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Effect of Mineral, Organic and Bio-Fertilization on Productivity of Moringa plant under Saline Conditions in North Sinai

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ABSTRACT

This study was carried out in sandy soil at DRC Station, Sheikh Zoweid region, north Sinai Egypt. The studied soil irrigated with two saline water (1.35 and 4.83 dS/m). Two field experiments were done on moringa trees in soil during two successive seasons. Drip irrigation system, 3 years old of moringa tress (672 trees/fed). Mineral fertilizers were applied at two rates 0.3 and 0.6kg/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 bio fertilizers/tree (Azotobacter and Bactria solved phosphor). The aim of this study is approaching to maximum yield (quantity and quality) of leaves and seeds of moringa by using the integration between mineral, organic and bio fertilization under the conditions of saline irrigation water in sandy soil.

The results obtain assure that the yield components of moringa trees increased with increase of NPK fertilizers rates and integration between fertilization types. This result was positive reflex on nutrients, total antioxidants and total phenols in leaves and seeds of moringa trees. The most effective treatment at second season was ($N_2P_2K_2$ +OM +Bio) which scored 3.51 and 1.61 ton leaves/fed while seeds was 0.42 and 0.21 ton seeds/fed for level 1.35ds/m and level 4.8 ds/m of water irrigation respectively. The economic treatment at the same conditions of most effective treatment was ($N_2P_2K_2$ +OM) which scored 3.46 and 1.52 ton leaves/fed while seeds was 0.40 and 0.20 ton seeds/fed respectively, the all treatments were taken the same trend for nutrients content, biochemical contents in leaves and seeds of moringa trees at two saline water levels.

Saline irrigation water at level 4.83 ds/m lower for all yield parameters than the level 1.35 ds/m for by average 43% and 50% at first and second seasons respectively, The control treatment was lower for yield components of moringa trees in second season than first season, Generally, the effect of fertilization types application on yield components, nutrients concentration, total phenol and total antioxidant activity in leaves and seeds of moringa trees can be descend by arranged follows; NPK fertilization > organic matter (OM) fertilization > bio fertilization at signal effect case, while at integration effect was descend by arranged as follows; NPK + OM+ bio fertilization > NPK + OM fertilization.

Key words: *Moringa olifera*, inorganic, organic and bio-fertilization, yield parameters, mineral and biochemical contents

Introduction

Moringa (*Moringa oleifera*) is well known for its multi-purpose attributes, wide adaptability and ease 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 protein than milk. Hence, it is considered as a powerhouse of nutritional value. The crop is grown purely as salt tolerant crop and nutrient management under saline irrigation is rarely practiced. Mostly farmers' are used moringa without any fertilizer management in the saline conditions. Hence, the present investigation was carried out to study the fertilizer management in moringa under saline conditions.

Salinity is a major problem that negatively impacts agricultural activities in newly reclamation areas of Egypt. The studied soil was affected by irrigation with two water salinity (1.3 and 4.8 dS/m) while the soil salinity was 1.7dS/m. Water of EC<0.75 dS/m has no detrimental, 0.75 - 1.50 dS/m was detrimental effects on sensitive crops, 1.50 - 3.0 dS/m required careful management practices, and 3.0-7.5 dS/m was used only for salt tolerant plants (Gary and Delno 2004).

The suitable spacing to production yield of moringa trees, Radovich (2009) reported that the wider spacing at 0.75 m × 1 m is more feasible for leaf production, while the spacing is 2.5 m × 2.5 m is suitable for pod production. Addition of 300 g of complete fertilizer or 0.5–2 kg of manure per tree is recommended at planting. Mendieta *et al.* (2013) indicate that Moringa at a planting density of 167,000 plants /ha if the soil is regularly supplied with N at a level of approximately 521 kg /ha/year in conditions where phosphorus and potassium are not limiting.

