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Effect of some fertilization treatments on vegetative growth of Moringa grown in saline habitat

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Abstract:*Moringaoleifera*considered as one of the most nutritious plants in the world, which have multipurpose uses, nutritional and medicinal values, that is why it is called a miracle tree. Two field experiments were conducted in the Model Farm of National Research centre, El Tour, South Sinai under drip irrigation systemto evaluate the effect of organic and biofertilizer on growth and some physiochemical parameter of Moringa plants undersaline habitat conditions.The experiment was laid out in completely randomized block.Results showed that plant height, number of branches per plant, number of leaves per plant, leaf area (cm^2), stem diameter (cm) dry weight of leaves(g), dry weight of stem(g) and dry weight of root(g) were significantlyaffectedwith the application of inorganic, organic and biofertilizer individually or in combination.Theresults revealed that T_{11} (50% Min. fert. + 2.5kgChicken man. + Cerialene) exhibited significant increases in most of the growth parameterscompared to other treatments. It is clear that inoculation with Cerialene improves all the tolerance feature of Moringa plants and increase plant adaptation to saline habitat.Thehighest content of soluble carbohydrates, proline (ug/g fresh wt.) and sodium content (mg/g dry wt.) were recorded in $T_{2,}$ meanwhile T_{11}produced the highest chlorophyll a+b (mg/g freshwt.), crude protein and potassium content(mg/g dry wt.) as well as K/Na ratio.The micronutrients behaviors followed the same trends of growth criteria, where T11, T10 and T9 produced the highest contents of Zn, Mn, Fe and B in the leaves of *Moringaoleifera*descendingally.

Key words: Moringa- organic - biofertilizer - saline habitat.

Introduction

Moringaoleifera L, alternatively known as the drumstick tree, horseradish tree, ben tree, paradise tree and Mother's Best Friends a genus Moringa in the Moringaceae family. Native to the Himalayas in northwestern India.It is now widely cultivated in tropical and subtropical areas all over Asia, Africa and South America (Nagao *et al*.,[1]). It can be cultivated as an annual or perennial plant for its leaves, pods, seeds for oil extraction and water purification. Leaves and pods of Moringa are a nutritional powerhouse and provide a great range and amount of essential proteins, vitamins (A, B1,B2 ,B3 ,B6 and ascorbic acid)and minerals (Ca, P, K, Fe, Mg and zinc) (Fahey,[2] and Fatima and Muna[3]).Moringa regarded as a natural and environmentally friendly product (Eman, [4]).

The nature of the soil in Abo Kalam, El Tour, South Sinai, is sandy and saline which affects the productivity of most of the crop cultivated therefore, the addition of organic fertilizer is considered a sound mean to increase crop yield and improve soil properties such as water holding capacity, organic and carbon contents and soil macro- and micronutrient status (Bouajila and Sanaa.,[5]and Alexandra*et al*.,[6]).Many authors

have observed that the use of organic fertilizer amendments improve plant growth and yield of moringa (Adebayo *et al.*,[7], Adegun and Ayodele[8]and Ndubuaku*et al.*,[9]).

Protecting the environmentandreductionof agricultural costs, considered a target for many researchers working insustainableagriculture development, therefore the addition of bio-fertilizers can be a good way to reduce the use of mineral fertilizers, increase availability of nutrients in the soil and improve soil structure (Ahmed *et al.*,[10] and Zayed,[11]). Biofertilizercan solve the expected problems of food shortage due to various environmental stresses and increasing global population (Bhardwaj*et al.*,[12]).Manyresearchers have shown the positive effect inoculation of Moringa with biofertilizer (Dash and Gupta [13], Zayed, [11]andAttia*etal.*,[14]).

In light of the policy of continuous escalation of prices of mineral fertilizers, it is expected to become small-scale farmers to resort to the use of organic and biofertilizer that are available, affordable, to improve the soil properties and enhance crop productivity. This experimentwasconducted to study theeffect of organic and biofertilizer on growth and some physiochemical parameter of Moringa plants grown in saline habitat under the circumstances of El Tour, SouthSinai.

