29.78a
Cerealine	71.07c	88.84c	111.05c	78.97c	98.41c	123.40c	14.34c	17.77c	22.22c	15.78c	19.74c	24.67c
LSD 0.05	**2.80**	**4.40**	**6.30**	**3.10**	**5.10**	**6.50**	**1.00**	**1.10**	**1.30**	**1.05**	**1.10**	**1.45**
Interaction												
AxB	*	*	*	*	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference at 5% level using (L.S.D.) test
*: Significant at 0.05 level of probability.

Table (6). Interaction between mineral+organic and biofertilization on shoots fresh weight/ plant (g) for moranga plant at three cuts during 2014 and 2015 seasons.

Treatments		Shoots fresh weight /plant (g)					
		2014 Season			2015 Season		
Org.+mineral	Biofertilization	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut
100% org.	Uninoculation	72.57	90.72	11.42	80.64	100.80	126.00
	Phosphorein	83.29	104.11	130.16	92.54	115.80	144.60
	Mycorrhizal	92.10	115.13	143.81	102.33	127.92	159.90
	Cerealine	78.10	97.63	121.98	86.78	108.48	185.60
75%org.+25%mineral	Uninoculation	80.64	100.30	126.00	89.60	114.66	140.00
	Phosphorein	92.84	115.68	144.44	102.88	128.20	160.66
	Mycorrhizal	102.34	127.92	159.90	113.70	142.13	177.66
	Cerealine	86.76	108.48	85.60	96.42	120.53	150.66
50%org.+50%mineral	Uninoculation	65.31	81.65	102.06	72.57	90.91	113.40
	Phosphorein	74.95	93.70	117.13	83.28	104.11	130.14
	Mycorrhizal	92.88	103.61	129.52	92.10	115.12	143.64
	Cerealine	70.29	87.83	109.84	78.10	97.63	122.04
25%org.+75%mineral	Uninoculation	58.78	73.82	91.86	65.31	81.65	102.06
	Phosphorein	67.46	84.32	105.42	74.95	93.65	117.12
	Mycorrhizal	74.59	93.25	116.57	88.88	103.60	129.51
	Cerealine	63.26	79.08	98.86	70.29	87.86	109.83
100%mineral	Uninoculation	52.90	66.13	82.66	58.78	73.48	91.85
	Phosphorein	60.73	75.89	94.87	67.46	84.99	105.41
	Mycorrhizal	67.14	83.92	104.91	74.59	93.25	116.56
	Cerealine	56.94	71.71	88.97	63.26	79.08	98.85
LSD 0.05		**3.30**	**5.40**	**6.50**	**3.50**	**5.70**	**7.40**

Table (7). Interaction between mineral+organic and biofertilization on shoots dry weight/ plant (g) for moranga plants at three cuts during 2014 and 2015 seasons.

Treatments		Shoots dry weight /plant					
		2014 Season			2015 Season		
Org. + mineral	Biofertilization	1st cut	2nd cut	3th cut	1st cut	2nd cut	3th cut
100%org.	Uninoculation	14.52	18.14	22.68	16.13	20.16	25.20
	Phosphorein	16.65	20.82	26.03	18.50	23.13	28.92
	Mycorrhizal	18.41	23.02	28.78	20.46	25.58	31.98
	Cerealine	15.61	19.52	24.41	17.35	21.69	27.12
75%org.+25%mineral	Uninoculation	16.12	20.16	25.20	17.91	22.40	28.00
	Phosphorein	18.51	23.13	28.92	20.56	25.70	32.26
	Mycorrhizal	20.46	25.58	31.98	22.74	28.42	35.53
	Cerealine	17.35	21.69	27.14	19.28	24.10	30.13
50 % org.+50%mineral	Uninoculation	13.06	16.33	20.41	14.51	14.80	22.67
	Phosphorein	14.99	18.73	23.43	16.65	20.81	26.02
	Mycorrhizal	16.57	20.72	25.90	18.41	23.02	28.78
	Cerealine	14.06	17.57	21.96	15.62	19.52	24.40
25%org.+75%mineral	Uninoculation	11.75	14.69	18.37	13.06	16.32	20.41
	Phosphorein	13.49	16.86	21.41	14.99	18.74	23.45
	Mycorrhizal	14.92	18.65	23.31	16.52	20.72	25.40
	Cerealine	12.65	15.82	19.79	14.05	17.57	21.90
100%mineral	Uninoculation	10.58	13.22	16.54	11.75	14.69	18.37
	Phosphorein	12.14	15.18	18.97	13.49	16.86	21.08
	Mycorrhizal	13.42	16.78	21.03	14.91	18.64	26.70
	Cerealine	11.38	14.23	17.79	12.62	15.81	19.76
LSD (0.05)		**1.08**	**1.15**	**1.28**	**1.06**	**1.20**	**1.47**