To concern the different fertilization types for obtain the yield goal of moringa plants, Prabhakar and Hebbar (2007) reported that the yield and yield components significantly increase when added 15 kg/tree of

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farm yard manure (FYM) with , 5 kg/hectare of biofertilizers (*Azospirillum* and phosphate solubilizing bacteria) as compared to other organic treatments . Adebayo *et al.* (2011) reported that the cow dung application significantly had higher number of leaves, higher plant height and also yield parameters of moringa than other organic amendments (poultry manure and different combinations of composted organic waste). Vijay Kumar (2012) stated that the sludge left over from the water after treatment can also be used as a bio-fertilizer/bio-compost which has been shown to increase yields of Moringa trees. Mendieta *et al.*(2013) indicate that Moringa can maintain up to 27 ton/ha dry matter yield at a planting density of 167,000 plants /ha with N at level 521 kg /ha/year in conditions where phosphorus and potassium are not limiting. They added, significantly higher protein content was found in the Moringa at N fertilizer levels 521 and 782 kg N/ha/year (87.9 and 93.7 g kg-1 DM) compared with lower levels. Makinde (2013) stated that the highest fertilizer rate (120 kg N:P:K 15:15:15/ha) produced the highest quantity of protein (19.01%) and other yield parameters of moringa plants, when comparison with other rates of fertilizers.

Regard to oil seeds production, total antioxidants and total phenols in moringa trees, Anwar et al (2006) showed that the proximate analysis of M. oleifera seeds from saline and non-saline areas of Pakistan. As for as the oil yield of M. oleifera seeds, there was no significant (P = 0.05) variation in the oil contents. On other side, found different results were reported by Flagella *et al.* (2004), who demonstrated a significant effect of salinity on the oil yield from the sunflower seed of a hybrid variety. Royo *et al.* (2005) reported a minor effect of soil salinity on the oil content of Arbequina olive oil. However, Heuer *et al.* (2005) reported no any change in the oil content due to effect of salinity. Kwami *et al.* (2003) reported that the total phenolic content, total antioxidant activity and total flavonoid content in wheat were (709.8-860.0 µmol of gallic acid equiv/100 g of wheat), total (37.6-46.4 µmol of vitamin C/g), and (105.8-141.8 µmol of catechin equiv/ 100 g of wheat) respectively, while in moringa trees, Ogbunugafor *et al.*(2011) reported that M.oleifera seeds gave oil yield of 41.47% which was content total phenol (mg Gallic Acid Equivalent/g), total flavonoids (mg Rutin Equivalent/g) and total antioxidant capacity (mg Ascorbic Acid Equivalent/g) were 40.2, 18.2 and 37.9 respectively. And addition, Singh *et al.* (2013) they found that the phenolic compounds in moringa seeds was significantly higher ($p < 0.05$) in bound phenolic extract (4173.00 ± 32.22 mg gallic acid equivalents (GAE)/100 g) than in free phenolic extract (780.00 ± 14.2 mg GAE/100 g) and it showed higher antioxidant and antimicrobial activities.

Concerning to nutrients contents in moringa trees, Isaiah (2013) reported that the suitable rate of NPK was 90kgN:P:K/ha to found the sufficient levels of nutrients in moringa tress and produce best yield of leaves and seeds. Raja *et al.* (2013) stated that the moringa nutrients as average values were protein 8.2g, P 112 mg, K 300 mg, Ca 185mg, Mg 147 mg, Fe 4 mg, Mn 0.36 mg, Zn 0.6 mg and Cu 0.2 mg/100gm of moringa leaves, while in pods were protein 2.1g, P 50 mg, K 461 mg, Ca 30 mg, Mg 45 mg, Fe 0.36 mg, Mn 0.26 mg, Zn 0.45 mg and Cu 0.16 mg/100gm of moringa pods. Igwilo *et al.* (2014) stated that the moringa oleifera roots are rich in anti-nutritional factors and hey are widely used in traditional medicine in Africa, Asia and Americas. The objective of this work is to approach the goal yield of moringa under the conditions of saline water irrigation in sandy soil at North Sinai by using the different types of fertilizers and integrated between their to achived the best yield under irrigation by saline water.

Materials and Methods

Experiment was conducted in two years 2011 and 2012 on 1.5 years old moringa trees grown on a sandy soil (Table, 1) at El Sheikh Zoweid Research Station, DRC, North Sinai, Egypt, 310 14' 9.8" N, 340 6' 54.4" E at an elevation of 25m above sea level.