Materials & Methods

Two field experiments were conducted in the Model Farm of National Research centre, El Tour, South Sinai to study the impact of organic and biofertilizer on growth and some physiochemical parameter of Moringa. Plants were transplanted in El Tour, South Sinai at 7th and 18thSep 2014, 2015 respectively, and grown under drip irrigation system with saline water (EC : 8.7 dSm^{-1}), water analysis of Abo Kalam Well are presented in Table (1).

Table (1): Water analysis of Abo Kalam well, El Tour. South Sinai.(Average data of 2014 and 2015 seasons)

pH		7.49
EC dS^{-1}		8.7
Soluble cations Meq/L	K^+	0.5
	Na^+	69.2
	Mg^{++}	11.9
	Ca^{++}	21.6
Soluble anions Meq/L	SO4--	26.6
	Cl-	74.2
	HCO3-	2.4
	CO--	-

Experiment was laid out in completely randomized block (0.5 x 1.5 m distance between plants) i.e. 5600 plants /fed., the mechanical and chemical analysis of the soil was carried out by using the standard method described by Klute[15]Table (2). Control plant (100% mineral fertilizer) received 20 g calcium superphosphate (15.5% P_2O_5) and 30 g potassium sulphate (48.0 % K_2O) and 30 g urea (46.5% N). The other treatments were as follows.

T_1: Control (mineral fertilizer)
T_2: 5 kg Compost
T_3: 5 kg Chicken manures
T_4: 2.5 kg Compost + 2.5 kg Chicken manures
T_5: 50% Min. fert. + 2.5 kg Compost
T_6: 50% Min. fert. + 2.5 kg Chicken manures
T_7: 5 kg Compost + Cerialene
T_8: 5 kg Chicken manures + Cerialene
T_9: 100% Mineral + Cerialene
T_{10}:50% Min.fert. + 2.5 kg Compost + Cerialene
T_{11}: 50% Min.fert. + 2.5 kg Chicken man. + Cerialene.

Table (2): Mechanical and chemical analysis of the soil.(Average data of 2014 and 2015 seasons)

Depth		00 – 30 cm	30 – 60 cm
Soil texture		Sandy soil	Sandy soil
pH		8.1	8.4
EC dS^{-1}		15.1	4.52
Soluble cations Meq/L	K^{+}	0.4	0.24
	Na^{+}	112.0	27.0
	Mg^{++}	28.8	5.5
	Ca^{++}	60.5	12.5
Soluble anions Meq/L	$SO4^{--}$	61.0	10.64
	Cl^{-}	139.0	31.0
	$HCO3^{-}$	2.7	3.6
	CO^{--}	-	-

The chemical analysis of both green manure (compost) and chicken manure are presented in Table (3). All agronomic practices were followed as recommended for Moringa production in this district. A representative vegetative plant sample was taken after 210 days from transplantation for each treatment from four replicates for measuring plant height (cm.), number of branches, number of leaves, leaf area (cm^{2}), stem diameter (cm),dry weight of leaves(g), dry weight of stem(g) and dry weight of root(g).

The following physiochemical measurements were determined in the fresh leaves: chlorophyll a+b (mg/g fresh weight) according to von Wet stein[16], proline according to Bates *et al.,*[17]. Then the different parts of the plant were then dried to constant weight at 70° to determine the dry weight (g) of leaves, stem and root. The dried plants were then thoroughly ground to fine powder and total nitrogen percentage was determined according to the method described by A.O.A.C, [18]. Zn, Mn, Fe and B were also determined as described by A.O.A.C, [18].

Crude protein was calculated for each treatment. The content of sodium and potassium were determined in the digested material using Jenway flame photometer as described by Cottenie*et al*., [19]. The obtained data were subjected to the proper statistical analysis according to Gomez and Gomez[20]. Since the trends were similar in both seasons, the homogenty test was carried out according to Partlet's test and the combined analysis of the data was applied according to Gomez and Gomez[20]. Treatment means were compared using LSD test at 5% level.