B) Chemical composition

Data presented in Tables (8 and 9) indicated that organic manure plus mineral fertilizers significantly affected nitrogen (%), phosphorus (%), potassium (%), protein (%), total carbohydrate (%) and vitamin (C) in both seasons. Application of 75% organic manure + 25% mineral; gave rise the highest mean values of all studied chemical composition parameters as compared with application 100 % mineral fertilizer in both seasons.

The increment in chemical composition of moringa leaves using the treatments of organic manure may be owing attributed to increase in the occupancy root zone of plant result of adding organic manure which reflected on N, P and K uptake by plant and confirm the pervious of vegetative growth. Similar results were obtained by Prabhakar and Hebbar (2007), Adebayo *et al.* (2011) on *Moringa oleifera*, Makinde (2013) on moringa plant and Attia *et al.* (2014) on moringa plant.

Concerning the bio-fertilization, treatments in Tables (8 and 9) revealed that inoculation moringa plants with bio-fertilization, increased all the studied of chemical composition in both seasons compared to uninoculated moringa (control).

It can, also, be suggested to use combined biofertilizer including phosphorein, A- mycorrhizal and cerealine biofertilizer including all biofertilizer to produce a high quality moringa trees. Several reports on biofertilizer utilization have emphasized that a single inoculation showed higher productivity than uninoculation treatment (control). Shah *et al.* (2006), Attia *et al.* (2014) and Mazher *et al.* (2014).

The interaction between combination organic manure and mineral and bio-fertilization were significant for N, P and K % in both seasons (Table 10). Application of 75% organic manure+ 25% mineral, gave the highest mean values of N% with cerealine, P% with phosphorein and K% with A- mycorrhizal inoculation as compared with was uninoculation treatment.

The significant differences for the interaction between combination organic manure plus mineral and bio-fertilization in both seasons due to application of 75% organic manure+ 25% mineral, brought about the greatest protein percentage with treatment of cerealine biofertilizer and total carbohydrate (%), vitamin (C) with A- mycorrhizal in both seasons (Table 11).

In conclusion, some organs of moringa are good source important minerals and these plants might be explored as a viable supplement and ready source of dietary minerals in animal and human food. There was a significant variation in macro and microelements in moringa leaves. Also, the application of 75% organic manure+ 25% mineral gave the highest vegetative growth and chemical composition with A- mycorrhizal inoculation.

Table (8). Nitrogen, phosphorus and potassium percentages as affected by mineral-organic and biofertilization in 2014 and 2015 seasons.

Treatments	2014 Season			2015 Season		
	N %	P %	K %	N %	P %	K %
A)Mineral + Organic						
100% Organic	2.91b	0.400b	2.35b	3.23b	0.448b	2.61b
75% org. + 25% mineral	3.22a	0.450a	2.61a	3.61a	0.498a	2.90a
50 % org. + 50% mineral	2.62c	0.360c	2.11c	2.91c	0.403c	2.33c
25% org. +75% mineral	2.35d	0.320d	1.91d	2.61d	0.355d	2.12d
100% mineral	2.12e	0.290e	1.96d	2.35e	0.318e	2.17d
LSD 0.05	**0.10**	**0.012**	**0.11**	**0.11**	**0.040**	**0.19**
B) Bio-fertilization						
Uninoculation	2.19c	0.250d	2.04d	2.43c	0.280d	2.16c
Phosphorein	2.57b	0.472a	2.15c	2.85b	0.520a	2.38b
Mycorrhizal	2.67b	0.410b	2.40a	2.92b	0.452b	2.66a
Cerealine	3.16a	0.326c	2.25b	3.51a	0.364c	2.48b
LSD 0.05	**0.11**	**0.015**	0.08	**0.12**	**0.050**	**0.17**
Interaction						
AxB	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference at 5% level using (L.S.D.) test

*: Significant at 0.05 level of probability.