The treatments comprising of Nitrogen, Phosphorus, Potassium, and bio-fertilizers were supply to 672 tree of moringa/fed, which planted in 2.5x 2.5 meter space, under two types of irrigation water (i.e. non-saline and saline). Mineral fertilizers were applied at two rates 300g and 600g/tree of ammonium nitrate (33.5 %N), 130g and 260g/tree of calcium super phosphate (15.5% P2O5) and 150g and 300g/tree of potassium sulphate (50% K_2O). 1.5 kg compost/tree with 1liter bio fertilizers/tree (Azotobacter and Bactria solved phosphor) and all rates of calcium super phosphate were mixed with 0.15 m depth of top soil around the tree trunk at one dose December, while nitrogen and potassium were applied in three equal doses in March, April and June.

Seeds and leaves samples of Moringa oleifera were collected at harvest stage from April to June (2011 & 2012). The leaves, pods, and seeds/tree were recorded in both seasons. Plant samples were analyzed for N, P and K according to Cottenie et al (1982). Measurements total antioxidants and total phenol in soil and plants of wheat according to Rimmer (2009). Total proteins of seeds and total carbohydrates were analyzed according to the AOAC official methods (1990). The oil seeds were extracted as following described by Stockfleth and Brunner (1999).

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Table 1. Some of chemical and physical soil properties of the studied soil.

Depth cm	pH (1:1)	E.C dS/m 1:1	OM	$CaCO_3$	Sand	Silt	Clay	C.E.C meq/100g soil	Texture	
			%							
0-30	7.88	1.71	0.52	2.85	90.22	6.43	3.35	4.24	Sandy	
30-60	7.62	1.54	0.38	2.57	92.14	5.52	2.34	3.65	Sandy	
60-90	7.36	1.38	0.23	2.23	92.77	5.11	2.12	3.52	Sandy	
Soluble cations and anions in soil (meq/L) and Total antioxidants and phenol acids										
	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO_3^{-1}	Cl^{-1}	SO_4^{-2}	SAR	T. phenol	T.A.A
0-30	6.32	1.58	5.72	3.49	6.32	1.58	5.72	2.94	304	83
30-60	5.66	1.43	5.13	3.21	5.66	1.43	5.13	2.77	226	57
60-90	4.92	1.35	4.58	2.96	4.92	1.35	4.58	2.53	172	38
Available nutrients in soil (ppm)										
	N	P	K	Fe	Mn	Zn	Cu			
0-30	24.6	2.38	32.5	1.14	0.81	0.52	0.23			
30-60	20.4	2.25	29.7	0.92	0.72	0.41	0.19			
60-90	18.9	2.12	25.8	0.81	0.64	0.35	0.13			
Soluble cations and anions in wells water irrigation (meq/L)										
	pH	EC	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO_3^{-1}	Cl^{-1}	SO_4^{-2}	SAR
Well 1	7.6	1.35	7.54	0.52	3.24	1.5	1.25	8.52	3.13	4.90
Well 2	7.95	4.83	34.81	1.87	6.84	3.42	3.64	32.86	10.3	15.37

Total phenol antioxidants (μmol of Gallic acid/ml extract) and Total antioxidants activity (μg of Ascorbic acid/ml extract.).

Soil and plant Phenol Acids and Total antioxidant

Soil (2 g) was extracted with 10 mL of deionized (DI) water for 16 h on a reciprocal shaker followed by centrifugation and collection of the supernatant for purification. The soil pellet was then extracted with 10 mL of 50 mM EDTA (pH 7.5) for 16 h on a reciprocal shaker. After EDTA extraction, the samples were centrifuged and the supernatant saved for purification.

Antioxidant ability assays Total antioxidant activity

The assay was based on the reduction of Mo(VI)-Mo(V) by the extracts and subsequent formation of a green phosphate/Mo(V) complex at acidic pH (Prieto et al 1999). The extract (0.1 ml) was mixed with 3 ml of reagent solution (0.6 M sulphuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate). The tubes were incubated at 95°C for 90 min. The mixture was cooled to room temperature, and then the absorbance of the solution was measured at 695 nm against blank (Prieto *et al.* 1999).The total antioxidant activity was expressed as ascorbic acid equivalents (AAE) in milligrams per gram of the extract.