Table (3): Chemical composition of Farmyard manures and chicken manure.(Average data of 2014 and 2015 seasons)

Characters	Chicken manure	Farmyard manure
Organic matter %	49.2	32.65
Organic carbon %	29.0	21.36
C/N ratio	14.7	14.1
Ph	7.5	7.2
EC mmhos/cm^{2}	2.2	1.65
Total N %	2.0	1.12
Available P (ppm)	116	85
Available K (ppm)	105	66

Results and Discussion

I-Effect of fertilization treatments on some growth parameter of Moringaplants.

Data presented in Table (4)shows that all treatment with minerals, organic and biofertilizer significantly affected all the studied characters, i.e.plant height (cm.), number of branches per plant, number of leaves per plant,leaf area (cm^{2}), stem diameter (cm) dry weight of leaves(g), dry weight of stem(g) and dry weight of root(g).

Concerning plant height (cm.), data indicated that T_{11} (50% Min.fert. + 2.5 kg Chicken man. + Cerialene) induced thetallest plant, while the shortest plant recorded in T_2 (5 kg Compost).Superiority for T_1 treatments could be due to solubility of nutrients and rapidly release of mineral fertilizer for plant when comparison with organic fertilization (Compost or Chicken manures) which are slow releasefertilizers.Likewise, increment in plant height in response to mineral fertilizer has been reported byMakinde, [21] and Attia*et al.,*[14].

The highest number of branches and leaves number/plant was recorded in T_{11} fertilization treatment without significantly different between treatments (T_7, T_8, T_9 and T_{10}). Also there were no significant differences between sources of organic fertilizer.Similarly, increasing in number of branches and leaves/plant response to inorganic, organic and bio-fertilizer have been reported byMakinde[21] whofound that the application of120kgN:P:K/ha significantly produced more leaves as compared to 90kgN:P:K/ha. Fertilization of poultry manure increased number of leaves and stem girth of moringa compared to NPK and organo-mineral fertilizer while the control treatment had the least growth values(Dania*et al.,*[22]).

Furthermore, T_{11}treatment recorded the highest increase in leaf area (cm^2) and stem diameter (cm) amounting to 15.95and 18.92%, respectively as compared with control treatmentT_1(Table 4). Fertilization treatments can be arranged indescending order for leaf area (cm^2) as follows:T_{11},$T_{10,}$ T_9, $T_{8,}$ T_7, T_1, T_6, $T_{5,}$ T_3, T_4andT_2, affirming that inoculation of Moringa with Cerialene in combination with inorganic and/or organic fertilizer positively affected leaf area (cm^2) and stem diameter (cm).This incrementin leaf area (cm^2) and stem diameter (cm)may be due to the positive impact of organic fertilizer in improving physical, chemical and biological properties of soil in salt-affected areas leading to enhancement of plant growth(Ahmed *et al.,*[10], Hussein *et al.,*[23]and Alexandra *et al.,*[6]). In this regard, Azza*et al.,*[24] concluded that supplying *Moringao leifera*tree with biofertilizers during its early stage of growth can be a better source of nutrients and less harmful than inorganic fertilizers.

Table (4) Effect of fertilization treatmentson some growth parameter of *Moringaoleifera*L.(Combined analysis of 2014 and 2015 seasons)

Fertilizer treatments	Plant Height (cm)	Number of branch/plant	Number of leaves/plant	Leaf area (cm^2)	Stem diameter (cm)	Dry weight (g)		
						leaves	stem	Root
T_1(control)	90.5	24.12	30.2	38.11	2.22	9.87	44.14	13.5
T_2	84.3	22.18	26.62	35.03	1.89	7.36	33.75	10.28
T_3	86.5	22.73	27.31	35.93	2.01	7.87	36.06	10.98
T_4	85.6	22.9	27.13	35.69	1.94	8.65	38.66	11.83
T_5	89.6	23.4	28.25	37.17	2.2	9.87	44.05	13.48
T_6	92.3	23.44	28.94	38.07	2.04	9.98	43.86	13.46
T_7	93.5	22.5	29	38.16	2.1	10.29	45.21	13.87
T_8	94.76	24.1	29.71	39.1	2.21	10.68	47.05	14.43
T_9	95.6	24.52	30.03	39.51	2.18	10.55	46.47	14.25
T_{10}	96.73	25.4	30.53	40.17	2.26	11.35	49.69	15.26
T_{11}	98.68	26.3	31.25	41.11	2.31	11.57	50.67	15.56
LSD 5%	8.33	2.45	2.98	4.65	0.16	1.02	4.54	1.29