Table (9). Protein (%), vitamin (C) and total carbohydrate (%) as affected by mineral-organic and biofertilization in 2014 and 2015 seasons.

Treatments	2014 Season			2015 Season		
	Protein %	Vitamin (C) mg/100 ml juice	Total carbohydrate %	Protein %	Vitamin (C) mg/100 ml juice	Total carbohydrate %
A) Mineral + Organic						
100% Organic	18.60b	0.526b	19.79b	20.20b	0.584b	22.06h
75% org.+25%	20.22a	0.584a	22.06a	22.47a	0.648a	24.51a
mineral50%org.+50%mineral	16.36c	0.467c	17.87c	18.18c	0.519c	19.85c
25% org.75% mineral	14.71d	0.420d	16.10d	16.34d	0.467d	17.87d
100% mineral	13.25e	0.409d	14.47e	14.70e	0.454d	16.08e
LSD 0.05	**1.10**	**0.35**	**1.30**	**1.20**	**0.052**	**1.45**
B) Bio-fertilization						
Uninoculation	14.02c	0.449d	14.27d	15.20c	0.497c	15.85d
Phosphorein	16.05b	0.497b	19.02b	17.83b	0.552a	21.14b
Mycorrhizal	16.67b	0.514a	22.03a	18.51b	0.570a	24.54a
Cerealine	19.70a	0.466c	16.90c	21.95a	0.518b	18.78c
LSD (0.05)	**1.20**	**0.015**	**1.50**	**1.30**	**0.040**	**1.90**
Interaction						
AxB	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference at 5% level using (L.S.D.) test

*: Significant at 0.05 level of probability.

Table (10). Interaction between mineral+organic and biofertilization on macronutrients (N, P and K %) for moranga plants in 2014 and 2015 seasons.

Treatments		N%		P%		K%	
Org. + mineral	Biofertilization	2014	2015	2014	2015	2014	2015
100% Org.	Uninoculation	2.41	2.67	0.28	0.31	2.13	2.36
	Phosphorein	2.83	3.13	0.52	0.58	2.36	2.62
	Mycorrhizal	2.93	3.25	0.45	0.50	2.64	2.93
	Cerealine	3.48	3.66	0.36	0.40	2.27	2.51
75% org. + 25% mineral	Uninoculation	2.68	2.97	0.30	0.34	2.87	2.63
	Phosphorein	3.14	3.49	0.59	0.65	2.62	2.91
	Mycorrhizal	3.26	3.62	0.50	0.55	2.93	3.26
	Cerealine	5.86	4.29	0.40	0.45	2.53	2.80
50 % org. + 50% mineral	Uninoculation	2.16	2.40	0.25	0.28	1.92	2.13
	Phosphorein	2.54	2.82	0.47	0.52	2.12	2.33
	Mycorrhizal	2.64	2.93	0.40	0.45	2.37	2.63
	Cerealine	3.13	3.47	0.32	0.36	2.04	2.21
25% org. +75% mineral	Uninoculation	1.94	2.16	0.22	0.25	1.73	1.92
	Phosphorein	2.28	2.54	0.41	0.45	1.91	2.12
	Mycorrhizal	2.37	2.63	0.57	0.40	2.13	2.37
	Cerealine	2.81	3.12	0.29	0.32	1.85	2.05
100% mineral	Uninoculation	1.75	1.94	0.20	0.22	1.57	1.74
	Phosphorein	2.06	2.28	0.37	0.40	1.75	1.94
	Mycorrhizal	2.13	2.37	0.33	0.36	1.92	2.13
	Cerealine	2.53	2.81	0.26	0.29	2.58	2.86
LSD (0.05)		**0.13**	**0.15**	**0.017**	**0.06**	**0.14**	**0.20**

Table (11). Interaction between mineral+organic and biofertilization on Protein %, Vitamin (C) and Total carbohydrate % for moranga plants in 2014 and 2015 seasons.