Measurement of total phenol compounds

Total phenolic constituents of plant extracts were performed employing the literature methods involving Folin-Ciocalteu reagent and gallic acid as standard (Slinkard and Singleton, 1977). Extract solution (0.1 ml) containing 1000 ug extract was taken in a volumetric flask, 46 ml distilled water and 1 ml Folin- Ciocalteu reagent were added and flask was shaken thoroughly. After 3 min, 3 ml of solution 2% Na2CO3 was added and the mixture was allowed to stand for 2 h with intermittent shaking. Absorbance was measured at 760 nm. The same procedure was repeated to all standard Gallic acid solutions (0-1000 mg, 0.1 ml-1) and standard curve was obtained. The obtained data were statistically analyzed according to Gomez and Gomez (1984). Analytical data of the studied soils are presented in table 1. Analyses were accomplished according to Page, *et al,* 1984 and Klute, 1986).

Results and Discussion

Effect of fertilization on yield parameters of Moringa olifeira trees

Data in Table (2) stated that the yield components of moringa trees increased with integration between fertilization types where that mineral and organic fertilization record increasing over control by 85% as average for all yield parameters of moringa trees, while the mineral, organic and bio fertilization record 86% over control. The highest signal effect of fertilization types on yields of moringa trees was mineral fertilizers at the first and followed organic fertilization was second, while bio-fertilization was lower effect than other fertilization types. The yield components of moringa trees were increased with NPK fertilizers rates increased

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during two seasons. The economic treatment was (NPK+OM) which achieved high yield components of moringa trees, while the highest treatment for yields was (NPK+ OM + Bio). The results above obtained due to the mineral fertilization was more solubility of nutrients and rapidly release the nutrients for plant when comparison with organic fertilization which slow release, while bio-fertilization was indirect effect on nutrients solubility in soil. The N fertilizer was more effect on leaves yield and protein content, while P and K fertilizers record best results on yield and quality of oil moringa seeds at table(3). The above results agreed with those obtained by Prabhakar and Hebbar (2007), Adebayo *et al.* (2011) and Makinde (2013).

Saline irrigation water at level 4.83 ds/m decreased all yield parameters by average 43% and 50% when comparison salinity water irrigation at level 1.35 ds/m at first and second seasons respectively (Tables2 and 3). The control treatment was lower for yield components of moringa trees in second season than first season, this due to no fertilizers applications and consumption or depletion of nutrients in soil by moringa trees. The statistical analyses of obtained results at 5% were significant for all variables with all the studied factors interactions. The obtained results are in accordance with those obtained by Flagella *et al.* (2004) , Royo *et al.* (2005) and Anwar et al (2006).

Table 2. Effect of fertilization on yield parameters of *Moringa olifeira* trees

Fertilizers treatments	Leaves (kg)		Pods (kg)		Seeds (g)		Seeds (kg)	
	/tree						/fed	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1								
Control	0.87	0.32	1.71	0.86	84	39	56	26
$N_1P_1K_1$	2.45	1.34	5.65	2.96	282	141	190	95
$N_1P_1K_1$ +OM	2.98	1.93	7.03	3.99	394	197	265	132
$N_1P_1K_1$ +OM +Bio	3.17	2.16	8.87	4.93	458	216	308	145
$N_2P_2K_2$	4.15	2.06	7.37	3.96	470	245	269	138
$N_2P_2K_2$ +OM	4.93	2.59	10.78	5.03	540	304	394	205
$N_2P_2K_2$ +OM +Bio	5.16	2.64	11.5	6.1	605	321	417	216
Season2								
Control	0.73	0.29	1.58	0.67	75	32	50	22
$N_1P_1K_1$	2.7	1.25	5.88	2.84	299	132	201	89
$N_1P_1K_1$ +OM	3.47	1.59	7.92	3.54	419	186	282	125
$N_1P_1K_1$ +OM +Bio	3.69	1.77	9.78	4.27	460	208	309	140
$N_2P_2K_2$	4.38	1.91	7.86	3.71	496	200	293	134
$N_2P_2K_2$ +OM	5.15	2.26	11.68	5.33	631	295	402	195
$N_2P_2K_2$ +OM +Bio	5.22	2.39	12.11	5.79	674	317	423	208
$LSD_{0.05}$ Treat.	0.07	0.03	0.14	0.07	8.03	4.02	5.40	2.70
$LSD_{0.05}$ Season	0.04	0.02	0.08	0.04	4.64	2.32	3.12	1.56
$LSD_{0.05}$ Interaction	0.10	0.05	0.22	0.11	12.27	6.14	8.26	4.12