In the same Table data indicated that $T_{11,}$ T_{10}, and $T_{8,}$ produced a significant increase in dry weight of leaves amounting to (11.57, 11.35 and 10.68 g respectively) as compared to the control treatment. Additionally, T_{11} and T_{10} resulted in a significant increase in dry weight of stem. The increments were (14.97% and 12.57%, respectively) compared with the control treatment, while T_5, T_6, T_7, T_8 and T_9 insignificantly affected dry weight of stem compared with the control treatment. The organic and bio-fertilization protects plants from the salt stress and promote growth. Bouajila and Sanaa[5] found a positive correlation between the addition of compost and soil organic carbon contents on plant. Furthermore, organic fertilizer can improve plant health beyond the nitrogen fertility value. Therefore, the application of organic fertilizer for soil remediation is important for sustainable land use and crop productivity.

Concern the effect of different fertilization treatments on dry weight of root of Moringa plants, it can concluded that T_{11} (50% Min. fert. + 2.5 kg Chicken man. + Cerialene) was significantly superior over all other fertilizer treatments.This may be due to the role of microbial inoculation in changing the root morphology via producing plant growth regulating substance such as indole acetic acid (IAA), gibberellins (GA) and cytokinins (CK) (Zayed, [11]).

II-Effect of fertilization treatmentson some physiochemical parameter of Moringa plants.

Data in table (5) showed that the lowest content of soluble carbohydrates and proline (ug/g fresh wt.)were recorded in moringaplants fertilized with(50% Min. fert. + 2.5 kg Chicken man. + Cerialene),meanwhile plants fertilized with(5kg Compost)produced the lowestchlorophyll a+b (mg/g fresh wt.)and crude protein content. Furthermore, plants fertilized withfull dose mineral fertilization produced the highest content of chlorophyll a+b (mg/g fresh wt.). Strengthen effect of mineral fertilizer on chlorophyll content may be due to fact that,nitrogen is a major component of chlorophyll, amino acids, the building blocks of proteins and energy-transfer compounds that reflect on structure of chloroplast (Marschner,[25]). In this concern,Ghoneim and El-Araby[26] stated that leaves contents of chl. (a), chl. (b), chl. (a+b), N and K, were positively and significantly affected by organic manures.

It is clear that inoculation withCerialene improves all the tolerance feature of *Moringa* plants and increase plant adaptation to saline habitat. Our results are in agreement with those obtained by Dania*et al.*,[22] and Attia*et al.*,[14]. On the other hand, Imoro*et al.*,[27]indicatedthat the photosynthetic pigments in the leaves were not significantly affected by the effects of both sources of organic manure.

Data in Fig (1) revealed thatsodiumand potassium content (mg/g dry wt.) were significantly affected with organic and biofertilizertreatments. T_{11}(50% Min. fert. + 2.5 kg Chicken man. + Cerialene) recorded the highest values forpotassium content (mg/g dry wt.)and the lowest values for sodium content (mg/g dry wt.) meanwhile, T_2(5 kg Compost) reversed the result.This result consistent with previous research of Adesemoye and Kloepper[28] who stated that, some microbial inoculants can improve plant uptake of nutrients and thereby increase the use efficiency of applied chemical fertilizers and manures.

Table (5) Effect of fertilization treatmentson some physiochemical parameter of *Moringaoleifera*L.(Combined analysis of 2014 and 2015 seasons)

Fertilizer treatments	Soluble carbohydrates %	Proline (ug/g fresh wt.)	Chlorophyll a+b (mg/g fresh wt.)	Crude protein %	K/Na ratio
T_1(control)	20.36	343.06	3.56	10.83	1.07
T_2	22.35	359.98	3.05	9.13	0.78
T_3	21.32	351.22	3.16	9.46	0.83
T_4	20.36	343.06	3.18	9.52	0.86
T_5	20.02	340.17	3.26	9.75	0.89
T_6	20.25	342.13	3.34	9.99	0.94
T_7	21.33	351.31	3.11	10.32	0.96
T_8	20.66	345.61	3.28	10.41	0.95
T_9	21.36	351.56	3.39	10.62	1.03
T_{10}	19.77	338.05	3.36	10.74	1.06
T_{11}	19.35	334.48	3.46	10.96	1.10
LSD 5%	NS	NS	NS	NS	0.08