Treatments		Protein (%)		Vitamin (C) (mg/100 ml juice)		Total carbohydrate (%)	
Org. + mineral	Biofertilization	2014	2015	2014	2015	2014	2015
100% Org.	Uninoculation	16.72	16.72	0.488	0.543	15.68	17.42
	Phosphorein	17.64	19.60	0.543	0.604	20.89	23.22
	Mycorrhizal	18.32	20.35	0.562	0.624	24.00	26.97
	Cerealine	21.73	24.14	0.509	0.566	18.57	20.64
75% org. + 25% mineral	Uninoculation	16.74	18.60	0.542	0.603	17.42	19.36
	Phosphorein	19.63	21.81	0.604	0.671	23.22	25.80
	Mycorrhizal	20.36	22.62	0.624	0.688	26.47	29.96
	Cerealine	24.16	26.85	0.566	0.629	20.64	22.93
50 % org. +50% mineral	Uninoculation	13.53	15.03	0.434	0.483	14.11	15.68
	Phosphorein	15.88	17.64	0.482	0.536	18.80	20.89
	Mycorrhizal	16.49	18.31	0.494	0.554	21.84	24.27
	Cerealine	19.55	21.77	0.452	0.503	16.72	18.57
25% org. +75% mineral	Uninoculation	12.16	13.61	0.396	0.434	12.70	14.11
	Phosphorein	14.28	15.87	0.434	0.482	16.98	18.80
	Mycorrhizal	14.83	16.47	0.450	0.499	19.66	21.84
	Cerealine	17.57	19.52	0.407	0.452	15.04	16.71
100% mineral	Uninoculation	10.93	12.14	0.380	0.422	11.43	12.09
	Phosphorein	12.84	14.27	0.422	0.469	15.23	16.91
	Mycorrhizal	13.33	14.81	0.436	0.480	17.69	19.66
	Cerealine	15.80	17.56	0.396	0.440	13.54	15.04
LSD (0.05)		**1.22**	**1.33**	**0.040**	**0.055**	**1.35**	**1.96**

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الملخص العربي

تأثير التسميد المعدني والعضوي والحيوي علي نمو وإنتاج نباتات المورينجا

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أجريت تجربتان حقليتان في المزرعة البحثية بكلية الزراعة (سابا باشا) جامعة الأسكندرية–منطقة أبيس– حمهورية مصر أثناء موسمي الزراعة ٢٠١٤، ٢٠١٥ لدراسة تأثير التسميد المعدني والعضوي والحيوي علي نمو وإنتاج نباتات المورينجا.

صممت التجربة بتصميم القطع المنشقة مرة واحدة مع ثلاث مكرارت وكانت القطع الرئيسية عبارة عن خمس تداخلات من التسميد المعدني والعضوي وهي (١٠٠% سماد عضوي، ٧٥% سماد عضوي+٢٥% سماد معدني،٥٠% سماد عضوي+٥٠% سماد معدني،٢٥% سماد عضوي+٧٥% سماد معدني،١٠٠% سماد معدني)، بينما أربع معاملات تسميد حيوي (بدون تلقيح، فوسفورين، ميكوريزا، سيريالين) كانت موزعة في القطع المنشقة الأولي.

وكانت من أهم النتائج المتحصل عليها مايلي:

١. أدي إضافة ٧٥% سماد عضوي+٢٥% سماد معدني للحصول علي أعلي القيم للصفات المدروسة.
٢. كان التفاعل بين ٧٥% سماد عضوي+٢٥% سماد معدني مع التلقيح بالميكوريزا أفضل تفاعل للحصول علي أعلي متوسط قيم لإرتفاع النبات، طول الساق، قطر الساق، عدد الأفرع/نبات، الوزن الرطب والجاف للمجموع الخضري/نبات، النسبة المئوية للبوتاسيوم والكربوهيدرات وفيتامين سي، ولكن أدي التفاعل بين إضافة ٧٥% سماد عضوي+٢٥% سماد معدني مع التلقيح بالسيريالين إلي أعلي نسبة مئوية للنيتروجين ومحتوي البروتين بينما التلقيح بالفوسفورين إلي أعلي نسبة مئوية للفوسفور لنبات المورنيجا في الدراسة. مع هذا فإن جميع الصفات تحت الدراسة تأثرت معنوياً بمعاملات التلقيح وإضافة ١٠٠% سماد معدني مع المعاملة بدون تلقيح.