Table 3.Effect of fertilization on bio-chemicals content of *Moringa olifeira* seeds

Fertilizers treatments	Protein %		Oil %		Carbohydrates %	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1						
Control	7.81	3.71	12.20	6.44	5.21	2.72
$N_1P_1K_1$	10.88	6.38	19.70	12.60	10.15	5.48
$N_1P_1K_1$ +OM	13.00	8.11	22.50	13.65	10.49	6.68
$N_1P_1K_1$ +OM +Bio	13.81	9.00	23.80	15.33	10.56	6.79
$N_2P_2K_2$	16.19	10.17	29.20	19.32	11.20	5.97
$N_2P_2K_2$ +OM	17.94	11.67	30.70	19.81	11.58	7.61
$N_2P_2K_2$ +OM +Bio	18.31	11.86	31.50	20.72	11.82	7.79
Season 2						
Control	7.38	3.52	11.30	6.16	4.93	2.57
$N_1P_1K_1$	11.81	6.29	20.70	12.04	10.32	5.17
$N_1P_1K_1$ +OM	13.38	7.55	23.50	12.81	10.68	6.19
$N_1P_1K_1$ +OM +Bio	14.44	8.54	24.70	13.86	10.86	6.23
$N_2P_2K_2$	16.88	9.80	30.90	17.64	11.36	5.56
$N_2P_2K_2$ +OM	18.44	10.55	31.60	19.18	11.76	6.76
$N_2P_2K_2$ +OM +Bio	19.13	11.39	33.30	20.02	12.11	6.88
$LSD_{0.05}$ Treat.	0.17	0.12	0.32	0.22	0.10	0.07
$LSD_{0.05}$ Season	0.10	0.07	0.19	0.13	0.06	0.04
$LSD_{0.05}$ Interaction	0.27	0.19	0.49	0.33	0.16	0.11

Effect of fertilization on nutrients contents in moringa trees

Regard to macronutrients in leaves and seeds of moringa trees were affected by fertilizers application at tables 4 and 5 whose relieve that N fertilizers of minerals fertilization was superior treatment to produce leaves of moringa trees, while P and K fertilizer was superior to produce yield and quality of oil seeds. Ca and

Mg were higher increase by organic fertilization when comparison with other fertilization types. The nutrients were increased with increase fertilizers application rates The micronutrients behaviors were taken the same trends of yield components and macronutrients, where that the mineral fertilizers was highest effect on nutrients contents in leaves and seeds of moringa trees, while the organic matter treatment is the following in effect after mineral fertilizers treatment, the bio-fertilizers treatment was lower effect on nutrients contents than other treatments (Tables 6 and 7). The second season was higher for nutrients contents in leaves and seeds at lower salinity level than first season, while it was decreased in the second season at higher salinity water level. This results is due to negative effect of saline irrigation water on plant absorption for nutrients. Concerning to increase yield components with different fertilization types at lower salinity of irrigation water, this fact is due to the nutrients were store in the moringa trees and residual effect fertilizers in soil, at the same time the control treatment was decreased in the second season about first season this due to non-fertilization and depletion of nutrients from soil by moringa trees. The statistical analyses of obtained results at 5% were significant for all variables with all the studied factors interactions. The obtained results are in accordance with those obtained by Isaiah (2013), Raja *et al.* (2013) and Igwilo *et al.* (2014)