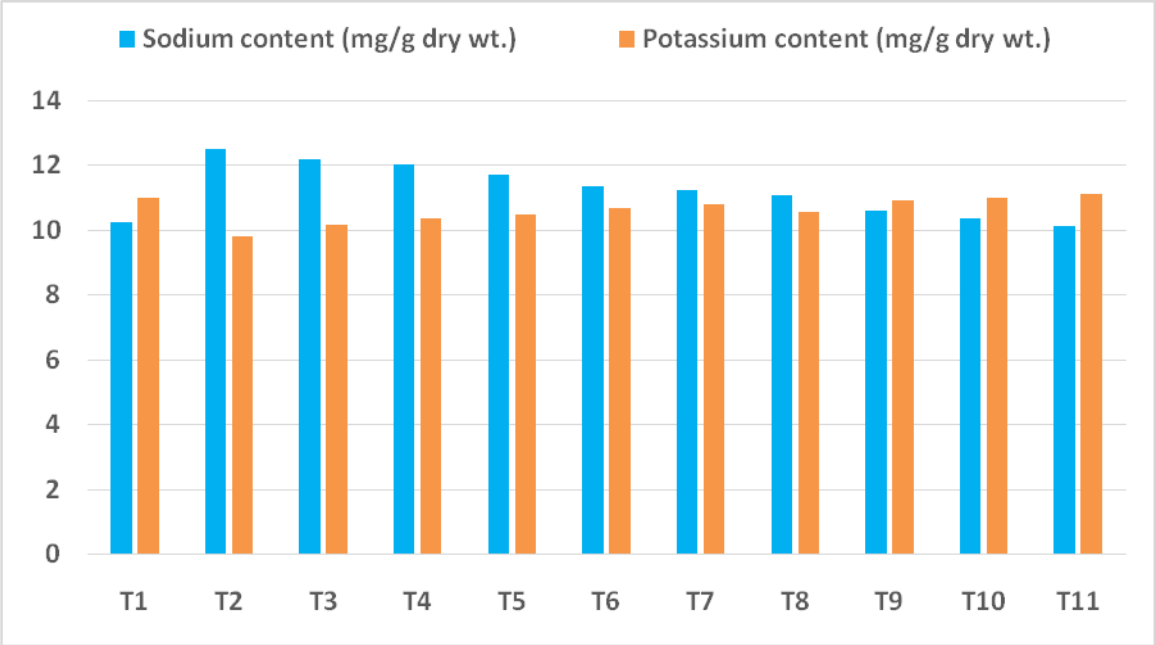

Fig 1 Effect of fertilization treatmentson Na and K content of Moringa plants. (LSD 5%: Na: 0.98 and K: 0.87)(Combined analysis of 2014 and 2015 seasons)

Data presented in Table (5) also show the effect of organic and biofertilizer on K/Na ratio in Moringa plants. It is evident that T $_{11}$(50% Min. fert. + 2.5 kg Chicken man. + Cerialene) has the most advantageous effect on (K/Na ratio). Fertilization of moringa plants with (50% Min. fert. + 2.5 kg Chicken man. + Cerialene) gave superiority in inducing the highest degree of adaptation under saline habitat, which resulted in the significant increases in all studied growth parameters and dry matter accumulation. Using biofertilizers can help solve the problem of feeding the increasing global population under environmental stresses like drought, saline and so on. Its improved nutrient uptake, plant growth and plant tolerance to abiotic and biotic stress (Bhardwaj*et al.*, [12]).

III-Effect of fertilization treatmentson micronutrient content of Moringa plants.