Table 4. Effect of fertilization on macronutrients content in moringa seeds

Fertilizer treatments	N%		P%		K%		Ca%		Mg%	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1										
Control	1.18	0.79	0.09	0.07	0.58	0.42	0.21	0.12	0.11	0.08
$N_1P_1K_1$	1.65	1.36	0.21	0.14	1.18	0.73	0.38	0.2	0.19	0.13
$N_1P_1K_1$ +OM	1.87	1.73	0.25	0.19	1.25	0.88	0.42	0.26	0.24	0.17
$N_1P_1K_1$ +OM +Bio	2.02	1.92	0.27	0.2	1.27	0.91	0.45	0.28	0.26	0.19
$N_2P_2K_2$	2.36	2.17	0.29	0.22	1.33	0.87	0.41	0.23	0.23	0.16
$N_2P_2K_2$ +OM	2.58	2.49	0.33	0.28	1.38	0.96	0.49	0.29	0.27	0.19
$N_2P_2K_2$ +OM +Bio	2.68	2.53	0.35	0.29	1.42	0.98	0.52	0.3	0.29	0.21
Season 2										
Control	1.09	0.73	0.07	0.05	0.46	0.35	0.18	0.1	0.09	0.05
$N_1P_1K_1$	1.84	1.32	0.24	0.11	1.21	0.62	0.41	0.15	0.21	0.1
$N_1P_1K_1$ +OM	2.08	1.61	0.29	0.13	1.32	0.76	0.48	0.18	0.26	0.14
$N_1P_1K_1$ +OM +Bio	2.21	1.82	0.31	0.14	1.38	0.78	0.5	0.2	0.28	0.16
$N_2P_2K_2$	2.59	2.09	0.32	0.18	1.51	0.71	0.46	0.17	0.25	0.13
$N_2P_2K_2$ +OM	2.87	2.25	0.37	0.21	1.67	0.87	0.55	0.21	0.29	0.15
$N_2P_2K_2$ +OM +Bio	2.93	2.43	0.39	0.22	1.73	0.89	0.57	0.23	0.31	0.17
LSD0.05 Treat.	0.03	0.03	0.004	0.003	0.02	0.009	0.005	0.003	0.003	0.002
LSD0.05 Season	0.02	0.02	0.002	0.002	0.01	0.005	0.003	0.002	0.002	0.001
LSD0.05 Interaction	0.04	0.04	0.007	0.005	0.02	0.013	0.008	0.004	0.005	0.003

Table 5. Effect of fertilization on macronutrients content in moringa leaves

Fertilizer treatments	N%		P%		K%		Ca%		Mg%	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1										
Control	2.07	1.08	0.11	0.06	0.59	0.38	0.25	0.13	0.15	0.1
$N_1P_1K_1$	2.83	1.99	0.18	0.11	1.12	0.74	0.48	0.21	0.25	0.18
$N_1P_1K_1$ +OM	3.26	2.35	0.21	0.13	1.15	0.78	0.53	0.24	0.29	0.21
$N_1P_1K_1$ +OM +Bio	3.48	2.62	0.22	0.13	1.17	0.81	0.55	0.26	0.32	0.23
$N_2P_2K_2$	4.24	3.09	0.25	0.15	1.23	0.87	0.51	0.25	0.27	0.2
$N_2P_2K_2$ +OM	4.51	3.42	0.28	0.17	1.28	0.91	0.55	0.28	0.32	0.23
$N_2P_2K_2$ +OM +Bio	4.68	3.47	0.29	0.18	1.32	0.94	0.58	0.29	0.35	0.25
Season 2										
Control	1.94	0.88	0.08	0.05	0.55	0.32	0.22	0.11	0.12	0.07
$N_1P_1K_1$	3.03	1.62	0.19	0.09	1.15	0.56	0.51	0.18	0.28	0.14
$N_1P_1K_1$ +OM	3.44	1.92	0.22	0.1	1.19	0.58	0.55	0.21	0.32	0.16
$N_1P_1K_1$ +OM +Bio	3.67	2.14	0.23	0.11	1.21	0.6	0.57	0.23	0.34	0.17
$N_2P_2K_2$	4.46	2.53	0.26	0.12	1.27	0.65	0.54	0.22	0.31	0.15
$N_2P_2K_2$ +OM	4.73	2.79	0.29	0.15	1.31	0.68	0.57	0.24	0.34	0.17
$N_2P_2K_2$ +OM +Bio	4.85	2.84	0.31	0.16	1.34	0.7	0.59	0.26	0.36	0.18
LSD $_{0.05}$ Treat.	0.04	0.04	0.003	0.002	0.011	0.008	0.005	0.002	0.003	0.002
LSD $_{0.05}$ Season	0.03	0.02	0.002	0.001	0.007	0.005	0.003	0.001	0.002	0.001
LSD $_{0.05}$ Interaction	0.07	0.06	0.005	0.003	0.017	0.013	0.008	0.004	0.005	0.003

Table 6. Effect of fertilization on micronutrients contents (ppm) of *Moringa olifeira* seeds

Fertilizers treatments	Fe		Mn		Zn		Cu	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1								
Control	197	106	79	33	38	15	20	9
$N_1P_1K_1$	219	198	89	64	53	29	29	18
$N_1P_1K_1$ +OM	305	242	120	80	65	38	37	22
$N_1P_1K_1$ +OM +Bio	327	262	131	89	72	43	41	26
$N_2P_2K_2$	232	218	108	77	62	35	34	23
$N_2P_2K_2$ +OM	380	261	124	95	75	45	42	27
$N_2P_2K_2$ +OM +Bio	393	273	135	102	80	49	46	29
Season2								
Control	185	94	65	28	32	11	17	7
$N_1P_1K_1$	246	159	94	54	59	24	33	14
$N_1P_1K_1$ +OM	332	193	137	68	71	30	40	19
$N_1P_1K_1$ +OM +Bio	358	209	142	76	78	34	44	22
$N_2P_2K_2$	251	172	114	65	69	28	38	16
$N_2P_2K_2$ +OM	396	205	148	80	83	35	47	26
$N_2P_2K_2$ +OM +Bio	408	214	157	86	88	38	50	27
LSD $_{0.05}$ Treat.	3.61	2.46	1.25	0.98	0.74	0.49	0.44	0.31
LSD $_{0.05}$ Season	2.08	1.42	0.72	0.56	0.43	0.28	0.26	0.18
LSD $_{0.05}$ Interaction	5.51	3.76	1.90	1.49	1.13	0.75	0.68	0.48

Table 7. Effect of fertilization on micronutrients contents (ppm) of *Moringa olifeira* leaves

Fertilizers	Fe		Mn		Zn		Cu	
treatments	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1								
Control	178	96	63	25	31	11	11	6
$N_1P_1K_1$	193	114	75	50	35	23	19	13
$N_1P_1K_1$ +OM	286	196	96	64	49	30	29	17
$N_1P_1K_1$ +OM +Bio	297	206	108	73	52	35	32	20
$N_2P_2K_2$	228	121	91	59	41	27	23	15
$N_2P_2K_2$ +OM	311	215	113	75	53	35	35	20
$N_2P_2K_2$ +OM +Bio	330	226	123	82	57	40	37	23
Season2								
Control	162	78	58	21	27	9	9	5
$N_1P_1K_1$	214	108	97	42	39	19	21	11
$N_1P_1K_1$ +OM	293	179	116	53	56	25	32	14
$N_1P_1K_1$ +OM +Bio	315	198	119	60	59	29	34	16
$N_2P_2K_2$	248	118	105	52	43	22	25	12
$N_2P_2K_2$ +OM	332	201	121	66	57	29	35	16
$N_2P_2K_2$ +OM +Bio	347	217	127	71	62	33	39	19
LSD $_{0.05}$ Treat.	2.82	2.41	1.01	0.82	0.51	0.41	0.43	0.24
LSD $_{0.05}$ Season	1.63	1.39	0.59	0.47	0.29	0.23	0.25	0.14
LSD $_{0.05}$ Interaction	4.31	3.68	1.55	1.25	0.78	0.62	0.66	0.36

Data in Table (8) shows that the application of NPK, organic matter and bio fertilization were increased total phenol and total antioxidant activity in leaves and seeds of moringa trees. In the same side, the total phenol and total antioxidant activity concentrations in leaves were higher than in seeds. Moreover, the integration effect between the fertilization types were increased total phenol and total antioxidant activity. The effect of fertilization types on total phenol and total antioxidant activity in leaves and seeds of moringa trees can be descend by arranged follows; NPK fertilization > organic matter (OM) fertilization > bio fertilization at signal effect, while at integration effect was descend by arranged as follows; NPK + OM+ bio fertilization > NPK + OM fertilization > bio fertilization. At the same trend of yield components and nutrients concentrations, the total phenol and total antioxidant activity in leaves and seeds of moringa trees were taken of the same trend for saline water effect, where as its decreased with higher saline water lever ,while increased with lower saline water level. The above results agreed with those obtained by Kwami *et al.* (2003), Ogbunugafor *et al.*(2011) and Singh *et al.* (2013)