The micronutrients behaviors followed the same trends of growth criteria, where T_{11}, T_{10} and T_9 produced the highest contents of Zn, Mn, Fe and B in the leaves of *Moringaoleifera*, (Fig, 2). The statistical analyses of obtained results at 5% were significant for all variables with all the studied factors. The obtained results are in accordance with those obtained by Igwilo *et al*., [29]. In this concern, Ghoneim and El-Araby[26] stated that, Fe were positively and significantly affected by organic manures whereas, chicken manure exceeded both compost and cattle manures.

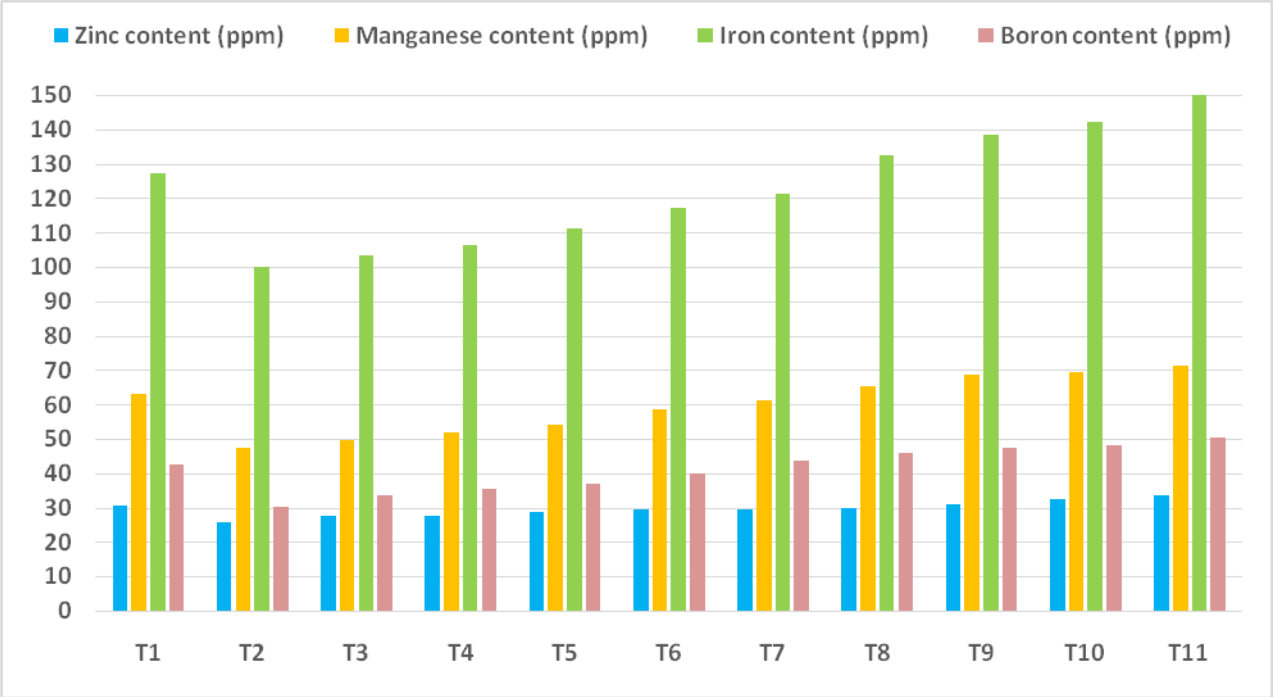

Fig 2 Effect of fertilization treatmentson micronutrient content of Moringa plants.(LSD 5% Zn: 1.93, Mn: 4.65, Fe: 9.68 and B: 3.98)(Combined analysis of 2014 and 2015 seasons)

Conclusion

Results of this study showed that, under appropriate management, the use of efficient organic and biofertilizers leads to a significant increase in growth and biomass of *Moringa oleifera*. Combined application of organic and biofertilizers might play a significant role in improving the growth response and nutrient uptake of *Moringao leifera*. Plant may perform better growth, survival and more biomass production. In conclusion, under the circumstances of South Sinai, the integration of fertilization types was the best method to obtain the best growth of *Moringao leifera*. The most effective treatment was T_{11}(50% Min. fert. + 2.5 kg Chicken man. + Cerialene).

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