In conclusion, under the conditions of the study soil, the integration of fertilization types was the best method to obtained yield goal of leaves and seeds of moringa trees. The most effective treatment at second season was ($N_2P_2K_2$ +OM +Bio) which scored 3.51 and 1.61 ton leaves/fed while seeds was 0.42 and 0.21 ton seeds/fed for level 1.3ds/m and level 4.8 ds/m of water irrigation respectively. The economic treatment at second season was ($N_2P_2K_2$ +OM) which scored 3.46 and 1.52 ton leaves/fed while seeds was 0.40 and 0.20 ton seeds/fed for level 1.35 ds/m and level 4.83 ds/m of water irrigation respectively. The superior treatment ($N_2P_2K_2$ +OM +Bio) at level 1.35 ds/m was achieved total antioxidants activity 221 and 171 µg As/ml for leaves and seeds, and it was 743 and 423 µmol Gallic acid/ml recoded to total phenols, while at level 4.83 ds/m it achieved total antioxidants activity 113 and 83 µg As/ml for leaves and seeds, and it was 194 and 367 µmol Gallic acid/ml recoded to total phenols. Saline irrigation water at level 4.8 ds/m decreased all yield parameters by average 43% and 50% when comparison salinity water irrigation at level 1.35 ds/m at first and second seasons respectively, The control treatment was lower for yield components of moringa trees in second season than first season, this due to no fertilizers applications and consumption or depletion of nutrients in soil by moringa trees. The all variables of moringa trees take the same the above trend for saline irrigation water effect, where as its decreased with higher saline water lever, while increased with lower saline water level. Generally, the effect of fertilization types on yield components, nutrients concentration, total phenol and total antioxidant activity in leaves and seeds of moringa trees can be descend by arranged follows; NPK fertilization > organic matter (OM) fertilization > bio fertilization at signal effect, while at integration effect was descend by arranged as follows; NPK + OM+ bio fertilization > NPK + OM fertilization > bio fertilization. This fact assures that important of integration fertilization for approach the yield goal of moringa leaves and seeds under conditions of saline irrigation water in the studied soil.

Table 8. Effect of fertilizers and antioxidants on total phenol and antioxidants.

Fertilizers treatments	Total Antioxidants µg of Ascorbic acid/ml ext.				Total phenol µmol of Gallic acid/ml ext.			
	Seeds		Leaves		Seeds		Leaves	
	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m	1.3dS/m	4.8dS/m
Season1								
Control	59	31	95	48	151	80	320	161
$N_1P_1K_1$	81	47	131	69	208	116	535	271
$N_1P_1K_1$ +OM	125	68	178	98	321	174	686	355
$N_1P_1K_1$ +OM +Bio	139	74	194	106	350	188	713	367
$N_2P_2K_2$	107	59	156	81	271	137	579	302
$N_2P_2K_2$ +OM	155	85	208	109	391	199	717	372
$N_2P_2K_2$ +OM +Bio	162	89	217	120	414	216	725	379
Season2								
Control	53	26	87	45	144	73	304	157
$N_1P_1K_1$	87	39	135	67	218	104	639	263
$N_1P_1K_1$ +OM	130	65	184	92	331	153	704	334
$N_1P_1K_1$ +OM +Bio	145	71	201	98	367	173	723	344
$N_2P_2K_2$	114	54	163	76	285	124	603	284
$N_2P_2K_2$ +OM	162	80	212	101	411	185	730	359
$N_2P_2K_2$ +OM +Bio	171	83	221	113	423	194	743	367
$LSD_{0.05}$ Treat.	1.76	0.93	2.01	1.08	4.37	3.20	6.66	3.38
$LSD_{0.05}$ Season	1.02	0.54	1.16	0.62	2.52	3.20	3.85	1.95
$LSD_{0.05}$ Interaction	2.70	1.42	3.07	1.64	6.67	3.20	10.18	5.16

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